ANCIENT IRON SMELTING TECHNOLOGY AND THE SETTLEMENT PATTERN IN THE KIRI OYA BASIN IN THE DRY ZONE OF SRI LANKA

By

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To my beloved parents
Solangaarachchige Don Joseph Solangaarachchi
Sembukuttiarachchige Ambrosia Silva
&
To my beloved aunt
Rev. Sister Mary Julia Silva

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LIST OF ABBREVIATIONS

ASCAR	Archaeological Survey of Ceylon, Annual Reports
CCF	Central Cultural Fund
CJSG	Ceylon Journal of Science G, Archaeology Ethnology
Con	Context
Cv	*Culavamsa*
EHP	Early Historic Period
Eng	English
EZ	Epigraphia Zeylanica
JISI	Journal of Iron and Steel Institute
JRASCB	Journal of the Ceylon Branch of the Royal Asiatic Society
KAVA	Kommission fur Algemeine and Verglichende Archaeologie
KO 14	Kiri Oya - site 14
KOB	Kiri Oya Basin
LHP	Late Historic Period
MHP	Middle Historic Period
Mv	*Mahavamsa*
Pers com	Personal Communication
PGIAR	Postgraduate Institute of Archaeology
RAÄ	Riksantikvarieämbetet (Swedish Board of National Antiquities)
RBE	Reddish Brown Earth
Repri	Reprinted
Revi	Revised
SARCP	Settlement Archaeology Research Collaboration Project
SDR	Sigiriya Dambulla Region
Sin	Sinhalese
SIT	Sigiriya Iron Technology
Tam	Tamil
UHC	University of Ceylon, History of Ceylon
Unpub	Unpublished

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

ANCIENT IRON SMELTING TECHNOLOGY AND THE SETTLEMENT PATTERN IN THE KIRI OYA BASIN IN THE DRY ZONE OF SRI LANKA

By

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Chair: Peter Schmidt
Major: Anthropology

The objective of this research is to examine the metallurgical and socio-political aspects of ancient iron smelting in the Kiri Oya Basin (KOB), Dry Zone of Sri Lanka. I used various archaeological methods, sub-disciplines of anthropology that included the study of historical sources and oral traditions. I concentrated on the settlement patterns from the 3rd century B.C. to the 10th century A.D., the period represented by the inscription evidence in the KOB.

I directed the settlement pattern survey that identified 112 archaeological sites. There are four major categories: ancient iron smelting sites, village habitations/settlements, religious centers, and places interlinked with the hydraulic network. Using survey data, I investigated three major topics: how the iron smelting centers were distributed in settlements; how the ancient settlement pattern in Sri Lanka described in the ancient chronicles (Buddhist monasteries, the surrounding settlement and the hydraulic irrigation network had an interconnected relationship) illustrating in the KOB settlements; and how we can trace political and religious legitimacy throughout the settlement.

I directed excavation at four different sites to identify the chronological order in the KOB settlements, to describe the material culture and its relevant social strata, to date the period that the smelting activities went on, and to reveal the metallurgical characteristics. My archival

research was the basis for my description of ancient iron smelting technology and its connection with the socio-political organization.

The research results indicate that the iron smelting activities that were using an advanced bloomery process with magnetite ore were mainly conducted in the 4^{th} century A.D., prior to King Kasyapa's reign in the 5th century A.D. This study enabled me to trace the authority of the centralized political system over the settlement, the inter-connectivity of Buddhist monasteries with the settlements and different social stratifications that existed over the landscape. The material culture of the KOB settlements highlighted three main periods of activity: 3rd century B.C. to 2^{nd} century A.D.; 2^{nd} century to 5^{th} century A.D.; 7^{th} century to 10^{th} century A.D.

CHAPTER 1
INTRODUCTION

Research Aims and Strategy

This study presents the ancient iron smelting technology in and around the Sigiriya-Dambulla Region in the Dry Zone of Sri Lanka and its connection with the settlement pattern and the socio-economic system that connected with the ancient religious political structures, the secular elites, and the rural settlers. In other words, this dissertation is a study of both the technological as well as the socio-economic, religious, political, symbolic aspects of metallurgy. I examine the relationship and interaction between the religious and political structures, the secular elites and the rural settlers who engaged in iron metallurgy, symbolic aspects of religious and political sectors and their prominent ideologies as they were expressed in the social cultural complexities in the era.

One of my major aims has been to examine the concept of "gamai-pansalai, vavai-dagobai"1 that was the ancient settlement pattern in Sri Lanka. As it is described in ancient chronicles and oral traditions: the connection of Buddhist monasteries with the socio-political system of the society that was based on the ancient agro-hydraulic economy. I examined, how this concept worked in the ancient iron smelting settlements in the Kiri Oya Basin (hereafter refers as KOB), the micro region of study for this research. Kiri Oya is one of the four waterways that flourished the Sigiriya-Dambulla region that is located within the boundary of Rajarata2

[1] *gamai-pansalai, vavai-dagabai,* (village – Buddhist monastery, man made reservoir –Buddhist temple,)

In other words, it provides the connection between Buddhist monastery with the ancient settlement and the agro-hydraulic economy.

[2] *Raja* -king, *rata*- country, country of kings or land of kings

According to the ancient chronicles, Ruhunu Rata, Maya Rata and Pihiti Rata were three provincial/ruling divisions in ancient Sri Lanka. Pihiti was known as the rajarata before 12th century. There was a long discussion to define the exact boundaries between ancient provincial divisions in Sri Lanka. Mahaweli Ganga, the longest river flowed into (country of kings), the first recorded ancient ruling center in the island. This first detailed archaeometallurgical study in the region presented here follows up on the preliminary study that I conducted (Solangaarachchi 1999). In this study I explored the connection of the ancient iron smelting communities with the landscape in conjunction with the religious-political system of the society.

In this present study my aim has been to develop deeper understand of the particular characteristics of the iron smelting technology, its related activities and their connections with the settlements along the KOB geographical regions. I have also compared these results with the status of iron and its production in Sri Lanka general. In order to carry out an inclusive examination, I examined the metallurgical and socio-political aspects of the ancient iron smelting technology from an archaeological point of view as well as considering literary sources and oral traditions, thus using sub-disciplines of anthropology. This dissertation presents the research in three sections: aims & previous research; case study & present research; and interpretations that I have made based on the research in six stages:

1. The first part of the research I focused on a general overview of the ancient settlement pattern in the Kiri Oya Basin. It is followed by documenting 112 archaeological sites over a 1750 km2 area during the first field season of the project for this dissertation (registered as the project of Sigiriya Iron Technology- hereafter refers as SIT project) that was conducted in 2004 (Chapter 5 and Appendix D). Through spatial analyses, I tried to understand the distribution pattern of material culture that is related to iron production activities within the settlement.

2. In the second part of the research, during the second field season in 2005, I conducted detailed survey in order to understand the social organization in the settlement within the selected area nearly 100 km2 . I mapped 80 sites to understand the settlement pattern. I used the obtained settlement pattern as a model for the interpretation of the research data.

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the ocean at Trincomalee, had been defined as the boundary between Rajarata and Ruhuna. Bandaranayake suggests that Kalu Ganga and Mahaweli Ganga as the southern boundaries of Rajarata (pers. comm.).

3. The third part, I focused on the case study of excavations and chronology. After analyzing revealed data from the field survey, I selected four major sites for conducting excavations: an iron smelting site, monastery site, settlement site and ancient reservoir that are represented in the ancient settlement pattern: “gamai-pansalai, vavai-dagobai”. My purpose was to understand the connection between the Buddhists monastery with the ancient settlements based on the agro-hydraulic economy. Through these excavations, I could build up the chronological sequence of excavated sites, thus finding the connection between them and the settlement of the KOB.

4. In the fourth part I focused mainly on the metallurgical aspects of the excavation at Dikyaya, one of the large iron smelting sites in the KOB. My attempt was to find more metallurgical data to compare with already known data for understanding iron smelting activities in the KOB. I also interpreted excavation data through metallurgical analyses in order to make a comparative study with the Alakolavava, Dehigaha-ala-kanda iron production site, I had studied this site in detail for my MPhil dissertation (Solangaarachchi 1999).

5. In the fifth part, I concentrated on finding data in textual sources that included inscriptions. I collected oral traditions that would help me to understand the iron smelting technology and historical activities of the region and the area’s contribution to the state directly or through the monastery indirectly. I used the oral traditions as a bridge to fill the gap between literary data and excavated data. Basing my findings on the survey data supplemented by inscriptions, literature, and oral traditions, I was able to address issues relating to the cultural and social dynamics of the KOB.

6. Finally, I can sum up my overall purpose as the interpretation of data from the present research in terms of the socio-political reactions of humans. I was able to use data from previous research in the island and data mainly from the Indian context comparatively to give more weight to my explanations.

Before I describe my present study, I describe archaeological development in Sri Lanka to provide better understanding of the social and political ideology connected with archeological research and the changes that have occurred since the colonial period.

The Regional Development of Archaeological Concept in the Sri Lankan Context

In the late the 1860s, the British colonial government appointed the Archaeological Committee for the documentation and preservation of ancient monuments and inscriptions in the North Central Province. Since then, the “Western” archaeological thought in Sri Lanka gradually turned into different paths through generations until it leading up to the present trend towards the indigenous archaeology embedded within national ideologies. When looking back, it indicates that there have been three main phases in Sri Lankan archaeology: The Colonial period (especially the years under the British government 1871-1948), The Post-Colonial Period (around and after independence in 1948), and the National Archaeology (the period beginning in the early 1970s). As in many other non-Western colonized countries, Sri Lankan archaeology had different perspectives in different periods that were inter-woven with contemporary global views in archaeology, colonizers' perspectives, as well as with national socio-religious-political agendas. In the early period, it has been connected with an "orientalism" (Said 1978) point of view and later it seems to have a tendency towards ideologies of "nationalization" and "aryanization" (Basham 1952), as well as "Indianization" (Coomarswamy 1908; Bandaranayake 1980). Finally, it took new trends in making alternative history by analyzing and re-examining previous work and conducting research in different theoretical perspectives. During the past two decades, most archaeological works that have been conducted in the country tried to reconstruct indigenous history free of colonial paradigms.

Archeology During the Colonial Period

As in most of other non-western countries, documenting the Sri Lankan past began with the traveler's and administrators' accounts written mainly by persons from the west, usually from Europe. As they were often unaware of the values and beliefs underlying the sites and monuments of non-western communities in the orient, they documented religious and royal architecture in Sri Lanka that was less known or totally unknown to the Western society. Therefore, the first steps in Sri Lankan archaeology were not much different from elsewhere in the non-western world, its roots connected with the concepts of interest, excitement and curiosity. "Orientalism," the term what Edward Said named this academic and artistic tradition that comes with "Orient," the western view on the east that shaped by the 18th and 19th centuries attitudes of the era of European imperialism (Said 1978). The result is summed up in the following comment:

> The orient was almost a European invention, and had been since antiquity a place of romance, exotic beings, haunting memories and landscapes, remarkable experience. (1)

Early colonial period archaeology in Sri Lanka focused mainly on documentation of ancient architectural and inscriptional work in the North Central Province (Figure 1-1). Although where and what was investigated depended on the curiosity and its connected eurocentric perspectives of the British colonial administrators, they succeeded in including every monument, road and ancient reservoir into the one inch topographical maps. They eventually produced descriptive documentary journals on sites and inscriptions that they "discovered."

Bell's Kegalle Report (1892), Lawrie's gazetteer for the central Province (1898), Parker's reports on archaeological discoveries in southern province (1884) and ancient weapons and tools (1909), Brohier's work on irrigation technology (1934), Hadfield's work on ancient iron and steel (1912), Codrington's work on numismatics (1924), and Annual Reports of Archaeological Survey of Ceylon (ASCAR) are good examples for remarkable contributions for the early archeology of the island. In addition, Goldschmidt's efforts on inscription documentation, undertaken between 1875-1879 under the colonial government became the foundation for the study of Sri Lankan epigraphy (Müller 1883).

A comparison of early Sri Lankan archaeological records with other contemporary colonial archaeology reports in the same geographical region indicates that the Sri Lankan material is much more trustworthy. These investigators had two especially valuable sources of help to achieve this trustworthiness. The guidance provided by *Mahavamsa* helped them to have a better understanding of the material evidence that they unearthed archaeologically.

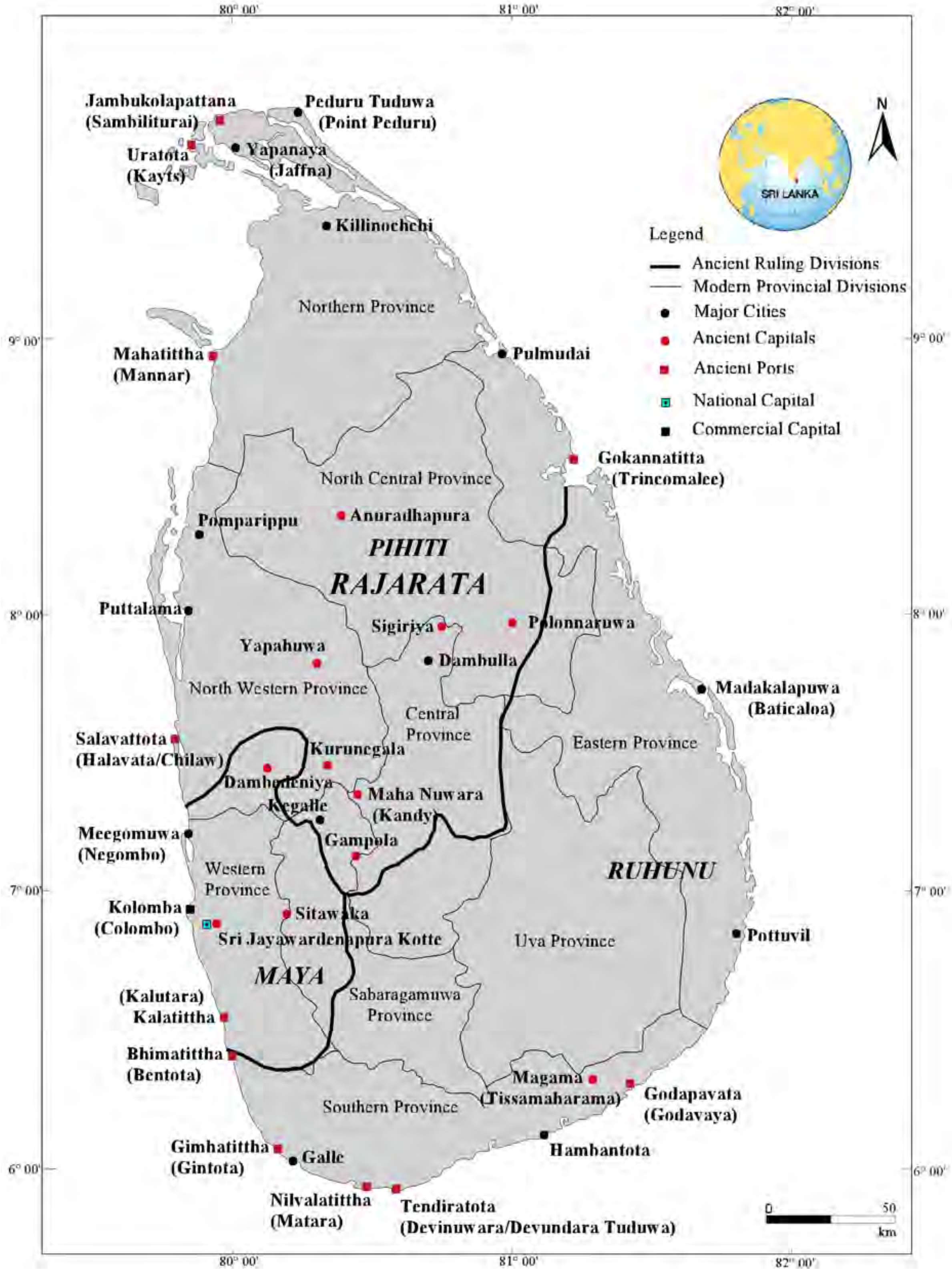


Figure 1-1. Map of Sri Lanka: ancient and modern provincial divisions.

The contributions of well-established Buddhist educational institutions in the island had already handed down knowledge in generations, including history through written and oral traditions. The ancient chronicle *Mahavamsa*, the "Great Genealogy" that was written in *pali* by a Buddhist monk around 5th century A.D. provides documented history continuously since the 6th century B.C. Two Indo-European language specialists translated *Mahavamsa* into English (George Turnour in 1987) and into German (Wilhelm Geiger in 1912) for providing assistance to understand the pre-colonial history of the island (Vimalananda 1952). Colonial administration also impressed on information given by *Mahavamsa* and other literary sources (*Dipavamsa, Chulavamsa*, etc.) as those have illuminated the country's ancient history, rulers, cultural life, and chronological order of Buddhist monuments dating from the 6th century B.C. Emperor Asoka's period of India (Ferguson 1876).

One can argue that the official birthday of Sri Lankan archaeology was started when Senarat Paranavithana became the first native Sri Lankan archaeological commissioner (1940-1956), instead of Harry Charles Purvis Bell's (H.C.P. Bell) appointment as the first archaeological commissioner (1890-1912) for the island. As the first archaeological commissioner H.C.P. Bell's (Ceylon[3] Civil Service) significant work on exploration and inscriptions has also made considerable contribution to early Sri Lankan archaeology. Although Bell commenced his large-scale archaeological work in restoration and excavation, he failed to bring Sri Lankan archaeology into the scientific and intellectual developments as Mortimer Wheeler did in India. Bell's work falls somewhere between an antiquarian and an archaeologist, only concerned with the *degagement* - the unearthing - of monuments, instead of concentrating on stratigraphy, the

[3] Lankadipa or Sihala Dveepa, the ancient name of Sri Lanka was changed to Ceylon by colonial governors. The name *Ceylon* was changed to *Sri Lanka* on May 22, 1972 by the national government.

assemblage of finds, sequence and chronology, analysis and interpretation (Bandaranayake 1994).

As a result of Wheeler's remarkable contribution and the training provided to his colleagues, Indian archaeological development reached memorable achievements before the independence than the Sri Lankan archaeology, even though Sri Lankan and Indian archaeological work started in same period under the same imperial authority and both countries got independence during the same period. The following quotation serves to provide a reason for the differences between two countries, helps to evaluate Bell's archaeological work, and uncovers the hidden ideology of colonial period archaeology that they have conducted in most of their colonized countries:

> Although he encouraged and acknowledged the work of his Sri Lankan co-workers, they remained assistants rather than colleagues. His colonial authority, command over resources and legitimizing achievement stood in the way of the emergence of any Sri Lankan archaeologists or the development of a native academic tradition of field-based archaeology, which had to await Paranavitana's intervention in the 1930s and '40s. (Bandaranayake 1994b)

Post-Colonial Archaeology

The beginning of postcolonial archeology has been effected by national propagandas (eg. Anagarika Dhammapala's and Walisinha Harischandra's national and Buddhist movements), aroused several decades before and after time independence. These leaders who led national and Buddhist movements advocated against colonial perspectives; they emphasized Buddhist art and architecture to renew the splendor of the past achievements and to bring back the strong sense of religious identity that had been lost during the colonial era (Portuguese 1505-1658, Dutch 1602-1796, English 1796-1948). The aim was to encourage the sense of the Sri Lankan national identity and unity that was submerged during the colonial period. Archaeology was seen as a serious discipline for studying pre-colonial culture.

In the period between 1948 until early 1970s, Sri Lankan archaeology was interwoven with the re-awakening and conservation of national identity. But a strong vein of European archaeological thought and practice remained. Therefore, there is no doubt about the importance of Paranavithana's role as the first national archaeological commissioner of Sri Lanka as he had wide-ranging knowledge of oriental languages, epigraphy, and Buddhist architecture. His work was recognized for its importance in the development of national archaeology (for example, Paranavithana 1946, 1956, 1970). His appointment as the first research professor of archaeology at the University of Ceylon (University of Peradeniya) in 1957, marked the official beginning of the archaeology department as a recognized academic scholarly endeavor in the Sri Lankan university atmosphere. His research-oriented and interpretational approach completed the transition from antiquarianism to archaeology, an achievement that had not been reached under Bell's direction.

Although archaeology had been introduced as a European invention by colonial administrators, Sri Lankan national leaders did not want to discontinue recognizing value in what had been done, especially in the use of ancient literacy sources. Therefore, epigraphy, art, Buddhist and royal architecture remained dominant themes in the Sri Lankan archaeological study over these three decades. Early researchers did not want to archaeological investigations turn away from the use of *Mahavamsa* as a guide, because it provides valuable evidence that reinforces studies of the glory of achievements in successive Buddhist kingdoms, beginning in the 6th century B.C. with Vijaya, reputedly the founder of the Sinhala ethnicity (the majority of the country) and the legendary colonizer of Sri Lanka.

As mentioned, one of the core objectives of post-independence Sri Lankan archaeological research was: to add new depths and dimensions to the ancient glory of the past that connected with an awaking nationalism. Hence, nationalization and aryanization became major themes in the post-colonial archaeology that attempted to identify national or ethnic identity through archaeological evidence. Archaeological data were manipulated for nationalist purposes. Archaeology played an important role in rebuilding national identities and uniting these with what were contemporary political issues. But these perspectives did not relate in any way with Gustaf Kossina's pure ethnic ideology and nationalistic theories that were applied to the German archaeological material culture to confirm the origins of the Germanic people and to prove their racial purity.

When we examine Sri Lankan post-independence archaeological studies, we can identify its underlying social ideology that was connected to the concept of national identity. We can see clearly that most studies ignored the geological and socio-political connection with South India. They had tendency and were oriented to determining the *Mahavamsa's* concept of "aryanization" and to looking for evidence to prove the Sri Lankan connection to North Indian "Aryan" ethnic identity. Some writers argue that the early north Indian Aryan traders had much more connections with Sri Lanka than did the South Indians because the northern Indians had developed of shipping and commerce and achieved a higher standard material culture that provided a better market for trading Sri Lankan luxury goods to North India than the South (Perera 1952:193).

Mahavamsa's North Indian "migration theory", "early Aryan settlement" of the island, its attempts to connect early kings with the *Sakiyas*[4] royal clan and Buddha (Basham 1952), and to measure Sri Lankan art and architectural roots within an Indian origin have created the foundation for the concept of Indianization. Therefore, Ananda K. Coomaraswamy's "Medieval Sinhalese Art" (1908) and its diffunist "Indo-Centric" view were widely accepted among

[4] Buddha was the son of Suddhodana, one of the kings of the tribe of the *Sakiyas*.

historians and archaeologists and the “Indo-Centric” appeared as a central theme for the academic discipline until 1970s.

National Archaeology

The period beginning in the early 1970s can be marked as the turning point when Sri Lankan archaeology moved towards national archaeology with archaeologists developing a new scientific tradition. One might regard Sri Lankan archeology in the early 1970s as still being under a colonial umbrella with archaeologists continuing to follow a colonialist archaeological discipline, as most of Sri Lankan archaeological research did not depart from the British academic discipline that has been used since independence. It is considered, quite logically, a historical discipline rather than a scientific discipline. The first establishment of Sri Lankan archaeology departments in universities occurred under history departments or as sub units of history departments causing this early academic tradition to be different from archaeology in the North American academic discipline that has developed under the discipline of anthropology, not history.

One can argue that most Sri Lankan archaeological research followed in the path of a descriptive academic discipline rather than that of a theoretical or critical perspective. Although archaeological interest in ancient monuments was reflected in descriptive documentation, basically different from modern archaeology, this method was used by several archaeologists who considered it their responsibility to document Sri Lankan archaeological heritage sites that had been neglected or destroyed during the colonial era. In contrast, theoretical treatments emerged in selected fields: ancient Sri Lankan art (Wijesekera 1970; Manjusri 1977; Gunasinghe 1978; Bandaranayake 1986), architecture (Bandaranayake 1974; Basnayake 1986; Silva 1988; Wijesuriya 1988) and inscriptions (Parnavithana 1970 & 1983; Aryasingha 1965; Dias 2001).

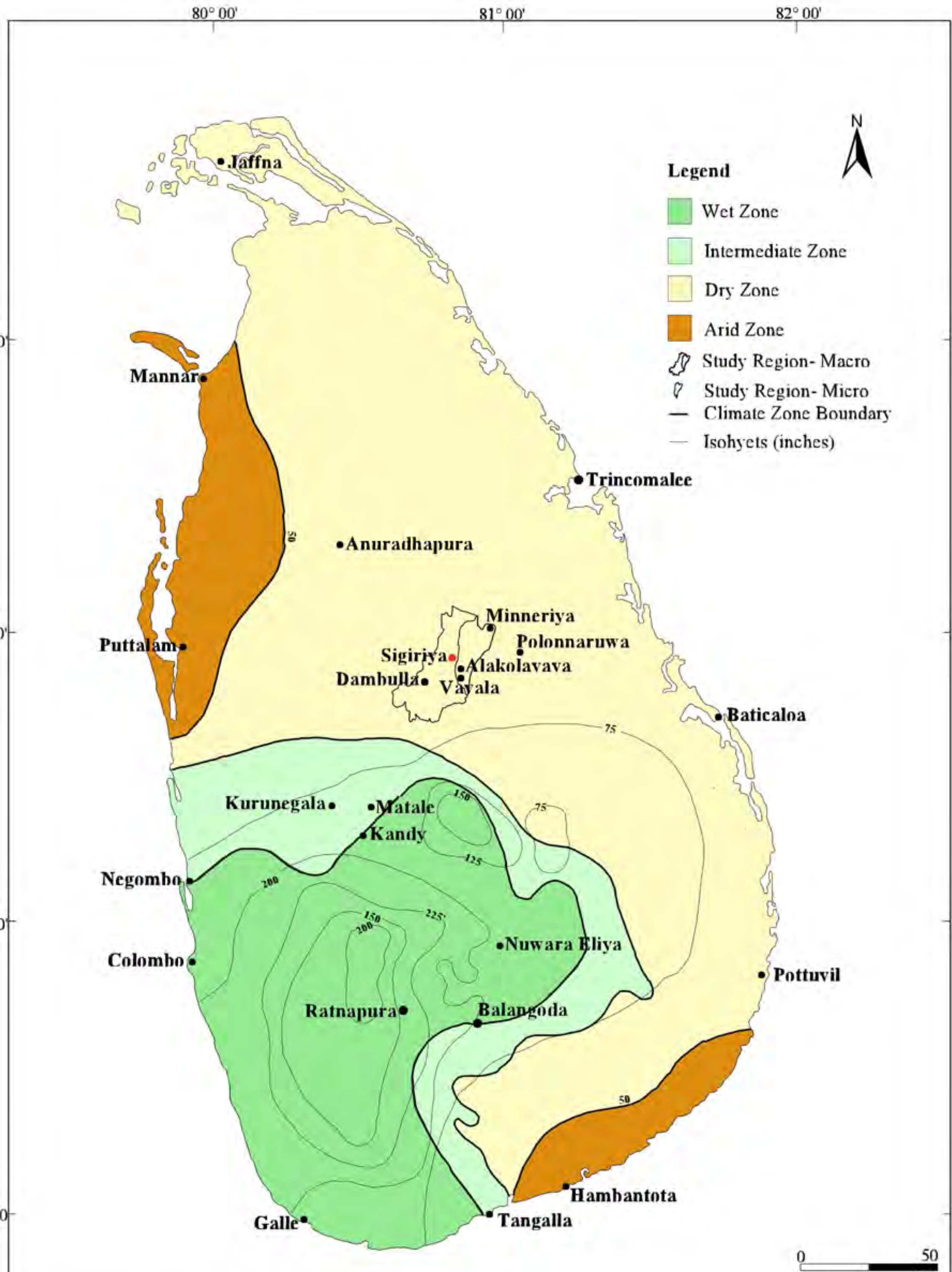


Figure 1-2. Map of Sri Lanka: climate zone boundaries and the study region.

Except for Paranavithana’s intellectual contribution based on his humanistic based research, there are several pioneers of national archaeology who brought Sri Lankan archaeology to an empirical data-oriented scientific path: Bandaranayake (architecture, paintings, settlement archaeology, social systems, heritage management, excavations and pottery chronology), Basnayake (architecture), Deraniyagala (excavation methodology, prehistory, iron age, and pottery chronology), De Silva (painting technology), Gunawardana (irrigation technology and social organization), Wijeypala (prehistory and Neolithic), Senevirathne (protohistory/iron age and megalithic tradition), Silva (architecture and heritage management) and Siriweera (techniques of agro-economy).

Siran Deraniyagala, the leading expert of prehistory of Sri Lanka, took advanced steps in the subject after E.E. Green and J. Pole’s 1880’s study of surface collections of quartz and chert (cited in Deraniyagala 1980:153). He introduced a multidisciplinary approach to the Sri Lankan archaeology through research that was conducted in the northern, eastern, southern, and northwestern lowlands of Sri Lanka under the supervision of the Department of Archaeology. He also formulated models and hypotheses for testing (Deraniyagala 1992). He conducted the first stratigraphically based excavations at the Anuradhapura citadel that yielded evidence to push back Sri Lankan history by some three to four centuries from the theory of legendary Vijaya and his Aryan settlement. Deraniyagala also developed a pottery chronology based on the stratigraphy (Deraniyagala 1972; 1984; 1986).

Senake Bandaranayake’s work also brought Sri Lankan Archaeology in a new direction through his architectural, anthropological, and philosophical academic background and his reflective-interpretative, theoretical concerns, research interests. His work showed how he used their application on a diverse range of sources such as art, architecture, and material remains

(Bandaranayake 2007). He raised the question of state formation under the concepts of a Marxian school that started in 16th century Europe, and tried to build hierarchical orders in archaeological data in order to discuss the pre-modern social formation and Asian Feudalism in South Asia (Bandaranayake 1978; 1984b; 1985; 1989). His study on landscape archaeology, "the study of the total archaeological landscape" provides the possibility of framing questions relating to the practice of the state and its impact on others, rather than just concentrating on the origins of the state (Bandaranayake 1990; 1994a). He is one of the pioneers who started to discuss and reject the dominant concepts of "Indianisation" (Bandaranayake 1974: 9-11; 324-325) and Coomaraswamy's diffiunist "Indo-Centric" view (Bandaranayake 1980:68-84). Through his study on the Early and Middle Historic Period (EMHP) monastery and building categories and types, he was able to present a taxonomy that used classic techniques in archaeology and that implicitly involved a conceptual or theoretical basis that had rarely been applied in the empiricist and 'Orientalist' scholarly traditions in South Asia (Bandaranayake 2007). As the Director of the Cultural Triangle Projects in Sigiriya and Dambulla, he introduced "open area excavation" with a context-matrix recording system and pottery typology that is based on form, size, and function (Bandaranayake 1984a).

Although pioneers of the national archaeology obtained international graduate and postgraduate education in theoretical and academic sub-fields in anthropology and so could grab and work with contemporary development of the field at an international level, they did not succeed in bringing their students to their level theoretically. These pioneers claimed that they had to use their time to build national level archaeology, institutions, run cultural resource management programs, and conduct, write, and publish their own research (Bandaranayake 2007, Deraniyagala pers. com.). Very few in the next generation, who graduated as archaeologists, so there were not enough of them to conduct research all over the island. This generation gap at academic and professional levels opened opportunities for foreign archaeologists to conduct research and training through exchange programs.

During the decade of the 1980s, the native academic tradition of field-based archaeology was developed with the initiation of Sri Lanka-UNESCO collaborated Central Cultural Fund's (CCF) Cultural Triangle Project, and the setting up the Postgraduate Institute of Archaeology (PGIAR) under the umbrella of the University of Kelaniya. The Cultural Triangle takes its name from the fact that it is contained within a triangle formed by three ancient capitals of the Early, Middle and Late Historic Periods: Anuradhapura (5th century B.C. to 10th century A.D.), Polonnaruwa (11th to 13th century), and Kandy (15th to 19th century). Anuradhapura, Sigiriya, Dambulla, Polonnaruva and Kandy were selected as major historical sites for preserving cultural and religious values through archaeological research, excavations, and conservation (Figure 1-3).

Both CCF and PGIAR marked new chapters in the development of Sri Lankan archaeology and facilitated building a much better trained younger generation in field archaeology. The Triangle pioneered a "Training and Research Base" to conduct multi-disciplinary teamwork involving academics, professionals, and university students in various sub-disciplines of archaeology, and it brought Sri Lankan archaeology rapid growth in scientific-based field operations through its interwoven partnerships between the Archaeological Department and the universities of Sri Lanka. The Cultural Triangle Project has made it possible for university students to contribute national heritage management activities through their archaeological research. The Cultural Triangle has also been a resource for "graduate employment". Public interest in archaeology and ethics of cultural heritage management coincide with cultural ideology, government support, and most importantly the remarkable contribution of

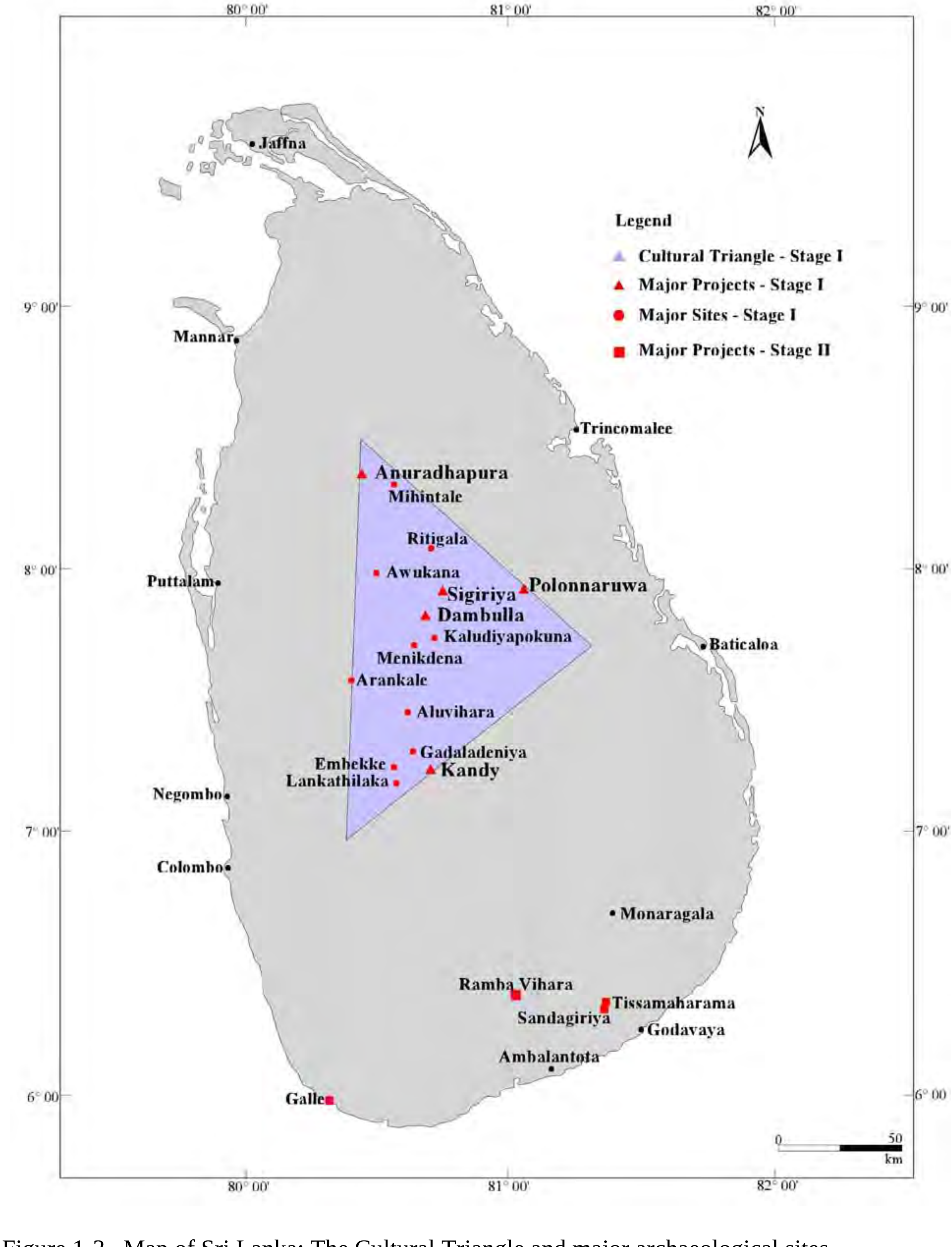


Figure 1-3. Map of Sri Lanka: The Cultural Triangle and major archaeological sites.

Roland Silva, the first Director General of the CCF, who oversaw it attain success within the targeted time period.

Present Interests in Archaeology

During the last decades of the 20th century, as the result of national education system and national university system, the archaeological discipline gradually shifted from an empirical and descriptive academic tradition mainly focused on great monuments, ephigraphical works, and art to a discipline of archaeological material and analyses based on a multidisciplinary research approach connected with social sciences, natural sciences, and theoretical frameworks.

There is no doubt that in the late 1980s the Settlement Archaeology Research Collaboration Project (SARCP) – "the study of the total archaeological landscape" (in collaboration with the Swedish Board of National Antiquities (*Riksantikvarieämbetet)* and SAREC in Sweden) became a pioneer program that succeeded in moving Sri Lankan archaeological studies from its dominated themes of a religious and royal monumental "elite" based archaeology to a study on "common people."

As the founder of the PGIAR and the SARCP Project, Senake Bandaranayeke introduced the idea of team-based, multidisciplinary studies of a selected area and applied a well-known model- that is, environmental factors are the key for understanding population distribution- to four major waterways in the Sigiriya-Dambulla region of the Dry Zone of Sri Lanka (Bandaranayake *et al.* 1990, 1994). After SARCP project, this concept has not been continued at the national level. But, as the result of training and benefits obtained one way or another through the settlement archaeology training program, major themes of the project have continued as individual disciplines and emerged them as new fields in Sri Lankan Archaeology: Palaeoecological studies in the Horton Plains (Premathilake 2003), Development of Buddhist Monasteries & Urbanism in the Tissamaharama Region (Gunawardena 2003), Development of

Urbanism in Southern Sri Lanka (Somadeva 2006), Food and Urbanism in Southern Sri Lanka (Adikari forthcoming), Settlement Patterns in the Malvatu Oya and Kala Oya Basins (Vidanapathirana 2007), Copper metallurgy and its sources (Thantilage 2008), and Iron Metallurgy and Settlement Pattern in the Kiri Oya Basin, Dry Zone (Solangaarachchi 1999 and this study).

The decades of the 1980s and 1990s saw Iron Age (especially on Mesolithic to Iron Age transition Period), archaeo- metallurgy, and maritime archaeology become prominent themes in the national archaeology. Comparing with studies on the Mesolithic period and its lithic technologies that were dated 34,000 BP onwards, the period from the Mesolithic to Iron Age transition period is less evident (Deraniyagala 1992, 1998). Although recent excavations provide probable evidence for the existence of a “Neolithic” period, such as cereal cultivation and pottery together with stone stools (Wijepala 1997; Deraniyagala 1998; Premathilake 2003), until we find clear evidence for copper-alloy using Chalcolithic settlements, a Neolithic/Chalcolithic period is still a controversial stage in the Sri Lankan context. When evidence for an early iron using culture was unearthed from a megalithic mortuary complex, it created an ongoing argument for the connection of the early Iron Age with peninsular India (Seneviratne 1984; Deraniyagala 1998). Before coming to a conclusion, we still need to obtain more evidence for the early Iron Age transition period in Sri Lanka. In late 1980s important breakthroughs in the archaeological investigation of iron metallurgy were made by the PGIAR, in collaboration with the Swedish Board of National Antiquities under the SARCP at Alakolavava in the Sigiriya-Dambulla Region (SDR) in the dry zone (Forenius & Solangaarachchi 1994; Solangaarachchi 1999) and by the Archaeology Department working in collaboration with a British team at Samanalavava on the banks of the upper Valave River in the intermediate/wet zone (Juleff

1998). The background of studies on the Iron Age and iron metallurgy in Sri Lanka is discussed in Chapter 2 in detail.

There is less archaeological attention to tracing the social and economic structural changes of the colonial period material culture. But some architectural studies and conservation were done at colonial buildings and monuments. In contrast, the investigation of the European colonial impact in the New World has been one of the unique concerns of historical archaeology (Dyson 1985). Some argue that most of the nations who had colonial experience had illiterate or low level literate populations and therefore the social changes brought to their lives by colonizers can only be studied through the material culture including archaeological excavations (Bartel 1985). But Sri Lanka's written history, begun long before the colonial occupation, provides ample evidence for the social changes during pre- and postcolonial eras. Most archaeological investigations were conducted on early historic period material cultures that can be traced in the vanished glory of the past. Although, this is one probable reason for the rare attention to colonial period material culture, buildings from the colonial period were already declared as being part of Sri Lanka's heritage. Maritime Archaeology in the bay of Galle emerged from surveys and management of maritime heritage as a collaborative venture among Sri Lankan, Dutch, and Australian researchers (Green & Devendra 1993), connected with the Southern Cultural Triangle project whose purpose was conducting archaeological investigations and conservation at major historical sites within Tissamaharama (the ancient capital of *Ruhunu* that goes back to 3th century B.C.), Monaragala, and Ambalantota.

With the beginning of a new millennia public interest on *Mahavamsa* increased rapidly and some researchers have started to move away from archaeological concepts that are related to nationalistic issues. They have begun to dissolve boundaries between written and oral history in the study of Sri Lanka's past. Political conflict connected with terrorism in the northern and eastern provinces of the island also created a background for re-analyzing *Mahavamsa's* concepts of origins of early settlements, using all relevant sources of other data (oral, historical, and ethnographic) to push back *Mahavamsa's* history before the legendary arrival of Vijaya to trace early settlements on oral traditions related to *Ramayanaya*. Unfortunately, most investigators failed to understand that *Mahavamsa* was written by a monk following in an ancient tradition, recording the past through oral tradition. Some Western scholars take *Mahavamsa* as a source of political notions; 'a court chronicle' or part of a 'political tradition' that had given a central point to each king politically and morally and paid little or no attention to the actual construction of the society (Kemper 1991:21). Although we can find some religious bias in it, it is a priceless source for the reconstruction the Sri Lanka's history, Theravada Buddhist beliefs, and the Sri Lankan ancient monarchy.

There is also a new tendency to apply Western archeological theory and concepts to the interpretation of Sri Lankan history and material culture. But, when using alternative methods and archaeological interpretive theories that are introduced from the West to interpret non-Western culture, we have to be careful because they emerge as products of western influence (Schmidt 1995). When we introduce archaeological interpretive theories from the West into the Sri Lankan archaeological context, we must be careful not to impose Western scientific methods and interpretive paradigms without a clear understanding of the ideology and philosophy that exists in Sri Lankan archeological endeavors.

Presentation of Dissertation

This dissertation is not primarily devoted to study of the metallurgical aspects of iron smelting technology. Although that focus was one of the major aspects, the research is mainly based on the socio-economic and political aspects that are related to iron smelting technology in the KOB. Theoretical background, data acquiring and analytical methods, and concluding arguments are presented through three sections: aims & previous research; case study & present research; data analyses & interpretation.

Research Objectives & Background

Research objectives and the background of the dissertation will be discussed through Chapters 1, 2, 3, and 4. Archaeological and geographical settings of the research area are provided along with previous archaeological research data to understand the settlement pattern in the KOB. Archaeological studies on iron smelting technology in Sri Lanka, and conceptual background are also presented for understanding data and to sustain arguments. Chapter 1 summarizes the aims and design of the research and development of archaeological concepts in Sri Lanka for providing entrance to the present study and better understanding of the social and political ideology connected with archeological research and its changes since the colonial period.

Chapter 2 provides a historical outline and an overview of the archaeology of iron technology in Sri Lanka. Scientific methods and techniques that have been used in recent years (Forenius & Solangaarachchi 1994; Juleff 1998; Solangaarachchi 1999) for examining the origin and smelting technology of iron, and its development that have been revealed through historical and archaeological evidence are also discussed here in providing inputs to questions of chronology and sourcing of iron metallurgy in the island. The basic requirements of early iron technology in Sri Lanka are highlighted and compared with world and Indian data. As iron smelting technology no longer exists as a living technology in the island, this study mostly depends on literary sources, ethnographical evidence and the data revealed from recently excavated iron production sites in the island. The metallurgical survey on ancient iron production provide here included early usage of iron and steel, raw materials, production technology, social and economical values.

The first half of Chapter 3 provides an overview of the geographical setting in the Sigiriya-Dambulla region with a special focus on the KOB. It discusses environmental parameters and vegetation and it attempts to analyze the connection between technology and environmental resources. The resources referred to are the occurrence of iron ore, fuel use, and water, all of which are basic to the iron industry. In addition an attempt has been made to analyze the geophysical factors to see whether the velocity of wind affected the smelting process. In addition, I discuss the possibility of the existence of a transport system that enabled the development of the industry, even if resources were not located close to the industrial zone. If the area was rich in resources, there had to have been a system of transport to distribute the products to the main trading and political centers.

The second half of Chapter 3 discusses the historical and research background of the research setting in the Sigiriya-Dambulla Region, the macro region and the Kiri Oya Basin, the micro region. In addition, special focus is given to the previous research in the KOB. This also attempts to analyze the past urbanization of the area to discover a probable connection with the iron industry. In the process, the locations of the iron industry and whether there was any connection between the main ruling centers and the trading centers have been discussed. Here, an attempt has been made to find a connection between the historical backgrounds of the area with the archaeological data yielded so far in the study region.

Present Research and Case Study

The second part of the research is devoted to the case study. It will be presented through Chapters 4, 5, and 7 to provide the theory, the objectives, methodology, and revealed data from archaeological and ethnographical survey and excavations.

The first part of Chapter 4 provides the conceptual background and theoretical framework of the dissertation. Four themes have been chosen as representative of recent work focusing on archaeological methods and theory, and their relationship to texts: king, Buddhist monastery and social economic system; technology and social agency; beliefs, symbolism, and oral tradition; settlement pattern and iron production. Theoretical perspective of the dissertation on social organization in ancient Sri Lanka is a combination of ideas generated by Webber (hydraulic-bureaucratic official-state in 1947), Wittfogel (hydraulic agriculture and Oriental Despotism in 1957), Gunawardana (monastic organization and economy in 1979), Bandaranayake (pre - modern social formation in 1974 and 1989), Shaw (sacred landscape in 2000 and 2000b), and Coningham & Gunawardhana *et al. (*state of theocracy in 2007).

The second part of Chapter 4 presents the principle aims of the research and the general and specific hypotheses tested in the dissertation. It also provides data collection methods that have been used: collecting data from documentary and textual sources; surveying and mapping the proposed region; conducting archaeological excavations; employing ethnographic research; and, physical, chemical, and metallurgical analyses of artifacts.

The final part of Chapter 4 provides the main objectives and methodology of the ethnographic survey and presents how I obtained data used to fill gaps in archaeological data. There is ethno-archaeological work that combines with archaeological and ethnographical approaches in the region. Interviews with religious and secular leaders, elderly people in the study area, obtained oral traditions that are related to the region; they are provided here to understand missing links in socio-cultural activities and the settlement pattern.

Chapter 5 presents results from the regional survey conducted through the SIT project in 2004-2006; these also provided to understand the characteristics of the iron smelting technology and the activities connected to this technology and their relation to the settlements along the KOB. Site descriptions (Appendix D) are provided here based on the density of material culture identified from the Nuwaragala-kanda up to the Minneriya Vava along the KOB that are related to ancient iron smelting activities, ancient habitations, and religious performance sites. I also try to understand the "internal dynamics of Buddhism in the local landscape" (Willis 2000; Shaw 2000). Finally, I discuss methods and objectives of detailed survey at the Alakolavava-Vavala settlement as a part of the Sigiriya hinterland known in ancient times as the "*Sihagiri Bim*," the Sigiri territory that includes a large number of rural settlement sites, man-made reservoirs, protohistoric cemeteries, major iron smelting centers, and Buddhist monasteries.

Chapter 6 provides data revealed from test, trench, and open excavations conducted in 2004 and 2005 at four different sites: Dikyaya-kanda, an iron smelting site (SIT 22), Vavala Buddhist Monastery, a religious complex (SIT 6), Kosgaha-ala-ulpothaha, an ancient settlement site (SIT 7), and Vavala Vava, an ancient manmade reservoir (SIT 25). Like most field archaeology, settlement pattern archaeology was heavily dependent upon excavation for fully accurate and complete results, at least in many situations (Willey 1999:11). Historical and geographical overviews of every excavated site are provided here to understand the excavated material culture. Site description, excavation techniques and methodology, stratigraphic recording, and the sample collection system are also presented for reconstructing the ceramic chronology and the culture history of excavated sites. A special focus of this chapter is the excavation of the Dikyaya-kanda iron smelting site. Finally, radiocarbon dates are provided to connect sites and to understand the cultural chronology of the material culture.

Data Analyses and Interpretation

The final stages of the research that are devoted mainly to analysis (excavated pottery; for dating samples through the radiocarbon analysis; archaeometallurgical analyses) and concluding arguments are presented through Chapters 7 and 8. These two chapters provide an overview of the ancient iron smelting technology, the settlement pattern, and its chronology along the KOB through analyses of cultural remains and other historical data that were obtained through previous stages of the study.

Chapter 7 is devoted to furnace construction, a metallurgical overview of iron smelting technology, and the material culture in the KOB. It provides special attention to the discussion of the technological value of the Alakolavava - Dehigaha-ala-kanda iron smelting site that I studied previously and excavated in 1989 and 1990 under the “Settlement Archaeology Project” (the first phase of my research) and the Vavala – Dikyaya-kanda iron smelting site that I excavated for this study (second phase of my research) in 2004-2006. Both sites are located east to the Konduruvava Range that is located between the Anuradhapura and the Polonnaruwa peneplains as a boundary. Through this chapter, I also attempt to date smelting activities in the area through the use of radiocarbon dating, pottery distribution, and typology (Appendix/s Jand K), and to present the significant characteristics of the production process: environmental and historical location of the furnaces, construction materials and type of furnaces, the type of ore, fuel and flux used, the use of *tuyeres* and bellows, the slag composition, mechanisms and operation and the volume and quality of the final product.

Chapter 8, the concluding chapter summarizes the socio-economic aspects and the settlement pattern in the KOB. It reviews the basic hypothesis and main research questions of the thesis with the data obtained through Chapters 3, 4, 5 and 6 and provides the connection to iron smelting settlements with the rest of the socio-political-religious strata in the society and the area’s irrigation network, the significance of data that are related to major research questions, the connection between environmental resources and iron smelting, the nature of the spatial and functional organization of the smelting sites (including probable reasons for the selection of the area as an iron producing center), the connection between iron production and urbanization of the area, and the role of iron in the region.

CHAPTER 2
ARCHAEOLOGY OF IRON METALLURGY: THE PAST & PRESENT IN SRI LANKA

Overview

This chapter provides an overview of the archaeology of iron technology in Sri Lanka. As iron smelting technology does no longer exists as a living technology in the island, data on ancient iron metallurgy provided here mostly depend on literary sources, ethnographical evidence, metallurgical studies conducted throughout the country and the data revealed from recently excavated iron production sites in the island (Forenius & Solangaarachchi 1994; Juleff 1998; Solangaarachchi 1999). The origin and smelting technology of iron, and its development that have been revealed through historical and archaeological evidence are also discussed here in providing inputs to questions of chronology and sourcing of iron metallurgy in the island. The basic requirements of early iron technology in Sri Lanka are highlighted and compared with world and Indian data. The metallurgical survey on ancient iron production provided here includes the early usage of iron and steel, raw materials, production technology, and social and economical values.

Studies of Pre-Colonial Iron Metallurgy

The study of pre-modern iron metallurgy in Sri Lanka seems to have started in the 19th century. Early descriptions and investigations such as those of Knox (1681), Davy (1821), Ondaatje (1854), Tennent (1859), Baker (1885), Coomaraswamy (1908) and Hadfield (1912) have indicated that Sri Lankan iron and steel occupied a significant place in the south Asian iron technology complex. Much of the work of these early writers was eyewitness descriptions of indigenous iron smelting technology. Although Sri Lankan ancient chronicles: *Mahavamsa, Culavamsa*, *Dhatuvamsa*, *Dipavamsa*, *Thupavamsa* and *Pujavaliya* and numerous epigraphs on stones provide evidence for using gold, silver, lead, copper and iron from early historic times onward, there are not enough archaeological studies carried out in various parts of the island to confirm such written evidence and the records of the ancient metallurgical knowledge. Therefore, the ancient metallurgical knowledge of Sri Lanka is essentially incomplete due to the scarcity of research material published on archaeometallurgy.

In the late 1980s important breakthroughs in the archaeological investigation of this subject were made by the Postgraduate Institute of Archaeology (PGIAR) in collaboration with the Swedish Board of National Antiquities under the Settlement Archaeology Research Collaboration Project (SARCP) in the Sigiriya-Dambulla Region (SDR) of the dry zone (Forenius and Solangaarachchi 1994; Solangaarachchi 1999) and by the Archaeological Department working in collaboration with a British team at Samanalavava on the banks of the upper Valave River in the wet zone (Juleff 1990a) (Figure 2-1). Samanalavava, the west-facing smelting site, was identified as using a wind-pressure technique without bellows for the smelting process (Juleff 1996; 1998). At Alakolavava, the evidence suggests that the smelters used a multiple/poly-tuyere system with bellows. However, in addition to these two sites, the existence of iron slag mounds throughout the island bear evidence that this technology was widespread. According to the data, which were documented by researchers in different fields, we can understand the production technology and its social, economic and political aspects such as the social organization of ancient iron technology in Sri Lanka.

Chronology

The data relevant to the origin and chronology of Sri Lankan iron technology has been found so far only from the archaeological excavations that were conducted in various parts of the island. According to existing archaeological evidence, the hunting and gathering Mesolithic culture was directly superseded by the protohistoric early iron age (Deraniyagala 1990). This has been confirmed thoroughly from the excavation conducted in the Anuradhapura citadel

(Deraniyagala 1972) and a prehistoric cave in Sigiriya, Aligala (Karunarathne and Adikari 1994). One possibility for the absence of an intervening Neolithic or Chalcolithic culture is the influence of environmental factors in the island (Deraniyagala 1972; 1998). According to Deraniyagala, the heavy soils of the island clothed in rain forests were difficult to cultivate with Neolithic or Chalcolithic technology as manifested in peninsular India (Deraniyagala 1990). But recent research conducted in Horton Plains (Premathilake 1997) and various rock shelter sites in the island (Wijeyapala 1997) recently yielded data to contradict this argument. Some evidence found from the protohistoric layer in Anuradhapura citadel (Deraniyagala 1990) and the protohistoric megalithic burial site at Pomparrippu (Begley et al. 1981) underwrote an argument that its origin was connected with Indian influence (Deraniyagala 1990; 1998, Senevirathne 1995). Discovery of few pieces of copper slag from the 'Mesolithic' context at Matte could be the first evidence for Chalcolithic horizon in Sri Lanka (Deraniyagala 1998).

The earliest known date for the Iron Age, 10th-9th century B.C. (998-848 B.C.) was established through C^{14} dating in a megalithic protohistoric context from Aligala in Sigiriya (Karunaratne and Adikari 1994). The dating came from a slag sample immediately above the Mesolithic layer at Aligala. When I was conducting preliminary exploration in the Sigiriya Eastern Precinct, the appearance of a surface cave deposit with several slag samples was my reason for selecting Aligala as one of the sites for excavation under SARCP (Solangaarachchi 1990:110). The slag samples found with iron artifacts from the excavation in the Anuradhapura citadel dated to the 10th-9th century B.C. (930-800 B.C.) were the other earlier finds of the Iron Age (Deraniyagala & Abeyrathne 1997). It is important to note that these two sites were situated in the dry zone, the region where the earliest historic settlements were established on the island. According to the above data, it is likely that iron smelting technology was started at some point in time during or before the 10th century B.C. Both samples indicate that the earliest archaeological evidence of the iron technology in the island began with the agrarian Megalithic culture in the Pre-Vijayan period. I composed the following table using data obtained from the materials published by Deraniyagala 1990; 1998; Wijeypala 1997; Premathilake 2003; Bandaranayake 2005; Adikari, Thanthilage, Vidanapathirana and Welianga *et al*. 2010.

Table 2-1. Early (historic) chronology of Sri Lanka

Chronology	Period	Place
Mesolithic	34,000 C14 BP	Fa Hien Lena (Bulathsinhala)
	28,500-11,500 C14 BP	Batadomba-lena (Kuruwita)
	27,000-3500 C14 BP	Beli-lena (Kitulgala)
	10,500 C14 BP	Alu-lena (Attanagoda near Kegalle)
	6500 TL BP	Bellan-bandi Palassa (Embilipitiya)
	1800 BC	Matota
	1000 BC	Aligala (Sigiriya)
Mesolithic/Neolithic?	6300 C14 BP	Dorawaka-kanda (near Kegalle)
Transition	4000 BC	Horton Plains Alawala (near Attanagalla) Matota
Protohistoric Iron age	1000 BC - 600 BC	Anuradhapura, Sigiriya
Basal early Historic	600 BC - 500 BC	Anuradhapura,
Lower early Historic	500 BC - 250 BC	Anuradhapura Anaikkoddai
Mid early Historic	250 BC - 100 AD	Anuradhapura, Tissamaharama, Matota, Kantarodai,
Upper early Historic	100 AD - 300 AD	Anuradhapura
Middle Historic	300 AD - 1250 AD	Anuradhapura Matota Sigiriya Polonnaruwa

According to Kennedy's (1986; 1987) and Deraniyagala's (1990; 1992) physical anthropological studies of skeletal remains from the Pomparrippu Megalithic burial site, there are major differences between Mesolithic Balangoda man (from Bellan bandi palassa, dated ca

4500 B.C.) and early iron age man. On the other hand there are some similarities between Mesolithic man and modern man and also the Pomparrippu early iron age man.

According to previous research, the Sri Lankan Vaddas are descended directly from the Balangoda man. If so, we have to answer the critical question of who introduced iron to the island-whether indigenous people or some migrants or traders. Further research is needed to answer this question and so it should be left for the future.

A frontal bone, the bone of the human cranial vault, smeared with red ochre, which was found from Ravana Alla cave and two fractional human bones which were also coated with red ocher (haematite) and unearthed at Fa Hien cave (ca 5400 cal BP) are the earliest examples of the use of iron ore in Sri Lanka (Deraniyagala 1992). The evidence that is described above belonged to the Mesolithic culture and it appears to be used for ritualistic or funerary purposes. The stone tools of the Mesolithic culture associated with red ochre found during the explorations and excavations conducted in most parts of the island suggest that iron ore was used in the lithic societies for such purposes even before identification of the metallurgical value of iron ore.

Early Usage of Iron and Steel

There is some important evidence found for the early usage of iron in Sri Lanka made by Parker (1884; 1909) Coomaraswamy (1908) and Geiger (1960). Parker (1909) had drawn attention to the ancient weapons and tools in early historic times onwards. Coomaraswamy`s study was especially focused on iron objects in the Kandyan Kingdom, and Geiger refers to some objects mentioned in the *Culavamsa.*

The earliest recorded iron artifacts were found at the Anuradhapura citadel, dated to the 10th-9th century B.C. (Deraniyagala and Abeyratne 1997). An excavation conducted by Parker at Tissamaharama, the ancient citadel in Ruhuna, yielded a great variety of iron objects such as domestic implements and weapons dated 40 A.D. Among these artifacts there are spear heads, a javelin head, a kris blade, wedges, axe heads, knives, craftsmen`s tools, carpenters' tools and rock cutting chisels. He also recorded the occurrence of iron ore and iron tools at Akurugoda in the Hambantota district (Parker 1884). The metallurgist Maliyasena suggests that the carpenters' tools and rock cutting chisels which were recorded by Parker most probably were made of steel (Maliyasena 1987).

Hadfield takes a prominent place among the investigators of Sri Lankan archaeometallurgy. In his studies on the samples of iron and steel from Sigiriya, dated to the 5th century B.C., he recorded that the masters of iron technology of that time had known the art of strengthening steel (Hadfield 1912). The earliest dated example for steel in Sri Lanka, where case hardening and quenching techniques have been applied, was the sample (a chisel) found from Sigiriya that Hadfield had analyzed (Maliyasena 1986). The other known steel artifact was found in Madura-Oya dated to the 11th century A.D. made with a high carbon content. (Brown 1982; Juleff 1996). Mass produced iron objects belonging to the historic period were recorded from the recent excavations which had been conducted under the Central Cultural Fund in and around the Sigiriya, Polonnaruwa and Anuradhapura regions (Bandaranayake 1984; Prematillake 1982; Wickramagamage 1984; Rathnayake 1982). According to the analytical work done by Maliyasena on artifacts found in Polonnaruwa, it has been suggested that the rock cutting chisels were made of steel purposely (Maliyasena 1987). Of the two finished steel artifacts recorded recently from the Samanalavava area, one was a scraper which was found from the excavations at the west-facing site dated to the 7-10 centuries A.D. and the other was a chisel found at the Kosgama furnace site which was probably a natural draft furnace site dated to the 3rd century B.C. (Wayman and Juleff 1996).

The explorations conducted in the Samanalavava area revealed two crucible ingot fragments, crucibles, iron blooms and small iron bars. The two crucible ingot fragments were collected from the Mawalgaha village, where there was the eye witness evidence for crucible steel manufacturing work that Coomaraswamy mentioned (1908). The Samanalavava archaeological team was collecting the samples that belonged to W.A. Siyadoris, the grandson of Kiri Ukkuwa, who demonstrated how to make steel for Coomaraswamy. The crucibles were found in a garden close to the paddy field of Mawalgaha village (Wayland and Juleff 1996).

Raw Materials

In considering ancient production systems, there is evidence to suggest that the distribution of Sri Lanka`s natural vegetation and mineral resources played an important role in the production processes. The basic raw materials used in the production of iron and steel were iron ore and charcoal. There were some accounts on the types of raw materials that were used in ancient times (Knox 1681; Davy 1821; Coomaraswamy 1908). The ancient iron producers used haematite (Fe_2O_3), limonite ($Fe_2O_3.nH_2O$) and to a lesser extent magnetite (Fe_3O_4) ores as the principal raw material for their smelting process. Knox had observed that the ancient Sinhalese obtained iron ores at a depth of less than 6 feet (2 m) in several places. But he didn't mention which type of iron ore was used (Knox 1681). Davy has given more descriptive details on Sri Lankan iron ores and their usage at that time. He refers to iron in different forms as iron pyrites, magnetite iron ore, specular iron ore, red haematite, bog-iron ore, and earthy blue iron phosphate. Red haematite and bog iron ore are more common than other varieties (Davy 1821). According to Coomaraswamy's description, in some districts magnetite ores were used while others used haematite and limonite ores, which were widely distributed in small quantities as nodules (Coomaraswamy 1908). Senevirathne (1985; 1992), Karunarathne and Disanayake(1990) have given their attention to studies mostly relevant to the archaeological context. Generally, iron smelters have used haematite (Fe_2O_3) and limonite ($Fe_2O_3.nH_2O$) for primitive bloomery furnaces. This is due to the difficulty of reducing very dense iron oxide in a bloomery furnace. The Samanalavava iron smelters also used limonite and haematite iron ores for the production process (Juleff 1990a). There is evidence for limonite ore being used by iron smelters of the Ridiyagama area for their production process (Bopearachchi pers.com.). The Anuradhapura Gedige site yielded some pieces of iron slag and limonite nodules indicating that these iron smelters also used limonite ore (Deraniyagala 1986).

The early Iron Age community had used iron ore mainly distributed in the dry zone of Sri Lanka and which could be obtained at the surface level in those areas. The probable reason for a lesser extent of magnetite being used might be the difficulty of reducing a very dense iron oxide like magnetite in primary bloomery furnaces. It cannot be obtained at the surface level and needed deep mining. The other reason might be that the early habitation sites of the early Iron Age were situated at a long distance from the magnetite deposits. A few uncertain examples for the use of magnetite ore in early times in Sri Lanka were found in Anuradhapura and Panirendawa. A nail revealed from the protohistoric context in the Anuradhapura citadel (Maliyasena 1986) and slag and clay crucibles from the surface survey at Panirendawa indicate signs of magnetite ore being used (Seneviratne 1985).

Types and the distribution pattern of iron ore

According to the earliest accounts of Sri Lanka, it seems that the country was rich in iron ores and it could be found at less than 4-5 feet (1.2-1.5 m) in depth in the ground (Knox 1681). The `Blue Book' which was published by the government in 1988 recorded that there were 17 iron mines in the western province and 20 iron mines in the Southern province, West of Girapattu in the Hambantota district. It was also recorded that 650 pounds of iron ore were sold at the rate of 8 cents per pound (Karunarathne and Dissanayake 1990). Tennent had also recorded that iron ore was found in the South Western part of Sri Lanka and iron workers used to break off a sufficient quantity of iron within 3 hours (Tennent 1859). During the 19th century, the technology of iron smelting was practiced only near Balangoda and smelters of the area used to go to Nuwara Eliya for collecting the ore. They also used to smelt the ore at the same place where they had collected them (Coomaraswamy 1908).

The Lawrie's Gazette, published in 1896, has recorded the villages called *Akarahaduwa* and *Akarahadiya,* which used to smelt iron ore and supply a certain amount of rough iron lumps to the king's treasury as their principal service. The villages' names starting with *Akara* and *Agara* had been engaged in the service mentioned above. The royal treasury distributed iron lumps among the blacksmiths for the production of iron tools. The prefix *agara* in Sinhala means the iron mine. Therefore the village names starting with the prefixes, *agara* and *akara* refer to villages that used to mine iron (Karunarathne and Dissanayake 1990). Recently, some traces of ancient mining have been found near the Panirendawa Magnetite ore deposit recently (Bopearachchi pers. com.).

The hydrated iron oxides such as haematite, limonite, goethite, and the high grade iron ore deposits of magnetite are the main two types of iron ore that occur in Sri Lanka (Cooray 1984; Somasekeram 1988). Ancient iron ore deposits in Sri Lanka are given in Figure 2-1.

Hydrated iron ore deposits

Haematite, limonite, and goethite iron ores are hydrated iron oxides which are occurring as surface or hill cappings and as scattered boulders of irregular masses extending a few feet below the surface or near the surface (Cooray 1967; Herath 1980; Somasekaram 1988). The nodular form of haematite and limonite arises as a decomposition product of rocks that are spread in small quantities (Coomaraswamy 1908).

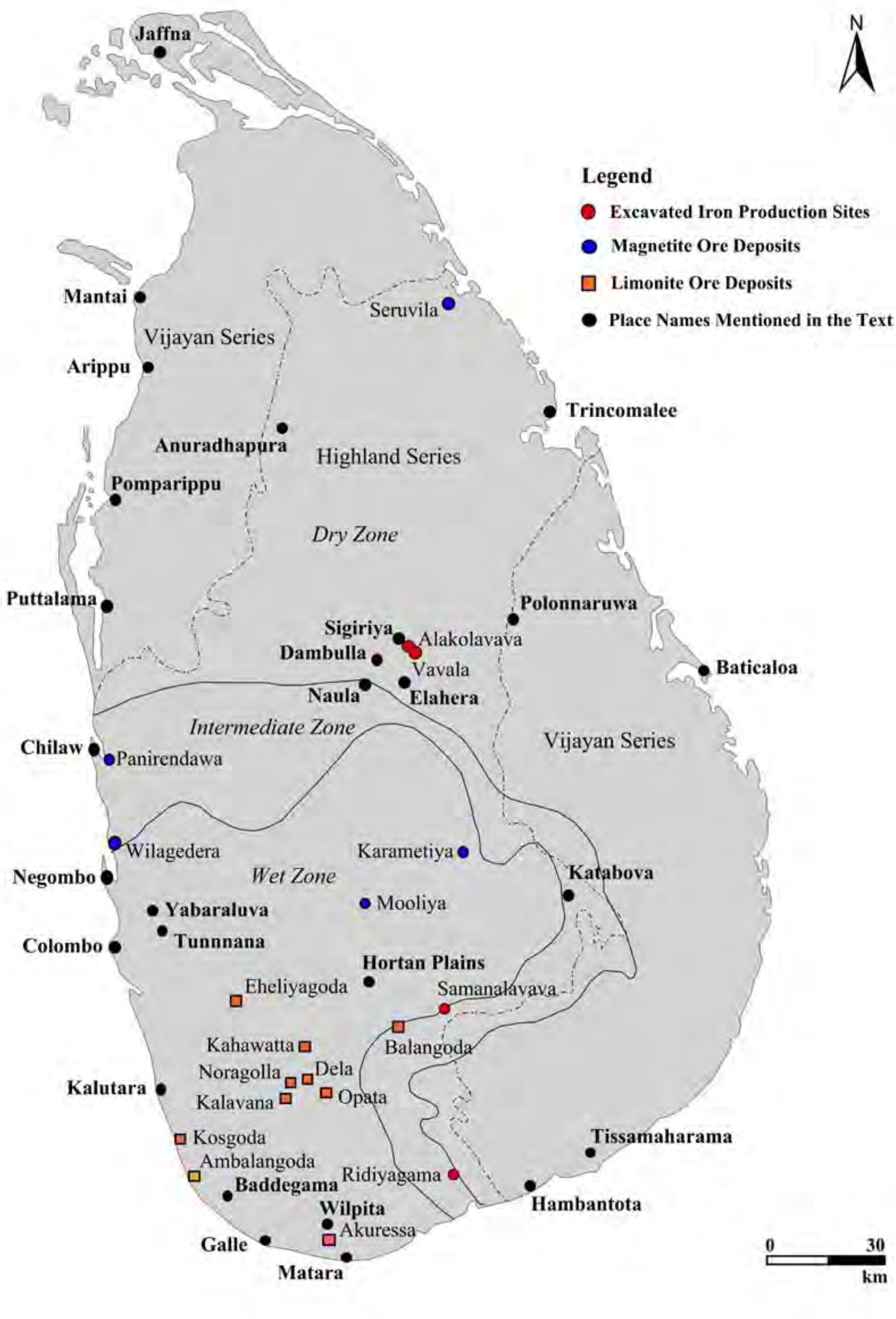


Figure 2-1. Map of Sri Lanka showing locations of ancient iron ore deposits in Sri Lanka and places mentioned in Chapter 2 (Solangaarachchi 1999). Data of iron ore deposits for Solangaarachchi 1999 obtained from Senevirathne 1985 and 1992.

According to Cooray (1967) and Herath (1980) the hydrated iron ore deposits are distributed:

- Mainly, in the south west of the island; at Ambalangoda near Godakele and in veins of quartz at Mount Lavinia on the sea shore,
- Particularly in the Rathnapura District; Rakwana, Balangoda and Kalawana in the Sabaragamuwa Province. The most important deposits are occurring at Dela, Noragolla, Opata and Poranuwa in the Rathnapura district and Wilpita in Galle district.
- To a lesser extent in Galle and Matara districts in the southern province.

Iron smelting works using nodular limonite and haematite iron ore in the Ambalangoda area in the South Western part of the island (Tennent 1859) and the Balangoda area in the Sabaragamuwa province (Coomaraswamay 1908) have been recorded from the 17th century onwards (Knox 1681; Davy 1821; Baker 1885). The excavations done recently had evidence of using that type of ore from the Early Historic layers in Samanalavava, upper Valave region and Ridiyagama, lower Valave region (Juleff 1998; Bopearachchi pers. com).

An iron-rich layer of nodular ironstone or ferricrete is commonly found in many parts of the island but particularly distributed in the Dry Zone. It has also been called nodular gravel, pisolitic gravel, or lateritic gravel. The nodular ironstone is found on top of the crystalline rocks of the Dry Zone and the northern part of the island, especially in the area between Puttlam, Kurunegala and Galgamuwa. It is dark brown in color and is often mixed with clay whose colors range from yellowish to brownish. The formation of nodular iron stone is based on the activity of iron oxide on the rocks during the heavy rainy season and the hot dry season (Cooray 1967). The nodular form of iron stone has been recorded from the Proto Historic Early Iron Age sites and Early Historic sites at the Anuradhapura Gedige and the citadel (Deraniyagala 1972), Pomparippu (Begley 1981) and Akurugoda in Tissamaharama (Parker 1884). According to Cook's accounts, the nodular iron ore exists in masses embedded in the crystalline rocks. The main deposits are in areas extending from Kalutara to Baddegama, Eheliyagoda to Kahawatta and Matara to Akuressa (Cook 1953).

According to the archaeological excavations that have been conducted in the north western portion of the island and the Jaffna peninsula, signs of ancient iron smelting have been recorded (Carswell and Prickett 1984; Begley 1967; Senivirathne 1985). Analytical works on the above soil regions and the North Central Province indicate those soil regions contain ferruginous gravel below the Reddish Brown Earth (RBE) formation. In the Jaffna peninsula and Mannar, the RBE is found on the surface of the limestone and in the north western area in cavities within the limestone. The RBE is best developed in the Dry Zone. It is developed over the lowest peneplain in Northern, North Central, Eastern and Southern provinces, where biotite and hornblende bearing gneisses occur in the Vijayan complex and the Highland complex (Figure 2-2), the area between Polonnaruwa and Trincomalee which lies in the Dry Zone (Dahanayake et al. 1979; Cooray 1984). The RBE group would have been formed due to the oxidization in tropical climatic conditions. In the brown earth limonite is present while in the red earth haematite is dominant (Cooray 1984).

High grade iron ore deposits

According to Davy’s description, magnetite had been found in masses embedded in gneiss in the Kandy region and in a granite rock at Katabowa in Wellassa and in Trincomalee (Davy 1821). Coomaraswamy has also recorded the iron smelting process with the use of magnetite ore in some districts. But he doesn't mention the names of the districts (Coomaraswamy 1908). The nature of the boundary between the Highland and the Vijayan series is a possible base for mineralization of metals (Somasekeram *et al*. 1988). The detailed map of geological regions of Sri Lanka is provided in Figure 2-2.

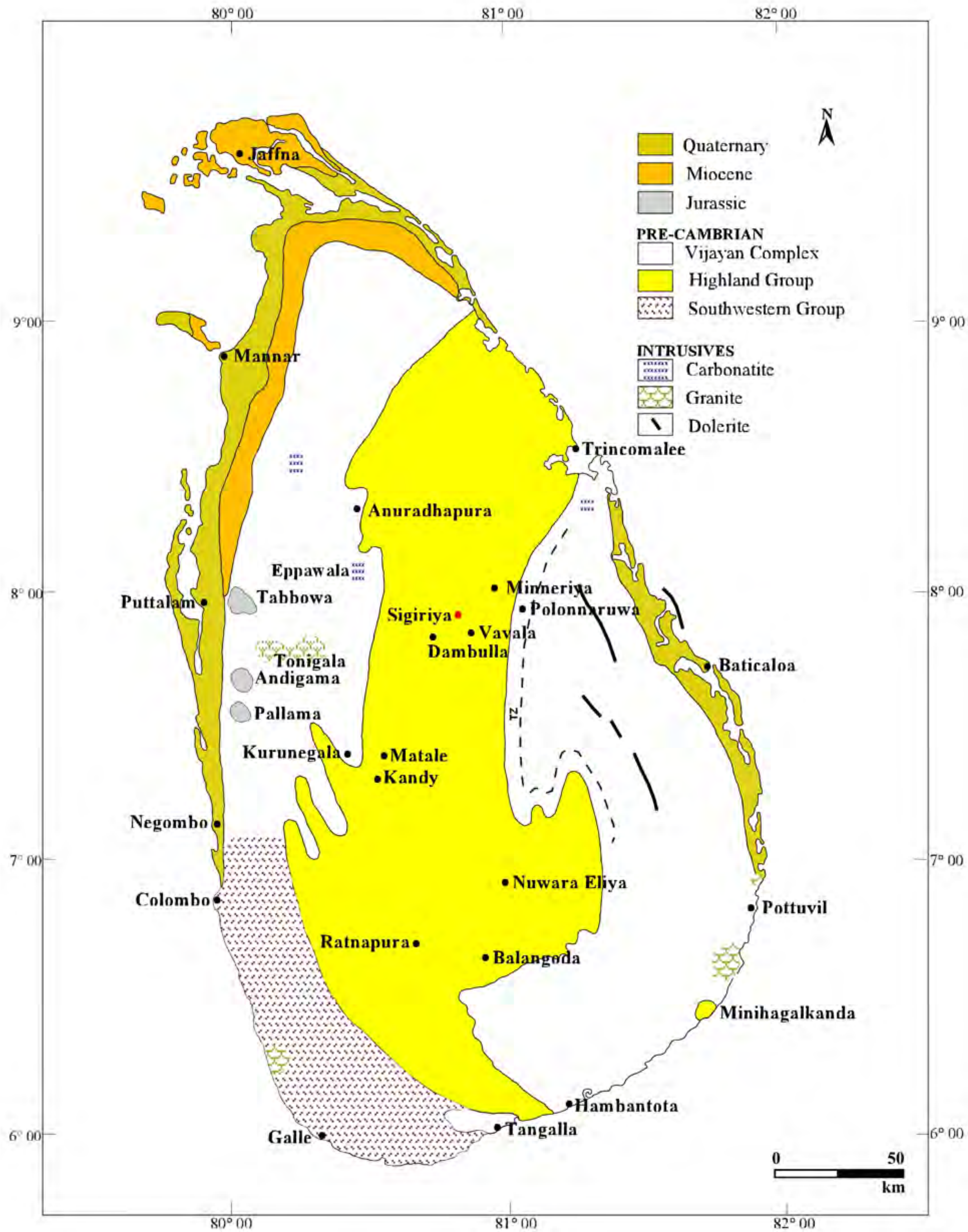


Figure 2-2. Geological regions in Sri Lanka: The Highland and the Vijayan Series (after Cooray 1984).

The high grade iron ore deposits of magnetite occur in the Puttlam district at Panirendawa near Bingiriya and Chilaw, in the Kurunegala district at Wilagedara near Tambakanda, Northeast of Negombo. Also copper/magnetite deposits occur at Seruwila in the Trincomalee district. These deposits were rediscovered recently in 1962, 1959 and 1971 respectively.

The project of mineral investigation was conducted in the Seruvila area in 1980 under the Mining and Mineral Development Corporation and the Geological Survey Department in collaboration with a French team - BRGM (Herath 1980). The large deposits of magnetite in Seruwila are located in the eastern coast of the island and on the boundary of the Highland and Vijayan series. Among the three magnetite deposits, the Panirendawa and Seruwila deposits are larger than the Wilagedera deposit. While the Panirendawa deposit contains around 5.6 million tons in quantity and is found 80-500 feet (24-150 m) below the surface, the Seruwila deposit contains around 7 million tons and is found about 200 feet (60 m) below the surface. Panirendawa and Wilagedara deposits are located in the west coast of the island and occur in banded formations with quartzite, and the Seruwila deposit is mostly disseminated in the rock (Herath 1980; Cooray 1984; Senevirathne 1985).

The region of the Seruwila mineral zone is divided as Block `C' Arippu and Kollankulam. Some slag heaps were found from the investigation of the area; historical sources and inscriptions indicate that well organized copper smelting works had been activated during the Early Iron Age in the area. It is important to note that the two small deposits of magnetite at Mooloya and Karametiya are situated too far from the Early Iron Age habitation site (Herath 1980; Senevirathne 1985). A single large heap 2 meters in height and extending over 100 meters in length consists of smelting slags recorded from the explorations near the Tambakanda hill recently (Juleff 1998). Analyses of iron ores in Sri Lanka are provided in Table 2-2.

Fuel

Wood was used by the ancient iron workers as the main source of fuel in the production process. The ability to do so depended on the natural vegetation. The availability of fuel and the type of fuel capable of producing the required degree of temperature are the most important factors for pre-modern iron smelters. During the production process they had to increase the temperature inside the furnace for reducing the non-compact ores like haematite and limonite up to 1200 °C while magnetite (which is a compact ore) up to 1800 °C, requires a comparatively much higher temperature.

Ethnographic and literary evidence indicates that the pre-industrial smelters of Sri Lanka utilized either wood charcoal or paddy husk as a fuel base (Davy 1821; Baker 1898; Coomaraswamy 1908). Due to the high siliceous content in the paddy husk, it is capable of glowing and retaining heat much longer than wood charcoal. On the other hand, using the cow dung could generate a sufficient temperature of 1200 °C, which is the reducing temperature of non-compact ores used mostly in the ancient iron smelters. The evidence found from the excavation in the Anuradhapura citadel indicates that the proto-historic communities used paddy husk as a tempering agent for firing (Deraniyagala 1972; Seneviratne 1985). Paddy husk also has been recorded as a fuel for iron works in India (Tripathi and Tripathi 1994). There is no direct evidence for using animal dung as a fuel base in the ancient Sri Lankan context. But there is evidence in the megalithic context in Deccan, Peninsular India, for using animal dung as a fuel to obtain heat (Seneviratne 1985). Even today it is a commonly used fuel in India. The pre-modern iron smelters used specific types of wood which give a high temperature and do not readily reduce to ash. Such wood was easily available in the environs of the working sites engaged in the smelting and smithing processes.

Table 2-2. Analysis of iron ores in Sri Lanka

Constituents	Dela[a] limonite	Panirendawa[a] magnetite	Seruwila[a] magnetite	Samanalavava[b] haematite	Balangoda[c] haematite	Alakolavava[d] magnetite
Fe_2O_3	80.11	73.21	94.66	79.46	72.30	98.5
Sio_2	4.25	18.70	0.86	6.15	9.14	0.1
Al_2O_3	2.22	5.59	3.34	3.52	9.85	0.8
MnO	0.94	0.69	0.02	0.02	-	-
TiO_2	-	-	0.12	0.14	-	0.1
P_2O_5	1.75	0.11	Tr.	0.81	0.05	-
CaO	0.11	0.73	-	0.06	-	-
MgO	-	0.74	-	0.09	-	0.5
S	0.19	0.17	0.70	-	-	-
H_2O	-	-	-	-	8.40	-
K_2O	-	-	-	0.25	-	-
Cr_2O_3	-	-	-	0.05	-	-
Ni ppm	-	-	-	90	-	-
Cu ppm	-	-	-	206	-	-
So_3	-	-	-	0.11	-	-
P	-	-	-	-	0.22	-
FeO	-	-	-	-	0.22	-
Total	100.59	99.94	99.70	100.9	99.96	-
Loss on Ignition	11.02	-	-	10.37	-	-

Note: I composed this table using data obtained from the following sources.

[a] Herath J.W. 1980. Mineral resources of Sri Lanka. *Economic Bulletin No. 2.* Colombo: Geological Survey Department.1980.

[b] Juleff G. 1998. Early Iron and Steel in Sri Lanka: A Study of the Samanalavava Area. *AVA-MATERIALIEN 54*. Mainz: Verlag Philipp von Zabern.

[c] Coomaraswamy, A.K. 1908. Medieval Sinhalese Art. Broad Campden: Essex House Books.

[d] Noreus, D. 1999. Chemical Characterization of Ore, Slag and Iron from an Advanced Bloomery Process in the Sigiriya-Dambulla Region. In *Early iron smelting technology in the Sigiriya-Dambulla Region: Dehigaha-ala-kanda at Alakolavava*. The thesis submitted for the degree of Master of Philosophy (MPhil) to the Postgraduate Institute of Archaeology. Sri Lanka: University of Kelaniya.

Metallurgical studies on Alakolavava, Dehigaha-ala-kanda furnaces are also given in Appendix G and the Dikyaya-kanda furnace at Vavala are given in Chapter 7.

Ondaatje (1854) and Coomaraswamy (1908) also documented the manner in which iron was converted into steel with some chips of *Cassia auriculata* (Sin. *ranavara*) and *Toddelia aculeata* (Sin. *kudu-miris*) wood. According to Coomaraswamy, the steel made in this method is free from sulphur and phosphorus and very rich in carbon (1.97%). *Cassia auriculata* also has been recorded in India for the iron working process; it is grows mostly in the arid zones in Southern India (Prakash 1990a; Tripathi and Tripathi 1994).

The dense and heavy charcoal yielding wood species of *Shorea rubasta* (Sin. *Sal*), *Caltropis gigantica* (Eng. Bamboo, Sin. *una*), *Tectona grandis* (Eng. Teak Sin. *thekka*), *Xylia dolaberiformis* (Eng. Grool), *Acacia arabica* (Eng. Babul), *Asclepias gigantica* and *Convolvulus laurifolia* are also recorded in the ethnographic history, which is relevant to Indian iron working (Prakash 1990a; Tripathi and Tripathi 1994).

The other species were recorded in Sri Lanka as *Syzygium zeylanicum* (Sin. *marang*), *Syzygium assimile* (Sin. *damba*), *Syzygium spathulatum* (Sin. *path-beriya*), *Anacardium occidentale* (Sin. *Kaju*), *Acronychia pedunculata* (Sin. *ankenda*), *Schleichera oleosa* (Sin. *Kon*), *Madhuca Longifolia* (Sin. *mi*) and *Wendlandia bicuspidata* (Sin. *wanaidala*) which were used in the pre-modern period (Senevirathne 1985; Juleff 1998).

According to the ethnographical records, the pre-modern iron workers used to call *Syzygium zeylanicum* (Sin. *marang*) as *yakada marang* (Sin. *Yakeda*, Eng. Iron). It indicates the utilization of this wood species for iron working. The Syzygiums species have also been recorded in Africa for making charcoal (Schmidt 1997; Juleff 1998).

I used all information given above to compose the Table 2-3. In addition, I used botanical terms taken from five commonly used sources (Trimen 1895; Pulimood and Joshua 1951; Worthington 1959; Gunawardhena 1968; Dassanayake and Forsberg 1981).

Table 2-3. Recorded wood species for the iron working process in ancient Sri Lanka

Botanical Term	Family	Sinhala Name	Tamil Name	English Name	Habitat
Anacardium occidentale	Anacardiaceae	*kaju*	*mundiri(kottai)*	Cashew	Dry regions
Acronychia pedunculata	Rutaceae	*ankenda*	-	-	Dry zone
Cassia auriculata (syn. C.laurifolia)	Leguminoseae	*ranawara*	*avaram*	Tanner's Cassia	Dry regions (common in low country)
Litsea ovalifolia	Lauraceae	*beriya*	*tipparathai*	-	Higher hills
Madhuca longifolia (syn. Bassia longifolia)	Sapotaceae	*mi*	*iluppai*	-	Dry zone (occasionally wet zone)
Schleichera oleosa (syn. S.trijuga)	Sapindaceae	*kon*	*kuula*	Ceylon Oak	Dry zone
Syzygium assimile (syn. Eugenia assimile)	Myrtaceae	*damba*	-	-	Moist regions
Syzygium gardneri (syn. Eugenia gardneri)	Myrtaceae	*damba*	*nir-naval*	-	Central province
Syzygium spathulatum	Myrtaceae	*path-beriya*	-	-	Hill country
Syzygium zeylanicum (syn. Eugenia spicata)	Myrtaceae	*marang*	*marangi*	-	Dry regions/Central province
Toddelia asiatica (syn. T.aculeata)	Rutaceae	*kudu-miris*	*kandai*	-	Dry zone/hill country
Vitex pinnata (syn. V.altissima)	Verbenaceae	*milla*	*kadamanakku*	-	Dry zone/low country also found elsewhere
Wendlandia bicuspidate	Rubiaceae	*wanaidala*	-	-	Dry zone

Fluxes

In the iron smelting process, the flux is a substance which was added to a furnace charge to increase its fusibility and combine with those constituents not wanted in the final product and issued as a separate slag. The wood charcoal may have acted as a flux agent in many cases of iron smelting. According to the records of the pre-industrial iron producing method, it seems Sri Lankan and Indian smelters generally smelted the ore with no addition of flux. In these cases, the percentage of SiO_2 and CaO in the ore reacts as the flux. In some cases, crushed quartz was added to the smelting charge. Silica in the quartz acts as a flux and increases the separation of the iron bloom from the gangue in the furnace. The use of flux was not a common practice, although in some parts of India, limestone or sea shells were added as flux (Tripathi and Tripathi 1994; van der Merwe 1980).

Furnace Construction

The technological efficiency of the production process depended on the furnace construction. Therefore the most valuable part of studying the excavation of the iron smelting site is to study the remains in order to understand the structure of the furnace as accurately as possible. Three factors are basic requirements of the smelting process: the speed of increasing the temperature; attaining the temperature; the oxidation and reduction conditions inside the furnace. These factors depend upon the furnace structure.

The melting point of iron is 1534°C. It is a much higher temperature than copper (1083°C). The reason is that bonding iron to oxygen is much stronger than that of copper to oxygen. In the pre-modern furnaces such a high temperature could not be reached. Therefore with the help of charcoal in the furnace, a solid state iron was produced at about 1200°C. An enclosed furnace structure helped to raise the temperature up to 1200°C -1250°C with the help of natural or forced draught. The reduced iron was produced as a lump or bloom which was a mixture of solid iron, iron slag, and pieces of unburnt charcoal. The process that produced the wrought iron as a bloom in early times is called the bloomery or direct process and the furnace which was used for the process is called the bloomery furnace.

According to Martens classification (1978), there are three main types of furnaces. The determination is based on the construction of furnace superstructure. When we look at archaeological evidence, it seems that the type of the furnace depends on the local geological conditions in the area, the quality and quantity of the raw materials, and the nature and quantity of the output. Therefore some furnaces were constructed on the ground and the lower parts of some furnaces were dug in or down into the ground. The furnace shaft was constructed on the surface or in the pit.

In the South Asian complex, many types of iron smelting furnaces were recorded. The typology was mainly based on the size and the shape of the furnace, the type and the number of *tuyeres* and bellows, the slag tapping methods, and the metal refining technology. Most of these types were recorded in the Sri Lankan context as being in the Indian subcontinent (Benerjee 1965; De and Chattopadhyay 1984; Gaur 1983; Ghosh 1964; Gogte 1982; Holland 1892; Hughes 1873; Tripathi and Tripathi 1994; Watt 1890; Tripathi 1991; Watt 1890).

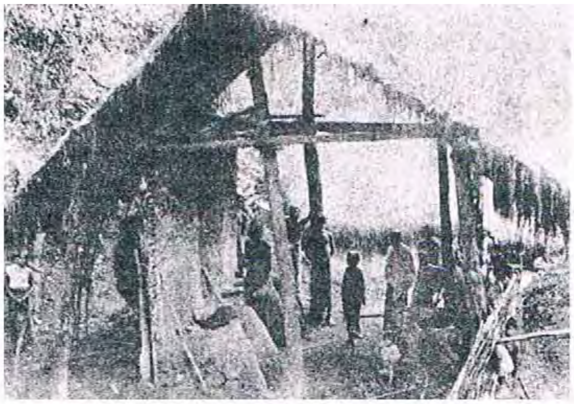
The earliest record of furnace construction in Sri Lanka was provided by Knox in his *`An historical relation of Ceylon'* (1681). According to his description, the furnace was constructed on the surface. Coomaraswamy (1908) has documented pre-modern iron and steel furnaces in Balangoda (Figure 2-3). According to his descriptive records, the iron smelting furnaces seem very similar to those described by Davy. Davy has given a very descriptive record of the construction method; it seems that the furnaces have been built above the ground in the form of a clay structure as follows:

> Their process of smelting iron, like most of their other processes, is chiefly remarkable for its simplicity. The most complete Singhalese smelting-house that I ever visited, consisted of two small furnaces under a thatched shed. Each furnace, at its mouth, was about one foot four inches, by eight inches in diameter; about three feet deep, and terminated in the form of a funnel, over a shallow pit inclining outward. They were made in a bed of a clay, about three feet high and three feet wide, against which a light wall about ten feet high, was raised to protect the bellows and operators, who were situated immediately behind. (1821)

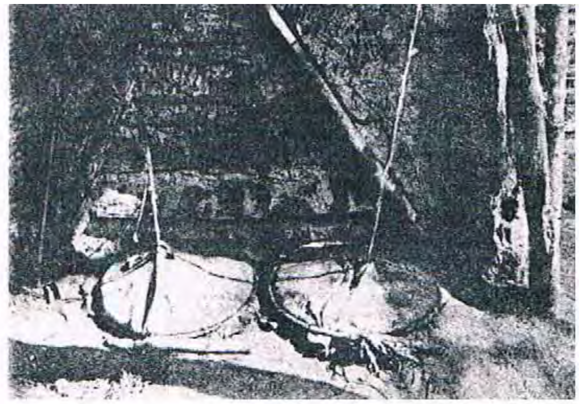
Coomaraswamy and Davy have recorded a box or rectangular type of furnace which was built on the ground. The steel making furnaces were smaller than the iron smelting furnaces and built at the ground level. The type of the furnace was semi-circular and was defined by a low clay wall, rising about six inches above the ground.

Recent excavations (1980s), in the ancient Sri Lankan iron smelting sites revealed various types: oval, circular semi-elliptical types with bowl or shaft typologies in Samanalavava (Juleff 1998); rectangular and circular shapes with shaft or domed construction features in SDR (Forenius and Solangaarachchi 1994); box and elliptical types forging furnaces in Ridiyagama (Bopearachchi pers. com.); circular type pit/bowl furnace at Salgahawatta in Anuradhapura citadel (Coningham and Allchin 1992).

The collaboration project between the Archaeological Department of Sri Lanka and the Commission for General and Comparative Archaeology of the German Institute of Archaeology (KAVA) has revealed a very significant chain or row type furnace used in ancient Sri Lankan metal production in Akurugoda, Tissamaharama, and the ancient capital of Ruhuna. The furnaces were aligned in a `battery' system with a long firing channel. West of the channel, 18 short branches were constructed similar to fingers placed on a palm. This long furnace, 11 meters in length, was preserved (Figure 2-4).



A. Iron smelting furnace; general view.



B. Iron smelting furnace; the bellows.

C. The furnace at work.

D. The bellows-blower.

E. Steel furnace at work.

F. Steel furnace; removing crucibles.

Figure 2-3. Pre-modern iron and steel furnaces in Balangoda, Sri Lanka (Coomaraswamy 1908).

The tiles scattered over the metal production site at Akurugoda indicate that a tiled roof had been built over the furnace. According to the excavators, the furnace had been used for copper or other precious metal production (Weisshaar and Wijeyapala 1994).

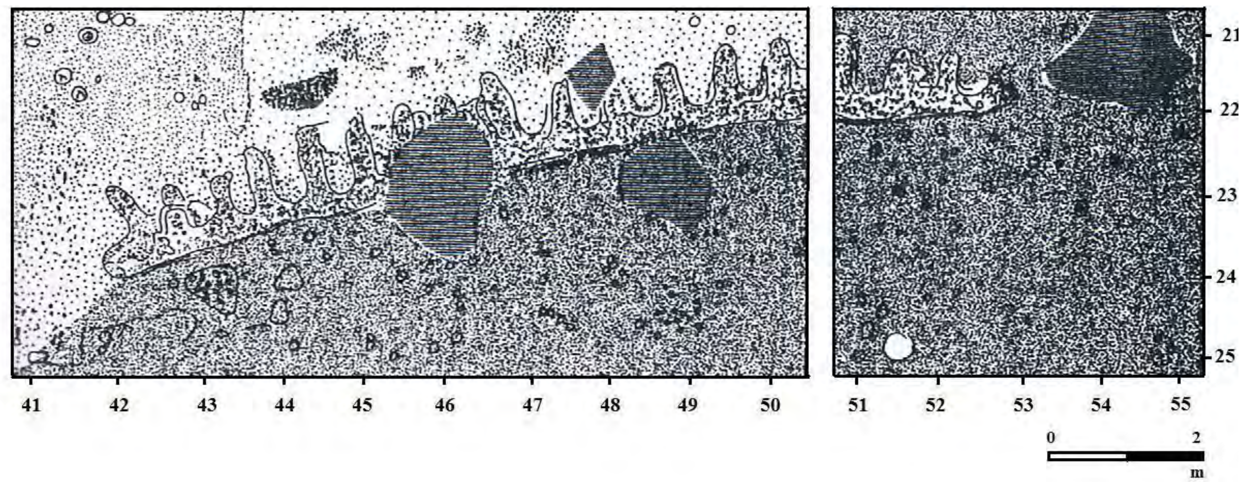


Figure 2-4. Metal smelting chain type furnaces at Akurugoda in Tissamaharama (Weisshaar and Wijeypala 1994).

From the early accounts given by Knox (1681), Davy (1821) and Coomaraswamy (1908), it seems that early furnaces in Sri Lanka were made of clay; they were above the ground, lying on a bed or a platform of clay. The Samanalavava excavations indicate that the furnaces had a base of sand, rock, clay or debris of iron production (Juleff 1998). Before the construction, a terrace is cut into the bedrock and the subsoil or the existing deposits of previous debris. The east/back wall of the furnace was located on the eastern edge; there is evidence of it being lined with a thin layer of clay. The furnace wall was also made of red clay which was transported from a distance to the smelting site. The west or front wall was made of slag and fired clay fragments with *tuyeres* re-used as a front wall base. Ethnographical studies done around the area indicate that stone was used for building the surrounding of the furnace and clay was used the furnace itself and the bottom of the furnace is covered by sand (Juleff 1998). The furnaces of Ridiyagama were also made with red clay and sand as in a typical (Bopearachchi pers. com.).

The middle historic period furnace unearthed from excavations done in 1985 at the Anuradhapura citadel indicates that the furnace was constructed with the use of burnt bricks (Seneviratne 1985). The walls of Naikund furnaces in India were also made with circular clay bricks (Gogte 1982; Tripathi and Tripathi 1994).

Air supply system

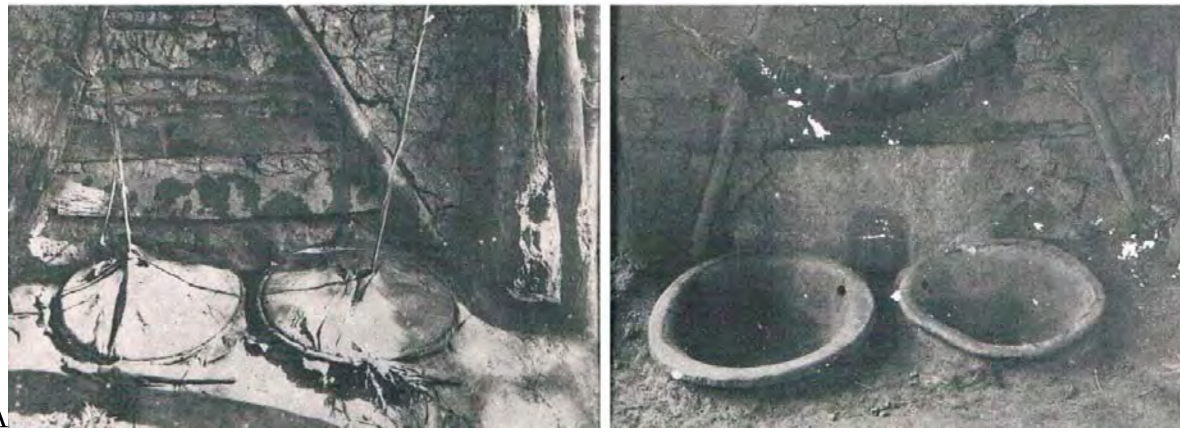
The maximum production that could be obtained from the raw materials used generally depended on the ability to control the reduction conditions in the furnace. Heat is the most important factor of the iron smelting process. The heat generated by an ordinary charcoal fire may reach up to 700°C. The furnace, should have facilities either of natural draught or forced draught to raise the required high temperature for the smelting process. A natural draught of air through a furnace is induced by a high chimney (Hedge 1990).

According to the archaeological and ethnographical evidence, three main systems were used for supplying the air to the furnace: natural or induced draught power; forced draught power blown by foot or hand-operated bellows and forced draught power blown by water-driven bellows.

Experimental archaeological research at Samanalavava indicates that ancient smelters in the area used the south-west monsoon winds that lashed across the region at a velocity of 70 km per hour from June to September as a natural draught. The furnaces were oriented towards the west to enable the use of the wind pressure principle to maintain a high temperature (Juleff 1998). The excavators of Ridiyagama furnaces also believed that the smelters of Ridiyagama used the wind pressure principle because the furnaces were oriented westwards and both sites are in the same geographical zone related to the river basin of Valave ganga (Bopearachchi pers. com.). Natural draught using furnaces were only recorded in Burma (Watt 1890), other than Samanalavava of the South Asian region. The natural draught furnace found in Burma had 20 *tuyeres* and was 3.2 m in height (Tylecote 1976). Furthermore research must be conducted to determine if there are furnaces of the same type in the South-Asian regions that have the same geophysical and environmental factors. In Africa some records revealed that the induced draught furnaces had more than 100 *tuyeres* (Tylecote 1976; 1980). Samanalavava furnaces in Sri Lanka also are believed to have used several *tuyeres* which were connected to the front wall (Juleff 1998).

A forced draught furnace will have provision for an air blast blown by foot or hand-operated bellows through *tuyeres.* There is evidence in literary sources to suggest that bellows were constructed of two large terracotta pots over which an animal skin was stretched. A well-seasoned deer or sambur skin had been drawn. In later periods a goat skin has been was commonly used. The more developed bellows were made of wooden panels, which were also covered with animal skin. These types of foot bellows were referred to as a *thalimana* (*thali* means pot). There is evidence of a bowl made of *Caryota urens* (Sin. *Kitul*, Eng. Toddy Palm) wood as a bellow base (Juleff 1998). The primitive bellows were operated by the foot of the smelter with a string attached to the bellow skin. The more developed ones were operated by hand. This type of hand-operated bellows was referred to as a *mainahama*. Primitive iron smelters used a single pair of small bellows, which were connected to the furnace through bamboo or clay pipes called *tuyeres*.

An ethnographic survey in Samanalavava region indicates that ancient smelters used bamboo pipe formed into a `Y' shape while two short pipes of the device connected to two bellows and the long end to the furnace wall (Juleff 1998). Usually the air was blown from a pair of bellows through one blow- pipe, but in large furnaces, four or even more bellows and *tuyeres* were provided (Prakash 1990a).



A B

Figure 2-5. Bellows used in early 19th century in Sri Lanka. A) Bellows-covered. B) Bellows-uncovered. Photographs from the Coomaraswamy's photo collection at the Kandy Museum.

Coomaraswamy has given detailed description for iron and steel making process (Figure 2-3). He notes how to make and operate the bellows as follows:

> The bellows, from which a continuous blast is kept for three hours or more, are worked by two other men, who share the work by turns; they are of a primitive but ingenious type. Behind the furnace are embedded vertically in the ground two logs of wood, about 17 inches in diameter, and hollowed out above to a depth of three or four inches; over each of these a piece of deer skin is tied, having a small hole near its centre, and at the centre a piece of cord attached, which latter is fastened six or seven feet above to a springy stick, the lower end of which is embedded in the ground. From each of these two sections of the bellows a small pipe conducts the blast into the hole leading to the well of the furnace. The bellows blower stands with his feet, one on each of the deer skins, facing the wall and lifting and putting down his feet in turn, drives a continuous blast of air into the furnace; for as he puts down his foot to press out the air from one skin, he covers the hole in it with the sole of his foot; and meanwhile the other skin is illed with air through the hole, which is uncovered when he lifts his foot, the skin being pulled up by the tension of the bent stick upon the string. On either side of the blower is a stake which he grips hold of, and to which a strap is fastened that passes round behind him and supports his back. (1908)

The bellows blown furnace type using a long single *tuyere* have provided in the Mandara Hills and the Nigerian Plateau in Africa (Tylecote 1976). Knox (1681), Davy (1821), Coomaraswamy (1908) and Parker (1909) have given more descriptive records for the ancient Sri Lankan bellows. The local name for *tuyere* - *vangi nalama* - is still being used among the *navandanno* generation at Embakke in the Kandy region. When I was interviewing a 55year old woman, Heen Manike at Embekke, she provided the above name for the *tuyere* that people are still using in gold crafting.

Production technology

The production technology of the iron smelting process directly depends on the quality of iron ore and other raw materials and the furnace construction in some way. The production process consists of pre and post activities, which are connected to the main process. The main stages or distinct processes involved in iron production are: the preparation of the ore, the preparation of charcoal, the operation of the furnace and the extraction of bloom.

Ancient smelters mostly used limonite and haematite ores for the production process as discussed. Low grade iron ores were softer and more easily crushed than those with higher iron content. A group of people collected or extracted the ore from the deposits. If the deposits were located at a distance from the smelting site, the first step in dressing the ore took place at the mine before the ore was transported to the smelting village or the production site.

At the next stage, the collected ore was piled in heaps for drying. After that they roasted the ore to expel much of the water content together with carbon dioxide and volatile components like sulphur in the ore. When roasting, the limonite ore is converted into haematite by removing the water content. The roasted ore was crushed into suitable sizes for the furnace and the inferior ore was sorted out and thrown away. Roasting the ore renders it more porous and fragile; therefore, it was very easy to crush and thus more suitable for reduction in the furnace. Sometimes iron smelters winnowed the particles of ore in strong wind to separate them into portions of different sizes. While the fine crushed portion was used for the production process, other portions were re-crushed to get smaller particles. According to ethnographical records, occasionally iron smelters used to roast the ore after crushing it into the smaller particles. They crushed the ore and then washed it often in running water, to remove the less dense gangue. Studies on ancient Sri Lankan and Indian iron smelting conducted so far have been concentrated mainly on the preparation work with ore as mentioned above or very similar activities (Knox 1681; Juleff 1998; Tripathi and Tripathi 1994).

In the Sri Lankan context, iron producers also used these two methods accordingly to ethnographical studies. In the surface kilns method or heap method, they heaped the selected branches of wood over the ground and burnt them. When they were burnt sufficiently, further burning was stopped with water or by covering them with green branches of wood and putting a thin layer of soil over them. In the pit kiln method, iron smelters used a pit dug out in the jungle about 2 m x 2 mx 1 m and put the green and dead branches of selected wood into it to burn for few hours. After that, the burnt pit was covered with a layer of green leaves and a layer of soil for one or two days. In these methods they usually put larger logs at the bottom and smaller branches over the top (Juleff 1998).

According to the accounts given by Knox (1681), Davy (1821) and Baker (1885), the descriptions of the smelting process were very similar to those witnessed by Coomaraswamy. I have seen a furnace operation very similar to that which Coomaraswamy has described still being used by the Indian Agaria tribes live in Madras in 1995. Agaria tribes are living in Madhya Pradesh between the rivers Son and Godavari (Tripathi and Tripathi 1994). *Agarias* are a special group or caste that are involved in iron smelting in their own traditional way. The name *Agarias* means the people who work with fire (Prakash 1989).

Ethnographic records in the Balanagoda area on furnace operation reveal that the smelters had used alternating layers of charcoal and ore in the ratio of 1:1(Juleff 1998). During the production process, more charcoal was added. Iron smelters of the area were used to start the production process early in the morning and extract the bloom in the evening. If the production process starts at night, it takes all night and the bloom is extracted early in the following morning (Juleff 1998).

When one production shift was finished, the smelters broke down the front wall of the bloomery furnace and the bloom was taken out. Ethnographic evidence on ancient Sri Lankan iron technology suggests that soon after the bloom was taken out they cleaned the furnace quickly before cooling for preparation of the next production shift. Sometimes they made a hole in the front wall for tapping the slag with the use of wooden sticks before cleaning (Juleff 1998). According to the early descriptions, the production process for a shift lasted three hours or more. When the bloom of iron was ready, the sand, which is used to close the furnace mouth, was cleared away and the bloom pushed out through the opening. Then the bloom was taken out with long tongs, which were made of green wood sticks. Then it was beaten on a wooden log and cut with a *Ketta* nearly half way through and thrown into water. Afterwards it was taken out and left for cooling. The bloom that was made as described above was sold to blacksmiths (Knox 1681, Coomaraswamy 1908). The *Agarias* had taken out the bloom through the hole, which was made by breaking the *tuyere* seal. Then they hammered the bloom for removing and squeezing out the slag.

The bloom was reheated to red heat in a blacksmiths forge to squeeze out any slag remaining in the bloom and to consolidate the metal and make a bar of wrought iron (Hodges 1964). In some cases it can be suggested that the smelter was used to refine the bloom before supplying the rough lumps of wrought iron to the king’s treasury for distribution to the ironsmiths (Karunarathne and Dissanayake 1990). The refined bloom was sold in bars for forging into artifacts.

Steel Production

The wrought iron, which is made through the smelting process, is soft. Therefore wrought iron must be converted into much harder material that could be used to work on hard surfaces like granite. The soft wrought iron was hardened by adding a carbon content of up to 0.3-0.4% and converted into steel. Steel is an alloy of iron and carbon. The source of carbon was charcoal, wood, or leaves. The amount of carbon absorbed into the iron depends on the temperature of the fire and the duration of the time that the object is left in the fire (Wheeler and Maddin 1980). According to the production technology and the final product, this process is variously known as cementation or carburization or case-hardening (Hodges 1976).

Crucible steel

The process of making steel was based on the principles of carburization of wrought iron in crucibles and these ingots were generally known as crucible steel or *wootz* steel. The ancient Islamic world used forged Damascus Swords from the high carbon crucible steel or Damascus Steel or *`Wootz Steel'* that was made in Southern India and Sri Lanka (Bronson 1986; al-Hassan and Hill 1986). The Warrangal district in the central Deccan Plateau in the Andra Pradesh (Old Hyderabad State), Mysore in Karnatake and Salem in Tamil Nadu were three world famous centers for the production of homogeneous carbon steel of 1-1.6% carbon which was known as *wootz* and exported to the west even as early as 400 B.C. (Tylecote 1980; Prakash 1989).

According to Indian scholars, the word *wootz* is derived from the Kannada word *wooku*, which means steel (Sin. *Vane,* Tam. *Urukku*) and there is evidence of the Damascus swords of *wootz* steel being present in the Persian court in the fourth and fifth centuries B.C. (McCrindle 1979; Prakash 1990a; Prakash and Tripathi 1990). According to *Periplus of the Erythrean Sea*, Indian steel was also being exported to Abyssinia (Schoff 1974; Prakash and Tripathi 1990).

The *wootz* steel was also known as “Damascus Steel” because it was the raw material of the Damascus swords. During the crusades, the Europeans first encountered the Damascus swords that were famous for their beautiful patterned surfaces or damascene patterning. The unusual vertical damask markings on the surface of the Damascus steel are iron carbide (Fe_3C) or cementite (Sherby and Wadsworth 1985)

Sri Lankan steel appeared in the book of al-Kindi who was a writer of the mid ninth century. According to him, four major sword-making centers of Yemen, Fars, Khorasan, and Mansura preferred using Serendib steel (Bronson 1986; Juleff 1998). Bronson mentioned some references to iron and steel exported from India and he also noted the reference to iron of the *Seres* which appeared in the Pliny's book *Historica Naturalis.* Schoff (1915) argued that *Seres* is derived from the Sinhalese word *seri.* According to the explanation given by Schoff, this may be the first connection of Sri Lankan iron production (Juleff 1990) with the west.

Knox (1681), Davy (1821) and Tennent (1859) had given brief accounts of steel production. The detailed accounts of the process of crucible steel making were given by Ondaatje, in *The Ceylon Almanack and Annual Register* (1854) and by Coomaraswamy in the *Administration Report of the Mineralogical Survey* (1904) and in his *Mediaeval Sinhalese Art* (1908). According to Ondaatje's record, Deheigolla and Iwalla in Wellase, Irewardumpulla in Kandapalla, also at Horaguna, Hanahappawaela, Kammala and Kosgama, Kammala in Kandapalla and Mahawalgaha village in Sabaragamuwa district made crucible steel and they used to supply a certain amount of steel for the king’s stores annually. Coomaraswamy eye-witnessed the steel-making process of Alutnuwara. This site is located one and a half miles from Alutnuwara Devale. I have had an opportunity to collect some crucible samples from the debris of crucibles near the paddy field during my visit at the site in 1991 (Figure 2-6).

Figure 2-6. A crucible sample collected near paddy field near Aluthnuwara Devalaya. (Presently exhibits at the Archaeology Museum of the Kelaniya University). Photographs by R. Solangaarachchi.

Hadfield was also impressed by the fact that traditional iron and steel production in Sri Lanka was of a very high standard (1912). Like earlier writers, Cipolla's writing quotes the references the European travelers had made to Sri Lanka. He noted that the Chingalas made the fairest gun barrels that may be found in any place and that Sri Lanka became a well known center for the production of fire arms (Cipolla 1965).

Crucibles

The Indian crucibles were made by hand in a conical form usually, 19 cm in length, 7 cm top diameter and 13 cm inner depth of unbaked ferruginous, tempered clay. The clay, which was used for making crucibles, was well-kneaded and contained a mixture of red loam with dried rice husk, a small quantity of some carbonaceous matter without sand, and gritty matter consisting mainly of aluminum silicate and quartz. Although the outer surface of the crucibles was rough and hard-pressed, the inner surface was smooth. It might be that it had been made on a wooden frame (Rao 1982; Prakash 1990b; Tripathi 1994). The shapes and sizes of the crucibles are different from place to place. Differences depended on the size of the furnace and the production process. While the Hyderabad crucibles were a cup shape. The Mysore crucibles were a conical shape. Both types of crucibles had a lid. The Tamil Nadu crucibles were in a flower-pot shape (Rao 1982). The ingots of typical *wootz* steel were widely traded in a rounded cake form (Sherby and Wadsworth1985).

In the Sri Lankan steel production, the crucibles appeared in various forms. The most well-known form was a tubular form. It was made of rice husk (Sin. *dahaiya*) and clay mixture in ratio of 1:1 (Ondaatje 1854; Coomaraswamy 1908; Juleff 1990b). Jayatilleke has described about 12 types of crucibles based on their shapes that were used in ancient Sri Lankan metal production (Jayatilleke 1990). The crucibles described by Coomaraswamy (1908) were each about 8 inches in length, 2 inches in diameter and a 1/4 of an inch in thickness. It is important to note that Mawalgaha crucibles are the same in shape and size as those described by Coomaraswamy.

The production method of *wootz* steel was very similar to the ancient Sri Lankan steel production method that was described by Ondaatje (1854) and Coomaraswamy (1908). Analysis of “wootz steel’ objects from India and Sri Lanka indicate that all of them contain an amount of carbon that is less than 2% of their consistency: Wootz steel in Sri Lanka 1.97%, Mysore 0.963%, Damascus Sword 1.677% and Wootz Steel in India 1.33% (Prakash 1997). In addition all samples have lesser amount of Silicon (Si), Sulphur (S) and Prosperous (P): Wootz steel in Sri Lanka Si 0.07%, S 0%, P 0.07%; Mysore Si 0.127%, S 0.02%, P 0.007%; Damascus Sword Si 0.011%, S 0.007%, P 0.086%; Wootz Steel in India Si 0.045%, S 0.180%, P 0% (Prakash 1997).

The first documented report on the method of the Sri Lankan steel production was given by Ondaatje in `*The Ceylon Almanak and Annual Register'* as follows;

> It consists in introducing a small bar of good iron into a clay mould of a tubular form which they call *"Covey"* with pieces of the dried wood of the *Cassia auriculata* (Ranawara of the Singhalese). The open end of the tube is afterwards closed with clay, and it is placed in a charcoal fire for two hours, by which process carbon is supplied to the iron, which is thus converted into steel. The proportions for making steel of the best qualities are as follows; 7 parts of iron to 3 of dried wood. They also used the wood of the *Toddelia aculeata* the "Kudu Meris" of the Singhalese, in which case the proportions are 3 of iron to 1 of wood. This wood, however, produces inferior steel, but by increasing the iron to 5 parts, a better kind may be obtained. This kind of steel is not generally manufactured, as it is brittle, and unmalleable.
>
> The bars of steel generally manufactured and sold by the Singhalese are small, weighing 15 ounces' (Ondaatje 1854).

When the crucible was shaken, if a `sloshing' sound was heard, it indicated that a significant that amount of carbon has been dissolved in the iron. Then the crucibles were cooled very slowly at least for a day. The slow cooling produces a homogeneous distribution of carbon between 1.5-2% throughout the steel. After cooling, the *wootz* steel is forged at a temperature of 850°C and hammered into a blade. Then these Damascus blades are usually hardened by water treatment or quenching as described above (Sherby and Wadsworth1985).

In the Sri Lankan context, sometimes the process was in several times, using single furnace operation to get refined steel. In such cases molten metal was poured directly into a another crucible and put again inside the furnace (Juleff 1998). The typical method of hardening and tempering practiced by the Indians was thrusting the red-hot blade (850°C-950°C) into a green trunk of *Musa sapientum* (Sin. *kesel*, Eng. plantain). Its alkaline sap was sufficient to quench the blade and harden it. The alkaline sap acted as a corrosion resistant coating on the surface of the blade (Prakash 1991). There was evidence for using this technique in ancient Sri Lanka. Ancient Sri Lankans used plantain ash for quenching (Prakash pers. com.).

In addition to these methods, according to ethnographic evidence, ancient Sri Lankans used to make sharp edges of the tools in various ways. One method was: heat the tool for a little while and put it into a mixture of salt and acid. The second method was: grinding together the latex of *Calotropis gigantea* (Sin. *wara,* Tam. errukalai) and the ash of *Euphorbia antiquorum* (Sin. *daluk,* Tam. chatura-kalli) together with droppings of bats and pigeons. Then the mixture was applied on the tools and allowed to dry. After that another portion of the above mentioned mixture was boiled in *Sesamum indicum* (Sin. *tala,* Tam. ellu, Eng. gingerly) oil and the tools were put into it. The third method was to put the tools in a mixture of ashes of plantain stems and butter milk for a whole day. Davy (1821) also describes a method that was used to sharpen the tools, using certain species of grinded wood.

Social and Economic Values

Iron has been one of the critical technological and economic resources in all historic societies. Iron making provides many illustrations of the ways that technological innovations change the lives of the members in the community into which they are introduced. It not only affected those actually engaged in production but also had a more general social, economic and political significance in its influence on trade, urban growth and patterns of consumption.

Social anthropologists and archaeologists have tried to describe the social effects of metallurgy in the past (Childe 1942; Engels 1884). According to Childe, the cart, the plough and the potter's wheel could not have been manufactured without the tools of the metal carpenter. All of these items were being made prior to the rise of urban society in the Middle East (Childe 1942).

In the study of socio-economic systems that are relevant to the iron production activities in ancient times, we have formulated some general themes for discussion: What demands were made by the various methods of iron production on the supply of raw materials and the supply and organization of labor? What kind of community or organization has developed to supply the needs of the industry? How has iron been distributed and used?

Organization of production

The organization of production in a settlement combined with different activities of the members of the society. These activities depended on the nature of the production. Industrial level production organization was more complicated than that at family level or in small unit production systems. The success of the industrial level production sometimes may depend not only on the same settlement but also on the different settlements of the area. That situation arose when there was scarcity of the raw materials in the production area.

Supply of the raw material

The starting point of the production process was collecting the ore. From that point to the stages of distribution of the product, production may involve several groups of people. As will be described later, the whole process of the production probably involved different groups of people, sometimes more than three or four castes in ancient Sri Lanka. In that case, leather workers or *hommarayo* and potters or *badahelayo* may indirectly be involved in the production, for supplying animal skins for the bellows and *tuyeres* for the furnaces respectively. The social organization of the area therefore consists of a chain system, which was connecting the crafts relevant to the production.

Supply of labor

There is no clear evidence of the supply of labor for iron production in early historic times in the island. The word *kabara* appeared in the Early Brahmi Inscriptions as a *gahapati*. Paranavitana suggested *gahapati* was a householder who was the head of a social unit as well as of the political organization of the time. He also suggested that the social unit could be a family or a *Kula* (Paranavitana 1970). The *gahapati* group of the early period constituted the large majority of the population and it had included several artisan groups (Karunatilaka 1988).

According to the early records made by Knox (1681) and Coomaraswamy (1908), we can suggest the nature of labor supply for the industry in the Kandyan Kingdom. During the Kandyan period (1480-1815 A.D.), for the requirements of the royal household, there were fourteen departments of public works. One department was a *Kottal-badda* consisting of different classes of craftsmen. Twenty *mul-acari* or blacksmiths and extra 8 blacksmiths without regular service were also included in it (Coomaraswamy 1908; Pieris 1956). There was another very special department called the *Pattal Hatara* (four workshops) consisting of very clever craftsmen. They were working immediately for the king and a member in this group supervised the craftsmen of the *kottal-badda* sub departments that were established in various parts of the island (Coomaraswany 1908). According to the sources described above, a well-organized `labor department' was established from early times to the Kandyan period in ancient Sri Lanka.

Labor organization

According to the early writings, the iron workers were obligated to contribute a fixed quantity of steel to the Royal Treasury annually. This was their *rajakariya* or service tenure for the king.   There is ample evidence to suggest that they were allocated land in return for their services to the state (Ondaatje 1854, Davy 1821, Coomarswamy 1908). The land was known as a *badal panguwa* (Knox 1681). They produced mainly iron implements for local consumption, including mammoties, knives, axes and sickles for agriculture; swords, spear heads, arrow heads and gun barrels for warfare; surgical instruments; such as forceps and scalpels, writing instruments including pen nibs and building equipment and tools such as keys, locks, hinges, latches, nails, chisels etc. (Parker 1909).

As early as the 3 rd century B.C., steel implements must have been used to carve the Early Brahmi cave inscriptions on hard surfaces like granite. With developments over time, steel production in Sri Lanka reached its zenith during the 5th century A.D.

Production community

The pre-industrial metallurgical data of the island can be obtained from the ethnographic, historical and archaeological evidence such as inscriptions. Even Childe has not given a clear idea of whether the metal smiths were involved in the craft as a full-time occupation, or not, in the Proto Historic period (Childe 1930). From the early historic period to the Kandyan period there is clear evidence of metal craft in the island (Paranavitana 1970; Coomaraswamy 1908).

Inscriptional evidence

The Early Brahmi inscriptions of Pre-Christian times (circa 2nd century B.C. to the 1st century A.D.), speak of the existence of craftsmen of different kinds of metal. They are referred to as *kabara* (ironsmith), *tabakara* (coppersmith) *topasa* (tinsmith). According to Paranavitana, the word *kabara* is derived from the Pali word *kammara* (Paranavitana 1970). The ancient texts of Sri Lanka (like *Culavamsa*) also recorded implements used in the iron production process such as bellows, blowpipe, anvils, hammers, sledge-hammers, axes, hatchets (wedges), tongs etc. (Seneviratne 1992). Such examples were provided from a large number of inscriptions, which were spread over the island. The inscriptions of Ganekanda Vihara, Mutugalla and Madugasmullla (Paranavitana 1970) have mentioned the craftsmen in iron as *kabara*. It is important to note, on the other hand, that a small scale production was activated as a small unit or at family level and that craftsmen had to conduct the whole process without doing other activities like agriculture. In this situation the raw materials were obtained from the nearby forests.

According to the inscription of Ganekande Vihara (1st century B.C. - 1st century A.D.), an ironsmith *naga* was a vice president *(anu-jeta)* of a social organization or a corporation *(puga)* and it indicates the status and the position which the ironsmith had in the society (Paranavitana 1970). The inscriptions have noted the donations which were made by ironsmiths to the *sangha.* These donations were generally given to *sangha* by the highest ranks of the society. It also indicates the high status the ironsmiths had in the society.

Caste system

A caste can only be recognized in contrast to other castes in the way in which its members are closely involved in a network of economic, political, and ritual relationship (Leach 1960). Generally castes are associated with traditional occupations. The first reference to the caste system in Sri Lanka appears in the records connected with the arrival of the *Maha Bodhi* in early chronicles like *Mahavamsa* and *Bodhivamsa.* According to *Bodhivamsa,* the king Asoka sent to Sri Lanka members of twenty four different castes, each consisting of eight sub divisions. Each caste had a specific duty to perform with respect to the *Maha Bodhi.* It indicates that that there were eight castes involved in the iron industry and another eight in the other metal industries. In more recent times the different stages of the iron production process have been associated with particular castes or *kula* in Sr Lanka. Those who extracted the iron from the ore were called the *yamanno* caste while the producers of steel or iron tools belonged to the *navandanno* or *aachari* caste.

The *navandanno* caste had higher status than the *yamanno* caste and, even a relatively high status among the other castes (Knox 1681). According to Knox, the *navandanno* caste was next to the *hondrews (govi)* caste or cultivator caste. Knox also reported that every man had to pay to his smith a certain amount of paddy during the harvesting as a custom (Knox 1681). During the Kandyan kingdom, the status they had in the society had degenerated to a much lower place (Knox 1681). In the mid 17th century the *navandanno* caste was rated as low caste (Pieris 1956). As result of this, the younger generation of these caste have a tendency to give up the involvement in the traditional craft. In ancient times the caste system was mainly occupation based. As a result, technology was preserved by being handed down from generation to generation. The caste system in ancient Sri Lanka was involved in maintaining the socio-economic system of the society. This caste based social economic pattern changed with the advent of foreign rule into a class system. As a result, the traditional technological knowhow was lost under colonialism. Another reason for this decline was the import of cheap steel and finished products of iron implements from Europe and the inability of the indigenous iron producers to adopt new advances in technology.

Even today, the *ge-names* (family names), which are handed down from generation to generation, indicate the origin of the generation and the past occupation of the generation. Mostly the *ge-names* of the black smith generation end with *achariyage.* The ethnographic study that was done by the Samanalavava exploration team includes the *ge-names* of *wane achariya* and *hatanpola achariya*, which belonged to the black smithy caste (Juleff 1990). The same *ge-name* of *achariyage* also has been recorded in the Salem district in South India recently. The person *Arunachala Achari* who descends from one of the famous *wootz steel-* making generation of Salem practiced making steel in his younger days (Nataraja 1997). This evidence indicates a possible connection of the Sri Lankan and the South Indian iron production technology. The other evidence is mentioned under the title of ritual practices below.

The *ge-name* of *wane guru* (teacher or headman of steel) also is connected with the craft of steel. According to the ethnographic evidence, the family name *vasagama* or *ge-name* of *Llihini Kaduwa* also represent the caste of steel sword makers. The ancestors of the *Lihini*

Kaduwa generation used to feed the birds of Lihini with steel powder. After that, they collected the droppings and separated the steel powder. Again the stained steel powder was put to them to be eaten and droppings were collected. This activity was done several times and swords were made of steel that was collected as described above. We cannot throw away this kind of folklore or *janakatha* as useless, because we can collect more important ethnographic evidence from *janakatha* and *janakavi*. At present, the *ge-names* or family names of the craftsmen generations cannot be collected properly, because most of them have changed the family names according to the new living style and the attitude of some members of the new generations who consider them as belonging to a low caste.

Flags

The earliest description and investigation of Sri Lankan banners and flags were made by Bell in his report of the Kegalle District (Bell 1892). Two ancient *hanumanta* flags (Figure 2-7), which belonged to the *navandanno* caste were reported in ancient Sri Lanka (Perera 1916). In the flags there are figures of *`visvakarma'* who is the god of architecture, *`hanuman'* the monkey god, the mountain of Himalayas, a smith at work and the tools which are related to the smithy. According to the ethnographic records on south Indian contexts, ` The *kammakar* caste of South India traces their ancestry to, the five sons of *`Visvakarma'*. The first was *`manu'* who worked in iron (Coomaraswamy 1908). According to the ethnographic evidence, the iron making tribes of Northern India worshipped *`Lord Asura'*. One of the wall paintings of Japan shows a Japanese iron working site and these is evidence that the craftsmen also worshipped *`Lord Asura'* as in India (Prakash 1997).

As described above, it can be suggested that ancient Sri Lankan iron production techniques were most probably connected with Southern India. It is important to note that the *kammakar* or *kammalar*; the names of the South Indian blacksmith castes, are very similar to the words referring to the Sri Lankan smithy and the smith as *kammala* and *kammal karayo* respectively.

Figure 2-7. Two hanuman flags of the *navandanno* caste (Perera 1916).

Folk songs or *Janakavi*

In folk songs or *janakavi,* handed down from generation to generation, which refer to iron producers, a clear distinction is shown between the *yamanno* and the *acchari* or *navandanno* caste, their production, the demands they had to fulfill and the socio-economic system of the society. According to the *janakavi, i*n iron smelters or iron worker's songs, we can understand the steps in the iron production process from mining or collecting the ore to making of steel (Appendix C).

Ritual practices

Ritual performances during iron smelting amplify the transformation of this technological activity into a more profoundly human and cultural activity. The ethnographical and archaeological and archaeological evidence has indicated that the community that was involved in the production process practiced some religious rituals. According to the study of African iron production, it seems that there are two main ideas associated with the rituals of the African iron smelters. One of them is `fertility' of the production, and the other is protection against evil or malevolent forces (Schmidt 1997; Schmidt 2009; Schmidt and Mapunda 1997). In many parts of Africa the furnace was symbolized by the body of a woman, while the production process was a birth of a child and the bloom was a child (Schmidt 1997; Schmidt 2009; Schmidt and Mapunda 1997). It might be indicated that the very critical stages of the production process and a successful production must be conducted by a clever craftsman. In many parts of the African continent it has been revealed that a very special construction connected with rituals has been made inside the furnace. This is a pit was generally located below the bottom of the furnace for burying a pot of medicine. This medicine is used during the pregnancy period and delivery. In some parts of Africa, the head smelter and his assistants take a smoke bath of herbals used by women suffering from fertility and delivery problems. During the production process, the ironworkers who operated the furnaces were prohibited from engaging in sex, and women between the ages of menarche and menopause were not permitted to enter the furnace premises. Those beliefs were recorded in many societies in Africa; and they believe that if someone neglects the rituals, they will cause an unsuccessful production (Herbert 1993; Schmidt and Mapunda 1997).

Ethnographical evidence has revealed the rituals and ceremonies from the songs and sacrifices of the tribes of Bihar, Orissa and Madhya Pradesh (Rao 1982; Prakash 1990a and 1990b). The Agaria tribe of Madhya Pradesh in India believed that all iron ore belongs to the goddess `Mother Earth'. So, they ritually obtain her permission before any digging. In fact, they follow a ritual involving animal sacrifice before firing the smelting furnace (Prakash 1990b). Although such clear ritualistic practices by ancient Sri Lankan iron workers have not been found, even today among the village community there is a tradition of worshiping local gods before starting any new important work. In the paddy cultivation, when the farmers are harvesting, they are practicing such a tradition. According to this tradition, we can suggest that ancient Sri Lankans had several ritual practices for different work; such practices are rare among the modern generation. It may be due to the cultural values of the new generation, which are ideologically and fundamentally very different from those of the ancient culture.

Coomaraswamy has noted in his `Medieval Sinhalese Art' (1908) that he has seen two moulded cobras on the wattle wall between the steel furnace and the bellows. He suggested that these symbols depict religious ideas. In the ancient Sri Lankan irrigation civilization, the cobra symbol was used as the divine guardian of water and also as a symbol of prosperity (Karunaratne, T.B. 1985). Coomaraswamy also mentions the practice described by Lawrie (1896). Ancient smelters who used to go to the Nuwara-Eliya region for making iron might be connected with some idea of ceremonial purity. This practice was somewhat similar to that of the African peoples to ensure the purity of the furnace premises. According to Lawrie, described above, ancient Sri Lankan iron smelters used to take sick people away from the neighborhood of the furnace because they believed that if they died near the furnace, it would defile the furnace (Lawrie 1896).

Distribution of the production

The production facilities might be provided by a social group and transport, trade and distribution might be arranged on a large scale, involving a more complex social organization. The distribution of artifacts which have been obtained directly or indirectly from a single origin provide important information. The past social organization could be reconstructed with the help of such artifacts found in the archaeological context. In the past, distribution of objects, which have been exchanged or traded probably, clustered around major centers (Hodder 1982).

According to the archaeological evidence found from the Early Iron Age, settlements of the island, it seems that the production of that period was generally conducted at the habitation (Parker 1884; Begley 1967; Deraniyagala 1972). As described above, this situation gradually changed from the beginning of the Early Historic Period. The evidence found for this situation was identified clearly in the Early Brahmi inscriptions of that period. The headman or *gahapati* appearing in the inscriptions of that period indicates the well-organized production organization that the period had. If so, there should have been a well-organized distribution system which was connected with the production activity for distributing or selling the production. There is valuable evidence in the Ganekande Vihara inscription to prove that the corporation or guild *(puga)* was probably involved with the production and distribution of the products. The cave donation for sangha by the members of Sidaviya Corporation also mentioned blacksmith naga as vice-president of the cooperation (Paranavvitana 1970).

The emergence of centralized and provincial institutions not only controlled the production surplus and its distribution system but also controlled the natural resources, labor and the production organization.

Ancient trade links of the island

The main attempt here is to note briefly the ancient trade links of the island connected with the ancient ports. Sri Lanka is mentioned from the second half of the 4th century B.C. by classical Greek and Roman writers and geographers such as Onesicritus (325 B.C.), Megusthenus, Eratosthenes (276-194 B.C.), Pliny (24-79 A.D.), the unknown author of the *Periplus* (1st century A.D.), Strabo (22-77 A.D.), Cosmas (6 th century A.D.) and Ptolemy (100-170 A.D.). According to Nicholas, Onesicritus had known about the island from the sailors who sailed around the Sind river delta (Nicholas 1959).

According to Pliny's account, mariners of Taprobane (Sri Lanka) were sailing in the Indian Ocean in his time and Cosmas also states that Sri Lanka sent out trading ships to foreign ports (Gunawardana 1990). Sri Lanka was also mentioned with the Indian Ocean trade by a number of Arabic and Persian Geographers (Prickett 1990). There is evidence found from Early Brahmi Inscriptions dated from the 3rd century B.C. to the 1st century A.D. to confirm such professionals engaging international maritime trade as *navikas* (mariners) (Paranavitana 1970).

According to *Mahavamsa*, the king Pandukabhaya (437-407 B.C.) laid out a quarter for the Yonas (probably Greek and Persians) near the western gate of the city (Geiger 1950, Weerakkody 1992). Sri Lanka lies near the midpoint of the major sea routes linking China, Southeast Asia with the Middle East and the Mediterranean world (Figure 2-8). Therefore, Sri Lanka is important as a transit trading place on one of the sea routes between India and Southeast Asia. These sea routes depended on the pattern of monsoon winds and oceanic currents (Gunawardana 1990).

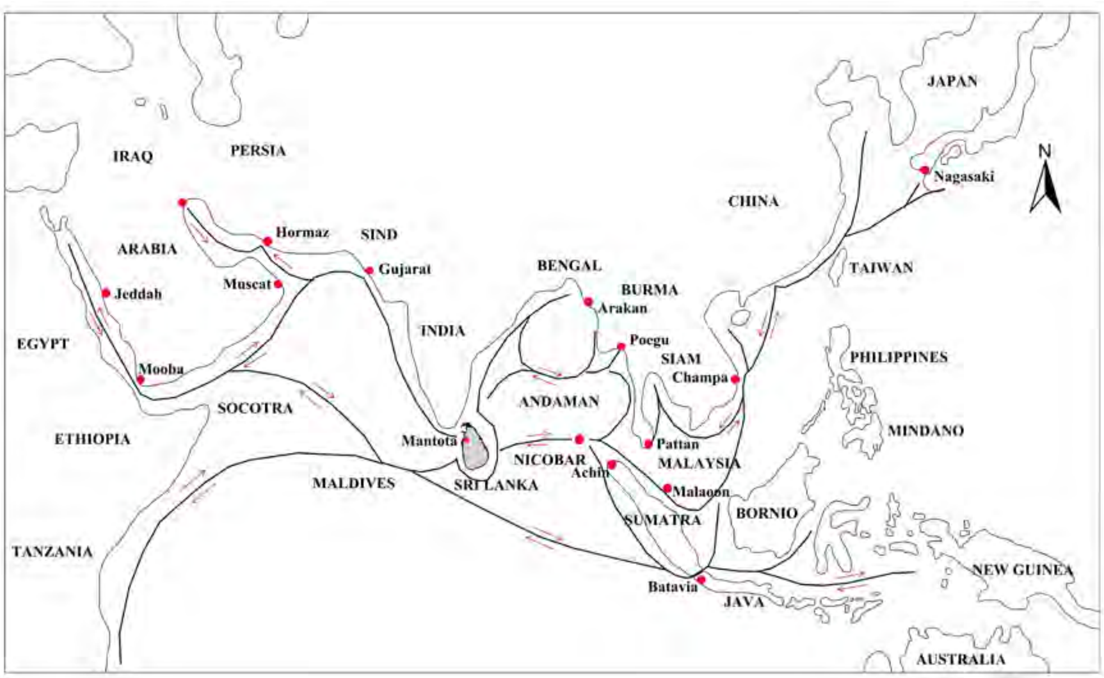


Figure 2-8. Ancient sea routes around Sri Lanka (after A.D.N. Fernando 1979).

Therefore the location of the island gave it a particular significance in the trade between the eastern and western parts of the Indian Ocean. According to Cosmos the Matota also (known as Mahatittha, Mahavoti, Mahaputu, Mahavatu, Mahavatutota, Mahapattana, Mantai) port was the main resort for the Indian, Ethiopian and Persian sailing ships (Gunawardana 1990). There is evidence of the Matota port being engaged in the Indian Ocean trade from the period before the 1st century A.D. at least up to the middle of the 13th century, the decline of the *rajarata* hydraulic civilization (Gunawardana 1990; Tampoe 1990; Silva and Bouzek 1990). According to Eratosthenes the Matota was very important as an international trading center from the 3rd century B.C. (Somarathne 1962).

Most important is the location of the Aruvi Aru river or the lower part of the Malwathu river which was linking it to the island capital of Anuradhapura (Figure 2-9). The study of the ancient history of Sri Lanka reveals that when the royal capital was transferred from Anuradhapura to Polonnaruwa, Gokanna (*Gokannatitta* in Pali) at the mouth of Mahavali river *(Mahavaluka Nadie)* near Trincomalee (Figure 2-9), became a flourishing harbor from around the 11th century. There is evidence of traders who reached the island from the east as early as 5th century A.D. (Bopeararchchi and Wijeyapala unpub.).

It is important to note that the earliest figure of a sailing craft was found in the island from the Early Brahmi Duvegala inscription (belonging to the 3rd century B.C.) in the Polonnaruwa district, which is situated close to Mahaweli river, connecting the seaport of Gokanna (Paranavitana 1970). Samanalavava and Ridiyagama iron production sites are located on the banks of the Walawa Ganga so that the finished products of the sites could be taken to the Southern coast and probably exported from Godavaya *(Gothapabbata* in Pali) port (Figure 2-9) which is situated near Ambalantota.

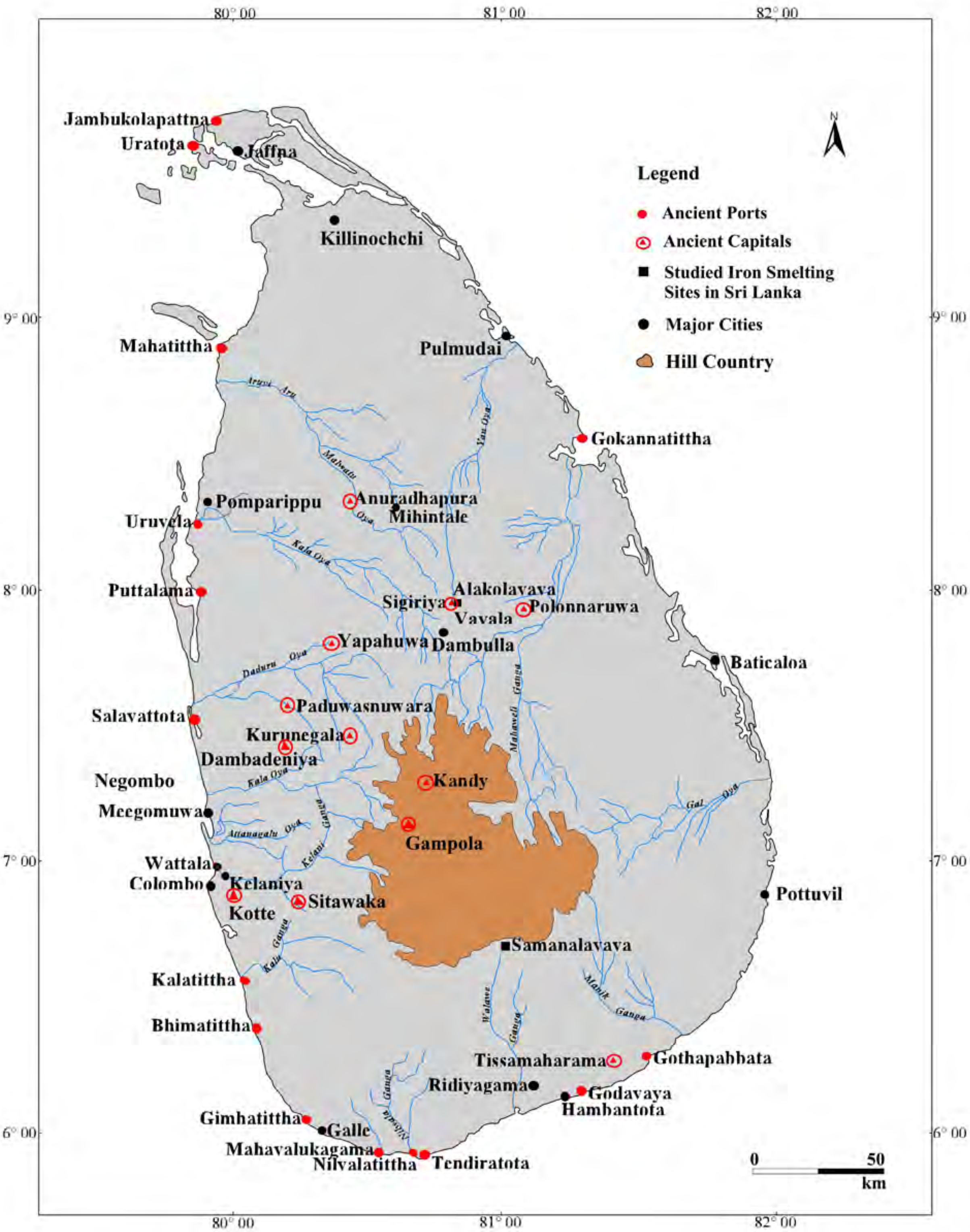


Figure 2-9. Ancient sea ports and main waterways in Sri Lanka.

The earliest evidence of the custom duties being levied in the island was recorded from the Godavaya Inscription dated 2nd century A.D. (Paranavithana 1970).There is some important evidence using of waterways for transporting of trading items or passengers along the rivers probably towards seaports. Such a ship dated 7th-8th century A.D., was found in 1988, in the Attanagalu Oya in the Gampaha District. It is important to examine the distribution pattern of the iron production which is described above and how it would be connected to the water way transporting system of the inland as well as to international trade through sea ports around the island.

Concluding Remarks

When we look into at Coomaraswamy's studies on Sri Lankan ancient iron metallurgy, we see that his writing was influenced by the already known Indian data. He tried to explain and interpret data in the Sri Lankan context with influence from the Indian context (1904; 1908). Senevirathne's writings mostly focus on resource utilization and origins of iron (Seneviratne 1984). He argued that the origin of iron smelting technology is connected with India. He is not the first who "Indianization" the Sri Lankan data. The author of the Mahavamsa also couldn't avoid "Indianization", and he did not credit indigenous people who lived before the 3rd century B.C. for their technological achievements.

Metallurgical studies have been conducted more recently that indicate that the only major source of copper ore south of Madhya Pradesh in central India is located at Seruvila in eastern Sri Lanka. Chalcolithic peoples of India and Sri Lanka exploited this resource (Seneviratne 1994; Deraniyagala 1998). Mantai could have been used as a port for shipping copper to India.

CHAPTER 3
THE STUDY REGION: GEOGRAPHICAL AND HISTORICAL OVERVIEW

Overview

In this chapter, I provide a brief overview of the physiographical and historical setting of the study region. Considering environmental factors is the key to understanding the ancient population distribution, in the first part, I summarize and analyze the natural environment of the Sigiriya-Dambulla region, including geography, environmental parameters and vegetation in order to understand the connection of environmental resources with other specific factors that are relevant to the ancient iron smelting activities and the settlement pattern of the region.

In the second part I review the area from prehistory to recent history to understand how the cultural landscape of the study region had been affected and shaped by human and environmental processes through time. In addition, I give special focus to the previous research in the Kiri Oya Basin (hereafter refers to as KOB). I also attempt to analyze the past urbanization of the area to find a probable connection with the iron industry. In the process, I discuss the centers of location of the iron industry and whether there was any connection between the main ruling centers and the trading centers have been discussed. I also try to find a connection between the historical backgrounds of the area with the archaeological data yielded so far in the study region. Before turning to the micro region of my research, I first provide some background on history, archaeology, geography and environmental parameters in and around Sigiriya hinterland.

The Sigiriya Dambulla Region: The Macro Region

I considered the region a nuclear area in terms of state formation and urban development, not only for the Sigiriya hinterland but also for the Sigiriya-Dambulla region (hereafter refers to as SDR) as a whole. I used Sigiriya as the central point of the study region (core area); it was the capital of the state around 5th century A.D., during the reign of King Kasyapa (477-495A.D.)

that was the main construction period of Sigiriya. Although, I have put a special focus on iron smelting technology and its related social formation in the KOB as the micro region for my research, I considered the SDR was considered as the macro region as we already know that the macro regional political relations between the core and periphery areas were found to play an essential role in the distribution of settlements.

The demarcation of the macro region of this study also can be considered as being almost similar to the SARCP study region that was thought of as the area, with a 10km radius around the major centers of Sigiriya and Dambulla measuring approximately 40km in north-south axis and 30km in east-west axis (Figure 3-1) that is determined according to the concept of "*Sigiri Bim*" (the territory of Sigiri) mentioned in the Viyaulpotha pillar inscription of King Sena II (853-887 A.D.) (EZ Vol. vi:176) of the Middle Historic Period and administration boundaries on relevant topographical sheets. The location of "*Sigiri Bim*"was also significant in ancient times; and formed an intermediate or transition zone as it was bordered by the three ancient core regions of Kurunegala, Anuradhapura, and Polonnaruwa (Bandaranayake 1990: 19).

The SARCP study region is demarcated by the Konduruvava mountain range from the east, the northern foothills of the central mountains to the south, the watershed between the upper Kala Oya and the Upper Yan Oya (Sigiri Oya) systems to the northwest and the lower Dambulu Oya Basin of the Kala Oya system west of Dambulla (Mogren 1990:53) as covering in the uppermost reaches of the Kiri Oya, Sigiri Oya, Mirisgoni Oya and Dambullu Oya that are four major waterways flourishing in the Sigiriya-Dambulla region (Figure 3-1).

The periphery areas of the Gal Oya Basin from the northeast, the lower Hanvalla Oya Basin from the southwest and the Hirati Oya Basin from the southeast are also included as they are located within the present administration boundaries of the study region (Mogren 1990:53).

Figure 3-1. Map of major geomorpholigical details and reservoirs in the Sigiriya- Dambulla Region: the macro region. KOB, the micro region is also marked with the red boundary line.

The eastern boundary of the SIT project, the project for the current study, was extended to the east from the boundary of the Anuradhapura and Polonnaruvava peneplains (that was considered as the SARCP eastern boundary); the two major geographical zones in Sri Lanka (Erb 1970) that lies on the Konduruvava mountain range. The extended portion includes with the area that is adjoined to the major watershed area of Minneriya Vava and both basins of two small streams of Kiri Oya that begin to flow from the west of Konduruvava mountain range to the east (Figure 3-1). One area covers from Peikkulama Vava to Migahawela Vava; the second from the Dikkandada-ala Vava to Moragaha-ala Vava from the north and Dikkandada-ala Vava to Ihakulu Vava from the south (Figure 3-1).

Kiri Oya Basin: The Micro Region

Although it needed to be surveyed, an even larger area in the SDR to examine its relationship with neighboring political centers, as we already know SDR as a important part of the politically centralized *rajarata* political structure (Bandaranayake 1984a and 1994a), I mostly concentrated on survey along the KOB as it was identified a well-settled communication corridor between the SDR, and the Minneriya-Giritale and Parakrama Samudra sub-systems in the Polonnaruwa district to the east (Bandaranayake 1994a:10). In addition, my long-term familiarity research in this region enabled me to conduct detailed study on iron smelting activities in the KOB. I used previous known data to fill the gaps on centralized socio-political aspects and relationships in the region. Although every settlement has its own political aspects at the regional level, as a part of the centralized political organization, political economic activities are often reflected in regional settlement pattern data.

The preliminary survey along the KOB, carried out under the SARCP in 1988 has provided a general idea of site locations. It made preliminary attempts to understand the settlement, rather than providing an in-depth picture of the settlement pattern (Manatunga

1990:75-92; Mogren 1994:27). The Kiri Oya is the major stream of the Minneriya Vava that flows about 30km from the Nuvaragala Vava located on top of the Nuwaragala kanda. The SARCP survey was conducted from the Nagolla Vava up to the Pihimbi-ala of the lower KOB (Manatunga 1990:75). The SIT project that I conducted in several field seasons between 2004-2006 attempted to reach most areas from the Nuvaragala Vava to the Minneriya Vava to get better understanding of the settlement distribution in the KOB.

Geography and Environmental Parameters in the Research Setting

The ancient civilizations, which were established near the mountains rich in ore deposits, were of great economic and political importance, which mainly depended on metal technology in the history of the ancient world (Macqueen 1975). Studies of the patterns of ancient settlements in Sri Lanka also proved that they had their unique technological systems, which were connected to their environmental resources (Seneviratne 1985 and 1992; Karunaratne and Dissanayake 1990). The pre-industrial technologies were mainly based on environmental factors such as soil, rain, natural vegetation etc.

> The first step towards understanding of a nation's past is to understand something of its geography (Wheeler 1968).

I present a general overview of the SDR, the macro region of study, with giving special focus to the geographical parameters in the KOB, the micro region. The data presented here are mainly derived from previous studies and together with present research findings are used for examining how environmental parameters are relevant to the settlement distribution and iron smelting industry.

Topography

The island of Sri Lanka is situated around 48 km to the east of the southern tip of India at approximately 8^{o} north of the equator. The geographical setting of the island is mainly dependent on this location. SDR, the macro region of the study topographically is considered as a part of the northern peneplain of Sri Lanka (Epitawatta 1990: 41). The area can be also considered as a separate geo-physical unit or as a sub-system of the major unit of the northern Dry Zone of the island.

Sigiriya, the main center of the study region, lies between 7°56'- 7° 58' north latitude and 80° 45'- 80° 46' east longitude in the Polonnaruwa one-inch topographical sheet and is situated about 164 km northeast of Colombo in Inamaluwa korale, Wagapanaha Pallesiya Pattu within the Dambulla Assistant Government Agent's division in the Matale district, Dry Zone of Sri Lanka.

The excavated iron production sites in the region that I address here, Dikyaya-kanda at Vavalavava (commonly known as Vavala) and Dehigahaa-ala-kanda at Alakolavava are located southeast of the Sigiriya rock around 8 ½ km and 5 ½ km respectively. The name Vavala-vava refers to the ancient reservoir located east of the present Vavala village, which took its name from that of the reservoir (Figure 3-1). According to the village lore, Vavala Vava was built during the reign of King Mahasen (4th Century A.D.). The excavated iron production site at Dikyaya-kanda is hidden in the jungle and is located 1 ½ km northeast of the present Vavala village. It lies at 7° 53’59” north latitude and 80° 47’23” east longitude (190m above MSL). The eastern narrow strip from the site to Peikkulama Vava and in between Kiri Oya and Konduruvava mountain range, where the site is located, is known as Dik-yaya (long & narrow-area) among the inhabitants of the area. Except for the Dikyaya-kanda iron smelting site, the other three sites excavated during this project are located west bank of Kiri Oya. Site environs of all excavated sites are provided separately in Chapter 6.

Geomorphology

Although previous archaeological research has emphasized the importance of the geological formation of the area, my special attempt here is to understand the geomorphic processes that led to ancient settlement patterns and iron production activities. The study region belongs to the northern peneplain of Sri Lanka and is demarcated on the south by the Wet Zone of the central highland or the northern foothills of the central mountains of Sri Lanka known as the Matale foothills. As clearly shown in the topographical sheets, the area consists of two distinct geomorphological units: a mountainous area and a flat terrain.

The mountainous area that has a high elevation and high slope angles extending from the southwest across the southern edge up to the northeastern boundary of the macro study region (Figure 3-1; Figure 3:2; Figure 3:3). The higher percentage (75%) of the study region is covered with the flat terrain at 150-200m average elevations and also has isolated mountains (Epitawatte 1990: 41). Sigiriya, Dambulla, Pidurangala and Mapagala are rise monadnocks (isolated mountains) on the flat terrain. GPS reading for the summit of the Sigiriya rock provides 364m above mean sea level.

The main geomorphological features of the KOB, where excavated sites situated are Gallindakanda on the north, Konduruvava mountain range and Sudukanda mountain range on the east and Nuvaragalakanda of the Elahera mountain range on the southeast (Figure 3-1; Figure 3:2). An outcrop of isolated rock boulders lies close to the stream in the area. The area of KOB lies about 150-250 m above mean sea level. The Konduruvava mountain range is located between the Anuradhapura and the Polonnaruwa peneplains as a boundary for both peneplains (Erb 1970) and also there is evidence of the ancient pathways connecting the two peneplains through the two gaps in the range between Peikkulama -Migasvava and Dikkanda-ala - Ihakuluvava (Figure 3-1).

Geology and Iron Ore

The central part of the Konduruvava range is made up of resistant charnockite rock and the rest of it dominated by quartzite and granulitic gneisses. The Sudukanda (white mountain) range and the Matale foothills is made up largely of whitish quartzite rocks (Vitanage 1959; Perera 1984): it got its name as the result of an exposed band of quartzite. The study region is made up of the rock type belonging to the Highland Series.

This type of rock was originated in the Pre-Cambrian period. Magmatite gneiss, quartzite/quartz and crystalline limestone are the main rock types, which are distributed in the area (Vitanage 1959; Cooray 1967). The belt of crystalline limestone deposits occurs across Kandy, Naula, Habarana and Kanadarawa (Herath 1980). The limestone band occurs in the study region and is sometimes even wider than one kilometer. The crystalline limestone is the main rock formation in the western plane of the Kiri Oya and it spreads to a width of about 3500m in the area (Vitanage 1959). In the terrain northwestward up to Alakolavava the well-defined limestone formation can be identified clearly. The limestone band generally runs under the soil in this area and is exposed in some high places where the surface soil has been eroded. It is important to note that the crystalline limestone is not conducive to wet agriculture.

The occurrence of garnet-biotite gneiss which is the main rock type of magmatite gneiss is commonly seen on the stone out-crops in the study region. Chemically, because of the presence of garnets the granitic gneisses are rich in iron. On weathering, the garnets turn into rounded concretions of iron oxide, set in a reddish brown clayey matrix. The other main type of Highland Series is quartzite also present in the area between limestone and gneiss and is also present in the banks of the Kiri Oya (Vitanage 1959). The quartzite is well bedded in the gneisses generally. Sometimes flakes of mica and other minerals are also embedded in the quartz (Epitawatte 1990:43).

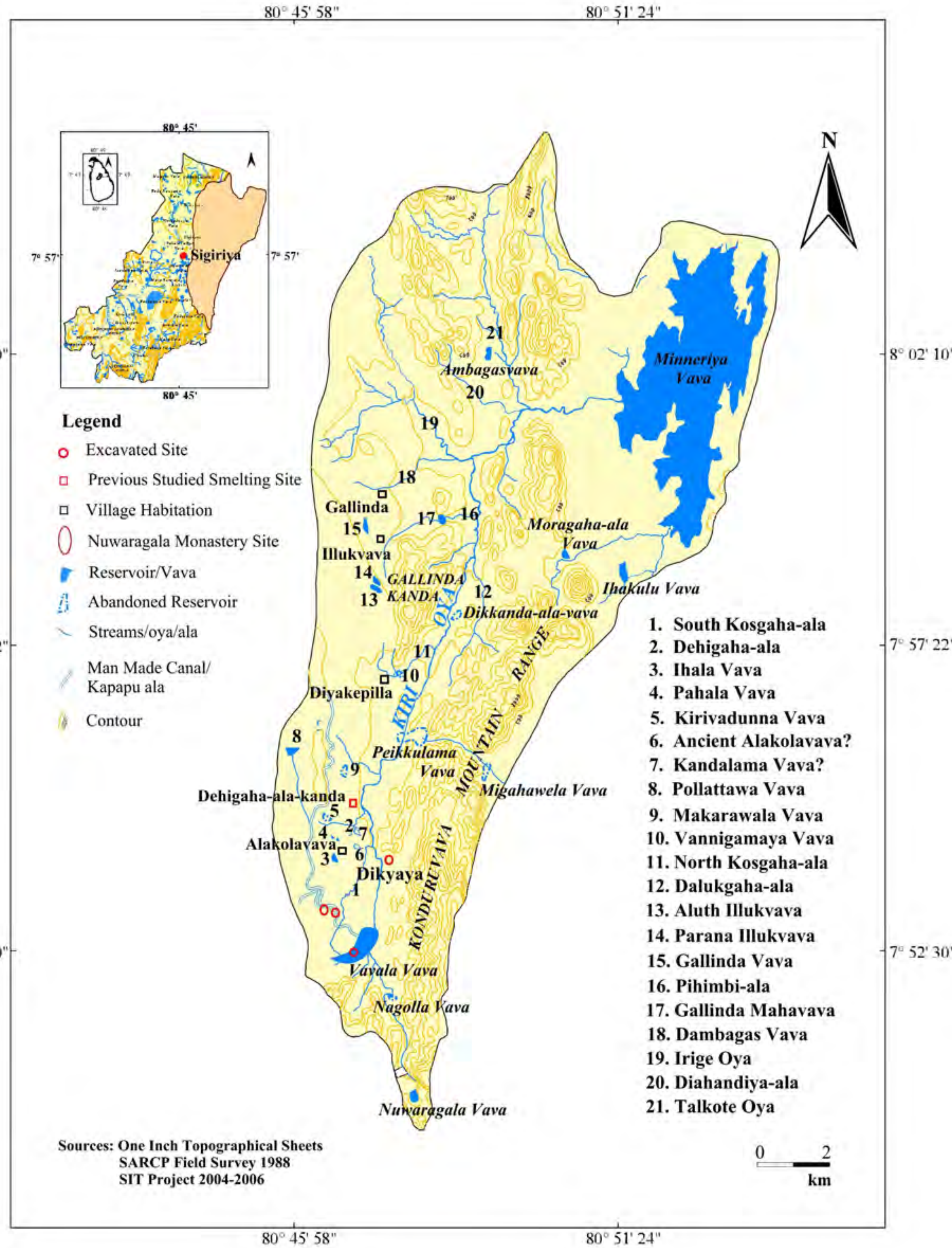


Figure 3-2. Major geomorphological units and the hydraulic network in the KOB.

Magnetite iron ore attached quartz was found in the rock boulders that are made up of metamorphic gneiss, on the eastern side of SIT 1. As mentioned in Appendix G, magnetite also has been identified from the iron ore samples collected within the area (Noreus in Solangaarachchi 1999). During the SARCP, a very important magnetite embedded piece of quartz was also collected as a special find and registered as AV/KO 14/S/91/565[19] (Figure 6-9) near the conical holes that are located on a flat rock boulder at the northern corner of the site. It was probably used for the purpose of grinding the ore. Except for these, the knowledge of the occurrence of iron ore around the excavated area at present is very limited. Among the other known magnetite deposits, the Seruwila magnetite deposit is the largest and the closest to the Kiri Oya Basin that is located within the Highland Series. According to Davy (1821), magnetite has been found in masses embedded in gneiss in the Kandy region and in a granite rock at Katabowa in Wellassa and in Trincomalee. Generally nodular ironstone or ferricrete is also found on the tops of the crystalline rocks of the Dry zone. The nodules are dark brown in color and are often mixed with yellowish to brownish clay (Cooray 1967). The formation of nodular iron stone is based on the reaction of iron oxide on the rocks during the heavy rainy season and the hot dry season (Cooray 1967).

Soils

The dominant soil group of the Dry Zone, the Reddish Brown Earth (hereafter refers to as RBE) is also the dominant along the KOB (Figure 3-3). The RBE is also developed on Highland series rocks in the area between Polonnaruwa and Trincomalee, which lies in the Dry Zone. It is the best-developed soil group in the Dry Zone, where the annual rainfall is less than 1500 mm (Cooray 1967; Deraniyagala 1992). RBE and Low Humic Gley (hereafter refers to as LHG) soil are the main soil groups, which are developed in most parts of the study region (Figure 3-3).

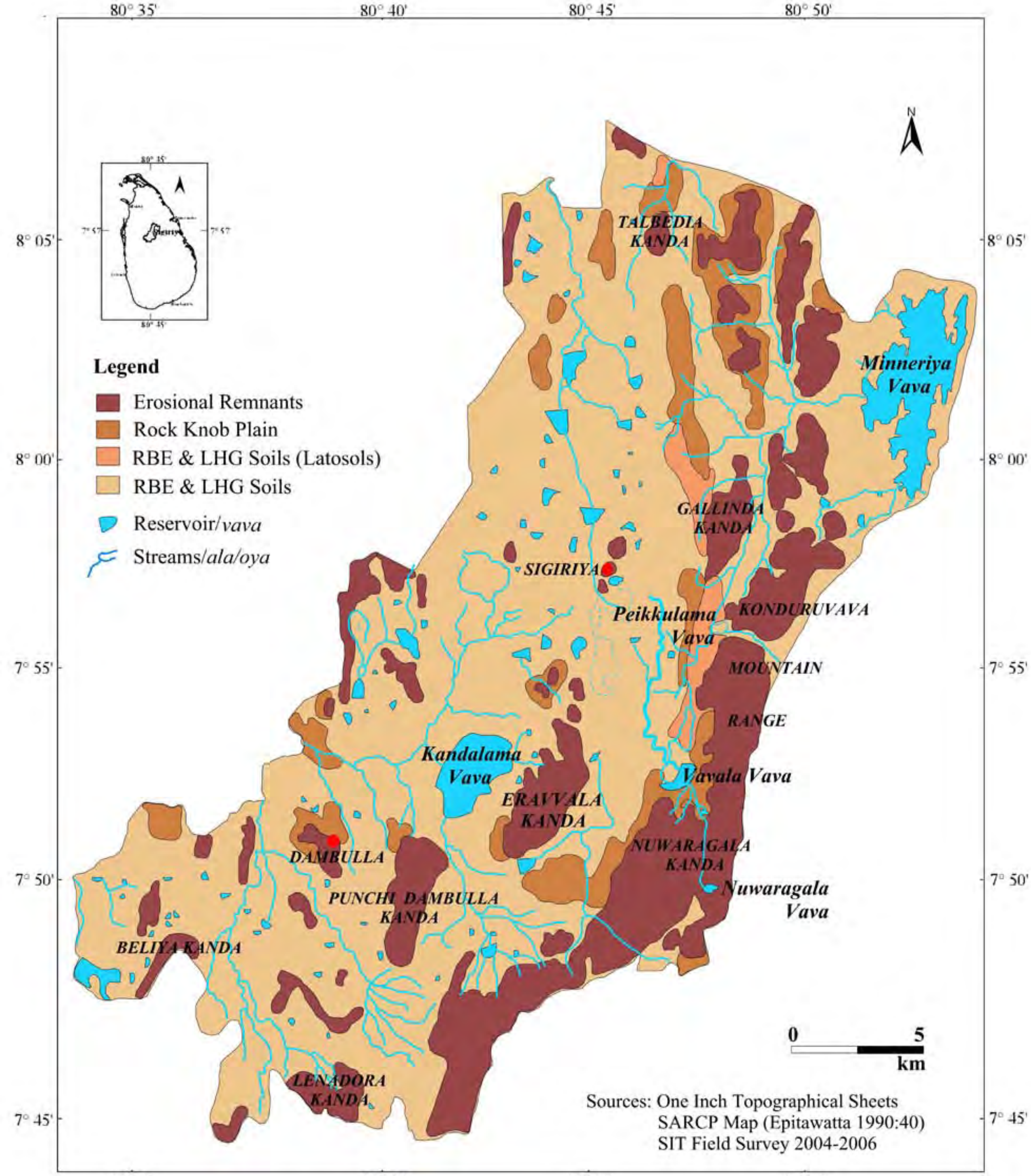


Figure 3-3. Major soil types of the study region- SDR, the macro region. (RBE- Reddish Brown Earths, LHG- Low Humic Gley Soils)

The erosional remnants, rock knob plains and the latosol soils are also found in the area of high elevation and high angles slopes (Epitawatte 1990:43). RBE is changing from dark brown to dark reddish brown in color, 1 m- 1.5 m on an average in depth, and sandy loam to sandy clay loam in texture and is mixed with quartz and iron stone gravel. Chemical reaction is slightly acidic to neutral and consistence is sticky when wet although hard when dry (Epitawatte 1990; Deraniyagala 1992). RBE is good soil for cultivation and there is evidence of ancient settlements being established in this soil region.

LHG soils have poor drainage qualities and become water-logged during the rainy seasons. This soil group is dark grayish brown or very dark brown in color, 1.5 m-2 m on an average in depth and is used extensively for paddy cultivation (Epitawatte 1990).

Drainage System

The study region lies astride the main watershed of Sri Lanka and is mainly located on the drainage basins of the Kala Oya and the Yan Oya (Sigiri Oya). The river basins of Mirisgoni Oya (MO), Kiri Oya (KO), Dambulu Oya (DO), Sigiri Oya (SO) and sections of the river basins of Gal Oya, Havanalla Oya and Heerati Oya are included in the study region (Bandaranayake 1994a).

MO is the largest catchment area (155.2 m^2) while placing KO to the second largest (99.2 m^2) in the study region (Epitawatte 1990:41). Kiri Oya springs from the Nuwaragala-kanda of the Elahera mountain range; while passing about 30km reached to the Minneri Vava it is fed by several springs and creeks. Every river that flows through the Dry Zone has a continuous series of reservoirs on practically every one of its tributaries. There is evidence that the Kiri Oya ran from Nuwaragala vava through a mountainous valley around 3km to reach the Nagolla Vava. But today it runs directly 5 km and reaches the Vavala-vava. Abandoned Nagolla Vava presently does not carry water; its reservoir bed is used as a farming land. From the Vavala Vava, the Kiri

Oya flows through flat land and is fed by its main tributaries, the Kosgaha-ala (south), the Dehigaha-ala, the Makarayavala-ulpotha-ala, the Kosgaha-ala (north) and the Pihimbi-ala in the western plain and the Dalukgaha-ala on the eastern mountains. The eastern flood basin is narrower than on the west because the Konduruvava mountain range is adjoining its banks.

Ihala Vava, Pahala Vava, Kirivadunne/Hirivadunna Vava, Kandalama Vava and the ancient Alakolavava are the five reservoirs associated with the Alakolavava village (Figure 3-2). Peikkulam Vava and Vavala Vava are also located closely on the north and from the south respectively (Figure 3-2). The Dehigaha-ala carries the excess water of the Pahala Vava and the rainfed Kirivadunne Vava into the Kiri Oya (Manjusri 1990: 116). Dehigaha-ala-kanda, the site excavated under SARCP is located on the western bank of the river. Dehigaha-ala flows from west to east at the southern end of the Dehigaha-ala-kanda iron production site (SIT 1) and flows northeastwards to join the Kiri Oya.

According to the information given by inhabitants of Migahawela, as the result of the cyclone in 1978 the dam of the Peikkulama vava had collapsed changing the Kiri Oya's flow to the left towards the Migahawela Vava. Today the basin of the stream towards Migahawela and the basin of the original course of the Kiri Oya both are known as the Kiri Oya Basin.

Climate

The climate of the island is mainly dominated by the tropical southwest monsoon system. Therefore in the description of the climate of the island, the terms `tropical climate' and `monsoon climate' appear. Climatically the island falls into two major regions as `Wet Zone' and `Dry Zone' according to the two principal rainfall and climatic types as well as the extent of humidity and aridity (Domrös 1974). Domrös (1974), Thambyahpillay (1958 and 1965) and Jayamaha (1959 and 1975) take a prominent place among others who have studied the climate of the island. The data presented here are mainly based on the study that was made by them. The

Dry Zone where the study region is located, occupies about 75% of the island. Climatically, the study area is located within the northern part of Dry Zone (Figure 1-2).

Temperature

The term `thermic diurnal climate' is best summarized as the thermic conditions of the island and it means that the changes of temperature between day and night are greater than the seasonal differences (Domrös 1974). From December to April/May (Northeast Monsoon and the first Intermonsoon seasons) the diurnal changes of temperature are greater than in the Southwest Monsoon and second Intermonsoon seasons. In this case the highest temperatures occur around noon from about 12.00 to 14.00 h. and the lowest in the early morning between 05.00 and 06.00 h. (Domrös 1974).

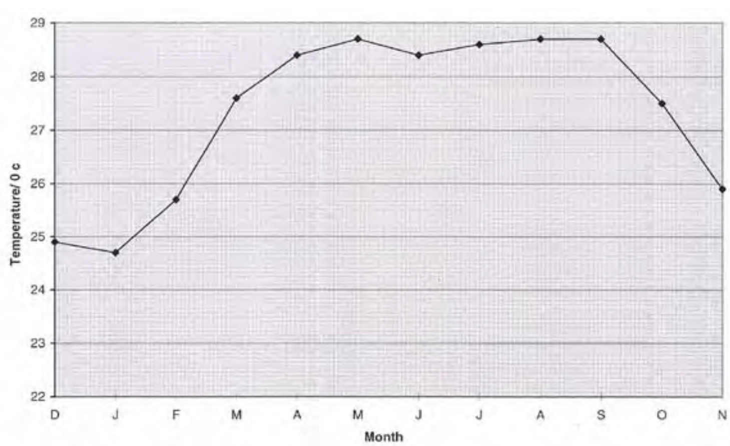


Figure 3-4. Diagram of monthly average temperature in Anuradhapura (1931-1960)[1]

The mean annual temperature of the island is 27°C - 28°C and in the Dry Zone, where the study region is situated it varies 25°C - 30°C. Generally in the Dry Zone, temperature is high over 33°C for most of the year (Cooray 1967; Herath 1980) and the study region is located within the higher isotherm (26.5°C- 28°C) of the annual average temperatures in the island (Domrös 1974). According to data from the Anuradhapura station of the meteorology department

[1] I collected data for figures 4-4, 4-5, 4-6, 4-7, 4-8 and 4-9 from the Meteorology Department in Colombo.

that was based by Domrös' study (Domrös 1974), the warmest months of the year are May/August/September (28.7°C) and the coldest month of the year is January (24.9°C). The annual temperature range in the area is 4.0°C.

Rainfall

The rainfall pattern in Sri Lanka is determined by the following three major factors (Domrös 1974; Deraniyagala 1992):

- The geographical position of the country and, therefore the effects of the monsoonal system.
- The smallness of the island (the furthest place being never more than ca: 110 km distant from the sea) and the effects of the sea breezes
- The relief of Sri Lanka characterized by the Central Highlands.

Four remarkable rainfall seasons could be seen in the island's weather (Cook 1931; Domrös 1974):

- The first intermonsoon period (from March to mid May)
- The Southwest (S-W) monsoon period (from mid May to September)
- The second intermonsoon period (from October to November)
- The Northeast (N-E) monsoon period (From December to February)

The Dry zone is typified by a large annual range in rainfall (Domrös 1974). An irrigation system is essential for rice cultivation because the rainfall is low and about 1000 mm per year in most areas. The intensity of rain causes a heavy overflow, erosion and waste unless stored in reservoirs. A larger amount of reservoirs spread over the Dry Zone as a result of these facts. The average mean annual rainfall lies between 1500-2000 mm in the study region and an average annual rainfall of about 1650 mm is received in the KOB generally. According to the study made by Domrös, the Dry Zone, where the study region is situated a very significant regional variation of rainfall occurs (Domrös 1974).

Sigiriya the center of the study region shows three major distinct climatic seasons:

- January to March - mild dry season
- April to August - major dry season
- September to January - major rainy season

The study region receives more than half the annual average rainfall of 1650 mm from October to January. The main source of rainfall is the Northeast Monsoon. During the Southwest Monsoon period the Dry Zone of the island has a dry season as the Central Highlands forming a barrier to the rain. The major rainy season starts with the second Intermonsoon season and continues during the Northeast Monsoonal Season. The Dry Zone receives a heavy rainfall in the second Intermonsoonal season due to the southward migration of the Intertropical Convergence Zone (ITCZ) and the depressions in the southern part of the Bay of Bengal (Thambyahpillay 1958; Suppiah and Yoshino 1983). The monthly rainfall recorded during the months of February to August is 125 mm.

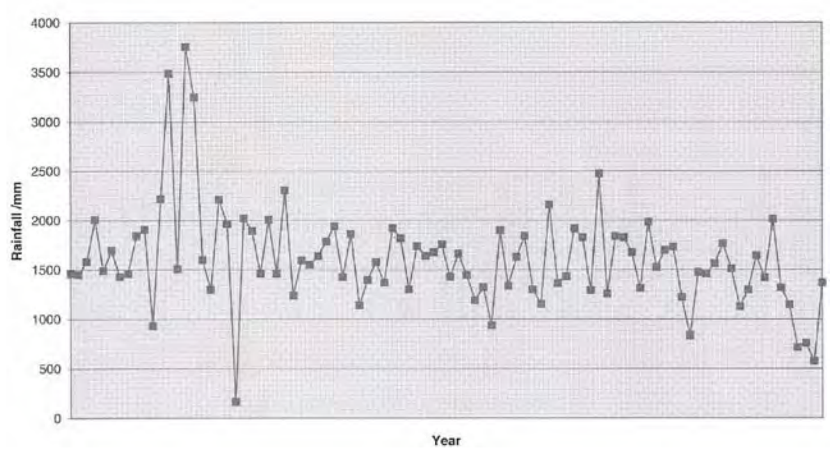


Figure 3-5. Diagram of annual rainfall in Minneriya (1899-1990).

The driest months of the year are June and July (less than 25 mm) with the intensive dry wind *yalhulanga*, the landscape turns a pale brown and with the low rainfall causes high evaporation leading to a water deficit. These are the main significant atmospheric features of the season (Perera 1984). There are no meteorological stations located within the study region.

Therefore, I used data collected by the Meteorology Department from the Minneriya and Kalavava stations, which are located very close to the study region and to its northeast and to the northwest respectively for drawing the diagrams given below. According to the diagrams the rainfall of the area varies in between 1250-1750 mm.

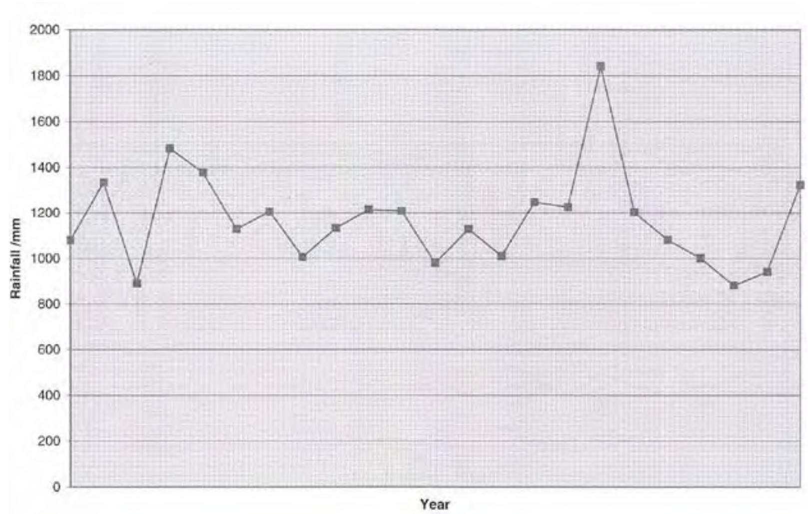


Figure 3-6. Diagram of annual rainfall in Kalavava (1890-1990).

Wind

As it is reported, using wind as a natural draught in the smelting activities of the Samanalavava furnaces (Juleff 1998), I gave special attention to study wind pattern of the region to find out if there is any connection with the KOB smelting process. The velocity and the direction of blowing are the most important aspects of the study of wind pattern. Three wind systems appear in the island: the Southwest, the Northeast and the Intermonsoon. The Monsoonal winds are dominant in the annual course of events and the Intermonsoon seasons are marked by changing wind directions (Domrös 1974; Deraniyagala 1992).

According to the observations carried out during the southwest monsoon period, the wind blows from the Southwest to the Northeast and diurnal variations of wind speed show that the wind is stronger in the day time than in the night (Nakagawa *et al.* 1983). The Southwest

Monsoon is stronger than the Northeast Monsoon and it develops from April/May to October and the Northeast monsoon December to March.

The situation of the Knuckles range produces a sharp climatic division in the northeastern and southwestern slopes. The highest point of the Knuckles range has a wind velocity of 80 km/h in the season of the Southwest Monsoon period (Domrös 1974). During the Southwest Monsoon period, rainfall concentrates on the windward slopes of central highlands and on the lee side, a dry foehn type wind locally called *kachchan* prevails with the influence of the Southwest Monsoon circulation in Sri Lanka (Domrös 1974; Yoshno, Urushibara and Nomoto 1983; Suppiah and Yoshino 1983). *kachchan* in Tamil means the Southwest wind (Domrös 1974), and it is commonly used to refer to a warm, dry, westerly wind that blows during the Southwest Monsoon season in the lowland Dry Zone (Domrös 1974; Yoshino et al. 1983; Suppiah and Yoshino 1983). The kachchan is characterized by a drying effect, high temperatures and low air humidity and it is often connected with a high wind speed (Domrös 1974). During the strong *kachchan* months the rainfall received in the Dry Zone is scarce (Yoshino 1983 and Yoshno, Urushibara and Nomoto 1983).

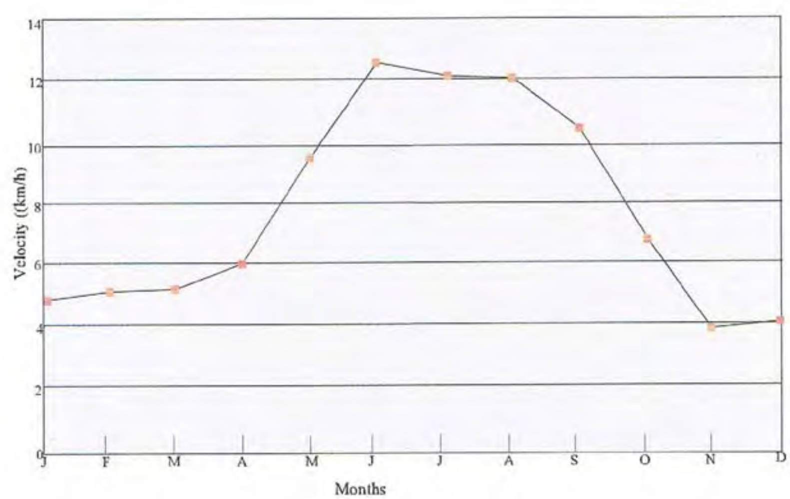


Figure 3-7. Diagram of monthly average wind velocity in Matale (1982-1991).

The *kachchan* wind that blows from May to August is known as *yalhulanga* in the study region. The excavated iron production sites in the KOB are also situated in the part of the Dry Zone where the *kachchan* effect appears and during the Southwest Monsoon period the high velocity of the *kachchan* lashes across the region, during the dry period of May to June.

As described above, the geomorphological facts around the area also appear to be very characteristic circulations of the wind velocity. There is no meteorology station located close to the site; therefore the data collected by the Meteorology Department from Matale, Mahailluppallama and Aralaganvila (in Polonnaruwa) are used for this study (Figure/s 3-7; 3-8; 3-9). The maximum mean wind velocity between June to August at Aralaganwila in Polonnaruwa (Figure 3-9), which is located very closely to the excavated iron production sites reach 10.3 km/h and the maximum for Matale is 6.6 km/h (Figure 3-7). According to diagrams at Maha Iluppallama the maximum mean velocity reaches 14.5 km/h and the minimum reaches 9.9 km/h in June under the conditions of the Southwest Monsoon (Figure 3-8).

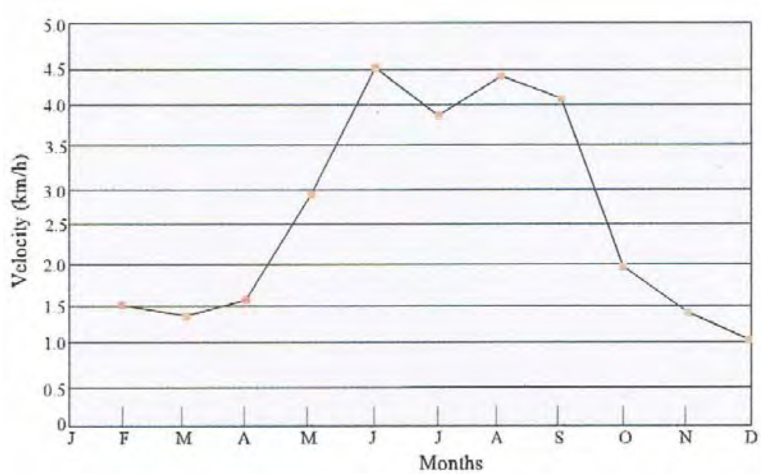


Figure 3-8. Diagram of monthly average wind velocity in Mahailluppallama (1989-1998).

But the velocity with which the wind lashes across the area must be high because the high mountain ranges are covering excavated sites that are located along the wind channel. The other important thing is that the Kiri Oya basin is located 600-700 m above sea level and the wind velocity is increasing gradually from the surface to upper levels. It is important to note that the wind velocities for Matale, Mahailluppallama and Araganwila given here are those of surface winds.

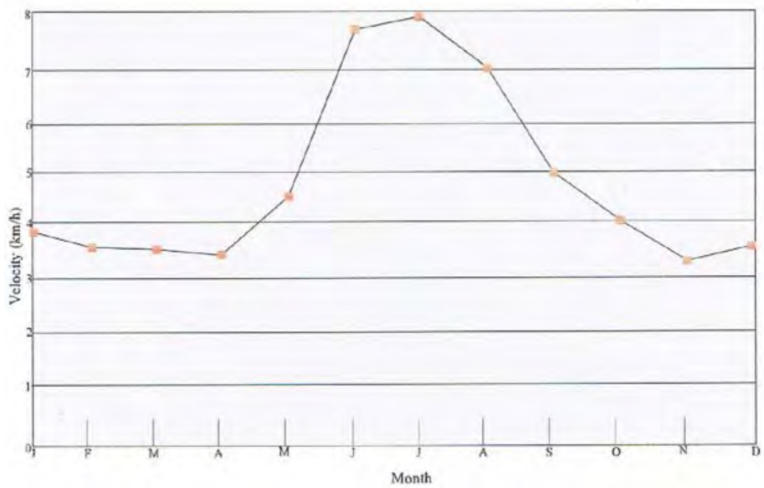


Figure 3-9. Diagram of monthly average wind velocity at Aralaganvila (1990-1995).

Vegetation

The study region belongs to the Dry Zone and the most dominant vegetation on the RBE (which is the most dominant soil type in the area) is dryzonal mixed evergreen forest (Cooray 1984). According to Holmes (1951) the present vegetation of the Dry Zone falls to the secondary forest type and the original natural vegetation disappeared due to the direct interference of early settlers. According to the classification of Balasubramaniam and Greller (1981), the Dry Zone vegetation in the study region falls into the tropical lowland seasonal rainforest type and Holmes classified it as dry mixed evergreen forest (1951). According to the Gaussen et al. (1968) classification, it falls into the semi-deciduous forest type. My attempt here is to analyze the previous studies on Dry Zone vegetation that were made by Gaussen, Legris, Viart and Labroue (1968), Dittus (1977), Holmes (1951), Perera (1975), Cramer (1993), Balasubramaniam and Geller (1981), Müller - Dombois (1968), Koelmeyer (1957), de Alwis and Ariyagama (1959), Prematilake, Epitawatta, Yasapala and Myrdal-Runebjer (1994) and to clarify, the area occupied by the specific plant species that were used for the ancient iron production process.

The major categories of the vegetation that are seen in the region are, dense forest, tree-savanna (Damana) grassland, shifting cultivation and homestead gardens.

Dense forest

The forest consists of the major layers of emergents, low canopy, sub canopy, lianas, climbers and shrubs in the area (Epitawatte 1990). The original forest consists of the dominated trees of *Diospyrus ebenum* (Sin. *kaluvara;* Eng. Ceylon Ebony), *Chloroxylon swietenia* (Sin. *buruta;* Eng. Satin Wood), *Berrya cordifolia* (Sin. *halimilla;* Eng. Trincomalee Wood) and *Manilkara hexandra* (Sin. *Palu;* Eng. Ceylon Iron Wood) species that are growing to a height of 20-25m above ground level. The other characteristic species of the Dry Zone *Vitex pinnata* (Sin. *milla*), *Cassia fistula* (Sin. *ehela*), *Schleichera oleosa* (Sin. *kon*) and shrubs like *Catotropis giganta* (Sin. *vara*), *Croton laccifer* (Sin. *gas kappetiya*) also occur in the region. Most of them are generally being used for construction works, agricultural purposes; making tools, and household utensils.

Tree-Savanna (`Damana') grassland

The abandoned fields, which were, once cultivated in the past have given rise to the savannas (`Damana' grassland) caused by the fire or the land clearing method of ` slash and burn. The main grass is *Aristida depressa* (Sin. *athtuttiri*) and it does not exceed the height of 1m. Other main types of *Cymbopogon confertiflorus* (Sin. *mana*) and *Imperata cylindrica* (Sin. *illuk*) are also seen in the area. The grasses form a continuous cover dotted with fire resistant trees like *Cassia fistula* (Sin. *ehala*), *Bauhinia racemosa* (Sin. *maila*), and *Cassia auriculata/Senna auriculata* (Sin. *ranawara*), which are characteristics of the area.

Shifting cultivation (*chena*) and present land use

Most of the area is cleared and burned for chena cultivation, for two or three years or sometimes more than ten years. In this cultivation system of the area, the big hard wood or edible fruit bearing trees are not removed. Dry grains like *Eleusine coracane* (Sin. *kurakkan;* Eng. Finger millet), *Panicum miliaceum* (Sin. *meneri;* Eng. Millet), *Soghum vulgare* (Sin. *idal iringu;* Eng. Sorghum), Zeamays indentata (Sin. *bada iringu;* Eng. Maize), *Sesamum indicum* (Sin. *tala;* Eng. Gingerly), *Brassica juncea* (Sin. *aba;* Eng. Mustard) and the other major cash crops like *Capsicum acuminatum* (Sin. *miris;* Eng. Chillies), *Brassica oleracea/capitata* (Sin. gova, Eng. Cabbage) and *Nicotiana tabacum* (Sin. *dumkola;* Eng. Tobacco) are most common crops in chena lands along the KOB (Figure 3-10B).

Figure 3-10. Three major types of cultivated crops in the KOB. A) The field is being prepared for cultivating big onions. Photograph from the PGIAR’s photo archive. B) The land is preparing for the cash crops. Photograph by R. Solangaarachchi. C) One of the paddy fields in the KOB. Photograph by R. Solangaarachchi.

A high tendency for cultivating *Allium cepa* (Sin. *Dambulu loku lunu;* Eng. big onions) has been seen recently (Figure 3-10A). Most parts of the area consist of abandoned chena land because of the problem of wild animals like *Elephas elephas maximus* (Sin. *aliya;* Eng. elephant) and *Sus scrofa cristatus* (Sin. *val ura;* Eng. wild boar).

Besides *Oryza sativa* (Sin. *Vee;* Eng. Paddy), some cultivated trees such as *Cocos nucifera* (Sin. *pol;*, Eng. Coconut), *Mangifera indica* (Sin. *amba;* Eng. Mango) that were introduced to the area with man's interference are also seen in the study region (Figure 3-10C). Even up-country cops like cabbage and beetroot could be grown at the lower elevations. Today most areas of upper KOB are linked with onion cultivation using water from reservoirs and tributaries that are connected with the Kiri Oya.

Historical Overview in the Research Setting

In this section, I analyze the past urbanization of the area relevant to three themes: whether there were any specific reasons that might have caused the urbanization of the area, with the special focus on the KOB to understand its settlement pattern and the social structure; as well as to identify whether Sigiriya acted as a regional center or central place of that socio-economic system.

Historical Background of the Sigiriya-Dambulla Region: The Macro Region

Sigiriya, the prominent center of the study region, is mostly highlighted in the history with the main construction period of 5th century A.D. and with King Kasyapa I (477-495 A.D.), who was the son of King Dhatusena (459-477 A.D.). According to *Culavamsa*, the more recent part of *Mahavamsa*, King Kasyapa moved the ruling center from the capital city of Anuradhapura to Sigiriya after he killed King Dhatusena, his father. He not only built his fortress there with a summit palace on top of the Sigiriya rock to protect himself from his half-brother Moggallana but also made other constructions, which include garden complexes (Figure 3-11) as symbols of his royalty (*Cv.* 38, 39). *Mahavamsa* provides ample evidence for how Buddhist monks of the Mahaviharaya were interfered directly in the state's political and administrative problems and described their role as the main advisers to the royalty. They might have not agreed with King Kasyapa on his conduct and he would have lost their main support after his father's death.

Figure 3-11. Sigiriya rock fortress and the garden complex. Photograph from the PGIAR's photo archive.

This was not the only reason for moving the ruling centre to Sigiriya, which marks a significant transformation in the history of the political capital. Studies on the archaeological setting of the area also indicate that King Kasyapa's selection of Sigiriya as a ruling and political centre by him was not accidental. The numerous rock shelters with or without dripledges, the early Brahmi inscriptions mentioning about donations to the Buddhist monks, the early Buddhist monastic sites with settlements, the major and minor irrigation network spread in and around the area, the graffiti of the `Mirror Wall' in the Sigiri fortress and the archaeological excavations conducted in the area and its surroundings indicate that the urbanization of the area extended from the Prehistoric times to the Late Historic Period (LHP). Here the attempt to highlight briefly how the urbanization of the area developed during the pre and post Kasyapan periods (as well as the Kasyapan period) and what connections it had with the main political centre of Anuradhapura.

The archaeological investigations done recently indicate that the settlements of the area started from the prehistoric times with the Mesolithic hunter-gathering community and continued towards the modern period with some periods of abandonment. Here the settlements of the area in prehistoric, protohistoric, early historic, middle historic and late historic periods based on the previous studies (mainly based on Bandaranayake 1984 and 1990) are discussed in brief.

Pre & Proto Historic Period

The area is rich in natural rock shelters, which are the characteristic feature of the Highland Series (Cooray 1967) and are located on elevated rock knob erosional remnants. According to Adikari's classification, the prehistoric settlements of the area can be divided into two types as cave dwellings and open-air sites (Adikari 1994b). Among the numerous rock shelters located in the study region, the selected caves at Dambulla, Pidurangala, Aligala and Potana were excavated systematically to understand the specific features of the settlements of the area (Adikari 1994b; Bandaranayake 1994). The earliest prehistoric dating of the area is 9000-2000

BC the Mesolithic context at Aligala cave, which is located near the eastern edge of the Sigiri rock (Adikari 1994b). The other important prehistoric excavation was done at one of the selected caves of the Potana cave complex, registered as MO 14 under the SARCP. The prehistoric dating of the site is 6000-3000 B.C. and two complete human skeletons of Homo Sapiens species were unearthed at the Mesolithic context which belongs to ca. 4000 B.C. (Adikari 1994a). Included in these two sites, the caves at Rangiri Dambulu Vihara complex and the upper terrace at Pidurangala were excavated under the KAVA program, and the surface collections from the open air sites of the area, stone tools of Mesolithic period made up of chert, quartz and bones were obtained (Adikari 1994b). Data obtained so far indicate that the settlements of the region started with the Mesolithic hunter-gathering community.

The settlement of the Vadda community, the community of Sri Lankan aborigines at Gallinda is the only Vadda village in the study region (Seligmann 1911). It also indicates that the environment and the terrain of the region were conducive to the vestigial hunting and foraging modes of existence and this had survived up to recent historical times in Sri Lanka (Bandaranayake 1990).

The best recorded archaeological example for the protohistoric period of the Sigiriya-Dambulla region is the megalithic cemetery complex at Ibbankatuwa located 3 km Southwest of Dambulla on the Colombo - Trincomalee highway which was excavated in collaboration with the KAVA Project (Seneviratne 1990). The first village settlement of the protohistoric period that was ever excavated in Sri Lanka indicates a habitation phase belonging to the protohistoric period, unearthed by the excavation conducted 250 m northeast to the megalithic cemetery site under the SARCP (Karunaratne 1994). The protohistoric layer (context 28) at the settlement dated 436-226 B.C. (Ua 5566) was overlaid by the early historic cultural phase (Karunaratne 1994).

According to remarkable archaeological records of the region, it can be assumed that the protohistory - early history (PHEH) transition appeared in the last few centuries of the first millennium B.C. (Bandaranayake 1990). According to the excavations conducted in and around the region, it seems that the transition first appeared with the irrigation based, iron using early agricultural community.

Early Historic Period

The earliest phase of the Early Historic Period (EHP 1 in Bandaranayake 1990) of the area is marked by the early Buddhist monastic settlements that were associated with rock shelters with drip-ledges and Early Brahmi inscriptions that mention the donations for the monasteries or to the Buddhist monks belong to 3rd/2nd century B.C. to 1st century A.D. (Paranavitana 1970). Within a 25 km radius of the centre of the study region there are about 25 rock shelter complexes with Early Brahmi inscriptions spread over the area and within each rock shelter complex there are internal chronological and spatial variables (Bandaranayake 1990). Among them Pidurangala, Dambulla, Enderagala, Kandalama, Ambulambe and Ritigala are some sites which were located around Sigiriya. There are about 36 rock shelters with 10 inscriptions in Sigiriya (Bandaranayake 1990). These inscriptions not only indicate donations for the monastery but also mention the administrative information around the major centre of the study region, which was associated with main centers like Ritigala and Dambulla (Paranavitana 1970, 1983). Except for this evidence, the data revealed from the excavations conducted in and around the study region, indicate that the several other rock shelter complexes were occupied by early and middle period monastic communities.

As described above, the well-known historical knowledge of the area (specially Sigiriya) is about the later phase of the Early Historic Period (EHP 3 in Bandaranayake 1990) with the major construction phase in the 5th century A.D. and the major phases of monastic construction were begun at Dambulla and Pidurangala at the time or immediately following it.

The phase between the middle phase of the Early Historic period (EHP 2 in Bandaranayake 1990) and the period immediately before the Kasyapa period (late 5th century A.D.) shows the scarcity of archaeological records when compared with the development of the adjoining regions of SDR (Bandaranayake 1984; 1990). He suggested that the study region might not have been a more developed compared with the core regions such as the main Kala Oya - Malvatu Oya area in the `Anuradhapura system' of that period and it is the main reason for this lacuna (Bandaranayake 1984; 1990). It is difficult to locate where the settlements were situated and to compare development with other core regions because they may not be identified archaeologically as the rock shelter sites of the earliest phase (EHP 1) and the grand constructions of the latter part of the late phase (EHP 3) during the Early Historic period at Sigiriya; they may be deeply hidden beneath the surface (Bandaranayake 1990).

The very important high technological construction of the Early Historic period is the major hydraulic work around the study region mainly based on Elahera, Minneriya, Giritale and Vahalkada (according to *Mahavamsa* Sirivalahassa Vava, built by king Mahasen) and Kalavava that were carried out in the reign of King Vasabha (65-109 A.D.), King Mahasen (276-303 A.D.) and King Dhatusena (459-477 A.D.). As mentioned above, Sigiriya becomes the political capital of Sri Lanka after the reign of King Dhatusena for a short period of about 18 years, marked with the great construction period of royal and urban complexes in the history. Even if only the Sigiriya urban complex is examined, it can be understood how the scientific, aesthetic and philosophical aspects are combined with hydraulic, metallurgical, constructional and other material technologies of the late phase of the Early Historic Period (EHP 3) in the region.

Middle Historic Period

The decline of the political capital at Sigiriya occurred immediately after the King Kasyapa's death and with the occupation of the inner citadel by monks after it was donated by king Moggallana. He also established his political center back in Anuradhapura following other kings who ruled before King Kasyapa. The Middle Historic Period began in Sigiriya at the end of the 5th century A.D. and it continued until the rise of the Polonnaruwa period. According to *Culavamsa* the earlier phase of the Middle Historic period (according to Bandaranayake's classification MHP I) Sigiriya was mentioned only during the reigns of King Moggallana III (618-623 A.D.) and King Silameghavarna (623-632 A.D.).

Except for the above evidence, the other historical data belonging to the Middle Historic Period was obtained from the graffiti on the ` Mirror Wall', the inscriptions spread over the area, and the archaeological excavations of the region. According to the results of the excavations which were conducted in and around the central part of the water garden and the boulder garden, it seems that after the Kasyapa's main construction period of the 5th century A.D., there are minor scale constructions which were connected with the monastery and they continued to the end of the middle phase of the Middle Historic Period (MHP 2) in the 10th century A.D. (Bandaranayake 1990). This evidence is not only found in the Sigiriya citadel area, but also in and around the study region within 500 - 1000 A.D., which is the most developed historical period. There were six monastery complexes: the monastery in the Sigiriya citadel, the Ramakale monastery, Pidurangala, Kaludiyapokuna, Manikdena and Dambulla belonging to this period that were identified and all of them were in the category of *pabbata* vihara. It is important to note that there is evidence for most of them being occupied at least within two constructional phases, certainly Dambulla, Pidurangala and Manikdena (Bandaranayake 1990).

Inscriptional data provided in the Middle Historic Period mostly belonged to the period from the 5th century A.D. to the 10th century A.D. (MHP 1 and MHP 2) which indicated the chronological pattern of the area (Bandaranayake 1990). The graffiti of the `Mirror Wall' also provides such chronological patterns for the first two phases of the Middle Historic Period (MHP 1 and MHP 2). In addition, archaeological excavations also well confirm that the chronological phases and the earliest graffiti of Sigiriya belong to the 6-7th century A.D. (Paranavitana 1956; 1970 and 1983; Bandaranayake 1984; 1990; Priyanka 1990). The most significant incident of the latter phase of the Middle Historic Period (MHP 3) is the decline of the Anuradhapura Kingdom with the ruling period of King Mahinda V (982-1029 A.D.). Some graffiti belonging to this period (MHP 3), confirm that Sigiriya was being visited by the people even in the Late Historic period (11-13th century A.D.) during the Polonnaruwa and also Dambadeniya periods (Priyanka 1990). From the data obtained from the excavations in Sigiriya and Dambulla it seems that there have been small-scale reconstruction or re-use phases in the 11-12th and 12-13th centuries A.D. (Bandaranayake 1990). The inscriptional records in Dambulla of King Nissanka Malla (1187-1196 A.D.) also confirm the excavation data of that reconstruction.

Late Historic Period

The excavations that were conducted in the citadel of Sigiriya indicate that the abandonment phase appeared between the 13th and the 17th centuries A.D. (Bandaranayake 1984). Bandaranayake draws his attention to that period through the previous studies made by Lewis (1895), Paranavitana (1959-1960 and 1961), Liyanagamage (1968), Indrapala (1970) and Pathmanathan (1972 and 1978) and he also highlights the Pathmanathan's phenomenon of the principality or chieftainship of Vanniyar or Vanniraja rank which appeared in the Dry Zone during the late 13th century A.D.(Pathmanathan 1972; Bandaranayake 1990). The Vanni principalities came to control the Dry Zone, specially *rajarata* with the decline of the centralized authority of the Anuradhapura Kingdom during the Polonnaruwa period. This system of Vanniyar principalities did not appear in the centralized system of the Anuradhapura kingdom. The authority of the Vanniyar appears to have existed from the Polonnaruwa period to the latter half of the 19th century of the Kandyan Kingdom up to the `Pandara Vanniyar' who was probably the last provincial ruler of that system (Bandaranayake 1990).

The existence of the Vanniyar is a significant feature during the Late Historic Period and it provides the data for the collapse of the centralized state formation and the rise of the unchallenged dominance of regional elites in that period (Bandaranayake 1990). Evidence is found in the ancient chronicle, *Rajavaliya* of the construction of a fortress along the route between Anuradhapura and the Kandyan kingdom as a resting place or ruling centre at Matale, built by Aryachakkravarti, the king of Jaffna in the 14th century A.D. for the expansion of Sinhalese power under the leadership of Alakesvara (Ilangasinha 1990). Ilangasinghe points out that the area north of Matale could have been ruled by Vanniyars and to confirm this view he also presents the data from the oral tradition of the Inamaluwa Ihala Valavva (Ilangasinha 1990). According to the oral tradition of the area, the name Inamaluwa is derived from *sitina-maluwa* which means resting place. The generation of Ihala valavva was originated by the Vanniyar elite (Ilangasinghe 1990). He also adds that even in the period of the Kandyan kingdom, a chieftain Vanniyar, who was the forefather of Inamaluwa Ihala Valavva, ruled the area of Nuvarakalaviya during the reign of Sri Vira Parakrama Narendrasinghe who was the last king of Sinhalese origin (Ilangasinghe 1990). This information provides us with the fact that even after the decline of the Anuradhapura centralized state, the study region was engaged as a central place with the political power of the Kandyan period through the other main political periods in ancient Sri Lanka such as Polonnaruwa and Dambadeniya periods. The *Mandarampura puvata* which belongs to the 17th century A.D. also states the importance of Sigiriya as an ancient capital. The oral tradition of that area also indicates that the origin of the village community also goes back to an earlier phase of the Late Historic period (Bandaranayake 1990).

Historical Setting in the Kiri Oya Basin: The Micro Region

I attempt here to highlight the connection of the KOB with the political capitals of ancient Sri Lanka based on previous studies. As it is an insufficient aim to focus on the KOB's interaction during the main periods of the Sri Lankan historical chronology due to the scarcity of previous research data in the KOB, I focus on the main historical periods of the Sri Lankan monarchy for this study. Historical data that I present here, mainly derived from the SARCP field survey in 1988 (Manatunga 1990) that I also participated as one of the members of the SARCP project.

Anuradhapura Period

The history of the area also goes back to the 3rd/2nd century B.C. marked by the early Buddhist monastic settlements that were associated with the rock shelters, as Sigiriya, which is the major centre of the study region. Vavala monastery (SIT 6/KO 22), one of the rock shelters site with three early Brahmi inscriptions provides evidence for the early monastic occupation in the KOB. Manatunga pointed out, the other rock shelter sites in or around Alakolavava village: Alakolavava ancient temple (SIT 28/KO 21) and Dehigaha-ala-kanda (SIT 1/KO 14) at Alakolavava; Gallindakanda (SIT 71/KO 38) might also have connected with the 3rd/2nd century B.C. Buddhist monastic habitation at the Vavala monastery (Manatunga 1990:75). The characteristic features of this region are that the major and minor irrigation systems connected with King Mahasen. According to Nicholas (Nicholas 1959), Suratissavapi (Duratissavapi) which was one of the earliest reservoir built by King Saddhatissa (137-119 B.C.) (*Mv. 33*) would be located in or around the Kiri Oya valley (Nicholas 1963 cited in Manatunga 1990). Village lore of the area, speaks of the connection of the ruins of the Nuvaragala-kanda which was located about 5 miles southeast of Alakolavava village with King Mahasen. According to them, it might have been once used as a residence of King Mahasen (275 -302 A.D.) during the construction of major irrigation work connected with Minneri vava which is spread across Kiri Oya (Bell, Fernando and Moysey 1914).

The reservoirs around Kiri Oya were also said to have been built by King Mahasen (Bell, Fernando and Moysey 1914). Still, the tradition of worshipping King Mahasen as a regional god, *minneri deviyo* (god of minneri) exists among the inhabitants of the Kiri Oya valley and the two *devales* used for this religious activity are situated at Diyakapilla and Gallinda. The Gallinda *devale* activities are practiced by the *Vadda*, Sri Lankan aborigines generation who are still living close to the Gallinda *devalaya*. One inscription of the Vavala monastery also indicates the political connection of that area with the Anuradhapura kingdom in the 4th century A.D., during the Pre Kasyapa Period. Manatunga (1990) points out the importance of that inscription and according to him it belonged to King Kitsirimevan (301-328 A.D.) who was the son of King Mahasen, and it refers to a grant to the monastery of a paddy field and the taxes from a reservoir (Manatunga 1990). He also suggests that it could be Vavala reservoir that is located close to the monastery (Manatunga 1990). Detailed description of the inscription and its new interpretation is provided in Chapter 5 and Appendix L.

According to the legend of Alakolavava village, the origin of the village can be traced back to the reign of King Mahasen during the 4th century A.D. During the SARCP field excavation seasons in 1990 and 1991, we were able to have his assistant to the site (SIT 01/KO 14) and get his memories repeated on village traditions. Oral tradition of the village given by the oldest villager, Dalupata Mudiyanselage Loku Banda,

> having arrived from Malvaradesa, the King had taken up residence first in Anuradhapura, and next in Ritigala, before finally settling down in Nuvaragalakanda. (Manjusri 1990)

This evidence also indicates the importance of the KOB during the 3rd and 4th century developments associated with King Mahasen. The remains of the monastery complexes in the KOB: one of them on the north of Dehigaha-ala-kanda (SIT 2/KO 17) falls into the category of *Pabbata vihara;* Nuvaragala kanda (SIT 84/KO 57) falls into the forest monastery type and they could belong to the Post Kasyapa Period in the Late Historic Period (Bandaranayake 1974; Manatunga 1990).

Manatunga (1990) draws his attention to the location of the `*Veluvana Vihara'* that was built by King Aggabodhi II (604-614 A.D.) for the *Sagaliya Nikaya* (*Cv. 41*), one division of early Buddhist monasteries in Sri Lanka. He also presents an argument with evidence for the identification of the site that was located between Sigiriya and Minneriya. According to him `*Veluvana Vihara'* (the monastery of the bamboo forest) could be the place with the evidence of early monastic remains found in Gallindakanda (Manatunga 1990). He further adds, to confirm that argument with the evidence of *Culavamsa*, and says that the King Jetthatissa (628 A.D.) had donated the land called *Kukkulavitti* to the *Veluvana Vihara* (*Cv. 44*); the present name of that place *Kukurumahangodavala kandattalama* derived from the ancient name given above (Manatunga 1990). Kadattalama and vitti means `a pass' and there is evidence for `a pass' at Gallindakanda towards Minneriya from Sigiriya (Manatunga 1990).

During the SARCP, two inscriptions were recorded near the Peikkulama reservoir bund: one of them seems to belong to the 6th-7th century A.D.; the second was the *attani* pillar inscription belonging to King Udaya II. It was also mentioned, that they were not able to be used for finding more evidence of their representing history as they were in a weathered condition (Manatunga 1990).

Polonnaruwa Period

According to Nicholas (1963) the area was first mentioned during the Polonnaruwa Period with King Vijayabahu I (1055-1110 A.D.), who was the first Sinhala King at Polonnaruwa. During his reign, he donated Merukandara Rata to his son-in-law King Veravamma (*Cv. 59*) and the place mentioned there, *Vapivataka*, most probably is Vavala (Nicolas 1963:111; Manatunga 1990).

During the reign of King Parakramabahu (one of the most developed eras in the Polonnaruwa period), Kiri Oya and the mountain Galkanda (Galkadulla or Silakanda) are also mentioned along with the war campaign of King Parakramabahu (*Cv. 67*). Most probably it could be Konduruvava mountain (Codrington 1922:69; Manatunga 1990:76). Kadulla means `a stile' and Konduruvava mountain has such `stiles' between the Polonnaruwa and Anuradhapura peneplain and Gal-kadulla means stone-stiles. This confirms the explanation given by Codrington (1922). In addition Nicholas also mentioned the places in *Culavamsa* Demeliyagala and Opanamika (*Cv. 67*) and Vikramapura also could be located within the KOB (Nicholas 1959; Manatunga 1990). If the identification of Galkanda as the Kondurvava mountain is correct, the places of Opanamika and Demiliagala must be located within the KOB as mentioned by Nicholas (1959) because according to *Culavamsa* these places appear after passing Galkanda when travelling from the Polonnaruwa peneplain (*Cv. 67*).

Kandyan Period

According to the chronological, historical and archaeological evidence, it seems that there was an abandoned period in the KOB appeared from the collapse of the Polonnaruwa period about the 13th century A.D. until the Kandyan period at the beginning of the 17th century.

During the Kandyan period, the KOB was also mentioned several times. Kiri Oya and the three habitations of Gonava, Nayakumbura and Peikkulama between Nalanda and Minneriya were mentioned in the accounts of English officers such as those of Pybus (1758), John Andrews (1795), John Davy (1821), Major Forbes (1840), Tennent (1860), Levers (1899) and Brohier (1934) until the 19th century. In descriptions those who travelled from Kandy to the Trincomalee port they have mentioned about crossing Peikkulama and it was referred to as a forest area. According to such evidence, it seems that the Kiri Oya Valley and of the two roads through the Konduruvava mountain, at least the road between Peikkulama and Migasvava were used until the 19th century when the early topographical maps were prepared (Manatunga 1990).

When we conducted SARCP excursions in 1988, there were five occupied old villages: Gallinda, Illukvava, Diyakapilla, (close to the Kosgaha-ala North) and Alakolavava. But Kosgaha-ala was totally abandoned during the SIT survey in 2004-2006 due to the regular wild elephant attacks in the region. Although Alakolava village is still occupied with descendents from old generation and remains with the *govigama* caste, Vavala, the present largest settlement in the KOB was re-occupied around 1969 under the government's resettlement "concept of *janapada*" with people who came from the different parts of the island representing different castes (pers. comm. with S. S. Somaratna a.k.a. raja).

Concluding Remarks

The study of environmental resources of the area attempts to provide the probable clues for the research concern (RQ 2: is there any connection with environmental resources of the area for the emergence of the iron smelter's settlement?) on the concurrent factors on which the determination of the choice of area for iron production is based. According to the study on the relationship between the technology and resource utilization, it seems that there is clear evidence in the Sri Lankan context for the connection between selection of settlements and environmental resources (Seneviratne 1990; Deraniyagala 1992). Such data are also found from the geological survey done recently and it indicates that the ancient iron smelting sites were located very close to or in the mining villages (Karunaratne and Dissanayake 1990). The *Kadaimpot* that belongs to the Gampola period (1341-1415 AD) also mention such mining villages located in the Matale District (Abeywardena 1978). According to Lawries Gazetteer, it seems that there were several iron mining villages located in the central province and they used to supply rough iron lumps to the king's treasury annually and such a mining village called `*Akaraheduwa*' was located near Naula close to the southern boundary of the study region (Lawrie 1898).

My field survey did not provide clear evidence of the huge magnetite ore deposit which was used to smelt iron by smelters in the Kiri Oya Basin, near excavated production sites. But during the detailed survey I conducted in 2005, larger blocks of iron ores were discovered at SIT 101 that is located southeast of the Dehigaha-ala-kanda iron production site (KO14/SIT 1). Although, there is clear evidence for the occurrence of magnetite iron ore at the excavated sites and in the surroundings as described above, the magnetite ore deposit that was used should be larger for conducting an industrial level production. The main reason for the existence of such large-scale production sites in this area is probably the location of an anthro-magnetite deposit in the vicinity. On the other hand, according to the metallurgical analysis the chemical composition of the magnetite ore samples that were collected at SIT 1 and SIT22 iron production sites indicate a resemblance with the Seruwila magnetite deposit (Table/s 2.2; 6-2; 6-3). But it is already known that the Seruwila deposit was used for smelting copper (Seneviratne 1994; Deraniyagala 1998). Through the above data, two probable clues arise to indicate the location of the deposit which has been used for the smelting process. The one possibility is that the smelters transported iron ore from a distant unknown deposit, which was mentioned by Lawrie in the Naula area. The most probable reason is that they had used a closer deposit, which might have been located somewhere on the Konduruvava Mountain range in the Kiri Oya catchment area. If the first possibility is true, it would have been a sufficient transportation system established through or close to the area used for transporting iron ore from the distant places. There is evidence of an ancient route from Elahera to Minneriya ran across the Nuwaragalakanda, which is 8 km southeast of Alakolavava village (Bell, Moysey and Fernando 1914). According to the one-inch topographical sheet of the region there are two gaps in the Konduruvava mountain range, which enabled this route connecting the Anuradhapura and the Polonnaruwa peneplains (Figure 3-1). The other two main routes run along the Kala Oya to the Uruvela port and along the Amban Ganga to the Gokanna port (Tilakerathne 1984). Seneviratne pointed out that the route system along the riverbanks and valleys eg, Kala Oya, Malvatu Oya, Yan Oya (Sigiri Oya) originated mainly to reach the resources (Seneviratne 1990).

According to the present study, the area has evidence of smelting iron not only at Dehigaha-ala-kanda and Dikyaya-kanda, but also at every major settlement cluster in the KOB at an industrial level and at a smaller scale units (Further details are given in Chapter 4). If so there had been a great economic advantage, as the production would have been carried out in a closer place where the raw material could be obtained easier than being transported from elsewhere.

The other main raw material for iron production is fuel. Wood was used by the ancient iron smelters as the main source of fuel in the production process. The ability to do so depended on the natural vegetation. Wood was used on a large scales as fuel during the smelting process as well as before the smelting process; wood was used for roasting the ore and pre-heating the furnace. Among the species of wood which have been recorded as being used in the iron and steel production, most of them are found in an around the KOB as well as the study region.

Madhuca longifolia (Sin. *mi*), *Schleichera oleosa* (Sin. *kon*), *Syzygium assimile/gardneri* or *Eugenia assimile/ gardneri* (Sin. *damba*), *Vitex pinnata* (Sin. *milla*), *Wendlandia bicuspidata* (Sin. *wanaidala*), *Anacardium occidentale* (Sin. *kaju*) and *Cassia auriculata* (Sin. *ranawara*) are the commonest species that were used in iron production and this area was rich with them. Even at present the area is covered with a high dense forest and also consists of the wood species that were mentioned above.

The drainage system of the area mainly depends on the Kiri Oya and its tributaries, which provide water sufficient for production. Clay must also be considered as one of the important raw materials as it was very often used for furnace walls and tuyeres. The richness of the Low Humic Gley soils in the area could provide clay for the construction of furnaces.

Although the *kachchan* wind lashes with high velocity through the area as described above, from the nature of the furnace construction i.e. being built below the ground level (for further details see Chapter 6), it cannot be concluded that a natural draught was used for the production process. On the other hand, the back wall of the furnace indicates clear signs of the forced draught (bellows) operation system. There is clear evidence of using wind as a natural draught in the smelting activities of the Samanalavava furnaces (Juleff 1998). Excavated iron production sites in the KOB do not provide such data. But it must be studied whether the wind power principle was also used in the neighboring area because KOB also has high velocity wind as in Samanalavava and is covered with high mountain ranges and is located in a place where the channeling effect of wind occurs.

In the iron smelting process that was practiced in ancient times, there was some evidence of limestone ($CaCO_3$) being used as a flux. According to an analytical report on iron ore and slag samples of Dehigaha-ala-kanda, it seems that the smelters of the site added silicon and calcium containing fluxing agent during the process. Usually the ancient iron smelters of Sri Lanka and India did not use fluxes in their production. The silicates of the ore act as a fluxing agent in this case. Although, it is important to note here that the collected marble/feldspar ($KAlSi_3O_8$) samples of the area also indicate a very high percentage of CaO, slag samples of the site indicate a very poor percentage of CaO (Appendix D).

The richness in high quality iron ore - magnetite, the high temperature yielding wood/charcoal as fuel and the water resources for use in the production activities indicate the signs of an industrial level production in the area. When considering the above data it can be suggested, that the technological system was connected with the presence of iron ore, wood, and water. It might be the main reason for the area being chosen for the iron production activity among the possibilities affecting the selection of the Kiri Oya. The reduction of wood and ore probably caused the decline of iron production in the Kiri Oya Basin.

The second part of Chapter 3 is devoted to analyzing historical sources relevant to RQ 2 (what is the cultural relationship of Buddhist monastery and the KOB settlements over time?) and RQ 3 (what kind of centralized political power developed over the social organization pattern of the KOB?).

The study of ancient settlements indicates that they were not always established dependent on the environment. They are also located in places that fulfill other requirements like defense, trade, and communication (Siriweera 1983). For the study of settlement patterns the historical and archaeological data of the area from the pre historic period to the pre-modern period have been used. The significant fact that is mainly highlighted in the study is the political and economic connection of the region with the centralized political ruling kingdoms throughout the whole of history. The main question is: what was the significant reason for that connection? Was it linked to some trade system connected to the iron industry or some transport network built throughout the region or some provincial ruling or religious centers connected with the centralized political center or all the reasons given above?

According to the study of the environmental connection in the region as discussed at the beginning of the chapter, a resource rich environment and the connected technologies contributed to the urbanization of the area from the prehistoric times onwards. The technological evolution of the area is clearly indicated in the two phases of technological development from the prehistoric period to the protohistoric- early historic period. The protohistoric - early historic transition mainly appeared with the irrigation- based, iron- using an early agricultural community (Bandaranayake 1990; 1994). Deraniyagala, also pointed out that the technological evolution in Sri Lanka between the two periods clearly indicates the transition from the hunting- gathering economic system to the food producing agro -economic system (Deraniyagala 1990). The ancient Sri Lankan Dry Zone economic system was mainly dependent on the irrigation based agro economy. The RBE which is the main soil group in the Dry Zone would have been conducive for agriculture only under irrigation and the plough (Seneviratne 1996). Therefore the vital role played in the economy of the area by water storing reservoirs connected with hydraulic net works spread out all over the region. The construction of the units of the hydraulic network as well as agricultural demands depended on iron tools. Therefore the iron producing activities may have taken an important role among the settlers who depended on the Dry Zone economy.

The main hydraulic work around the Sigiriya-Dambulla Region appeared from the 1st century B.C. to the 5th century A.D. and it caused a food surplus in the area, setting the scene for urbanization. According to Bandaranayake, during the Early and Middle Historic Period, the study region appears to be a medium density area of occupation. He presented this argument based on the much lower reservoir density of the area compared with the surrounding areas (Bandaranayake 1990). The appearance of a lesser reservoir density is seen in both the sectors of the KOB. The important question that rises is what significance does a lesser reservoir density have?

As discussed in this chapter, the crystalline limestone band was mostly spread through the western part of the KOB and limestone is not conducive to wet-rice cultivation. On the other hand these areas were rich in the major raw materials of the iron smelting. Therefore the settlers of the area might have used these `unsuitable' lands for iron production activities as a first priority over agricultural production.

The region might have been mainly occupied to supply the demands of the major political centers through the *rajakariya* (service to king) system through major economic or trading centers. The major demands that may have been fulfilled by the producers were war, agriculture, irrigation, and even possibly export.

The major irrigation works such as the Minneri Vava and several silt trapping reservoirs connected with the major reservoirs (for their maintenance) were also located in the eastern basin of the Kiri Oya and the Konduruvava mountain range, showing the signs of a well-defined hydraulic net work. Several reservoirs with the suffix *kuluvava* (for example Ihakuluvava) were located in the Polonnaruwa Peneplain and today this suffix is identified by some researchers as a reservoirs which was constructed for trapping silt, dissolved in water before it reached the main reservoirs (Awsadhahamy 1999).

As described in this chapter, several irrigation works and war campaigns were conducted by the main rulers in the history connected with the KOB. This appeared not only from the beginning of the 1st century A.D. to the 4th century A.D. but also continued in the later historical period. The main question is: How did KOB become a historically important place? It may be the mass production of iron in the area fulfilled the major demands of the socio-economic system such as agricultural, hydraulic as well as war requirements. The transportation network, which is laid along the region, might have helped to transport them through the major trading centers. There are some signs appearing in the history to indicate that the Sigiriya-Dambulla Region acted as a central place for the ancient ruling system. This argument confirms that even after the collapsed centralized ruling system of the Anuradhapura period, vanni principalities arose and came to control the region with the collaboration of the main political centers. They might have control the environmental resources and the products as the administrators of exchanging centers. Bandaranayake subscribes to this idea and he also has noted that the study region was formed as an intermediate or transition zone (Bandaranayake 1990).

The administrative power of monastic or religious centers of the area also appeared from the 3rd/ 2nd century B.C. to the 1st century A.D. The monastic complexes of the area are also important as major centers of the socio-political and economic organization of the region. Some information confirms further that there were royal grants to the monasteries in the KOB. Buddhist monasteries of the area might have played significant roles in the settlements and they also controlled the environmental resources and the distribution organization to facilitate the development of the industry. The royal grants might have been given for that participation in the socio-economic system of the kingdom. Using the data obtained from archaeological survey, in Chapter 4, I will discuss the connection of Buddhist monastery and the centralized ruling center and their power over the settlements in the KOB. Considering data provided in both sections in this chapter, it can be assumed that the settlements of the area clearly reflect a combination of environmental and socio-cultural factors.

CHAPTER 4
THEORY, METHODS AND ETHNOGRAPHIC VIEWS

Overview

The main topics in this chapter are the theoretical perspectives, archaeological methods and ethnographic views that I used to test my research hypotheses. A clear view of ancient iron technology cannot be achieved only through study of archaeological settings. Rather, archaeologists should work together with experts from other fields to understand the technical, historical, and anthropological dimensions. Studies on iron/metal technologies in Sri Lanka will continue to develop as an interdisciplinary field of research that will attract the participation of other anthropologists. In this dissertation I analyze the general and specific questions related to the project. I propose hypotheses that take this study beyond the usual boundaries of field archaeology into the mainstream of anthropological research. This study reveals new dimensions of the early technological development and its connection with the socio-economic systems of the country during this early period of Sri Lankan development.

Theory

In this section I mainly discusses the research questions that I addressed throughout this study and the conceptual background that I used for analyzing my research data on the iron technology, social organization, and the settlement pattern. It is my intention to expand the study of iron smelting technology and its contribution to the socio-economic systems of the region, especially what the varied technologies meant in terms of varying socio-economic development across the region. This study focuses deeply on variations in furnace structure/architecture, final smelting products, and the raw materials relevant to the bloomery processes found in the KOB. I also provide information related to our understanding of the relationship of the KOB 'iron smelters' settlement' with secular elites and Buddhist monastery.

Research Concerns and Questions

I formulated some general themes related to understanding the study region's settlement pattern and iron smelting technology. I then formulated research questions based on the data obtained from literary sources and ethnographic evidence that I presented in Chapter 2.

My research questions are related directly to the iron smelting technology, the social organization, the political system and the chronology in the KOB. Research questions related directly to the iron smelting technology are (1) what are the main characteristics of iron smelting technology in the KOB and selected raw materials/resources for the process; (2) what are the technological differences and similarities among smelting sites in the KOB and with other known iron smelting technologies in Sri Lanka. Research questions related to the socio-economic organization are (1) will the settlement pattern of the KOB display the concept of *"gamai-pansalai, vavai-dagobai"* that was the connection between the Buddhists monastery and the ancient settlements based on the agro-hydraulic economy or can we trace the "internal dynamics of Buddhism in the local landscape" (Willis 2000; Shaw 2000); (2) what demands have the various methods of iron making made on the supply of raw materials and labor and its organization; is there any connection with environmental resources of the area with the emergence of the iron smelter's settlement; (3) what impacts did the iron industry have on the early settlements and socio-economic and political systems of the region. Research questions addressed to the political system and chronology in the KOB are (1) what is the connection of the KOB with the centralized political authority and what is the chronological sequence of the KOB.

I finally reduced these questions into four major research questions that I addressed throughout the dissertation. These are (1) The Research Question 01 (hereafter referred to RQ 1), what are the major characteristics of iron smelting technology in the KOB?; (2) Research Question 02 (referred to RQ 2), is there any connection with environmental resources of the area to the emerging of iron smelters' settlement?; (3) Research Question 03 (referred to RQ 3), what is the relationship of Buddhist monastery and the KOB settlement over time?; (4) Research Question 04 (referred to RQ 4), what kind of centralized political power was activated over the social organization pattern of the KOB.

My hypotheses of the research are

1. The settlers who lived in the study region had a well-organized iron smelting network system prior to the 5th century AD, the Kasyapa Period, which was the main construction phase in the Sigiriya Kingdom. A well-organized socio-economic system based on iron may have contributed to the emergence of Sigiriya as a suitable location for urbanization.

2. The KOB settlers had a unique knowledge of the smelting technology and the area's resource utilization for the industry. The high quality of iron produced, the quantity of output, and the organization of production all suggest KOB settlement had an industrial level of production for use beyond the region as well as for local purposes such as agriculture (dependent on irrigation technology), war, and dealing with hard media such as gneiss and granite (such as rock sculptures and building technology).

3. The concept of "gamai-pansalai, vavai-dagobai", the ancient settlement pattern that was mentioned in the Sri Lankan chronicles can be found also in the "iron smelter's settlement" in the KOB.

4. Through the distribution pattern of the social structures in the local landscape, we can trace the political legitimacy and religious authority in the KOB settlements.

Theoretical Framework

I chose three themes as being representative of the recent studies focusing on archaeological methods and theory, and their relationship to texts: king, Buddhist monastery and social economic system; beliefs, symbolism, and oral tradition, settlement pattern and iron production. I used the following theoretical factors to examine my hypotheses. If we can find structures archaeologically, we can trace the social stratification in the landscape. The power of the monasteries and their higher social status in the society can be traced through the material culture (potsherds/artifacts).

I argue that we can discover how the centralized political legitimacy was activated over the social organization pattern of the KOB and what was the relationship between the Buddhist monastery and the KOB settlement. How was the relationship affected by the material culture. The distribution pattern of the material culture of the KOB also symbolizes hidden social structures.

> Structuralism is an approach to the complex product of human culture such as language, literature, myth and decoration that seeks to explain their superficial form by identifying and analyzing more fundamental underlying structures and structural relationships. (Shaw and Jameson 1999)

> Structure becomes a social logic underlying and giving meaning, sense and significance to that which may be empirically observed. It exists through its effects on social life but is not itself empirically observable. (Tilley 1990)

Levi-Strauss took the fundamental idea of a hidden structure beneath a cultural construct dependent for its form on contrasts. He used this approach to explore the ways that hidden structures are interwoven with language, myths, eating habits, and kinship, and explained the universal structures of meaning behind them and their relationship with human cognition. He focused on structures in human thought and saw social interaction as the cultural manifestation of such cognitive structures. This concept is one of the most influential conduits in archaeology. It is true that archaeologists mostly depend on the material culture that is empirically observable. But as Leach mentioned,

> Ideas are more important than things; creative imagination is deeply entangled with the formulation of verbal concepts; archaeologists need to appreciate that the material objects revealed by their excavations are not "things in themselves," nor are they just artifacts- things made by man-, they are representations of ideas. (Leach 1977:167)

Materials represent the ideas of people in a society who made objects that are then found in the archaeological contexts. Leach's reflections on archaeology are associated with what anthropology has to offer archaeology.

Schmidt developed and applied the ideological interpretation of culture that goes beyond the materialist interpretation for his work on African iron technology (Schmidt 1983 and 1997). He examined the changes in the relationship among elements of the religious, social and political systems, and used cross-cultural similarities in ritual and symbolic meanings associated with iron production to reconstruct the past and political systems of the society. He identified how political legitimacy was tied to iron production by analyzing the oral traditions related to the royal coronation ceremony. Archaeologists can find the connection between the ideological superstructure and material culture- archaeological evidence through knowledge derived from anthropological methods, such as ethnoarchaeology. The domain of symbolic thought and expression of a certain culture can be identified through metaphor, metonymy, and synecdoche that are embedded within the culture as folklore, oral traditions, mnemonic devices, written literature. Although cultural change may occur throughout time, the core meanings of the symbols remain.

When turning to history, it is important to discuss the relation between history and archaeology. How have archaeologists used history to study the past? How have they use historical sources to interpret material remains existing in the archaeological context? As Tilley pointed out:

> History and myths are not radically opposed. They are different names for narrative accounts with similar functions in different societies. (Tilley 1990)

It is true that most historical sources consist of mythical events as well as the history of the elite class, religious leaders, royalty, and usually male dominance. In most cases, history does not tell about the common people of the society. But archaeologists can find the structure of the society through structural analyses within these limitations.

Similar “events” can be found in different ways- as history in one culture and as myth in another culture. Myths embodied structures that were a direct product of universal cognitive structures, by which the human mind made sense of the world. The study of mythology provides a unique opportunity to study the structure of a society. Regardless of what a narrative “event” says, it is important to identify the social structure within its core to understand the meaning. Schmidt’s study of the myth of the iron tower of Buhaya shows how political legitimacy was closely tied to myths and rituals associated with iron production in Tanzania (Schmidt 1983 and 1997). Therefore, archaeologists can employ anthropological methods to understand the social-cultural phenomena embedded within the archaeological context.

We cannot apply Schmidt’s model on symbolism to identify the political legitimacy that is associated with iron production as iron production no longer exists in Sri Lanka. We can apply the symbolism model to the local landscape to see how political legitimacy and religious authority acted in the settlement in the KOB.

My theoretical perspective on the dissertation on social organization in ancient Sri Lanka is a combination of ideas generated by Gunawardana’s monastic organization and economy (1979) and Bandaranayake’s pre-modern social formation (1974; 1989). I also examined concepts underlying Webber’s hydraulic-bureaucratic official-state (1947), Wittfogel’s hydraulic agriculture and Oriental Despotism (1957), Shaw’s (2000a; 2000b), and Coningham, Gunawardhana, Manuel and Adikari’s state of theocracy (2007) in the KOB settlement.

Regional Archaeological Methods

In this section, I present survey methods and revealed data from 2004 to 2006 during the SIT project for this research in combination with SARCP data during 1988 to 1992 (Bandaranayake, Mogren and Epitawatta 1990; Bandaranayake, Mogren, Myrdal-Runebjer and Epitawatta 1994; Manatunga 1990; Forenius and Solangaarachchi 1994; Solangaarachchi 1999).

I built on the methodological foundations introduced by the “Settlement Archaeology Research Collaboration Project” (SARCP) in 1988 and applied this methodology several steps further to this study, mostly concentrating on the site formation process, size, and the artifacts distribution pattern. During my fieldwork, I addressed some general and specific issues related to ancient iron smelting technology and its impact on early settlements and socio-economic and political systems of the study region.

Settlement pattern study has become an important area of study in modern archaeology. It mainly focuses on the interactions between human and cultural systems. A settlement pattern study provides evidence about people whose lives were ignored in historical writing. Present archaeological research in Sri Lanka has gradually moved beyond to traditional concerns: ceramic chronology, explorations, and excavations. I made an effort to understand the settlement pattern of the iron smelters’ community in the KOB, a sub-area in the Sigiriya-Dambulla Region (SDR), one of the archaeologically best-known regions in Sri Lanka.

Defining a Site

I used the ancient village settlement pattern of the *raja-rata* mentioned in early sources and the visible site formation process for defining a settlement. Heavy artifact concentrations, residential architecture and pottery distribution patterns, all contribute to defining a site. If the pottery distribution is limited to a small area in a sloping valley or has a visible signs of an erosion and re-sedimentation, it does not count as a site. When we review records of survey archaeology, we see that a clustering location of a residue of human activity is defined as a site. Renfrew and Bahn’s definition for a site:

> A distinct spatial clustering of artifacts, features, structures, and organic and environmental remains-the residue of human activity. (Renfrew and Bahn 2000: 572)

Considering this definition, I registered every place that could be identified as the residue of human activity as a site on the first survey map: iron smelting site, settlement site, monastery site, inscription site. I used mainly the pottery distribution pattern to define the habitation area of a site. If the habitation area in a site is greater than the area of other activities, then I consider it as a settlement site. In other words, I considered it as a habitation, where residential activities were conducted. If the survey area is not greatly disturbed, then I could identify the site continuation. I mapped all the activities within one settlement site (eg. most of the large settlements have the smelting site and the sacred place inside the settlement). I considered the combination of sites as a settlement cluster in this study.

Main Objectives

The settlement pattern survey provides better understanding of chronological sequences related to socio-political-environmental processes and also can be identified as different settlement hierarchies. I mostly concentrated the survey on areas along the KOB as the core region of the research and used previous known data to fill the gaps on centralized socio-political aspects and relationships in the region. As a part of the centralized political organization, regional political economic activities are often reflected in regional settlement pattern data.

I also addressed some questions regarding the nature of urbanization in the region, especially in the KOB prior to the 5th century A.D., the major construction period of Sigiriya : first, to find if there had been settlement prior to the main construction period of King Kasyapa; second, why did King Kasyapa select Sigiriya as a suitable place for urbanization; third, during what period of history did these occupations occur; fourth, what was the connection between King Kasyapa's selection of Sigiriya and the early iron smelting communities or industry. In addition, I investigated the distribution pattern of iron smelting centers in the settlement, and the relationship of the ancient settlement pattern with the religious authority. Further, I wanted to identify the political legitimacy within the KOB.

As already mentioned in Chapter 3, although the area has evidence of historical connections from the early historic period up to the modern period, I concentrated my research design on the settlement patterns from the 3rd century B.C. to the 10th century A.D., the period in which we could expect empirical archaeological data in the KOB that connect with the iron smelting technology as we already have inscription evidence that represents this historical period. Research design is not merely concentrated on technological aspects of iron production; it is also widely focused on socio-political aspects. I have investigated the spatial and regional socio-cultural interaction of the region with iron production activities. Through this study, I can create several models for the socio-political activities and the settlement pattern of the region. The KOB settlement survey was designed to systematically make maps, collect data, excavate, and conduct artifact analyses.

Ethnographic Views

Ethnography, the fundamental research method of cultural anthropology, helps to interpret material culture unearthed archaeologically in the research setting. Ethnographic information acts as the bridge to fill the gaps that cannot be obtained using historical sources. First hand observation is the best way to get information on living traditions in the study setting. I couldn't use an "emic" perspective or "native's points of view to collect rituals and oral traditions about iron smelting technology and the smelting technology as the iron technology and the yamanno caste which conducted the process no longer exist in Sri Lanka. Therefore, I interviewed knowledgeable informants to collect oral traditions in and around KOB to get information on the past social-political activities in the area.

Oral traditions and beliefs I provide here are mainly connected with King Mahasen (269-296 AD), King Kasyapa (477-495), and King Parakramabahu's (1153-1186), all of whom are connected with the KOB. There are two *devales* dedicated to *minneri deviyo* in the KOB. One is located at Gallinda in Sigiriya (north of SIT 74). Newly built, the second *devales* is located near the Jayanthi sluice and the reservoir bund at the Minneriya reservoir bund (SIT 12). The ancient Minneriya *devale* is located 1km east of Minneriya reservoir. Both annual festivals of ancient *devale* and Gallinda *devale* are conducted by Mallawa Mudiyanselage Senevirathne of the Gallinda Vedda generation, the head *kapurala* (Sherman) of Gallinda. The cobra headed hair-dress of the statue at the ancient devale at Minneriya symbolizes the King Mahasen's connection with minor and major irrigation work in the region (Figure 4-1).

Figure 4-1. Worshiping statue of King Mahasen (*Minneri deviyo)* at Minneriya *purana devalaya* (old prayer shrine). Photograph by R. Solangaarachchi.

Local Beliefs and Traditions

Most of the oral traditions of the area are connected with King Mahasen. He is worshiped by inhabitants of the region as *minneri deviyo,* as their local guardian deity. His construction work at Minneriya reservoir and the magnitude of the irrigation network contributed significantly to the area's agro-economy. After every harvesting season, the annual festivals have been conducted by *kapurale* (shaman) at the local *devale* (prayer shrines) for getting blessings. All *devales* of the KOB are devoted to *minneri deviyo*. I had several interviews with three *kapurales* to obtain information about their *yathika* or *yahan Kavi (chanting poems)* during the festive rituals in progress. I also interviewed Rev. Nalande Jinarama to get information about the area. In addition, I interviewed two elderly men of the Ulpothagedera smithy village in Habarana to trace their knowledge about their iron smelting generation in the area.

Oral traditions of the area mainly link with King Mahasen's involvement on many occasions. According to villagers, the building remains of the top of the Nuwaragala-kanda were the remains of the king's palace that was used during his construction of the irrigation network as part of the Minneriya hydraulic system. Although recent archaeological excavations confirm its connection with a forest monastery that was used during the 7-10 century A.D. (Jayaweera *et al.* 1998), we cannot reject oral traditions, as we already have an example of King Moggalyana's donation of his brother's royal palace of Sigiriya to the monastery. The second clue is connected to King Mahasen's uncle, who stayed to help his nephew with the irrigation network. Oral traditions provide the family names of the *govigama* caste at the ancient village of Alakolavava: Dalupotha Gedera Mudiyanselage (or Dalumure Gedara) and Patabandi Gedera are the titles granted by the king's uncle for the service they provided to him.

One of the interesting oral traditions concerns King Kasyapa (477-495 A.D.), who is connected with KOB. It says that after he killed his father, King Kasyapa lost the support of the *sanga* or Buddhist monastery. Then he went to get support from his mothers relatives, the "yaksha" people who lived in the KOB. When I was interviewing Rannidelage Hendirik Appu, a

78 year old blacksmith of the navandanna or achari caste who lives at Ulpothagama, he referred to iron smelters as “Yaksa”. According to him, Yamanno or “Yakku” of Ritigala knew how to smelt iron from iron ore. If we connect both clues about the “Yaksha”, we can conclude that people who live in the KOB are iron smelters. If this conclusion is correct, there is no about King Kasyapa’s selection of Sigiriya as the place to build his royal palace. Perhaps after King Kasyapa’s death the royal capital returned to its origins at Anuradhapuraya.

Another oral tradition is connected to King Parakramabahu’s reign (1153-86 A.D.). According to the inhabitants of Alakolavava, the Prince Parakramabahu lived at Alakolava among his relatives when he prepared his war campaigns. The question is, why was the King attracted to the area? This needs additional study. Is it connected to iron metallurgy or are there also other reason?

Living with the Tradition

Although I have been involved in several study programs in the present study region since my undergraduate years, as a female field archaeologist among villages in the remote Dry Zone in Sri Lanka that have a culture, traditions, and belief systems different from my own, I expected that I would have to deal with various problems conducting a long term research project. But my previous involvement in the area gave me an opportunity to understand their regional beliefs and traditions not only as an observer but also as a participant. This long term familiarity provides a suitable background for practicing their traditions without conflict with my own traditions and Catholic belief.

The villagers’ Buddhism is interwoven with local deities and folk beliefs, such as the worship of *Minneri Deviyo*. Villagers perform certain rituals at the end of every harvesting season, during their important life incidents, and when they are sick to obtain a sense of security and protection. Respecting these traditions, I conducted the ritual offering to *Minneri Deviyo* at the beginning of each excavation and the survey as well as at the end of every field season (Figure 4-2).

Figure 4-2. Traditional rituals have been conducted during the SIT field season for *Minneri Deviyo.* A). Hanging a coconut at SIT07 for blessings before excavation. Photograph by a member of the excavation team. B) Making traditional milk-rice (for "*dana*") after excavation at SIT07. C) Offering at the Vavala vava excavation site for *Minneri Deviyo* on the final day of the project. Photographs B and C by R. Solangaarachchi.

It is important to note here that the preparation of "*dana*" or alms-giving is usually conducted by males, as they are the main participants of the agro-economy. It considered to be a long-term tradition. But it is not considered taboo for female participants. Although I was the main participant of the SIT project, I did not want to break this tradition and belief system even though villagers asked me to do the final offerings.

By gaining a deeper understanding of local belief systems, my use of ethnographic data with archaeology allows more informed interpretations that go beyond a strictly materialistic value.

CHAPTER 5
ARCHAEOLOGICAL SURVEY METHODS AND RESULTS

Overview

I present here the survey methods that I used for obtaining the data needed to analyze the main characteristics of the settlements in the area, and the results of the survey that provide the main characteristics of settlement patterns in the KOB. I used multi-disciplinary research incorporating the historical, social and natural sciences as well as basic archaeological techniques. I conducted the survey in several steps: following the maps created by the SARCP (Manatunga 1990:74), one inch topographical maps by the Survey Department (produced in 1927; revisited 1973; reprinted 1990; scale 1: 63360) and aerial photographs, I identified the proposed survey area. Conducting survey along the KOB and its tributaries, I plotted the identified archaeological sites on the one inch topographical sheets; I also identified the zone in densely distributed archeological sites or settlement clusters; and, I conducted a detailed survey in a selected grid that covers the highest zone of archaeological sites; identified the spatial distribution pattern.

The first stage of the project that I conducted in 2004 mainly focused on getting a general overview of the ancient settlement pattern in the Kiri Oya Basin (Figure 5-1). I devoted the first three months of the survey in 2004 to plotting the early settlement sites along the KOB, with a special focus on iron smelting activities. It was hard to identify most of the sites even with the help of previous surveys (Bandaranayake et al. 1990 and 1994; Manatunga 1990) and though I had participated in previous explorations of the area for the SARCP from the beginning to the end (1988-1992). I had studied and visited most of the sites during the first phase of my research on “iron smelting technology in the region” from 1992-1998 for my master’s thesis (Solangaarachchi 1999).

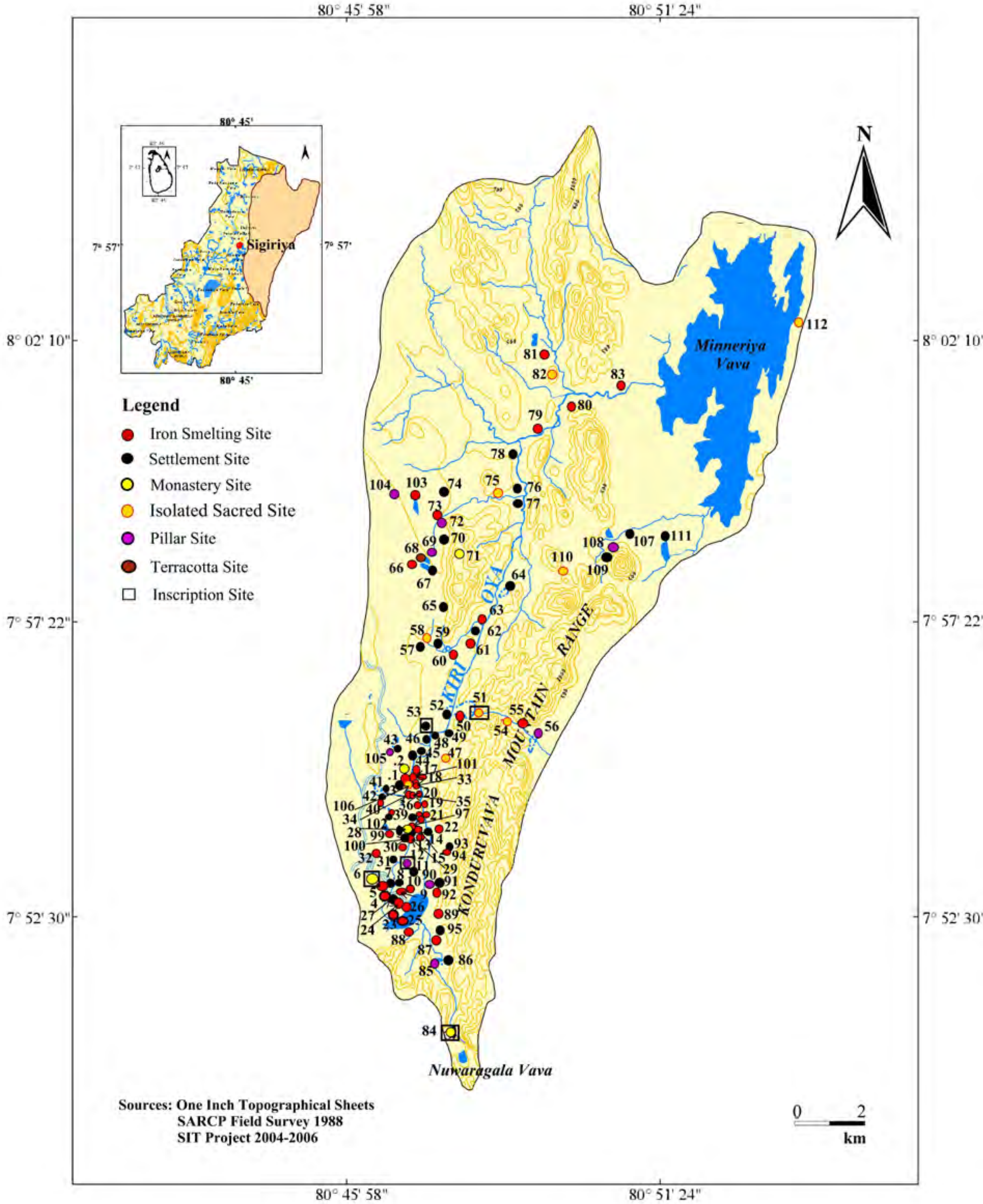


Figure 5-1. Investigated archaeological sites during the SIT field survey in the KOB. Detailed map of the clustering area is provided in Figure 5-4.

Most of the area's archaeological sites are currently being impacted by modern socio-economical activities. Also new sites could be seen as the result of preparation of new land for cultivation. Most streams linked with the ancient reservoir network are still used by present farmers around the area. The network of subsidiary or distributive canals in these hydraulic systems in the KOB was interlinked with settlement, both residential and monumental.

None of the SARCP sites haven't given their GPS coordinates and most not provided enough description to find out their exact location. Therefore, I decided to conduct a field survey along the KOB for this project in 2004 and get GPS coordinates, I used a different numbering system as SIT 1, SIT 2, etc. SIT stands for "Sigiriya Iron Technology". When possible, tried to find the parallel SARCP field designations.

I started the survey, from the Dehigaha-ala-kanda iron production site at Alakolavava (numbered as KO 14 by the SARCP and SIT 1 by the SIT project) one of the archaeologically best known and most studied sites since 1988. My first involvement at the site was to prepare the site map with the survey team in 1988. Then I conducted excavations in 1990 & 1991 under SARCP and continued to study data revealed at the site as well as KOB as the first phase of my study on "Ancient Iron Smelting Technology in the Sigiriya-Dambulla Region, Dehigaha-ala-kanda at Alakolavava" (Solangaarachchi 1999).

The exploration-team of the SIT project consisted of peasant farmers of the villages, former hunters in and around the study region, university students, and guides of the Wildlife Conservation. It was a big advantage to include peasant farmers and former hunters in the survey team as they knew their home territory and adjoining forest. They knew tracking paths in the forest, and how to avoid unexpected dangers such as wild elephants and poisonous snakes. The use of information provided by local informants who know the location of sites helped me to get a better understanding of the physiographic locations, (that is), whether they are located near water resources, or on marginal land not used for agriculture, or near early monastic or other habitation sites. The exploration campaign was conducted using compasses, GPS, aerial photographs, and the Survey Department's one-inch topographical sheets (produced in 1992; revised 1973; reprinted 1990).

Every site that I identified, was plotted on the one-inch topographical sheets according to the GPS coordinates. Most sites that we discovered were previously unknown. All sites that we plotted were photographed either in close or from a distance. Random samples of smelting remains were collected for later analyses. The first field season of the SIT project in 2004 was followed by documenting 112 archaeological sites (Appendix D) from the Nuwaragala-kanda up to the Minneriya Vava along the KOB, over a 1750 km^2 area. These sites are related to ancient iron smelting activities, ancient habitations, religious performance sites, and ancient reservoirs (Figure 5-1).

Results of the regional survey with the GPS points provided better understanding of the area's archaeological pattern, the characteristics of the iron smelting technology, activities connected to this technology, and their relation with the settlements along the KOB. Site description (Appendices D), pottery distribution and typology (Appendices J and K) that I provided in this research were based on the density of material culture from the Nuwaragala-kanda up to the Minneriya Vava along the KOB.

I devoted the second stage of the project in 2005 to conducting a detailed survey along the Kiri Oya basin. It is not possible to conduct a detailed survey without a systematic grid system. I stratified the surveyed region into several appropriate zones based on the data on the first survey map (Figure 5-1).

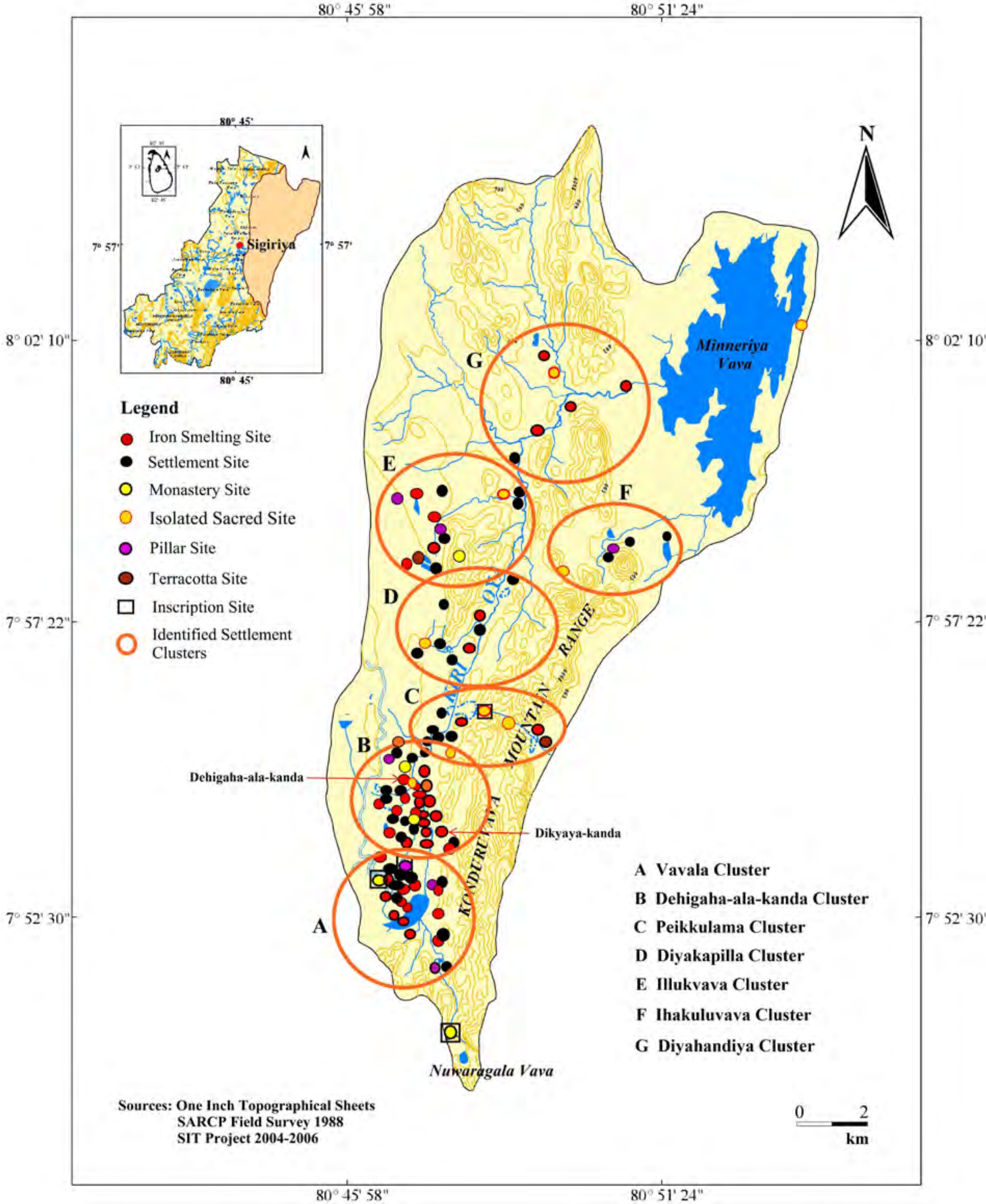


Figure 5-2. Micro settlement clusters that are connected with ancient monasteries and reservoirs in the KOB.

According to the observed spatial pattern on the survey map, I identified significant seven settlement clusters: Vavala Cluster; Dehigaha-ala-kanda Cluster, Peikkulama Cluster;

Diyakapilla Cluster; Illukvava Cluster; Ihakuluvava Cluster; and, Diyahandiya Cluster (Figure 5-2). These settlement clusters are spread over between Nuwaragala Kanda from the south and Minneriya Vava to the north. The SARCP also identified eight clusters from Nuwaragala Kanda to Pihimbi-ala (Manatunga 1990:78). Cluster demarcations of both the SIT and the SARCP have shared a much similar pattern with only slight differences in the Dehigaha-ala Cluster, the Gallinda Cluster, the Illukvava Cluster and the Peikkulama Cluster. The Ihakuvava and the Diyahandiya clusters are located in a new survey area that was not included in the SARCP study region.

According to the settlement cluster map (Figure 5-2), I identified the Dehigaha-ala-kanda Cluster (31%), Vavala Cluster (23%) and Illukvava Cluster (13%) as the highest zones that have provided densely distributed archeological sites. Therefore, I selected the Vavala and the Dehigaha-ala-kanda Clusters in order to conduct a detailed survey that covers the highest zone.

I applied a conventional grid to the selected area to facilitate making a detailed map of the spatial distribution of cultural activities (Figure 5-3). The second reason for selecting the "Dehigaha-ala-kanda-Vavala settlement clusters" to conduct a detailed survey was, that they provided a highly visible ancient settlement pattern on the preliminary survey map made in 2004. Dehigaha-ala-kanda is located in the Alakolavava village. Therefore I named the grid the "Alakolavava-Vavala Grid."

"Alakolavava-Vavala Grid", the selected conventional grid, lies between $7^0$51'- 7^0 56' north latitude and 80^0 46'- 80^0 48' east longitude in the Polonnaruwa one-inch topographical sheet (scale 1: 63360; one inch: one mile). It divided equal 400m x 400m sub-grids to understand the habitation pattern, industrial zone, religious sites, and hydraulic network in the KOB (1 inch = 25mm; 25mm= 1600m; 12.5mm=800m; 6.25mm=400m).

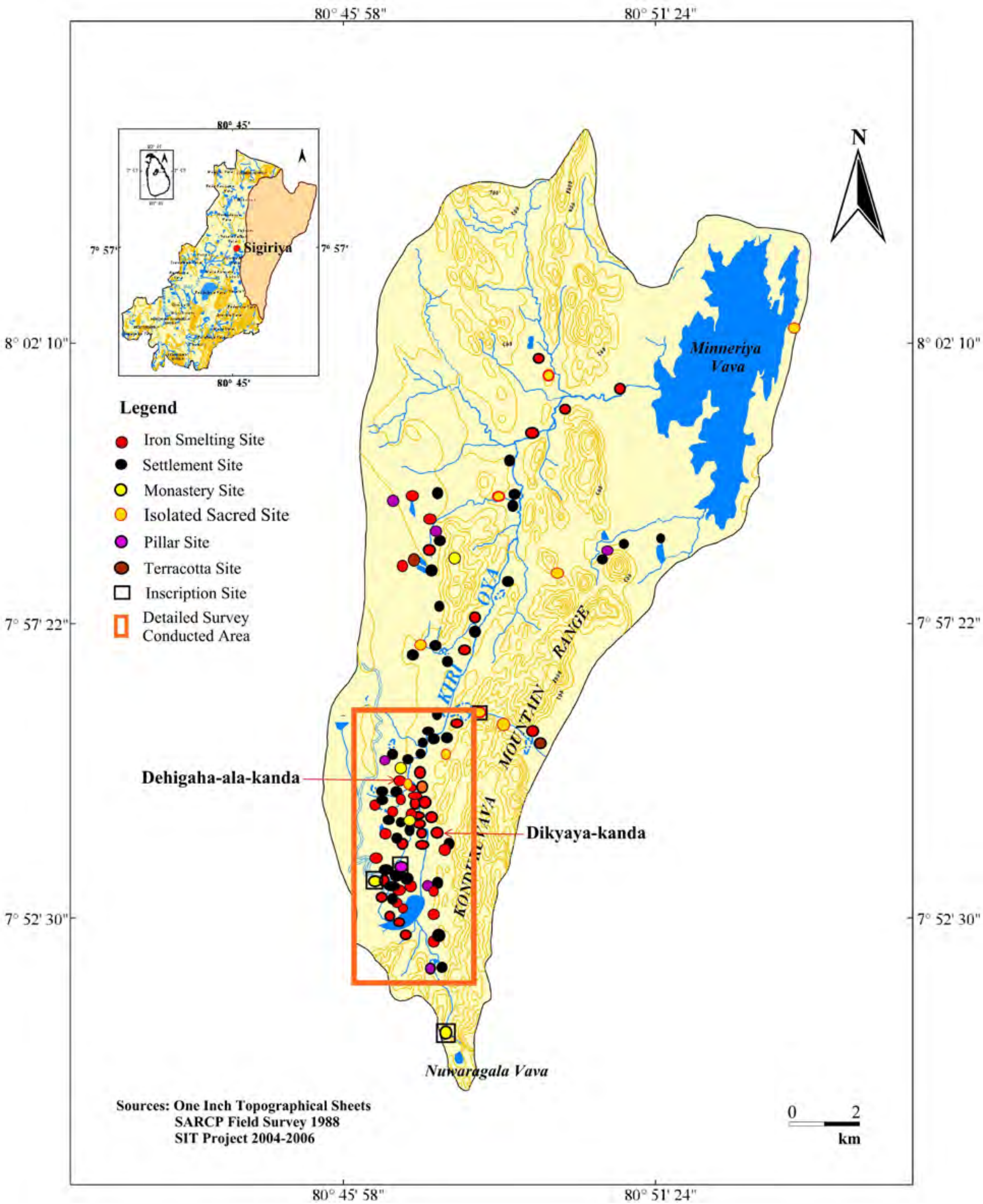


Figure 5-3. Investigated archaeological sites and the area showing the detailed survey conducted area.

To facilitate the reference and to ensure that I have not missed sites that may be located within the transects, I labeled them A-I from the west to the east (from Kapapu-ala to the western edge of the Konduruvava Mountain Range), 1-22 from the north to the south (from the Peikkulama Vava to the Nagolla Vava settlement at the Nuwaragala Kanda foothills) (Figure 5-4). During the survey, I followed the transects on the grid system and conducted the detailed survey within the selected area of nearly 32 km^2 and I mapped 75 sites in order to understand the settlement pattern.

I selected 4 sites from 75 sites that lay inside the survey grid for conducting excavations (Figure 6-1) and made detailed site maps for these selected sites (Figure 6-2; Figure 6-14; Figure 6-33): SIT 22, an iron production sites; SIT 6, a religious site; SIT 7, a settlement site; SIT 25, an iron smelting site inside a reservoir. I will discuss excavation objectives and the selection procedure in Chapter 6.

I also used the already produced SARCP map of SIT 1/KO 14, the Dehigaha-ala-kanda iron production site (Forenius and Solangaarachchi 1994:134) and the detailed maps of SIT 84/SIT 57, the monastery at the Nuwaragala Kanda (Bell, Fernando and Moysey 1914; Jayaweera, Dodanwala, Samaraweera and Kodituwakku *et al.* 1998) for this study. Using GPS readings and 8 radial transects that were placed over the site, I made site maps for 25 sites among the 75. I applied this method to large sites, when it was hard to see the demarcations and the dimension of the site. I made sketches for 44 out of 75 sites as they were spread all over a small area. Details of all maps are added to the grid map (Figure 5-4).

The detailed grid map helped to define clear distinct zones clearly in the Vavala and the Dehiga-ala-kanda settlement clusters - religious; habitation; industrial; irrigated; reservoirs - on the basis of their locations. It also helped to identify their inter-connectivity with each other. The obtained settlement patterns were used to examine how the ancient settlement pattern of early chronicles works in the KOB settlements and how to interpret the material culture.

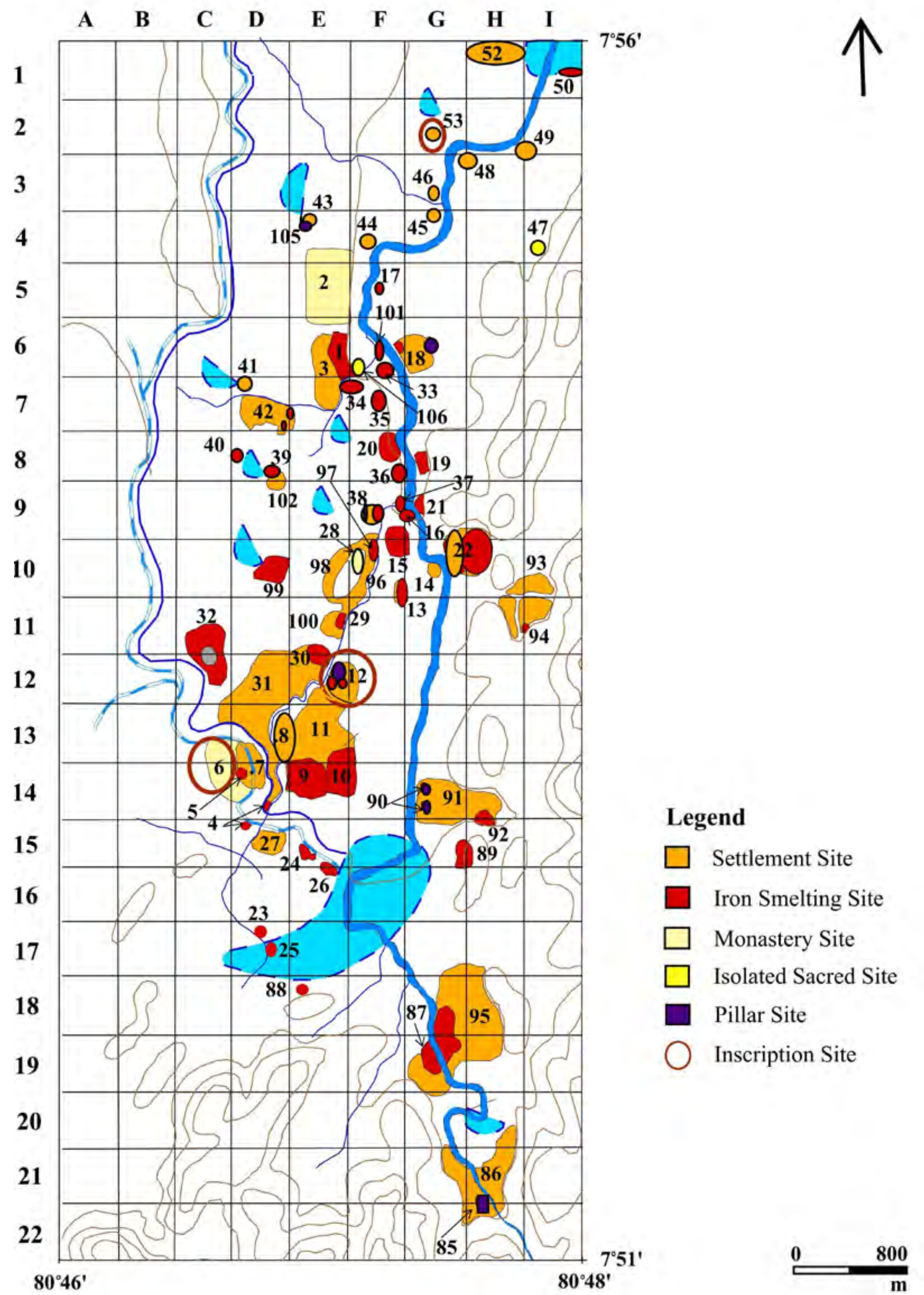


Figure 5-4. Detailed survey map of the "Alakolavava-Vavala Grid."

Special Environmental Factors and Problems During the Survey

Most areas within the selected survey grid are covered with high grown *Cymbopogon confertiflorus* (Sin. *mana).* It emerged as the major problem for deciding a site or size definition of a site in the survey. The survey in some areas were difficult. Such as from the Peikkulama Vava to Meegahawela and from the lower Pihimbi-ala to Minneriya Vava, especially the area in close proximity to Minneriya vava was the most the difficult area; it could not be reached properly.

Although we could only manage to conduct the survey that was just 10-20 meters in both basins of the Kiri Oya, due to the high lower vegetation (dense natural vegetation) and wild elephants, we succeeded in identifying the habitation sites hidden in the scrubbed thick forest by walking towards both basins of permanent waterways as main indicators. In the lower KOB, when we felt the presence of wild elephants in areas that are occupied in the scrubbed thick forest, we needed to leave the site quickly. We had to be satisfied with plotting the sites rather than documented them fully. Sometimes sites were overlapping, revisited or documented as a new site. But this problem could be solved as every evening we applied field survey data to our detailed grid map. Driving during the monsoonal rainy season is hard as topsoil in the pathways turned into slippery paste. Once we had a narrow escape, when I drove up a 45^0 angle to cross the waterbed of Kiri Oya to reach the Dikyaya-kanda iron smelting site.

Although the months of May to October were selected for conducting the field research in order to avoid the difficulties caused by the monsoonal rain, I had to continue fieldwork until November 17, 2004. We had major problems with monsoonal rains that started earlier than expected. Being unable to do outdoor research during the heavy monsoonal rainy days, I conducted some indoor research, such as interviews, and the analysis of excavation data. I conducted my fieldwork during the remaining days when the problems caused by rain were absent. Fortunately, we did not have any problem with the monsoonal rain from October 15, 2005 to December 05, 2005. (The monsoonal rain started for the region just after the evening of the final day of the fieldwork).

Usually I conducted the survey in the forested area when the assistance of villagers was available. It would have been nearly impossible without their help to identify landmarks of archeological significance and we would have definitely overlooked sites with sudden slopes or pits that are covered by savannas (`Damana' grassland) such as *Cymbopogon confertiflorus* (Sin. Mana) and *Imperata cylindrica* (Sin. illuk), and huge forests. Sometimes we went directly to the site in the forested area pointed out by village assistants. They also helped us avoid certain dangers, such as stepping over self-triggered trap guns of hunters and encountering wild elephants. We were lucky to survive two sudden appearances of wild elephants, stepping on hidden guns, and being bitten by snakes.

The social-political aspects that the new generation archaeologists have to face are much more complicated than those faced by the previous generations. Some areas are private property, and others are government properties that are controlled by various ministries and departments. Always we had to carry permission letters to show government officers. Today, elephants are creatures protected by Sri Lankan laws. So we carry only “thunder crackers” (*ali-vedi*) to avoid the sudden appearances of wild elephants.

Survey Results

I present here the settlement patterns in the KOB and their characteristics that could be identified during the survey. Through the KOB landscape we distinguishes four micro zones: sacred, habitation, industrial and reservoir could be identified in every settlement system (Figure 4-5; 4-6). Categorizing sites was mainly based on the distribution of artifacts, types of artifacts and architectural units in the sites. Inscription sites are not categorized separately as they are located either at a monastery site or at a habitation site. While architectural features in the site help in identifying sacred sites, pottery distribution is the main sign of the determination of settlement sites. Slag acted as the main indicator of an iron-smelting site. Remains of furnace superstructure, tuyeres and conical holes at a site were also used as signs for past activities connected to a smelting process. The usage of conical holes is still doubtful. Parker (1909), Lewis (1912) and Mogren (1990) have given their opinions on it (see Chapter 6).

We already have an adequate amount of knowledge of the area's connection with the centralized political power in different periods of history (Chapter 3). Investigations of the landscape patterning of the KOB revealed the invisible power of centralized political structure including secular and sacred elites' authority, and iron smelters/settlers' activities over the landscape. I summarize here how these structures are organized in the landscape.

All site descriptions along the KOB are given in Appendix D. Here an attempt is made to analyze only some of the important emergent factors of the area with special focus on the distribution system of the remains of the iron production. I start my discussion with monasteries in the KOB as they demonstrate the higher level of the stratification.

Sacred sites in the landscape

In this study I discovered 23 sacred sites into three main categories. Monastic centers are the main group that consisted with several architectural units making a complex (SIT 2, SIT 6, SIT 28, SIT 71, SIT 84). Isolated sacred sites, the second category do not show complex architectural units (SIT 47, SIT 51, SIT 54, SIT 58, SIT 75, SIT 82, SIT 103, SIT 106, SIT 110, SIT 112). Pillar sites, the third category made of several stone columns and locate in a large settlement site as a separate worshiping place (SIT 12, SIT 38, SIT 72, SIT 85, SIT 90, SIT 104, SIT 105, SIT 108). Rituals at second and third categories were connected either with Buddhism or rituals for local deities or both.

Every settlement cluster identified in the KOB has included sacred place either larger monastery complex or isolated sacred place and several pillar sites attached to the neighboring settlement (Figure 4-2). All major Buddhist monastery complexes in the KOB are located on barren mountain ridges of comparatively high elevation as seen in the surrounding area and the settlements (SIT 2, SIT 6, SIT 28, SIT 71, SIT 84).

The Dehigaha-ala monastery complex (SIT 2), the Vavala monastery complex (SIT 6) and the Nuwaragala-kanda monastery complex (SIT 84) are the largest monastery sites in the KOB. SIT 2 and SIT 6 are located on the Dehigaha-ala-kanda mountain ridge. SIT 84 is located on the Nuwaragala mountain ridge and the below to the Nuwaragala Vava, where the Kiri Oya starts its journey to the Minneriya Vava. It lies on the ancient Minneri-mawatha, from Lenadora to Minneriya via Alakolavava (Bell, Fernando and Moysey 1914).

The Dehigaha-ala-kanda monastery complex (SIT 2), the largest religious site at the Dehigaha-ala cluster (Figure 4-2), is located at the northern part of the Dehigaha-ala-kanda mountain ridge and at the middle of the cluster as surrounded by other sacred places of the settlement. It consists of a stūpa, a pond, a moulded *mal-āsana* (alter for offering flowers), stone pillars and stone slabs with moldings indicating its architectural connection with the Pabbatha Vihara type Buddhist monastery during the late Anuradhapura period.

The monastery complex of Vavala (SIT 6), the largest sacred site at the Vavala cluster, is built on a rocky hill slope facing the "remains of" the Kapapu-ala and the South Kosgaha-ala from the east, northeast to the Vavala Vava. It is surrounded by largest and prosperous settlement sites in the KOB. Three early Brahmi inscriptions (inscription No. 1, 2, and 4 in the Appendix L) dated 3rd century B.C. to 1st century A.D. and one late Brahmi inscription (Inscription No. 3 in the Appendix L) the 10th year of King Kithsirimevan's reign (son of King Mahasen) dated 306

A.D. are engraved on rock boulders at the site. Description will be provided in Chapter 5 and Appendix L. During the SARCP it was suggested the Vavala Vava as the Reservoir mentioned in the inscription (Manatunga 1900: 76). But recent reading done for the SIT project identified four reservoirs and six donors are mentioned in the inscription (Appendix L). The monastery complex consists nine rock shelters (with drip-ledges), remains of a *stūpa*, a pond, a *bodhighara* (house for the bo tree/bo-tree shrine), *pilimagē* (image house) *siema malakaya* (Chapter House) and stone slabs with moldings indicating probable evidence for using a Pabbatha Vihara type Buddhist monastery during the late Anuradhapura period. Further details and the map are also given in Appendix L and Chapter 5.

Ruins of the Nuwaragala-kanda monastery complex (SIT 84) are located on both banks of the Nuwaragala-ala (upper most part of the Kiri Oya). Oral tradition of the area connects the ruins at Nuwaragala-kanda with King Mahasen. It says, he built his palace at Nuwaragala when he was conducting the major irrigation work of Minneriya. Later it was identified as a "*pathanagara*" type monastery complex that contains ramparts, buildings, dwellings, *stupa*, *bodhi*, *moonstone*, pillars, ponds, pathways and terraces (Jayaweera et al. 1998). The inscription discovered at the abandoned sluice of the Nuwaragala Vava provides probable clue to data the monastery as active during the 8-9 centuries A.D. (Jayaweera et al. 1998). The only word appeared on the inscription is "*padoni*" that connects with the custom of "washing foot before entering to a sacred place" (ibid.) (Figure 5-6C; 5-6D).

Two smaller monastery sites in the KOB are: the drip-ledged rock shelter monastery at Alakolavava-Pansalwatta (SIT 28) in the Dehigaha-ala-kanda cluster, and the Gallinda-kanda Kukurumahangodavala-Kadaththalama monastery site (SIT 71) in the Illukvava cluster. SIT 28 is located in between Vavala monastery and the Dehigaha-ala-cluster on the southern end of the

Dehigaha-ala-kanda mountain ridge, earlier reported as several paintings on panels representing *Vessantara Jataka* and *Suvisi Vivarana* in Kandyan period “primitive folk art” style (Manatunga 1990: 81). But the site could be dated back to the same period to Vavala and Dehigaha-ala-kanda monasteries as they are located on the same mountain ridge (ibid.). Village oral tradition are connected with a Buddhist statue that was at the site around 3rd century A.D. during the reign of King Mahasen (Appendix D). There are traces for the old reservoir (Alakolavava *purana vava*) that could be seen northwest to the site.

Gallinda-kanda Kukurumahangodavala-Kadaththalama monastery site (SIT 71) has two medium sized drip-ledged rock shelters and four plaster coated brick walls, a stone terrace and a stone blocks paved pathway. Brick fragments and post holes at the site indicate that there was a columned building made with wooden posts. If the identification of the monastery as the `*Veluvana Vihara'* (Manatunga 1990: 76) that was built by King Aggabodhi II (604-614 A.D.) for the *Sagaliya Nikaya* (*Cv. 41*), one division of early Buddhist monasteries in Sri Lanka, is correct, at least we can date the site to 7th century A.D. Additional support can be given to identification of the Veluvana Vihara if Kukurumahangodavala-Kadaththalama is the same area mentioned as Kukkulavitti that granted by King Jetthatissa (628 A.D.) (Chapter 3). Isolated sacred sites, the second category do not show complex architectural units (SIT 47, SIT 51, SIT 54, SIT 58, SIT 75, SIT 82, SIT 103, SIT 106, SIT 110, SIT 112). Besides the Vavala cluster, every clusters at the KOB has one or two isolated sacred sites.

Considering architecture, building materials and locations of SIT 47 (a terraced building at Peikkulama-South), SIT 51 (remains of a building structure with a guard stone, pillars and inscription at Peikkulama Vava), SIT 58 (two small mounds with remains of a building structure and a flower alter at Diyakapilla), SIT 75 (a stone slab site at Gallinda Mahavava), SIT 82 (a *stupa* site at Minneriya, Veharapitiya), SIT 103 (a *stupa* or a 'cairn burial' or a ritual center of Vaddha people at Vehera-godalla near Gallinda Puranavava), and SIT 106 (a *stupa* or a burial structure southeast of SIT 1 and at the winding corner of the Dahigaha-ala), all seem connected with Buddhist worshiping activities.

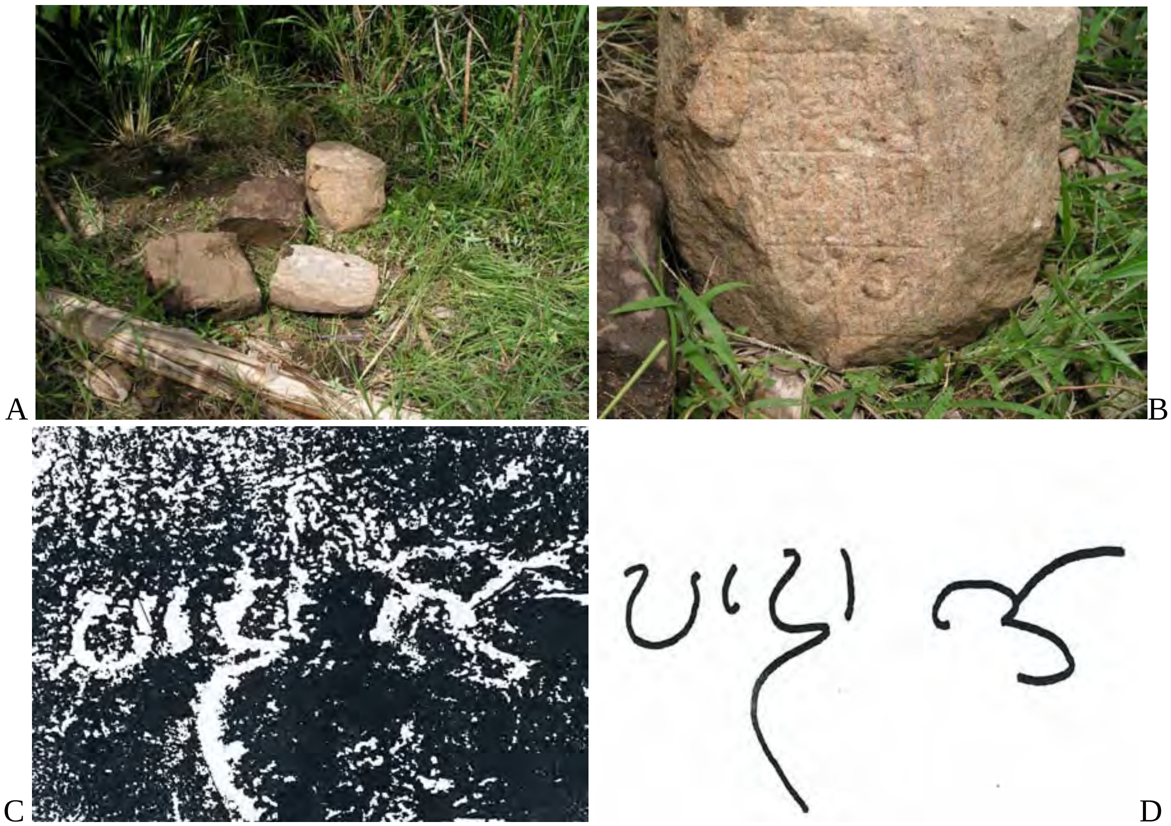


Figure 5-5. Pillar inscriptions in the KOB. A) Fragments of a attani pillar at SIT 12. B) Piece of a attani pillar inscription at SIT 12. Photographs A and B by R. Solangaarachchi. C) Pillar inscription at SIT 84, Nuwaragala monastery site (Jayaweera et al. 1998). D) Eye copy of the inscription at SIT 84 (Jayaweera et al. 1998).

Isolated sacred sites at Peikkulama Vava (SIT 51), one of the religious sites in the Peikkulama cluster, is located at the eastern bank of the Kiri Oya and north to the newly built eastern sluice of the Peikkulama Vava. While old bund of the vava can be seen east of the site, old pathway to Polonnaruwa, Migahawela laid just north of the site. A terraced wall (made of stone blocks) of the old bund of the reservoir may still be there. Several broken pillars, one guardstone, stones and brick fragments found at the site indicate that the site was once used as a Buddhist worshiping canter. The interesting find at the site was an *attani*[1] pillar inscription of Udaya II (887-898 A.D.) found *in situ* at the site (ASCAR 1956). This is one of the inscription in the KOB provides evidence for royal immunity grant to monks at a monastery.

Remains of a building structure at Peikkulama Galdeka (SIT 54), the other sacred site in the Peikkulama cluster, connects with oral traditions of the area. It says King Mahasen's cremation ash was buried at the site (Appendix D). When examine the remains of a foundation for a brick structure, these ruins maybe connected with the ancient pathway passing through the Konduravava mountain range and using as a controlling and guarding post (Manatunga 1990: 82) or a Buddhist monastery.

Isolated sacred site Vehera-godalla at Gallinda, Puranavava (SIT 103) in the Illukvava settlement cluster locates at the northeast bund of the reservoir, east of the limestone band and northwest of the Gallinda spring. The heaps of disturbed limestone rubble at the foot of the small hilly slope have been suggested that they are connected with 'cairn burials' (Manatunga 1990: 83) or ritual centers of Vaddha (aborigines or native Sri Lanka). that Gallinda considers as the Vaddha's old settlement (ibid.). Vehera-godalla also means "the mound of a stupa" (ibid.).

Vadda Vatiya at Moragaha-ala (SIT 110), the only sacred site could be located in the Ihakuluvava cluster is considered as a sacred place for Vadda people. The stone bund built to connect two low mountain ridges at the site considered to be the boundary for hunting lands of Konduruvava Vadda and Gallinda Vadda. The pathway from Ihakuluvava to the Dikkanda-ala runs across the bund.

[1] Attani pillar inscription: inscriptions erected by a king showing immunity grant to a monastery or legislative proclamation to inhabitants. These inscription represent the period between 700 to 800 A.D.

SIT 112 (Aluth *Devalaya* near Jayanthi sluice at the Minneriya Vava/reservoir bund) is one of well-known worshiping place that is dedicated for *Minneri Deviyo*. Minneriya Vava and a connected irrigation network in the area were built during the King Mahasen's reign (329 A.D.). Therefore, the people not only the Kiri Oya valley, but also surrounding area worship King Mahasen as their local guardian. The other two *devalayas* (prayer shrines) at Gallinda and Diyakapilla are also dedicated for *Minneri Deviyo.* Their annual festival is conducted at the end of every harvesting season.

Pillar sites, the third category made of several stone columns and locate as adjoins to a settlement site or/and close to a settlement's reservoir. They seem to be used as a separate worshiping place that connected with fertility rituals for agriculture and its related irrigation network (SIT 12, SIT 38, SIT 72, SIT 85, SIT 90, SIT 104, SIT 105, SIT 108).

Dehigaha-ala-kanda, the largest cluster (Figure 4-2) in the KOB, has two pillar sites (SIT 38, SIT 105). SIT 105 is located southeast to the Makarayaulpotha settlement site (SIT 43) and south to the Makaraulpotha Vava. The South Kosgaha-ala pillar site at Alakolavava (SIT 38) is located at the west bank of South Kosgaha-ala and southwest of its confluence with the Kiri Oya. Signs of an abandoned reservoir at the west of the site might be the ancient Alakolavava that was mentioned in the oral traditions of the area. The pillar at the site is close to the abandoned reservoir. A shallow conical hole, iron slag and a potsherds concentration of the site indicate, other than a sacred site, SIT 38 also used as a settlement site and an iron smelting site. According to the former farmer of the site, he found a long burial box made of clay at the southern edge of the land.

The Vavala cluster, the second largest settlement cluster of the KOB (Figure 4-2), has three pillar sites (SIT 12, SIT 85, SIT 90). The Pillar site at Vavala-yaya (SIT 12), one of the sacred sites in Vavala cluster, is located north of Vavala Vava. It is adjoined to the Vavala-yaya settlement site (SIT 11). Stone pillars at the site are all broken and only lower parts of them are still standing on the ground. An attani pillar inscription was discovered at the site as broken pieces (Figure 4-6A; 4-6B). The inscription was written in 10th century Sinhala letters as horizontal lines. But except several letters most of them are unreadable. Lots of potshards including black ware, fine ware, and red ware were spread all over the site. Terracotta figurines, the common findings at most pillar sites connected to larger settlements at the KOB were also recorded at the site.

The second pillar site at the Vavala cluster is located at Galkaruyaya at Nagolla Vava (SIT 85) and the foothill of the Nuwaragalakanda. Pillars of the site are arranged in three rows and belong to a ruined square architectural unit with two stone steps. Larger tile pieces of the site indicate that there was a tiled roof building at the site. A pottery lid with cobra hood carving was the interesting finding of the site (Figure 6-20B). It may be connected with fertility and an irrigation related ritual conducted at the site.

Vahakotteyaya Pillar site (SIT 90) in the Vavala cluster, located on the east bank of the Kiri Oya in between the Kiri Oya and the Konduruvava mountain range. Vavala Vava is located south of the site. Two mounds with 13 broken pillars, potsherds, tile pieces and large bricks at the site indicate that there was a sacred building. It may have some connection with ritual conducted at the site.

Both pillar sites at Kakunagasgodavala Kadaththalama (SIT 72) and Pattilava Puranavava, at Gallinda (SIT 104) in the Illukvava cluster are located close to the settlement’s reservoirs. Both sites might have used as a ritual center or nearby settlement.

Moragaha-ala pillar site at Ihakuluvava (SIT 108) is also located just south to the pathway from Ihakuluvava to the Dikkanda-ala, east to the Madayamala-ala and at the foothill of the Gomadiyapataha Kanda. Only one dressed pillar stone that is most similar to the guard stone that represents the early Anuradhapura period stood southwest of the Moragaha-ala Vava.

Settlement sites in the landscape

Past inhabitants located their dwellings where they had relatively easy access to needed resources and a high level of security. Their first priority was to be where they could reach water easily, and as many other resources as they could find. When we look at the KOB's settlement distribution pattern, it shows that they mostly chose to live near the water resources in the western basin of the Kiri Oya, as the flood basin of the eastern part is much narrower than it was in the flood basin of the western part. The foothills of Konduruvava Mountain Range are attached to the eastern basin in most areas, thus preventing the establishing of a settlement and providing security for the settlement.

The distribution pattern of most discovered settlement of the KOB share a similar pattern. During the SIT survey, 41 settlement sites were identified. There are 18 larger sites (SIT 3, 7, 8, 11, 31, 42, 52, 57, 64, 67, 70, 86, 91, 93, 95, 96, 98, 107) and 23 smaller sites (SIT 14, 27, 41, 43, 44, 46, 46, 48, 49, 53, 56, 59, 60, 62, 65, 74, 76, 77, 78, 100, 102, 109, 111). Most of the larger settlement sites are located close to a reservoir/vava, a perennial stream or a spring. An examination of the site locations in the "Alakolavava-Vavala Grid" (Figure 4-4) clearly shows that SIT 7, SIT 8, SIT 11, SIT 31, SIT 96 and SIT 98 are close together along the South Kosgaha-ala basins, SIT 3 and SIT 42 are fed by the Dehigaha-ala stream and reservoirs surrounding them, and SIT 18, SIT 86, SIT 91 and SIT 95 are adjoined to the Kiri Oya. The area between the Vahakotte-yaya (SIT 91) settlement to the Dikyaya-kanda iron production site (SIT 22) indicates that there was a water storage system at the eastern basin of the Kiri Oya. It connected with the Batuyaya/Hinni Kanatta settlement site (SIT 93), as there are no signs for a reservoir at the immediate environs of SIT 93.

One of the fascinating discoveries in the KOB settlement was terracotta figurines. They were recorded at 7 large settlement sites and 1 smaller settlement site. One of the largest terracotta sites at Illukvava (SIT 68) also recorded 85 terracotta figurines close to the reservoir bund. Further details are given in Chapter 7.

Some sites provided evidence that they have been used for multiple purposes rather than only conducting domestic activities (eg: SIT 7, SIT 22, SIT 56). SIT 53 that is located at the southwest of Peikkulama Vava provides evidence that the site was also used as a quarry site when it was active as a habitation site. The eroded inscription recorded at the site indicates the site could be dated 6-7 centuries A.D. Except for inscriptions at Vavala monastery (SIT 6) and Nuwaragala-kanda Monastery, other inscriptions found in the KOB are located in larger settlements (SIT 12) or close to the ancient pathways (SIT 51).

The sites attached to monastery site have shown a much higher material culture than others. Indicators of higher achievement are decorated, painted and polished pottery ware, terracotta figurines for rituals and different types of beads.

Iron smelting sites in the landscape

The common indicator for smelting sites is iron slags. In addition, most sites show remains of furnace superstructure along with tuyere fragments. There are 19 large iron production sites (including probable evidence for iron ore deposit-SIT 101 and iron ore crushing/preparation site- SIT 97) and 29 smaller iron smelting sites that were discovered. The distribution pattern of iron smelting site indicates that the KOB settlers were highly engaged in iron production activities.

A good number of smelting sites in the KOB have several conical holes on a flat rock boulder in at their immediate environs (Figure 5- 6). Among them, larger sites (SIT 1, SIT 10, SIT 22), small sites (SIT 5, SIT 21, SIT 30) and multipurpose site (SIT 38) were noticed. Usually most tuyeres found in the KOB are a cylindrical shape. But there are different types and sizes recorded in several sites. Conical shaped tuyeres (SIT 5, SIT 19), long type tuyere (SIT 16), octagonal type (SIT 1, SIT 22), and wide and long (SIT 32) are the major categories among them.

A  B

Figure 5-6. Conical holes located two rock boulders in the KOB. A) SIT 10. B) SIT 30. Photographs by R. Solangaarachchi.

Large iron production centers are mostly located nearby water resources, either Kiri Oya or its tributaries. Some larger production centers are adjacent to the larger settlement sites (SIT 1, SIT 9, SIT 10, SIT 22, SIT 32, SIT 85). Some small iron smelting sites are located close to reservoirs. Some catchment areas of reservoirs provide evidence for seasonal iron smelting activities. SIT 25, one of the excavation sites of the SIT project, has provided a seasonally activated smelting site inside the reservoir. Every settlement cluster in the KOB has at least one large smelting site. This indicates that the major economic system in the KOB was connected with the iron metallurgy and with the agri-economy. Based on the survey data, three settlement system boundaries in the “Alakolavava-Vavala Grid” can be identified (Figure 5-7).

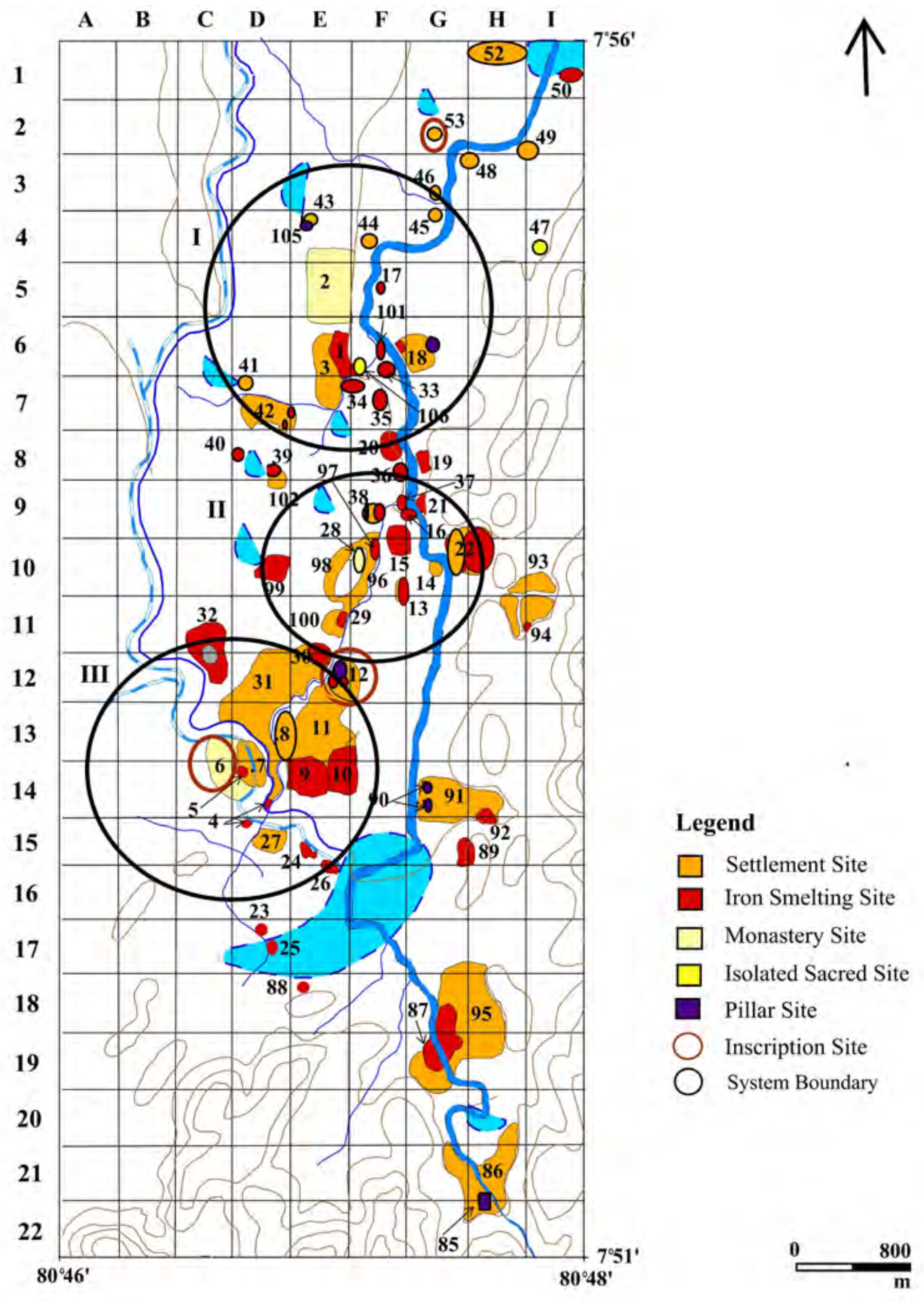


Figure 5-7. Settlement system boundaries in the "Alakolavava-Vavala Grid."

According to the system boundary map (Figure 5-7), monasteries are located in the center and are surrounded by settlements. Iron smelting zone of System I is mostly concentrated on the southeast side of the monastery (SIT 2) and at the western bank of Kiri Oya. Reservoirs are in the most outer zone of the system. Large settlements (SIT 3) are close to the iron production center and are located close to the monastery. In System II this pattern is repeated with some small variations (Figure 5-7). But in System III, large production sites are located close to the Vavala monastery (SIT 6) and close to the kapapu ala or South Kosgaha-ala.

When we applied observed pattern in the System I to the Dehigaha-ala cluster, we could distinguish four distinct micro zones in the settlements. The monastery is located in the innermost zone. Settlement sites are located around the sacred zone. The outer zone can be considered as the resource zone. The industrial zone is located close to the Kiri Oya and most probably from there it was easy to reach the main sources of raw materials. The location of these zonal system indicate that there was a close relation of the monastery to the settlement, the settlement to the industrial zone, and all habitation zones to reservoirs.

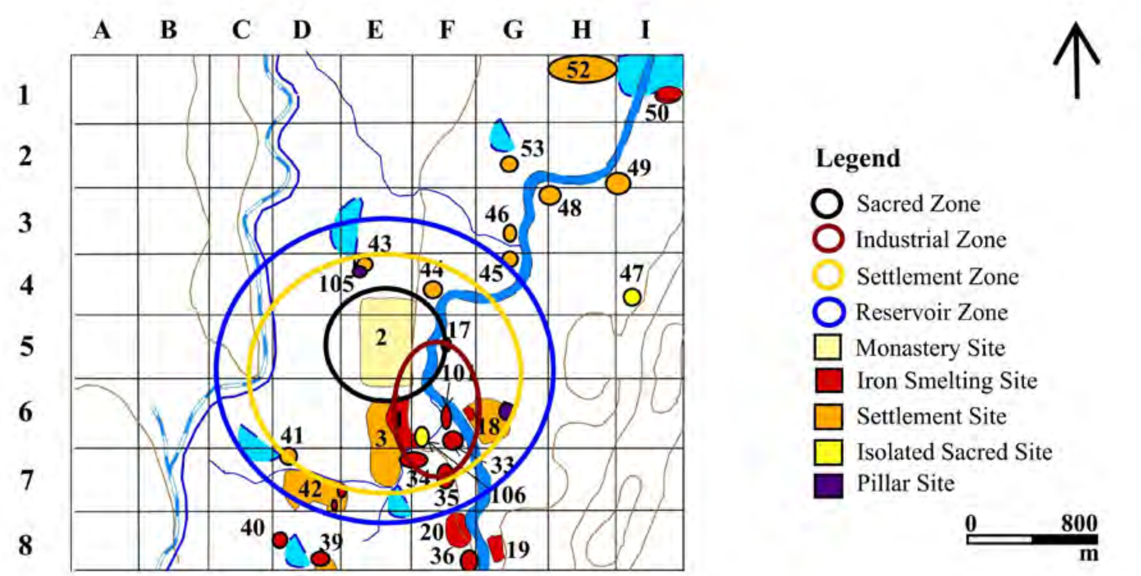


Figure 5-8. Settlement pattern at the Dehigaha-ala-kanda cluster.

When we look at the whole “Alakolavava-Vavala Grid”, we can identify the major industrial zone and the cultivation zone can be identified (Figure 5-9). While the industrial zone is concentrated in the area between Vavalayaya (SIT 13) and Dehigaha-ala-kanda (SIT 17), the cultivation zone is spread from Vavala Vava to SIT 13.

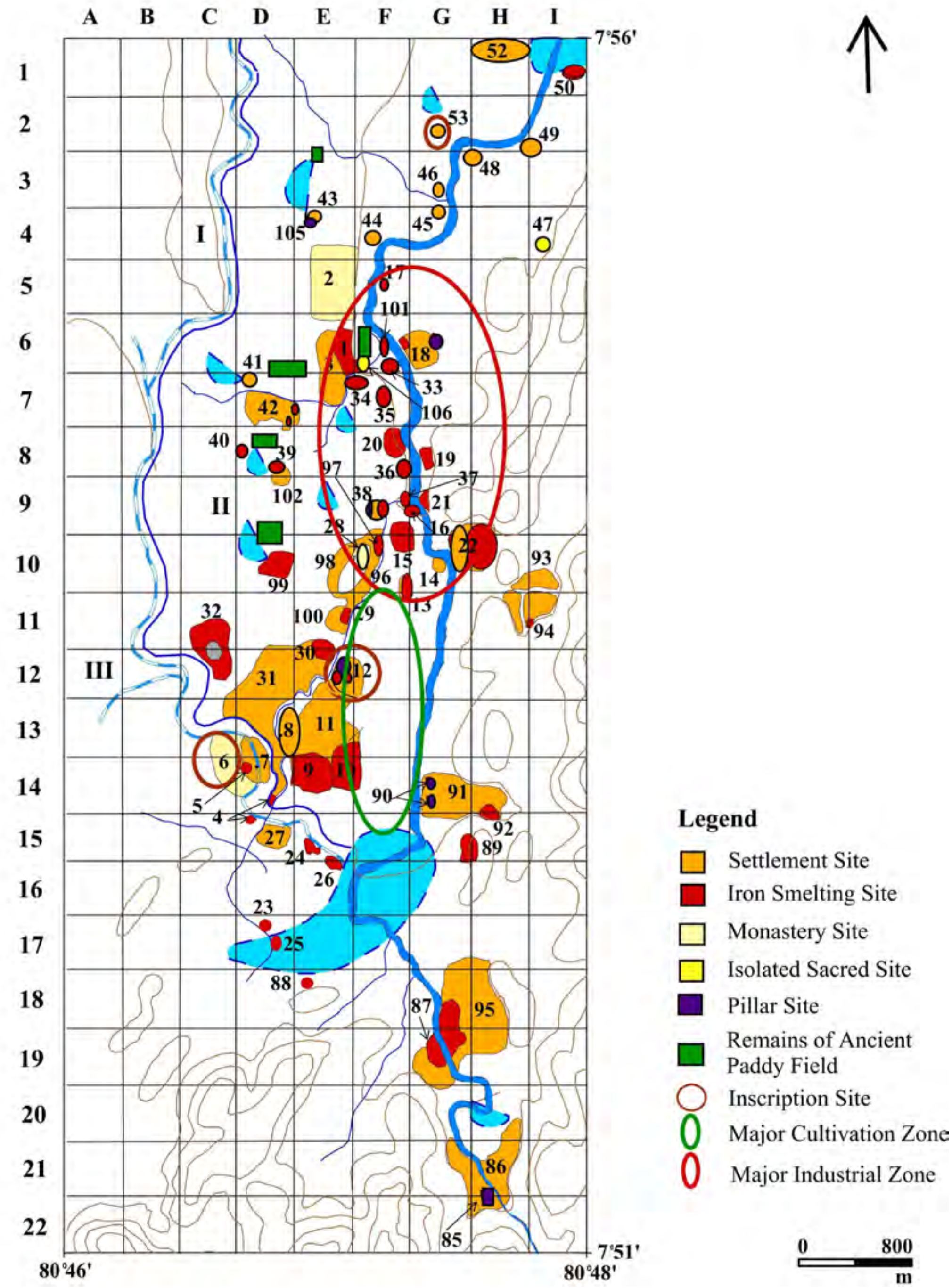


Figure 5-9. Map showing the settlement pattern of "Alakolavava-Vavala Grid."

Major settlements and small settlement patches are arranged over the landscape close to the water resources. It can be assumed that iron smelters' settlements in the KOB shared a much similar pattern with the ancient settlement pattern described in early chronicles in Sri Lanka.

Concluding Remarks

As I discussed in previous chapters, we could trace the relationship of Buddhist monasteries in the total landscape of KOB from Nuwaragala Kanda to Minneriya Vava. In other words, it clearly shows "the internal dynamics of Buddhism in the local landscape" (Wills 2000; Shaw 2000a and 2000b). As the second step, I selected Vavala Monastery to conduct test excavation to find material evidence that I present here for examining and confirming this relationship.

Although I determined that all large settlement clusters in the KOB shared a common cultural pattern, there are small variations. A large settlement cluster may contains sites that differ in size and functions (I refer to them as micro-settlements within the macro settlement clusters of the KOB) that were visible in the survey. Every macro settlement cluster of the KOB is complete with monastery, smelting sites, habitation areas, reservoir and a pillar site. Most pillar sites are located close to the catchment area of the reservoir, indicating some connection to religious activities near the reservoir. Every micro settlement cluster of the area has provided several iron smelting areas within the settlement. At least one of them can be seen as the magnitude site of production. The survey data indicates the micro settlements have connections with the socio-economic system as well as with the monastery. The higher elevation location of the monastery provides "power" over the settlement. It may have connected with the resource management and production management. The *Mahavamsa* gives ample evidence for the interference with the settlements by the monastery in ancient times. Evidence of such interference appears not only in the ancient history of Sri Lanka but also in that of Europe where the religious centers such as churches and monasteries interfered with the socio-political and economic organization of the region. At that time political power was invisibly dominated by the leaders of the religious centers. That system also appeared in the ancient Sri Lankan social-organization. KOB also provided two *attani* pillar inscriptions that spoke about grants for the monastery from the centralized political power/king. It shows that the Buddhist monastery acted as the authority medium between the king and the settlers.

Finds of terracotta figurines that represent "folk art" or "folk religion" in the KOB indicate, besides Buddhism, a local religious tradition was also practiced in the agro-economical social structure (detailed description is provided in chapter 7).

A significant fact is that large settlement sites, indicated by scattered potsherds over the surface, are located close to reservoirs *(vava)* or a stream. Even today most settlements are known by the name of the reservoir that is close by. This indicates that the *purana* (old) villages of the area were mainly dependent on the irrigated-economic system. It is important to note that the largest settlements of the KOB were also located close to the ancient transport routes that connected to the Polonnaruwa peneplain. It indicates the socio-economic connection that could have existed between the Anuradhapura and the Polonnaruwa peneplains.

Based on my study of the ancient settlements of the region, it can be said that there are some indications that the settlement pattern and the social structure of the region are based on iron production activities. Basically this research is focused on the consideration of whether there was any connection of the urbanization of the area with the iron industry or whether the iron technology was the significant factor for the urbanization of the area.

Iron was one of the critical technological and economic resources in all ancient societies. Iron making provides many illustrations of the way in which technological innovations changed the lives of people in the community into which these innovations were introduced. It not only affected those actually engaged in production, but also had a more general social, economic and political significance in its influence on trade, urban growth and patterns of consumption. Production facilities might be built and operated by a social group and transport, trade and distribution might be arranged on a large scale involving a more complex social organization. In more recent times the different stages of the iron production process have been associated with particular castes. The SIT survey identified 17 magnitude iron production sites among 48 iron production sites spread over the KOB. These large sites were most similar to Dehigaha-ala-kanda (SIT 01/KO14) that has been excavated under SARCP (Forenius and Solangaarachchi 1994; Solangaarachchi 1999). The location and the constructional features of Dehigaha-ala-kanda iron production site, especially the construction of the rampart, suggested that the site was fortified at one time as a well-organized production center.

Almost every settlement cluster in the KOB had such a monastic complex and much larger settlements had more than one. Such well-defined religious centers that were established in the region might have controlled the economic subsistence pattern. Such well-defined settlement patterns were established not only in the Kiri Oya basin but also in the other major river basins of the region.

Monastic sites were generally located on the barren ridges at comparatively higher elevations to facilitate an easy view of the surrounding land where to settlements were located while dwellings were located near reservoirs or water resources. Generally, production sites were established near the main raw materials of the industry or in the lands not conducive to agriculture. It is difficult to say whether they were engaged as full time iron producers because the RBE spread in most parts of the KOB and there are some signs of agricultural lands also located near the settlements. The agricultural settlements always reflect a combination of environmental and socio-cultural factors. Agricultural activities would be easily combined with iron smelting, if it is assumed that smelting took place more widely during the driest season, precluding cultivation.

It is possible to note here that the iron technology was the significant factor for the urbanization of the area. Some places provide clear evidence that if the production collapsed, the settlement was also abandoned with it for several years. It could be argued that King Kasyapa selected Sigiriya to build his fortress because already the area was developed with an agricultural and industrial economy based on a well organized iron industry.

CHAPTER 6
EXCAVATIONS

Overview

I discuss in this chapter the excavation data that were revealed from recent excavations conducted during the SIT project that I directed from May 2004 until January 2006 in the KOB. In addition, I present data that were obtained during the SARCP in the period between 1988 and 1992 as in the comparative approach (Bandaranayake, Mogren and Epitawatta 1990; Bandaranayake, Mogren, Myrdal-Runebjer and Epitawatta 1994; Forenius and Solangaarachchi 1994, Solangaarachchi 1999).

Like most field archaeology, settlement archaeology depends heavily upon excavation for fully accurate and complete results, at least in many situations (Willey 1999:11). On the other hand, archaeologically it is difficult to apply the theory of social organization to unearthed research data without first gaining an overall understanding of the region through a proper survey of spatial distributions.

Data on excavations in the KOB are presented in this chapter to test hypotheses on the socio-political issues in the environmental context of ancient settlements. In addition, my intentions are first, to examine the relationship between settlements and their environments, and second, to seek answers to the settlement-pattern related questions addressed in this research.

The overall objectives of the excavation seasons in 2004 and 2005 were to date sites and trace the connections of sites with each other as separate units as well as the connections with the whole settlement pattern of the KOB chronologically. In addition, analyze metallurgical characteristics of the region and to date the period/s during which the smelting process was in action.

Site Selection Strategies and Procedures

Although it was hypothesized that the area (KOB) was in action as one zone, I identified micro settlement clusters in connection with the location of reservoirs and monasteries (Figure 3-2). As mentioned in Chapter 5, I used Alakolavava and Vavalavava as two of the major settlement clusters in the KOB and selected four sites within the "Alakolavava-Vavala Grid" for conducting excavations in the 2004 and 2005 field seasons (Figure 6-1).

These excavation sites selected from 112 sites (Appendix D) that registered during the SIT field survey according to their relevance to ancient iron smelting activities, ancient habitations, religious performance, and inscription evidence. I selected excavation sites as representing the concept of ancient Sri Lankan "*gamai-pansalai, vavai-dagobai*" and attempted to check how this concept connected with the ancient smelting communities in the KOB. I also wanted to examine the connection of iron smelting settlements with the rest of the socio-political-religious strata in the society and the area's irrigation network. Focusing on these ideas, I conducted several test-, trench-, and open-excavations at four different sites:

- Dikyaya-kanda at Vavalavava SIT 22 - an iron smelting site
- Vavala Buddhist Monastery at Vavalavava SIT 06 - a religious site
- Kosgaha-ala-ulpotha at Vavalavava SIT 07 - a settlement site
- Vavala Vava SIT 25 - a vava /manmade reservoir

When selecting sites for excavations, I made an effort to focus on unoccupied and areas less affected by human interference to ascertain dating and function. In addition, the site selection procedure depended on some other important issues: avoiding tracks of wild elephants, transportation access and avoiding sites that are located inside the terrain of the wild life sanctuary. Except some areas that are located on the western bank of the Kiri Oya, most areas close proximity on the KOB are on the control of the Wildlife Department of Sri Lanka are protected from any kind of human activities.

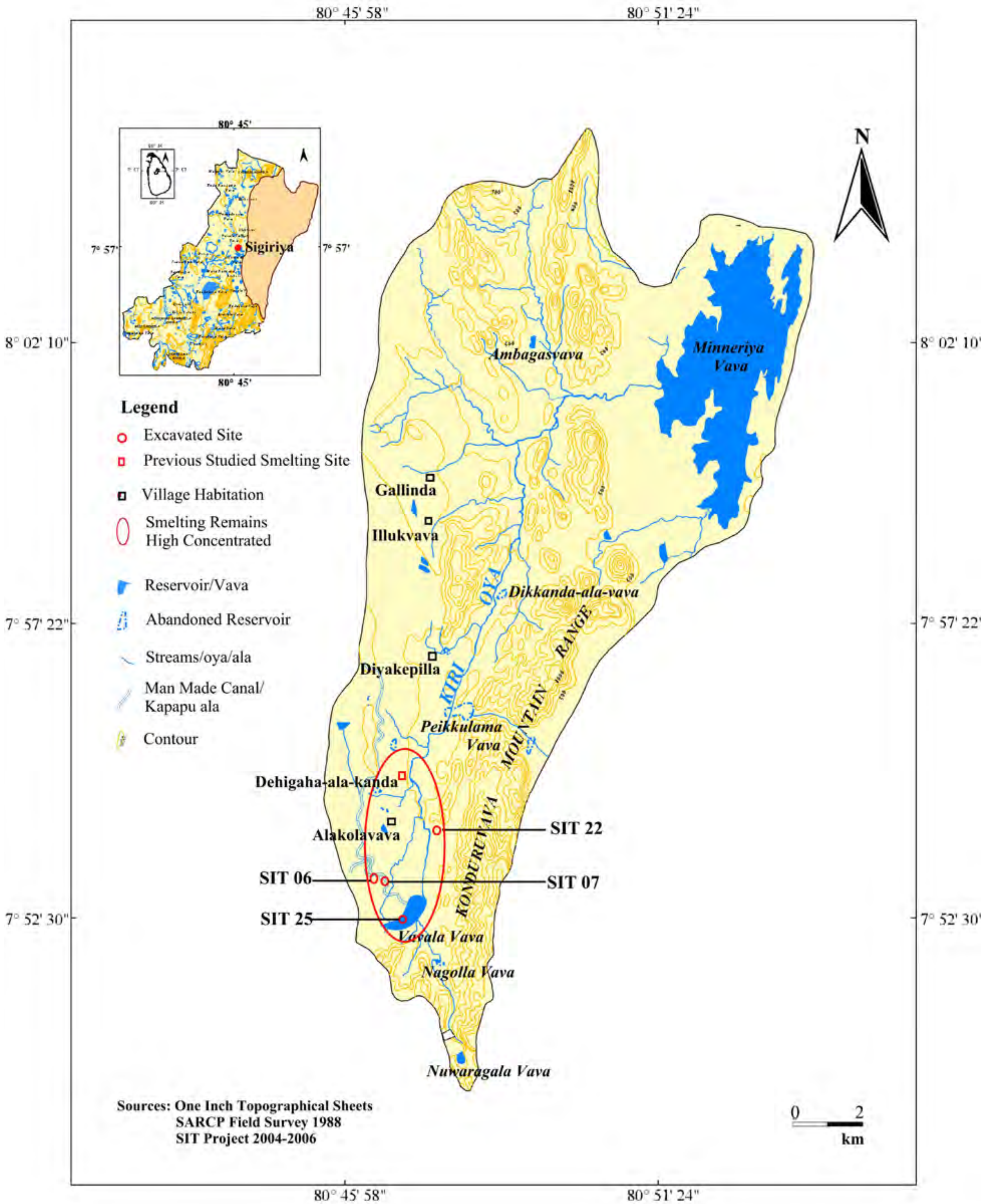


Figure 6-1. Selected sites for excavations in the KOB during 2004-2005 field seasons.

As mentioned in Chapter 3, soils of the KOB are mostly covered by RBE (Reddish Brown Earth) that can be easily transformed to a hard surface during the dry season (from February to October). Most iron smelting sites have been opened to the surface one way or another by human activities or by erosion. Although the area's well known slash and burn *chena* cultivation was recently superseded by onion cultivation that there is no difference between agricultural tools that are used for both cultivation patterns. Therefore, surface soil preparation cannot be considered a major change to the artifact distribution pattern of settlements. But there are noticeable mixed-up topsoil layers at every excavation site.

Farmers always try their best to avoid areas with heavy materials like iron slags and heavy concentrations of ceramics. In addition, inhabitants have a tendency to not destroy places and objects that represent their own cultural heritage. This cultural ideology provides some protection for archaeological remains in their plots. Some cultivators heaped them nearby their farming plots as mentioned in Appendix D.

As we already had excavated one of the iron smelting sites; Alakolavava, Dehigaha-ala-kanda located on the western Bank of the Kiri Oya during the SARCP (Forenius and Solangaarachchi 1994; Solangaarachchi 1999), I select one of the iron smelting sites at Dikyaya-kanda (SIT 22) that is located on the east bank of the Kiri Oya in the foothills of the Konduruvava mountain range (Figure 6-1). Although SIT 22 is located within the wildlife sanctuary, fortunately, the Wildlife Department of Sri Lanka granted me the permission to excavate, as the site is located very close to the demarcation border of the sanctuary and the land is already used for *chena* cultivation.

One of the excavations (SIT 6) for the project I conducted in front of the cave/rock inscription where there is a representation of the reign of King Kithsirimevan (296-324 A.D.) at

Vavala Buddhist Monastery (Figure 6-1). I assumed this location was the best place to get material evidence for answering my research questions and for reconstructing the chronology of cultural layers of the monastery. The cave dwelling at the site becomes active during full moon days when worshipers come to meditate. Rev. Nalande Jinarama, the chief incumbent of the monastery provided permission for the excavation without any hesitation.

Assuming that the Kosgaha-ala-ulpotha settlement site (SIT 7) provides the most data of the KOB material culture (Figure 6-1), I selected this privately-owned land for conducting several test pits. According to the Antiquities Ordinance of 1940 (Revised in 1956 & 1998) and the Cultural Property Act of 1988, on the discovery of any antiquity on any private property, the Director General of the Archaeology shall be entitled to the custody and control of such antiquity if he/she considers it is necessary to retain them (http://www.archaeology.gov.lk). So I had little doubt about requesting permission from the owner of the land to excavate at several places. Although the owner knew the Cultural Property Act, there was not any objection made by him.

Excavation conducted at the iron smelting site located inside the Vavala Vava (SIT 25), mainly focused on dating the smelting activities and the function of the reservoir (Figure 6-1). The Irrigation Department is the responsible institution and has authority over any activity in and around Sri Lankan reservoirs. I had to get permission from the Irrigation Department's Dambulla Branch to conduct a test unit excavation at Vavala Vava. Finally, I obtained the Archaeology Department's permission to conduct excavations at four sites even though I already had permission from immediate "owners" of the sites because no excavation can be conducted in Sri Lanka without a license issued by the Director General of Archaeology.

I never planned to camp at any of the excavation sites as wild elephants showed up most afternoons looking for fresh food from farming lands and the area is also well-known for regular elephant attacks. That forced me to select sites where I could transport equipment and the excavation team close to the sites even though a slippery top soil layer always created a hard time for driving. Small drizzles transformed dry topsoil to silky muddy layers. Most activities in the Dry Zone depend on the Monsoon rain or tried to avoid rainy season that comes with the second inter-monsoon period (from October to November) followed by the northeast monsoon period (From December to February).

Excavation Methodology

During the SIT project, archaeological investigations conducted at four of the selected excavation sites in four main stages:

- Preliminary survey in 2004; plotted sites with a GPS
- Detailed survey in 2004, 2005 and 2006; mapped sites within the selected grid
- Excavation in 2004 and 2005; at four selected sites
- Post survey/excavation analyses from 2004-2006

As I already provided the research strategy of archaeological survey in Chapters 4 and 5, I present here the excavation methodology that I followed during the two excavation field seasons for obtaining data on the iron smelting process, its relevant metallurgical aspects and socio-cultural activities in the KOB settlement zone.

Test excavation units were conducted as test pits and trench units placed in areas where the densest concentration of artifacts were observed by the detailed survey- mainly iron slags and ceramics. Trench excavations were conducted in two sites (SIT 22 and SIT 25), where slag mounds were seen. In other two sites, test units were conducted measuring 1mx1m, 1mx2m and 2mx2m. The locations of test units depended on the main perspectives of site selection. When needed, the excavation units were extended (SIT 22 and SIT 25) or new test units were performed (SIT 7) within the established grid to obtain more information.

A conventional a Free-standing grid system was used with the established Temporary Bench Mark (TBM) or arbitrary datum in every excavation for maintaining the recording and understanding the artifacts distribution pattern. The closest Bench Mark that was marked by the Government Survey Department is located just below the western bund of the Vavala Vava (810'/247m), approximately 3 km southwest to the Dikyaya-kanda iron smelting site (SIT 22), 1¼ km northwest to the Vavala Monastery (SIT 6) and the Kosgaha-ala-ulpotha settlement site (SIT 7). It is indeed difficult to transfer the Bench Mark to the Dikyaya-kanda site for two major reasons: first, we had very limited time, and the second, the distance from the vava to the site. Therefore, a TBM was established for SIT 22 on a small rock boulder, which is located northeast to the excavated trenches with an assumed height of 200m above mean sea level. In two other sites, small flat rock boulders that are located close to the excavation units were also selected to establish TBM. All measurements of the site were determined relative to that datum value. This datum value (200m) was also applied for every excavated site even though the excavated trench of the Vavala Vava (SIT 25) is located just 200m southeast to the Survey Department's datum. Although the mean sea level (MSL) for SIT 25 provided by the GPS device (772'/ 235m) and the Survey Department's datum value are close, the Irrigation Department's survey plan has a different value. So I decided to use 200m as the datum to avoid this discrepancy.

The center point for the grid was established at SIT 22 as N100/E100, SIT 25 as N200/E200, SIT 7 as N300, S300/W300, and SIT 6 as N400/W400 on flat surfaces for preparing the free standing 1mx1m grid system to facilitate recordings (Figure 6-6; Figure 6-18; Figure 6-26; Figure 6-35). With the use of compass and level, a base line was marked out 1m intervals through the center point from south to north covering the main occupied area of smelting or other cultural activities. For every site, an offset line was also marked out 1m intervals from the center point to the east or west along the base line as marking the 20x20m grid.

Every 1mx1m unit (pit) in the 20mx20m grid was numbered according to its x and y coordinates of the southwest corner. Excavation was conducted according to natural stratigraphy and followed every cultural activity in it. Hand trowels, small hand pickaxes (a tool specially designed for archaeological excavations in Sri Lanka) and brushes were used for every excavation and soil was sieved for collecting small artifacts like beads and seeds. After the first and second field seasons in 2004 and 2005, iron pegs were buried along the base line in certain places of the site and recorded landmarks and their distances to buried iron begs for relocating the same grid in future excavations if necessary. Every excavated test unit was backfilled with soil after completing the archaeological recording. Before covering, contemporary metal currencies and the main details of the excavation including names of the team who participated in the fieldwork were placed at the bottom of every excavated unit and thick polythene was put over them.

Recording Method

Every record of the excavation was registered under SIT/UF-PGIAR/2004 and SIT/UF-PGIAR/2005, which is the standard for the Sigiriya Iron Technology/host institution- home institution/year/followed by the site number, respectively (eg. SIT/UF-PGIAR/2004/22). Every unearthed artifact at every site was registered under a field number (eg. SIT22/04/01) and catalogue number on a specially designed catalogue card (Figure E-1A) to avoid mixing when storing artifacts. The catalogue number was assigned according to the PGIAR's catalogue number of the year (eg. PG/04/01). During analyzing, small find registration cards were used for reporting detailed description of artifacts (Figure E-2A, Figure E-2B). Locations of finds and other cultural remains were registered relevant to the unit/pit numbers of the grid system with (X, Y, Z) coordinates and z. The height above Mean Sea Level (Z) was measured in meters using the TBM established for the site and z value stands for below surface (bs) in centimeters. Potsherds and iron smelting remains that were abundant at excavated sites were labeled under different catalogue cards (Figure E-1B). But special types or rare typology of pottery and smelting remains were also registered on the special find catalogue card (Figure E-1A). All catalogue cards of the SIT project were designed according to the format of the PGIAR's and CCF's catalogue cards.

During the excavation, every clear recognizable natural and cultural phenomenon caused by the environment and human activities were registered as a context in sequential order. Every context was recorded in detail by using the highly descriptive context sheet. The contexts were assigned separate sequential orders at the different locations of the sites where the excavations have been conducted. Even in the second season in 2005 this system was followed (without overlapping the previous year's numbering system) for the locations where previous excavation was continued (eg: SIT 7). According to the matrix graph system (Harris 1979), the chronological order of the site was made graphically by using the context numbers (Figure 6-12; Figure 6-24; Figure 6-32; Figure 6-40).

Excavations were conducted vertically and horizontally by the context system. Although excavations were started as separate trenches or test pits, when they were extended to get more information, we continued them as open-area excavations without leaving the balk. If necessary, we left balks at some places to understand the stratigraphical sequence of the site.

When a new or special profile or context appeared, it was drawn on a graph sheet according to a scale. Before excavating or removing special features, their surface measurements were taken, all features were drawn and photographed in three main media; black and white, color prints (by a digital camera) and slides if necessary. Individual detailed photographs were taken with a scale and an arrow indicating the north. During the excavation every context with records of special cultural phenomena and the stratigraphic profile of every wall were drawn and photographed. Four scales were generally used:

- 1 : 20 - commonly used for the plans and profiles including the grid system
- 1 : 10 - used for the individual drawings with special features of the site (eg. furnace)
- 1 : 500 - used for the detail maps of the site (eg. detailed site plan)
- 1 : 1 - rarely used scale at the site, used only for very special finds from the site and during artifacts analyzing (eg. tuyeres and potshards with special marks)

Every administrative and scientific activity that was done at the site was recorded in the field notebooks. The main registers relevant to the excavation of the site were also maintained regularly for special finds, contexts, maps, photographs, pottery, sampling, equipments etc.

Upon completion of every field season, a preliminary report was sent to every institution where I had obtained permission to conduct surveys and excavations; including the Department of Archaeology, the Department of Wildlife Conservation, and one report was archived at the PGIAR of University of Kelaniya (Solangaarachchi 2005; 2006). Preliminary data were submitted to the National Congress of Archaeology in Sri Lanka (Solangaarachchi 2007).

Sampling, Analyzing and Dating

Samples of charcoal, bone, ceramics, furnace walls, tuyeres, iron slag, were collected and given field numbers for further study and scientific analysis (Appendix H and Appendix I). Soil samples were also collected from each stratum, cultural features or other special provenience for examining their composition and taking munsell reading (Appendix F). Every sample was labeled with location, associated cultural remains of the site and their coordinates (x,y,z) etc. Forty six samples among selected samples, including fragments of furnace wall, tuyeres and plaster of furnace wall, iron ore, iron slag, quartz/marble and crucibles were sent to the Arrhenius

Laboratory at Stockholm University in Sweden for metallurgical analyzing in order to find what raw materials were used and to understand the pyrotechnology: smelting processes, fluxes, and thermal aspects of ancient iron smelting (Appendix H).

Seven charcoal samples (4 samples from SIT 22, 1 sample from SIT 7, 2 samples from SIT 6) and one bone sample (from SIT 7) were sent to the Beta Analytic Inc. in Miami, Florida to date the contexts through radiocarbon analyses (Appendix I). Results are discussed here using the given sample number at the project along with the lab number that was given by the Beta Analytic Radiocarbon Dating Laboratory. Dates were also calibrated at Beta Analytic Inc. by Dardon Hood and his staff using INTCAL98 Radiocarbon Age Calibration (Stuiver, Reimer, Bard, Beck *et al.* 1998) and mathematical Pretoria calibration Procedures in C14 dates calibration (Talma and Vogel 1993) to convert radiocarbon BP result to calendar years.

Every evening during the excavation seasons, potsherds and artifacts were cleaned to remove remaining dust. Potsherds were washed and dried for further analytical work. The final stage of the project was mainly devoted to analyzing unearthed artifacts including pottery. Ceramic analyzing workshops were conducted to understand the form, function, surface treatment, temper and the period of the pottery according to the national typology of pottery of the historic period.

Ceramic data provided here were revealed through step-by-step analyses workshops conducted by the final year archaeology undergraduate students at the University of Kelaniya, who were directed by me. As the first step, all potsherds were separated according to their body and core appearance into six main categories; Red Ware (RW), Black Ware (BW), Black & Red Ware (BRW), Black & Gray Ware (BGW), Gray Ware (GW), Gray & Red Ware (GRW), and their sub divisions. Secondly, statistical analysis was conducted for all sherds after separating them into four major categories; diagnostic rimsherds (DR) and non-diagnostic rimsherds (NDR), decorated bodysherds (DB) and non-decorated bodysherds (NDB). Finally, detailed analyses were conducted for diagnostic rimsherds (DR) to find out their rim forms (incurve, straight, excurve), applied surface treatments (painted, slipped, polished, etc.) and tempered material/s (sand, mica, quartz, etc.). In addition, all were measured and drawn to create the typology. If any bases or spouts were recorded, they were registered under a different category. National Ceramic diameter chart for the archaeological sites was used for determining their probable diameter. Pottery typology and results are provided in Appendices J and K.

Dikyaya-kanda: an Iron Smelting Site

Undoubtedly, the most valuable part of the metallurgical research is to find *in-situ* data through excavations for examining the major aspects of ancient iron smelting technology. My major attempt of the excavation was to compare data revealed at the Dikyaya-kanda iron smelting site with data at the Dehigaha-ala-kanda iron production site that was studied in 1990-1999 (Forenius and Solangaarachchi 1994; Solangaarachchi 1999), dating the site and to get better understanding of major metallurgical values of the region. Therefore, the research data and the metallurgical activities presented in this dissertation are principally focused on the excavations of the major `factory' sites of Dikyaya-kanda at Vavalavava and Dehigaha-ala-kanda at Alakolavava.

Site Environment

The Dikyaya-kanda iron smelting site hereafter refers as SIT 22, it is one of the largest sites on the east bank of the Kiri Oya and approximately 1¾ km southeast to the Dehigaha-ala-kanda (hereafter refers as SIT 1)[1] iron smelting site, 2 km northeast to the Vavala Monastery and 2 km north to the Vavala Vava. The site lies at latitude 70°53'59"N and longitude 80°47'23" E in between the Kiri Oya and the Dikyaya Kanda, a mountain ridge of the Konduruwawa mountain range (Figure 6-1, Figure 6-2). The elevation of the site lies approximately 628' (192m) above mean sea level, the western edge of the land slightly slopes to the west. There are no signs of heavy erosion.

SIT 22 is surrounded by the Kiri Oya to the west, the Dikyaya Kanda to the east, abandoned chena lands north and south. The waterway flowing from the Dikyaya Kanda enters the site from northeast and runs northwards. A small embankment/bund that is connected with the southern edge of the Dikyaya Kanda and the southern lower mountain ridge can be seen about 125m southeast. Batuyaya-ala, a small stream from eastern mountain ridge flows towards the Kiri Oya in between these two mountain ridges and runs just 60m south of the site (Figure 5-2).

Like many parts of the Dry Zone, the dominant soil group of SIT 22 is also Reddish Brown Earth (RBE) and Low Humic Gley (LHG) soils (Latosols). The study region belongs to the Dry Zone and the most dominant vegetation on the RBE is dry-zonal mixed evergreen forest (Cooray 1984). The abandoned chena lands around the site are covered by *Aristida depressa* (Sin. *athtuttiri*) and *Cymbopogon confertiflorus* (Sin. *mana*). There are several *Bauhinia racemosa* (Sin. *maila*) trees along with a large *Lagenaria siceraria* (Sin. *diyalabu*) that could be seen on the eastern high ground (the "tree" shown in Figure 6-4), where rock boulders are located. The lower canopy of the location is characterized by isolated thorny bushes.

[1] Dehigaha-ala-kanda iron smelting site was registered as KO14 under SARCP (Bandaranayake et al. 1990; 1994; Manatunga 1990; Manjusri 1990, Forenius and Solangaarachchi 1994). KO stands for Kiri Oya. I presented my MPhil theses based on data that were revealed at the site and around the region (Solangaarachchi 1999).

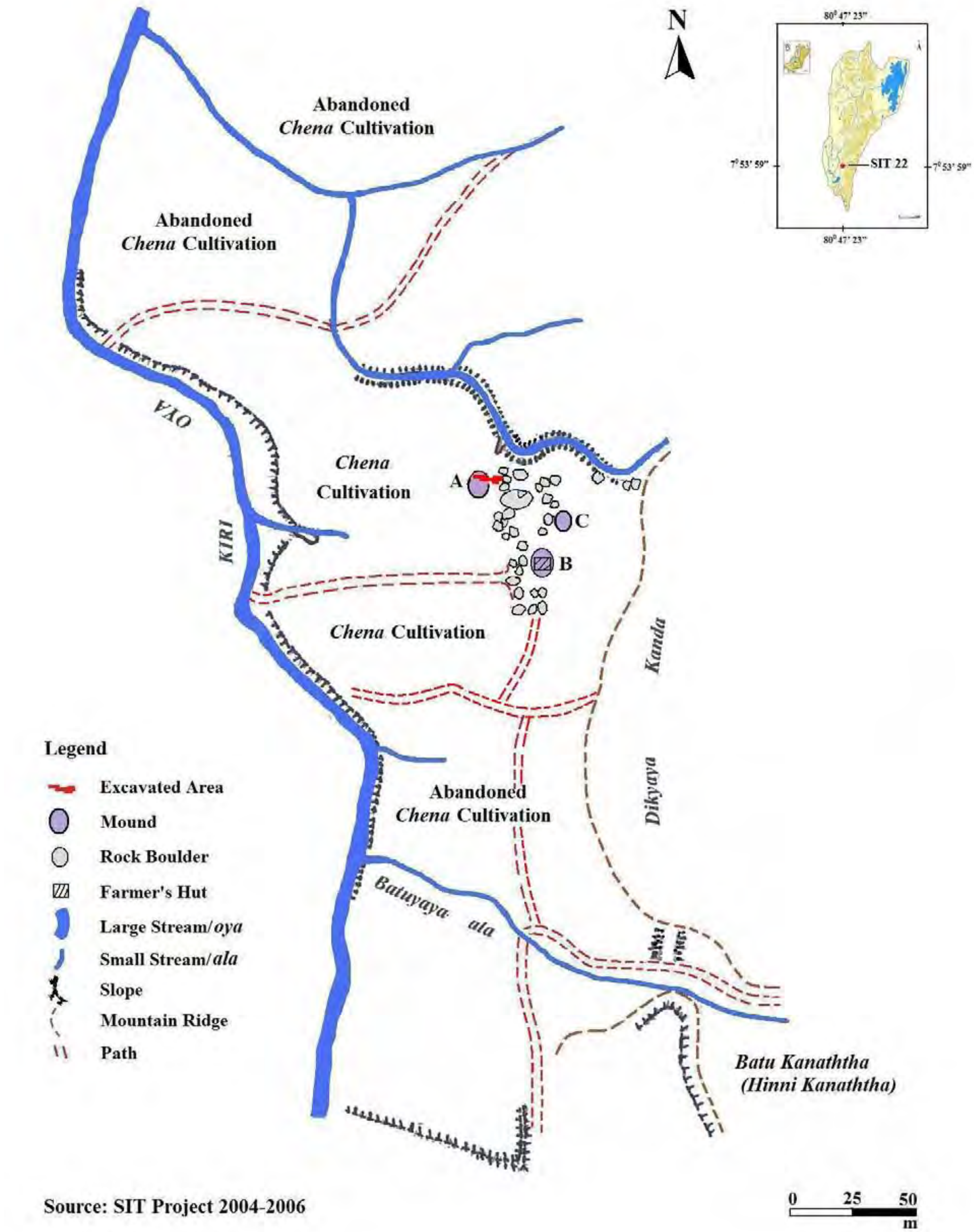


Figure 6-2. Site plan of the Dikyaya-kanda iron smelting site (SIT 22).

During the SARCP excursions, this site was not visible. After clearing the area for chena cultivation, farmers learnt that there were a heavy “stones” buried just few centimeters below the topsoil. Samaraweera, the present cultivator, uses the cleared central area of the site for onion cultivation *Allium cepa* (Sin. *Dambulu loku lunu*, Eng. Dambulu big onions) along with some other commercial vegetables (Figure 6- 3A; 3B). He decided to leave “stones” (blocks of iron slags) as they were and did not even try to remove them for cultivation. But there are some remaining signs on top of slag mounds from the previous cultivations.

Although the site covers approximately 200mx300m, it seems that the production activities were conducted mostly on the eastern portion of the land, the area around the rock boulders that can be seen at the east central part of the site (Figure 6-2). There are three noticeable slag mounds that are measured approximately 10mx15m (Mound A), 15mx20m (Mound B) and 5mx10m (Mound C) at the site (Figure 6-4). The farmer’s temporary hut is built on the top of the Mound B (Figure 6-3B). The original area of slag mounds cannot be determined, as farmers leveled and lowered edges of every mound where small amounts of smelting remains were scattered. But a larger amount of slag blocks, tuyere pieces and furnace walls could be seen nearby as well as at slag heaps that are gathered by the farmer at the site.

The western portion of the site is rich in potsherds-including rimsherds, decorated and non-decorated bodysherds. Colors range from gray-red to black. Most of them are red in color (Red Ware-hereafter refers to as RW), a second group are black (Black Ware- hereafter refers to as BW) and a few potsherds have black interior with red exterior (Black & Red ware-hereafter refers to as BRW). It can be assumed that the site was occupied at the same time as a smelting center and a settlement. I will provide detailed description of ceramics and statictics of analyzed data in Chapter 7, Appendix J and Appendix K.

A B C D

Figure 6-3. Important views at SIT 22. A) Seen from the south. B) Farmer’s hut and rock boulders mentioned in the text seen at the northeast. C) Excavation was conducted just west of the rock boulders. D) One of the conical holes mentioned in the text. Photographs by R. Solangaarachchi.

Rock boulders that are located almost at the center of slag mounds are of metamorphic gneiss. There are two depressions on the top of the two rock boulders that are located just 10 meters west of the mound A. One is in circular in shape with a 4m diameter and the second in squared with 2mx4m. Without removing trees on the top of them and the thick soil deposits due to continuous sedimentation over a long period of time, it is hard to identify and understand the function of these features. Limited time and the height of the boulders also prevented this huge task.

Although there are some structural remains attached to the rock boulders at the SIT 1 iron production site (KO 14 in Forenius and Solangaarachchi 1994; Solangarachchi 1999), there are no noticeable architectural features found around rock boulders at SIT 22. Both sites have conical holes that maybe connected to the grinding of iron ore (Mogren 1990: 58-59; Tripathi pers.com., Solangaarachchi 1999). Two conical holes are located on another flat boulder just 5m southwest of previous mentioned boulders at the site (Figure 6-3D; Figure 6-4) and both are measured 18cm in diameter and 20cm in depth.

The entrance path to the site lays across the Kiri Oya. It was not a major problem because most months of the year the Kiri Oya carries a little water. We also used this path to drive the excavation team and equipment to the site, even though we had to drive up to about 45 degrees at the eastern embankment of the Kiri Oya. There is a *vaga linda* [2] inside the winding corner of the Kiri Oya just few meters behind the path.

Main Objectives and Location Selection

Using the already drawn site map and detailed survey conducted in 2004, I assumed that the iron slag highly concentrated northeastern portion of the site was the main area that the smelting activities occupied. Blocks of iron slag in various sizes and shapes, several slag mounds covered with topsoil along with other remains of furnace superstructures bear testimony to the extent of production and the process of iron smelting technology of the site. The slag Mound A, which is covered with a topsoil deposit, slightly sloping to the west and located further north in the site, was selected as the prioritized location for excavation (Figure 6-5).

[2] Cultivation wells (English translation for *vaga linda*) are temporary wells dug in the streambeds and reservoir beds to obtain water requirements for cultivated lands and domestic requirements during dry months of the year. Some of them use year round and have diameters more than three meters. This is one of the huge problems in the Dry Zone, as it makes thick alluvial deposits in reservoir beds and one of the major reasons for elephants' deaths in the area.

The eastern part of the mound is flatter and higher than the western part (Figure 6-5). A one-meter contour survey was carried out at the mound to understand the height and the quantity of the slag heap (Figure 6-5).

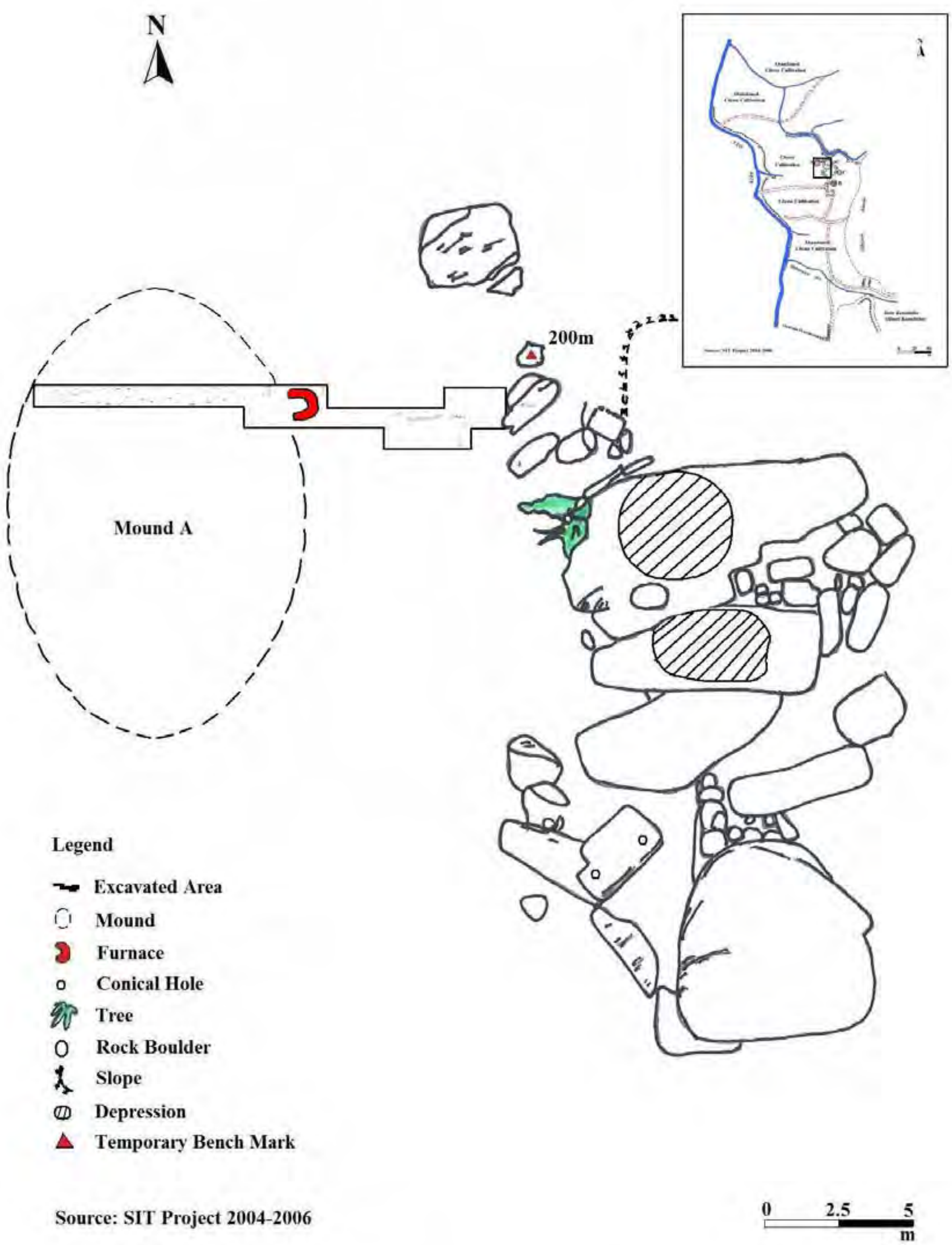


Figure 6-4. Detailed plan of excavated area at SIT 22.

With experience that I gained through previous excavation at SIT 1 in 1990-1991 and long term research that was continued until 1999, I assumed that there was a high possibility for the remains of furnaces being hidden somewhere in the eastern part of the Mound A. Although Mound B, the largest slag mound of the site, has visible furnace remains on the top, I did not want to move the farmer's hut, even though he was ready to do so.

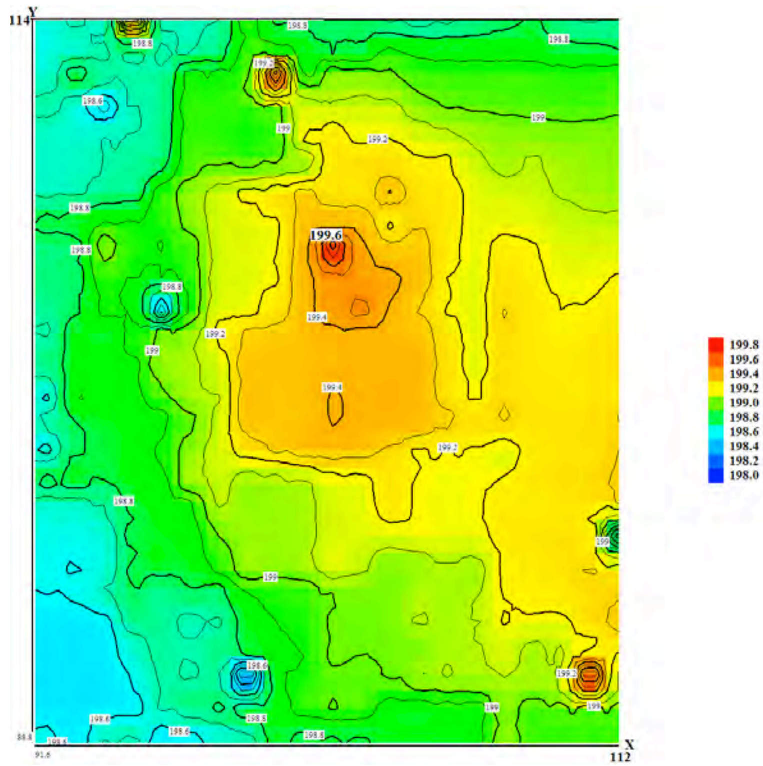


Figure 6-5. Contour map of Mound A at SIT22. While the Brownish Yellow area represents the highest area of the mound, the Blue area at the western edge is the lowest.

Therefore, I decided to conduct trench excavation across the mound at the northern corner of the Mound A (Figure 6-2; Figure 6-4) according to the following three main objectives:

1. To determine the technological attributes of the smelting processes used at the site through the main waste product and the relevant construction remains of the production process, such as furnaces, tuyeres, etc.

2. To identify the spatial and functional organization of the site.

3. To date the site to understand the chronology and the connection between the settlement pattern of the KOB as well as main political centers in the ancient Dry Zone.

The other main target of the trench excavation was to get a rough calculation of the amount of slag and remains of furnace superstructures to estimate the quantity of the production (Table 6-1). Trench 01 was started from the baseline of the grid towards the east (Figure 6-6). My main target was to reveal a furnace superstructure within the limited time and without exposing a large area. It was big advantage for me to hire two well-trained village assistants including A.G. Rathnayake of Pollaththawa village, who worked at Dehigaha-ala-kanda iron production site during two excavation seasons of the SARCP in 1990 & 1991 and S.S. Somaratna (a.k.a. Raja) of Vavalavava Village, the first person who informed me about the site. He is also knowledgeable about KOB and its surroundings.

When encountering a furnace superstructure within two weeks, we had already conducted excavation in four stages by starting two new trenches (Trench 02 and Trench 03) south to the first trench and extending towards the eastern end of the Trench 02 to a 2mx2m test pit (Test Pit 01) adjoining the rock boulders at the eastern high ground (Figure 6-3C; Figure 6-6). The excavation was carried out as an open excavation until the bedrock was reached at the eastern edge of the grid and at least to the level of virgin soil elsewhere (Figure 6-7). The ceramic-rich western portion of the site was not selected for test units, as the whole area was engaged in cultivation (Figure 6-3). I assumed that it would be hard to determine the stratigraphy as farmers watered and used the land every day, though it would be expected that a larger amount of potsherds would be documented to compare with unearthed potshards at the excavated units. It may have held evidence for the earliest cultural layer/settlement of the site before smelting activities were conducted. But I did a comparative study on surface collections and unearthed potsherds at SIT 22 and other excavated sites as well as collected potsherds during the survey in the KOB (Chapter 7; Appendix J and Appendix K). Ceramic studies have provided evidence that the settlement and the smelting activities were in active during the same period.

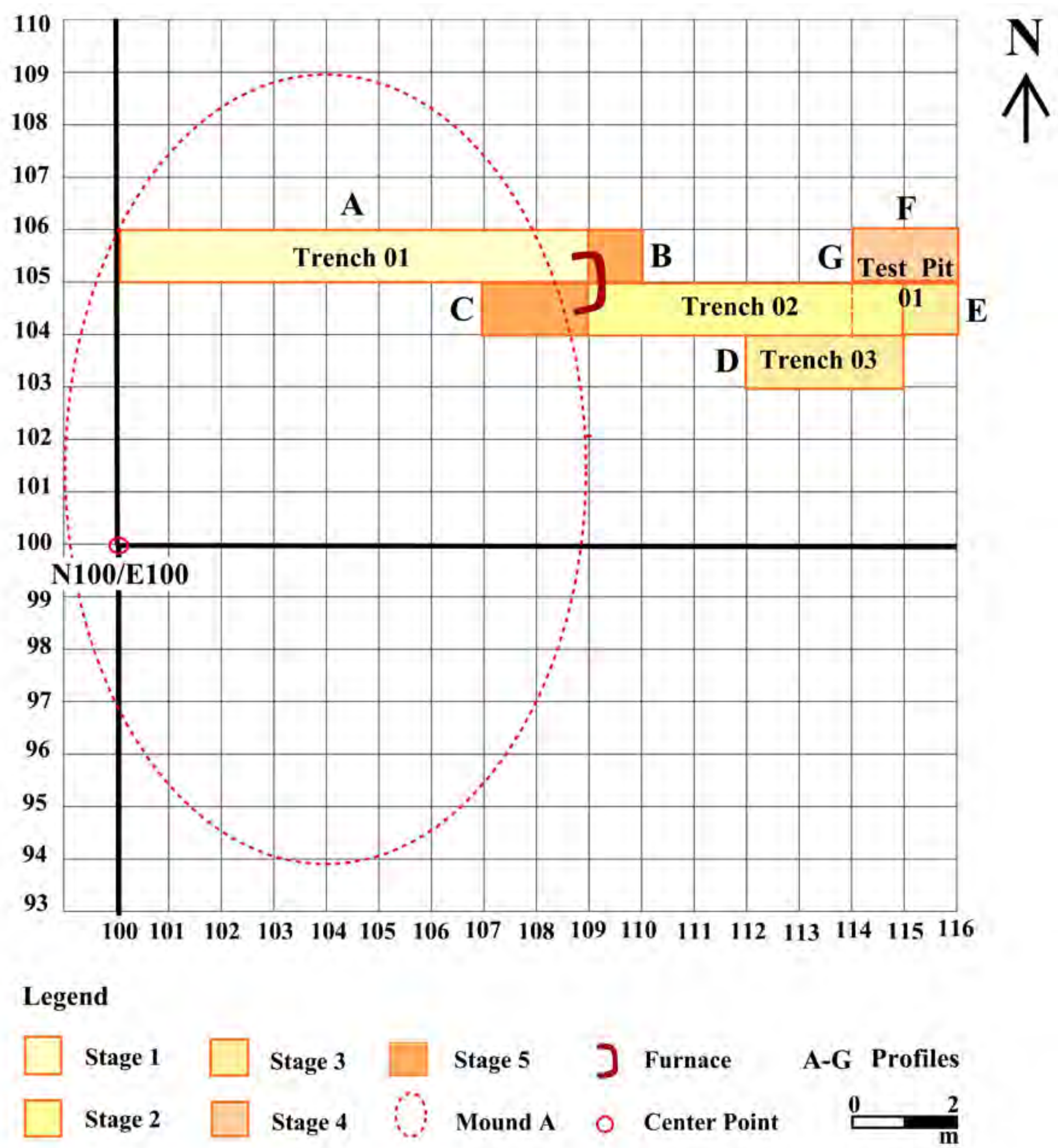


Figure 6-6. Grid plan of excavated area at SIT 22.

Stratigraphy

Excavated test units provide sequential order of five phases: Phase I- Non Cultural (virgin soil/natural soil deposit); Phase II- Period before the main construction; Phase III- Construction period of the furnace & smelting activities (directly occupied phase); Phase IV-

Destruction activities/ abandoned; Phase V- Modern Activities (disturbed layers). Four major settlement phases were identified (Figure 6-12). Phase III, the major phase of the site associated with iron smelting activities, shared similar stratigraphy with the excavated trenches and the test pit (Figure 6-7).

Phase I of the site is represented by natural deposits of non-cultural phase (Context/s 70, 69 and 66) that is laid over the bedrock (Context 76) that slopes from east to west, towards slag mound.

Phase II of the excavated units is represented by soil layers (Context/s 64 and 67) that have yielded weak evidence for cultural activities in the period before the smelting activities. These contexts only consisted of a few worn potsherds; 5 potsherds from Con. 64 (4 RW and 1 GW), and 4 potsherds from Con. 67 (2 RW and 2 BRW). It can be assumed that this phase is similar to the Phase I at the Dehigaha-ala-kanda iron smelting site, which was identified as the Early Anuradhapura Period I (Solangaarachchi 1999).

Phase III is characterized by the main period of the smelting activities and the furnace construction (Context/s 74, 57, 61, 53, 54, 55, 56, 72, 71, 73, 65, 68, 60, 62, 4, 75, 59, 58) that is represented by a large amount of iron slag, fragments of furnace wall and tuyeres, and 248 potsherds in every category (Appendix J). While the unearthed furnace (Figure 6-10) in this phase is registered as Context 57, Context 62 is the major soil layer that started at the middle of the furnace superstructure and slightly slopes towards the front (west) wall. Then it gradually rises westwards towards the mound A.

A fragment of a rarely shaped squared/octagonal tuyere was among unearthed artifacts at Context 4/62. Context 62 did not continue beyond the furnace (Figure 6-7A, 6-7B). This is the most connected context to the iron smelting process and was rich in charcoal, iron slags, whole tuyeres and fragments of tuyeres, furnace walls fragments with plasters, blocks of larger slags, and potsherds. The thickness of this layer is larger compared with other cultural layers.

One of the significant contexts of this phase is Context 55, rich in iron ore fragments and laid over the bedrock of the eastern edge of excavated area. It can be assumed that the eastern area of the site was used as the preparation of iron ore. Context 61 (identified as debris of a second furnace) laid just south of the unearthed furnace and was located on the north-south axis where there was series of furnaces on the same axis and active in same period as at SIT 1 (KO 14 in Forenius & Solangaarachchi 1994). Context 60 and Context 65 are significant with their *in situ* findings of layers of tuyeres (Figure 6-11; Table F-1). The profiles of these contexts have shown on the furnace profile that is provided below under the sub title on the “Significance of Context 57- the furnace.”

Although both contexts start at a relatively high level of the furnace, when they continue to the West, they gradually slope to a lower level. Context 60, found 130cm below the surface, consisted of five unbroken tuyeres, and a fragment of a tuyere along with charcoal and potsherds. These tuyeres (labeled as first or upper layer of tuyeres) laid 92-100cm below the top of the furnace. The second (or lower) tuyere layer (Context 65), found around 112cm below from the top of the furnace, consisted of 9 unbroken tuyeres and 3 broken tuyeres along with iron slag, fragments of furnace walls, potsherds, and large amounts of charcoal. Phase IV, the next cultural level in the test unit indicates an abandonment of smelting activities (Context/s 2/63, and Context/s 1/52), but with evidence for settlement. The main soil deposit of this phase was registered as Context 63 and it has comparatively fewer smelting remains than the main activity period of iron smelting.

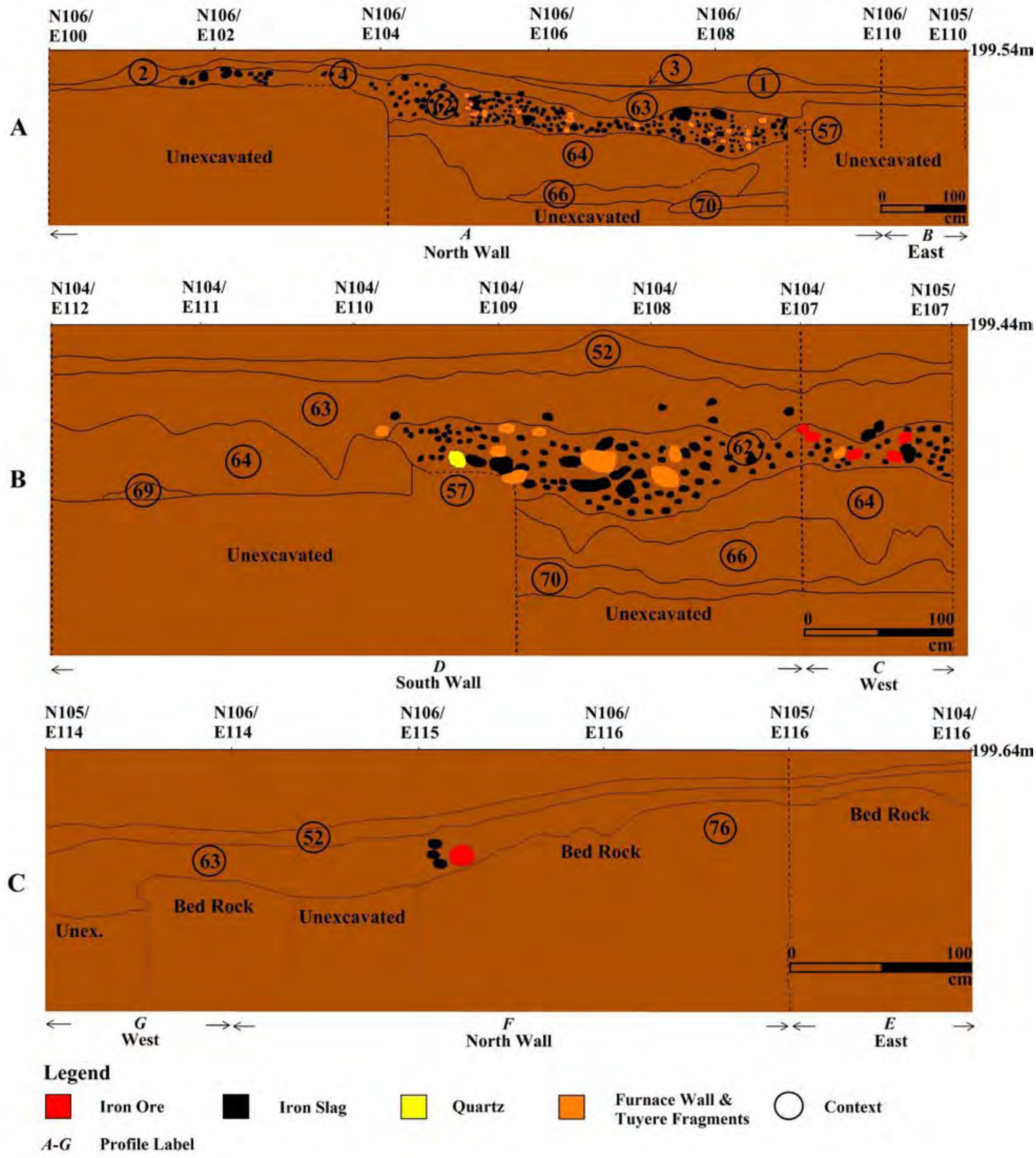


Figure 6-7. Test Units Profiles at SIT 22. A) Trench 01. B) Trench 02. C) Test Pit 01 & Eastern Edge of Trench 02. (The location of the unearthed furnace shown here as its given Context 57. Drawings of the furnace will be given as Figure 7-11 and in Chapter 7).

It runs from west to east in two trenches and slopes to the bedrock at the eastern edge of the test pit, where several pieces of iron ore and mixture of a clay and limestone could be seen (Figure 6-7C). This phase has the highest potsherds (847 sherds) density at the site and had similar ceramic types as in Phase III.

Phase V is the most recent phase of the site directly linked with modern activities and mixed with remains of modern deposits. The first level of the excavated area in this phase is a thin layer of humus (Context 3 and Context 51)[3] that could only be seen inside the shallow depression at the Trench 1 and over the layer that have been disturbed by the modern activities.

Only one tuyere fragment was collected. This layer was followed by a disturbed and comparatively thicker clay deposit (Context 1/Context 52) that consisted with iron slags, tuyere and furnace fragments, potsherds, and one bead. After clearing the land it was clearly noticeable several abandoned balks of the land that has been used for continuous cultivation. The disturbance and artifacts mixing up of Phase V, cause to this cultivation practice.

Summarizing the Material Evidence

Systematic excavations conducted over four months in four main stages at the site have led to the discovery of one furnace along with probable evidence for another furnace that is on the same north-south axis. A higher percentage of artifacts of the site are directly connected with the iron smelting process: furnace architecture (fragments of furnace walls, tuyeres, stone slabs), raw materials (iron ore, quartz, limestone) and smelting remains (iron slags and charcoal). In addition, a yield of 1104 potsherds was also unearthed at the site along with two beads (Table 6-1).

[3] We gave new numbers for every identified cultural feature when there was no direct continuation even though they appeared as a further extension of an already registered context.

Table 6-1. Unearthed artifacts at SIT 22

Artifact Discovered	Weight kg	Count
Iron Ore	1.3	*
Iron Slag	983	*
FurnaceWall/ Fragment	221	*
Tuyere/Fragment	23	*
Stone/Quartz	109	*
Potsherds	9.3	1104
Beads	**	2

* Total weight of unearthed iron ore, iron slags, furnace wall fragments, tuyere fragments and stone (quartz and granite) at test units (1mx9m, 1mx7m, 1mx3m, 2mx2m) are provided here. I did not count them as they were not in the same size (countable and non-countable sizes).
** The weight of two beads are only 2gms.

Ceramics at the Site

As shown in Figure 5-8, 81.25% of potsherds were identified as non-decorated bodysherds (NDB), 5.25% as decorated bodysherds (DB) and 10.33% as non-diagnostic rimsherds (NDR). Excavated test units only yielded a total of 35 diagnostic rimsherds (DR), only 3.17% of the total potsherds recovered (Table J-1c).

A larger yield of potsherds (716) were recorded from Context 1/52 in Phase IV identified as the abandonment phase for the smelting activities subsequent to the major iron smelting process (Figure 6-9; Table J-1a). Analyses also shows a higher yield of potsherds (847) were from Phase IV (Table J-1a).

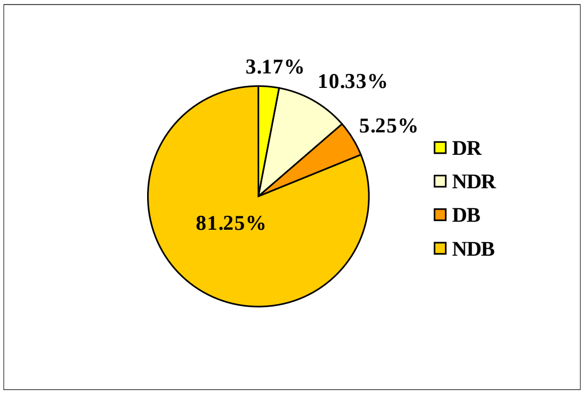
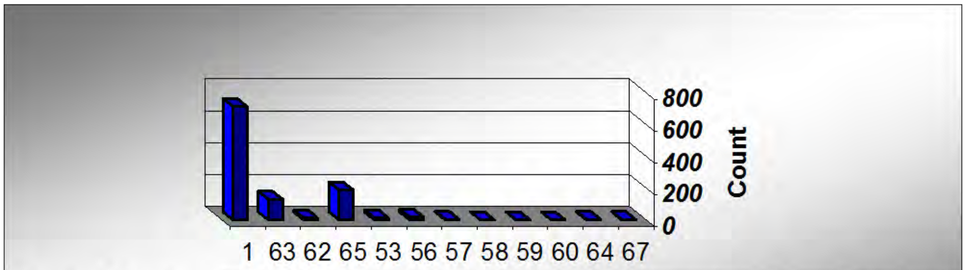


Figure 6-8. Percentage of four major categories of ceramic sherds unearthed at SIT 22.

When considering the ancient ceramics types in the region, all potsherds at the site could be categorized into six major ware types; RW- Red Ware, BW- Black Ware, BRW- Black & Red **Ware,** BGW- Black & Gray Ware, GW- Gray Ware, GRW- Gray & Red Ware) (Table J-1b).



Context Number	1	63	62	65	53	56	57	58	59	60	64	67
Count per Context	716	131	14	190	14	19	5	2	2	2	5	4

Figure 6-9. Total number of sherds per context at SIT 22. (Potsherds yielded contexts are only shown here).

As shown in Figure 5-10, RW sherds have the highest frequency at the site (43.66%); a total of 482, is the best known category of ancient ceramics in the region as well as throughout the historical period.

Morphologically, interior black and exterior red pottery type known as BRW represents the period from the early Iron Age (at Iron Age cemeteries from 6-7 century B.C. to early historic period; until 4th century A.D.) is recorded at a lesser frequency (3.53%). BW (4.88%) and GW (13.50%) are also recorded from early historic settlements in the region. BGW (4.53%), and GRW (29.90%) categories are not common types.

Considering the BRW naming method, I categorized the interior black and exterior gray pottery type as Black & Gray Ware (hereafter refers as BGW) and the interior gray and exterior red pottery type as Gray & Red Ware (hereafter refers as GRW). It seems that BGW and GRW were sharing similar manufacturing methods or similar firing techniques as BRW, but different firing temperatures inside a pottery kiln. One can consider BGW and GRW production might be happened due to the insufficient temperatures during the RW firing.

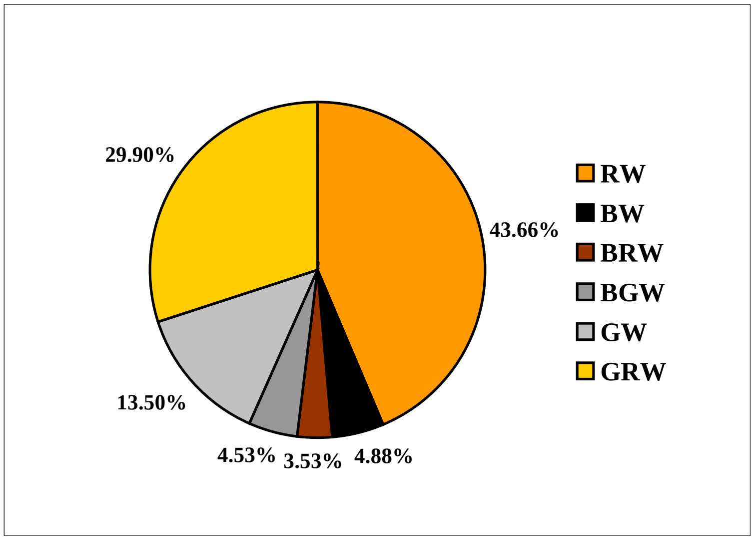


Figure 6-10. Percentage of ceramic ware types distribution at SIT 22. (RW- Red Ware, BW- Black Ware, BRW- Black & Red Ware, BGW- Black & Gray Ware, GW- Gray Ware, GRW- Gray & Red Ware)

I will provide the detailed analytical report of ceramic sub-divisions in Table J-1a and the typology of the pottery in Appendix K. In addition, Chapter 7, considers the material culture of the KOB and will also provide characteristics of pottery in the region.

Significance of Context 57- the Furnace

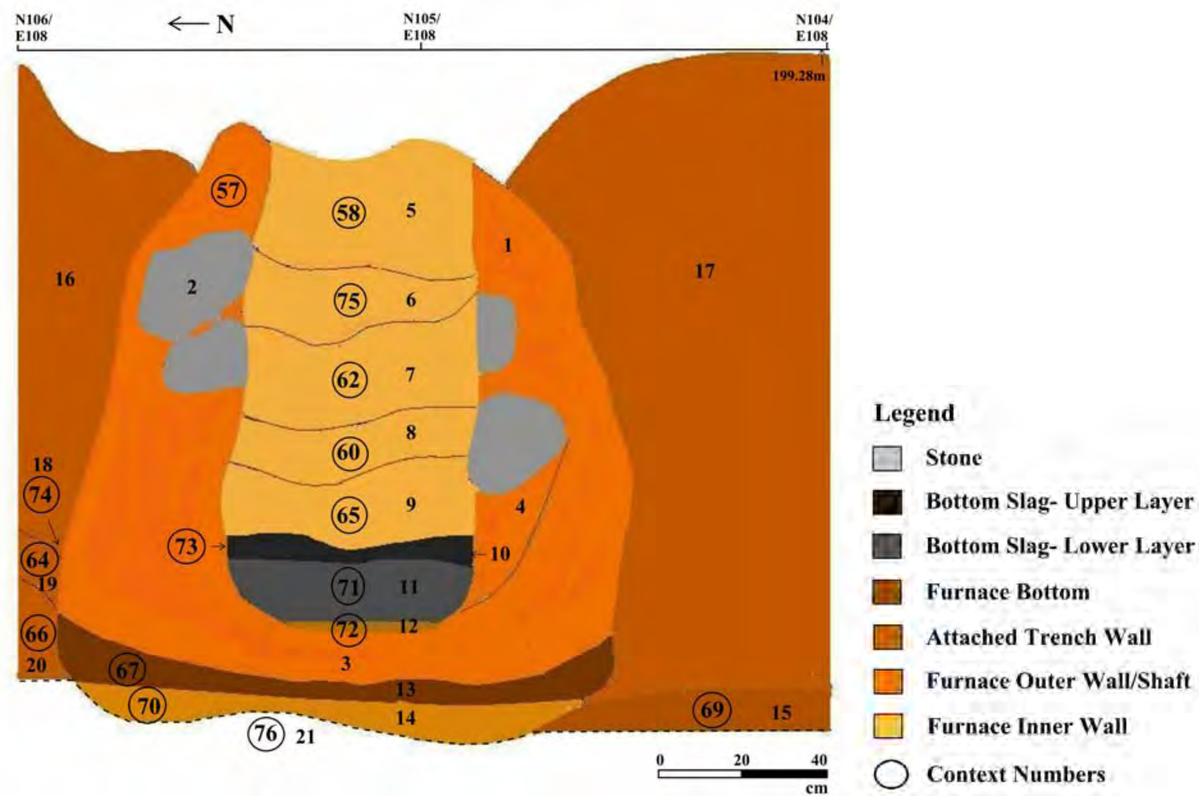
The major discovery of the site was remains of the bloomery furnace that was revealed in 2004. The remains of the second furnace on the same north-south axis provides concrete evidence for construction of series of a furnaces on the eastern flat ground of the mound as at SIT 1 (KO 14 in Forenius and Solangaarachchi 1994, Solangaarachchi 1999). Although the furnace was already given a context number (Con. 57), when commencing the furnace excavation, I decided to count every color difference inside the furnace as different context to understand the thermal aspects (Figure 6-11). As shown in Figure 5-11, Context/s 57, 58, 75, 62, 60, 65, 72 and 74 are directly connected with the furnace construction and represent temperature variations inside the furnace. Context 73 and Context 71 are the main by-products of the smelting process. Context 16 and Context 17 are walls of the excavated trenches that are attached to the furnace, and context/s 64 and 67 represent the period before the construction.

Contexts 66, 69 and 70 did not carry any cultural remains and represented the natural deposits of periods before the settlement of the site. There was little doubt when determining the place for Context 67 in the settlement history of the site. Although it seemed a continuation or burnt version of Context 66, I suggested placing it somewhere in between Phase I (non-cultural period) and Phase 111 (major construction period) with Context 64 as it carried 4 worn potsherds that represent the early historic period in Sri Lanka.

The furnace excavation was conducted layer by layer with extra attention for understanding furnace architecture and collecting charcoal and furnace samples for dating and analysis. The preserved height of the furnace is 155cm and the width on north-south axis is 130cm (Figure 6-11). Unearthed materials show that the opening of the air supply system of the excavated furnace was oriented to the west.

In addition, analysis of the unearthed furnace superstructure and associated artifacts has provided better opportunity to reconstruct furnace architecture, to determine its metallurgical aspects, and to date the time in operation.

Fourty six samples of iron smelting remains were collected as representing every important location in the furnace, to be used for understanding raw materials and for understanding pyrotechnology: smelting processes, fluxes, and thermal aspects of ancient iron smelting (Appendix H). All samples were collected according to the metallurgical training that I obtained from Dr. David Killick, at the University of Arizona.



1 Furnace Shaft - Red Burnt Clay - a higher percentage of quartz (Context 57)
2 Stone Slab - vertical/slightly sloped (Context 57)
3 Foundation of the Front Wall - red burnt clay (Context 57)
4 Red Burnt Clay - a lesser percentage of quartz (Context 57)
5 Furnace Wall - with inner clay plaster (Context 58)
6 Red Burnt Clay - affected by heat (Context 75)
7 Red Burnt Clay with Slag Lining - attached to slag (Context 62)
8 Very Dark Gray Clay - (Context 60)
9 Red Burnt Clay (Context 65)
10 Upper Layer of Bottom Slag (Context 73)
11 Lower Layer of Bottom Slag (Context 71)
12 Clay Plaster - (Context 72)
13 Burnt Soil Layer (Context 67)
14 Brownish Yellow Soil Layer (Context 70)
15 Gravel Rich Soil Layer (Context 69)
16 Trench 01
17 Trench 02
18 Cut Mark of the Furnace (Context 74)
19 Olive Yellow Soil Layer (Context 64)
20 Yellowish Soil Layer - higher percentage of quartz (Context 66)
21 Bed Rock (Context 76)

Figure 6-11. Front Elevation and Profile drawing of excavated furnace (Context 57) at SIT 22 seen from the west.

These samples were analyzed by Prof. Dag Noreus and his students at the Arrhenius Laboratory at Stockholm University in Sweden. The characteristics of Context 57, the furnace architecture and its operation, will be discussed in Chapter 7.

Problems and Concerns

The main technical problems that I experienced at SIT 22 were common and similar to at SIT 1 (KO14). The problem was that the combination of blocks of iron slags and other smelting debris made the soil nearly as hard as cement. It was difficult to conduct safe excavation without moistening the excavation area by pouring water continuously. Therefore during the day, we were consuming our time in fetching water from the Kiri Oya. Even after pouring water, the excavation couldn't be continued immediately because the water sank into the ground very slowly. When the excavation commenced inside the furnace (especially Context/s 58, 75 and 62), it was hard to remove soil layers that were attached to the furnace wall and smelting remains without moistening, as they had became one structure over centuries.

A second problem arose: when the soil was sufficiently wet, it was very hard to identify the stratigraphical sequence and the colors of soil layers correctly as their natural colors changed with wetness. The hardness of the soil in the site also made the excavation equipment blunt and they had to be sharpened and repaired every week during the whole field season. During the trench excavation over the slag heap (middle of the mound), this situation arose very often. Sometimes at the beginning of the day, water had to be removed before the excavation, as the very end of first excavation season in 2004 heavy rain covered the test excavation units. Clay remains could be damaged by the wetness if recording was not completed soon after they were unearthed.

Radiocarbon Dating

I selected four charcoal samples (Appendix I; Table I-1) from different contexts (contexts 65, 58, 68 and 62) that were sent to the Beta Analytic Inc. in Miami, Florida to date contexts. The results are given in Table 6-1 and Table I-2 (Figure 6-12; Figures I-1; I-2; I-3; I-4). They were analyzed and calibrated at the Beta Analytic Radiocarbon Dating Laboratory using latest INTCAL98 Radiocarbon Age Calibration database (Stuiver, Reimer, Bard, Beck, et al. 1998) and the mathematical Pretoria calibration Procedures in C14 dates calibration (Talma and Vogel 1993) for converting radiocarbon BP result to calendar years.

After conducting pretreatment procedure, Sample # SIT-22/04-01 (Beta-201941) yielded small amount of carbon, even though I submitted 30gms of charcoal. Therefore, it had to be analyzed by Radiometric- Standard delivery with extended counting (EC) for the best standard deviation. The sample was collected 142cm below the surface and in front of the furnace at test unit N105/E108. This is the most secure sample of the site and it represents Context 65, a soil layer that is consist of a lower layer of tuyeres (9 unbroken tuyeres and 3 broken tuyeres), iron slags, fragments of furnace wall, potsherds, and charcoal. The measured radiocarbon age of the sample is 1900±60 BP, the conventional radiocarbon age is 1860±60 BP (Table 5-2).

For SIT-22/04-02 and SIT-22/04-03 samples, the AMS-Standard delivery dating method was conducted, as they held very small carbon after pretreatment. Beta Analytic removed crushed rock-like material during the pretreatment process. Therefore, I decided to get AMS reading to reduce sigma value.

Sample # SIT-22/04-02 (Beta-201942) represents Context 58 that consisted of 1 tuyere fragment, 1 furnace wall fragment, iron slags, potsherds and charcoal. This sample was collected 78cm below the surface and 35cm below the top end of the furnace as well as inside the furnace at N105/E108. It provided 1780±40 BP as the measured radiocarbon age and 1780±40 BP as the conventional radiocarbon age.

Table 6-2. Radiocarbon dates for SIT22

Sample # & Beta Lab #	Measured Radiocarbon Age	Conventional Radiocarbon Age	2 Sigma Calibration (95% Probability)	1 Sigma Calibration (68% Probability)
SIT-22/04-01 201941	1900±60 BP	1860±60 BP	Cal AD 30 to 260 and Cal AD 290 to 320	Cal AD 80 to 230
SIT-22/04-02 201942	1780±40 BP	1780±40 BP	Cal AD 130 to 370	Cal AD 220 to 260 and Cal AD 290 to 320
SIT-22/04-03 201943	1790±40 BP	1760±40 BP	Cal AD 150 to 390	Cal AD 230 to 340
SIT-22/04-04 201944	1630±60 BP	1620±60 BP	Cal AD 260 to 290 and Cal AD 320 to 570	Cal AD 390 to 530

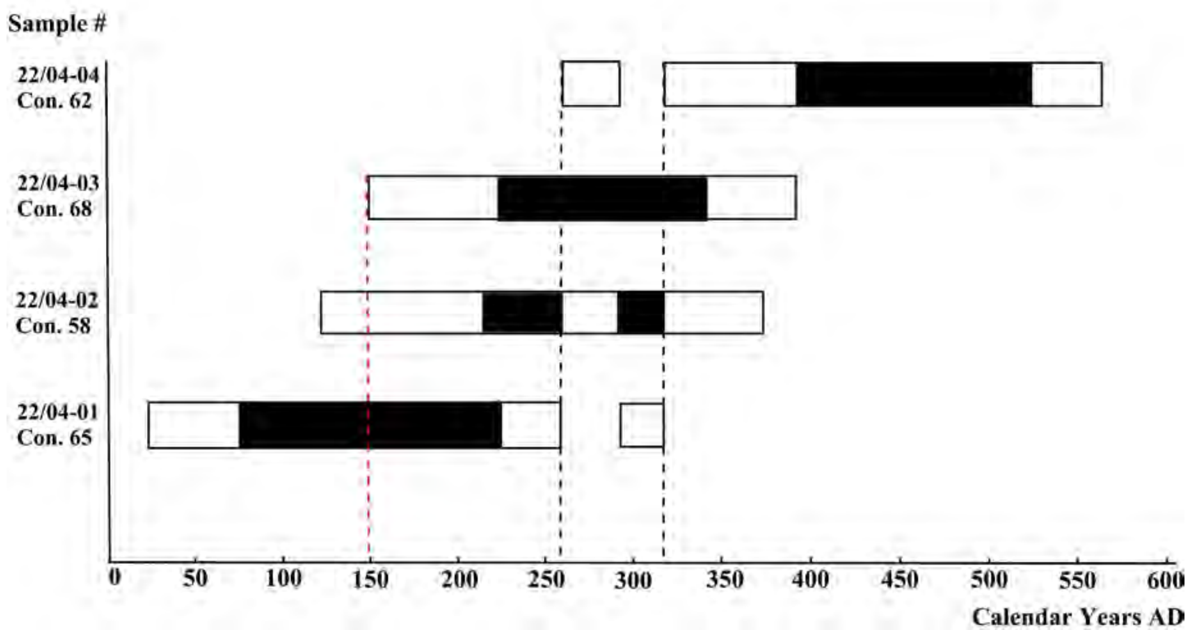


Figure 6-12. Diagram for Radiocarbon dates at SIT 22.[4] Calibrated age ranges from cumulative probability, two sigma (95%) & one sigma (68%). INTCAL98 (Stuiver, Reimer, Bard, Beck, et al. 1998).While hollow bars represent two sigma limits, solid bars represent one sigma limits. The original report made by the Beta Analytic Inc. is provided in Appendix I.

[4] This diagram was made according to the results provided by the Beta Analytic Inc (Appendix I).

Sample # SIT-22/04-03 (Beta-201943) represents Context 68, the semicircular burnt soil patch that spread from the front, West wall of the furnace towards the West. The sample was collected 139cm below surface and close to the front wall at N105/E108. This context is not rich in artifacts; consisting only of iron ore, iron slag, and 2 rimsherds. Its measured radiocarbon age is 1790±40 BP. The conventional radiocarbon age is 1760±40 BP (Table 6-1; Table I-2; Figure 6-12; Figure I-3).

Sample # SIT-22/04-04 (Beta-201944) was dated by the Radiometric Standard delivery as it yielded plenty of carbon after pretreatment. It was collected 130cm below the surface from Context 62 at N104/E108. Context 62 is rich in smelting remains: blocks of iron slags, tuyere and furnace wall fragments, potsherds and charcoal. This sample provided a different date range compared to the other three samples (Figure 6-12). It has 1630±60 BP as the measured radiocarbon age and 1620±60 BP as the conventional radiocarbon age.

Radiocarbon dates (Figure 6-12) indicate that the smelting activities of the site were in operation somewhere between the 2nd century A.D. and the 4th century A.D., a particularly early period for iron production of this scale and quality. The relevance, discrepancy and accuracy of the results compared with site stratigraphy will be discussed under site chronology below.

Site Chronology

Determining the chronology of the site not only depended on the radiocarbon dating. Here I also use previously obtained radiocarbon dates and pottery typology at SIT 1 in a comparative manner. Although the excavation has stratigraphicallly showed four cultural phases at the site (Figure 6-13), only three of them have provided charcoal samples. Among collected samples, four samples were sent from Phase III that represents the period of smelting activity, as most upper two layers that represent Phase/s IV & V seemed to be disturbed.

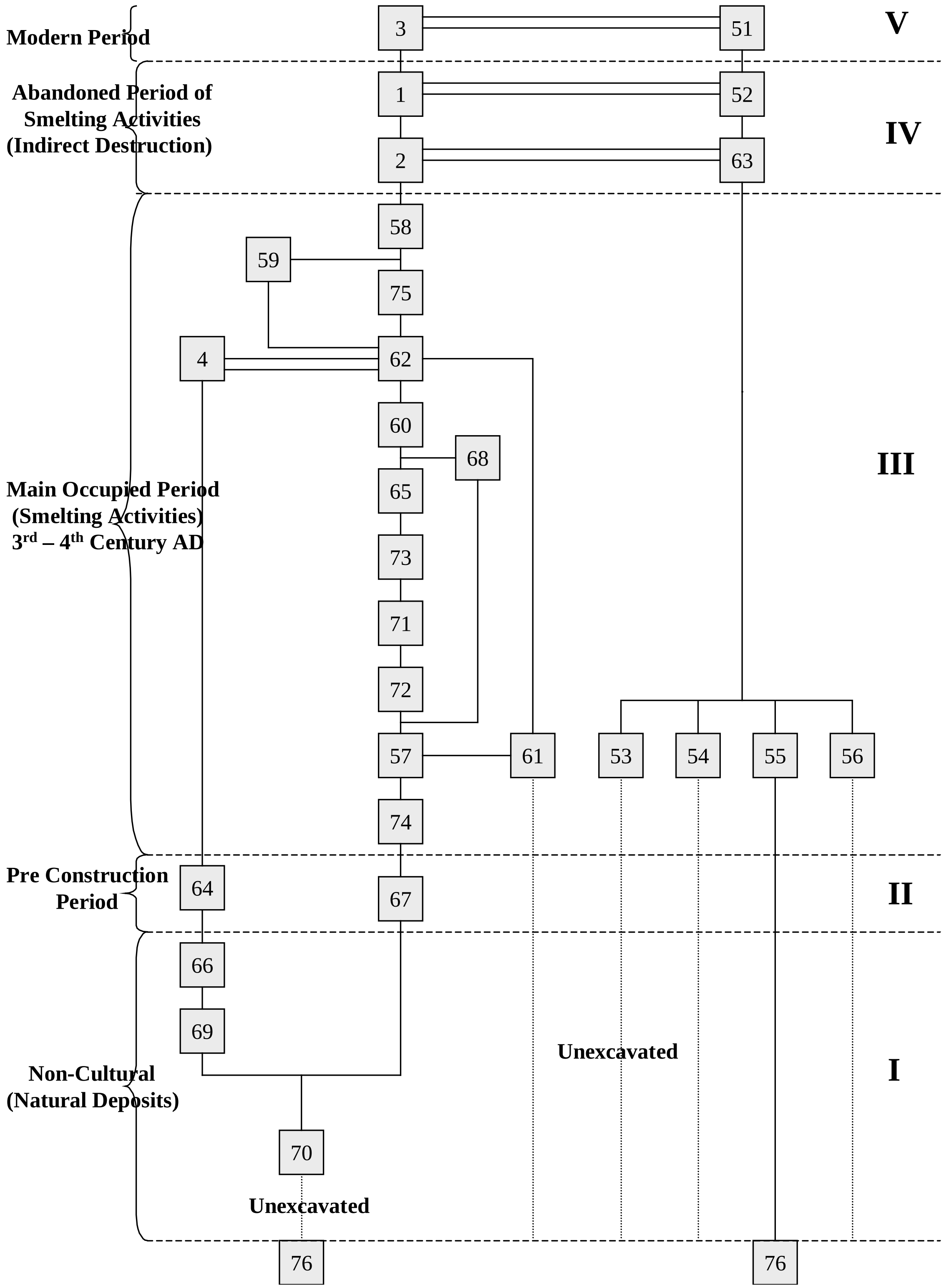


Figure 6-13. Site Matrix at SIT 22. The main occupied period of the site is dated here based on the radiocarbon dates provided in Table 6-2 and Figure 6-12. Contexts descriptions for given numbers are provided in Appendix F.

Except Sample # SIT-22/04-04 (Beta-201944), other three samples that I selected from Phase III have provided similar radiocarbon readings (Figure 6-12). These data are also compatible with radiocarbon dates with SIT 1, Dehigaha-ala-kanda iron smelting site that have been analyzed at the Svedberg Laboratory, Uppsala University. Using CalibETH 1.56 (1991) Radiocarbon Age Calibration**,** SIT 01 has dated (68.26% Probability, 1 Sigma Calibration value) in between 2nd century B.C. and the 4th century A.D. (KO 14 in Forenius and Solangaarachchi 1994, Mogren 1994). These data will be used again at the end of this chapter to summarize the excavation data in the KOB.

As shown in Figure 6-12, if we could consider SIT-22/04-01 (Beta-201941), SIT-22/04-02 (Beta-201942) and SIT-22/04-03 (Beta-201943) to determine the period that main activity of iron smelting have been conducted at the site, it ranges from Cal A.D. 50-Cal A.D. 320 (from left red dotted line to right black dotted line in Figure 6-12). But it provides much shorter time range from Cal A.D. 260-Cal A.D. 320 if use four radiocarbon dates.

The doubtful Sample # SIT-22/04-04 (Beta-201944), collected from Context 62 that is laid just below Context 63, the context represents the abandoned period of smelting activities (Phase IV) of the site (Figure 6-13). The location of two contexts (soil layers) has a high possibility for mixing up lower level of Context 63 with upper level of Context 62. The discrepancy sample might be collected from the Context 63 as the high content of slag at Context 62 has prevented to identify the demarcation of soil layers correctly. If this conception is correct, the smelting activities abandoned period of the site, can be dated 4th century A.D.- 6th Century A.D., Cal A.D. 390-530 /one sigma value (Figure 6-12; Figure I-4).

As mentioned before, Phase II, the period just before the smelting activities have been conducted, yielded 9 worn potsherds (2 BRW, 6 RW, 1 GW). It can be assumed that this phase is similar to the Phase I at the Dehigaha-ala-kanda iron smelting site, which was identified as Early Anuradhapura Period I (Solangaarachchi 1999) or Early Historic Period I (EHPI) in somewhere before or around 1st century B.C.

Considering above mentioned data, it can be assumed that the site was continuously used as a settlement from Early Anuradhapura Period to the modern period. The main activities of iron smelting was conducted during Reigns of King Mahasen (269-296 A.D.) and his son King Kithsirimevan (269-324 A.D.), who ruled the area before King Kasyapa, the founder of the main construction period of Sigiriya Royal City of 5th century A.D. (477-495 A.D.).

Vavala Monastery: a Religious Center

Ancient chronicles and inscriptions that are spread all over the country have provided clear evidence for the historical relationship of Buddhist monastery, royalty, and secular elites with each others and with the common people. Comparing with archaeological studies on Buddhist monastic architecture, there is very little attention was made understanding the how Buddhist monastery was acted on socio-political structures of the society (Bandaranayake 1974; Gunawardana 1979; Gunawardena 2003). One of the tasks of the SARCP was dedicated for understanding the settlement network beyond superstructure of the historical society. It also took preliminary steps to understand the distribution pattern of the monasteries on the landscape in the Sigiriya-Dambulla region (Bandaranayake 1990). The Sigiriya-Dambulla region, the macro region of present study consists of a larger number of EHP and MHP major Buddhist monastic settlements that are dated by the inscriptional evidence (for example, Dambulla, Enderagala, Sigiriya, Pidurangala, Vavala, Nuwaragala Kanda, Kaludiya Pokuna, Ramakale).

In present study, I wanted to take further step forward from the SARCP objectives and tried to understand the inter-relationship of Buddhism or Buddhist monastery and the settlement in the KOB. As I discussed in previous chapters (Chapter 3 and Chapter 5), we could trace the relationship of Buddhist monasteries in the total landscape of KOB from Nuwaragala Kanda to Minneriya Vava. In other words, it clearly shows "the internal dynamics of Buddhism in the local landscape" (Wills 2000; Shaw 2000a and 2000b). As the second step, I selected Vavala Monastery to conduct test excavation to find material evidence that I presented here for examining and confirming this relationship.

Site Environment

Vavala Monastery complex that is registered as SIT 6 (hereafter refers as SIT 6) is located 1 ¼ km west to the Kiri Oya and 750m northeast to the Vavala Vava (Figure 6-1). This site was registered as KO 22 under the SARCP (Manatunga 1990). It was built on a rocky hill slope as facing to Kosgaha-ala that is flown 250m east to the eastern hilly "boundary' of the monastery (Figure 6-14). The site is approximately spread over 400mx400m and slopes from west to east as descending around 50m height difference (Figure 6-14). Remains of kapapu-ala that used to bring water from Vavala Vava to Sigiri Maha Vava could be seen 200m east to the site. SIT 6 is one of the largest monastery complexes in the KOB that includes nine rock shelters (with drip-ledges) as representing architectural components of 3rd century B.C. to 1st century A.D. cave monastery type. It is the only monastery in the KOB still using for Buddhist religious activities. Remains of a stūpa, a pond, a bodhighara (house for the bo tree/bo-tree shrine), pilimagē (image house) siema malakaya (chapter house), stone slabs with moldings provide probable evidence for having been used it as a Pabbatha vihara type Buddhist monastery in a later period. Detailed descriptions of some of the major constructions of the site is provided in Appendix D.

The site lies at latitude 7° 53'16" N and longitude 80° 46'35" E and the elevation of the site ranges in between 845feet/258m and 701feet/214m above mean sea level (while the top of the *seenugala*/Bell Rock is considered as the highest point, *nipena pokuna*/Cobrahead Pond is considered as the lowest).

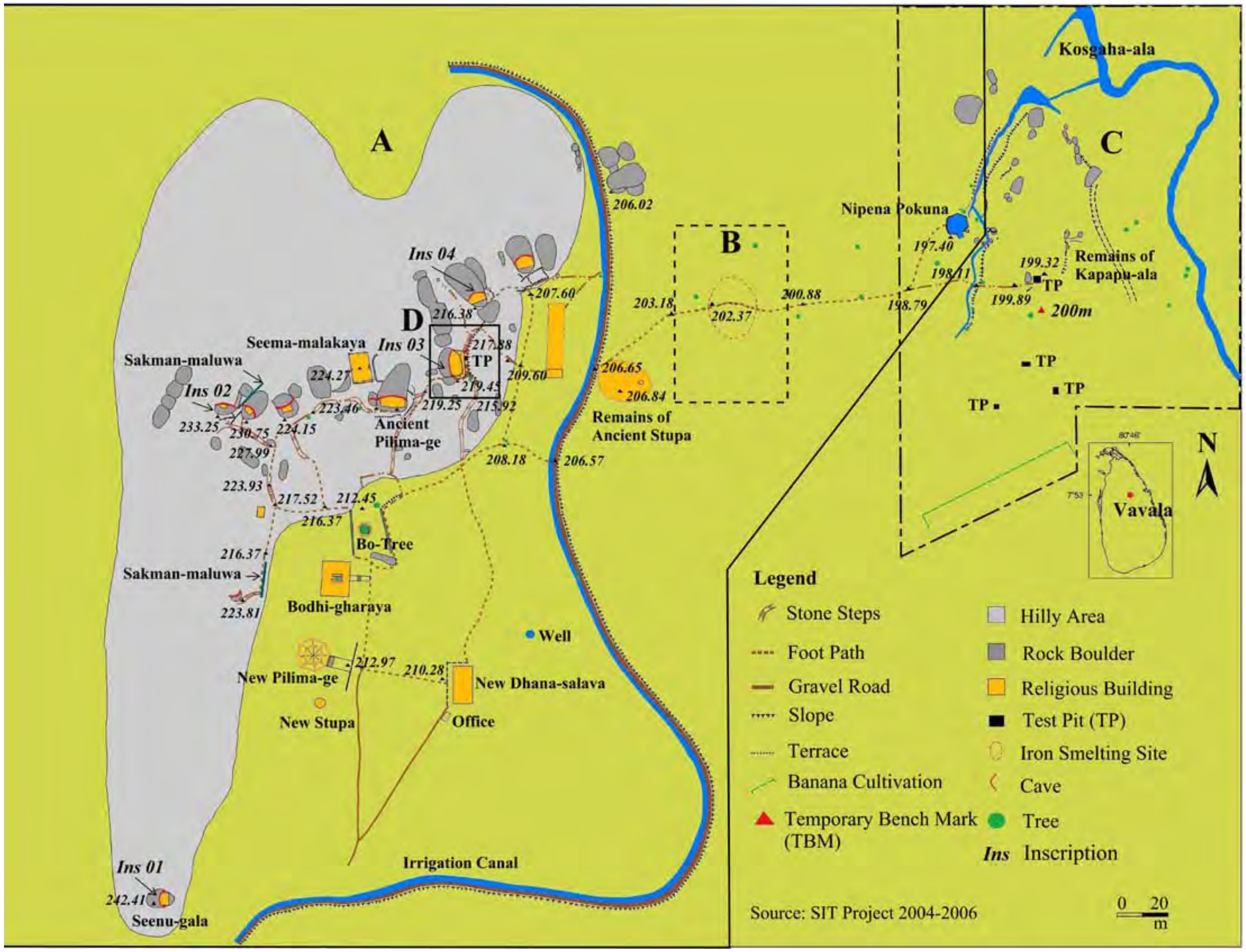


Figure 6-14. Vavala monastery (SIT 6) and the settlement (SIT 7). A) Vavala Monastery- SIT 6. B) Galwatta-hena iron smelting site- SIT 5. C) Kosgaha-ala-ulpotha settlement site- SIT 7. D) Excavated location at SIT 6. Heights of the map are given according to the given TBM (200m). GPS reading of MSL for major constructions are provided in Appendix D.

The middle of the northern portion of the site has signs of erosion towards the east due to a steep slope. Low rock boulders are located in the western hilly area of the site, consisting of erosional remnants of metamorphic gneiss. The dominant soil group of the eastern part of the site is Reddish Brown Earth (RBE), as in most parts of the Dry Zone. Except for a few isolated trees of *Manilkara hexandra* (Sin. *palu*, Eng. Ceylon Iron Wood), *Catotropis giganta* (Sin. *vara*), *Drypetes sepiaria* (Sin. *veera*), *Bauhinia racemosa* (Sin. *maila*), *Artocarpus heterophyllus* (Sin. *kos*, Eng. Jack Fruit), there is no vegetation in the middle part of the site. The western hilly area is covered by trees characterized by mixed evergreen forest, the most dominant vegetation on the RBE (Cooray 1984). The abandoned chena lands located just north to the monastery are covered by *Aristida depressa* (Sin. *athtuttiri*) and *Cymbopogon confertiflorus* (Sin. *mana*).

The eastern portion of the site is rich in potsherds including rimsherds, decorated, and non-decorated bodysherds. Colors of most bodysherds range from gray-red to black including RW and BW. Detailed description of pottery will be given below while summarizing the material culture of the site and Appendix J (Table J-2a; J-2b; J-2c; J-2d).

It is hard to determine ancient demarcations of the site, as any unit of an ancient settlement cannot be taken as an isolated unit because they were integrated as a whole. Technically, I considered the western edge of the hilly area, where ancient cave dwellings are located, as the western boundary of the site (Figure 6-14A). Although it is hard to separate "eastern boundary" of the site from the Kosgaha-ala-ulpotha settlement site (SIT 7), the Cobra-hood Pond (*nipena pokuna*), the lowest elevation of the landscape (701feet/214meters), was designated as the eastern demarcation. The pond (SIT 6-V in the Appendix D) is constructed at a perennial spring and just 100 meters northeast to Galwattahena iron smelting site (SIT 5) and to the northwest corner at the Kosgaha-ala-ulpotha Settlement Site (SIT 7). Except for the seven-headed cobra sculpture (guard stone) that was claimed as an *in situ* discovery, scattered bricks, brickbats a larger amount of potshards and remains of two stonewalls are also seen near the pond. The other interesting find at the vicinity was the conical hole (15cm in diameter and 16cm in depth) that is carved into a flat rock boulder just 10m southeast to the pond. There are some pieces of magnetite and quartz also in the vicinity.

All of the cave dwellings mentioned above are oriented to the East, South or Southwest towards religious buildings that are located on the flat land just East of the hilly area (Figure 6-14). One of the remarkable finds could be noticed in between the pond and the hilly area of the site is a remains of an ancient stūpa including a stone pillar, limestone slab with a squared middle cut mark, a foundation stone, *chathraya (*60cm in radius), large bricks and stones as evidence for a surrounding wall (SIT 6-IV in Appendix D), all of which represent the historical stūpa architecture.

There are four inscriptions at the site. While three early Brahmi inscriptions (Ins. 01, 02, 04) represent the period between 3rd century B.C. and 1st century A.D. and were carved just below the drip-ledges at the cave heads (Figure 6-14; Figure 6-15A; Figure 6-15B), the late Brahmi inscription (Ins. 03) that represents the tenth regnal year of King Kithsirimevan (son of King Mahasen) are engraved on a rock boulder that is located inside and at the ground level of the cave (Figure 6-14; Figure 6-15C; Figure 6-16). The site description of these locations will be provided in Appendix D and the readings, translation and estampages of inscriptions are provided in Appendix L.

Although the eastward-oriented cave that is suspected as the *pilimagē* (Image House) of the monastery (Figure 6-15D) has a drip-ledged rock shelter with an eastern entrance and steps (SIT6- III in Appendix D), no inscription could be traced at the site (Figure 6-15).

Figure 6-15. Four dripleged cave dwellings at SIT 6[1]. A) Inscription 01 can be seen just below the dripledge at *seenu-gala* (Bell Rock). B) Inscription 02 at *amaragala lene* (Cave of Amaragala). C) The dripleged cave dwelling that is bearing Inscription 03 that represents the 10th regnal year (306 A.D.) of King Kithsirimevan. The inscription is located inside this cave dwelling. (figure 5-16). D) Ancient cave dwelling mentioned in the text that is not bearing an inscription. Photographs by R. Solangaarachchi.

But well-preserved ancient construction with thick plaster coated large bricks and clay walls that divided the shelter into compartments. A torso of a small Buddha statue was identified as representing the middle Anuradhapura period (Manatunga 1990), brickbats, tile pieces and potsherds that are spread at the site along with the ancient construction indicate that the site was most probably used as the pilimagē.

[1] Inscription/s 01, 02, and 03 bearing three cave dwellings are provided here. Inscription #01 and # 02 can be seen just below the dripledge. Inscription #03 is located inside the building. While estampage making process of Ins. #03 will be provided as Figure 6-22, all inscriptions at the monastery premises are provided in Appendix L.

Significance of Inscription #03

Ample inscriptions that were written from 3rd century B.C. (in early Brahmi script) to 10th century A.D. (Sinhalese letters) provide a reliable source of information on contemporary social structure and various donations to Buddhist monasteries (and, it could be seen in the Sigiriya-Dambulla region) (Paranavitana 1970; Ranawella 1984; Somadeva 1994). Until the SARCP traced the Inscription (#03) that represented the period of King Kithsirimevan, it were considered that there were no inscription evidence in the region before the Kasyapa period that was around 3rd - 4th century A.D. (Ranawella 1984).

Inscription #03 was previously identified as a King Kithsirimevan's inscription about "grant to the monastery of a paddy field, and benefits from taxes from a tank", and it was also suspected that Vavala Vava was as "the tank" (Manatunga 1990:76). After reading the estampage of the inscription for this research, Malini Dias[2] has come to the conclusion that it was an inscription about donations to a monastery that was given by six people in August during the 10th year of King Kithsirimevan (son of King of Mahasen). Although it mentions donations for the maintenance of the monk's residence (*saga aba vatatiya)* by "taxes" from four reservoirs and two paddy fields, no names of these are given. There is no exact list of offerings mention in the inscription, but they may be yields from the paddy fields and taxes from reservoirs. Most probably the monastery can be identified as the Vavala monastery because the inscription is located at the middle of the monastery premises.

[2] Although former reading of this inscription for SARCP was done by Benille Priyanka (pers. com.), it was not published. Therefore, I made several estampages for getting full translation. Malini Dias, former Director of Inscription at the Department of Archaeology, read and provided an English translation of the inscription for this research (Appendix L)

But it mentions Kara Sudaka S(u)mana[3], Scribe Naga[4], elderly Siva[5] and Bhuti[6] as owners of reservoirs; Scribe Naga and Siyari[7] as owners of paddy fields; and chief Sonadeva living at the village of Dakapedi[8] as the owner of the cave (Figure 6-14C; Figure 6-15; Appendix L). The reservoirs in the inscription may be located in the vicinity of the KOB. Therefore, Vavala vava can be identified as one the reservoirs in the inscription. Dakapedi might be Diyakepilla village that is located around 6 ¼ km northeast to the monastery.

According to Dias, this is the first time she has seen *vayadeva* (elderly) in an inscription. The word "aba" can be "araba", the meaning "the residence". Due to a missing letter ("r"), there is high possibility for an incorrect identification of as "*abhaya dhanaya*" or, meaning of "release from death". This three-line rock inscription measured 4.62m in length and 0.6m in width. When examine the writing style and the quality of the inscription carefully, it seems that the inscription was not carved by a professional or specially trained inscription writer (*lekiya* = scribe) because only the first line is properly written.

I paid special attention to estampages of the inscription, as it represents the less understand history of the region, provides evidence for contemporary social formation, and it not has been published. As informed by villagers, they removed the top cave deposits and other debris of earlier contractions at the cave when they conducting renovation work. They dumped removals just in front of the cave as filling for protecting erosion towards steep slope.

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[3] ***Kara sudaka sumana*** *vaviya*

[4] ***Lekiya nakaya*** *vava kumbura*

[5] ***Vayadavi lekiya siyayaha*** (vapi)

[6] ***Bhutiya*** *vava*

[7] ***Siyariyaha*** *kubura*

[8] ***Dakapedi gamehi*** *vasana* ***jeta Sonadeveyaha*** *guha*

Fortunately, they were succeeded in saving the inscription after one of them identified it as an inscription carving (pers. com. with Mr. L. Wilson).

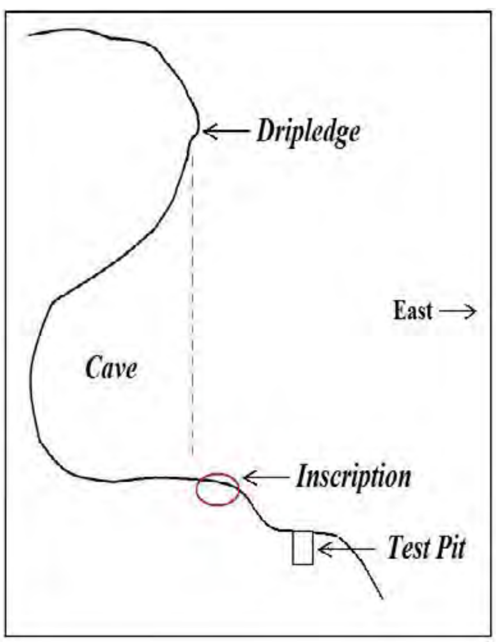
Figure 6-16. Estampage making process of Inscription #03 at SIT 6 that is located on the rock boulder ‘inside” the dripledged cave and just west to the test excavation. A) Ink rubbing as seen from North. B) Estampage left for drying. C) Ready for the second estampage as seen from South. Photographs by R. Solangaarachchi.

Main Objectives and Location Selection

When considering observed distribution patterns of the cave dwellings and inscriptions of the site, I assumed the long and board space in front of the cave dwelling that is bearing Inscription #03 as the best place to obtain material evidence for answering my research questions and for reconstructing the chronology of cultural layers at the monastery. As the inscription has provided the exact date of the donations "on the second day of the fortnight of the waxing moon in the month of Nikiṇi (August) in the tenth regnal year of King Siri Meghavanṇṇa Abhaya (296-324 A.D.)" (Appendix L), I decided to conduct test excavation at the northern corner of the locality (Figure 6-2; Figure 6-4) according to the following four main objectives:

- To determine the habitational sequence of the monastery
- To identify and check the inscription occupancy by material evidence
- To identify the relationship between the monastery and the surrounding settlement
- To identify the functional organization of the site and to check if there is any connection with iron smelting technology

The test excavation was carried out in an area of 2mx2m on the marked grid plan as an open excavation until the deepest level could be reached. But further East only half of the unit reached 190cm, as the area was blocked by heavy and long stones slabs (Figure 6-19).

A 

 B

Figure 6-17. Test excavation site at SIT 6. A) Sketch of the cave showing the locations of the test excavation and the inscription that laid in different levels of the site. B) Grid plan of the test excavation. Photograph by R. Solangaarachchi.

Excavation of the western part was conducted to 250cm in depth. I was unable to reach bedrock as stone slabs were laid across the test unit and their edges were also hidden beyond the walls of the excavation unit. At this point, I could not want to expand the test excavation. Study of rock shelter architecture will wait for future research at the monastery.

Stratigraphy

Excavated test units provide a sequential order of five phases: Phase I- Early Historic Period I - EHP I; Phase II- Non Cultural Layer; Phase III-Early Historic Period II - EHP II (the main construction period of the site); Phase IV- Modern Period I, Destruction activities & filling-Disturbed layers; Phase V- Modern Period. Two major cultural layers were identified through the context matrix system among the four habitation layers of the site (Figure 6- 19; Figure 6- 24).

Phase I, the first indication of the habitation, could be traced at the site and was dated between the 1st century B.C. to 2nd century A.D. through radiocarbon dating method (Figure 6-23; Table 6-2), confirming the earliest habitation given by three Brahmi inscriptions of the monastery. This phase is represented by two soil layers (Context/s 11 and 13) and stone paving (Context 14) that were found 135-220cm below the surface.

These contexts are not rich in potsherds compared to Phase III. Phase I yielded 21 potsherds from context 11 (10 RW, 2 BW, 5 BRW and 4 GRW), 24 potsherds from context 13 (13 RW, 3 BRW and 8 GRW). Context 11 is a comparatively hard soil layer of the test unit. Dating of this phase was obtained by two charcoal samples collected from Context 13 along with chert and quartz (Table F-2).

Phase II of the site is represented by a natural yellowish soil layer associated with mica sand deposits of non-cultural phase (Context 12) below the stone paving (Context 7/9) of Phase I, sloping towards middle of the test unit.

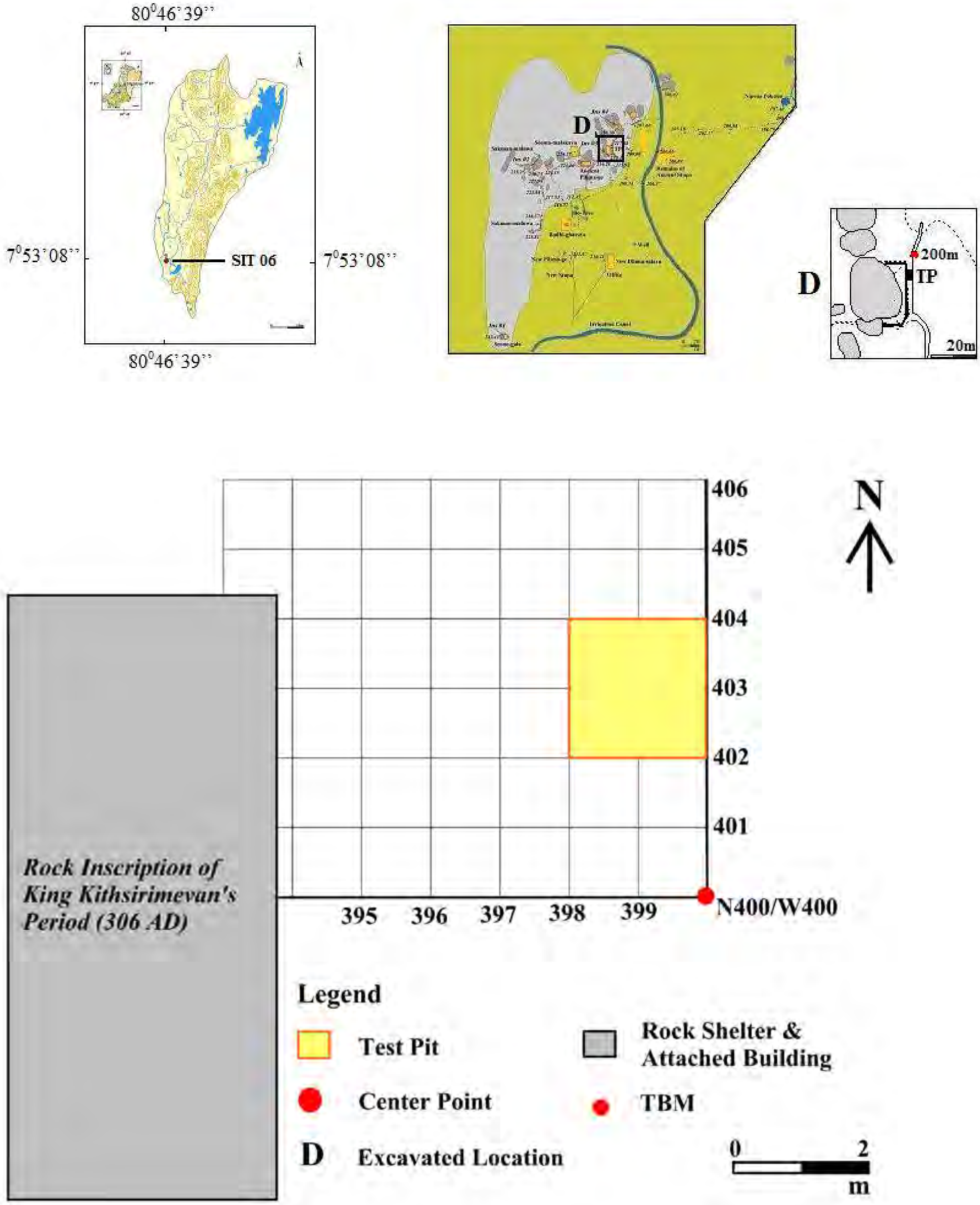


Figure 6-18. Grid plan of the excavated location at SIT 6.

The second major phase, Phase III, is characterized by a period of construction activities that might be associated with the period of Inscription #03 (Context/s 19, 20, 15, 16, 10, 10a, 17, 18, 7, 9, 8); stone paving, brick filling/fragments, large bricks, and 1 iron nails.

Other than these remains, this phase has only 1 identified iron object, 1 iron ore, 1 grinding stone, and no potsherds (Appendix F). Construction materials of this phase and the profile of the site have provided strong evidence for a two-columned foundation of a building in this phase. The upper layer of the foundation consisted of a brick pavement (Context/s 10 & 10a), followed by a stone pavement (Context/s 15 & 16). (One brick measured approximately 20cm*l*x23cm*w*x8cm*h*).

Context/s 15 & 16 are not similar to Context 14 in Phase I as it has natural eastwards slope of 45 degrees. Two brickbats fillings (Context/s 17 & 18) were laid on top of brick paving that are located parallel to the cave face. The major layer of this phase is Context 7/Context 9, the layer with a comparatively higher percentage of clay. Blocks of gathered stone (Context 8) that are laid or fallen as a circle found at N402/W398 & N403/W398 make up interesting feature at this phase. This phase also provides probable evidence of its association with the period of the inscription about the 10th regnal year of King Kithsirimevan (396 A.D.). Considering material culture that is associated with this construction, it can be suggested that the building was also constructed somewhere between 3-4th century A.D. (296-324 A.D.).

Phase IV, the next cultural level of the test unit, is characterized by the direct human interference of the site, its disturbed soil pattern has provided strong evidence for the filling mentioned by villagers (Context/s 4, 3, 5, 2 and 6). Context 6, a stone pavilion that appears in test units of N402/W399 & N403/W399 and the eastern end of the excavation seemed to be a modern construction for protecting the area from erosion.

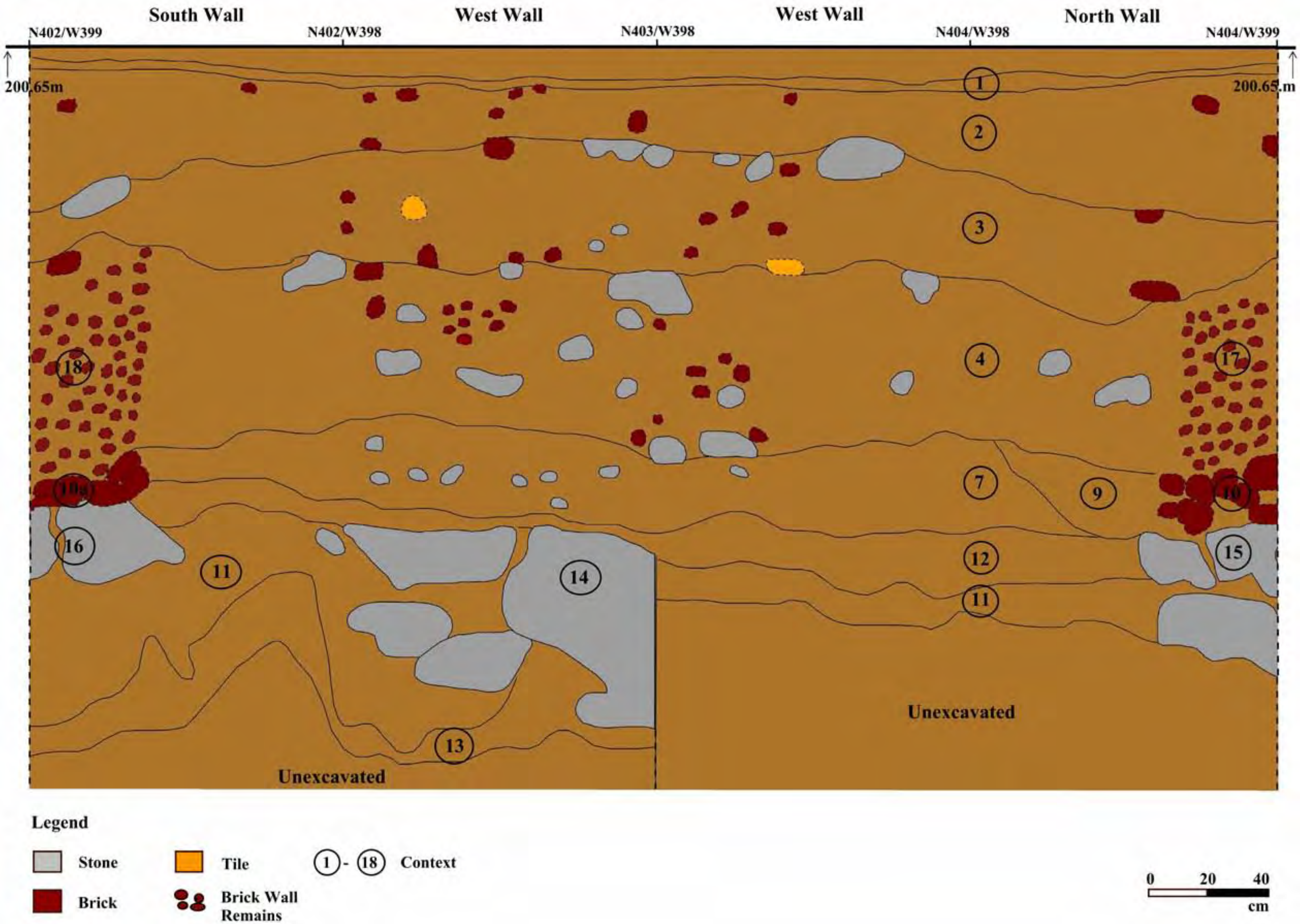


Figure 6-19. Test unit profile at SIT 6.

Context 2, unearthed just below context 1, spread over the entire site. It has yielded brickbats, tile pieces, bone fragments, and 3 iron nails. A brick structure labeled as Context 5 is at N402/W398 and N403/W398. The measurements of bricks are similar to bricks in Context 10/10a. Context 3 consists of brickbats, tile pieces, bone fragments, 1 iron nail and 133 potsherds (120-RW, 9-BW, 1-BRW, 3-GW). The sand percentage is higher compared to other soil layers of the test unit. The clay (mixed soil layer) labeled as Context 4 is the major layer that has yielded higher frequencies of material evidence at the site (616-potsherds, 1-bead, 7-iron nails, and iron slags). Potsherds are 386-RW, 73-BW, 47-BRW, 54-GW, 38-GRW and special categories of 1-Buff Ware and 17-Brown ware.

Phase V, the most recent phase of the site, is in direct contact with modern activities and is mixed with remains of modern deposits. This phase is characterized by a dark brown soil layer (Context 1) that could be seen over the test unit except at the western edge. Brickbats are the only material in this layer (Table F-2).

Summarizing the Material Evidence

Table 6-3. Unearthed artifacts from Phase III & Phase IV at SIT06 that are not collected under special finds category

Artifact discovered	Count	
	Large	Small
Brick pieces	111	1102
Tile pieces	52	372
Quartz & Pebbles[9]	69	219

Total numbers of stone (quartz and pebbles), pieces of bricks and tile pieces unearthed from context 1 to context 7/9 at the test unit (2mx2m) are provided here. From Context 1 to 7 seemed to be disturbed. Although Context/s 7/9 are not disturbed layers, it was hard to collect bricks, tiles, quarts and pebbles separately as the demarcation of the Context 7/9 could not be determined after removing large stone slabs that were laid across the test unit.

[9] Quartz & Pebbles were only in Phase IV, the phase that has been identified as the cave dump. They have provided probable evidence for the stone tool technology of a prehistoric Stone Age. Unfortunately the collection was missing since they transferred it to Colombo.

Material culture of the site is characterized by a higher yield of potsherds (794 counts), 1213 brickbats, 424 tile pieces, 288 quartz & pebbles, 12 iron nails, 3 unidentified iron objects, 2 beads, 2 pieces of iron slag, 1 piece of iron ore, 1 copper object/pendent, 3 grinding stones and bone fragments (as shown in Table J-2a; Table 6-3; Table E-2; Table F-2).

Ceramics at the Site

As shown in Figure 7-20, 69.77% of non-decorated bodysherds (NDB), 17.51% of decorated bodysherds (DB) and 9.57% of non-diagnostic rimsherds (NDR) were identified. Excavated test units only yielded a total of 25 diagnostic rimsherds (DR), only 3.15% of the total potsherds recovered at test excavation (Table J-2c). Compared with ceramics at SIT 22 with SIT 6, the frequency of decorated bodysherds is higher at SIT 6 (17.51%) than SIT 22 (5.25%).

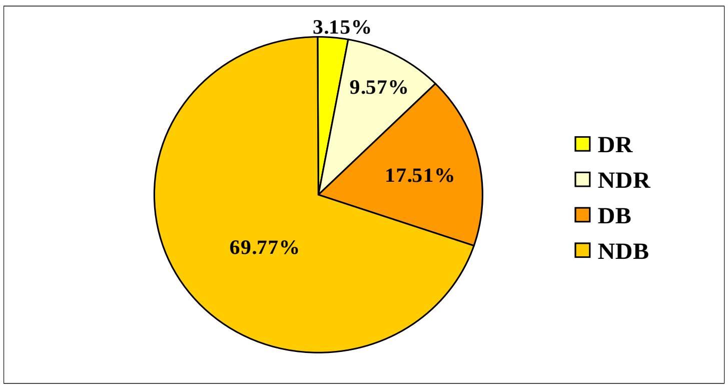


Figure 6-20. Percentage of four major categories of ceramic sherds unearthed at SIT 6.

The total amount of sherds 794 (8.797kg) at the site came from Contexts 3, 4, 11 and 13 at the site. Among them a larger yield (616) was recorded in Context 4 in Phase IV, identified as the mixed cave dump or disturbed phase (by the direct and modern human interference) laid over the Early Historic Period II (EHPII), the Major Construction period (Figure 6-21; Figure 5-24; Table J-2a). Analyses also shows a higher yield of potsherds (749) were from the Phase IV (Table J-2a).

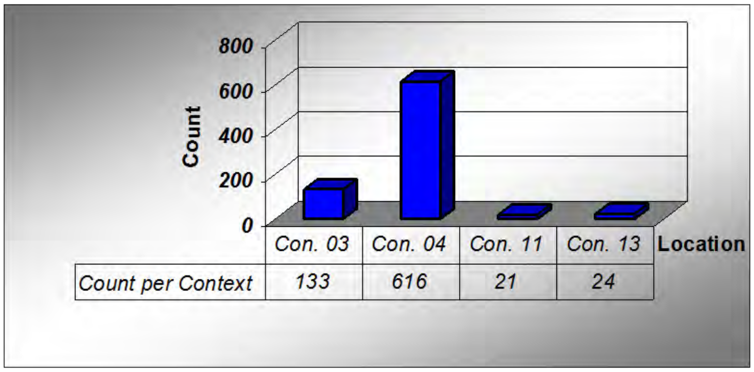


Figure 6-21. Total number of sherds per context at SIT 6 (Potsherds yielded contexts are only shown here).

All potsherds at the site can be categorized into five major ware types; RW- Red Ware, BW- Black Ware, BRW- Black & Red Ware, GW- Gray Ware, GRW- Gray & Red Ware) (Table J-2b). As shown in Figure 5-22, a total of 529 sherds of RW (66.62%) have the highest frequencies among all types, as in SIT 22. There are no sherds of BGW (Black & Gray Ware) at SIT 6.

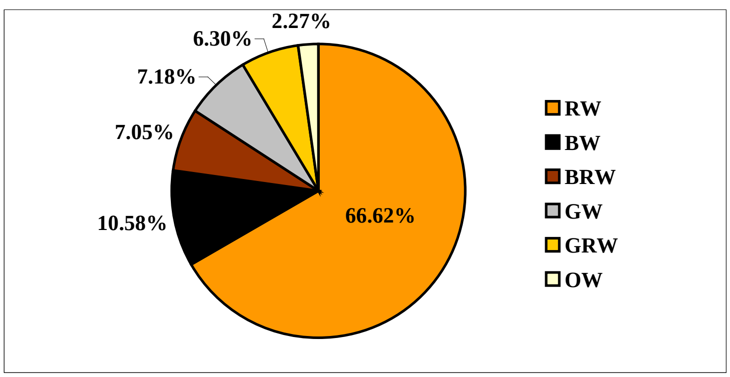


Figure 6-22. Percentage of ceramic ware types distribution at SIT 6. (RW- Red Ware, BW- Black Ware, BRW- Black & Red Ware, GW- Gray Ware, GRW- Gray & Red Ware, OW- Other Ware)

BRW represents the period from the early Iron Age/early historic (at Iron Age megalithic cemeteries from 6-7 century B.C. to middle historic period, until 4th century A.D.) also recorded in a lesser frequency (7.05%). BW (10.58%), GW (7.18%) and GRW (6.3%) are also recorded from the excavation unit at SIT 6. There are no sherds of BGW (Black & Gray Ware). The category OW includes rare ceramic types of the region-Buff Ware (1 count) and Brown Ware (17 counts). There are 2 painted sherds of Brown Ware among them.

Problems and Concerns

A main problem was the difficulty to continue excavation deeper to meet the bedrock, as stone slabs were laid across the test unit. This situation was seriously in the eastern half. So, I decided to continue excavation only at the western 1mx2m area. Even at the western part, we could not reach as deeply as we hoped. When reaching the bottom, there was not enough space to conduct excavation. In addition, we had to be very careful in removing large stone slabs at the site, as it mixes artifacts from different phases. It is hard to find secure charcoal samples from Phase III, the phase suspected to be the contemporary with the inscription #03, and Phase IV, the mixed cave debris. The only alternative was to get radiocarbon dates for the earliest layers of the test unit that belonged to Phase I, somewhere between 2nd century B.C. to 1st century A.D., as identified by three Early Brahmi inscriptions of the monastery.

Radiocarbon Dating

Fortunately, I was able to collect two well-secured charcoal samples (SIT-06/04-07 and SIT-06/04-08) from Context 13 at the test excavation unit (Appendix I, Table I-1). They were buried just below stone slabs at 208cm and -211cm depth respectively. AMS-Standard delivery dating method was used for both samples (8gms and 3gms), as they yielded very small carbon after conducting the pretreatment process. There was also the presence of crushed like rock.

Table 6-4. Radiocarbon dates for SIT 6

Sample # & Beta Lab #	Measured Radiocarbon Age	Conventional Radiocarbon Age	2 Sigma Calibration (95% probability)	1 Sigma Calibration (68% probability)
SIT-06/04-07 201947	1990$\pm$40 BP	1990$\pm$40 BP	Cal BC 60 to Cal AD 90	Cal BC 40 to Cal AD 60
SIT-06/04-08 201948	1940$\pm$40 BP	1930$\pm$40 BP	Cal BC 10 to Cal AD 140	Cal AD 40 to Cal AD 110

Sample # SIT-06/04-07 (Beta-201947) collected from Context 13, and 208cm below the surface at N403/W398 is associated with a few potsherds, chert and quartz. It was dated to 1990±40 BP radiocarbon age and conventional radiocarbon age of 1990±40 BP (Table 6-4; Table I-2; Figure 6-23; Figure I-6).

Sample # SIT-06/04-08 (Beta-201948) collected from the same context (Context 13), and 211cm below the surface at N402/W398, has provided 1940±40 BP as the measured radiocarbon age and 1930±40 BP as the conventional radiocarbon age (Table 6-4; Table I-2; Figure 6-23; Figure I-6).

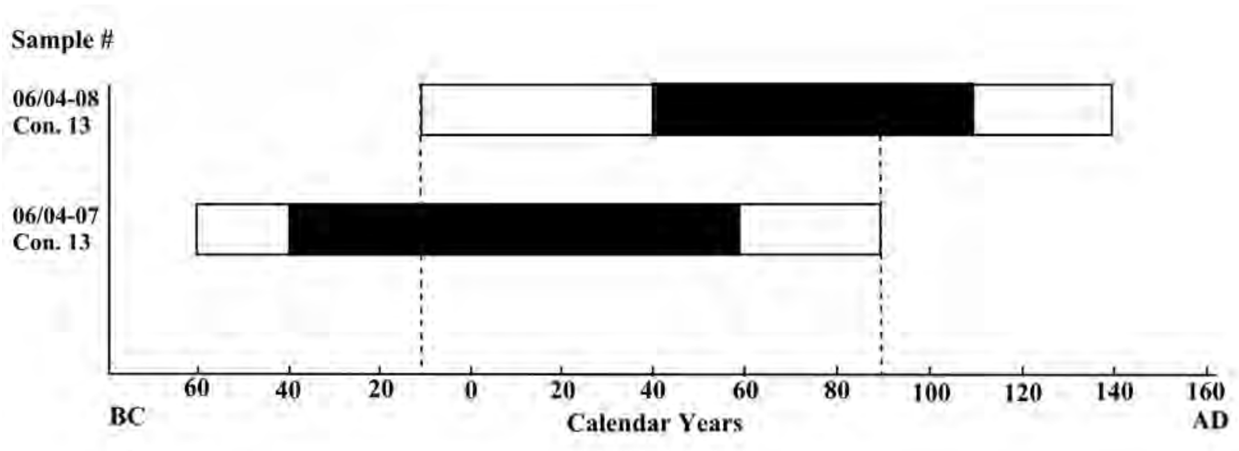


Figure 6-23. Diagram for Radiocarbon dates at SIT 6. Calibrated age ranges from cumulative probability, two sigma (95%) and one sigma (68%). INTCAL98 (Stuiver, Reimer, Bard, Beck, et al. 1998). While hollow bars represent two sigma limits, solid bars represent one sigma limits. The original report made by the Beta Analytic Inc. is provided in Appendix I.

The settlement layer labeled as Context 13 lies in between 1st century B.C. to 2nd century A.D., also tallying with the inscriptional evidence of the monastery to around the 1st century A.D. This is the only dated (through ^{14}C analyses) and excavated monastery site in the KOB.

Site Chronology

I considered inscriptional evidence, excavation data, and radiocarbon dates as primary sources for establishing the chronology of the site. Although the excavation has stratigraphicallly showed three historic phases (Phase/s I, III & IV) at the site (Figure 6-19; Figure 6-24), only two of them that came from the deepest soil layer (Con. 13) of the excavation unit that represents Phase I have provided charcoal samples for radiocarbon dates. The other collected samples from Phase IV were not sent for radiocarbon dating, as they seemed to be mixed with dumped cave deposit and considered unsecured samples.

Both Samples; Sample # SIT-06/04-07 (Beta-201947) and Sample # SIT-06/04-08 (Beta-201948) have provided almost similar radiocarbon readings (Figure 6-23), and are also compatible with three Early Brahmi inscriptional data of the monastery, which lies 2^{nd} century B.C. – 1^{st} century A.D., the Early Historic Period I (EHPI).

Phase III, the second occupied period has provided clear evidence for the cave dwelling architecture at the site. It can be assumed that this phase falls between 3-4^{th} century A.D. (296-324 A.D.), the period somewhere around 10th regnal year of King Kithsirimevan (396 A.D.) that represents by the Inscription #03 at the vicinity. Dating of Inscription # 03 is also compatible with radiocarbon dates with main activity periods of iron smelting at SIT 1, Dehigaha-ala-kanda and SIT 22, Dikyaya those were in active in between 2^{nd} -4^{th} century A.D. or most probably around 4^{th} century A.D.

Although Phase IV, the phase mainly occupied with the cave dump provides probable material evidence for the stone tool technology of prehistoric Stone Age, it did not have conducted enough analyses to confirm the prehistoric occupation of the site. But there are five major prehistoric habitats were identified within 6km radius of Sigiriya (Bandaranayake 1994).

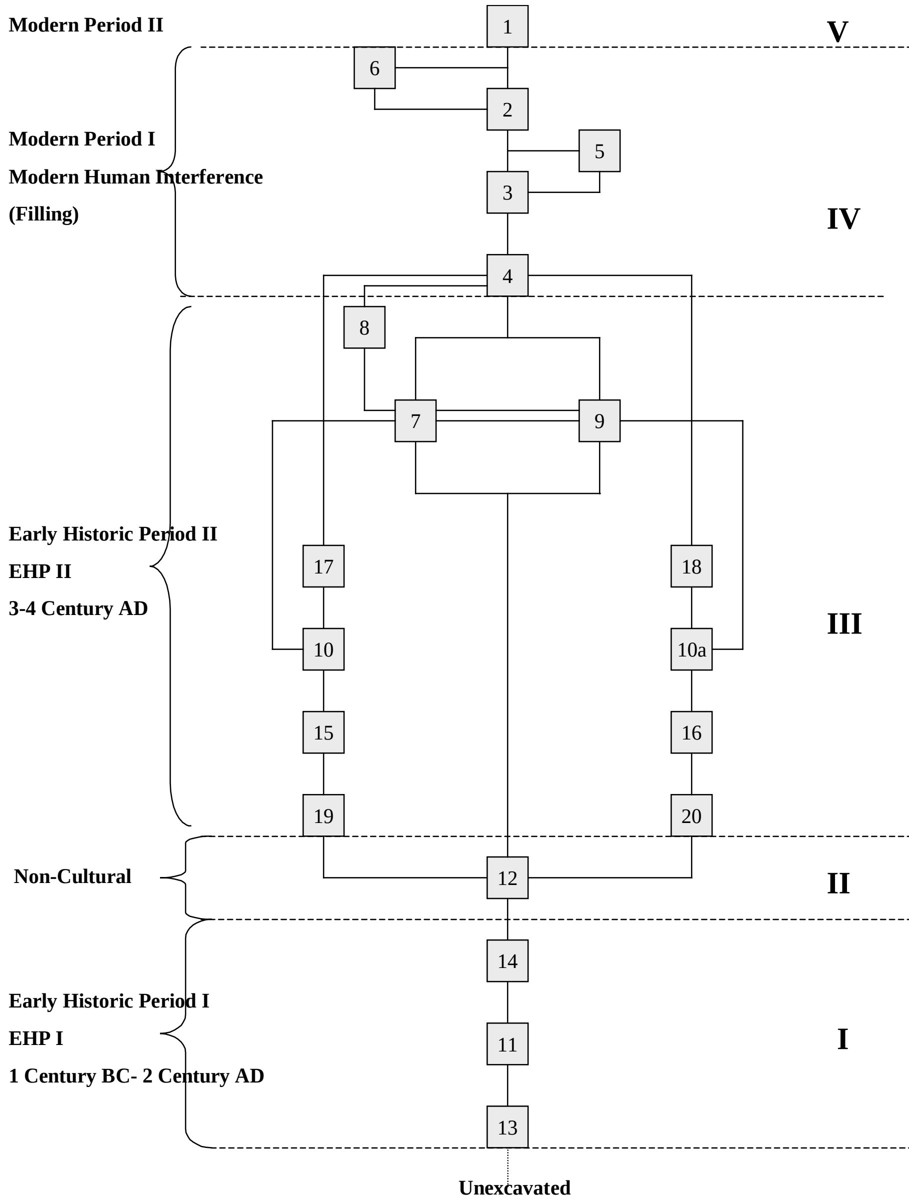


Figure 6-24. Matrix Account at SIT 6. The main occupied period of the site is dated here based on the radiocarbon dates provided in Table 6-4 and Figure 6-23. Contexts descriptions for given numbers are provided in Appendix F.

Considering above-mentioned data, it can be assumed that the site was continuously used as a habitation site from prehistoric period (at least with Mesolithic stone age technologies) to the modern period. Three early Brahmi inscriptions and one later Brahmi inscription are provided concrete evidence to prove that there was a monastery at least since 1st century B.C./A.D. and around 3rd-4th centuries A.D.

Kosgaha-ala-ulpotha : Ancient Settlement

As most of Sri Lankan archaeological studies were oriented towards brick made large religious and royal architecture, we only have little knowledge (eg: Paranavitana 1931; Nicholas 1956; Ellawela 1969; Leach 1961; Tennakoon 1974; Bulankulama 1976; Bandaranayake 1990) about pre-modern settlement pattern of rural society or the people, who gave their service for making these constructions and large hydraulic net-work that are located throughout *rajarata*. Archaeological surveys that have been conducted during SARCP (Manatunga 1990) and SIT (Solangaarachchi 2005; 2006) projects have already provided the distribution pattern of the non-producer centers including early to late historic Buddhist monastic settlements and major hydraulic network that are located along the KOB. As Bandaranayake pointed out, settlements of village communities who have provided the life support system for these non-producer secular and sacred elites must lie in their immediate environs (Bandaranayake 1990).

We have only very limited knowledge of settlement pattern of the SDR, the phase between the middle phase of the Early Historic period-EHP 2 (300 A.D.) and the period immediately before the Kasyapa period-EHP 3 (late 5th century A.D.) as the major sites show a lacuna in the archaeological records (Bandaranayake 1984; 1990). He suggested area's "under-development" nature that have been compared with the core regions such as the main Kala Oya - Malvatu Oya area in the `Anuradhapura system' of that period as one of the probable reasons for this gap. Although we cannot take this argument seriously as we already mapped settlement pattern of the area, as he suggested the main reason for the lacuna of the evidence is connected with scarcity of archaeological research of the area, difficulty in locating, where the settlements were situated because they may not be identified easily as the rock shelter sites of the earliest phase (EHP 1) and the grand constructions of the latter part of the late phase (EHP 3) during the Early Historic period at Sigiriya due to being deeply hidden beneath the surface (Bandaranayake

1990) and the nature of the remains of that period also caused difficulty in locating the sites. On the other hand, contemporary agricultural and settlement expansion of the area add some difficulty to locate original settlement pattern of the area.

Considering above major facts and assuming Kosgaha-ala-ulpotha settlement site (hereafter refers as SIT 7) represents the KOB settlement's material culture, I selected Kosgaha-ala-ulpotha settlement site for conducting excavations in 2004 and 2005 field seasons (Figure 6-1). In addition its location lied with the immediate environs to the Vavala Monastery (Figure 6-14) and densely spread out potsherds that represents different chronological levels of historic period at the site (Appendix J) are also among main reasons for selecting the site to conduct excavation. Although systematically we divided distribution of the settlement as separate units in surveying, the other surrounding sites are (SIT 8; SIT 9; SIT 10; SIT 11; SIT 12; SIT 30) also connected with SIT 7 as one "settlement unit" and shared much similar settlement pattern (Figure 5-4). Among these sites, *attani* pillar inscription at SIT 12 provides concrete evidence for the ancient settlement that have been activated between 7th-10th century A.D.

Site Environment

SIT 7, one of the ancient settlements of the KOB (KO 22 in Manatunga 1990) is located 1 ¼ km west to Kiri Oya and 750m northeast to Vavala vava (Figure 6-1). It is demarcated east from Kosgaha-ala (South), north from small stream that flows from pond of Vavala Monastery to Kosgaha-ala, west (& northwest) from Vavala monastery (SIT 6) and Galvatta-hena iron smelting site (SIT 5) and south from Kosgaha-ala-ulpotha iron smelting site (SIT 4). Although it is hard to determine the demarcation of the monastery and the settlement, I consider rock boulders and the monastery pond as the northeastern demarcation of the site (Figure 6-14).

The site lies at latitude N 7° 53'14" and longitude E 80° 46' 46" approximately 733feet/ 223m above mean sea level. Except northern and eastern edges of the site there are no heavy signs of erosion. The site makes about one meter sudden slope before gradually sloping towards Kosgaha-ala as the construction of two terraces that are made of stone blocks. It seems that these two terraces were made as the eastern demarcation of the site at the eastern edge and as the protection of erosion towards Kosgaha-ala (Figure 6-14). The remains of kapapu-ala lies in between terraces and Kosgaha-ala (Figure 6-14). Although the site is approximately spread over 300mx500m area, densely pottery scattered area is only 110m x 175m. A large amount of potshards (including lots of decorated ones), pinnacles, grinding stones, iron slag, iron ore confirms its occupation as a settlement.

A  B

C

Figure 6-25. Kosgaha-ala-ulpotha settlement site (SIT 7). A) Konduruvava mountain range is seen east to the site. The first excavation of the site was conducted just east to the rock boulder. Green horizontal tree line marks the location of Kosgaha-ala. B) Other three test units were conducted, where Savana (Damana) grassland are grown during the post cultivation period. Highest rock boulder at the Vavala monastery (SIT 6) is seen background. C) The land just west to the trench excavation was conducted is preparing for the onion cultivation. Photographs by R. Solangaarachchi.

When the land was preparing for current onion cultivation, farmers could collect some terracotta figurines at the northwest corner of the site. This is one of the sites in the KOB that has provided densely scattered different types of potsherds. As most sites in the region, SIT 7 is also covered with savanna (Damana grassland) during the abandoned period in between two cultivation seasons (Figure 6-25B). The abandoned fields, which were, once cultivated in the past have given rise to the savannas caused by the fire or the land clearing method of ` slash and burn'.

Except Bassia latifolia (Sin. *mee)* tree that is located 20m south west to the test pit #01 (TP), there are few trees can be seen in between remains of the Kapapu-ala and Kosgaha-ala. Banana plants are also grown as the commercial cultivation just south to the test unit excavation. TBM for the excavation is marked on a small flat rock that is located under *Mee* tree (Figure 6-14).

Main Objectives and Location Selection

When considering, already observed distribution pattern of the ceramics and other artifacts, assuming SIT 7 represents the KOB settlement's material culture, four test units were opened up measuring 1mx1m, 1mx2m and 2mx2m in areas where the densest concentration of ceramic has appeared (Figure 6-26).

After examining the surface collection of artifacts, I assumed the area around the rock boulders as the best place to get material evidence for reconstructing the chronology of cultural layers of the site and its connection with the monastery. One of the farmers at the site claimed that they found several pieces of crucibles around the area, where we decided to conduct the first test unit, when they were preparing the land for cultivation.

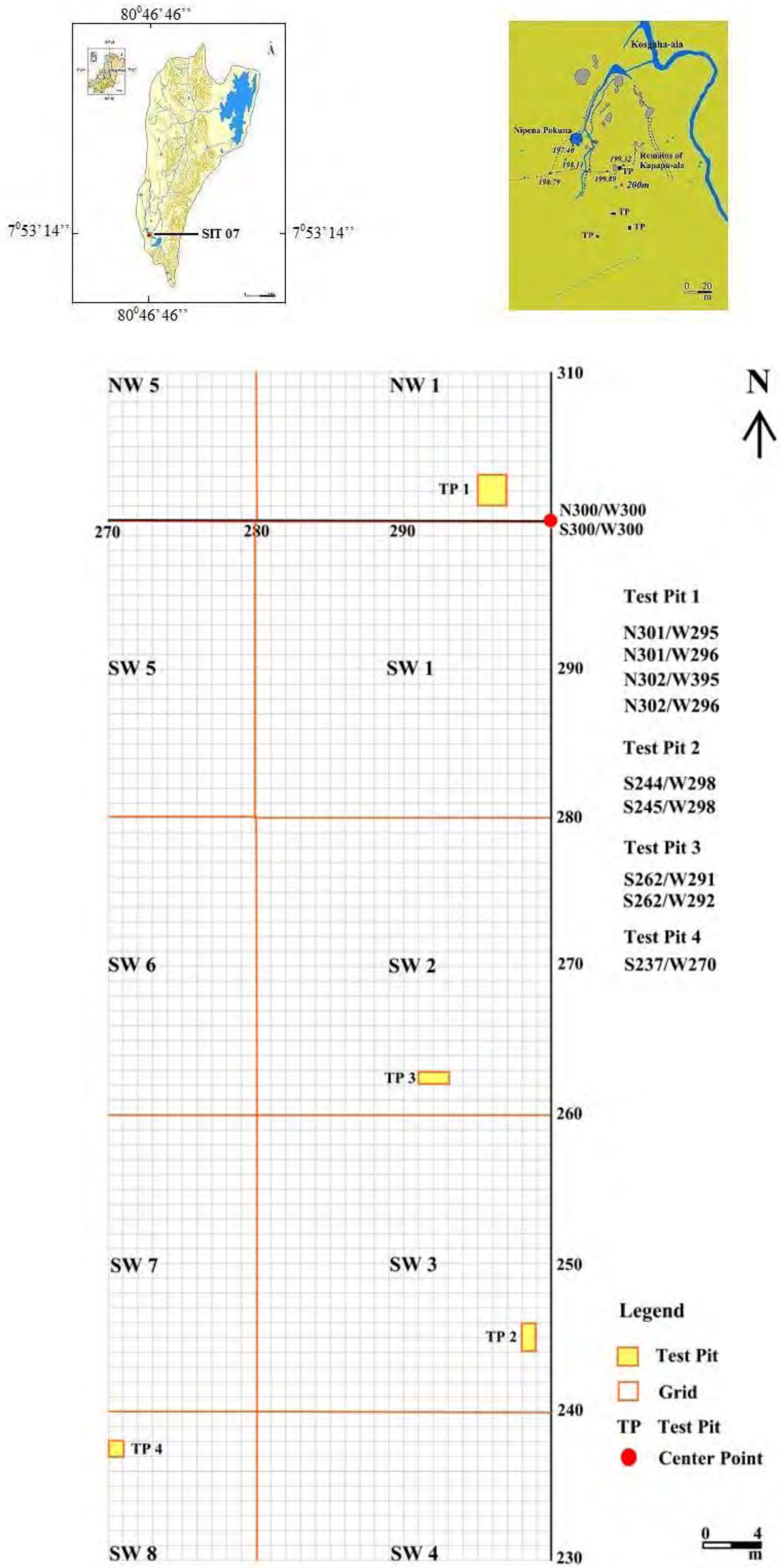


Figure 6-26. Grid plan of excavated area at SIT 7.

Main objectives of both field seasons are focused:

- To determine the chronological sequence of the site
- To find out the connection with the monastery during periods mentioned in inscriptions
- To identify the relationship between the monastery and the surrounding settlement
- To identify functional organization of the site and its relation with iron metallurgy

The test excavation was carried out within the marked grid plan as an open excavation until the deepest level could be reached without damaging and mixing up material culture. Second field season was mainly devoted for collecting charcoal samples for radiocarbon dating.

Stratigraphy

Four excavation units have mostly shared similar stratigraphical sequence as showing clearly identified three major phases (Figure 6-27; Figure 6-32). Identified stratigrapgical sequence has provided in the context matrix chart for the site (Figure 6-32). Not as in previous mentioned two sites (SIT 22 and SIT 6), it is hard to provide distinguish cultural phases archaeologically as only radiocarbon data could be obtained from the site.

The main three phases of the site are: Phase I- Non cultural Phase (virgin deposit), Phase II- Cultural Phase, Phase III- Cultural Phase, but disturbed by modern activities (Figure 6-32). Both Phase II and Phase III are shared much similar pottery distribution pattern that is belonging to in or before the Early Historic Period II (1st century A.D.- 4th century A.D.). But the debatable radiocarbon date (8th-10th century A.D.) that was yielded from Context 11 at Test Pit #02 cannot be ignored as the *attaini* pillar inscriptions usually spread out 7-10 centuries A.D. in the island.

Phase I of the site is represented by natural deposits of non-cultural phase (Context/s 5, 3, 6, 14, 15, 24, 25, 32 and 33). Except Context 3, other soil layers were not continued until reached the bedrock (Context 16) as they continuously show absence of any material evidence for confirming cultural activities of the period. Bedrock slopes from west to east towards Kosgaha-ala at Test Pit #01.

Phase II, the first indication of the habitation could be traced at the site through two sources; pottery typology and radiocarbon dating. Context 11 was dated in between 8^{th} - 9^{th} century A.D. through radiocarbon dating method (Figure 6-31; Table 6-5) and pottery typology of this phase has provided possible evidence of the occupation of the site in between 1st century A.D.- 4th century A.D. This phase is represented by twelve soil layers (Context/s 2, 4, 8, 9, 10, 11, 12, 20, 21 and 23) and stone structures (Context 13 and 22) that are unearthed 4-122cm below the surface. These contexts are rich in potsherds comparing with other three excavation sites of the project.

The major phase of the site, Phase II is characterized by the main period/s of occupation of the site that is mainly represented by a larger amount of potsherds, pieces of crucibles, iron ore, iron slags, chert, quartz flakes, grinding stones and bone fragments (Table F-3). These phase is provided 4744 count of potshards; Context 02 (288 potshards, fragment of a crucible, iron slags), Context 04 (647 potshards, quartz flakes, chert pieces, iron ore, iron slag), Context 08 (204 potshards), Context 09 (873 potshards, bone fragments), Context 10 (870 potshards, grinding stone, chert pieces, iron ore, iron slags), Context 11 (282 potshards, quartz flakes and chert pieces), Context 12 (441 potshards, iron slag and one human bone-humerus), Context 20 (394 potshards), Context 21 (429 potshards), Context 22 (80 potshards), Context 30 (165 potshards) and Context 31 (71 potshards) in different types that are belonging to the historical pottery typology in the region (Appendix F).

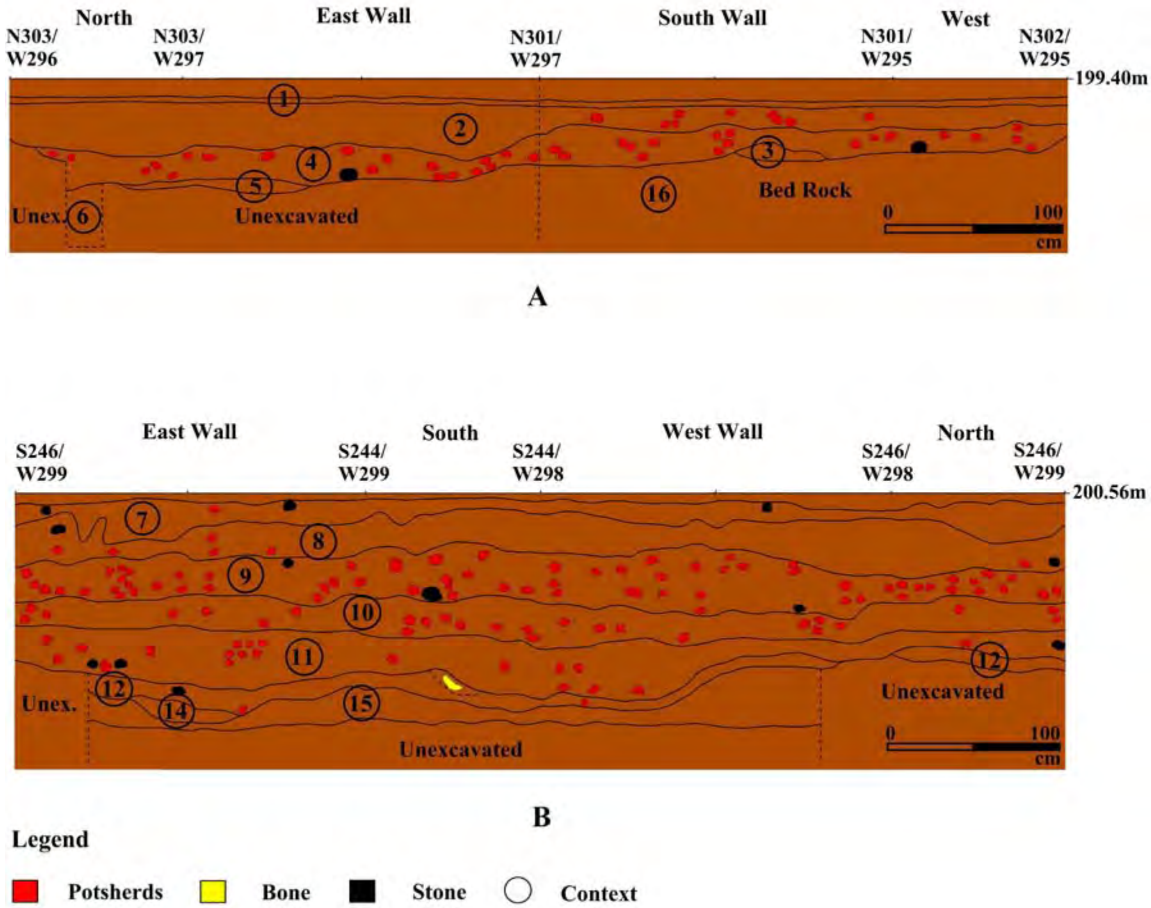


Figure 6-27. Test Units Profiles at SIT 7. A) Test Pit 01. B) Test Pit 02.

Phase III, the most recent phase of the site directly contact with modern activities and mixed with humus deposit. This phase is characteristics by a black soil layer (Context 01 and Context 07) that could be only seen at Test Pit 01 and Test Pit 02. Context 01 at has yielded 157 potsherds, iron slags and fragments of a crucible (Table F-3). Context 07 does not provide any cultural material. Although, Phase I and Phase II were determined as two different phases, material evidence of these two phases are almost similar to each other. It seems that this phase has disturbed by modern cultivation practices of the site.

Summarizing the Material Evidence

Material culture of the site are characterized by a higher yield of potsherds (4901 counts), 5 quartz flakes, 8 chert pieces, 7 iron slags, 7 pieces of iron ore, 3 grinding stone, 1 copper object, 2 pieces of terracotta figurines, 14 fragments of human bone (including piece of a right humerus), 2 crucibles, I ceramic, 1 charcoal sample (as shown in Table J-3a; Table E-3; Table F-3). Although there is ample evidence for the area's iron smelting technology, there are no crucibles recorded in the region to confirm the existence of local steel production. These are the only crucible samples unearthed so far in the region.

Ceramics at the Site

SIT 7 has yielded a higher percentage of potsherds (4901sherds/ 34.08kg) compared with other excavated sites during the SIT field seasons from 2004 to 2006. As shown in Figure 5-28, 68.68% of potsherds were identified as non-decorated bodysherds (NDB), 18.16% as decorated bodysherds (DB) and 9.39% as non-diagnostic rimsherds (NDR). Excavated test units at the site yielded a total of 185 diagnostic rimsherds (DR) in 3.77% of total potsherds (Table J-3c).

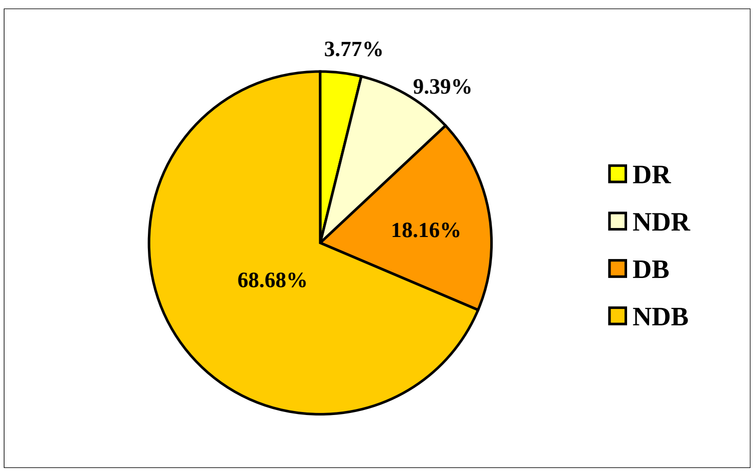
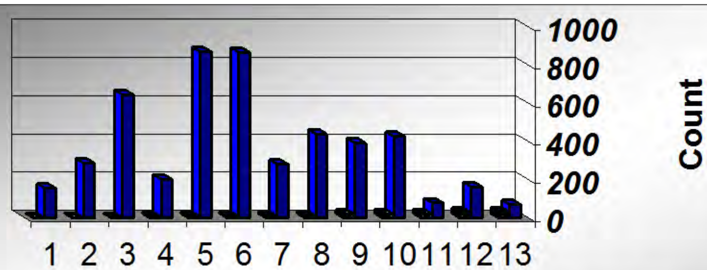


Figure 6-28. Percentage of four major categories of ceramic sherds unearthed at SIT 7.

The percentages of four major categories of potsherds at SIT 7 are very similar to SIT 6 (Table. J-2C). A larger yield of potsherds (4901) was recorded from thirteen soil layers (Context/s 1, 2, 4, 8, 9, 10, 11, 12, 20, 21, 23, 30, 31) in Phase I and Phase II at SIT 7 (Table J-3a). Analyses also shows, a higher yield of potsherds (4744) were recorded from Phase II that have been identified as the major cultural phase of the site that is laid over the natural soil deposits (Table J-3a).

Five major ware types of potsherds at the site were identified; RW- Red Ware, BW- Black Ware, BRW- Black & Red Ware, GW- Gray Ware, GRW- Gray & Red Ware (Table J-3b). As shown in Figure 6-30, 62.99% is RW, the higher yield of potsherds (3087) at the site. This was the highest yield of RW unearthed at any excavated sites of the SIT field seasons.



	1	2	3	4	5	6	7	8	9	10	11	12	13
Context Number	1	2	4	8	9	10	11	12	20	21	23	30	31
Count per Context	157	288	647	204	873	870	282	441	394	429	80	165	71

Figure 6-29. Total number of sherds per context at SIT 7 (Potsherds yielded contexts are only shown here).

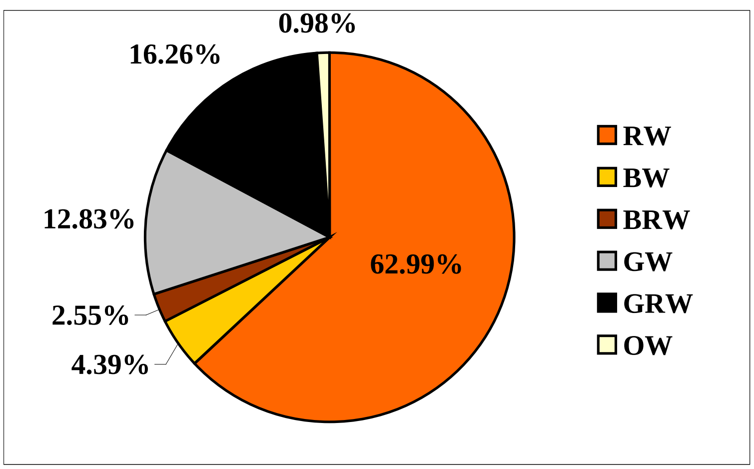


Figure 6-30. Percentage of ceramic ware types distribution at SIT 7. (RW- Red Ware, BW- Black Ware, BRW- Black & Red Ware, GW- Gray Ware, GRW- Gray & Red Ware, OW- Other Ware)

BRW that has appeared from the early Iron Age (at Iron Age cemeteries from 6-7 century B.C. to early historic period; until 4th century A.D.) also recorded in a lesser percentage (2.55%). Early historic period representing BW (4.39%) and GW (12.83%) were also recorded along with shards of GRW (16.26%). There were no any sherds of BGW recorded.

Radiocarbon Dating

I selected two samples (Appendix I, Table I-1) from the Test Pit 02 in different contexts (Context/s 12 and 11) were submitted to the Beta Analytic Inc. for Radiocarbon Dating. SIT-07/04-05, a human bone sample (61gms) unearthed 119cm below the surface was not datable as it hasn't yield collagen. Bleaching in the sun, heating and leaching in the soil maybe the probable reasons for no longer collagen existing in the bone. Sample # SIT-07/04-05 (Beta-201945), the bone sample that was collected 119cm below the surface at S244/W298 from Context 12 is associated with large fragments of potsherds, one polished & decorated BW and one piece of iron slag (Table I-1; Figure 6-31; Figure I-6; Table F-3).

SIT-07/04-06, a charcoal sample (4gms) had a very small amount of carbon. It needed to be used AMS-Standard delivery dating method. According to the report (Appendix I), during the pretreatment process it also has to be removed crushed like rock debris. As for other samples INTCAL98 Radiocarbon Age Calibration database (Stuiver *et al.* 1998) and the mathematical Pretoria calibration Procedures in C14 dates calibration (Talma and Vogel 1993) were used to convert radiocarbon BP result to calendar years. Dating result for the sample is provided in Table 6-5 and Table I-2 (Figure 6-31, Figure I-5).

Sample # SIT-07/04-06 (Beta-201946) collected 77cm below the surface at S244/W298 from Context 11 that is associated with large fragments of potsherds, chert and quartz (Table F-3). It has provided 1150+40 BP as the measured radiocarbon age and 1130+40 BP as the conventional radiocarbon age (Table 6-5; Table I-2; Figure 6-31; Figure I-6).

Table 6-5. Radiocarbon date for SIT 7

Sample # & Beta Lab #	Measured Radiocarbon Age	Conventional Radiocarbon Age	2 Sigma Calibration (95% Probability)	1 Sigma Calibration (68% Probability)
SIT-07/04-06 201946	1150+40 BP	1130+40 BP	Cal AD 790 to 1000	Cal AD 880 to 980

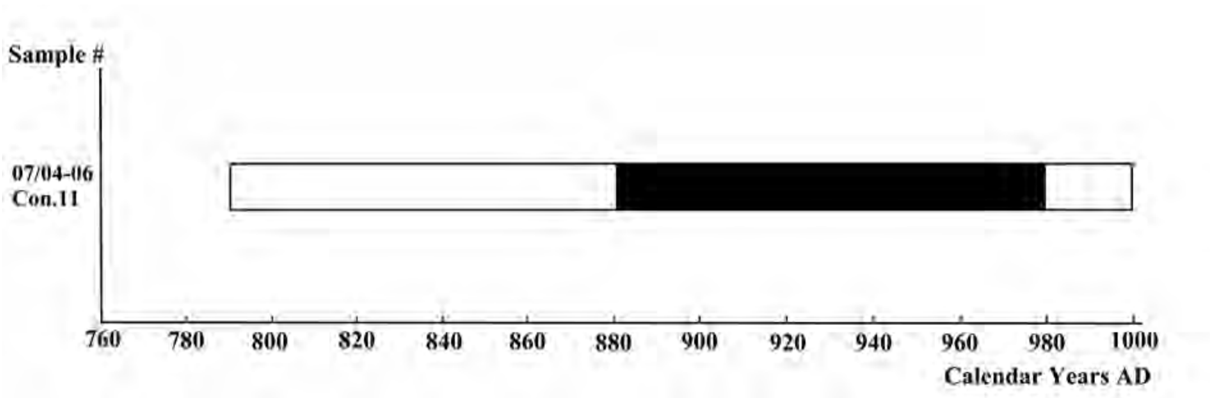


Figure 6-31. Diagram for Radiocarbon date at SIT 7. Calibrated age ranges from cumulative probability, two sigma (95%) and one sigma (68%). INTCAL98 (Stuiver, Reimer, Bard, Beck, et al. 1998). While hollow bars represent two sigma limits, solid bars represent one sigma limits. The original report made by the Beta Analytic Inc is provided in Appendix I.

Unfortunately, there was only datable sample unearthed at the site. The sample was collected from Context 11, the habitation layer at Test pit #02. According to the Radiocarbon date, it lies between the 8th century A.D. and the 10th century A.D.

Site Chronology

As we have one datable sample for radiocarbon analyses, the chronology of the site cannot be depended only on the radiocarbon dating. Comparative studies of previous studied pottery typology of the region are the only other alternative to determine the site chronology. Although the excavation has stratigraphicallly showed two historic phases (Phase/s II & III) at the site (Figure 6-32), only one of them has provided charcoal samples for getting radiocarbon dates. As mentioned above, the datable sample that came from 77cm below the excavation unit (Con. 11) that represents Phase II was sent for radiocarbon dating. Human bone sample, the other collected sample, was also unearthed from Phase II. This sample was not helpful in dating the site, as it has not yielded collagen.

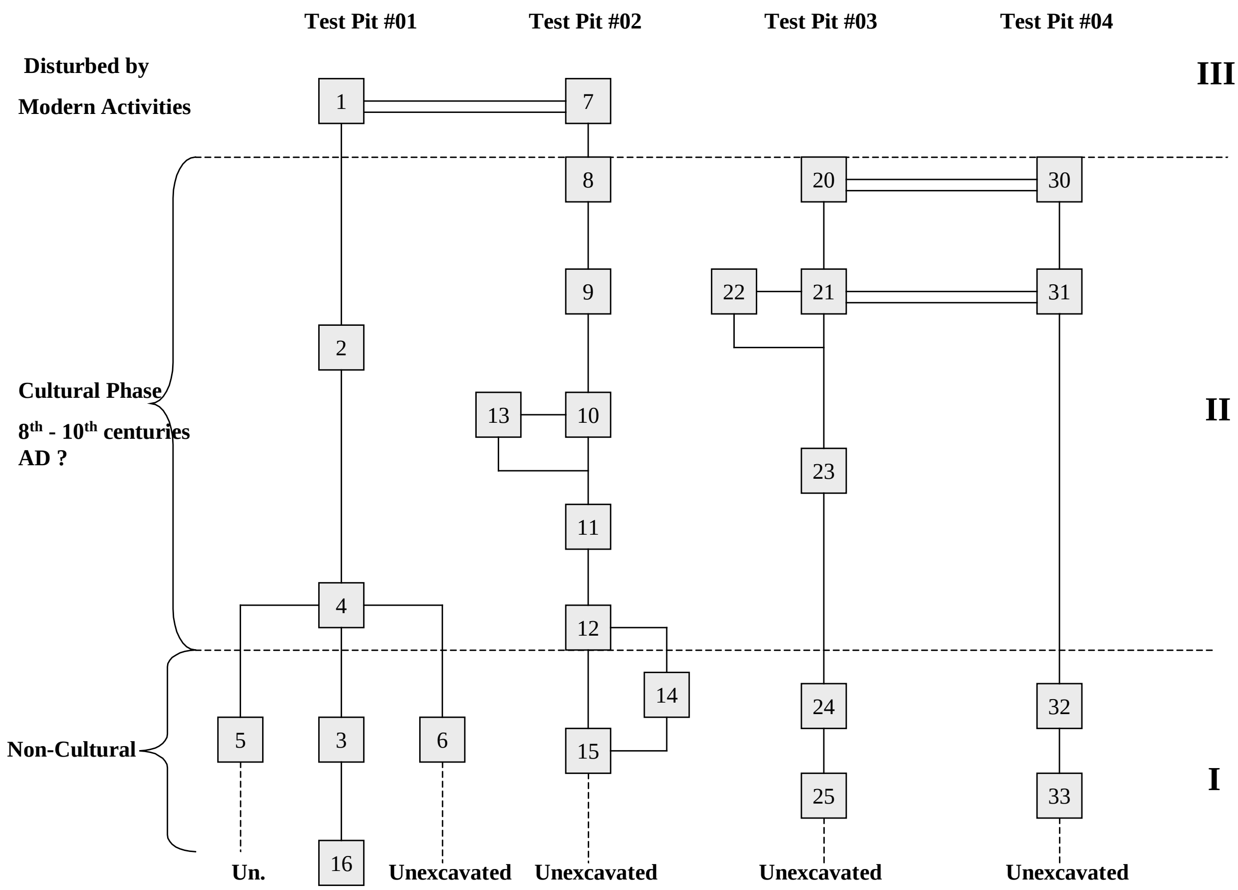


Figure 6-32. Matrix account at SIT 7.

The sample # SIT-07/04-06 (Beta-201946), the only datable sample unearthed at the site was collected from Context 11, one of the habitation layers at Test pit #02. It lies between the 8th century A.D. and the 10th century A.D. (Figure 6-31). These data are not compatible with either three Early Brahmi inscriptional data of the monastery, which lies 2nd century B.C. – 1st century A.D., the Early Historic Period I (EHPI) and with the later Brahmi inscription of the monastery which lies around 3rd-4th centuries A.D., between Early Historic Period II (EHPII) and Early Historic Period III (EHPIII) or two radiocarbon dates yielded at the monastery around 1st century B.C. to 2nd century A.D. (Figure 6-23).

The chronology that are given by the *attaini* pillar inscription is the only compatible data with the radiocarbon date obtained from the sample # SIT-07/04-06 (Beta-201946) at SIT 7. As mentioned earlier, the *attani* pillar is located at SIT 12, the immediate environs of SIT 7. As both sites shared much similar material evidence, it can be concluded both sites were active as one settlement during the early historic period. If so, we can confirm that one of the occupations of the site was around 8^{th}-10^{th} century A.D. However, the absence of datable specimen (through radiocarbon analyses) prevents to trace the early occupation of the site.

In addition, both SIT 6 and SIT 7 pottery types are shared almost similar distribution pattern of pottery. Both sites are provided BRW that has appeared from the early Iron Age (at Iron Age cemeteries from 6-7 century B.C. to early historic period; until 4^{th} century A.D.). It can be argued both sites were occupied as early as 1^{st} century B.C./A.D. and had their habitation continuation up to 10^{th} century A.D.

Vavala Vava: an Ancient Reservoir

The very important high technological construction of the Early Historic period is the major hydraulic work around the Sigiriya-Dambulla region mainly based on Elahera, Minneriya, Giritale and Vahalkada and Kalavava that were carried out in the reign of King Vasabha (65-109 A.D.), King Mahasen (276-303 A.D.) and King Dhatusena (459-477 A.D.). Sigiriya, the center point of the region, becomes the political capital of Sri Lanka after the reign of King Dhatusena and during King Kasyapa (477-495 A.D.) for a short period of about 18 years, marked with the great construction period of royal and urban complexes in the history.

One of the clear indicators to trace the settlement locations in the Dry Zone of Sri Lanka is a network of village irrigation reservoirs (Bandaranayake 1988). As we can clearly identify during the SIT field survey that have been conducted along both basins of the Kiri Oya, the ancient settlement formation of the KOB also indicates the concept of “*gami-pansalai, vavai-*

dagobai” and their inter-relationship with each other. Developments of irrigation systems provide the economic power of leaders through its connected resource management directly or indirectly. As mentioned by inscriptions, labor, cultivation, and resources from reservoirs; fish, taxes are the major facts that were activated by the irrigation network management of the region.

Although, the historical sources and epigraphical materials, the main sources that we use to identify physical location of ancient Sri Lankan hydraulic network, Vavala Vava has not been identified in any sources as any inscription in the KOB does not given exact name and location of reservoirs (except Minneriya Vava that has been built by King Mahasen. *Mv. 37:47*). But according to the most of village lore of the region, all major and minor irrigation systems in the KOB are connected with King Mahasen. Some argue, *Suratissavapi* (*Duratissavapi*) that was one of the earliest reservoirs built by King Saddhatissa (137-119 B.C.) (*Mv. 33:9*) that have been renovated by King Parakrama Bahu I (1164-1197 A.D.) would be Kandalama Vava or another in the vicinity that would have been located in or around the Kiri Oya (Nicholas 1960:45; 1963:182). Although well-developed irrigation network of the KOB mainly connected with the main stream of the Kiri Oya or rain fed storage system (*kulu vava*), we cannot get exact names and locations of reservoirs that have been mentioned in the Vavala donatory inscriptions at the monastery or ancient chronicles in Sri Lanka.

Although Inscription #03 at Vavala Monastery was carved in August during the 10th year of King Kithsirimevan (son of King of Mahasen), and mentions benefits from taxes from reservoirs as the donation for the maintenance of the monk’s residence, there were no any name are provided. Considering location of the inscription and the location of Vavala Vava, it can be suggested that Vavala Vava as one of the reservoirs that is mentioned in the inscription. Manatunga also suggested, Vavala Vava as the reservoir that is mentioned in the inscription

(Manatunga 1990). But the inscription has provided four private owned reservoirs by names of owners.

According to Nicholas (1963) the area was first mentioned during the Polonnaruwa Period with King Vijayabahu I (1055-1110 A.D.) who was the first Sinhala King at Polonnaruwa and the donation of Merukandara Rata (*Cv. 59*) that he granted to his son-in-law King Veravamma. Nicholas also suggested that the place mentioned as Vapivataka in Merukandara Rata, could be taken as modern Vavala (Nicolas 1959 in Manatunga 1990). If this argument is correct, this was the only trace we could find Vavala in the ancient text.

Besides that the valuable information given by Nicholas (1963: 109-110) is the identification of Inamaluwa Vava as the Endaragalu Vava that is located 11km southwest to Sigiriya (Figure 3-1) and was built by King Aggaboghi II (604-614 A.D.). Ancient literary sources (*Cv. 60: 49-52*) said that King Aggabobodhi renovated abandoned several reservoirs including Inamaluwa Vava and Talautu Oya, the major stream for feeding Minneriya Vava (*Cv. 60: 48-54*). This is one of the major facts to understand the authority of centralized power over the study region.

Site Environment

Vavala Vava is one of the ancient reservoirs in the KOB and presently using largest reservoir in the KOB. It is located 9.6km southeast of Sigiriya and at the foot of Konduruvava mountain range at east and Nuwaragala kanda from southeast. According to data provided by the irrigation department, today the reservoir spreads over 96 acres (38.85 ha) at FSL (full supply level) and irrigates an area of 240 acres (97.13 ha) paddy fields while its catchment area is spread over 3 square miles. Earthen bund of the vava that is approximately 1.36 km long and the width at the top measures around 4m. The southern reservoir bund lays over the south Kosgaha-ala stream and northern (northeastern) part over the Kiri Oya (Figure 6-33). The Kiri Oya runs from the reservoir towards north today known as Vavala Oya among villagers. The contour plan of the reservoir that is provided here (Figure 6-33) is made based on the survey map that has been drawn by the irrigation department of Matale sub division while they were conducting renovation work and documentation in 1967.

The iron-smelting site that was selected to excavate under SIT field season is located around 70 m east of its southeastern part of the bund and north to its *vana* that is located highest place of the south western edge of reservoir that starts South Kosgaha-ala. Although the site is located inside the vava, it seems that except east-western monsoonal season, the area not covered by water (Figure 6-35D) as it appears on a natural mound (Figure/s 6-35A; 6-35B).

The site lies at latitude N 7° 52’34” and longitude E 80° 46’59”, approximately 772 feet/ 235 m above mean sea level. According to the Irrigation Department’s survey plan, BM on the headwall of sluice lies at 102.22 m and at the excavated site 118 m. Avoiding the discrepancy between GPS reading and the readings of the contour plan, the TBM for the excavation is marked as 200m on a small flat rock that is located at the southeast to the test trench excavation.

Looking at the flood level of the reservoir, there is high probability to suggest that the iron smelting activities took place seasonally on the top of the mound. Lots of potsherds, blocks of slags, and furnace walls are scattered on the mound that measured 15 meters in length (north-south) and 10 meters in width (east-west). According to the shape of the mound, it can be assumed that the furnaces built at the eastern sector of the mound faced to the West.

Main Objectives and Location Selection

Using the already drawn site map and detailed survey conducted in 2004, I decided to conduct trench test excavation across the mound (slag mound?). The middle of the mound that has provided smelting remains along with potsherds and comparatively having slight slope to

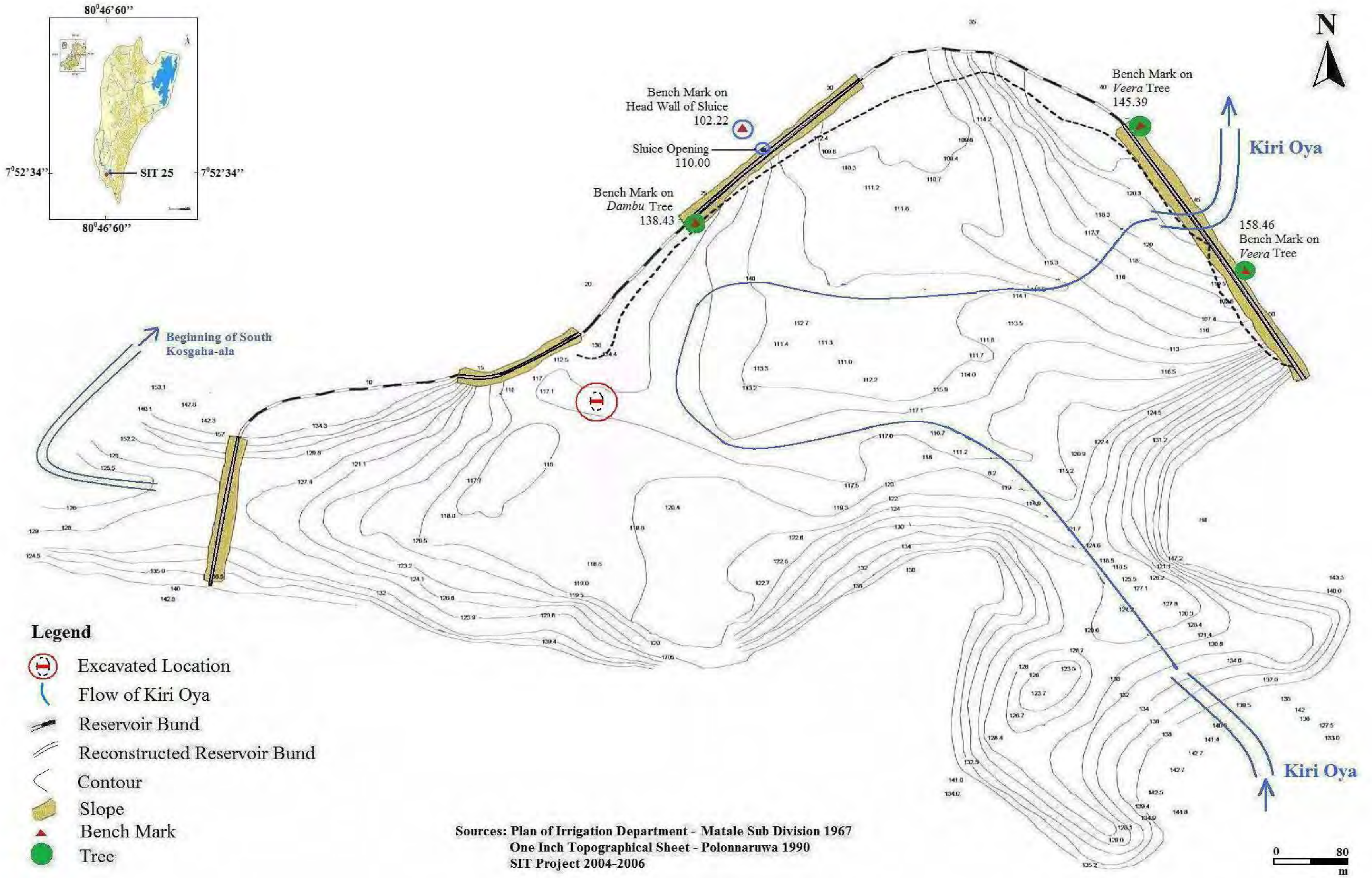


Figure 6-33. Contour plan of the Vavala Vava (SIT 25). Excavated location is highlighted with a red circle.

the West than eastwards, was selected as the prioritized location for excavation (Figure 6-34). As shown in Figure 6-34, the eastern part of the mound gradually slopes towards the waterbed of the reservoir. As at SIT 22, one-meter contour survey was carried out at the mound to understand the height and the spreading pattern of the mound (Figure 6-34).

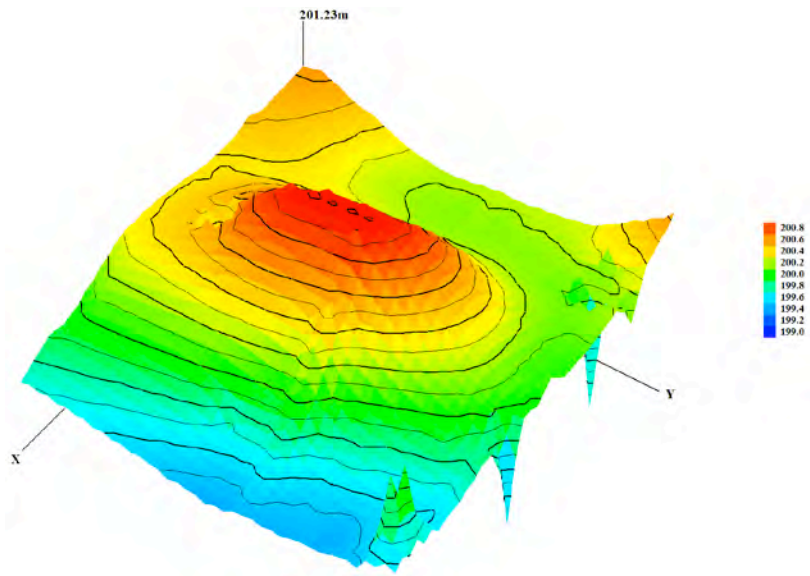


Figure 6-34. Contour map of slag mound at SIT 25. While the Reddish Orange area represents the highest area of the mound, the lowest level that represents by the Blue area is oriented towards the middle of the reservoir. The highest level of the map (201.23m) represents one of the highest points that is located West to the site and in between mound and the reservoir bund.

The excavation of the site was conducted in five stages as extending trenches towards eastwards and westwards (Figure 6-35C), and as joining at the top of the mound (Figure 6-36) focused on following main objectives:

- To date and understand the smelting activities
- To determine if smelting activities were conducted in seasonal basis
- To date the reservoir bed and its connection with smelting activities
- To compare the chronology of the reservoir and smelting activities with the inscriptional data at the monastery

Figure 6-35. Important views from the Vavala Vava iron smelting site. A) Smelting site/mound seen at the middle. Vavala vava and Konduruvava mountain range are at background. B) Grid being prepared for the excavation. C) Test excavation at the mound as seen from east. D) At the beginning of monsoonal rain, the reservoir has started to fill with water. During rainy season, the mound was started to cover with water. Photographs by R. Solangaarachchi.

The test trench excavation was placed at the marked grid plan (Figure 6-36) as an open excavation until the deepest level could be reached without damaging and mixing up material with the ground water level of the reservoir. My main target was to reveal data on smelting activities and collecting samples for dating purposes before the next monsoon rain arrived in the area. We managed to reach the bedrock only at eastern part of the Trench #01 (Figure 6-37). We decided to discontinue excavation on the western part of the mound, as there were no cultural layers beyond that point; rising ground water level from the reservoir started to enter towards the test excavation; the expected material evidence including the "furnace" superstructure had been destroyed by the heavy water flow during the monsoonal rains.

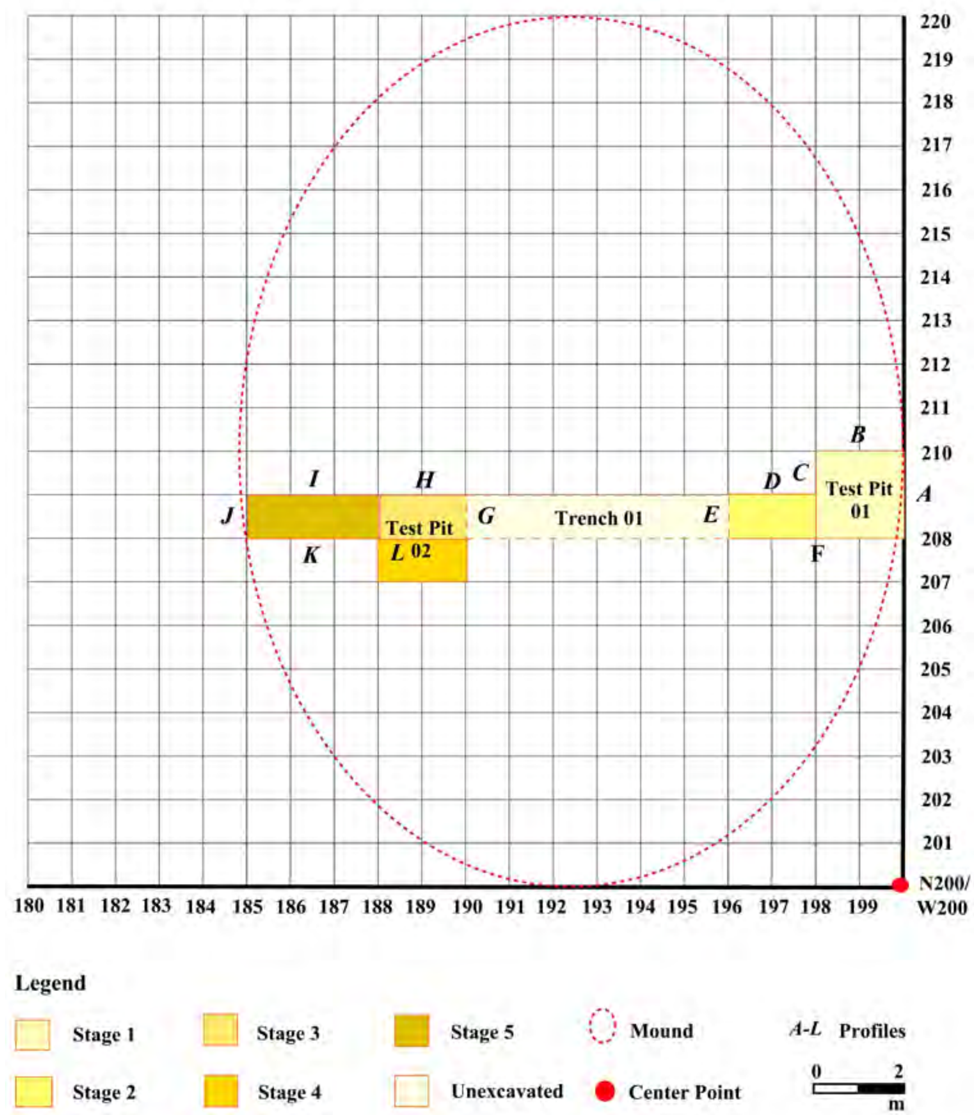


Figure 6-36. Grid plan of the excavated location at SIT 25.

Stratigraphy

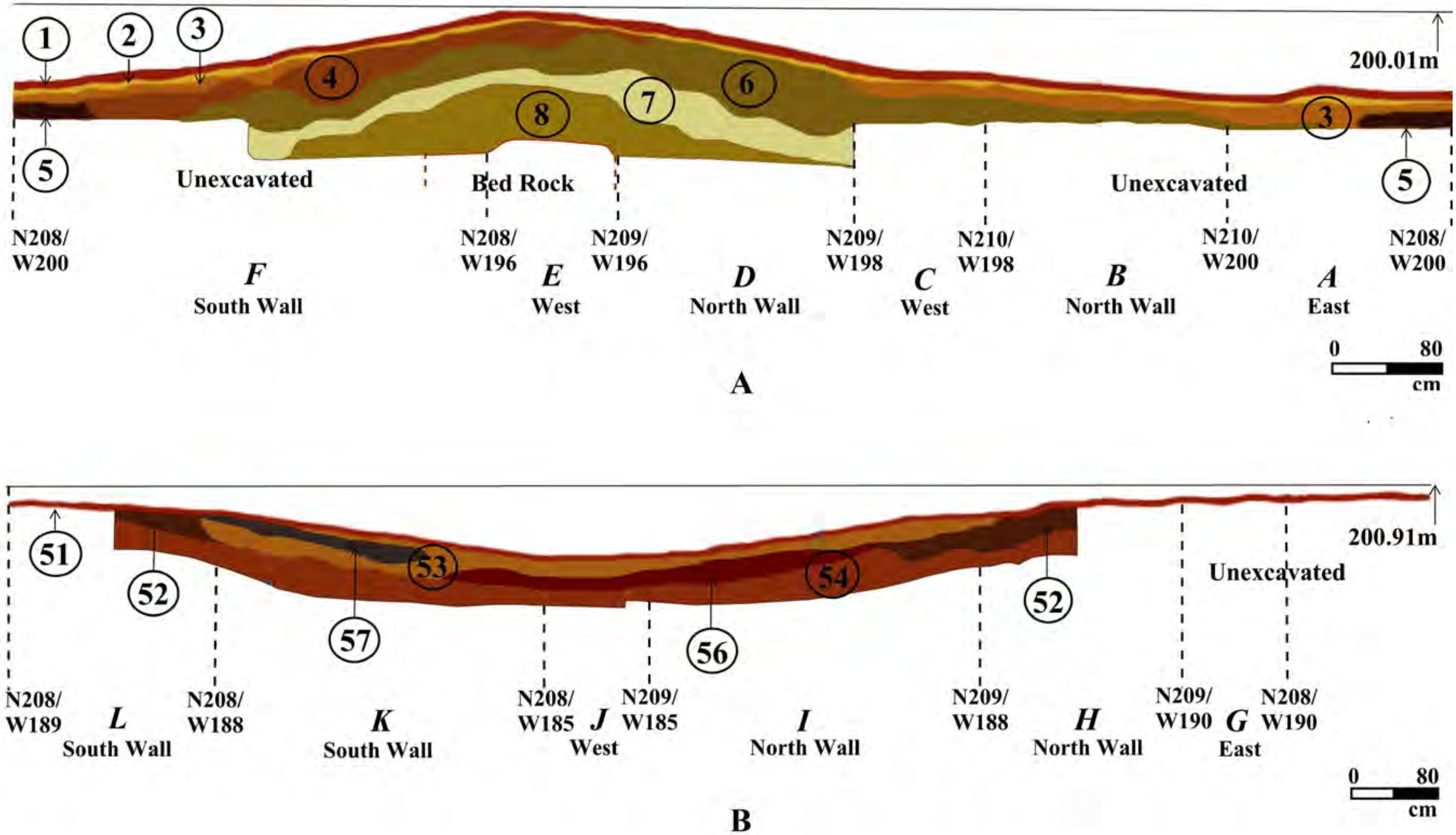
Excavated test units have provided sequential order for six phases: Phase I- Non Cultural Sand Layer; Phase II- Smelting Activities Period 1; Phase III- Clay Layer (vav matta); Phase IV- Smelting Activities Period 2, Phase V- Non Cultural Sand Layer, Phase VI- Smelting Activities Period 3 (disturbed by modern activities) (Figure/s 6-37; 5-38). Both Phases IV and Phase VI, two phases that were associated with iron smelting activities shared similar stratigraphy in the excavated trench and the test pits (Figure 6-38). The first period of smelting activities that have shown at Trench 01 (east) was not appeared at Trench 02 (west), as the excavation was discontinued due to reasons given above (Figure 6-38).

Phase I of the site is represented by natural deposits of non-cultural phase 1 (Context 08) at Trench 01 (east) and Test Pit 01. Phase 1 spreads 60-100 cm below the surface and lay over the bedrock (Context 9) that slopes from west to east, towards the waterbed of the reservoir.

Phase II of the excavated unit is represented by a soil layer (Context 7) that has spreads 40-120 cm below the surface and yielded few evidence (1 slag piece, burnt clay, and fragments of a furnace wall) for the smelting activities (Table F-4). But it did not provide any potsherds. This Phase was only seen at Trench 01 (east) and Test Pit 01.

Phase III is characterized by the abandoned period of the smelting activities or any other cultural deposits (Context/s 6, 54). While Context 06 at Trench 01 (east) is consisted with clay layer that usually very common in every reservoir bed (commonly known as *vav matta*), Context 54, the soil layer at Trench 01 (west)/Test Pit 02 was associated with gravel and quartz (Table F-4). Context 6 was very similar to the Context 54 at SIT 22, Dikyaya iron smelting site. It seems that this Context 54 was not deeply covered by the water level of the reservoir. This Phase spreads 20-80 cm below the surface (Table F-4).

Phase IV, the second period that have given evidence for smelting activities represents by Context/s 4, 5, 3 at Trench 01 and Context/s 55, 56, 52, 57, 53. This phase at Trench 01 (East) has yielded fragments of furnace walls, iron slags, and 3 brittle potsherds. Blocks of fussed iron slags, 30 individual iron slag pieces, and blocks of burnt clay has provided at Trench 02 (West) (Table F-4).



Legend

1-8 & 51-57 Context Numbers **200.01m & 200.91m** Level Lines ***A-F*** & ***G-L*** Profile Labels

Figure 6-37. Test Units Profiles at SIT 25. A) Test Pit 01 and Eastern Part of Trench 01. B) Test Pit 02 and Western Part of Trench 01.

Context 55 that was consisted with gathered stone structure/paving? and blocks of fussed slag was the noticeable feature found at this phase. This Phase spreads 8-80 cm below the surface.

Phase V, the abandoned period that was marked by cultural deposit absent sand layer (Context 2) and was spread 4-12 cm deep from the surface level ground could be seen all over the Trench 01 (east) (Figure 6-37).

The topsoil layers at Trench 01 (Context 1) and Trench 02 (Context 51) are identified as Phase IV and the third period of smelting activities of the site. This context has yielded fragment of furnace walls, iron slags, 9 potsherds and a fragment of a crucible. It gradually slopes east towards the waterbed of the reservoir. Maximum thickness of this layer is 10cm (Table F-4).

Summarizing the Material Evidence

Trench excavation of the site only yielded relatively less material evidence comparing with other three excavated sites during the SIT field seasons. Among unearthed artifacts, higher percentage was related to the iron smelting process or furnace architecture (fragments of furnace walls and iron slags). In addition, a yield of 23 potsherds along with one fragment of a crucible was unearthed (Table F-4).

Ceramics at the Site

As shown in Figure 6-39, 47.83% of potsherds were identified as non-decorated bodysherds (NDB), 30.43% as decorated bodysherds (DB) and 17.39% as non-diagnostic rimsherds (NDR). Excavated test units only yielded one diagnostic rimsherds (DR). It is only 4.35% of the total potsherds recovered at the test excavation (Figure 6-39; Table J-4c).

Total of 23 potsherds were unearthed from Context 1/51 in Phase VI (20 potsherds) and Context 03 in Phase IV (3 potsherds) that are two major phases have been identified as two periods of smelting activities conducted (Figure 6-40). Both two phases were laid over two abandoned phases of the site (Figure 6-38; Table J-4a). The first smelting activity period (Context 7 in Phase II) did not provide any potsherds, smelting remains instead.

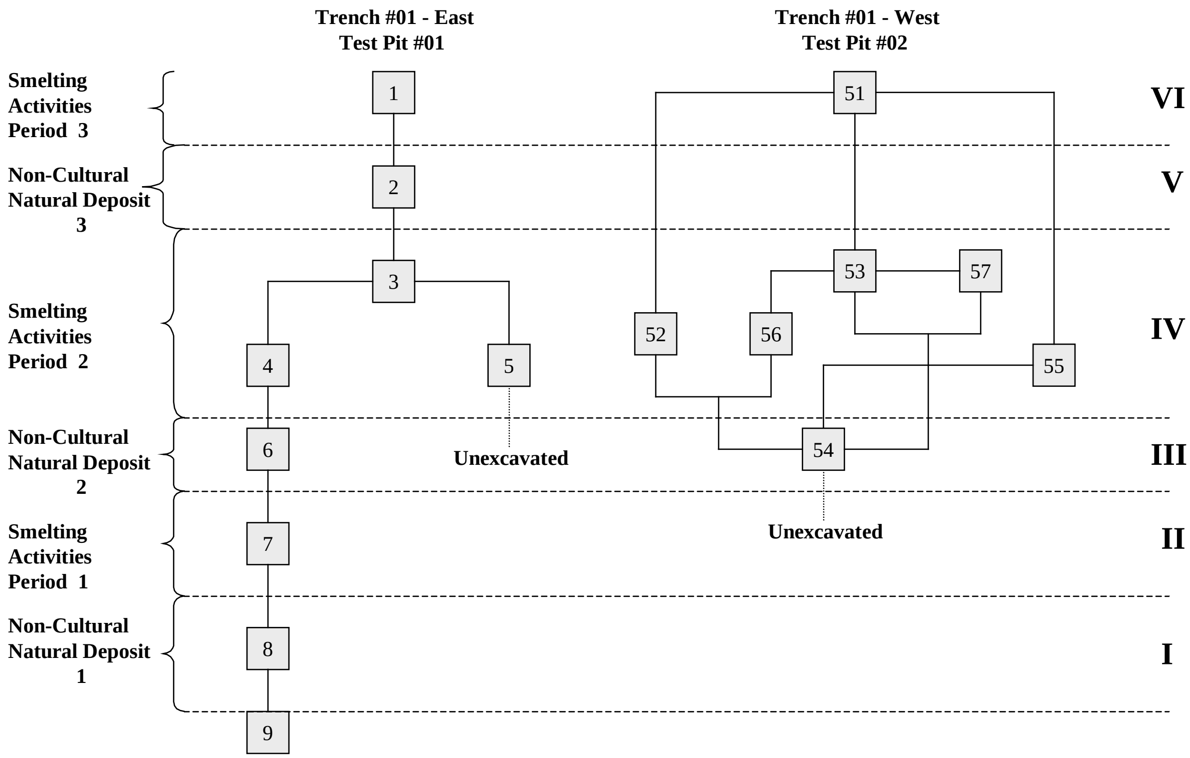


Figure 6-38. Matrix account at SIT 25.

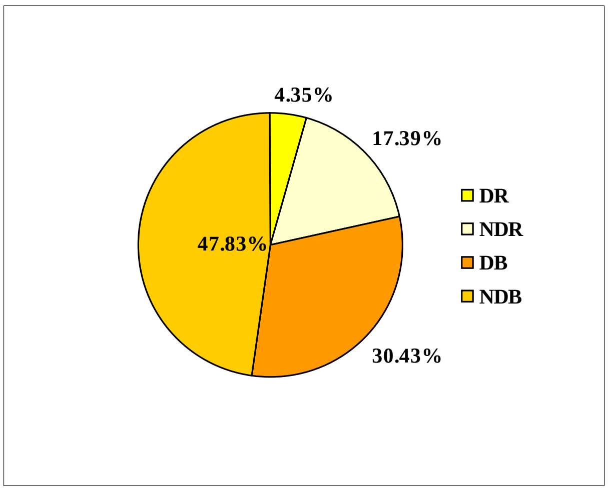


Figure 6-39. Percentage of four major categories of ceramic sherds unearthed at SIT 25.

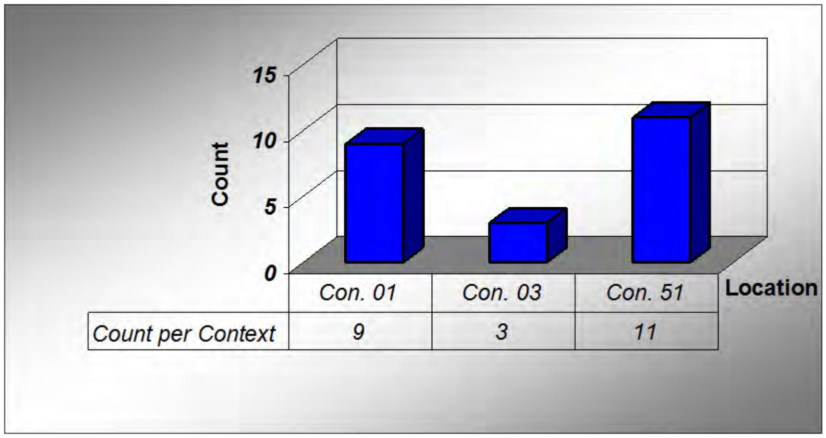


Figure 6-40. Total number of sherds per context at SIT 25 (Potsherds yielded contexts are only shown here).

All potsherds at the site are RW- Red Ware that is the best known category of ancient ceramics in the region.

Problems and Concerns

The major concerns that I experienced at SIT 25 were inability to collect datable materials for radiocarbon dating or potsherds that represents the pottery typology in the region. Well-developed ancient pottery typology of the region one of the best known relative dating method that we use dating the subsequent settlement and material evidence in stratigraphic order at any given archaeological site. On the other hand, the unearthed potsherds are not secured samples for getting chronology of the site through absolute dating method like Thermo luminescence.

Pollen analysis is the other option that I wanted to use for getting at the chronology of the site. As the site is located inside the reservoir, it would be the best solution to date pollens at excavated soil layers that are interwoven with reservoir sediments. But I could not get assistance for this analytical method.

Site Chronology

Although the excavation at the site has stratigraphically showed three major cultural phases that are connected with iron smelting activities (Figure 6-38), none of them have provided any datable specimen. Myrdal-Runebjer's recent study on "Transbasin Irrigation System" in the region is the only dated startigraphical sequence we currently have in the Vavala Vava vicinity (Myrdal-Runebjer 1996). Calibrated dating (Ua 3185) that she received for sediment layers at abandoned Vavala vava canal ranges between 398-628 A.D. (Myrdal-Runebjer 1996:129). According to village lore, the construction of Vavala vava canal (*Kapapu-ala*) is connected with King Mahasen (269-296 A.D.). Sigiri Mahavava that is located northwest of Vavala vava was supplied water from Vavala vava by Vavala vava canal (Bell, Fernando and Moysey 1914; 1990:253).

Concluding Remarks

This chapter mainly focused on RQ 1 (what are the major characteristics of iron smelting technology in the KOB?) and RQ 2 (what is the relationship of Buddhist monastery and the KOB settlement have showed over time?). Although each excavation was designed for getting answers for different objectives, the overall attempt was to date each site and to check its place in chronological order to establish their relationship with each other in the total settlement pattern that is based on the irrigated agro-economy. Data revealed from excavations have provided concrete evidence for the settlement expansion in the KOB ranges in between 2nd century B.C. and 10th century A.D. with three identical occupation phases: 2nd century B.C.- 1st century A.D.; 2nd century A.D.- 5th Century A.D.; 7th century A.D.- 10 century A.D. (Figure 6-41).

Among four excavation sites, the earliest radiocarbon dates are obtained from two charcoal samples that are collected from Phase I at Vavala monastery. Both data are also compatible with three Early Brahmi inscriptional data of the monastery, which lies 2nd century B.C. – 1st century A.D., the Early Historic Period I (EHPI). As mentioned in site chronology at SIT 22 excavation, both iron-smelting sites in the KOB have yielded a habitation layer just before the main smelting activities have conducted. Through pottery typology, it can be assumed that the habitation layers of both sites are laid in somewhere before or around 1st century B.C. Radiocarbon date at SIT 1/KO14 has also confirmed this chronology (Forenius and Solangaarachchi 1994; Mogren 1994a).

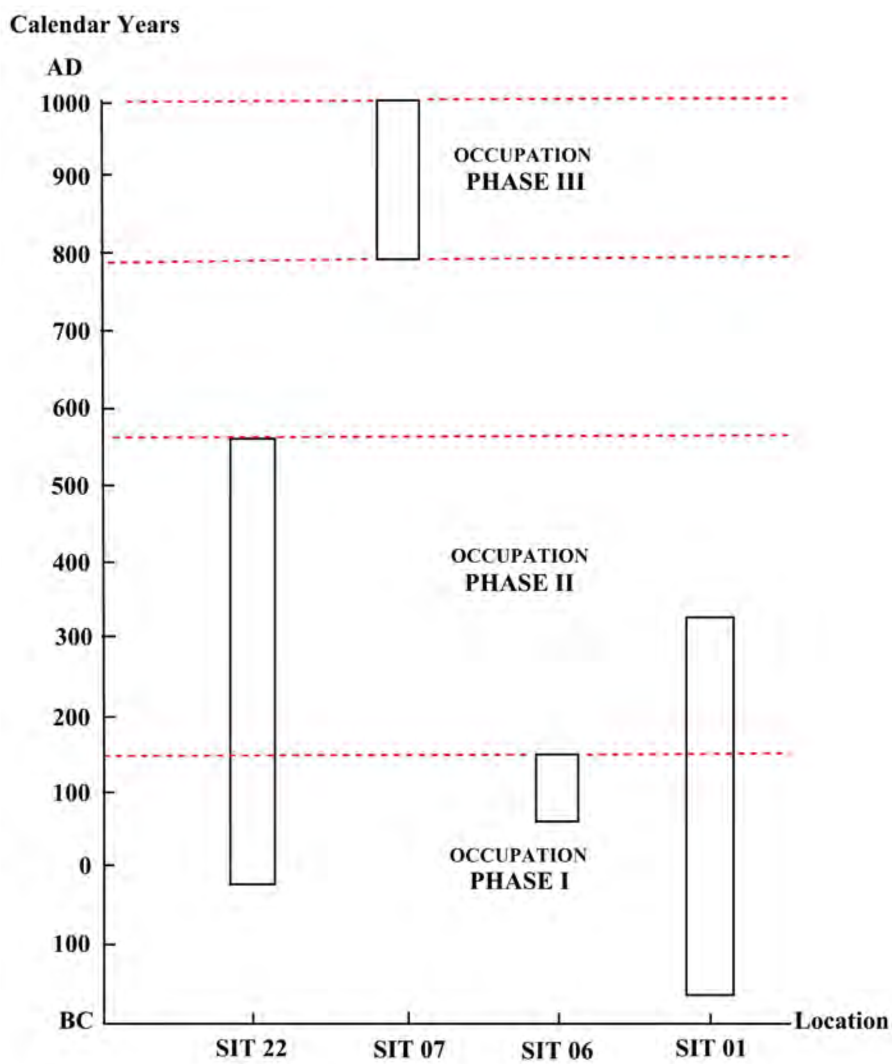


Figure 6-41. Main phases of occupation in the KOB that are provided by Radiocarbon dating (SIT 22-4 samples; SIT 7-1 sample; SIT 6-2 samples; SIT 1-7 samples). The original report made by the Beta Analytic Inc in Appendix I is used for making graphs for SIT 22, SIT 7 and SIT 6. Data for SIT 1/KO14 obtained from the SARCP project (Forenius and Solangaarachchi 1994; Mogren 1994b).

This evidence suggested that the area was continuously occupied from (at least) 1st century B.C. We do not have any radiocarbon data for secure cave excavation in the KOB so far to push back this chronology. But we already know, Sigiriya-Dambulla region already provided ample evidence for Mesolithic habitation (Karunarathna and Adikari 1994; Bandaranayake 1994). All excavated sites that I selected for the SIT project are connected one way another with iron smelting activities. Although SIT 6 consists with cave deposits that would have provided evidence for a prehistoric habitation, the selected location for excavation was mainly focused on different aspects. This site selection procedure was the probable season for the absence of artifacts in prehistoric occupation levels.

Two iron smelting sites excavated in the KOB: SIT 22 under this research in 2004 and SIT 1/KO14 under SARCP in 1990-1991 (Svedberg Laboratory, at Uppsala University Lab #s Ua-5215, Ua-5216, Ua-5217, Ua-5218, Ua-5509, Ua-5510, Ua-5511 in Forenius and Solangaarachchi 1994; Mogren 1994b) have provided almost parallel data. According to data, it seems that the main activities of iron smelting was conducted during Reigns of King Mahasen (269-296 A.D.) and his son King Kithsirimevan (269-324 A.D.), who ruled the area before King Kasyapa, the founder of the main construction period of Sigiriya Royal City of 5th century A.D. (477-495 A.D.). Comparative study of furnaces unearthed at two sites (Dehigaha-ala-kanda at Alakolavava and Dikyaya-kanda at Vavala vava) is provided in Chapter 6. The second occupied period at Vavala monastery (Phase III) is also lied in between 3-4th century A.D. (296-324 A.D.), the period somewhere around 10th regnal year of King Kithsirimevan (396 A.D.) that represents by the Inscription #03 also compatible with radiocarbon dates with main activity periods of both iron smelting sites. Usually the ruling year of the king was used as the dating method for the inscription.

Radiocarbon data for one of the habitation layers at Test pit #02 at SIT 7 settlement site lies between the 8th century A.D. and the 10th century A.D. (Figure 6-31). These data are no compatible with either three Early Brahmi inscriptional data of the monastery: which lies 2nd century B.C. – 1st century A.D., the Early Historic Period I (EHPI); or with the later Brahmi inscription of the monastery which lies around 3rd-4th centuries A.D., between Early Historic Period II (EHPII) and Early Historic Period III (EHPIII); or with two radiocarbon dates yielded at the monastery around 1st century B.C. to 2nd century A.D. (Figure 6-23); or with the main activity period of iron smelting have been conducted at SIT22 and SIT 1/KO14 that ranges from Cal A.D. 260-Cal A.D. 320 (Figure 6-12).

But it is compatible with the chronology that is given by the attaini pillar inscription that is located at SIT 12, the immediate environs of SIT 7. As both sites are shared much similar material evidence, it can be concluded both sites were active as one settlement during the early historic period. If so, we can confirm that one of the occupations of the site was around 8th-10th century A.D. However, the absence of datable specimen (through radiocarbon analyses) prevents to trace the early occupation of the site.

Absence of datable samples and enough material evidence at Vavala vava the main reservoir of the selected grid, we missed the opportunity for dating the smelting activities at SIT 25 and the reservoir bed. Only compatible dating for the vicinity has yielded for sediment layer at abandoned Vavala vava canal ranges between 398-628 A.D. (Myrdal-Runebjer 1996:129). Village lore also connected the construction of the Vavala Vava canal (Kapapu-ala) with King Mahasen (269-296 A.D.).

Although we couldn’t get datable materials that are belonging to this chronological pattern at SIT 7, the settlement site, material evidence recorded at the monastery and settlement are shared similar pottery distribution pattern. Comparing with ceramics at SIT 22 with SIT 6, it can be noticeable that the percentage of decorated bodysherds is higher at SIT 6. Both SIT 6 and SIT 7 pottery types are shared almost similar distribution pattern of pottery. Both sites are provided BRW that has appeared from the early Iron Age (at Iron Age cemeteries from 6-7 century B.C. to early historic period; until 4th century A.D.). It can be argued both sites were occupied as early as 1st century B.C./A.D. and had their habitation continuation up to 10th century A.D.

Crucible samples that are yielded from both SIT 7 and SIT 25 provide areas contribution for steel production along with iron smelting activities. Every excavated site has provided iron slags at least from one habitation layer. Three layers with smelting remains that are followed by abandoned periods at Vavala Vava excavation have provided probable evidence for its seasonal usage for iron smelting activities. It can be assumed that the smelting site at Vavala Vava was took place somewhere after the major construction phase of the reservoir and smelting activities was conducted seasonally, when water level was decreased during dry seasons. Samanalavava smelting furnaces also recorded seasonal activation of the smelting process, when the wind velocity was lashed in high volume in the area (Juleff 1998).

Considering above data, we can assumed that the main habitation layers in the KOB is lied in between 2nd century A.D. and 4th century A.D.: during the reigns of King Mahasen and King Kithsirimevan. As this chronology lied with the inscription #03 at the monastery, it can be assumed that the monasteries relationship with the settlement in the KOB.

CHAPTER 7
MATERIAL CULTURE AND IRON METALLURGY IN THE KOB

Overview

This chapter addresses the material culture of the KOB that represents socio-cultural activities in different periods of the KOB history. I gave my special attention to the furnace architecture and metallurgical evaluation for discussing the characteristics of iron smelting in the KOB. In addition, I present pottery typology in the KOB along with pottery typology in the Sigiriya-Dambulla Region (SDR) to identify the occupational phases and different social stratifications of the KOB. This material evidence provided here is mainly derived from two major sources: SIT field seasons that have been conducted from 2004-2006 and SARCP field seasons conducted from 1988-1992. I also present the main characteristics of terracotta figurines of Illukvava (SIT 68) that are well known as the Illukvava collection (Deraniyagala 1958:G 19) and presently are exhibited at the archaeological museum in Anuradhapura as terracotta is one of the stunning discoveries in most settlement sites in the KOB (Appendix D).

Most artifacts presented here are derived stratigraphically from excavations at iron smelting sites (SIT 22 and SIT 1/KO 14), the monastery (SIT 6), the settlement (SIT 7) and the reservoir (SIT 25). Other artifacts described here was collected unstratigraphically during field survey or from the museum collection. The major aim of studying material culture of the KOB is to get better understanding of the meaning and the function of artifacts and how these two objectives symbolize the ideology of the KOB settlers.

In the first part I present the furnace architecture and its major construction units. The second part provides the metallurgical aspects: raw materials, waste/by- products, steel and crucibles and their analysis. The third part discusses the material culture of artifacts that are not directly connected with the smelting process. Metal objects, stone, bone, bead, terracotta, ceramics, pottery typology are main themes and typologies I present here as major classifications. This chapter answers research questions that are related to iron smelting technology (RQ1) and environmental resources in the KOB (RQ 2) and try to understand distribution pattern of material culture throughout the KOB. In addition, I made an attempt to analyze social stratification through the material culture.

Furnaces in the KOB

Systematic excavations conducted at both iron smelting sites have led to the discovery of series of furnaces at SIT1/KO 14 (Forenius and Solangaarachchi1994) and one furnace along with probable evidence for another furnace at SIT 22 (Dikyaya-kanda). Furnaces at both sites are placed on the same north-south axis along with fragments of iron ore, iron slags, tuyeres, etc. used in the iron smelting process. Except for these major remains of the production process, a few metal and stone artifacts and a large amount of potsherds were also unearthed at both sites.

A B

Figure 7-1. The furnace unearthed at Dikyaya-kanda (SIT 22). A) Side elevation showing the construction of the furnace wall. Photograph by R. Solangaarachchi. B) Front view of the furnace. Second layer of tuyeres also can be seen *in situ* on the top of the front wall of the furnace. Photograph by a member of the excavation team.

Furnace superstructure at both smelting sites can be categorized into bloomery furnaces type (Figure 7-1; Figure 7-2). The series of furnaces at SIT 1 and SIT 22 were placed above and on the eastern side of the slag mound, which consists of the waste materials of the production process. Every excavated furnace was constructed along the north-south axis and the openings for the air supply system were oriented to the west. The very significant feature of the construction was that every furnace at SIT 1/KO 14 was built in a pit that has been carved in the bedrock (Figure 7-2A). The carved pits were oval in shape, the longer axis (east to west) being 1.5 m and the western half of the pit was carved out in such a way that it almost looked like two rounded steps (Figure 7-2A).

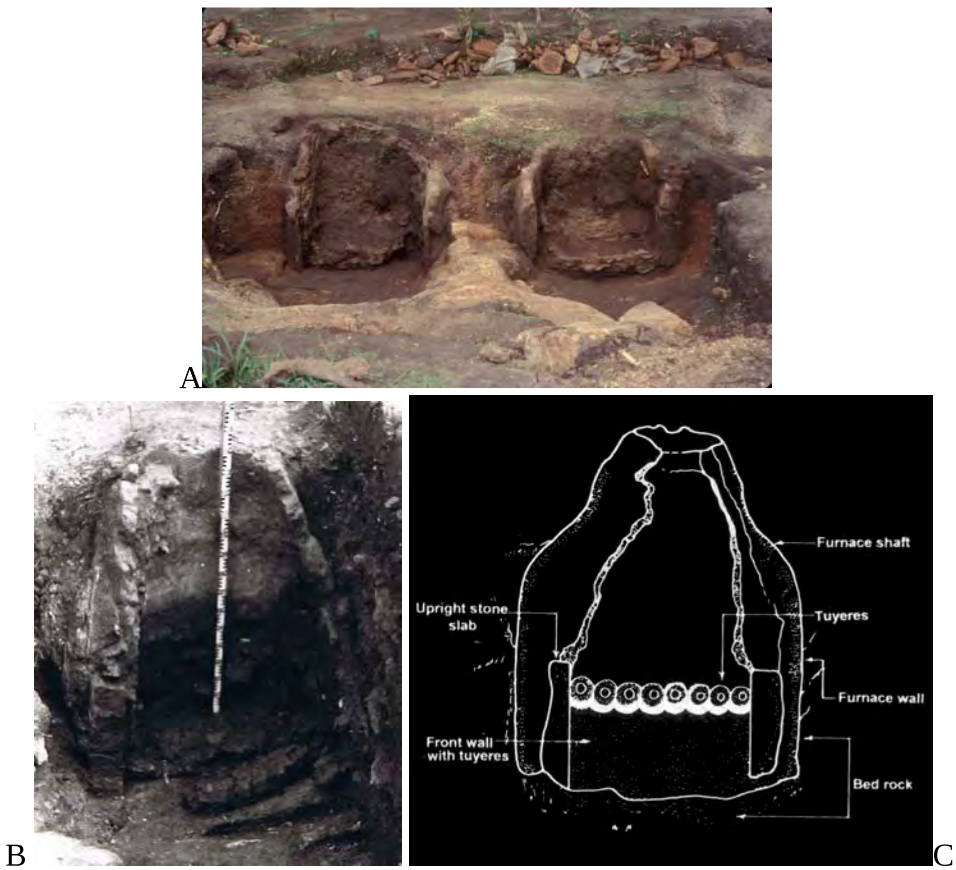


Figure.7-2. Furnaces at Dehigaha-ala-kanda (SIT 1). A) Unearthed two furnaces; No. 6A and No. 6B. B) Well-preserved furnace; No. 27. C) Reconstructed drawing of the furnace No. 27. Photographs 7-2A & 7-2B from the PGIAR's photo archive. Furnace no. 27, presently exhibits at the Sigiriya archaeology museum (Solangaarachchi 1999).

The reason for the construction of the two rounded steps might have been to facilitate the removal of iron bloom and waste material from the pit during the smelting process. There is a relatively flat space of about one square meter in front of every furnace at SIT 1. The very bottom end of the furnace lay about one meter below the top of the bedrock (Forenius and Solangaarachchi 1994). In contrast, the furnace unearthed at SIT 22 was built on a carved pit on the natural soil layer that lay just over the bedrock (Figure 7-3). But the semi-circular black soil patch could be seen in front of the excavated furnace at SIT 22 indicating that there was a similar construction to facilitate the production process or some activity was conducted during the process.

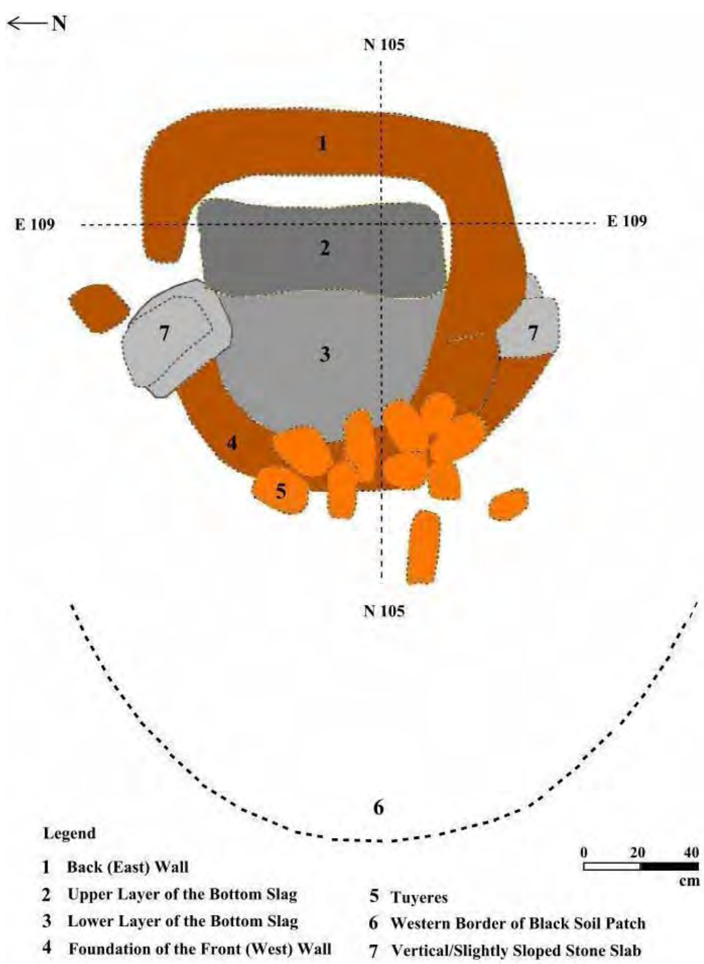


Figure 7-3. Ground plan of the furnace at SIT 22.

Furnace Construction

The most valuable part of studying the excavation of the iron smelting site is to understand the structure of the furnace. The technological efficiency of the production process is mainly depended on the furnace construction. Three factors are the basic requirements of the smelting process: the speed of increasing the temperature; attaining the temperature; the oxidation and reduction conditions inside the furnace depend on the furnace construction. I discuss here the furnace construction of SIT 1 and SIT 22 and their main characteristics.

The major raw materials used for the furnace construction of both sites are clay and stone slabs. The back walls (eastern wall) of the furnaces at SIT 1 and SIT 22 are vertical and are embedded in the bedrock or natural soil layer and lined with clay. The sidewalls of furnaces at SIT 1 are also directly connected with the carved-out rock and also are vertical up to the level of the stone slabs, which were used for building the furnace (Figure 7-2C). Smelters at SIT 22 inserted several stone slabs horizontally to build sidewalls and to facilitate the arch of the furnace chimney (Figure 7-1A).

The height of the furnace shaft above the upright stone slabs was about 80 cm and about 15 cm in thickness at SIT 1. The stone slabs were placed on the left and right sides of the front wall (missing) of a furnace. They were and placed directly on the bedrock at the bottom of the pit (Figure 7-2). The slabs on the sides that were facing the furnace shafts were covered with clay lining. Starting from the top of the stone slabs, the furnace shafts grew narrower as they increased in height. The height and shape of the shaft had the capability of controlling the temperature and ensure the strength of the furnace construction. The height of a furnace when reconstructed with the remaining fragments seems to be about 2 m while the thickness of the side wall was about 20-40 cm. The thickness included the stone slabs at the lower half and grew thinner upwards to about 3-4 cm at the top (Figure 7-2). The stone slabs also ensured the strength of the furnace by carrying the weight of the superstructure that was made of clay. The other probable reason is to determine the breaking margin of the front wall without harming the rest of the furnace construction when removing the iron bloom out after the production process is completed.

Furnace walls at both sites were built with clay and quartz grains. The outermost layer was built with bigger grains than the inner. The inside of the furnace walls were made with a smooth clay lining that was a few millimeters thick. The back walls had a slightly curved shape at the top. In every excavated furnace at both sites, the front wall (western wall) was not found *in situ*. The reason for this may be that the wall had to be broken in order to take out the spongy iron bloom which was the final product of furnaces of this type.

However, the shape of slag remaining at the bottom of the furnace at SIT 1 and the construction of the lower part of the front wall, which was made with semi circular imprints for carrying the tuyeres (Figure 7-2C), indicate that the front wall may have been vertical at least up to the height of the stone slabs. The front of the furnace shaft at SIT 1 probably began from the top of the stone slabs curving inwards and the top obviously must have had almost parallel walls indicating a short chimney of a hearth. But the front wall of the furnace at SIT 22 is circular shaped (Figure 7-3; 7-4). The shape of the bottom slag layer also confirms its semi-circular shape. Considering the evidence, the furnace superstructure at SIT 22 can be put into the domed category in Martens classification (1978) (Chapter 2).

Imprints of the lower part of a bottom slag which belonged to the furnace (6A) excavated in 1990 at SIT 1, indicated that the lower part of the front wall of the furnace probably had been built with wooden bars placed horizontally. But no evidence was found for the whole furnace being made with the use of a wooden frame or wooden bars.

Figure 7-4. The furnace at SIT 22 showing the circular shaped front wall. The photograph was taken from the top and behind the furnace. The arrow points the front wall. Photograph by R. Solangaarachchi.

Table 7-1. Approximate measurements of the furnaces in the KOB

Provenance	Furnace #	Location	Breadth at the bottom/m N-S	Depth at the bottom/m E-W	Preserved height/m
Dikyaya-kanda*/ SIT 22	57	N104/E108 N104/E109 N105/E108 N105/E109	0.80	0.60	1.55
Dehigaha-ala-Kanda SIT 01	6A	507.3-508.7/ 117.6-118.3	0.95	0.50	1.18
Dehigaha-ala-Kanda SIT 01	6B	509.2-510.6/ 117.4-118.4	0.97	0.40	1.47
Dehigaha-ala-Kanda SIT 01	25**	505.0-506.0/ 118.0-118.5	N/A	N/A	N/A
Dehigaha-ala-Kanda SIT 01	26	503.3-504.3/ 118.1-118.7	0.96	0.40	0.9
Dehigaha-ala-Kanda SIT 01	27	500.0-501.4/ 118.2-118.9	1.05	0.45	1.65

*Diagram is provided as Figure 7-5. **This furnace is not excavated.

Every excavated furnaces at the KOB often had to be repaired before a new production cycle could begin. In the furnaces at SIT 1 and SIT 22, there is evidence to suggest that these furnaces were repaired on several occasions. The width at the bottom of a furnace SIT 1 was 95-105cm and the depth was (east to west) 40-50cm (Table 7-1). Taking the above as well as the height of the furnace into consideration, the furnaces were relatively broad and had the shape of a rectangular bottle.

The width at the bottom of the furnace at SIT 22 was 0.80 cm and the depth (east to west) was 60 cm (Table 7-1). Furnaces at both sites share almost similar measurements in height and in width. Although furnaces at SIT 1 were relatively broad and had the shape of a rectangular bottle level with the chimney superstructure (Figure 7-4), the furnace at SIT 22 seems to had a fairly rounded bottom and it was more likely that it carried the rounded shape at least at the bottom level (Table 7-1).

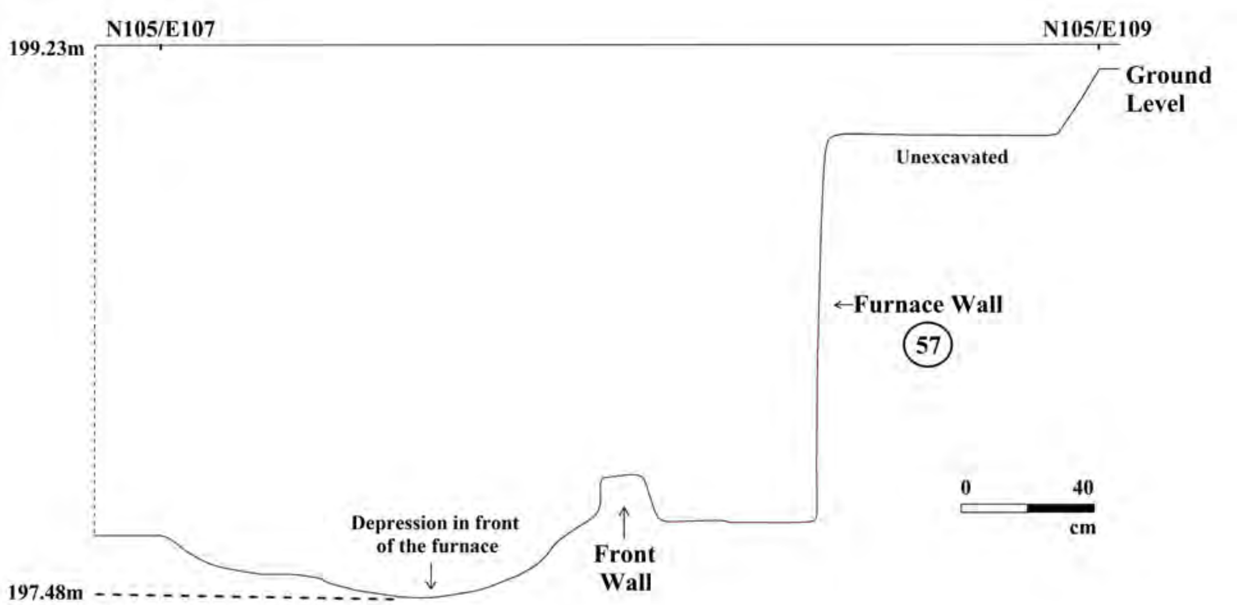


Figure 7-5. Cross section of the furnace at SIT 22 as seen from the south.

Tuyeres

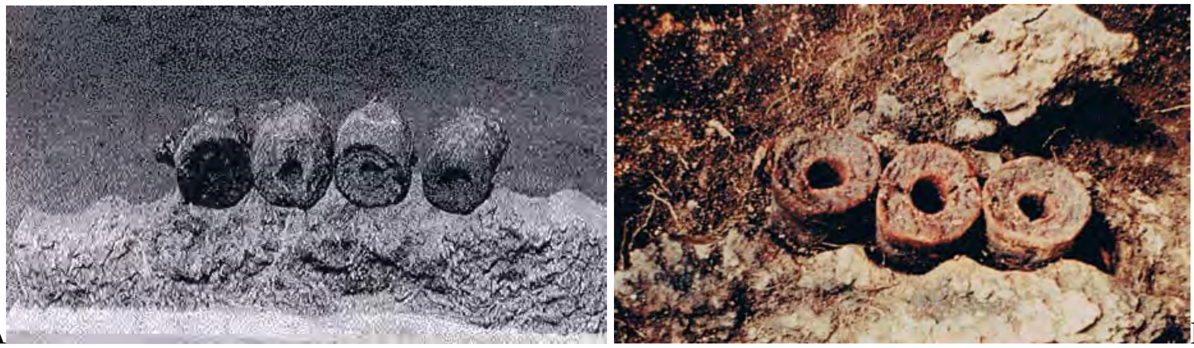
Excavations of both smelting sites yielded well-preserved tuyeres and numerous amount of fragmentary tuyeres. They were gathered in and around the furnaces as well as among waste materials in slag heaps where debris of the production process had thrown away. Tuyeres unearthed at both sites were made of clay and were cylindrical or fairly octagonal in shape (Figure 7-6A; 7-B; 7-C; 7-D). But conical shaped tuyeres were collected at SIT 4 during the SIT survey in the KOB. Conical shaped tuyere was also collected at the Kolambayaya smelting site during the survey along the Mirisgoni Oya (MO 27 in Solangaarachchi 1999). Conical tuyeres were also recorded in Samanalavava furnaces in southern Sri Lanka (Juleff 1998).

The length of the tuyere is about 15-30 cm and it is dependent on the thickness of the furnace wall where the tuyeres were placed in the furnace. The outer diameter of the tuyere is about 9 cm and the diameter of the inner hole where the air intake to the furnace is regulated varies from 3-4 cm. One of the ends in most of the unearthed tuyeres were covered with slags as those ends was located inside the furnace (Figure 7-6). The weight of a tuyere is around 0.5-2kg at both sites.

Some tuyeres found at SIT 1 had fabric imprints on the outer surface; thus indicates some connection with the tuyere manufacturing method. There is no evidence for the tuyeres being re-used after the first production cycle was finished. During the first stage of excavation in 1990 at SIT 1, two cylindrical tuyeres were found *in situ* attaching to a fragment of a front wall of the furnace along with two fragments of front wall with the semi-circular imprints of tuyeres. This evidence indicated that tuyeres had been attached to the front wall parallel to each other. In 1991 the same evidence was found in the front of the furnace (No. 26) with three parallel tuyeres (Figure 7-7B)

Figure 7-6. Four types of tuyeres found in the KOB. A) Cylindrical shaped long tuyere unearthed at SIT 22. Field no. SIT22/04/40. B) Cylindrical shaped long tuyere unearthed at SIT 22. Field no. SIT22/04/39. C) Octagonal (fairly) Octagonal shaped long tuyere fragments collected at SIT 01. D) Cylindrical shaped short tuyere unearthed at SIT 1. Field no. AV/KO14/S/91-569. E) Conical shaped tuyeres collected at SIT 4 during the SIT survey. Photographs by R. Solangaarachchi.

In the same field season in 1991 at SIT 1, a fragment of a front wall of the best preserved furnace/No. 27 (Figure 7-2B) was found with eight similar imprints of the tuyeres. This fragment lay in front of the furnace (Figure 7-7A) and registered it as tuyere carrier/holder. This extraordinary find proved that the iron masters at SIT 1 used eight tuyeres for one furnace at the same occasion. I named this multiple tuyere arrangement as “poly tuyere system” (Solangaarachchi 1999). The furnace at SIT 22 also has provided the poly tuyere arrangement (Figure 7-1B; Figure 7-3). But considering the shape of the front wall of excavated furnace at SIT 22, most probably, tuyeres may have been arranged circularly on the front wall rather than parallel to each other. Two layers of tuyeres unearthed at the SIT 22 furnace may indicate that smelters had used two layers of tuyeres for one furnace.



A B

Figure 7-7. Tuyere arrangement of the furnace at SIT 1. A) A fragment of a front wall (tuyere carrier/holder) with eight imprints of tuyeres. It unearthed *in situ* in front of the furnace no. 27 at SIT 1/KO 14. This reconstruction shows, tuyere arrangement in the furnace. Presently it exhibits at the Sigiriya archaeology museum. B) Three tuyeres attached to the front wall of the furnace. This fragment found *in situ* in front of furnace no. 26 at SIT 1/KO 14. Photographs from the PGIAR's photo archives.

The Poly tuyere system is a very special arrangement used for controlling the heat, which is essential for the success of the production process. But it is difficult to determine the height and the angle of tuyere arrangement on the furnace wall as they laid on the ground, when they were unearthed. Looking at the furnace construction and the damaged part of the back wall, it can be suggested that the tuyeres were probably attached to the furnace 25-40 cm above the furnace bottom. For analytical details on the tuyeres at SIT 1 see Appendix D (Noreus in Solangaarachchi 1999).

Bellows

When considering the furnace construction it seems that the bellows were probably placed in or beside the pits in front of the furnaces. The remains of the bellows and bellow tubes were not found *in situ* because they must have been made of organic material and decayed due to the tropical climatic conditions. Pressure marks on the lower parts of the back walls (east walls) in every furnace, indicate the use of a forced draught which must have been regulated by bellows. The idea is further confirmed by the construction of the furnace with the location of the tuyeres. The bottom of the furnace was about one meter below the ground level and the openings of the tuyeres were also placed below the ground level (Figure 7-2C). There is no doubt that the natural draught could not have been used for the production process in both excavated sites in the KOB. In contrast, wind pressure technique was recorded at Samanalavava furnaces (Chapter 2).

The architecture of this type of bloomery furnaces resembles the architecture of those found in the Indian subcontinent (Chapter 2). According to this evidence usually a pair of bellows had been used to provide air through one tuyere (Prakash 1990a). Coomaraswamy also reported that a type of bellows was used in the early 20th century in Balangoda, Sri Lanka. Recent excavation has revealed a multiple tuyere using technology from the same area but there is evidence that the smelters of the area used the power of natural draught rather than a forced draught induced by bellows (Juleff 1998).

The multiple/poly tuyere using technology with bellows was also reported in northwest Tanzania from the research carried out by Schmidt and Avery (1978). According to them, those furnaces also used eight tuyeres and each one was connected to a goat skin bellow which was pumped up and down. The furnaces were dated to 1500-2000 years ago and had the ability to produce medium-carbon steel (Renfrew and Bahn 1991). Based on the space in front of the tuyeres and between each of them, it cannot be suggested that the furnaces at KOB had a bellow for each tuyere.

This multiple/poly tuyere using technology in Sri Lanka is similar to Japanese “tatara” technology. The significance of the construction of the `tatara' furnace is that they use 20 tuyeres per side and air is induced by treading on a bellow called a `tenbin' (Tate 1998). This poly/multiple tuyere arrangement is very similar to the KOB tuyere arrangement. Therefore, it can be suggested that the smelters of the site used a one hand driven bellow connected to eight tuyeres as in the Japanese `tatara' furnaces or a one foot driven pair of bellows. If they used a foot driven pair of bellows, four tuyeres were probably connected to one bellow pipe and the others to the next bellow pipe. The bellows were probably located in a one meter space west of the pit described above or to the west and upper level of the rounded steps. When we examine the construction of Asian furnace, it is clear that the ancient smelters of the Asian iron technology complex preferred to use an advanced technique by directing the forced or natural draught from one side of the furnace towards the smelting zone. Juleff termed this model of furnace as a `frontal' (Juleff 1996).

Table 7-2. Unearthed remains of smelting process and the furnace structure at SIT22

Artifact	Weight/kg
Ceramics	9.3
Iron Ore	1.3
Iron Slag	883
Furnace Wall	221
Tuyere/Fragment	23
Stone	109

* Total numbers of stone (quartz and granite), furnace wall fragments and iron slags unearthed at test units (1mx9m, 1mx7m, 1mx3m, 2mx2m) are provided here. Here all smelting activities are determined as belonging to one period.

Considering unearthed remains of smelting process and remains of the furnace structure, it can be assumed that smelting activities at SIT 22 were conducted over a long period on a large scale (Table 7-2).

A Metallurgical Overview

The metallurgical analysis based on this metallurgical review is mainly based on data at SIT 1/KO 14 that have been revealed during the SARCP 1991-1992 (Appendix G) and data at SIT 22, SIT 7, SIT 6 and SIT 25 that have been revealed during the SIT 2004-2006 (Appendix H). Fifty samples of iron smelting remains from excavated sites and from other major production sites surveyed during the SIT project were sent to the Arrhenius Laboratory at Stockholm University in Sweden for metallurgical analyzing in order to find out what raw materials were used and to understand the pyrotechnology: smelting processes, fluxes, and thermal aspects of ancient iron smelting. The analytical data basically provided here are based on the report of Dehigaha-ala-kanda and Dikyaya-kanda iron smelting sites provided by Dag Noreus. The metallurgical report of Dehigaha-ala-kanda (Appendix G), first used for my MPhil dissertation in 1999 (Noreus in Solangaarachchi 1999).

Furnace Operation

Although the technique of the smelting process varies greatly from area to area, the basic principle remained the same. The operation of the furnace mainly depends on the scientific basis of the iron metallurgy.

Scientific Basis

The success of the furnace operation or the smelting process mainly depends on the presence of carbon monoxide (CO) which acts as an active reducing agent in the furnace. The extraction of iron from the ore occurs through reduction with charcoal at a high temperature and charcoal acts as a fuel and a reducing medium. According to the characteristic atmospheric conditions and chemical reactions of the bloomery process, the inside of the furnace can be divided into three major zones as combustion, solution and reduction (Clough 1985). According to the general method of furnace operation the furnace is preheated at first and then filled with ore and charcoal layer by layer. The air is supplied through *tuyeres* blown by bellows or natural draught for the process. The oxidation zone is created near the tuyeres. At a temperature between 1100°C-1300°C, carbon monoxide is formed by the combustion of particles of charcoal with the air blown through *tuyeres.* The main reaction of the combination zone is the reaction of oxygen with carbon (C) which yields from charcoal and they are converted into carbon dioxide (CO_2). This carbon dioxide reacts with more charcoal to form the reduction gas, carbon monoxide (CO) in the solution zone.

In the primitive furnaces, the ore was incompletely reduced because the temperature did not reach 1100°C-1300°C. Therefore reduction was completed in two stages. In the reduction zone ferrous oxide (FeO) was formed at first as the result of the ore (eg. Magnetite Fe_3O_4) reacting with carbon monoxide (CO). Secondly, ferrous oxide was partly reduced to iron as the result of the reaction with carbon monoxide and partly turned to slag together with the gangue or mainly silicates as fayalite (Fe_2SiO_4).

The fayalite compound melts at 1170°C and it can absorb oxides of manganese, magnesium and aluminum present in the gangue (Hegde 1990). In some parts of South Asia there is evidence of using lime ($CaCO_3$) as a flux (Tripathi and Tripathi 1994). In such cases the slag produced also contains calcium silicate compound.

Unless the charcoal is broken into small pieces before charging, the distribution of carbon in the charge may not be sufficiently uniform and unless the ore is adequately porous it will not be completely reduced because the carbon monoxide will not be able to reach all parts of the ore. These two reasons caused the production of a small quantity of low quality output relative to the amount of raw material used. The other important thing is that when too much enthusiasm is shown in the use of the bellows, or as another reason too much oxygen is produced inside the furnace, especially due to the local absence of carbon, the already reduced iron may become reoxidized. This causes the whole process to be a failure.

As discussed above, the iron smelting process requires more critical conditions than copper for a successful production. At least it requires a temperature of 1250°C to separate the useless gangue from the smelting charges in the furnace. Therefore it needs a good supply of oxygen to reach this high temperature. It is very difficult to maintain a reducing condition with a good supply of oxygen.

Ancient smelters were capable of controlling these critical points and complicated demands and producing high quality iron with the experience of long term technological knowhow. They knew how to produce the desired quality of metal by achieving long-term experience, even though they did not have a clear understanding of the chemical and metallurgical principles of the smelting technology.

Raw Materials and Waste Products

The basic raw materials used in the iron smelting process were iron ore and wood. Clay was also used as a main construction material of the furnaces. The accounts of the types of raw materials which were used in ancient times are described in detail in Chapter 2. Iron ore and iron slags are the major materials to understand the metallurgical evaluation of the smelting process. Some important results of scientific analysis of samples collected at both sites is briefly present here to provide understanding the mettalrgical skills of KOB smelters.

Iron ore

It is considered that Magnetite(Fe_3O_4), the very dense iron oxide, is difficult to reduce in the bloomery furnace. X-ray diffraction confirmed, iron ore samples collected from furnace walls, tuyeres at SIT 1, SIT 22 and from other iron production sites in the vicinity are magnetite. The chemical analysis revealed all ore samples to have a very high purity (Appendix G; H).

The iron oxide content of SIT 1 ore is around 98 wt.% (Table 7-4) and SIT 22 is around 90 (Table 7-3). Analysis reports shows that one of the troublesome elements of aluminum is dominant in the ore. It caused polymerization of the slag and make it more difficult to be removed from the iron bloom. The main type of iron ore is magnetite (Fe_3O_4) that used for smelting process in the KOB. Further details of analysis are given in Appendix G and H.

The use of magnetite in bloomery furnaces has so far been identified only in a few exceptional cases in the world. Modern archaeometallurgists assume that the dense magnetite ore would be difficult to reduce with this technique because it would be impossible to attain flame temperature high enough reduce to magnetite in these furnaces. The primitive smelters in the Salem district, India used only well disintegrated and weathered pieces of quartz-magnetite schist and even pieces of pure magnetite were rejected because of their superior hardness and compactness. But in Darjeeling and west Dhura districts in northeast India magnetite was used for the smelting process to make sharp edged and good quality weapons. The furnace construction was also developed to reduce magnetite ore (Tripathi and Tripathi 1994). Indian smelters were also used to make wootz steel either from bloom iron, or even directly from magnetite (Needham 1980).

Table 7-3. Analysis chart of the iron ore samples at Dikyaya-kanda (SIT 22), Vavalavava

		Atom%	
	SIT22-01	SIT22-02	SIT22-04
Fe	93.721	0	91.046
Na	0*	64.908*	0*
Mg	0.815*	0*	0*
Al	2.833	0*	0.919
Si	0.597	1.756	3.735
P	0.108*	5.322	2.771
S	0.243*	1.079*	0.017*
Cl	0.077*	7.177	0*
K	0.159*	0.762	0.017*
Ca	0.082*	0.402	0*
Sc	0.055*	0.231*	0.178*
Ti	0.72	4.715	0*
V	0*	6.768	0.111*
Cr	0.081*	0.178*	0.136*
Mn	0*	0.334*	0.11*
Sr	0.265*	0.144*	0.269*
Co	0*	6.226	0*
Ni	0.244*	0*	0.158*

Area scan * = less than 2 sigma. Analyses report was done at the Arrhenius lab at the University of Stockholm under the supervision of Prof. Dag Noreus (Appendix G).

The dominant impurity in the ore from Dehigaha-ala-kanda is aluminum (Appendix G). The melting point of aluminum (Al) is very high. Therefore it is more difficult to remove from the iron bloom. In such cases during the process iron smelters have added silicon and calcium containing flux to facilitate the slag separation and to decrease the viscosity of the slag. In spite of this the smelters must have been exceptionally skilful as the low iron content and the still very high aluminum content in the slag would have forced them to work very quickly and at a high temperature, in order to remove the slag from the bloom, before it became too viscous in the final stages of the process (Appendix G). The chemical compositions in the slag samples indicate that most of the aluminum in the slag came from the ore.

A

B C

Figure 7-8. Iron ore samples found in the KOB. A) Pieces of iron ore unearthed at SIT 22. B) Pieces of iron ore unearthed at SIT 1. C) Block of iron ore collected at SIT 101. Scale is given in inches. Photographs by R. Solangaarachchi.

The manganese (Mn) content of the ore is low when compared with the ore from other sites of the area. Manganese (Mn) is also more difficult to reduce than iron and it remains with the slag to the end of the process. The slag from the site also has a low percentage of manganese.

Iron is fragile and brittle when sulphur (S) and phosphorus (P) are present. Usually iron derives phosphorus from ore. At a low temperature phosphorus goes to slag, and at a high temperature it is absorbed by iron. Usually in the bloomery process, phosphorus goes to slag below the melting point of iron (Serning 1979). The analysis report shows that the iron ore of SIT 1 is free of sulphur and phosphorus. But the ore of SIT 22 has both elements. According to Serning the ancient smelters of Sweden also preferred to use magnetite and haemetite rather than limonite because of their low quantity of phosphorus (Serning 1979).

Table 7-4. Analysis chart of the iron ore samples at Dehigaha-ala-kanda (SIT 01/KO 14), Alakolavava

Sample	WEIGHT%								
	Fe_2O_3	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
KO141	98.3	-	-	1.3	-	0.4	-	-	-
	98.0	-	-	1.6	-	0.4	-	-	-
KO14 2B	98.6	-	0.4	0.9	-	0.1	-	-	-
	96.5	-	0.3	0.3	-	0.1	-	-	-
KO 14 2B	97.7	-	0.2	1.4	-	0.4	0.3	-	-
KO 14 14B	98.4	-	-	1.1	-	0.1	0.4	-	-
	98.5	-	0.1	0.8	-	0.1	0.5	-	-
KO 14 14BX	99.0	-	0.2	0.5	-	0.1	0.3	-	-
	98.1	-	0.2	1.1	-	0.2	0.4	-	-
KO 14 18	97.9	-	-	2.0	-	0.1	-	-	-
	96.7	-	0.2	2.5	-	0.2	0.4	-	-

Appendix G provides the analysis report for the SARCP project done at the Arrhenius lab at the University of Stockholm by Prof. Dag Noreus.

Figure 7-9. Magnetite embedded piece of quartz at SIT 01/KO14 Field no: AV/KO 14/S/91/565[19]. Photographs by R. Solangaarachchi.

During the SIT survey, a site consisted with a large block of magnetite ore (SIT 101) and ore preparation area (SIT 97) were identified. But it is still doubtful about the exact location of the ore deposit. During the SARCP excavation, a magnetite embedded quartz piece was found among the waste heaps below a rock with conical holes (Figure 7-9). The shape of the holes indicates that they once were a support for some revolving machinery used for crushing and maybe also for separating the ore from the gangue.

Preparation of ore and conical holes

Before the production process, the pre-modern smelters roasted ore to convert it into hematite and remove much of the water content together with carbon dioxide and other volatile components like sulphur in the ore (Hedge 1990). But the places where the roasting activities were conducted could not be traced because surface soil was burnt due to *chena* and tobacco cultivation in all discovered sites in the KOB. The smelters also ground or pounded the ore making it suitable for putting it into the furnace. This technique was used to reduce every particle of the ore and get a high yield from the process.

The pounding or grinding activities have probably taken place in connection with the conical holes. Conical holes located on several rock boulders (SIT 1, SIT 5, SIT 10, SIT 21, SIT 22, SIT 30, SIT 22, SIT 38) in the KOB are irregular in pattern (Figure 5-6).

The functional values of the conical holes are still doubtful. Henry Parker (1909) and Frederick Lewis (1912) reported them as `rock cut marks' found in the Northern, North Central, North Western, North Eastern, Eastern and Sabaragamuwa Provinces. They suggested that the `rock cut marks' were connected with some activity such as sharpening steel chisels by stone sculptors engaged in the construction of monasteries. Parker also suggested that they were chekku which are connected to the traditional oil extraction mortar method and as pits in the traditional olinda game (Parker 1909).

The conical holes found in the KOB are possibly connected to the mortar machinery to grind iron ore before smelting (Mogren 1990; Forenius and Solangaarachchi 1994). Evidence reported from India at Khairadih in Uttar Pradesh and at Senuuar in Rohtas district of Bihar of conical holes also found on flat rock boulders at both iron production sites further supposed the above idea (Tripathi pers. com.). The ethnographical evidence also found from India shows that this technique is still being used for grinding zinc in the Udaipur area (Tripathi pers. com.).

Charcoal

The high temperature yielding and low coal ash obtaining seasonal variations of wood were selected by the ancient iron workers as the main source of fuel in the production process. The availability of fuel and the type of fuel capable of producing the required degree of temperature are the most important factors for pre-modern iron smelters (Chapter 2).

Charcoal burning for fuel for the smelting process probably took place at the locations where the wood was collected. But most wood species which are recorded to have been used in iron and steel production in the pre-modern period are found in and around the Kiri Oya basin even at present. The excavations conducted all over the site could not give any traces of charcoal preparation work or charcoal storing location. *Chena cultivation* might have erased such indications from the area. But charcoal burning pits were probably located very close to the production site.

Flux

Based on the analysis report on ore and slag samples from the site, it seems that the smelters of the site added a silicon and calcium containing fluxing agent during the process. On the other hand the silicates of the ore and the ash from hard wood might probably also have acted as fluxing agents. The survey of the area revealed the presence of concentration of limestone

($CaCO_3$) and marbles/feldspar ($KAlSi_3O_8$). Potassium was probably added to the slag via potash (K_2CO_3) from the fuel (Appendix G).

Clay

Clay was often used for making furnace walls, tuyeres and packing or lining the stone slabs of the furnace. The analysis report (Appendix G) has shown that the composition of the clays used in the furnace walls and the tuyeres in the KOB are different from each other. They indicate that their heat resistances were different, because higher temperatures may have been reached very close to the zone where reduction activities were severely activated. Therefore, the tuyeres were made of a type of clay which was capable of withstanding much higher temperatures than the furnace walls (Appendix G).

The melting points of clay and slag are close and slag reacts with clay to a considerably greater degree (Serning 1979). Therefore the inner part of the furnace wall mostly affected the slag. It is clear that the tuyeres were made of a type of clay which was capable of withstanding much higher temperatures than the furnace walls.

Iron slags

Iron slags of irregular shapes and sizes of the smithy type were found from both excavation sites. Bottom slags, tuyere slags and the slags almost like tapped slags are the main types (Figure 7-10).

Chemical and micro structural analysis of collected samples is given in Appendixes G and H. In the slag samples collected at SIT 1, an iron rich wüstite phase (FeO) was not found. But only the usual fayalite phase (Fe_2SiO_4), an iron poor glassy phase was found (Appendix G). According to chemical analysis the iron oxide contents in the slags from both sites are unusually low for bloomery slags.

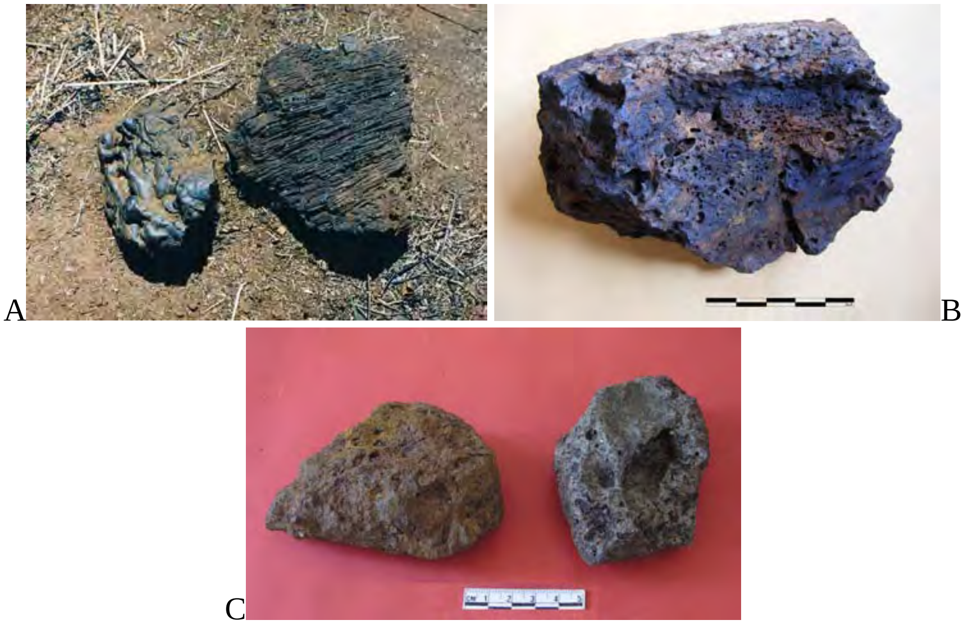


Figure 7-10. Different types of iron slag samples collected in the KOB. A) Slag with grass imprints collected at SIT 1. B) Part of the slag block unearthed at the bottom of the furnace at SIT 22. Scale shown in inches. C) Solid slag pieces unearthed at SIT 7. Scale shown in centimeters. Photographs by R. Solangaarachchi.

Table 7-5. Analysis chart of the iron slag samples at Dikyaya-kanda, Vavalavava

	Atom%				
	SIT22-08	SIT22-09	SIT22-10	SIT22-11	SIT22-13
Fe	37.84	42.385	64.604	52.918	49.204
Na	12.711*	0.756*	0*	3.751*	1.018*
Mg	2.385	2.221	0.87*	1.502	1.958
Al	7.408	8.088	7.794	7.37	7.727
Si	20.496	20.014	11.086	19.21	24.555
P	7.215	7.906	3.672	3.083	4.329
S	0.266	2.57	0.54	0.168*	0.05*
Cl	0*	0.734	0.149*	0.092*	0
K	1.923	0.582	1.499	1.61	1.963
Ca	3.745	6.056	2.477	5.088	4.296
Sc	0	0.05*	0*	0*	0*
Ti	0.742	5.211	4.353	2.176	0.659
V	0.013*	0*	0.041*	0.085*	0.021*
Cr	0*	0.132*	0.017*	0.007	0.019*
Mn	4.357	2.588	2.609	2.336	3.239
Sr	0.172*	0.266	0.289*	0.135*	0.141*
Co	0.063*	0*	0*	0.152*	0*
Ni	0.28	0.224*	0*	0.105*	0.144*

Area scan * = less than 2 sigma. Analyses report was done at the Arrhenius lab at the University of Stockholm under the supervision of Prof. Dag Noreus.

Slags from both sites are consisted of a lower iron oxide content of fayalite (Fe_2SiO_4) compound when compared with slag samples from other production sites which were situated around the area. This indicates that the yield at the site has been very high (Appendix D). Considering the above data, it can be assumed that the smelters of KOB had the knowledge to select ore of good quality which could obtain a high yield compared to the quantity of raw materials used and advanced smelting technology to achieve high quality.

Evidence of Steel Production in the KOB

The procedure for producing steel from wrought iron is mostly recorded in most ancient smelting sites (Sherby and Wadsworth 1985) and this principle was not applied in England until 1800 (Holland 1892; Tripathi and Tripathi 1994). The carbon content of steel is intermediate between that of cast iron and wrought iron. The percentage of carbon in wrought iron between 0.06-0.09% while that in cast iron is between 2-5% and it is hard and brittle. The percentage of carbon is ranging from 0.1 to 2 in steel. The hot steel is hardened by plunging it into cold water or liquid. This process is called quenching and was a very early discovery (Needham 1980). The hardness of the quenched steel changes with the variation of the percentage of carbon (Hodges 1964). When the percentage of carbon is increasing, then the hardness of the quenched steel is also rapidly increasing. For example, the when percentage of carbon in the steel has 0.1%, 0.3%, 0.5%, 0.7%, 0.9%, 1.2% values, then the Brinell hardness is increasing 155, 500, 670, 710, 680, 685 respectively (Hodges 1964).

When converting iron into steel, its structure changes in two main phases depending on the amount of carbon absorbed. These phases depend on the hardness of the steel. Although, the temperature of 1200°C the wrought iron is in solid state, its crystals have a face-centered cubic structure. In the face-centered phase, with the arrangements of carbon atoms in the spaces between the iron atoms, this formation is called austenite. When the steel is cooling very slowly at the room temperature, the iron crystals are converted into a body-centered cubic structure with little room for carbon. This formation is called ferrite and carbon is in solid solution of iron. Therefore low carbon steel contains ferrite.

When the steel is cooling rapidly by quenching (by water treatment), carbon atoms are trapped in distorted, tetragonal body-centered crystals called cementite or iron carbide (Fe_3C). The metal is soft if ferrite is the dominant. Cementite is harder than ferrite (Wheeler and Maddin 1980; Sherby and Wadsworth 1985: 112-120; Prakash 1991).

Steel

Very tiny (~ 10 gram) but important pieces of iron have been found attached to a piece of slag. According to the analysis report (Appendix G), it seems that the furnaces at the site had fairly strong reducing conditions for producing `steely' iron. According to analyses made by Noreus, it does not have any impurities in it and indicating that it is suitable for subsequent steel manufacture, for example, cementation in the so called Wootz process (Tylecote1979). Hadfield has a prominent place among the investigators of Sri Lankan archaeometallurgy. In his studies on the samples of iron and steel from Sigiriya, dated 5th century A.D., he recorded that the masters of iron technology of that time had known the art of strengthening steel (Hadfield 1912). The earliest dated example for steel in Sri Lanka that was produced by applying hardening and quenching techniques, was the sample (a chisel) found in Sigiriya and analyzed by Hadfield (Maliyasena 1986).

Wrought iron, which is made through the smelting process, is soft. Therefore wrought iron must be converted into much harder material that could be used to work on hard surfaces like granite. The soft wrought iron is hardened in a crucible by adding a carbon content of up to 0.3-0.4%, a process that converts iron into steel. Steel is an alloy of iron and carbon. The source of carbon was charcoal, wood or leaves. The amount of carbon absorbed into the iron depends on the temperature of the fire and how long the object is left in the fire (Wheeler and Maddin 1980).

Crucibles

In the Sri Lankan steel production, the crucibles (Sin. *kova*) appeared in various forms. The most common form was a tubular form that was made out of rice husk (Sin. dahaiya) and mixed with clay in a ratio of 1:1 (Ondaatje 1854; Coomaraswamy 1908; Juleff 1990b). Jayatilleke has described about 12 types of crucibles based on their shapes which were used in ancient Sri Lankan metal production (Jayatilleke 1990). The crucibles described by Coomaraswamy (1908), were each about 8 inches in length, 2 inches in diameter and a 1/4 of an inch in thickness.

A  B

Figure 7-11. Pieces of crucibles unearthed in the KOB. A) Interior of crucibles. B) Exterior of Crucibles. While two samples at the left side unearthed at SIT 7 (Field no./s SIT07/04/05 and SIT07/04/06), the other sample unearthed at SIT 25 (Field no. SIT25/04/04). Photographs by R. Solangaarachchi.

Although there is ample evidence for the area's iron smelting technology, there are no crucibles recorded in the region to confirm the existence of local steel production. Excavation conducted at SIT 7, SIT 6 and SIT 25 yielded pieces of crucibles confirming the existence of steel production in the region (Solangaarachchi 2007).

The crucible pieces unearthed in the Kiri Oya Basin are also in tubular form. Although the length of the crucibles cannot be determined, it seems that all of them were having the same diameter and thickness: the inner diameter has about 2 inches while the outer diameter has about 3 inches; the thickness is about 1/2 an inch (Figure 7-11). Analyses of these were done at the Arrhenius lab at the University of Stockholm (Appendix H).

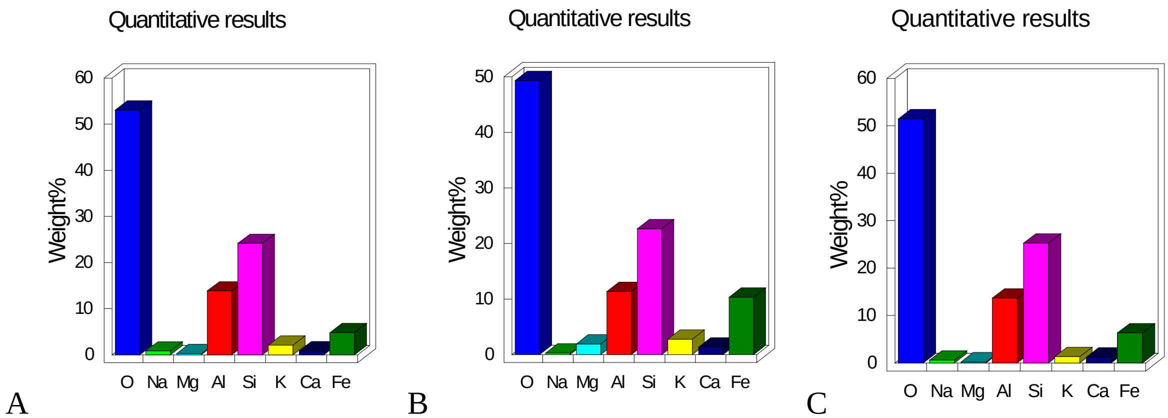


Figure 7-12. Quantative results of crucibles unearthed in the KOB. A) Analysis of crucible sample # SIT 07-05 (Field number SIT07/04/07). B) Analysis of crucible sample # SIT07-06 (Field number SIT07/04/08). C) Analysis of crucible sample # SIT25/04/04 (Field number SIT25/04/04). Detailed analysis report is provided in Appendix H.

Analysis report of crucible samples (Figure 7-12; Appendix H) indicate that there is high percentage of silicon and aluminum. The analysis report of Sri Lankan crucibles seem that they were made of rice husk (Sin. *dahaiya*) and clay mixture in ratio of 1:1 (Ondaatje 1854; Coomaraswamy 1908; Juleff 1990b). Jayatilleke has described about 12 types of crucibles based on their shapes that were used in ancient Sri Lankan metal production (Jayatilleke 1990). But he has not given analysis of crucibles. But he mentioned graphite was not used in ancient times. It seem that the Silicon content of crucible samples were came rice husk and clay.

Material Culture

In this part, I provide the material culture not directly related to the iron smelting process. Metal objects, stone, bone, bead, terracotta, ceramics and pottery typology are the main themes I present here to understand the social stratification that is embedded physically and symbolically in the KOB's material culture. The analysis chart of artifacts is provided in Appendices E, F & J.

Metal Artifacts

It is unusual to find finished objects on iron production sites. The main final product of the smelting sites is a currency bar. So most probably fragments of currency bars do occur but no such remains of currency bars were found at any excavated sites. SIT 9 is the only site that recorded some fragment of iron bars during the SARCP (KO 54 in Manatunga 1990:84).

Iron objects

SIT 6 is provided with a sufficient amount of iron nails among other excavated sites in 2004 and 2005. It seems that the Phase III, the second occupied period at SIT 6 has provided clear evidence for the cave dwelling architecture at the site. It can be assumed that this phase is associated in between 3-4th century A.D. (296-324 A.D.), the period somewhere around 10th regnal year of King Kithsirimevan (396 A.D.) that represents by the Inscription #03 at the vicinity.

A   **B**

Figure 7-13. Iron nails unearthed at SIT 6. A) Field no./s from left to right; SIT/04/10, 02 28, 13, 23, 19. B) Field no./s from left to right; SIT/04/16, 24, 20, 25, 08. Photographs by R. Solangaarachchi.

Tile pieces (large 52/small 372) and bricks (large 111/small 1102) are other architectural features unearthed along with Iron nails at the site. Two iron nails (Con. 3 and Con. 20) one iron ring (Con. 9) and three spearheads (Con. 9 and Con. 32) that are unearthed at SIT 1/KO 14 were in a very deteriorated condition (Solangaarachchi 1999).

Very tiny (10 gm) but important pieces of iron have been found attached to a piece of slag at SIT 1/KO14. According to the analysis report (Appendix G), it seems that the furnaces at the site had fairly strong reducing conditions for producing `steely' iron.

Figure 7-14. Fragmented mammoty found at SIT 33. Photographs by R. Solangaarachchi.

Survey results show that the KOB settlers had well connected agro-hydraulic socio-economic system all over the settlements. Every settlement of the KOB is surrounded by reservoirs and connected agricultural lands in addition to iron smelting centers. But only the agricultural tool collected in the KOB is fragmented mammoty (7-14).

Copper objects

A 

Figure 7-15. Copper pendent found at SIT 6. Field no. SIT06/04/22. Photographs by R. Solangaarachchi.

While the SIT 6, monastery site has provided one copper object (Figure 7-15), SIT01/KO14 have provided one copper object. This artifact may be used as a offering during the ritual practice conducted at the monastery.

Stone Artifacts

A   B

C 

Figure 7-16. Grinding stones unearthed in the KOB. A) Grinding stone unearthed at SIT 7. Field no. SIT07/04/36. B) Grinding stones unearthed at SIT 6. Field no./s SIT 06/04/18 and SIT 06/04/30. C) Grinding stone unearthed at SIT 1. Field no: AV/KO14/S/91/565[19]. Photographs by R. Solangaarachchi.

Grinding (hammer) stones, a few chert pieces and quartz flakes are the lithic artifacts found from excavation at the site. Seven hammer stones (Find No. 508, 521, 522, 545, 553, 570 and 572) made of gneissic river pebbles are heavy and associated with furnaces and seem to have been used for crushing ore at SIT 1. In addition SIT 6 and SIT 7 have provided some grinding stone. Some of them had well-defined pits and some researchers argued that they were prehistoric pitted pebbles probably used as fire-lighting instruments and re-used as ore preparation hammers (Deraniyagala 1972; Juleff 1998).

A B C D

Figure 7-17. Quartz flakes and cherts unearthed from SIT excavations. A) Chert and two quarts flakes at SIT 6. Field no./s SIT06/04/31; 09; 33. B) Chert flakes at SIT 7. Field no./s SIT07/04/03; 69; 73. C) Quartz flakes unearthed at SIT 7. Field no. SIT07/04/05. D) Quarts pieces unearthed at SIT 7. Field no. SIT07/04/79; 19; 14. Photographs by R. Solangaarachchi.

During the preliminary stage of exploration work in 1988, the quartz flakes were interpreted as the remains of a prehistoric camp site (Manjusri 1990). This interpretation was changed with new evidence from the excavations in 1990 and 1991. It is now suggested that they are the waste from ore crushed into suitable size and prepared for the furnace. The quartz which contained ore was thrown away with other unwanted materials (Forenius and Solangaarachchi 1994).

Cobra-headed sculptures were recorded near most of the reservoirs in Sri Lanka. The most recognizable idea goes with its connection with the irrigation network. It also connects with *Naga* people; one of the ancient tribe appears in the oral traditions in the island and the *Mahavamsa*.(*1:45-77*). The Cobra-hooded sculpture placed near the pond at SIT 6 is the only sculpture that could be noticed in the KOB (Figure 7-18). It may be connected with the irrigation network in the KOB.

Figure 7-18. Cobra-headed (seven) stone sculpture at SIT 6. According to villagers, it was unearthed from the pond during the renovation work. Photographs by R. Solangaarachchi.

Beads

Figure 7-19. A bead unearthed at SIT 6. Field no. SIT06/04/15. Photographs by R. Solangaarachchi.

This is the only field unearthed at SIT 6. Two beads were also unearthed at SIT 22 in 2004 (Field no. PG/04/03; PG/04/30). According to villagers, when they were preparing the land for cultivation, they collected bead fragments in different colors at most settlement sites in the KOB. As they claimed, it seems that bead yielded sites are the most prosperous settlements in the KOB.

Faunal remains

Archaeologists mostly used faunal remains to identify its function in the field. Osteological analysis helps to understand the eating habits of ancient people, their age, sex and cause of death. Due to the chemical composition of the Dry Zone soils, most bone fragments unearthed are in decayed condition. One of the samples unearthed at SIT 7 is laid below a broken pot. It may be used as for burial purpose. The soil layer is dated 8th- 10th century A.D.

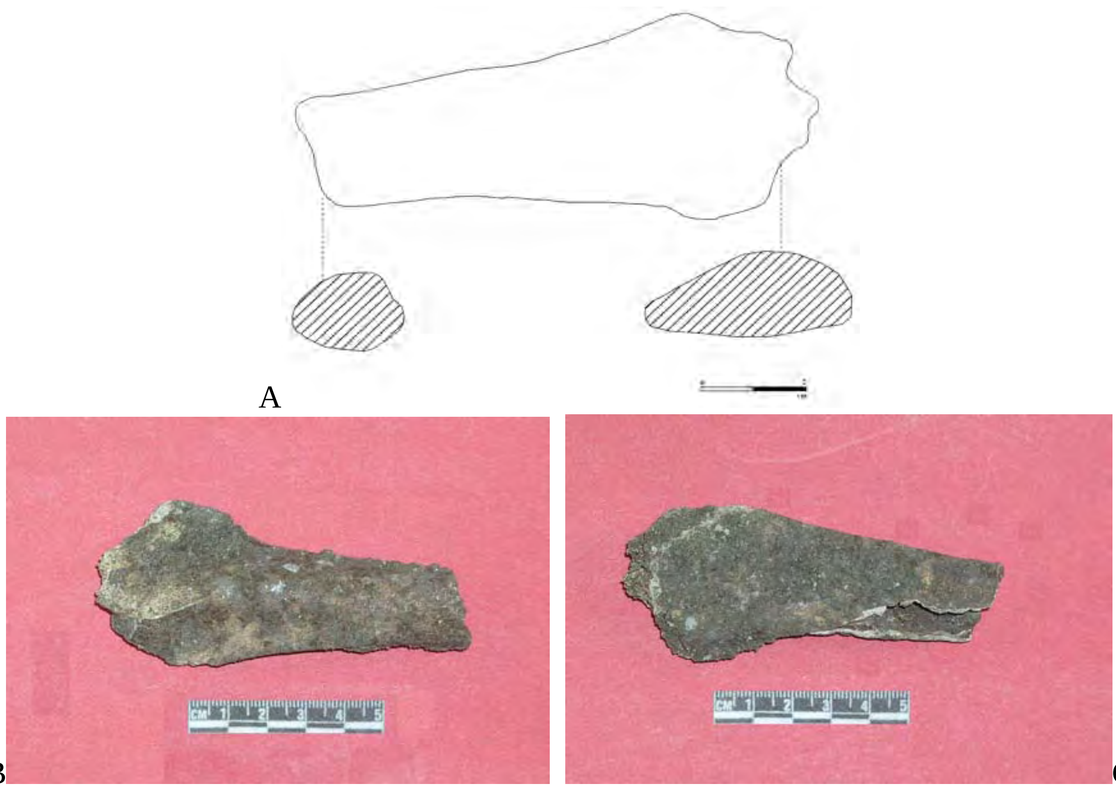


Figure 7-20. Human bone (humerus) unearthed at SIT 7. Field no. SIT 07/04/38. A) Sketch of the bone. B) Front view of the bone. C) Back view of the bone. Photographs by R. Solangaarachchi.

Terracotta Figurines

The Illukvava terracotta site is one of the major terracotta sites in the Sigiriya-Dambulla Region that was discovered just below the ancient Illukvava reservoir bund in the KOB (SIT 68/ KO44 in Manatunga 1990). Terracotta figurines of Illukvava (85 figurines) are well known as

Illukvava collection (Deraniyagala 1958:G 19) and presently are exhibited at the archaeological museum in Anuradhapura.

Data presented on Illukvava terracotta for this research are mainly based on the Nandadeva's report (Nandadeva 1990: 221). There are nearly 21 sites identified so far in the entire island (Nandadeva 1990: 221). Several ideas were given for explaining this significance "folk art". After looking at their "grotesque appearance" Hocart took them as objects representing "*Yakkas*" (deities).

But he considered that there is not any connection with the standard art of the period (Hocart 1924). P.E.P. Deraniyagala considered them as representing a distinct cultural phase of "Tabbova-Maradanmaduwa Culture" (Deraniyagala 1953; 1961). While some researchers gave their special attention to production technology (Jayatilleke 1983), some tried to deal with its chronology (Hocart 1924:10, cited in Nandadeva 1990; P.E.P. Deraniyagala 1961:264; S.U. Deraniyagala 1972a:165; Jayathilake 1983). According to them, the chronology of the Sri Lankan terracotta (folk art) tradition is aligned with early centuries A.D. (Hocart 1924:10, cited in Nandadeva 1990); 2nd century A.D. (P.E.P. Deraniyagala 1961:264); 300-1000 A.D. (S.U. Deraniyagala 1972a:164). Jayathilake suggested them as a folk religion or cult that may have connected with pre-Buddhist religion (Jayathilake 1983). Bandaranayake also considered them as a sub-stratum folk culture belonging to the post Polonnaruwa period (1250 A.D. onwards).

Godakumbure (1965, cited in Nandadeva 1990), Jayathilake (1983) and Deraniyagala (1961:249) suggested them as objects that are related to fertility and productivity with both humans and agriculture. Deraniyagala tried to highlight its ritualistic similarities with "*gammandiya*" fertility ceremony still practiced today in southern Sinhalese villages (Deraniyagala 1961:261).

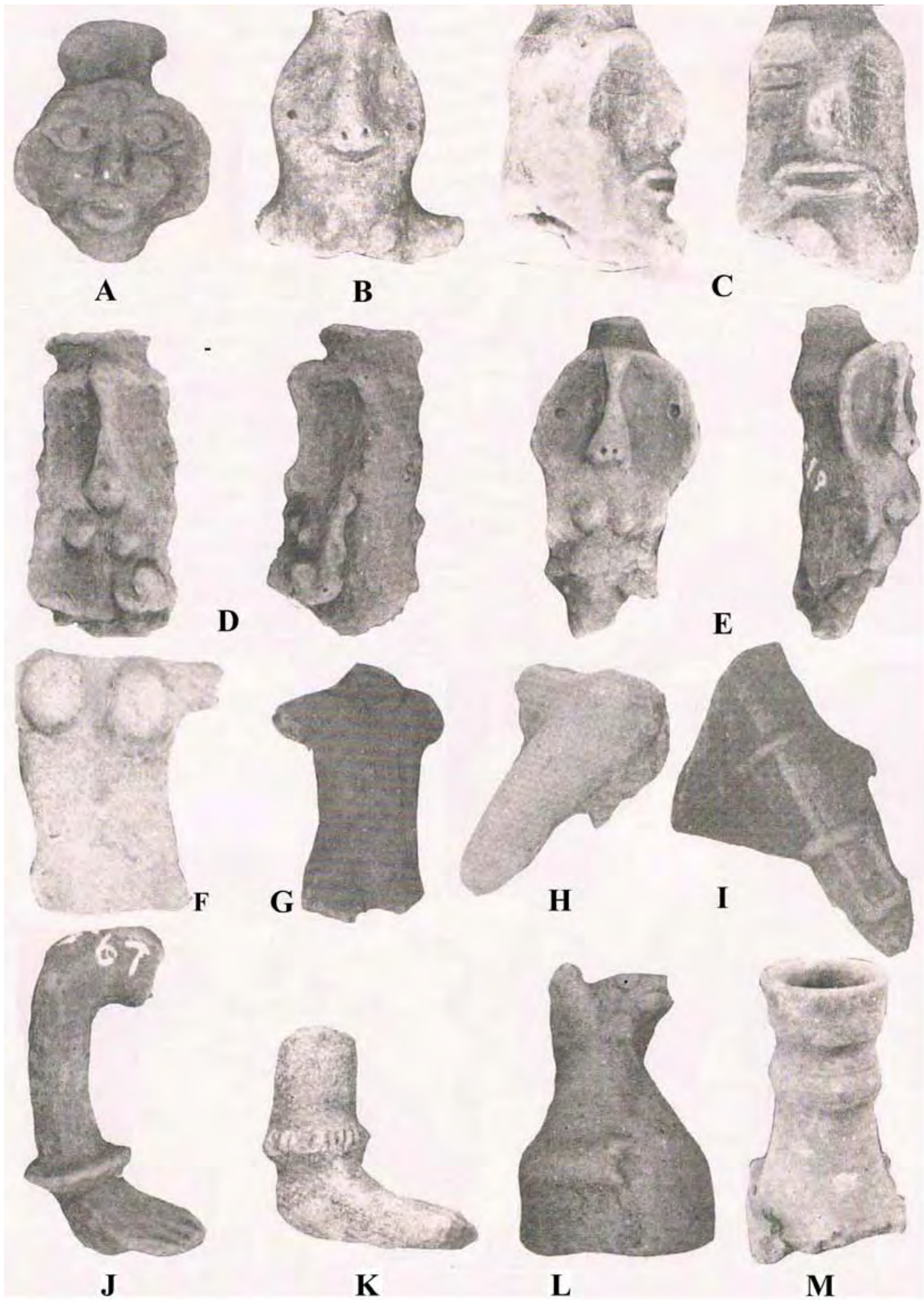


Figure 7-21. Terracotta figurines reported at Illukvava (SIT 68) in the KOB. (Selected from Nandadeva 1990: 220-236). A) Heads with disc-like coiffure type. B) Icthyphallic type. C) Flat head with grooved-eye type. D) Semi-anthropomorphic type. E) Semi-anthropomorphic type. F) Human torsos (female). G) Human torsos (male). H) Phalli (decorated). I) Phalli (undecorated). J) Human limb (hand). K) Human limb (leg). L) Zoomorphic type. M) Inanimate object.

Except for the Illukvava terracotta site, there are seven other sites were discovered in the KOB during the SIT field seasons 2004-2006 (SIT 7, SIT 8, SIT 11, SIT 12, SIT 57, SIT 95, SIT 102). All sites are connected with the agro-hydraulic network of the KOB. Considering the locations of the sites and the symbolic aspects that they represent, it can be hypothized that they are connected with a local religious tradition in the agro-economical social structure even though Buddhism was practiced in the state level as well as through the local monastery system.

Pottery Analysis and Typology

Pottery of the KOB represents the social starigraphy of its makers and users and has symbolic and exchange value. The collected pottery from the explorations as well as excavations conducted over the region was classified not only as separate sites. I mainly used the common pottery typology under the SARCP project that was introduced J.A.D.S. Senarathne Jayaweera as in a comparative manner. Here mainly I provide the pottery typology in the SIT 1, Dehigaha-ala-kanda at Alakolavava as all pottery types claimed at Dikyaya-kanda (SIT 22) also share a similar distribution pattern.

As in the first stage all potsherds were divided into two main categories as Special Ware and Red Ware. Black and Red Ware, Black Ware, Mica Finished Ware, Buff Ware, Red Painted Ware and Decorated Ware are the varieties belonging to the category of Special Ware, which were commonly found in the region.

Red ware, the common and abundance pottery type of the region, was classified under the categories of Diagnostic Rims (DR), Non Diagnostic Rims (DR), Decorated Body sherds (DB), Non Decorated Bodysherds (NDB), Bases, Lids and Spouts. In the second stage, every DR was drawn to scale and assigned to the relevant type. Finally, a comparative study was carried out on this typology with the already known classification of pottery of Sigiriya (Bandaranayake 1982), Gedige (Deraniyagala 1972), Jethavanarama (Ratnayake 1982), Abeyagiri (Wickramagamage 1984) and Kuna's (1987), classification of pottery of Anuradhapura (Jayaweera 1992.).

According to the comparative study made by Jayaweera, it seems that the dating of the pottery in the Sigiriya-Dambulla region goes back to the protohistoric period and continues to the Middle Historic Period.

The classification indicates that the sequence of pottery of the area belongs to three main periods of history:

- Proto historic period to the second phase of the Early Historic Period

  PHP - EHP 2 - 900 B.C. - 300 A.D.
- Third phase of the Early Historic Period to the early phase of the Middle Historic Period

  EHP 3 - MHP 1 - 500 A.D. - 700 A.D.
- Early phase of the Middle Historic Period to the second phase of the Middle Historic Period

  MHP 1 - MHP 2 - 700 A.D. - 1000 A.D.

Most pottery types found at the settlement sites of the region are similar to those in Bandaranayake's (1982) pottery classification of Sigiriya citadel area, but there are some differences in the shape of the types (Jayaweera 1992). The occurrence of Red Ware, especially cooking pots is the most significant feature of the production sites. Commonly Red Ware found in the production sites indicates some difference between the potsherds found in other sites of the region. There is some degree of development in the types of tray bowls and cooking pots from the Dehigaha-ala-kanda production site as well (Jayaweera 1992).

The tray bowls found in iron production sites seem to belong to two categories, with rim and without rim typologies. It is very important to note that these two types are not found in the Sigiriya citadel area. Even the typology of tray bowls with rims indicate that they also belong to a period earlier than that of types 8 and 10 of the Sigiriya citadel (Jayaweera 1992).

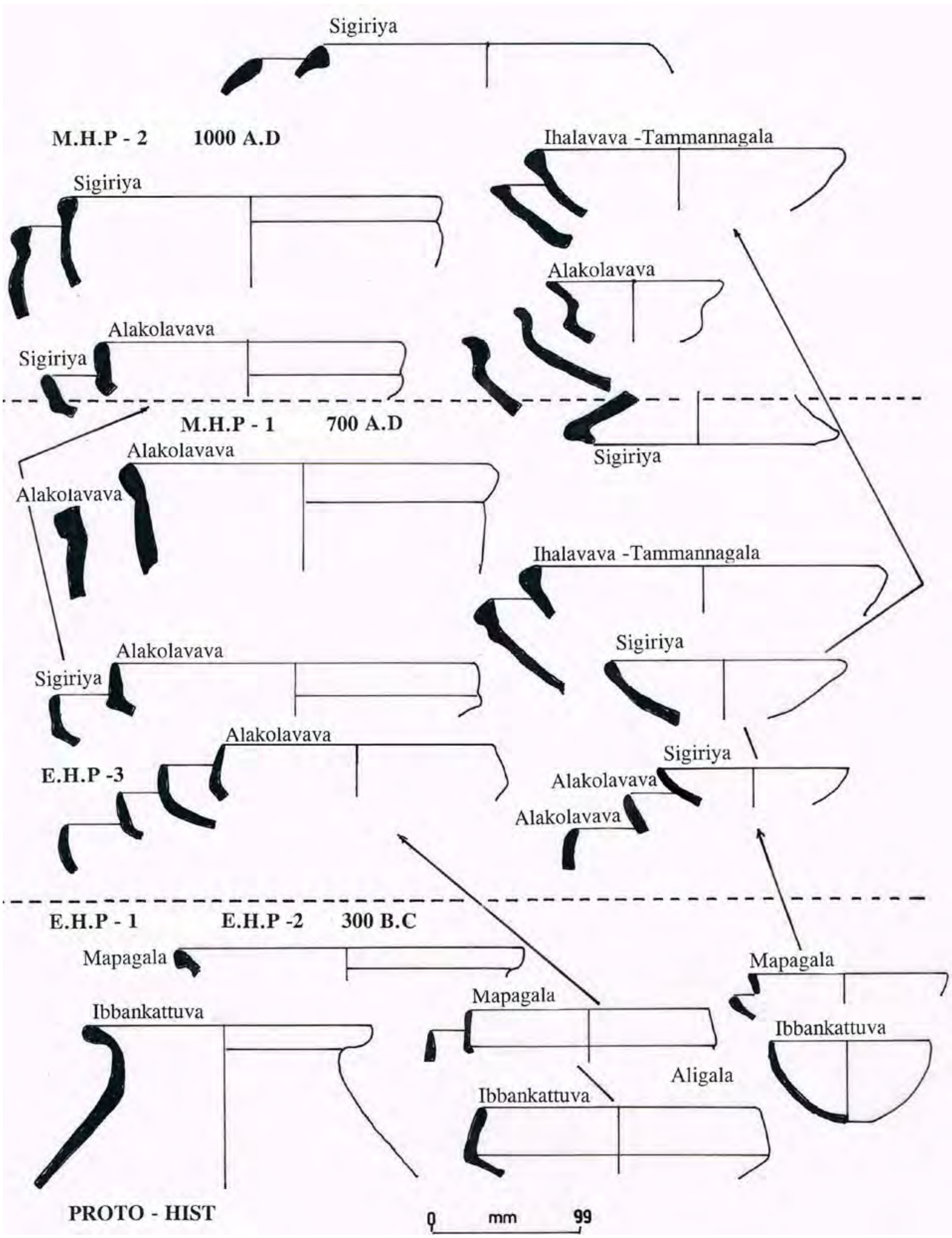


Figure 7-22. Pottery sequence (tentative) of SDR (Jayaweera 1992).

Most types of pottery which were found in the production sites and which belong to the EHP are very similar to BRW of the megalithic tradition (Jayaweera 1992). The other important fact is that the thickness of Red Ware in the production sites is greater than that in other settlement sites. These types of potsherds; specially cooking pots known *atiliya,* were scattered over the production sites of the area in large amounts. As described in Chapter 2, a primitive type of bellows was constructed with two large terracotta pots over which an animal skin was drawn. The local name used in ancient times for the bellows is *thalimana.* Here *thali* means pot. The large amount of scattered pieces of thick Red Ware indicates that it probably was used as bellow bases. The potsherds belonging to the storage type which were found in the production sites also seem to have been produced with a rough finishing technology than the potsherds of the settlement sites. It also indicates that the pottery used in the production sites were probably made for industrial purposes.

The pottery found at Dehigaha-ala-kanda was mainly compared with the pottery typology of the Jethavana, Abhayagiri and Gedige sites in Anuradhapura and with Samanalavava. The main types of pottery found at Dehigaha-ala-kanda are: Black-and-Red Ware, Black Ware and Red Ware. The sherds of Black-and-Red Ware are of a coarse ware, of a very poor level of production, while the Black Ware, in contrast is a fine ware and the manufacturing standard of Red Ware is very high. Red Ware is the type, which is mostly found at the site (Jayaweera 1990; Forenius and Solangaarachchi 1994). A few terracotta discs were also found in different contexts at the site.

According to factors such as form-function-size, the type of Red Ware can be divided into groups of tray bowls (*tati, kabala, kusalana*), cooking pots/utensils (*atili, appalla, mutti*), water carrying pots/vessels (*kalaya, kotalaya, mutti*) and storage pots/vessels; jars (*baraniya, bujama*)

(Appendix J in Solangaarachchi 1999). The tray bowls of the site were divided into two categories according to types with and without rims. The vessels without rims can be assigned to an earlier period than those with rims. The tray bowls without rims (1b-1e) and with rims (1i) of Dehigaha-ala-kanda (Appendix H in Solangaarachchi 1999) were similar to those found at Abhayagiri (Figure 13, from 41 to 49 in Kuna 1987), Gedige (16a, 16aIII in Deraniyagala 1972]) Jethavana (3b at S5W8F3 in Ratnayake 1984) and Alakolavava (6075p in Jayaweera 1992). This type clearly appeared in the 4th century B.C. It is important to note here that this type was not found in Sigiriya (Bandaranayake 1982) and at Samanalavava (Juleff 1998). The tray bowls without rims found in the gravel layer beneath, the slag Mound A, belonged mostly to the Black-and-Red Ware familiarly associated with the megalithic tradition and the Protohistoric-Early Historic Period (PHEH) (Appendix J).

The types of rimmed tray bowls of 1j1, 1j2 (Appendix J in Solangaarachchi 1999) were similar to those found at Samanalavava type 2i, 2ca(i) in Juleff 1998.) and fairly similar to the form at Jethavana (3a at S5 W8 F4 in Ratnayake 1984) which are found with coins dated from the 1st century B.C. - 3rd century A.D. The type of 1i4 (Appendix J in Solangaarachchi 1999), the developed type of tray bowls are similar to the type (10d3) from Sigiriya. This type was not commonly found after the 5th century A.D. According to that data it can be assumed that the tray bowls without rims belonged to an earlier period than those with rims.

The type of atili belonging to 2b4 (Appendix J in Solangaarachchi 1999), Jayaweera (6292p) is similar to the type of pottery found at the Gedige (3(c)i in Deraniyagala 1972, Abhayagiri (Figure 13, Plan 35 in Kuna 1987), Jethavana (the type dated 150 A.D.) at 94b-S5W8F4 in Ratnayake 1984. This type is fairly similar to the type of pottery found at the Gedige (3(c)i layer 4a in Deraniyagala 1972.

It is possible to suggest, tentatively that the pottery found at the site points to an evolution from the Protohistoric-Early Historic (PHEH) transition to phases 1 and 2 of the Early Historic Period (EHP 1 and 2) (Forenius and Solangaarachchi 1994 and Appendix J in Solangaarachchi 1999).

It can be considered that the potsherds found at Dehigaha-ala-kanda are similar to the pottery of the Early Historic Period. Most of the tray bowls (1b, 1e and 1i) and cooking pots, atili (2b2, 2b3, 2b4, 2d2 and 2d3) are very special forms, among the types *atili* and *appalla*. This form is very rare even in Sigiriya.

A  B

Figure 7-23. Two special types of pottery sherds found in the KOB. A) Potsherds categorized as Fine Ware/ Buff Ware unearthed at SIT 6. Filed no. SIT06/04/32. B) Rimsherd (P/05/32) showing cobra-hood symbol collected at Galkaruyaya Pillar site (SIT 85) that is located 500m north to the Nagolla Vava. Photographs by R. Solangaarachchi.

According to the above data, it can be assumed that the iron production activities of the site belonged to the Early Historic Period. The ^{14}C dates of the site further confirmed this dating of the site. The pottery found at the every excavated site were counted and weighed ware-wise for each context. Using those calculated data, bar charts were made on the computer for each context to understand the use of one type of pottery in different periods of history etc. (Appendix J in Solangaarachchi 1999).

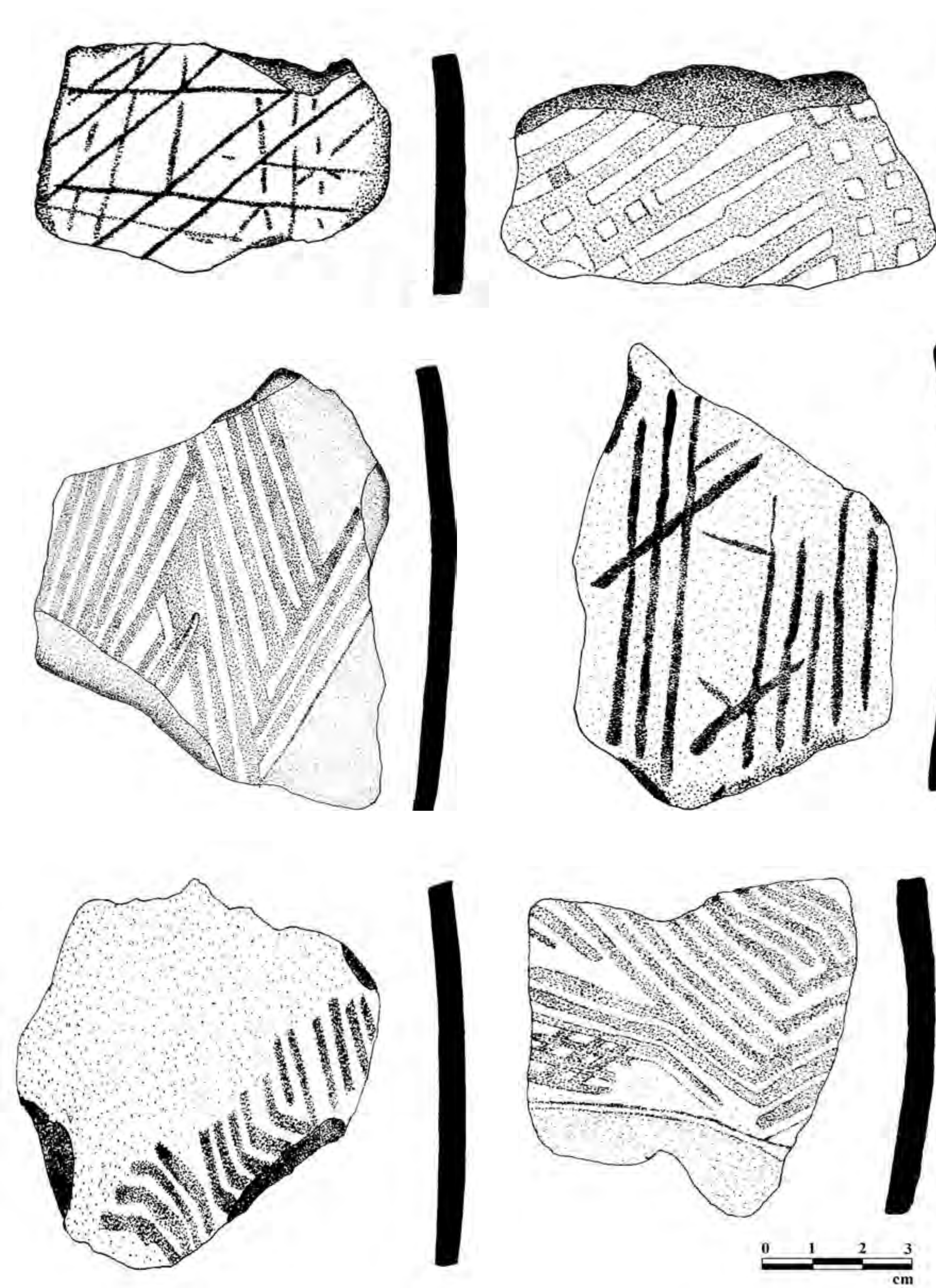


Figure 7-24. Some of the decorated bodysherds unearthed at SIT 7.

Concluding Remarks

The material culture of the KOB shows the very dynamic and diverse socio-cultural activities of the inhabitants throughout the different periods of their history. Metallurgical remains, pottery, and terracotta figurines are the three major artifacts that represent the different periods from the 2nd Century B.C. to the 10th century A.D.

Pottery is the main media that we examined in order to identify the occupational phases and different social stratifications of the KOB. Excavation data and survey data show different social stratifications that symbolize the hierarchical system of the society. Pottery unearthed at Vavala Monastery (SIT 6) and at the Kosgaha-ala-ulpotha settlement site (SIT 7) show much similar standards of manufacturing.: Fine Ware, Polished Ware, Painted Ware and Decorated Ware (Figure 7-25) are the most common findings in both sites. It seems that secular elites settlements were located in the immediate environs of the Buddhist monastery. The material culture of these settlements had higher standards than other settlements that are located at a greater distance from the main monastery complex.

The other important fact is that the thickness of Red Ware in the production sites is greater than that of Red Ware found on other settlement sites. Large amount of these types of potsherds, especially cooking pots (*atiliya*) were scattered over the production sites in large amounts. We could trace the three different hierarchical systems in the KOB: sacred elites, secular elites and the common people.

Although settlers in the entire KOB from Nagolla Vava to Minneriya Vava were engaged in metallurgy, they did not share similar patterns in using of raw materials and building furnace architecture. Metallurgical efficiency different from one site to the other. Analysis reports of iron ore and iron slag illustrated their different metallurgical skills. It seems that there are varying groups people who controlled the tuyere and pottery manufacture. Tuyeres collected in the KOB are different in size and quality. Although there is ample evidence for the area's iron smelting technology, there are no crucibles recorded in the region to confirm the existence of local steel production. The Kosgaha-ala-ulpotha settlement site and the Vavala Vava iron smelting site, yielded pieces of crucibles confirming the existence of steel production in the region.

Material evidence indicates that the terracotta tradition or folk art tradition of the area have been popular among the settlers of the KOB. The location that they discovered, and their representive ideas may be connected with a local religious tradition in the agro-economical social structure, even though Buddhism was practiced at the state level as well as through the local monastery system was active.

The Cobra- headed symbol that is on the fragmentary pottery lid found at the Galkaruyaya pillar site (SIT 85) and the Cobra-headed sculpture near the pond at the Vavala monastery (SIT 6) symbolize settlers' connections with the irrigated agro-economical system. The above data suggest that the KOB settlers were not only engaged in smelting technology. They were also skilled participants in the agro-economical system of the *rajarata* social pattern.

CHAPTER 8
CONCLUSION: SUMMARIZING THE CHARACTERISTICS OF "IRON SMELTER'S SETTLEMENTS" IN THE KIRI OYA BASIN

Overview

I summarize here the main characteristics of iron smelters settlements in the KOB. These characteristics were established through careful recording of the revealed material evidence and observed spatial distribution pattern during the survey. This study connected with metallurgy, urbanization, settlement pattern and political structures in the KOB. The metallurgical aims of this study were mainly to focus on evaluating the smelting technology, and to date and analyze the nature of the spatial- functional organization of smelting sites in the KOB. This study also aimed at determining if there is any connection of the environmental resources of the area with the emerging settlements based on iron smelters. The relationship of the Buddhist monastery and the KOB settlement that developed over time, and the centralized political power that headed the social organization of the KOB are the two other main themes that are discussed in this study.

Iron Metallurgy in the KOB

According to archaeological and written evidence, it seems that pre-modern iron metallurgy began to appear in the island during the protohistoric period in the 1st millennium B.C. The social pattern related to iron metallurgy superseded the hunting and gathering Mesolithic culture (Deraniyagala 1990). The earliest known occurrence of iron in neighboring India was found on the chalcolithic levels at Ahar dated circa 1300 B.C. (Tripathi 1990). The development of iron production in India that occupies an important place in the south Asian zone and the reputation of `wootz' steel spread over the ancient world.

The metallurgical aspects of this study mainly focused on analyzing the materials that came from the excavations of Dikyaya-kanda (SIT 22) at Vavalavava and Dehigaha-ala-kanda (SIT 1/KO 14) at Alakolavava and iron smelting sites around the area in order to identify the processes and products of the technology that the smelters used. Special attention has been given to showing how this technology is reflected in other aspects of culture and social structure.

In addition to analyzing the historical and archaeological records, ethnographic reports, and ethnohistorical research on ancient iron technology in the island, this study looks at how the iron smelting technology compared with known production technology elsewhere in the world. This study, as detailed in Chapter 2, made extensive use of the metallurgical principles of iron technology.

Consumption of Environmental Resources

There are a few investigations on iron production in the island that help to establish a connection between environmental resources and iron production. The study of environmental resources in the area is an attempt to provide probable clues for the research problem related to the concurrent factors which determined the choice of KOB for iron production. According to studies of the connection between technology and resources, there is probable evidence in the Sri Lankan context for a correlation between them (Seneviratne 1990; Deraniyagala 1992; Juleff 1998).

The main raw material for iron production is iron ore. According to revealed evidence that is described in previous chapters, there is no clear archaeological evidence of the huge magnetite ore deposit which was used to smelt iron in the KOB. But the occurrence of magnetite ore at the excavation sites and in the surroundings indicates that there was a large deposit of iron ore at the nearby environment. The main reason for the existence of such large-scale production sites in this area is the fact that there was an anthro-magnetite deposit situated in the vicinity. According to the present study, the area has yielded evidence of iron smelting from the Nagolla Vava to the Minneriya Vava at an industrial level. If so, there would have been a great economic advantage, as the production would have been carried out in a place where the raw material could be obtained close by, rather than being transported from elsewhere.

The other main raw material for iron production is fuel. Wood was used by the ancient iron smelters as the main source of fuel in the production process. The ability to do so depended on the natural vegetation. Wood was used on a large scale as fuel during the smelting process as well as before the smelting process, when it was used for roasting the ore and pre-heating the furnace. Most of the species of wood that have been recorded as being used in iron and steel production are found in and around the Kiri Oya basin as well as in the study region (see Chapter 2). *Madhuca longifolia* (Sin. mi), *Schleichera oleosa* (Sin. Kon), *Syzygium assimile/gardneri* or *Eugenia assimile/ gardneri* (Sin. damba), *Vitex pinnata* (Sin. milla), *Wendlandia bicuspidata* (Sin. Wanaidala), *Anacardium occidentale* (Sin. Kaju) and *Cassia auriculata* (Sin. ranawara) are the commonest species that were used in iron production and this area was rich in them. Even at present the area is covered with a high dense forest of the wood species mentioned above.

The drainage system of the area mainly depends on the Kiri Oya and its tributaries that provide the main factor, that is, sufficient water for production. Clay must also be considered an important raw material that was very often used for constructing furnace walls. The richness of the Low Humic Gley soils in the area could provide clay for the construction of furnaces.

Although the Kachchan wind lashes with high velocity through the area, the nature of the furnace construction i.e., being built below the ground level (as detailed in Chapter 7), it cannot be suggested that a natural draught was used for the production process. However, the back wall of the furnace provides clear signs of the use of a forced draught (bellows) operated system. There is clear evidence for the use of the wind as a natural draught in the smelting activities of the Samanalavava furnaces (Juleff 1998.). Further studies are required to establish whether the wind power principle was used in the neighboring area in the KOB which has high velocity wind as in Samanalavava and is covered with high mountain ranges. It is also located in a place where the channeling effect of wind occurs.

In the iron smelting process that was practiced in ancient times, there was some evidence of limestone ($CaCO_3$) being used as a flux. According to the analysis report on iron ore and slag samples from the site, it seems that the smelters added silicon and calcium containing fluxing agents during the process. Silicates of the ore also act as a fluxing agent. Limestone in the area may have been used for their production.

The richness in high quality iron ore - magnetite, the use of high temperature yielding wood as fuel, and the accessibility of water resources for use in production activities indicate the signs of a high technological level of production in the area. When considering the above data, it can be suggested, that the technological system was connected with environmental factors in the area, such as the presence of iron ore, wood and water. This may be the main reason the KOB area was chosen for iron production activities.

Quality of the Production Process

According to the revealed data, it seems that the smelters of the site had the ability to control the heat and also to gain a high temperature in the furnaces essential for the success of the production process. The smelters used advanced techniques to avoid cold zones and to distribute the air equally to the smelting zone by using eight tuyeres for one furnace and a high shaft. The main advanced technique used to achieve the above demand was the narrow construction of the reduction zone. The furnace orientation was on a east-west axis; the construction of the shaft was of fundamental significance in the development of iron metallurgy.

Therefore, it is very interesting that the excavation has shown that this technology was first practiced in Sri Lanka in the 1st millennium B.C.

Very high quality iron ore was used, such as magnetite, to produce steel directly in the bloomery furnaces in the KOB to make sharp edged weaponry for war and agricultural implements. The piece of iron found attached to the bottom slag of the furnace proved that there had been direct production of steel practiced at the site (Appendix G). Different types of found slags were analyzed. The results have established that the iron production would have been of high quality and that the smelters had the ability to extract a large amount of iron compared to the amount in the ore. The size of the furnaces indicate that large quantities of high quality iron, and probably steel, would have been produced. Such production would have far exceeded the requirements of the locality. It may be that the iron was used not only within the country, it could even have been exported. This suggests the existence of a highly developed transport and trade system. Within the island there had to be a trade system that connected the island to the outside world.

^{14}C dates indicate that the industry in the KOB was productive between the 2nd century B.C., and the 4th century A.D., even before the main construction period of the 5th century A.D., Sigiriya kingdom.

The Role of Iron in the Region

Agriculture helped the expansion of the protohistoric settlements in Sigiriya which flourished around the waterways in the area. In the second stage of the evolution of an agricultural society, and the opening up of new social structure in the early historic period, a demand was created for more extensive use of high quality iron and steel.

The emergence of minor irrigation networks which gave rise to large irrigation systems and the food surplus that resulted from that system most likely would have created a favorable background for the adoption of new technological methods. These factors may have contributed to the emergence of Sigiriya as a suitable location for urbanization. Therefore, in the light of this, and the various excavations conducted around Sigiriya, it becomes clear that even long before the 5th century urbanization, there were iron production and related socio- economic activities in the Sigiriya area. Similarly, a thorough study of ancient economic patterns indicated that the economic structure of the *raja rata*, which is, dependent on the irrigated-agro economic system, was based on iron use.

The use of a hard stone like granite in Sri Lanka's finest ancient architectural edifices and sculptures, provides more evidence of high quality iron production in Sri Lanka from the beginning of the first millennium B.C. to the pre-modern era. In the 1920s the archaeologist Hocart observed that the transition from limestone to granite as a building material took place in the 5th century A.D. He drew special attention to the use of "square hammered stones" in the constructions of the Sigiriya fortress wall and the cyclopean style stone walls at Mapagala (Figure 8-1A). The ability to cut massive blocks of granite of the types mentioned above probably depended on major developments in the production of iron and steel in the Sigiriya hinterland. These finds provide further support of the high quality of the granite carving of the stone thrones in the assembly hall and in the palace on the summit of the Sigiriya rock (Figure 8-1B).

The approximate volume of iron production can generally be estimated from the amount of slag remaining on the site. However, most slags remain buried under soil layers. According to rough calculations, more than 10,000 tons of iron had been produced at SIT 1. A study of the high technological knowledge possessed by these iron masters, the highly developed furnaces used in the process, the high iron content of the ore used, the iron content of slag, all these make it clear that the iron masters in the KOB were capable of producing very high quality iron relative to the amount of raw material used. The high quality of iron produced, the quantity of output and the nature of the organization of production suggest an industrial level production for use beyond the Sigiriya-Dambulla Region (SDR), for local purposes such as agriculture and war, and even possibly for export. There is written evidence that blacksmiths of the Kandyan period used to supply a certain quantity of steel for the royal treasury as their service rent or *rajakariya* annually.

A   B

Figure 8-1. Granite constructions in Sigiriya. A) The fortifications at Mapagala. 3rd –5th century A. D. Photograph by M. Upananda. B) A granite throne at the top of the Sigiriya Rock. 5th century A. D. Photograph by R. Solangaarachchi.

A total of 48 iron production sites including about 19 of similar magnitude have been found so far in the area. There are some records, in neighboring India, at the Early Historic site of Kamrej, which is situated on the banks of the river Tapi. This site dated to the same period as the excavated iron production sites in the KOB (especially SIT 1). Kamrej was mentioned in a Greek maritime guide *Periplus Maris Erythraei* as a coastal trading station engaged in the export of iron to the Red Sea littoral and the Mediterranean region. In considering ancient production systems, there is evidence to suggest that the distribution of Sri Lanka's natural vegetation and natural resources played an important role in its socio-economic patterns in the ancient periods.

The iron industry might have influenced the economic and political development of the island during the pre industrial era.

A study of the high technological knowledge possessed by these iron masters, the highly developed furnaces used in the process, the high iron content of the iron ore used, the iron content of slag-all make it clear that workers were capable of producing very high quality iron relative to the amount of raw material used. The high quality of iron produced, the quantity of output and the nature of the organization of production suggest an industrial level production for use beyond the SDR and the Samanalavava area for local purposes such as agriculture and war, and even for export.

As early as the 3rd century B.C., steel implements must have been used to carve the Early-Brahmi cave inscriptions on hard surfaces like granite. With developments over time, steel production in Sri Lanka reached its zenith during the 5th century A.D. This development was probably a major reason for the transition that occurred from limestone to granite as building material. The extensive distribution of rock sculptures of outstanding artistic quality provides a good example of the quality of traditional iron and steel implements. The importing of iron and steel implements from Europe during the colonial period and the inability of indigenous iron producers to adapt to new advances in technology led to the decline of indigenous iron and steel production in Sri Lanka.

Settlement Patterns and the Chronology in the KOB

According to research on ancient settlements in the region, it can be suggested that there are some indications of settlement patterns and social structures that could have been based on iron production activities. Basically, this research is focused on the consideration of whether there was any connection between the urbanization of the area and the iron industry, or whether iron technology was the significant factor for the urbanization of the area.

The technological evolution of the Sigiriya-Dambulla Region (SDR), as discussed previously, is clearly indicated in two phases of technological development from the prehistoric period to the protohistoric- early historic period. The protohistoric - early historic transition mainly appeared with irrigation based iron using early agricultural communities (Bandaranayake 1990; 1994). The construction of the units of the hydraulic networks, as well as agricultural demands, depended on the use of iron tools. Therefore iron producing activities may have played an important role among the settlers who were engaged in the Dry Zone economy.

The main hydraulic work around the SDR appeared from the 1st century B.C. to the 5th century A.D. and caused a food surplus in the area. This might have been based for suitable environmental conditions in the area for urbanization. According to Bandaranayake, during the Early and Middle Historic Period, the study region appears to have been an area of medium population. He presented this argument based on the much lower tank density of the area compared with those of surrounding areas (Bandaranayake 1990). The appearance of a lesser tank density is seen more clearly in both basins of the Kiri Oya. The important question that arises is, what is the significant factor for the appearance of a lesser tank density.

As discussed in Chapter 3, the crystalline limestone band was mostly spread through the western part of the KOB; limestone is not conducive to agriculture. On the other hand, these areas were rich in the major raw materials of the iron smelting process or they could have been easily transported there. Therefore the settlers of the area might have used these lands for conducting iron production activities on mass scale as a first priority over agricultural production.

As described in Chapter 3, several irrigation works were constructed and war campaigns were conducted by the main rulers during the period of history connected with the KOB. This connection lasted not only from the beginning of the 1st century A.D. to the 4th century A.D., but also continued to the 19th century. The main question is; why did history reserve an important place for the KOB. It might be due to the fact that the mass production of iron in the area fulfilled the major demands of the socio-economic system such as agricultural, hydraulic needs as well as war requirements. The route network, which went through the region, might have helped to transport them through the major trading centers.

According to data provided in this study, it is clear that iron technology was the significant factor for the urbanization of the area. There is clear evidence of instances in which settlements were abandoned for several years when the production process collapsed. King Kasyapa may have selected Sigiriya to build his capital because the area was already developed with an agricultural and industrial economy based on a well-organized iron industry during the reigns of King Mahasen (269-296 A.D.) and King Kithsirimevan (296-324 A.D.) those who constructed major irrigation net-work in and around the KOB. The most probable second reason that derives from oral traditions. It ties with the King Kasyapa's maternal kinship with the "yaksha" people who lived in the KOB. "Yaksa" refers to Yamanno or "Yakku" caste (Chapter 4).

The emergence of Sigiriya as the capital city must have greatly affected the Kiri Oya valley and there would have been an inter-connection between the Kiri Oya valley and the Anuradhapura kingdom even before the 5th century A. D. (Manatunga 1990: 76). The economic surplus that occurred through the well organized socio-economic system based on a developed material culture may have enabled the 5th century urbanization of the area. The main granite construction of Sigiriya and crucible fragments unearthed during the SIT project provide evidence of steel production being established in the area.

According to the revealed data, we can trace three main phases of the history through inscriptional evidence (Table 8-1). Radiocarbon dates confirmed the main occupancy of these periods. Both inscriptional and radiocarbon data have provided evidence of the settlement expansion in the KOB between the 2nd century B.C. and 10th century A.D. with three identical occupation phases: 2nd century B.C.- 1st century A.D.; 2nd century A.D.- 5th Century A.D.; 7th century A.D.- 10 century A.D. (Figure 6-41; Table 8-1).

Table 8-1. Three main occupied phases in the KOB

3rd century B.C. -1st century A.D.	2nd century A.D. -5th century A.D.	7th century A.D. 10th century A.D.
*3 inscriptions Vavala Monastery, SIT 6	*1 inscription Vavala Monastery, SIT-6	*2 inscription Peikkulama, SIT 51 Peikkulama, SIT 53 *1 inscription Nuwaragala, SIT 84 *1 inscription South Kosgaha-ala, SIT 12
*2 ^{14}C dates Vavala Monastery, SIT 6 *1 ^{14}C date Dehigaha-ala kanda	*4 ^{14}C dates Dehigaha-ala kanda, SIT 1 *4 ^{14}C dates Dikyaya-kanda, SIT 22	*1 ^{14}C date South Kosgaha-ala, SIT 12

Production Organization of Iron Smelting Community

When considering the survey data presented in Chapter 5, it seems that it would have been a well-organized production organization controlling the quantity of smelting output in the KOB. Small smelting sites in the KOB may have been able to meet the demand of the family and the demands of the village that were controlled by urban units. The nature of the organization of large production centers suggest an industrial level production that was engaged in supplying the needs of the area for local purposes such as agriculture, the demands of the major political centers for materials needed for security purposes, and possibly for exporting demands. Demands of the area might be controlled by organized urban societies in small trading centers. A corporation would have controlled well-organized trade or distribution centers.

The region might have been mainly occupied with supplying the demands of the major political centers through the *rajakariya* (service to the king) system throughout the major economic or trading centers. But we do not have literary sources that would give idea of who were the resource controllers in the KOB. The management of the environmental resources of ancient Sri Lanka played a vital role in the high technological development of production. In ancient times resources were used only for religious purposes. Then economic power passed on to different social groups and gradually became the property of organized ruling centers or the centralized ruling center.

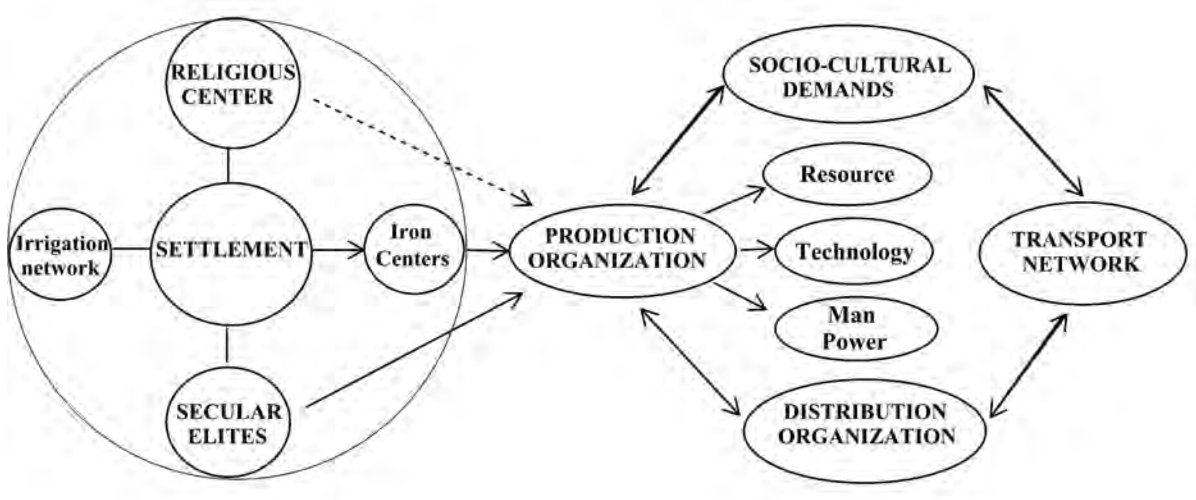


Figure 8-2. The model showing the production organization in the KOB (after Solangaarachchi 1999).

As discussed in previous chapters, we could find the ancient *rajarata* settlement pattern in the KOB. The settlement, monastery and the reservoirs are the major structures of the rajarata settlement pattern. The observed survey pattern of the KOB has illustrated that (Figure 5-7; 5-8) the settlement system of the KOB is consisted with a Buddhist monastery, sector of secular elites, commoners settlements, irrigation network and iron centers. Representatives of the social strata of this settlement system may have connected well with the resource management, production and distribution organization (Figure 8-2).

Buddhist monastic order in the KOB is in the upper level of the hierarchical system. Their habitations are located on the top of the mountain ridges as symbolizing their authority over the landscape (Chapter 5). Secular elites habitations are attached to the sacred sites and in between sacred and common habitants' zone. Village reservoirs and (resources?) are located in the outer zone. Locations of iron centers are mainly depend on the availability of raw materials. The industrial zone (including the ore-crushing site, SIT 97 and the area consisted with larger blocks of iron ore/deposit, SIT 101) in the selected pattern of Dehigaha-ala cluster (Figure 5-8) is located close to the sacred and secular elites zones. We can see this settlement distribution pattern all over the KOB in small variations (Figure/s 5-2; 5-7). It can be assumed that secular elites had direct involvement to the resource management system and the monastery had the direct or indirect involvement (Figure 8-3).

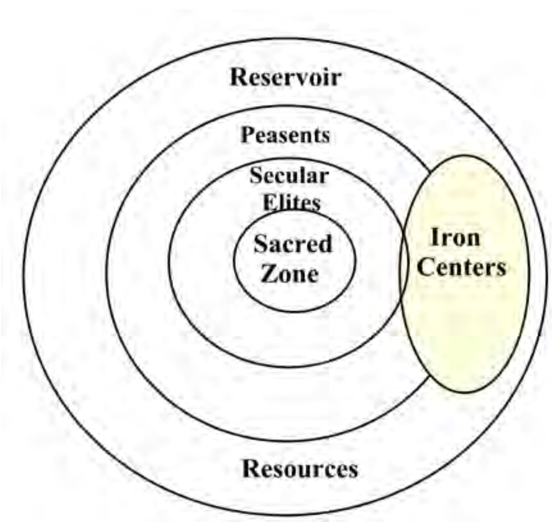


Figure 8-3. The model showing the settlement distribution pattern in the KOB.

Sacred and Secular Elites Involvement in the KOB

The administrative power of monastic or religious centers of the area also appeared from the 3rd/ 2nd century B.C. to the 1st century A.D. The monastic complexes of the area were important as major centers of the socio-political and economic organization of the region. Through the spatial analysis and material culture of the KOB we could see the how the hierarchical order organized in the landscape.

Ample inscriptions that were written from 3rd century B.C. (in early Brahmi script) to the 10th century A.D. (Sinhalese letters) in the SDR provide a reliable source of information on contemporary social structure and various donations to Buddhist monasteries (Paranavitana 1970; Ranawella 1984; Somadeva 1994). These inscriptions mostly provide information on ancient donations to sanga or Buddhist monasteries made by people in different social strata. The most common tittles that appeared in cave donations in the KOB are *parumaka* and *gamika*. While *parumaka* referred to secular elites strata in the administrative system, *gamika* identified a village leader or householder (Ellavala 1969; Paranavitana 1980). Fourteen parumakas are reported in the SDR (Somadeva 1990).

There are several titles that appeared in KOB inscriptions: *parumaks* and *gapati* on the Inscription No. 2 in the Vavala monastery dated 3rd century B.C. to 1st century A.D.; Scriber (*lekiya*) and a chief (*jeṭa*) on the Inscription No. 4 is dated 4th century A.D. (Appendix L). In addition the Peikkulama pillar inscription is dated in the reign of King Udaya II (887-898 A.D.) and provides royal titles: administrative officer, security officer and chief secretary (ASCAR 1956, p 12 No. 27). Vavala Inscription No. 3 mentions about area “chiefs” who privately owned reservoirs (4 *vaviya*), paddy fields (2 *kumbura*) and a cave (1 *guha*). Tonigala inscription also represents the period of King Kithsirimevan mentions *vavi hamika/vapi-hamika* –as the proprietor of the reservoir (Paranavitana 1970:121). According to the inscriptional, archaeological and ethnographic data, it clearly shows the identical hierarchical system that appeared in the KOB settlement (Figure 8-4).

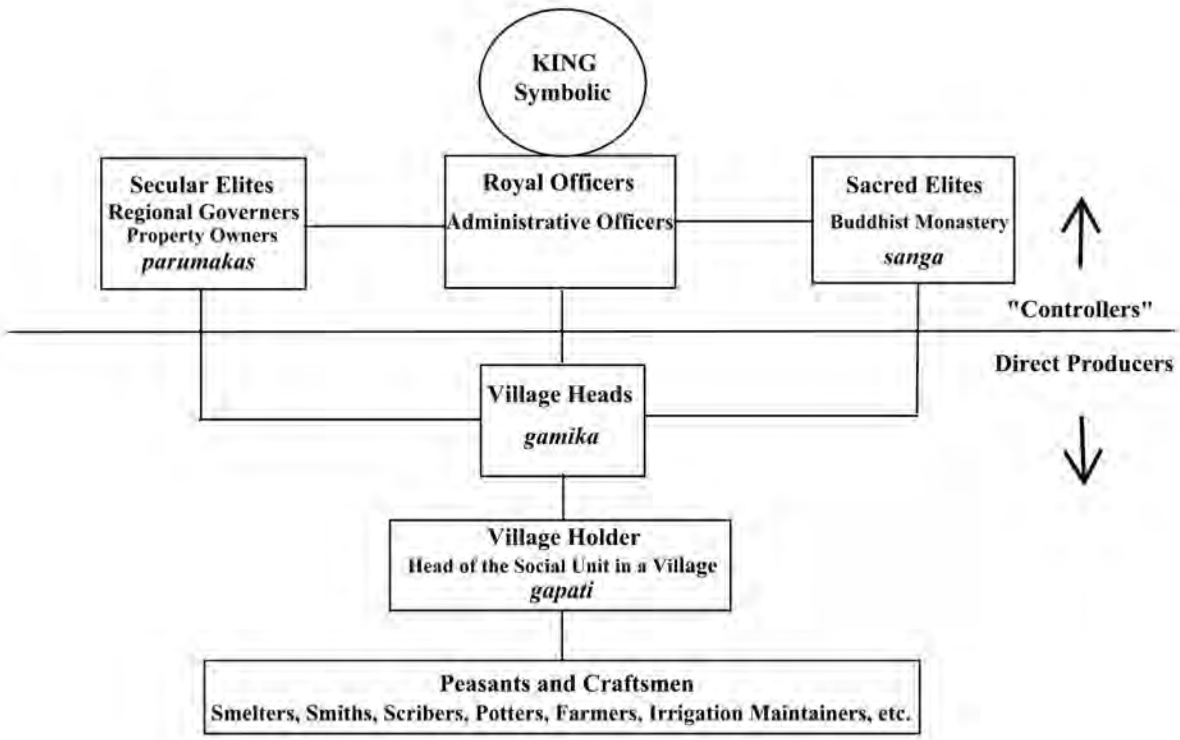


Figure 8-4. The hierarchical system appeared in the KOB settlement. Main idea for this system was obtained from Bandaranayake's "Pre-Modern Structure" (Bandaranayake 1990c).

Ganekande Vihara inscription (1st century B.C. - 1st century A.D.) provides a valuable source for an organization that had a vice president from the caste of the ironsmith. According to the inscription, an ironsmith *naga* was a vice president *(anu-jeta)* of a social organization or a corporation *(puga)* and it indicates the status and the position, which the ironsmith had in the society (Paranavitana 1970). It may provide a probable clue, that heads of ironsmiths would have their own distribution organization. This evidence provides most probable proof for identifying the social strata/s that were involved in the production organization and the resource management.

Are there any Signs of “The State of Theocracy” in the KOB?

Shaw’s studies on Sanchi, the Buddhist monastic complex site in Central India (Shaw 2000), Sinopoli’s study on Vijayanagara period settlement in India (2005), Gunawardana’s study on the socio-religious structure in early medieval Sri Lanka (1979), Bandaranayake’s monastery and the spatial organization of the Buddhist monastery complexes of the Early and Middle Historical Period (1989; 1990c), the concept of “the State of Theocracy” presented by Coningham, Gunawardhana, Manuel and Adikari. et al. (2007) are recent studies mainly focused on Buddhism and its connection with the socio-economic system in the society.

Survey data in the KOB could trace the socio-religious mechanisms and “the internal dynamics of Buddhism” in the KOB and the dialectical relationship between Buddhism and the surrounding settlement. It cannot be suggested that there were any signs of the “state of theocracy.” Shaw (2000), Sinopoli (2005), Coningham, Gunawardhana, Manuel and Adikari *et al.* (2007) have conducted their studies in areas where major sacred cities or major administrative cities are located. The settlement pattern organizations in the landscape in sacred cities showed a much difference from the KOB settlement pattern. The settlement pattern in the KOB did not provide exactly separate different zone variations as were shown in major sacred cities in ancient Sri Lanka.

Although the Buddhist monastic order in the KOB represents the visible upper level of the hierarchical system in the KOB landscape, we could trace the invisible power of the king through inscriptions. The Peikkulama inscription clearly shows the royal immunity grants were made by royal officers to the Abayagiri Mahaviharaya under the “royal seal.” Centralized political structure was maintained by loyal bureaucracy and regional governors. Inscriptions spread over the country provide evidence for royal grants to Buddhist monasteries all over the country. Kings's power symbolically spreads over the landscape through inscriptions and royal officers who were the representatives of the upper level of the hierarchical system. Throughout the history, political leaders have used religion to promote and justify their views and policies. When we look at this evidence, it is doubtful to consider that ancient Sri Lanka was a state of theocracy, even though we could trace the role of Buddhist monasteries as ritual centers and the administration centers in the socio-economic system of ancient Sri Lanka.

APPENDIX A
GLOSSARY I – LOCAL TERMS

achari	smith/metalsmith/blacksmith
ala	small stream
attani	(attani pillar inscription: inscriptions erected by a king showing immunity grant to a monastery or legislative proclamation to inhabitants. These inscription represent the period between 700 to 800 A.D.
chena	large portions of land which have from time to time been cleared of forest by burning for the cultivation of non irrigated crops
chekku	a traditional method of oil extraction from coconut using a bull which turns a loaded wooden pestle in a large stone mortar
devalaya	a religious place dedicated to a local deity
kabouck	laterite
ketta	knife made of iron or steel for hard working
mahabodhi	the sacred Bo tree at Anuradhapura, still preserved as a living monument. It was brought from India. It is the southern branch of the Bo tree at the foot of which the Buddha attained enlightenment.
mahaviharaya	the major monastery of the Anuradhapura kingdom. It continued to have its influence subsequently. The Buddhist monks who lived here the *theravada* (one of the two major schools of Buddhism found in Sri Lanka) point of view.
nuwarakalaviya	area covered by the catchment area and the area fed by Nuvaravava Kalavava and Padaviya vava
oya	large stream
pabbata vihara	a kind of Buddhist monastery which was mentioned in the inscriptions dated 1st -2nd centuries AD
pana povanawa	quenching
rajakariya	compulsory service to king
rajarata	in ancient times Sri Lanka was divided into three parts, Ruhunu, Maya and Pihiti or rajarata. Rajarata was demarcated by Mahaweli ganga and the Kelani Ganga on the south

thalimana	foot bellows used for iron production
vaddas	aborigines of Sri Lanka.
vangi nalama	tuyere
vava	man made reservoir for irrigation that was wrongly named as a tank during the colonial (specially British) Period
yabora	iron slag
yakede	iron
yamanno	iron smelters
yapas	iron ore
yalhulanga	two main cultivation seasons in Sri Lanka are *yala* and *maha*. *kachchan* winds (South-west winds) that blow in the *yala* season from May to August, locally known as *yalhulanga*.

APPENDIX B
GLOSSARY II – TECHNICAL TERMS

alloy	a substance consisting of two or more elements of which at least one metal
annealing	heating the metal in a fire for a short time to a moderate temperature to reduce the hardness or to produce a structure suitable for further treatment
archaeometallurgy	science which studies ancient metallurgy in its widest sense from its beginning up to the industrial age
austenite	iron crystallized in a face-centered cubic lattice with one iron atom in each cube face
Balangoda man	Balangoda Mesolithic man. *Homo sapiens balangodensis*. Now regarded as *H. sapiens sapiens* (the species of modern man)
case-hardening	cementing to harden the surface of metal by localized heating and quenching of the surface
cast iron	brittle and not malleable iron with more than about 2% carbon
cementite	a compound of iron (Fe) and Carbon (C), Fe3C which is a very hard magnetic constituent with a complex, form in steel
charge	quantity of raw material in a furnace
cold hammering	hammering at normal temperature
fayalite	crystalline iron silicate (Fe2SiO4)
ferricrete	a near-surface crust of material cemented together with iron oxide
flux	a substance added to a furnace charge which combines with those constituents not wanted in the final product and issues as a separate slag
gangue	minerals of little economic value which are associated with metallic ores
haematite	Fe_2O_3 is the outermost lightest iron oxide in the forge scale
iron bloom	the lump of iron in a solid state reaction below the melting point

limonite	$Fe_2O_3.nH2O$
magnetite	Fe3O4 -is the black, magnetic, dense iron oxide
martensite	a supersaturated solution of carbon in ferrite (a-iron) formed by rapid cooling, quenching of austenite
native copper	copper available in the ground in bulk metallic from
quenching	water treatment in hardening steel by plunging it at a red heat into cold water, oil etc.
steel	iron carbon alloy with carbon less than 2%
tuyere	a clay nozzles/pipes attached to the furnace wall to orient the air produced by bellows
wrought iron	pure iron made by direct process
wustite	iron oxide FeO occurring on a large scale and are common in iron slag where it exits as light, rounded dendrites in a matrix of silicate

APPENDIX C
THE FOLK SONGS ON ANCIENT IRON SMELTING PROCESS IN SRI LANKA

Iron Smelting

යකඩ නිස්සාරණය
yakađa nissaranaya

1 අතක් කවිසි කවිසියා - කකුල කවිසි කවිසියා
1 atak kavisi kavisiyā - kakula kavisi kavisiyā

2 මෙඅත අඹයි යමනා - මෙපය අඹයි යමනා
2 me-ata ambayi yamanā - me-paya ambayi yamanā

3 හම් පාගයි යමනා - යගලද යයි යමනා
3 ham pāgai yamanā - yagalađa yai yamanā

4 බොරේ විදියි යමනා - බොර ගොඩලයි යමනා
4 borē vidiyi yamanā - bora gođalayi yamanā

5 මහ බඩගෙඩි යමනා - කන්දේ යයි යමනා
5 maha bađagedi yamanā - kandē yai yamanā

6 කන්දෙ නොයන්නයි කීවේ - යගලට යන්නයි කීවේ
6 kandē noyannayi kivē - yagalata yannayi kivē

7 හම් පාගන්නයි කීවේ - යකඩ සදන්නයි කීවේ
7 ham pāgannai kivē - yakada sadannayi kivē

Iron Smelting

1	Blessing the arm	-	Blessing the leg
2	Iron smelter uses the arm	-	Iron smelter uses the leg
3	iron smelter treads the bellows	-	iron smelter goes to the iron ore
4	iron smelter pierces the slag	-	iron smelter brings out the slag
5	iron smelter with big pot-belly	-	iron smelter goes to the hills
6	I was asked not to go the hill	-	I was asked to go the iron ore
7	I was asked to tread the bellows	-	I was asked to produce the iron

Iron Forging

. යකඩ තැළීම
. *yakada talima*

1 Kirihälayā
1 කිරිහැලයා

2 කවුද කතා කළේ - කන්දේ ගුරා
2 kavuda katā kelē? - Kandē Gurā

3 මක්කටද ආවේ ?- යකඩ තලන්න
3 makkatada āvē? - yakada talanna

4 මක්කද ගෙනාවේ - මුරුංගා
4 makkada genāve? - murungā

5 කෝටුං බෝටුං අපට මොකටද ?
5 k*ōtum bōtum apata mokatadā?*

6 අපි ඒවා කන්නේ නෑ - වත්තෙන් පහළට කෝඩුං පෝ
6 api ēvā kannē nā - vatten pahalata kōdum pō

7 දුම්බර මහගෙට ඇවිලු පන්දම කවුද නිවන්නේ ?
7Dumbara mahageta ävilu pandama kavuda nivannē?

8 කිරිහැලයා
8 Kirihälayā

9 කවුද කතා කලේ - කන්දේ ගුරා
9 kavuda katākelē? - Kandē Gurā

10 මක්කටද ආවේ? - යකඩ තලන්න
10 makkatada āvē? - yakada talanna

11 මක්කද ගෙනාවේ - වම්බටු
11makkada genāve? - vambatu

12 වම්බටු තොම්බටු අපට මොකටද?
12 vambatu tombatu apata mokatadā?

13 අපි ඒවා කන්නේ නෑ - වත්තෙන් පහළට කෝඩුං පෝ
13api ēvā kannē nā - vatten pahalata kōdum pō

14 මල්ලියා සරිමං නයිදෙත් සරිමං
14 malliya sariman Nayidet sariman

15 කම්මල් වත්තට ගෙන්නු පන්දම කවුද නිවන්නේ?
15 kammal vattata gennu pandama kavuda nivannē?

16 දීරෝ දීරෝ
16 Dirō Dirō

17 කවුදැයි කවුදැයි කතා කරන්නේ?
17kavudäyi kavudäyi katākarannē?

18 කන්දේ දූරයා කතා කරන්නේ
18 Kandē Durayā katākarannē

19 මන්දැයි ආවේ ? - යකඩ තලන්න
19 mandäyi āvē? - yakada talanna

20 මොනවද ගෙනාවේ - මැකරල් මිටියක්
20 monavada genāvē? -makaräl mitiyak

21 අපි ඒවා කන්නේ නෑ - වත්තෙන් පහලට කෝඩුං පෝ
21 api ēvā kannē nā - vatten pahalata kōdum pō

22 දීරෝ දීරෝ
22 Dirō Dirō

23 කවුදැයි කවුදැයි කතා කරන්නේ?
23 kavudäyi kavudäyi katākarannē?

24 කන්දේ දූරයා කතා කරන්නේ?
24Kandē Ddurayā katākarannē

25 මන්දැයි ආවේ? - යකඩ තලන්න
25 mandäyi āvē? - yakada talanna

26 මොනවද ගෙනාවේ - වට්ටක්කා ගෙඩියක්
26monavada genāvē? - vattakkā gediyak

27 දරත් බාරත් අපි කන්නේ නෑ - අපේ කම්මල නොගනිති ඒවා
27 dārat bārat api kannē nā - apē kammala noganiti ēvā

28 දීරෝ දීරෝ
28 Dirō Dirō

29 කවුදැයි කවුදැයි කතා කරන්නේ?
29 kavudäyi kavudäyi katākarannē?

30 කන්දේ දූරයා කතා කරන්නේ
30 Kandē Ddurayā katākarannē

31 මන්දැයි ආවේ - යකඩ තලන්න
31 mandäyi āvē? - yakada talanna

32 මොනවද ගෙනාවේ - පුහුල් ගෙඩියක්
32 monavada genāvē? - puhul gediyak

33 අලු දොස් දිය දොස් අපි කන්නේ නෑ
33 alu dos diya dos api kannē nā

34 අපේ කම්මල නොගනිති ඒවා
34 apē kammala noganiti ēvā

35 කිරිහැලයා
35 Kirihälayā

36 කවුද කතා කළේ? - කන්දේ ගුරා
36 kavuda katākelē? - Kandē Gurā

37 මක්කටද ආවේ? - යකඩ තලන්න
37 makkatada āvē? - yakaka talanna

38 මක්කද ගෙනාවේ? - හාල් කුර මල්ලයි, ලුනු කුර මල්ලයි
38 makkada genāve? - hāl kūra mallayi, lunu kūra mallayi

39 හරි හරි දූල්ලා මගේ දූල්ලා
39 hari hari Dullā, magē Dullā

40 මං කන කෑමත් උන්දෑ දනිතෙයි මං බොන බීමත් උන්දෑ දනිතෙයි
40 man kana kämat undä daniteyi, man bona bimat undä daniteyi

41 කුනාගෙ යකඩත් මංම තලඤ්ඤයි
41 Kunāge yakadat manma talaññayi

42 කුනීගෙ යකඩත් මංම තලඤ්ඤයි
42 Kunige yakadat manma talaññayi

43 උන්දැගෙ යකඩත් මංම තලඤ්ඤයි, මංම තලඤ්ඤයි
43 undäge yakadat manma talaññayi, manma talaññayi

Iron Forging

1	*Kirihälayā*		
2	Who is calling?	-	*Kande Gurā*
3	Why have you come?	-	I came to forge iron
4	What have you brought?	-	drumsticks
5	What do we need such woody sticks?		
6	We do not eat those	-	Throw them away/down from the garden
7	Who will put the torch off that was lighted up for madam *Dumbara*?		
8	*Kirihälayā*		
9	Who is calling?	-	*Kande Gurā*
10	Why have you come?	-	I came to forge iron
11	What have you brought?	-	bringjal
12	What do we need bringjal?		
13	We do not eat those	-	Throw them away/down from the garden
14	Little brother I am okey, *Nayide* I am okey		
15	Who will put the torch off that was brought to the smithy garden?		
16	*Dirō Dirō*		
17	Who is calling?		
18	*Kandē Durayā*		
19	Why have you come?	-	I came to forge iron
20	What have you brought?	-	a bundle of peapods/snake beans
21	We do not eat those	-	Throw them away/down from the garden
22	*Dirō Dirō*		
23	Who is calling?		
24	*Kandē Ddurayā*		
25	Why have you come?	-	I came to forge iron
26	What have you brought?	-	A pumpkin
27	We do not eat those	-	Our smithy does not accept those

28 *Dirō Dirō*
29 Who is calling?
30 *Kandē Dduraya̅*
31 Why have you come? - I came to forge iron
32 What have you brought? - An ash pumpkin
33 We do not eat those bad vegetables.
34 Our smithy does not accept those

35 *Kirihälayā*
36 Who is calling? - *Kande Gurā*
37 Why have you come? - I came to forge iron
38 What have you brought? - a bag of rice and a bag of salt
39 Oh yes *Dullā*, my dear *Dullā*
40 He knows what I eat, He knows what I drink
41 I will forge myself the iron that belongs to *Kunā*
42 I will forge myself the iron that belongs to *Kuna*
43 I will forge myself the iron that belongs to him, I will forge myself

Quenching

පණ පෙවීම
pana pevima

1 වනාන්තරේ ගල් උණුවෙනවා හේමා
1 vanantarē gal unuvenawā hēmā

2 ගමේ කම්මලේ මිටියේ වැඩ හේමා
2 gamē kammalē mitiyē väde hēmā

3 මඩේ බොරදියේ පණ රැකුණා හේමා
3 madē boradiyē pana rakunā hēmā

4 මෙතුන් පදේ කීවේ ගිරයට හේමා
4 metun padē kive girayata hēmā

Quenching

1 Iron ore is smelting in the forest
2 It turn to a areca-nut cutter (tool) with help of a hammer at the smithy
3 Quenching is done in the muddy water
4 These three lines here is described the method of making a areca-nut cutter

APPENDIX D
SITE CATALOG OF KOB

SIT 1 – Dehigaha-ala-kanda at Alakolavava
Iron smelting site
N 7°54’48”, E 80°47’05”, MSL 715’

This site is located approximately 5 ½ km southeast of the Sigiriya rock, 250m west of the Kiri Oya and the top of the southern part of the low mountain ridge Dehigaha-ala-kanda. The site is just north of the Dehigaha-ala-ulpotha, the perennial spring that is located in the Dehigaha-ala-tributary, one of the western streams of Kiri Oya. This site is registered as KO 14 under the SARCP (Manatunga 1990:80). The site is demarcated by the Premarathna’s chena land (onion cultivation) from the west and an abandoned paddy field from the east, which is located between the site and the eastern flow of the Dehigaha-ala. The Dehigaha-ala runs from south of the site and joins the Kiri Oya northeast of the site. The site spreads over an approximately 150m x 250m area. It seems that iron smelting activities were conducted only in the western part of the site that is spread over a 80m x 200m area. There is no western demarcation of the Kabouk/laterite terraced boundary wall or rampart that was observed from 1988 until 1999 (Manjusri 1990; Manatunga 1990; Solangaarachchi 1999), as a result of extending the cultivated land further east. But the remains of the southwestern part are still there and the protected site’s fortification can be seen (Manjusri 1990).

The presence of four drip-ledged rock-shelters at the eastern part of the site, a series of mortises and postholes on a rock boulder and an adjacent cave that would have been used to build a wooden construction, a cave roof with remains of lime plaster, a large amount of potsherds that are spread at these three rock shelters and the earth depression similar to a pond are indications that it has been occupied as an early Buddhist monastic center before being converted to an iron production center (Manatunga 1990). On the other hand; three large slag mounds with large blocks of slags, six `conical holes' on two flat rock boulders of the site, a large mound of earth mixed with charcoal and ash indicate that the site was used as an iron production site for a long period. Unfortunately, treasure hunters destroyed all the conical holes of the site between my last visit in 2000 and my visit in 2004.

The Dehigaha-ala-kanda iron production site was excavated and studied in detail along with an unearthed series of furnaces that have been used for iron smelting activities between the 2nd century B.C. and the 4th century A.D. (Forenius and Solangaarachchi 1994; Solangaarachchi 1999). Data revealed at the site are discussed in Chapters 5, 6, and 7 and comparison is made with the Dikyaya-kanda iron production site (SIT 22).

Bricks found at the southeast corner of the site are evidence of a rounded shape building construction that is made of brick found at the Sigiriya Royal Complex (20m x 23m x 8cm). The description of the site is given here as SIT 106.

SIT 2 – Dehigaha-ala-kanda at Alakolavava
Ancient Buddhist monastery complex
N 7° 55’05”, E 80°46’50”, MSL 715’

This site is located 5 ½ km southeast of the Sigiriya rock, 100m west of the Kiri Oya and 75m north (northeast) of the Dehigaha-ala-kanda iron smelting site (SIT 1) at the northern part of the Dehigaha-ala-kanda mountain ridge and 400m south of the Makarayāwala Ulpotha (N 70^0 55’10”, E 80^0 47’12”). It is registered as KO 17 under the SARCP (Manatunga 1990). Vavala Monastery (SIT 6) and Vavala Vava are located 3 ¼ km southwest and 4km southeast respectively. SIT 2 is approximately spread over 600m x 300m. Remains of a stūpa, a pond, a moulded *mal-āsana* (altar for offering flowers), stone pillars and stone slabs with moldings indicate that it had been used as a Pabbatha Vihara type Buddhist monastery during the late Anuradhapura period. Iron ore, brickbats, and potsherds are scattered on the flat land east to the site up to SIT 1. There is a terrace wall made by 1m x 1m stone blocks. I provide here detailed architectural descriptions as separate units with GPS readings as the architectural features are spread all over the area.

SIT 2 – I (Dehigaha-ala-kanda Buddhist Monastery Complex)
Stone slab-site
N 7° 54’ 56”, E 80°47’ 13”, MSL 615’

This is located in the southwest corner of the complex (SIT 2). There are several carvings on rock boulders for water drainage and some marks can be identified as breaking marks that can be made during the breaking process. Next to the boulder there are five stone slabs; two of these were damaged among them. One slab, measured 1 ½ m x 1m, has moldings on edges.

SIT 2 – II (Dehigaha-ala-kanda Buddhist Monastery Complex)
Mal-āsana (flower offering stone slab/alter)
N 7°54’ 58”, E 80°47’ 12”, MSL 623’

This is known as *mal-āsana* (alter for offering flowers) or *gal- anda* (stone bed) by villagers at Alakolavava. It is located 30m southeast of the complex (SIT 2) and measured about 3.30m x 1.40m. It has moldings on four sides and seems to have been used when the SIT 2 was active as a monastery. When I revisited the site in 2004, I found that it had been broken into several pieces by treasure hunters. South East of the *mal-āsana*, there is another boulder with carvings.

SIT 2 – III (Dehigaha-ala-kanda Buddhist Monastery Complex)
Pillar site/Bodhighara? (Bo-tree house/shrine)
N 7°54’ 58”, E 80°47’ 12”, MSL 614’

A small mound with four heads of stone pillars is located 25m from the northwest corner of *mal-āsana* (SIT 2-II). These pillars lie at the middle of the mound as in a line and are measured as 86cm in length/height and 22cm in width. Pillars are located between two boulders. South of the line of pillars, another unbroken pillar (200 in length/height) can also be seen.

Another stone slab lies (1m x 0.86m) to the north of the pillars. It could be the structure that has been identified as the *bodhighara* of the monastery (Manatunga 1990).

SIT 2 – IV (Dehigaha-ala-kanda Buddhist Monastery Complex)
Stūpa site
N 7°55’ 00”, E 80°47’ 12”, MSL 715’

The mound with 15meters diameter that is located 110m north of the mal-āsana could have been the *stūpa* of the monastery. Pieces of bricks and potsherds (red ware) are scattered all over the mound. There is a hole (1.38m in depth) at the middle of the mound that was dug by treasure hunters. There are five layers (rows) of bricks that can be seen inside the hole. Bricks are similar to those found at SIT 1 and the Sigiriya Royal Complex. (20m x 23m x 8cm).

SIT 2 – IV (Dehigaha-ala-kanda Buddhist Monastery Complex)
Pond
N 7°55’ 00”, E 80°47’ 13”, MSL 643’

This is a manmade pond (1.30m x 4m) that is carved on a rock boulder (5m x 25m) 20m northeast of *stūpa*. While three sides of the pond seem man-made, the eastern upper level remains a natural source of water. The rock boulder slopes north towards Makarayāwala Ulpotha.

SIT 3 – Valikadayaya at Dehigaha-ala-kanda
Settlement site
N 7°54’46”, E 80°46’ 58”, MSL 603’

This site is spread over 200m x 400m area; it is located just west of the Dehigaha-ala-kanda iron smelting site (SIT 1) and just north of Dehigaha-ala. Kirivadunna/Hirivadunna Vava, one of the reservoirs of the Alakolavava Village, is located 500m west of the site and signs of an abandoned reservoir could be seen at the southeastern edge and opposite bank of the Dehigaha-ala. There is an abandoned paddy field at the northeast corner of the site. A larger amount of potshards is spread over 200m x 200m and a lesser amount of potsherds are found further north, west and south of the Dehigaha-ala. Since 2008, this area has been used for onion cultivation continuously. Several heaps of potshards and iron slags can be seen at corners as farmers gathered them when they were preparing the land for cultivation. Therefore it is very hard to determine the exact locations of potsherds inside the settlement.

SIT 4 – Kosgaha-ala-ulpotha at Vavala
Iron smelting site
N 7° 53’05”, E 80° 46’ 40”, MSL 680’

This site is spread over a 150m x 150m area. It is located 200m southeast to Vavala Monastery complex, 800m northwest to Vavala vava, and 200m northwest to Kosgaha-ala-ulpotha (N 7° 52’57”, E 80° 46’ 52”). The area is rich in iron smelting remains; it is attached to the southwest bank of the *kapapu-ala,* a man-made canal that flows from the Vavala vava to the Sigiriya Maha Vava. Oral traditions of the area connect the construction of the *kapapu-ala* with King Mahasen. The site is spread over the opposite side of the *kapapu-ala* in east-west direction. The western half of this site is registered as a small pottery site (KO 56) that existed during the SARCP, because of the presence of a few pieces of brick fragments, one piece of tile and an iron slag (Manatunga 1990:84). The South Kosgaha-ala adjoins to the latter half as the eastern boundary. Today the land belongs to Weerarathne. The bund of the kapapu-ala runs just 2m behind his house and it indicates that the house was built after leveling the southern/western edge of the bund and the smelting site. The bund/mound is about 3-4meters in height (MSL 689’). According to Weerarathna, there were different types of beads, pinnacles and pedestals found at the site. When I was examining the profile of the bund, I could see a larger amount of potshards and iron slags, pieces of furnace walls, and conical shaped tuyere pieces. This is the first site that has recorded conical shaped tuyeres along the KOB. It seems that the bund was made at the top of the smelting remains with soil brought from the outside. Without proper excavation, it is hard to say whether the bund was built or rebuilt several times after or before smelting activities were conducted. This site is proposed for future excavation.

SIT 5 – Galwatta-hena at Vavala
Iron smelting site
N 7° 53’14”, E 80° 46’ 38”, MSL 704’

A mound with smelting remains that is located east of the Vavala monastery complex and in between the modern irrigation canal and the remains of the abandoned *Kapapu-ala’s* bund. The South Kosgaha-ala is about 450m east. Signs of a dried waterway run from east to south of the site. The pond (with the “Cobra-hooded” guard stone) that belongs to the Vavala monastery is located 100m northeast of the site. A path runs through the middle of the mound in an east-west direction and the eastern end turns towards the pond. The mound spreads over 30m from north to south and 20m from east to west. It seems that there are several furnaces in a north-south direction. Presently, one of the furnaces could be seen at the surface as the result of removing soil for preparing the path (2m wide) towards the pond. An open area has a iron melting remnant; iron slags, furnace walls and tuyere pieces. Several lumps of slags are scattered over the site. A brick wall that is 3 meters in length can be noticed southeast of the furnace remains. But without excavation it cannot be determined if both of them are representative of the same period. In addition, there are many potsherds and blocks of quartz that are visible at the surroundings.

A conical hole (15cm in diameter and 16cm in depth) on a flat rock boulder can be seen 110m northeast to the site close to the “Cobra-hooded pond” of Vavala Monastery (SIT 6-V). Some pieces of magnetite and quartz are also noticeable near the conical hole. The map of the site and description are provided in Chapter 6.

SIT 6 – Vavala -vava Monastery at Vavala
Ancient Buddhist monastery complex
N 7° 53’16”, E 80° 46’ 35”, MSL 820’

This monastery complex was built on a rocky hill slope (slopes to the east) facing the “remains of” the Kapapu-ala and the South Kosgaha-ala from the east, 750m northeast to the Vavala vava and approximately spread over 400m x 400m. This site is registered as KO 22 under the SARCP (Manatunga 1990:81). Three early Brahmi inscriptions (inscription No. 1, 2, and 4 in the Appendix L) and one late Brahmi inscription (Inscription No. 3 in the Appendix L) of King Kithsirimevan’s reign (son of King Mahasen) are engraved on rock boulders at the site. Description is provided in Chapter 6 and Appendix L. The latter was previously read by Benille Priyanke (pers. Com.) who identified it as King Kithsirimevan’s inscription about granting taxes to the monastery of paddy fields and from the vava (Manatunga 1990:82). Manatunga suspected that the Vavala Vava is the Reservoir mentioned in the inscription (ibid.). Although a former reading of this inscription was done for the SARCP, it was not published anywhere. Therefore, I made several estampages for getting a full translation. Malini Dias, the former Director of Inscription at the Department of Archaeology, read the inscription and made an English translation of the inscription for this research that is provided in appendix L. According to the new reading, there are several reservoirs and donors are mentioned in the inscription.

This is one of the largest monastery complexes with nine rock shelters (with drip-ledges), remains of a *stūpa*, a pond, a *bodhighara* (house for the bo tree/bo-tree shrine), *pilimagē* (image house) *siema malakaya* (Chapter House) and stone slabs with moldings. There is some probable evidence for using a *pabbatha* vihara type Buddhist monastery during the late Anuradhapura period. Description of some major constructions is provided next. Further details and the map are given in Chapter 6.

SIT 6 – I, (Vavala Buddhist Monastery Complex)
Cave with the inscription of King Kithsirimevan’s Reign (301-328 A.D.)
N 7° 53’08”, E 80° 46’ 39”, MSL 790’

The shelter of the cave faces east. Generally, most inscriptions have been carved above drip-ledges. Although this cave has a drip-ledge, its inscription has been carved on a rock boulder that is located inside and at the ground of the cave. It has two readable lines with 5 meters in length and 0.5 meters in width. The boulder slopes to the east. As villagers said, it was uncovered when the filling of the cave was removed for the modern construction. Today it is used as a *dana sala*. (a hall for alms giving). The modern iron fence that protects the inscription prevents photographing the inscription as one unit. At the entrance to the cave building, there is an undecorated *sandakada pahana* (moonstone). It seems to have belonged to the Early Anuradhapura period. But it is hard to determine the building’s age as being similar to that of the moonstone, as the site seems to be modified with several architectural features from different buildings during past decades. There are several tile pieces found at the site indicating that there was a tile-roofed building attached to the cave. Potshards are scattered in front of the building.

A test excavation was conducted in 2004. Revealed data and further details are provided in Chapter 6.

SIT 6 – II (Vavala Buddhist Monastery Complex)
Seenu-gala (Bell Rock) cave with an early brahmi inscription - No. 1
N 7° 53’15”, E 80° 46’ 32”, MSL 845’

This is an isolated rock boulder that is located further south of the complex. It has a drip-ledged cave with an early Brahmi inscription that is oriented to the east. The modern *ghanthara* (bell) of the monastery is placed on top of the rock boulder. It provides the best view of the area, when looking from the top of the rock. Details of inscription are provided in Chapter 6.

SIT 6 – III (Vavala Buddhist Monastery Complex)
Cave dwelling or ancient *pilimagē* ? (image house)
N 7° 53’15”, E 80° 46’ 32”, MSL 805’

This is a rock boulder that has an eastward oriented drip-ledged cave. The cave/rock shelter has ancient construction with thick plaster-coated large bricks and clay walls that divided the shelter compartments. As mentioned in the SARCP publication (Manatunga 1990), a torso of a small Buddha statue that is identified as representing the middle Anuradhapura period can still be seen at the rock shelter. Several pieces of brickbats, tile pieces and potshards are also seen at the site. The construction was most probably used as the *pilimagē* (image house) of the monastery. It has an eastern entrance with several steps.

SIT 6 – IV (Vavala Buddhist Monastery Complex)
Ancient *stūpa* site
N 7° 53’11”, E 80° 46’ 46”, MSL 705’

According to villagers, when the area was preparing for new settlement (Vavala Janapadaya) in 1971, there were remains of an ancient *stūpa*. Some architectural features of a *stūpa* construction can still be seen, such as a stone pillar, a limestone slab with squared middle cut mark, a foundation stone, a *chathraya* (60cm in radius) and a stone pillar. Brick and stone pieces are also found at the site. It seems that brick was used for building the surrounding wall of the *stūpa*.

SIT 6 – V (Vavala Buddhist Monastery Complex)
Nipena *ulpotha* (Cobra-hooded Spring) Pond
N 7° 53’15”, E 80° 46’ 52”, MSL 701’

This pond is located at the perennial spring; it is northeast of the mountainous area of the Vavala Monastery, just 100 meters northeast of the Galwattahena iron smelting site (SIT 5) and the northwest corner at the Kosgaha-ala-ulpotha Settlement Site (SIT 7). A “Cobra –headed” sculpture (guard stone) is attached to the east wall of the pond. This sculpture has seven heads.

According to the villagers, it was found *in situ* during the removal of the earth fill to recover the pond. This pond is measured as 30m x 15m. A larger amount of potshards, bricks and brick bats are scattered throughout the nearby area. Remains of two stone walls also can be seen near the pond. Other remaining features provide evidence for ancient architectural activity at the site.

A stream runs from east of the pond and joins South Kosgaha-ala at the northeast. There is a conical hole (15cm in diameter and 16cm in depth) on a flat rock boulder that is 10m southeast to the pond. There are some pieces of magnetite and quartz also noticeable in the vicinity. As mentioned above, the Galwatta-hena iron smelting site is located in close proximity.

SIT 7 – Kosgaha-ala-ulpotha at Vavala
Settlement site (west bank)
N 7° 53’14”, E 80° 46’ 46”, MSL 733’

Presently, this site is known as SA-05 or *Vanni Mama*’s (T.M. Dingiri Banda) land. Although under the SARCP it was registered as KO 52 and sufficient evidence was provided to identify the site (Manatunga 1990:84), it was not given detailed description. The site is demarcated east from South Kosgaha-ala, north from the small stream that flows from the pond of the Vavala Monastery to the South Kosgaha-ala, west (& northwest) from the Vavala monastery (SIT 6) and the Galvatta-hena iron smelting site (SIT 5) and south from the Kosgaha-ala-ulpotha iron smelting site (SIT 4). Rock boulders that are located northwest of the site can be seen as the demarcation of the monastery. The eastern part of the site slopes towards the South Kosgaha-ala. There are remains of two terraces made of stone blocks. Remains of kapapu-ala indicate that it flowed in the eastern sector of the site (in between SIT 7 and the South Kosgaha-ala).

The site spreads over a 300m x 500m area. But a densely pottery scattered area is only 110m x 175m. Densely scattered potshards (including lots of decorated ones), pinnacles, grinding stones, iron slag, iron ore confirm its usage as a habitation. Site extension couldn't be identified as farmers heaped potsherds, iron slags, grinding stones and other material remains at corners when the middle portion of the land was being prepared for cultivation. Without proper excavation, it is hard to identify the original pottery distribution pattern due to the long-term cultivation. During the SIT project survey (2004-2006) the land was being used for onion cultivation. According to villagers, they could collect some terracotta figurines at the northwest corner of the site when preparing the land for cultivation. Test excavations were conducted in 2004 and 2006. Revealed data and further description with the map of the site are provided in Chapter 6. Excavation of the site also provided grinding stones, crucible remains and human bone fragments.

SIT 8 – Kosgaha-ala-ulpotha at Vavala
Settlement site (east bank)
N 7° 53'15", E 80° 46' 48", MSL 724'

This might be the site registered as KO 53 under SARCP (Manatunga 1990:84) as it is hard to identify the exact location of KO sites without GPS coordinates that provided brief site description. Currently this plot is owned by P.G.M. Rambanda (Patabandi Gedera Maragamuwa Rambanda). This settlement is located just east of the SIT 6; at the east bank of South Kosgaha-ala; 400m northeast to the Vavala monastery; 750m northwest to the Vavala vava. The site spreads approximately 200m x 400m. But there are no densely spreading potshards at the eastern part of the site due to the erosion towards South Kosgaha-ala. As in the SIT 7, there are numerous potshards spreading all over the site including decorated potshards with fine ware. Two grinding stones were collected in the eastern part of the site. Villagers reported that they had collected some terracotta figurines (they named them as "*mati bonikko*"- clay dolls) in the north/northeast area of the site while preparing land for cultivation.

It seems that the SIT 7 and the SIT 8 were activated as one settlement. But the South Kosgaha-ala flows in between the two sites. This may be the major reason for registering them as two sites. Currently there is ongoing onion cultivation. This site is proposed for further study and excavation.

SIT 9 – Vavala-yaya (South) (FC 4 #88) at Vavala
Iron smelting site
N 7° 52’59”, E 80° 46’ 59”, MSL 726’

This large iron production site is located 500m southeast to the Vavala monastery (SIT 6), 400m northwest to the Vavala vava. This iron production site is located at the south end of the Kosgaha-ala-ulpotha settlement site (SIT 8). The Kapapu-ala runs south of the site. It is hard to determine the southern extension of the site, as it is hard to trace the distribution pattern of cultural materials on the savanna vegetation between the site and the Kapapu-ala. Presently this land is owned by A.G. Asoka (Aluth Gedera Asoka) and the plot number is known as FC 4 #88. During the SARCP, this site was registered as KO 54 (ibid.). It is hard to determine the demarcation of SIT 8 and SIT 9. It seems that SIT 9 is further extension from SIT 8 towards east. The site spreads over 250m x 250m. Since the 1988 survey, the land has been continuously used for *chena* cultivation; in later years it has been mostly used for onion cultivation. Asoka reported that he removed the mound with smelting remains: iron slags and furnace remains; tuyeres, furnace walls. He gathered all cultural remains in several places very close to their previous origin when he was spreading the land further east for cultivation. We can still trace the locations of two mounds and their orientation. One mound is located close to the southeast demarcation of the site. It seems that the mound was spread about 60m from north to south and 10m from west to east. It can be assumed that furnaces were aligned in a north-south direction. The second one is located at the northeast corner of the site with a 3-4m radius.

The location of the larger mound is still rich in blocks of iron slags, pieces of solid iron ore, furnace walls, tuyeres (one tuyere with moldings?), and pinnacles or pedestals of the clay objects. Potshards and brickbats are also spread over the site. There were some iron bars also recorded during the 1988 survey (Manatunga 1990).

SIT 10 – Vavala-yaya (South) at Vavala
Iron smelting site
N 7° 53’11”, E 80° 47’ 00”, MSL 730’

This site is located northeast of SIT 9, 600m southeast to the Vavala monastery (SIT 6), 300m west to the South Kosgaha-ala and 400m north to the Vavala Vava. This land is known as Javari Mudalali’s plot. It spreads approximately over 200m x 300m and slightly slopes to the east. There were seven conical holes found on a flat rock boulder at the northeast corner of the site and three of them are much deeper than the rest. The depths of these are laid in between 7-33cm and the diameter is between 12-28cm. Two flat rock boulders could be seen to the north and east of the conical holes. A larger amount of iron slags and potshards could be seen just west of the north rock boulder.

SIT 11 – Vavala-yaya (North) (FC 5) at Vavala
Settlement site
N 7° 53’22”, E 80° 46’ 59”, MSL 719’

This large settlement site, known as FC 5, is spread over 300m x 500m. It is located just north to SIT 9, east to SIT 8 and as adjoining to SIT 10 and SIT 12. It seems all these sites represent one settlement. As in Kosgaha-ala-ulpotha settlement (SIT 7), this site also consists of many potshards and a fair amount of iron slags. Terracotta figurines were also recorded in the northeast corner of the site. Hence, it is also known as the place of “*mati bonikko*”- clay dolls. I found potshards of different thicknesses and several decorations at the site. Black ware and fine ware pots were among them. Presently the land is being used for onion cultivation.

SIT 12 – Vavala-yaya
Pillar site/*attani* pillar inscription site
N 7° 53’25”, E 80° 46’ 52”, MSL 725’

There are several standing pillar stones found 200m northeast of the “boundary” of SIT 8 and north to SIT 11. This site is presently owned by Y.M. Hussain (Yunus Mohamad Hussain). It is located north of Vavala Vava, northeast of the Vavala monastery (SIT 6) and the area in between the South Kosgaha-ala and the Kiri Oya. It spreads approximately over 200m x 200m. Stone pillars mentioned above are all broken and only lower parts [75cm(h) x30cm (l) x10cm (w)] of them are still standing on the ground. There are pieces of a broken pillar with unreadable letters also found at the vicinity. It can be assumed that these pieces belong to a one-pillar inscription (*attani*). Cultivators of the land gathered them into two places. Most of them are eroded and all letters cannot be read properly. They are in horizontal lines and some letters representing 10th century Sinhala letters can still be identified. One piece of the pillar with letters was handed over to Rev. Nalande Jinarama at the Vavala monastery for protection for future references.

As at other settlement sites at Vavalayaya, there are lots of potshards including black ware, fine ware, and red ware spread all over the site. While at the east corner of the site, many iron slags can be seen, pillars are located at the western edge of the site. Terracotta figurines were also recorded at the site.

SIT 13 – Vavala-yaya (North) at Vavala
Iron smelting site
N 7° 53’53”, E 80° 47’ 22”, MSL 682’

This site is located 2km north to the Vavala Vava between the South Kosgaha-ala and the Kiri Oya (west valley). The site spreads approximately 100m x 150m from south to north. Jayathilake’s land adjoins SIT 13 at the north. Presently the land is used for *chena* cultivation and is known as the S.S. Ariyadasa’s land. On the long strip from just north of the Vavala Vava to SIT 13, there is no noticeable material evidence found at the adjoining part of the western KOB for tracing settlement sites. It can be assumed that the long strip has been used as the irrigated paddy rice cultivation for the settlement. This site is located at the northern end of the long strip/paddy field. A rock boulder is located at the southwest edge of the site between the paddy field and the site.

This site was registered as KO 7 during the SARCP (Manatunga 1990:80). Although there are several pieces of iron slags and remains of furnace structures (furnace wall pieces and tuyeres) spread at the site, there are several slag heaps that could be seen in the area covering a 10m radius. According to Ariyadasa, the owner of the land, they removed the slag mound when they were plowing the land by a tractor. But soil layers indicate that there was a large slag mound and the eastern edge of the land is still covered by remains of slag heaps. A lesser amount of potshards can be seen at the site. This site is selected as suitable for a test excavation. The small hill that is located 50m east of the site has some indications of a terraced structure. Several dressed quartzite stones that are laid next to the structure were probably used as steps for the building at the top of the hill (ibid.).

SIT 14 – Vavala-yaya (North) at Vavala
Settlement site
N 7° 53’53”, E 80° 47’ 23”, MSL 685’

This site is located in between the lower stream of the South Kosgaha-ala, the western bank of the Kiri Oya and 100m northeast to SIT 13. It is spread approximately 100m x 100m area and slopes steeply towards the Kiri Oya. But in between the Kiri Oya and the western higher ground there is a flat land, where different types and a larger amount of potshards could be seen in the vicinity. Presently the land is used for *chena* cultivation and is known as Gamini's land (one of village informants of the SIT survey team).

SIT 15 – Divulpitiya at Alakolavava
Iron smelting Site
N 7° 54'09", E 80° 47' 18", MSL 637'

A large iron smelting site with several mounds and slag heap, it is located on the west bank of the Kiri Oya and east to the lower stream of the South Kosgaha-ala. The South Kosgaha-ala joins Kiri Oya just 150m northeast of the site. The site gradually slops to the south and the east and spreads approximately over 200m x 200m. A larger amount of iron slags, pieces of tuyeres, furnace walls and potshards can be seen at the site. Potshards have large diameters and thick rims compared to those at other sites. There are small pieces of red ware also scattered all over the site. It seems that these were attached to the settlement within the area where the smelting activity was conducted.

SIT 16 – Divulpitiya at Alakolavava
Iron smelting site
N 7° 54'09", E 80° 47'14", MSL 623'

This iron smelting site is also located on the west bank of the Kiri Oya just 150m north of SIT 15 and east to the lower stream of the South Kosgaha-ala. The South Kosgaha-ala joins to the Kiri Oya at the northeast corner of the site. The site covers 100m x 100m with iron smelting remains; pieces of iron ore, furnace walls, two pieces of tuyeres, iron slags and a few potshards. Both tuyere pieces represent one tuyere and 40cm in length together. This is the longest tuyere that could be noticed in the Kiri Oya basin.

SIT 17 –Dikyaya (middle) at Dehigaha-ala-kanda
Iron smelting site
N 7° 55'02", E 80° 47' 11", MSL 625'

This might be the site recorded as KO 15 during the SARCP survey because potshards and two pieces of iron slags were found at the vicinity (Manatunga 1990:81). SIT 17 is located in the middle of the long strip at the eastern bank of the Kiri Oya. The long stripe covers ground from the South Kosgaha-ala confluence to the Peikkulama Vava and is known as Dikyaya among villagers. The Dehigaha-ala-kanda monastery site is located just west of the site and at the western bank of the Kiri Oya.

This site spreads approximately over 50m x 50m and several iron slags and potshards could be seen. But the iron slags are not densely distributed. The thick forest marks the eastern boundary of the site. This area is covered by a savanna valley with *mana* grass (*Cymbopogon confertiflorus*) and it slopes to the west at the site. Therefore, it is hard to locate the exact location and the distribution pattern of cultural remains of the sites at the eastern Dikyaya as they are continuously affected by erosion. Although some potshards could be seen a few meters east of the site, it could not be considered as a site because there is doubt about the site formation process. SIT 17 locates comparatively on a flat land in the valley.

SIT 18 – Dikyaya (Middle) at Dehigaha-ala-kanda
Settlement site
N 7° 54'49", E 80° 47' 15", MSL 652'

This site is located about 175m southeast of SIT 17 and the east bank of Kiri Oya. While potshards could be seen all over the site (approximately 75m x 100m), iron ore and iron slags are concentrated only in the 50m x 50m area at the northeastern edge of the site. The site gradually slopes to the west towards the Kiri Oya. A broken pillar, 20cm(w)x40cm(l)x50cm(l) is laid on a mound at the eastern corner of the site and 200m east of Kiri Oya. It is very difficult to examine it more because it is covered by high grown *mana* grass (*Cymbopogon confertiflorus*) as at SIT 17. The broken pillar indicates that there was a ceremonial or religious architectural unit active at the site.

SIT 19 –Divulpitiya at Dehigaha-ala-kanda
Iron smelting site
N 7° 54’22”, E 80° 47’ 18”, MSL 635’

This site, located on the eastern bank of Kiri Oya, is known as Wijeweera’s (a.k.a. Kalu Mahattaya) onion plot. Large blocks of iron slags were found at the stream bed that is at the southern boundary of the site. It seems that the stream was created recently; water flows from northeast high ground south to join Kiri Oya as dividing the site into two portions. Both have small pieces of potshards and iron slags. But no iron ore could be noticed at the vicinity. According to Wijeyweera, he had to remove large clay pieces (probably furnace walls), when he prepared the land for cultivation. The area covers approximately 150m x 150m. It can be assumed that iron smelting furnaces are hidden next to the eastern stream that is not used for cultivation as it is covered by thick *mana* grass (*Cymbopogon confertiflorus*). Considering the size and amount of slag blocks, it can be suggested that there was a large smelting site at the site.

SIT 20 – Divulpitiya at Dehigaha-ala-kanda
Iron smelting site
N 7° 54’37”, E 80° 47’ 12”, MSL 637’

Presently, known as the Sarath’s/Mahinda’s land, it is located on the west bank of the Kiri Oya and just 100m northwest of SIT 19. Tuyere pieces, iron slags, iron ore and potshards are among cultural materials found at the site. Smelting remains densely distributed at the eastern area, the higher ground of the site. As the results of long-term cultivation activities (especially *chena* cultivation), there is less evidence for smelting activities found at the western part. According to farmers, they removed furnace remains when preparing the land. Smelting remains are still noticeable at profiles of balks (*niyara*) among onion beds. Anyway, it can be assumed that superstructures of furnaces still may be there, as farmers never plough the land with modern machineries. Iron smelting activities of the site covers approximately 100m x 150m.

SIT 21 –Dehigaha-ala-kanda (east), Divulpitiya at Alakolavava
Iron smelting site
N 7° 54’10”, E 80° 47’18”, MSL 630’

Located on the eastern bank of the Kiri Oya at the South Kosgaha-ala confluence, the land is presently owned by Piyasiri Mudalali. It is demarcated on three sides by the winding Kiri Oya and on the eastern side by the foot of the mountain. The site covers approximately 75m x 150m and slopes to the west at the Konduruvava Mountain Ridge adjacent to the eastern demarcation. Iron slags, furnace walls and tuyere pieces and potshards are cultural materials found at the site. Two conical holes could be seen on two flat boulders at the eastern part of the site. While the one is measured as 12cm diameter and 1cm in depth, the other is 15cm diameter and 5cm in depth. Although there is evidence of seasonal erosion, there is no doubt about the site formation, as it cannot be assumed cultural remains of the site shifted by floodwater from somewhere else. But there is evidence that floodwater brought cultural remains at the site to the Kiri Oya bed. It can also be assumed that the place was used as a smelting center rather than a settlement.

SIT 22 –Dikyaya-kanda at Vavala
Iron smelting site/settlement site
N 7° 53’59”, E 80° 47’23”, MSL 628’

This is a large iron smelting site that is located approximately 8 ½ km southeast of the Sigiriya rock and on the east bank of the Kiri Oya, in between the Kiri Oya and the Dikyaya Kanda; a mountain ridge of the Konduruwawa Mountain Range. The site slightly slopes to the east. But there are no signs of heavy erosion. Presently, Samaraweera, the owner of the land uses it for onion cultivation. The site covers approximately 200m x 300m and is demarcated by the Kiri Oya from the west, the Dikyaya Kanda from the east, abandoned *chena* lands from the north and the south. The waterway that flows westward from the Dikyaya Kanda enters the site from the northeast and runs northwards. Batuyaya-ala runs just 60m south from the site. A small bund that is connected to the southern edge of the Dikyaya Kanda and a southern lower mountain ridge could be seen about 125m southeast. Batu ala, a small stream from the eastern mountain ridge, flows towards Kiri Oya in between these two mountain ridges.

Two conical holes are located on one of the rock boulders at the northeastern portion of the site. A farmer's temporary hut was built after leveling one of the slag mounds among three mounds. A larger amount of slag blocks, tuyere pieces and furnace walls could be seen near the three mounds as well as at slag heaps that are gathered by the farmer of the site. The western portion of the site is rich in potshards. It can be assumed that the site was used at the same time both as a smelting center and as a settlement. Trench and open excavation were conducted at the site in 2004. Further details are given in chapters 6 and 7.

SIT 23 –Vavala Vava (south)
Iron smelting site
N 7° 52'36", E 80° 46'47", MSL 745'

Located just west of the southern end of the Vavala Vava bund at the Thusitha's garden, the slag mound at the site spreads over 50m x 50m and the height of the mound is about 2m. There are various types and sizes of iron slags and potshards found at the site.

SIT 24 –Vavala Vava at Vavala
Iron smelting site (west)
N 7° 52'46", E 80° 46'56", MSL 729'

Located west of the Vavala vava and just southwest to the *Kapapu-ala*, the site slopes from west to east. There are two small hilltops behind the site. The mound spreads about 100m from the north-south direction and 75m to the east-west. Many potsherds, blocks of iron slags and furnace walls could be seen *in situ*. The remains of a farmer's hut were visible at the eastern corner of the mound. This is a proposed site for future excavation.

SIT 25 –Vavala-vava at Vavala
Iron smelting site
N 7° 52'34", E 80° 46'59", MSL 772'

Vavala Vava is presently the largest reservoir in the KOB. This iron smelting site is located inside the vava just east of its southeastern part of the bund. The highest place of the vava, the *vana*, can be seen 400m southwest to the site. Although it is located inside the vava, it seems that except for the east-west monsoonal season, the area is not covered by water as it is on a natural mound. Iron smelting activities probably took place seasonally on the top of the mound. Lots of potshards, blocks of slags, furnace walls are scattered on the mound that measures 15m in length (north-south) and 10m in width (east-west). According to the shape of the mound, it can be assumed that the furnaces built at the eastern sector of the mound were facing the west.

During the SIT project, test excavations were conducted at the site in 2004 and revealed data are discussed in chapter 6.

SIT 26 –Vavala-vava
Iron smelting site (west)
N 7° 52'44", E 80° 46'58", MSL 715'

This site is located west of the Vavala Vava and southwest of the junction where *Kapapu-ala* joins to the vava. It is hard to determine the size and the distribution of the site as it is covered by highly grown *mana* grass (*Cymbopogon confertiflorus*). But there are numerous potshards, iron slags and furnace remains scattered over 50m x 50m at the site.

SIT 27 – Kosgaha-ala-ulpotha at Vavala
Settlement site
N 7° 52’54”, E 80° 46’40”, MSL 715’

This site is located 550m northwest of the Vavala Vava and southeast of the junction where *Kapapu- ala* meets the Vavala Vava. The Kosgaha-ala-ulpotha, a perennial spring in the bed of the Kosgaha-ala, is located at the west boundary of the site. According to the potshards distribution pattern at the site, it could be traced approximately over the 150m x 150m area. This site is registered as KO 55 during the SARCP survey (Manatunga 1990:84).

SIT 28 – Pansalwatta-yaya at Alakolavava
Rock shelter/ monastery
N 7° 53’57”, E 80° 47’06”, MSL 737’

This site is located southeast of the Sigiriya rock and Alakolavava village, and northwest to the Vavala Vava. This is a drip-ledged rock shelter that was registered as an “Ancient Monument” by the Department of Archaeology (Ancient Monument Register: 475) and by the SARCP survey (KO 21 in Manatunga 1990:81). The rock shelter is oriented to the east and measured as 14m (l)x 7m (w)x7m(h). Remains of wattle and daub (*varichchi*) walls that divided the rock shelter into two compartments as mentioned in Manatunga 1990 could be seen. The wall is about 40cm and remains of lime plaster with red, black and blue lines confirm that there were paintings on lime plaster. There is also evidence for moldings on plastered walls as collected pieces of molded plaster were found at the site during the SIT survey in 2004-2005. The moldings are also made as lines. Manatunga also reported that there were several paintings on panels representing the *Vessantara Jataka* and *Suvisi Vivarana* in the Kandyan period “primitive folk art” style (Manatunga 1990). But he also mentioned that the site could be dated back to the same period of Vavala and Dehigaha-ala-kanda monasteries as they are located on the same rock ridge (ibid.).

Besides plaster remains there are also many potshards scattered around the area. According to village informant, Dissanayake Banda, villagers removed the walls while renovating the place as the village temple was used until recently. He also mentioned that there were figures of Buddha and drummers among wall paintings. The place also was destroyed by treasure hunters. Village oral tradition says that there was a Buddhist statue illuminating itself and because of that statue, the people called the village Alakolavava (*Aloka-vava*; illumination/lighting reservoir). There are traces for the old reservoir (Alakolavava *purana vava*) that could be seen northwest of the site.

SIT 29 – Kuratiyaya/Asamodagamyaya at Alakolavava
Iron smelting site
N 7° 53’42”, E 80° 47’06”, MSL 750’

This site is registered as KO 5 by the SARCP survey (Manatunga 1990:80) and is located approximately 15km southeast of the Sigiriya rock, 1.6km northwest from the Vavala Vava and 500m southeast to the Alakolavava Ihala-vava. It is demarcated from the north and the west by the Kuratiyaya-ala and the east from the South Kosgaha-ala. Kuratiyaya-ala joins to the Kosgaha-ala at the northeast corner of the site. Relatively, this site is located on high ground that slopes to the north and east and spreads over 150m x 150m.

A large amount of blocks of iron slags, pieces of furnace walls and tuyeres, potshards and iron ore could are seen at the site. During the SARCP survey, it has been identified as a settlement site due to the concentration of potshards. Later in 1999, when the site was excavated by the Sigiriya Project of CCF, two smelting furnaces were unearthed. But no radiocarbon dates are available. Excavators assumed that there was a deposit of iron ore at the site (Dodanwala 1999). The site is known as the B. A. Lional’s plot.

SIT 30 – South Kosgaha-ala at Vavala/Alakolavava
Iron smelting site (west bank-middle)
N 7° 53'32", E 80° 46' 58", MSL 736'

This site is located 150m south of the Kuratiyaya/Asamodagamyaya iron smelting site and the west bank of the South Kosgaha-ala. The northern portion of the site is higher than the southern area and slopes to the south and the east. Six conical holes are located on the flat rock at the northeastern edge of the site. It seems that the iron smelting activities at the site were conducted in a 150m x 150m area close to the conical holes. Several slag mounds could also be seen in the northwestern area, where smelting activities were conducted. Presently, the land is known as Jayatissa's plot. Although the SARCP survey could not identify its spreading area, it registered the site as KO 4 and recorded potsherds, iron slags distribution and a flat rock with six conical holes (Manatunga 1990:80).

SIT 31 – South Kosgaha-ala at Vavala/Alakolavava
Settlement site (west bank-middle)
N 7° 53'19", E 80° 46' 48", MSL 720'

This is a large settlement site that is located on the west bank of the South Kosgaha-ala,1km northwest of the Vavala Vava and 650m southeast of the Alakolavava Ihala-vava. It spreads from 150m south of the Kuratiyaya/Asamodagamyaya iron smelting site to the South Kosgaha-ala-ulpotha (SIT 7) settlement site and the Vavala monastery complex (SIT 6). The potshards distribution pattern of the site indicates that this settlement spreads approximately over a 250m x 800m area. This settlement adjoins the SIT 30 iron smelting site at the northeast.

SIT 32 – Gravel Site at Alakolavava
Iron smelting site
N 7° 53'28", E 80° 46'28", MSL 733'

This site is located at the east bank of *Kapapu-ala*, the ancient canal that runs from the Vavala Vava to the Sigiriya Mahavava. The site slopes to the south towards Vavala monastery. It seems that the smelting activities were conducted on both sides of *Kapapu-ala*. The Vavala Vava and the Vavala Monastery (SIT 6) are located 1½ km southeast and 400 m south of the site. Alakolavava Ihala-vava could be seen 600m northeast of the site. Presently the site is being destroyed due to modern development, as it was selected for digging gravel soil to rural roads construction works. A large amount of tuyere pieces, furnace walls, slags, iron ore (magnetite) and remains of superstructures of furnaces can be seen at profiles of the gravel pit that is distributed over a 200m x 400m area. There are several pieces of potshards that were also found at the site.

According to the bottom slags of the site, it can be assumed that the bottom diameter of the furnace is about 1meter. It is hard to identify the difference between *Kabouk* (the soil that is covered by a thick coat of laterite) and iron slags because the morphology of both seems the same to the naked eye (instead of lab analyses).

SIT 33 – Dehigaha-ala (East Bank) Divulpitiya at Alakolavava
Iron Smelting Site
N 7° 54’43”, E 80° 47’09”, MSL 598’

This site spreads over a 100m x 100m area and is located between the Dehigaha-ala and the Kiri Oya at the Dehigaha-ala confluence. Dehigaha-ala-kanda iron production site (SIT 1/KO 14) is located west to the site. Although the SARCP recorded the land as an abandoned paddy field (KO 12 in Manatunga 1900:80), presently it is used as a large cultivated land by Wijerathna and Senevirathna. There are two mounds of iron slags measuring 10m x 10m and 30m x 20m that could be seen at the middle and the southwest corner of the site respectively. A spreading pattern of large blocks of iron slags, furnace walls and tuyere fragments indicates that the smelting activities had been conducted in the southeast portion of the site. A fragmented Mammoty (Figure 7-14) collected during the survey. Potsherds are scattered on the western portion of the site.

SIT 34 – Dehigaha-ala (South) Divulpitiya at Alakolavava
Iron smelting site
N 7° 54’40”, E 80° 47’ 08”, MSL 673’

This site is on the eastern bank of the Dehigaha-ala, west bank of the Kiri Oya, southwest of SIT 33/KO 12 and south of SIT 1/KO 14. It spreads over a 150m x 150m area and was registered as KO 13 during the SARCP (Manatunga 1990: 80). A stream that runs towards the Dehigaha-ala could be seen at the east demarcation of the site. Blocks of iron slags and iron ore are laid at the stream bed. Slag remains and rounded shaped furnace walls are scattered over a 5m x 10m area near the farmer’s abandoned hut at the site. The land is known as D. A. Rathnayake’s or Sirikumara’s plot. Potsherds are also spread in a lesser amount.

SIT 35 – Dehigaha-ala (South) Divulpitiya at Alakolavava
Iron smelting site
N 7° 54’36”, E 80° 47’08”, MSL 675’

This site is located on the west bank of the Kiri Oya, east of the Dehigaha-ala and southeast of SIT 1/KO 14. Probable geographical indications of abandoned Kandalama Vava, one of the ancient reservoirs at Alakolavava village, could be traced approximately 200m southwest to the site. Iron smelting remains spread rarely over a 100m x 100m area that slopes to the east. Few amounts of potsherds could be seen.

SIT 36 – Divulpitiya at Alakolavava
Iron smelting site
N 7° 54’18”, E 80° 47’15”, MSL 680’

This site is located on the west bank of Kiri Oya, north of the South Kosgaha-ala confluence. SIT 19 is located opposite the bank of the Kiri Oya. This site is presently known as Binera’s plot. A large amount of iron slags are scattered all over the site which is approximately 200m x 200m area.

SIT 37 – Divulpitiya South at Alakolavava
Iron smelting site
N 7° 54’14”, E 80° 47’18”, MSL 666’

This site is located on the west bank of the Kiri Oya at the South Kosgaha-ala confluence and covers a 110m x 100m area. SIT 19 is located opposite the bank of the Kiri Oya. Blocks of iron slags and a few potsherds are found in the vicinity. Remains of a burnt clay floor could be seen in the southwest corner of the site. The site is presently known as Manel’s plot.

SIT 38 – South Kosgaha-ala (North) at Alakolavava
Settlement/pillar/burial? site
N 7° 54’08”, E 80° 47’10”, MSL 675’

This site is located at the west bank of South Kosgaha-ala and southwest of its confluence with the Kiri Oya. It was registered as a small pottery site during the SARCP (KO 1 in Manatunga 1990: 80). The site spreads over a 250m x 250m area. Potsherds, small brick fragments and iron slags are scattered over a 50m x 50m area in the middle. There is a small mountain ridge west of the site. A stone pillar that measured 160cm(*h)*x22cm(*l)*x25cm(*w)* is laid between the mountain ridge and the potsherds concentrated area. According to the farmer of the site, he found a long burial box made of clay at the southern edge of the land. But there is no other evidence found during the SIT survey. A shallow conical hole could be seen on a small rock boulder at the middle of the site. Signs of an abandoned reservoir can be seen in the west. It might be the ancient Alakolavava that was mentioned in the oral traditions of the area.

SIT 39 – Pahala Vava (East) at Alakolavava
Iron smelting site
N 7° 54’14”, E 80° 46’43”, MSL 676’

This small iron smelting site is located just southeast of the Pahala Vava bund at Alakolavava village. It spreads over a 15m x 20m area including iron slags and few potsherds. This site was registered as KO 48 during the SARCP (Manatunga 1990: 84).

SIT 40 – Pahala Vava (West) at Alakolavava
Iron smelting site
N 7° 54’23”, E 80° 46’37”, MSL 676’

This site is located southwest of the Pahala Vava bund at Alakolavava village. Iron slag and potsherds spread over a 10m x 10m area in a lesser amount. During the SARCP, this site was registered as KO 49 (ibid.).

SIT 41 – Kirivadunna/Hirivadunna Vava (West)/Valikadayaya at Alakolavava
Settlement site
N 7° 54’40”, E 80° 46’38”, MSL 653’

This site is located close to the limestone band and joined in the west to the bund of abandoned Kirivadunna Vava. Alakolavava Pahala Vava is located further south. The western branch (dried bed) of the Dehigaha-ala flows south to the site. Potsherds are concentrated in an area spreading 50m x 50m. Chert fragments, quartz and iron slags could be seen in a lesser amount. The SARCP registered this site as a small pottery site (KO 18 in Manatunga 1990: 81).

SIT 42 – Pahala Vava (North) at Alakolavava
Settlement site
N 7° 54’34”, E 80° 46’36”, MSL 669’

This large settlement site is located between the abandoned Kirivadunna Vava and Alakolavava Pahala Vava. A dried western branch of the Dehigaha-ala could be seen just north and an abandoned paddy field south of the site. Potsherds concentrate in an area spread over 200m x 500m. Iron smelting activities were conducted in an area (indicate by iron slags) spread over two places (each measured 50m x 50m) at the eastern edge of the site. Iron ore scattered at the southeastern corner of the site. Chert fragments could also be seen in a lesser amount. This may be site KO 13 registered during the SARCP (Manatunga 1990: 80).

SIT 43 – Makarayawala Cave Site at Alakolavava
Settlement site/Cave dwelling
N 7° 55’15”, E 80° 46’46”, MSL 637’

This cave dwelling site is located southeast of the Makarayawala Vava and south of the Makarayawala-ulpotha-ala. The Dehigaha-ala-kanda monastery complex (SIT 2) is located southeast of the site. No dripledges could be seen on the cave. The cave dwelling that measured 4*w*x15*l*x6*h*m faces to the east. It may be belonged to the SIT 2 when the SIT 2 monastery complex was active. A small amount of potsherds could be seen at the site.

SIT 44 – Makarayawala-ulpotha at North Dehigaha-ala-kanda
Settlement site
N 7° 55’10”, E 80° 47’05”, MSL 602’

This site spreads over a 200m x 200m area on the west bank of Kiri Oya, southeast of the Makarayawala Vava. Potsherds are scattered in a sufficient amount of small heaps at several places. It seems these were made by farmers during the preparation of the land for the cultivation. Other than potsherds, no cultural remains were noticed.

SIT 45 – Makarayawala-ulpotha (South)
Settlement site
N 7° 55’19”, E 80° 47’18”, MSL 594’

This site is located on the west bank of the Kiri Oya and south of the Makarayawala-ulpotha ala at its confluence. It seems like an abandoned paddy field. It spreads from the North Dehigaha-ala-kanda (SIT 44) to the Makarayawala-ulpotha stream as a flat land (KO 16 in Manatunga 1990:81). It is hard to determine the size of the settlement. But potsherds are highly concentrated in an area spreading over 50m x 50m.

SIT 46 – Makarayawala-ulpotha (North)
Settlement site
N 7° 55’21”, E 80° 47’18”, MSL 591’

This site is located 20m west of the Kiri Oya and north of Makarayawala-ulpotha ala at its confluence. Potsherds and a lesser amount of brick fragments could be seen approximately over 50m x 50m. The site slopes to the east. Although the SARCP recorded (KO 50 in Manatunga 1990:84) the presence of tile pieces, they could not be traced at the site.

SIT 47 –Peikkulama South
Religious/Sacred site
N 7° 55’10”, E 80° 47’48”, MSL 595’

This site is located east of the Kiri Oya, south of the Peikkulama Vava and the foothills of the Konduruwawa Mountain Range. There is a mound at the site terraced by granite blocks (measuring 40cm x 40cm x 20cm) from three sides. South of the terraced mound, there are the remains of a building made of burnt clay bricks (measuring 30cm x 20cm x 5cm) that could be seen. The site is spread over a 100m x 100m area.

SIT 48 –Peikkulama Southwest
Settlement site
N 7° 55’27”, E 80° 47’30”, MSL 576’

This site is located on the east bank of the Kiri Oya and southwest of the abandoned Peikkulama Vava. Potsherds spread over a 50m x 50m area close to the winding pathway of the Kiri Oya. Small pieces of iron slags are the other cultural remains found at the site.

SIT 49 –Peikkulama South
Settlement site
N 7° 55’29”, E 80° 47’40”, MSL 575’

This is the last settlement site found from Dikyaya to Peikkulama. Both SIT 48 and SIT 49 seem like isolated habitation sites. Potsherds spread over a 75m x 75m area just 400m east to SIT 48.

SIT 50 –Peikkulama Vava
Iron Smelting site
N 7° 55’48”, E 80° 47’55”, MSL 556’

This site is just south of the Peikkulama Vava and the northern end of the southern mountain ridge that is located south of the vava. Blocks of iron slags and potsherds could be seen over a 50m x 50m area. It is hard to identify the continuation of the site as surroundings of the site are covered by thick grown scrub.

SIT 51 –Peikkulama Vava
Religious/inscription site
N 7° 55’51”, E 80° 48’08”, MSL 554’

This site is located at the eastern bank of the Kiri Oya and north of the newly built eastern sluice of the Peikkulama Vava, east of the old bund and south to the old pathway to Polonnaruwa, Migahawela. The branch of the Kiri Oya turns just north to the road at the site. There are several broken pillars, one guardstone, stones and brick fragments. According to village informants, the pillar inscription of Udaya II (887-898 A.D.) was found *in situ* (Paranavitana 1990). The ruins of the site spread over a 17m x 22m area circularly. During the SARCP it was identified as the ruins of the ancient sluice (KO 58 in Manatunga 1990:84). A terraced wall (made of stone blocks) of the old bund of the reservoir may still be there.

SIT 52 –Idallavala at Peikkulama Vava
Settlement site
N 7° 55’52”, E 80° 47’40”, MSL 555’

This is one of the largest settlement sites at the KOB. It is located at Idallavala on the western bank of the Kiri Oya just west of the Peikkulama Vava. The site spreads approximately over a 300m x 400m area. Densely spread potsherds and a few pieces of iron slag could be seen. As mentioned in the SARCP report, recently built wattle and daub walls (made of clay from the site) and recently dug clay pits at the site show horizontally and vertically scattered potsherds at the site (KO 20 in Manatunga 1990:81). The other noticeable construction of the site is three stone terraces that were built in the north south direction with 20m distances with each other (ibid.).

SIT 53 –Peikkulama Southwest
Stone quarry and settlement site
N 7° 55'40", E 80° 47'28", MSL 556'

This site is located southwest of the Peikkulama Vava and SIT 52, the large settlement site at Iddallavala. This is a stone quarry site with not completely prepared rock boulders for dressing stones. There are several cut marks on the boulders and half split stone boulders providing evidence of dressing. The site spreads over 10m x 10m at the middle of the ridge and south of the abandoned reservoir. It has been suggested to provide quarries for construction work of the Peikkulama Vava (KO 34 in Manatunga 1990: 82).

The SARCP recorded a badly eroded inscription on a rock boulder to the northwest of the site (KO 33 ibid). As mentioned in Manatunga 1990, densely scattered potsherds could be seen. But SARCP couldn't identify the characters suggested as been similar to those of the 6^{th} or 7^{th} century A. D. script of early Sinhala.

SIT 54 –Peikkulama Galdeka
Remains of a building structure
N 7° 55'48", E 80° 48'45", MSL 515'

Ruins of a building structure are located on the eastern bank of the Kiri Oya and 1 ½ km east of the Peikkulama Vava. There is a narrow space created by the mountain ridges on the valley. A branch of the Kiri Oya runs towards Migahawela, Polonnaruwa in between this narrow space as parallel to the pathway to Polonnaruwa. (Due to the damage to the Peikkulama reservoir bund, the ancient waterway of the Kiri Oya changed its path towards Polonnaruwa along this narrow valley). There are remains of structures on rock boulders at both sides of the narrow space. The ruins of the southern boulder consisted of a square terrace (25m x 25m), surrounded by semi-dressed stone blocks, three stone pillars and brick fragments. According to the oral tradition told by E. M. Vimalasena, an elderly villager who guided us from the Peikkulama Vava to Migahawela village, there was a gold pot with King Mahasen's ash found at the site. The letters on the pot were read by the "Thero of the Attanakadawala Maha Viharaya as "*Mahasen maharaja*". But it has not been recorded anywhere else.

The northern boulder has a series of mortices in a semi-circular line (25m in length) at the bottom. It indicates that there was a foundation for a brick wall or a structure connecting to the southern boulder. These ruins may be connected with the pathway. It may have acted as a controlling and guarding post or a pass (KO 32 ibid).

SIT 55 – Migahawela
Iron Smelting site
N 7° 55'37", E 80° 49'04", MSL 589'

This site is located 1km east to SIT 55 on the ancient pathway to Polonnaruwa and just north of the waterway (a branch of the Kiri Oya /Migahawela-ala). Iron slags and potsherds are scattered over 10m x 10m area.

SIT 56 – Migahawela Vava
Settlement site
N 7° 55'27", E 80° 49'15", MSL 600'

This site is located northeast of the bund of the abandoned Migahawela Vava. Potsherds (including decorated potsherds), iron slags, tiles and brick fragments are spread over a 25m x 25m area in a sufficient amount. There are several stone pillars laid at the southwest corner of the site. One can be identified as a foundation of a front door as it has cut marks on both sides to connect two sides of a door. Pillars are 2m in height. According to the farmers of the village, they cultivated the land during the *mas kannaya* (November to January).

SIT 57 – Diyakapilla Puranagama
Settlement site
N 7° 56’53”, E 80° 47’18”, MSL 651’

Located south of present Diyakapilla village and the south bank of Diyakapilla-ala. The footpath from the North Kosgaha-ala village to Illukvava village runs just north of the site. Potsherds, brick fragments and iron slags could be seen along with large blocks of *kabouck* (laterite). It might be used for the construction of an abandoned reservoir bund or related structure at the vicinity. A primitive type of terracotta figurines has been recorded on the northern bank of Diyakapilla-ala (KO 31 in Manatunga 1990:82). A whole year long perennial spring, rising from the limestone bed of the tributary is one of the important factors of this settlement. This site spreads over a 200m x 400m area approximately.

SIT 58 – Diyakapilla
Sacred/Religious site
N 7° 57’00”, E 80° 47’25”, MSL 635’

This site is located north of the Diyakapilla-ala and northwest of the Vannigamaya Vava. There are rectangularly arranged four limestone slabs and two small mounds at the site. The rectangular arrangement indicates a building foundation. While one mound has a short stone pillar on it, the other has a stone slab like a flower alter. As mentioned in the SARCP publication, a pond-like earth depression could be still be seen at the site (KO 24 in Manatunga 1990:82). Brick fragments and potsherds are scattered at the site. Velangaha-ulpotha could be seen in the streambed close to the site. The site spreads over a 25m x 25m area.

SIT 59 – Vannigamaya Vava (Northwest) at Diyakapilla
Settlement site
N 7° 57’02”, E 80° 47’36”, MSL 625’

This site is located northwest of the Vannigamaya Vava and north of the Diyakapilla-ala on the Diyakapilla-North Kosgaha-ala road. Potsherds are scattered in a lesser amount. Although the area between the site and the Vannigamaya Vava had some signs of erosion during the rainy season, it can be assumed that the formation of the site was at its original place. The site spreads in a 15m x 15m area.

SIT 60 – Vannigamaya Vava (Southeast) at Diyakapilla
Settlement site
N 7° 56’52”, E 80° 47’50”, MSL 670’

This settlement is located about 1km southeast of the Vannigamaya Vava and the west bank of the Kiri Oya. The area seems like a flat land that spreads from the Makarayawala Aluth Vava. Potsherds and a lesser amount of iron ore could be seen 15m x 15m area.

SIT 61 – Kumburu Yaya at North Kosgaha-ala
Iron smelting site
N 7° 56’59”, E 80° 48’05”, MSL 551’

This site is located between the west bank of the Kiri Oya and North Kosgaha-ala village at the southeastern corner of the paddy field. Several mounds of iron slag blocks, furnace wall fragments, 5cm diameter tuyeres, brick fragments and potsherds spreading over 150m x 150m of the site indicate that the site had been activated as an iron production center.

SIT 62 – North Kosgaha-ala
Settlement site
N 7° 57’12”, E 80° 48’15”, MSL 553’

This site is located on the western bank of the Kiri Oya and the southern bank of the North Kosgaha-ala. It is hard to determine the size of the site as potsherds and the iron slag concentrated area is limited in a 15m x 15m space of the site.

SIT 63 – North Kosgaha-ala
Iron smelting/smithy site
N 7° 57’25”, E 80° 48’20”, MSL 554’

This site is located on the western bank of the Kiri Oya; it is close to the North Kosgaha-ala. The SARCP reported the site as a collapsed iron smithy due to the presence of iron slags and brick fragments (KO 28 in Manatunga 1990:82).

SIT 64 – Dikkanda-ala (Southeast) at Diyakapilla
Settlement site
N 7° 57’52”, E 80° 48’45”, MSL 555’

This is one of the largest settlement sites in the KOB. Densely scattered potsherds in different sizes and in a sufficient amount of iron slags including bottom slags are spread over a 300m x 300m area between the abandoned Dikkanda-ala Vava and the eastern bank of the Kiri Oya. An abandoned paddy field can be seen at the northeastern corner of the site.

SIT 65 – Diyalabugaha-ala at Gallinda
Settlement site
N 7° 57’37”, E 80° 47’32”, MSL 614’

This settlement site is located north of North Kosgaha-ala village and west of the Gallinda Kanda. Potsherds are scattered over 25m x 25m in a sufficient amount at the west bank of the Diyalabugaha-ala. During the SARCP this site was registered as KO 29 (Manatunga 1990:82).

SIT 66 – Purana Vava at Illukvava
Iron smelting site
N 7° 58’29”, E 80° 47’12”, MSL 666’

This site is located in the catchment area of the Purana Vava southwest of the vava. A large amount of iron slags and furnace remains were found in a mound oriented east-west direction and spreads over a 50m x 50m area.

SIT 67 – Purana Vava at Illukvava
Settlement site
N 7° 58’20”, E 80° 47’28”, MSL 685’

This large settlement site is located on the west bank of the Pihimbi-ala. This site is between the Aluth Vava (Angulanawala Vava) and the Purana Vava at Illukvava. Gallinda mountain ridge is located east of the site. This settlement spreads over a 200m x 200m area just at the eastern end of the Purana Vava bund. Different sizes of potsherds were found. Some of them have rims in larger diameters. In addition iron slags and brown chert pieces can be seen at the vicinity. The SARCP registration number of this site is KO 42 (Manatunga 1990:83).

SIT 68 – Purana Vava at Illukvava
Terracotta site
N 7° 58’33”, E 80° 47’20”, MSL 656’

This site is located just below the western end of the Purana Vava bund. There are 85 terracotta figurines found at the site (2m x 2m) by accident when renovating the reservoir bund in 1958 (Deraniyagala 1958:22-25). The collection of terracotta figurines are consistent with human and animal figurines that are suspected of having some connection with fertility related rituals (Nandadeva 1990: 220-236). Presently these are stored at the Anuradhapura Archaeological museum (KO 44 in Manatunga 1990:83). Other than a few potsherds, no other cultural remains were noticed.

SIT 69 – Purana Vava at Illukvava
Iron smelting site
N 7° 58’40”, E 80° 47’25”, MSL 675’

This site is located on the west bank of the Kiri Oya and the Pihimbi Oya, just north of the Purana wela (paddy field) and north to the Illukvava Purana Vava. Tissa Banda, one of the farmers of the site says that he removed lots of iron slags at the middle of the site when he was preparing the land for onion cultivation. The site covers an area 75m x 100m. There are lots of potsherds found in the north corner of the site. Large blocks of iron slags were also found at the northeast corner of the site.

SIT 70 – Kakunagasgodavala Kadaththalama at Illukvava
Settlement site
N 7° 58’42”, E 80° 47’32”, MSL 650’

This is a large settlement site located at the east bank of the Pihimbi-ala and on the west bank of the Kiri Oya. The waterway comes from Gallinda Kanda and flows towards the southeast corner of the land. Then it runs towards the north corner to join the Kakunagasgodavala-ulpotha. A larger density of potsherds spreads over a 500m x 1500m area. Iron slags and brick fragments could also be seen in a sufficient amount. The SARCP registration number of this site was KO 43 (Manatunga 1990:83). D. M. Ajith Vijitha Kumara, the farmer of the plot says that he collected blue and white beads during the preparation.

SIT 71 – Kukurumahangodavala-Kadaththalama at Gallinda-kanda
Monastery site
N 7° 58’32”, E 80° 47’55”, MSL 650’

This monastery site consists of two medium sized drip-ledged rock shelters and four plaster coated brick walls (one wall is about 40cm). While one rock shelter measures about 12m(w)x30m(l)x5m(h), squared hooded the other is measures about 5m(w)x5m(l)x2 ½ m(h). The terrace runs from the north corner of the largest rock shelter and is continued to the south until it meets the south corner of the second shelter. The terrace is made of stones in 4/5 rows. There is a 2m wide, stone blocks paved pathway that could be seen leading south to the dripledged rock shelter. Below the rock shelters there are stone blocks, brick fragments and post holes. As mentioned in the SARCP report (KO 38 in Manatunga 1990:83), these remains would have been used for a wooden columned building.

SIT 72 – Kakunagasgodavala Kadaththalama at Gallinda-kanda
Pillar site
N 7° 58’57”, E 80° 47’36”, MSL 583’

Remains of a pillared structure at the Kakunagasgodavala Kadaththalama and north to its ulpotha (spring). There is remains of a building measured 4 x 3m and consisted with 7 stone pillars about 1 meters in height. Brick fragments and potsherds could be seen in a lesser amount. The large settlement site SIT 70 is located south of this pillar site.

SIT 73 – Mahavava at Gallinda
Iron Smelting Site
N 7° 59’10”, E 80° 47’30”, MSL 529’

This site is located west to the Pihimbi-ala and the Kiri Oya at Vedivadichchayaya. Gallinda-Moragahavava road is located just east of the site. Iron slags and potsherds could be seen in a sufficient amount in the approximately 15m x 15m area.

SIT 74 – Gallinda-ulpotha
Settlement site
N 7° 59’30”, E 80° 47’22”, MSL 604’

This small site is located just east of the well known Gallinda spring. It is very hard to identify the site distribution pattern (potsherds) as the area is covered by thick layers of fallen leaves. Gallinda spring is located just few meters away from the motor road from Sigiriya and Moragasvava. This site was registered as KO 38 during the SARCP (Manatunga 1990:83).

SIT 75 – Mahavava at Gallinda
Stone slab site
N 7° 59’32”, E 80° 48’30”, MSL 650’

A large stone slab could be seen just below/east to the Gallinda Maha Vava along with few potsherds. It is about 10m in length and 1m in width. No other cultural remains were found.

SIT 76 – Mahavava at Gallinda
Settlement site
N 7° 59’32”, E 80° 49’04”, MSL 620’

This small pottery site is located on the west bank of the Kiri Oya, north of the Pihimbi-ala and east to the Gallinda Mahavava. A few potsherds could be seen south of the Mudiyanse’s paddy field. According to him, he could see the layer of potsherds spreading 30cm vertically from the surface to below. The area spreads over 7m radius.

SIT 77 – Mahavava at Gallinda
Settlement site
N 7° 59’28”, E 80° 49’05”, MSL 650’

Going south to SIT 76, another pottery site is located in the southern bank on the Pihimbi-ala and west of the Kiri Oya. It seems that SIT 76 and SIT 77 were active same time as one settlement. Potsherds of the site also spread over a 5 x 8m^2 area.

SIT 78 – Mahavava at Gallinda
Settlement site
N 8° 00’02”, E 80° 48’55”, MSL 414’

This is the last settlement site could be traced in the lower KOB. It is located east to the Timbiriaththavala kanda and between the Pihimbi-ala and Dambagas-ala at Ranavarayaya. This site only provides potsherds in a small area. Potsherds distribution pattern could not be traced due to the thick deposits of dried leaves. On the other hand, we had to leave the area quickly, as the area is said by the guides of the Wildlife Department to be a sleeping ground of wild elephants during the daytime.

SIT 79 – Deganthuduwa at Minneriya
Iron Smelting site
N 8° 00’38”, E 80° 49’21”, MSL 406’

Densely scattered potsherds, iron ore, and iron slags were found at this site in a 5m x 5m area on the western side of the dried bed of the Kiri Oya at Degantuduwa. This site is located approximately 1km northeast of the Erige Oya confluence at the Kiri Oya.

SIT 80 – Diyahandiya at Minneriya
Iron Smelting site
N 8° 00’59”, E 80° 49’53”, MSL 356’

This site is located 500m southwest of the junction, where the Diyahandiya-ala and the Talkote Oya join to the Kiri Oya. Iron slags could be seen at the site in a sufficient amount in about a 3m x 4m area. Without conducting a proper excavation, it is hard to say, whether the site was in active seasonally or not. Compared to the western vally of Kiri Oya with the eastern valley, the eastern valley of the Kiri Oya around that area is couple of meters lower. But, the formation of the site was most probably not affected by floodwater.

SIT 81 – Ambagasvava at Minneriya
Iron Smelting site
N 8° 01’49”, E 80° 49’19”, MSL 371’

This iron smelting site is located at the premises of the Ambagasvava Wild Life Conservation Office in the Minneriya National Park, just south to the Minneriya-Polonnaruwa road and the Ambagasvava reservoir. The Talkote Oya flows about 1km east to the site. Large blocks of iron slags, tuyeres and furnace wall fragments and a few potsherds could be seen at a circular mound 10m in radius. According to the Mr. Upali Padmakumara, the Park Warden, when they were building a water tank at the site, they identified its archaeological value. Although they sent information, no one came to visit the site until I visited it. But the site distribution pattern could not be understood, as there are several building constructions at the site. Considering formation of the slag, it can be assumed the site once used as a larger iron production site.

SIT 82 – Veharapitiya at Minneriya
Sacred/Religious site
N 8° 01’31”, E 80° 49’31”, MSL 350’

This site is located inside the Minneriya National Park and southeast of the Ambagasvava Wild Life Conservation Office. The Talkote Oya flows 500m east of the site. Circularly scattered brick fragments could be seen on a flat rock boulder at the site. They spread 10m in radius. Considering the distribution pattern of brick fragments, it can be assumed that there was a *stupa* at the site. It is important to note here, the area’s name for the site, *veherapitiya*, means ‘the flat land of the *stupa*’.

SIT 83 – Unapitiya in the Catchment Area of the Minneriya Vava
Iron Smelting site
N 8° 01’15”, E 80° 50’48”, MSL 396’

This is the last iron smelting site found at the KOB, before the Kiri Oya enters the Minneriya Vava. The site is located on the west bank of the Kiri Oya at Unapitiya to the north of Dewilamulla. Iron slags in a concentrated area measuring 1m x 2m is limited to a one place. Although there is a in sufficient amount of iron slags; no large blocks were in sight.

SIT 84 – Nuwaragala-kanda
Monastery site
N 7° 50’32”, E 80° 47’42”, MSL 1025’

This site locates at below the Nuwaragala Vava, where the Kiri Oya starts its journey to the Minneriya Vava. It lies on the ancient Minneri-mawatha, from Lenadora to Minneriya via Alakolavava (Bell et al. 1914) The site previously known, surveyed and discussed with detailed descriptions in several publications (Bell, Fernando, Moysey 1914; Bandaranayake, Mogren and Epitawatta 1990; Jayaweera, Dodanwala, Samaraweera and Kodituwakku *et al*. 1998). Oral tradition in the area connects the ruins at Nuwaragala-kanda with King Mahasen. It says that he used the place as his palace when he was conducting the major irrigation work of Minneriya.

Ruins of the Nuwaragala-kanda are located on both banks of the Nuwaragala-ala (the upper most part of the Kiri Oya). They spread over a 180mx340m area (Data for this calculation obtained from Bell et al. 1914). The survey conducted by the Sigiriya Cultural Trangle Project in 1998 identified the place once used as a "*pathanagara*" type monastery complex that contains ramparts, buildings, dwellings, *stupa, bodhi, moonstone,* pillars, ponds, pathways and terraces. According to the characters of the inscription that was discovered at the abandoned sluice of the Nuwaragala Vava, researchers also conclude the monastery was active during 8-9 centuries A.D. (Jayaweera et al. 1998). They also suggested the word on the inscription "*padoni*", also connects with the custom that appears at a monastery (ibid.). The SARCP registration number for the site was KO 57 (Manatunga 1990: 84).

SIT 85 – Galkaruyaya at Nagolla Vava
Pillar site
N 7° 51'32", E 80° 47'31", MSL 819'

This site is located approximately 400m south of the Nagolla Vava and 75m west of the Kiri Oya (Nagolla Oya) and foothill of the Nuwaragalakanda. Ruins of a squared pillared building that measures 8.60m x 9.80m could be seen at the site. Pillars were placed in three rows as each one has four pillars. Two pillars are still stood on the ground. Others fell down, as they were broken. Middle pillar is measured as 180cm(*h*)x35cm(*l*)x24cm(*w*). North of the building, there are two stone steps. Flat large tile pieces and potsherds in large diameters are densely scattered at the site. It is interesting to note that one piece of a pottery lid found at the vicinity has a cobra hood symbol (Figure 6-23B). It may be connected with fertility and an irrigation related ritual conducted at the site. Several slag pieces could be seen at the site. According to

Ratnayake, the farmer at the site, they found long tuyeres, when they were preparing the land for cultivation.

SIT 86 – Galkaruyaya at Nagolla Vava
Settlement site
N 7° 51’41”, E 80° 47’42”, MSL 750’

This site is located on the east bank of the Kiri Oya and south of the abandoned Nagolla Vava. It spreads over a 300m x 500m area. Galkaruyaya pillar site is located at this settlement. Varies size of potsherds are densely scattered.

SIT 87 –Nagollavava North
Iron Smelting site
N 7° 52’13”, E 80° 47’30”, MSL 823’

This large iron smelting site spreads over both banks of the Kiri Oya and southeast to the Vavala Vava and slopes to the east and southeast. It spreads over a 300m x 350m area. The waterway comes from a spring at the southwest corner of the site and runs towards the northwest to join the Kiri Oya at the northern edge. An abandoned bund can be seen just 50m south to the point across the Kiri Oya. Large blocks of iron slags, along with densely scattered potsherds could be seen at the site. A dam that run across the Kiri Oya is located at the northern edge of the western part of the smelting site. This site is known as the Senevi’s plot. This is a proposed site for future excavation.

SIT 88 – Catchment Area at Vavala Vava
Iron Smelting site
N 7° 52’18”, E 80° 47’00”, MSL 877’

Small iron smelting site at the Vavala Vava catchment area, spreads over a 20mx20m area. The mound at the site is oriented in an east-west direction. Several slag pieces are spread at the top of the mound.

SIT 89 – Kenda Kanatta at Vavala Vava
Iron Smelting site
N 7° 52’49”, E 80° 47’31”, MSL 877’

This large iron smelting site locates northeast to the Vavala Vava and the east bank of the Kiri Oya at an abandoned onion field. It also locates in between two waterways. One runs towards the Vavala Vava and the other to the Kiri Oya. Both waterways started from the Nuwaragala-kanda. Blocks of iron slags and a few potsherds could be seen at the top of a mound (slag mound?) that slopes to the west. It spreads over a 50m x 75m area. The site is presently covered by *mana*.

SIT 90 – Vahakotteyaya
Pillar site
N 7° 53’08”, E 80° 47’26”, MSL 740’

This site is located on the east bank of the Kiri Oya in between the Kiri Oya and the Konduruvava mountain range. Vavala Vava is located about 150m south. There are two mounds with pillars that are oriented to the northeast-southwest direction. The gap between mounds is 18m. While one mound spreads 8m in diameter the other one measured 9m. The mound one is located 19m east to the Kiri Oya. The other is 13m east to the Kiri Oya. There are 7 pillars (only one stood, others are fallen) on the first mound and the second has six pillars (only two stood up). Potsherds, tile pieces and large bricks were noticed at the vicinity. During the SARCP it was identified as a Buddhist monastery (KO 8 in Manatunga 1990: 84).

SIT 91 – Vahakotteyaya
Settlement site
N 7° 53’08”, E 80° 47’28”, MSL 740’

The pillar site at the Vahakotteyaya (SIT 90) is located at this large settlement site. The settlement spreads from the east of the Kiri Oya and covers about 400m to the east until it reaches to the Konduruvava Mountain Ridge. It spreads 350m approximately from the north to the south. Bakmeegaha-ala, a stream flows between the two hilltops of the mountain ridge and enters the site at the north corner and divides into two waterways. One runs towards the west to the Kiri Oya and the other towards the south. An ancient bund was seen 200m north to the site. Another bund was seen about 800m north of the first bund and both are connected to the eastern mountain ridge at the east and western high ground of the eastern Kiri Oya Valley at the west. It would have been used as a water storage pond or small reservoir by surrounding settlements. Densely scattered varies size of potsherds can be seen at the site.

SIT 92 – Vahakotteyaya
Iron smelting site
N 7° 53’57”, E 80° 47’32”, MSL 735’

It is located at the southeastern corner of the Vahakotteyaya settlement (SIT 91). Blocks of iron slags, tuyere and furnace wall fragments spread over the 75m x 75m area. The southern branch of the Bakmeegaha-ala runs at the western demarcation of the site.

SIT 93 – Batuyaya/Hinni Kanatta
Settlement site
N 7° 53’37”, E 80° 47’43”, MSL 676’

This large settlement site is located east bank of the Kiri Oya and about 400m southeast to the SIT 22, Dikyaya-kanda iron production site. The Konduruvava Mountain Range served as the western demarcation of the site. The site spreads over a 300m x 400m area. This settlement flourished by three waterways that flow towards the Batu-ala, the stream runs from the mountain to join the Kiri Oya. There is a dam between the site and the Kiri Oya. It also provides evidence that there was a water storage place (vava/reservoir) inside the settlement. Densely scattered potsherds and pinnacles could be seen at the site.

SIT 94 – Batuyaya/Hinni Kanatta
Iron smelting site
N 7° 53’37”, E 80° 47’42”, MSL 674’

This large iron smelting site adjoins to the SIT 91, the settlement site at Batuyaya. It locates at the southeastern corner of the settlement and spreads over a 75m x 100 area. Large blocks of iron slags, tuyeres, furnace wall fragments along with potsherds could be seen at the site.

SIT 95 –Nagolla Vava North
Settlement site
N 7° 52’12”, E 80° 47’30”, MSL 823’

This large settlement site adjuncts to the SIT 87, the iron smelting site at the Nagolla Vava . It spreads to the north from SIT 87 approximately 300m x 400m and to the south from SIT 87 in a 200m x 200m area. Densely distributed potsherds and fragments of terracotta figurines could be seen at the site. Presently cultivated by K.G. Navaratna (Raja).

SIT 96 – Pansalwatta at Alakolavava
Settlement site
N 7° 53’52”, E 80° 47’08”, MSL 695’

This large settlement site is located on the west bank of the South Kosgaha-ala and between the South Kosgaha-ala and the Alakolavava monastery site (SIT 28). It demarcated by the Kuratiyaya iron smelting site (SIT 29) from the south and from a modern quarry site from the north. It faces to the paddy field that is located on the east. The site spreads over a 100m x 400m area and varies sizes of potsherds can be seen.

SIT 97 – Pansalwatta at Alakolavava
Iron ore preparation site/Iron smelting site
N 7° 54’00”, E 80° 47’07”, MSL 686’

This site locates just north to the quarry site at the Pansalwatta settlement (SIT 96), northeast to the Alakolavava monastery site (SIT 28) and adjoins at the east to the South

Kosgaha-ala. It spreads over a 100m x 100m area and slopes from south to north direction. Between the two hilly mounds that are located north and south of the site, a depression can be seen at the middle. It seems like a preparation area of iron ore as lots of crushed iron ore scattered.

SIT 98 – Ihalavava at Alakolavava
Settlement site
N 7° 53’58”, E 80° 46’58”, MSL 710’

This large settlement site locates about 400m east to Alakolavava and Ihalavava and 200m southeast to the Ancient Alakolavava. It is and below the rock boulder where Alakolavava Monastery (SIT 28) is located. SIT 28 is located at the opposite site. It spreads semi-circularly around the rock boulder is about a 100m x 500m area. Densely scattered potsherds and a few pinnacles and iron slags can be seen at the site.

SIT 99 – Ihalavava at Alakolavava
Iron smelting site
N 7° 53’54”, E 80° 46’41”, MSL 669’

This large iron smelting site locates just southeast to the Alakolavava, Ihalavava bund and spreads over a 125m x 125m area. Ancient paddy field of Ihalavava is also seen 100m northeast to the site. Iron slags and tuyere fragments can be seen at the site.

SIT 100 – Kuratiyaya/Asamodagamyaya at Alakolavava
Settlement site
N 7° 53’50”, E 80° 46’53”, MSL 653’

This site is located just west of the Kuratiyaya iron smelting site (SIT 29). It also spreads towards the east and is attached to the south demarcation of SIT 29. Kuratiyaya-ala flows between the SIT 29 and the SIT 100. The eastern portion of the site spreads over a 50m x 100m area and the southern portion about 50m x 50m. Potsherds and iron slags can be seen at the site.

SIT 101 – Dehigaha-ala (East Bank) Divulpitiya at Alakolavava
Iron ore deposit/ site
N 7° 54'58", E 80° 47'09", MSL 889'

This large site is demarcated by the Dehigaha-ala from the west, by the stream that flows to the Dehigaha-ala from the east. There are blocks of iron slags and blocks of iron ore (Figure 6-8) can be seen at the streambed. Not only at the streambed, lots of iron ore blocks are also laid below the mound at the western portion of the site. It indicates that the huge deposit of iron ore is hidden somewhere in or around the site.

SIT 102 – Pahalavava at Alakolavava
Settlement site/terracotta site
N 7° 54'09", E 80° 46'47", MSL 623'

This site is located in the southeastern corner of the reservoir bund, just south of the Pahalavava iron smelting site (SIT 39) and east to the public well at the Alakolavava village. The site slopes to the east and potsherds spread over an 80mx100m area in a lesser amount. According to Senavi Banda, a village assistant for the survey, villagers found several terracotta figurines when they dug a pit.

SIT 103 – Puranavava at Gallinda
Iron smelting site/Burial site
N 7° 59'30", E 80° 47'09", MSL 581'

This site locates at the northeast bund of the reservoir and east of the limestone band. There is lesser amount of iron slag and potsherds spread over a 10mx10m area. Gallinda Veharagodalla, mentioned in the SARCP publication (KO 45 in Manatunga 1990:83) is located north to the site and north west to the Gallinda spring. There are several heaps of disturbed limestone rubble at the foot of the small hilly slope. It has been suggested that they are connected with 'cairn burials' or ritual centers of Vaddha (aborigines or native Sri Lanka) that Gallinda considers as the Vaddha's old settlement (ibid.).

SIT 104 –Puranavava, Pattilava at Gallinda
Pillar site
N 7° 59’32”, E 80° 46’56”, MSL 614’

Six broken pillars can be seen southwest of the Gallinda Puranavava iron smelting site (SIT 103). The only standing pillar among them is 95cm in length. The others only have broken pedestals. The site might be used as a ritual center for the nearby settlement.

SIT 105 –Makarayaulpotha
Pillar site
N 7° 55’15”, E 80° 46’45”, MSL 623’

This site is located about 50m southeast to the Makarayaulpotha settlement site (SIT 43) and south to the Makaraulpotha Vava. There is only one fallen pillar that can be seen on a mound spread 5m in radius. It measures 1.70cm(*h*)x28cm(*w*)x20cm(*l*). It would have been used as a sacred place when the settlement was active.

SIT 106 –Dehigaha-ala-kanda
Sacred/Religious site
N 7° 54’48”, E 80° 47’00”, MSL 623’

This site is located on the west bank of the Dahigaha-ala, and just southeast of the abandoned paddy field that attaches to the SIT 1. Dehigaha-ala runs from the southern demarcation of the site eastwardly to the north. A circular brick foundation 1.30m in radius can be seen below the surface and inside a pit dug by villagers. To the north of the foundation there is an abandoned earthen bund that runs from the eastern bank of the Dehigaha-ala towards SIT 1. The foundation made of large bricks that measures as 20cm (*w*)x 20cm(*l*)x6cm(*h*) in 4 rows. It seems empty in the middle. Sarath, the village assistant of the survey, said that they found a sand pot (ash?) at the middle. Except for a few potsherds, there were not any other cultural remains noticed. It seems like a *stupa* or a burial structure of a person from a higher rank of society.

SIT 107 –Moragaha-ala (East) at Ihakuluvava
Settlement site
N 7° 58’46”, E 80° 50’59”, MSL 410’

This site is located in the southeast corner of the Moragaha-ala Vava on both sides of the pathway from Ihakuluvava to Dikkanda-ala. The reservoir is not marked on the Polonnaruwa topographical sheet. It lies at latitude N 7° 58’53” and longitude E 80° 50’28”, approximately 390feet/119m above mean sea level. It was built between two mountain ridges: from north the Kalugalhinna Kanda and the south from the Gomadiyapataha Kanda.

This large settlement spreads over 300m x 300m area. Densely scattered potsherds, in a lesser amount of large bricks and iron slags are seen.

SIT 108 –Moragaha-ala at Ihakuluvava
Sacred site/Pillar site
N 7° 58’40”, E 80° 50’22”, MSL 358’

It locates just south to the pathway from Ihakuluvava to the Dikkanda-ala, east to the Madayamala-ala and the foothill of the Gomadiyapataha Kanda. Only one dressed pillar stone, 50cm in height can be seen. There are not any characters written, even though it has a semi circular top with one smoothly dressed side. It is most similar to the guard stone that represents the early Anuradhapura period.

SIT 109 –Moragaha-ala (West) at Ihakuluvava
Settlement site
N 7° 58’38”, E 80° 50’20”, MSL 365’

It is located just southeast to the SIT 108 and east to the Moragaha-ala. Potsherds, brick fragments and a few cherts fragments are scattered over the site. Although it is hard to identify the site demarcation, it seems the site spreads along the Moragaha-ala towards the south.

SIT 110 –Vadda Vatiya at Moragaha-ala
Sacred site
N 7° 58’13”, E 80° 49’42”, MSL 420’

This is a sacred site for Vadda people. The stone bund built to connect two low mountain ridges at the site considered to be the boundary for hunting lands of Konduruvava Vadda and Gallinda Vadda. The pathway from Ihakuluvava to the Dikkanda-ala runs across the bund. The bund runs 80m from southwest to northwest and is 5m in height.

SIT 111 –Vasala Potana at Ihakuluvava
Settlement site
N 7° 58’52”, E 80° 51’32”, MSL 365’

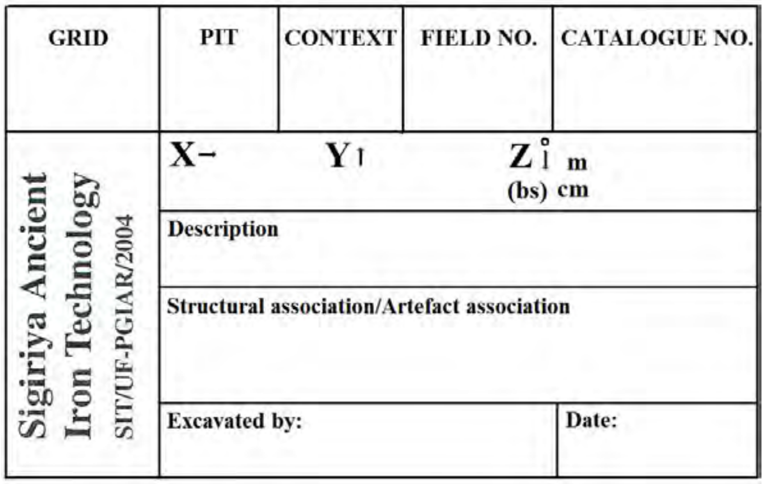
It is located just west of the pathway from Ihakuluvava to the Dikkanda-ala, southwest to the Minneriya Vava, northeast of the Ihakuluvava bund and close to the boundary of the Minneriya Wildlife Sanctuary. Densely scattered potsherds and tuyere fragments can be seen.

SIT 112 –Aluth Devalaya at Minneriya
Sacred site
N 8° 02’40”, E 80° 53’45”, MSL 327’

It locates near the Jayanthi sluice and on the reservoir bund at the Minneriya Vava (reservoir) bund. Presently, well-known worshiping place among pilgrimages and local tourists who come to visit the Minneriya Vava. This *devalaya* is dedicated for *Minneri Deviyo*. Minneriya Vava and connected irrigation network of the area were built during the King Mahasen’s reign (329 A.D.). Therefore, the people not only the Kiri Oya valley, but also surrounding area worships King Mahasen as their local guardian. According to the Irrigation Department of Minneriya records, the Minneriya Vava was renovated in 1949. The full supply level is 307.40 ft above MSL (the bund’s top level 318.65ft MSL). The catchments area spreads over 92.60 square miles and irrigable lands spread over 25,000 acres. Minneriya Purana

Devalaya is located west to the Minneriya Vava and it is not located inside the SIT study region. I provide a brief description of it under the ethnographic view in Chapter 4.

APPENDIX E
ARTIFACTS ANALYSIS



GRID	PIT	CONTEXT	FIELD NO.	CATALOGUE NO.

Sigiriya Ancient Iron Technology
SIT/UF-PGIAR/2004

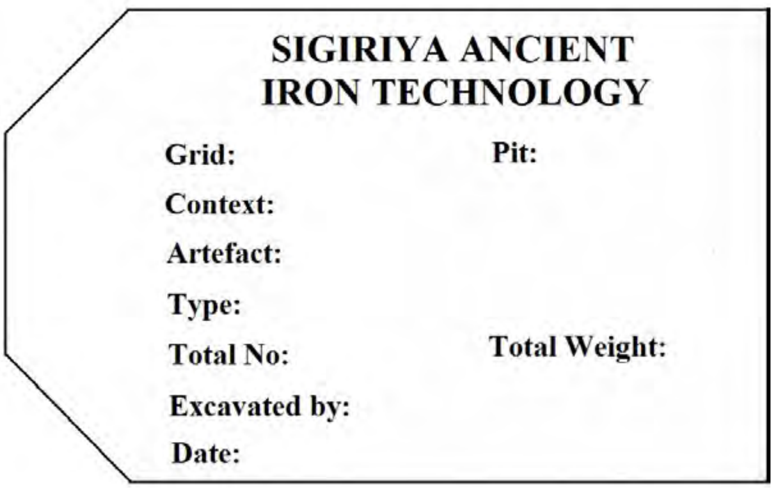
X→ Y↑ Z↕ m (bs) cm

Description

Structural association/Artefact association

Excavated by: | Date:

A



SIGIRIYA ANCIENT IRON TECHNOLOGY

Grid: Pit:
Context:
Artefact:
Type:
Total No: Total Weight:
Excavated by:
Date:

B

Figure E-1. A) Artifact (special finds[1]) registration sheet - for the field. B) Ceramic[2] and iron slag registration sheet - for the field.

*Some samples were collected specially for metallurgical analyses. Lab numbers were assigned for these samples. Some samples for metallurgical analyses were selected among unearthed samples, which have already assigned field numbers. Therefore, these specimens have both a field and a lab number. In addition, sample numbers were assigned for all samples according to their site numbers before sending metallurgical analyses.

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[1] Rare finds unearthed at every excavated site registered under this category. As smelting remains, furnace fragments and tuyeres are abundant at iron smelting sites; selected fragments among those were registered as special finds. All others were weighted separately to get rough idea of the volume of the production at the site.

[2] When potsherds rich at any site, selected special potsherds were registered under special find category. Others registered under B. All potsherds were analyzed and weighted during post-excavation workshops (Appendix J).

Sigiriya Ancient Iron Technology SIT/UF-PGIAR/2004	CATALOGUE NO. S/ yr / no.	MATERIAL/OBJECT

name no. SITE:	CONTEXT: field no.		
X → Y ↑ Z ↕ above mean sea level	OTHER LOCATIONAL DATA (if any)		
STRUCTURAL ASSOCIATION	NO. OF OBJECTS	LENGTH	WIDTH
	THICKNESS	HEIGHT	DIAMETER
ARTEFACT ASSOCIATION	WEIGHT	COLOUR	TYPE/SHAPE

Photo Register No. Date	Analysis Report No.	CONTACT PRINT
Analysis Register No. Date	Drawing Register No.	
Excavated by Date	Storage No.	
Catalogued by Date	Photo No.	

A

% of whole: 10 20 30 40 50 60 70 80 90 100 uncertain	condition rating: good 10 9 8 7 6 5 4 3 2 1 poor
conservation rating: importance 3 2 1 0 urgency 3 2 1 0	condition: preserved broken fragmentary bent worn corroded brittle disintegrating
NOTES: Function Proposed dating etc.	DESCRIPTION AND SKETCH scale:

B

Figure E-2. A) Front view of the artifact analysis sheet - for the lab. B) Back view of the artifact analyses sheet - for the lab.

Table E-1. Artifacts analysis at SIT 22

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	01	PG/04/01	NE01	N105/E101 Trench 01	41	26	199.28	20	02	Tuyere Fragment
	02	PG/04/02	NE01	N105/E102 Trench 01	15	80	199.28	20	02	Tuyere Fragment
	03	PG/04/03	SW01	N/A (surface)	N/A	N/A	N/A	0	N/A	A Bead[a]
	04	PG/04/04	NE01	N105/E100 Trench 01	78	23	199.12	27	04	Tuyere Fragment[b]
	05	PG/04/05	NE01	N104/E114 Test Pit 01	80	01	199.30	02	51	Tuyere Fragment
	06	PG/04/06	NE01	N104/E112 Trench 02	30	15	199.98	20	52	Iron Ore[c]
	07	PG/04/07	NE01	N104/E114 Test Pit 01	32	78	199.02	30	53	Iron Ore[d]
	08	PG/04/08	NE01	N104/E114 Test Pit 01	20	80	198.96	30	53	Iron Ore
	09	PG/04/09	NE01	N104/E111 Trench 02	23	20	198.81	48	63	Iron Oree[e]
	10	PG/04/10	NE01	N104/E113 Trench 02	47	19	198.75	45	54	Iron Ore[f]

[a] A blue bead was among surface collection at the western portion of the site that is used for onion cultivation.

[b] This was the only octagonal shaped tuyere fragment (7.65cm in length and 6.1cm in width) unearthed at the site (sample # SIT22-22).

[c] Squared piece of iron ore (Sample # SIT22-05).

[d] Squared rusty colored piece of iron ore with silver core (Sample # SIT 22-03).

[e] Rounded shaped piece of iron ore (Sample # SIT22-07).

[f] Thin flat squared piece of iron ore (Sample # SIT22-06). One side has polished shiny look and the other has small bubbles.

Table E-1. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	11	PG/04/11	NE01	N104/E115 Test Pit 01	85	72	199.28	17	55	Iron Ore
	12	PG/04/12	NE01	N103/E113 Trench 03	70	74	199.15	09	52	Iron Ore
	13	PG/04/13	NE01	N104/E113 Trench 02	40	15	198.88	33	54	Iron slag
	14	PG/04/14	NE01	N104/E112 Trench 02	72	02	198.89	32	63	Iron Slag [a]
	15	PG/04/15	NE01	N104/E113 Trench 02	02	03	198.87	45	54	Charcoal
	16	PG/04/16	NE01	N104/E114 Test Pit 01	40	23	196.70	53	53	Iron Ore [b]
	17	PG/04/17	NE01	N103/E112 Trench 03	60	50	198.65	26	56	Iron Ore
	18	PG/04/18	NE01	N105/E108 Trench 01	42	33	198.52	73	58	Fragment of a Furnace Wall
	19	PG/04/19	NE01	N105/E107 Trench 01	63	33	198.48	78	58	Tuyere Fragment [c]
	20	PG/04/20	NE01	N104/E108 Trench 02	60	20	198.42	85	61	Plaster of a Furnace Wall [d]
	21	PG/04/21	NE01	N105/E108 Trench 01	95	90	198.54	65	58	Fragment of a Furnace Wall (very top curved end)

[a] Triangular block of iron slag (Sample # SIT22-16).

[b] Rusty Black squared piece of iron ore (Sample # SIT22-01).

[c] Cylindrical tuyere fragment (Sample # SIT22-25).

[d] Thin, pale yellow clay plaster that was attached to the inner wall (Sample # SIT22-26)

Table E-1. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	22	PG/04/22	NE01	N105/E108 Trench 01	75	85	198.25	107	62 (57) [a]	Inner part of the Furnace Wall [b]
	23	PG/04/23	NE01	N105/E108 Trench 01	25	12	198.05	128	57	Fragment of a Tuyere Holder (Front Wall) [c]
	24	PG/04/24	NE01	N104/E108 Trench 02	12	78	198.06	130	60	A Tuyere (cylindrical) [d]
	25	PG/04/25	NE01	N104/E108 Trench 02	46	86	198.06	130	60	Fragment of a Tuyere (cylindrical)
	26	PG/04/26	NE01	N104/E108 Trench 02	45	65	198.06	130	60	A Tuyere (cylindrical)
	27	PG/04/27	NE01	N105/E108 Trench 01	02	55	198.22	116	60	A Tuyere (cylindrical)
	28	PG/04/28	NE01	N105/E108 Trench 01	30	05	198.06	130	60	A Tuyere (cylindrical)
	29	PG/04/29	NE01	N104/E108 Trench 02	32	58	198.01	125	60	fragment of a Tuyere [e] (cylindrical)
	30	PG/04/30	NE01	N104/E107 Trench 02	17	96	197.70	164	68	A Bead

[a] The furnace unearthed at the site was registered as Context 57. But the sample collected at the level of soil layer that was registered as Context 62.

[b] While outer part was in pale red, inner in olive green (Sample # SIT22-21).

[c] Lower part of the front wall of the furnace used to place tuyeres. When a wall fragment found with imprints of tuyeres, it registered as a tuyere holder or tuyere carrier.

[d] Field # 24 – Field # 30 unearthed *in situ*. In the text, this tuyere layer mentioned as the upper/first layer of tuyeres.

[e] Cylindrical tuyere fragment (Sample # SIT22-23).

Table E-1. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	31	PG/04/31	NE01	N104/E107 Trench 02	45	22	199.43	86	62	Fragment of a Parallel Tuyere[a]
	32	PG/04/32	NE01	N105/E108 Trench 01	20	70	198.72	120	65	Fragment of a Tuyere[b]
	33	PG/04/33	NE01	N104/E108 Trench 02	53	70	198.12	130	65	A Tuyere (cylindrical)
	34	PG/04/34	NE01	N104/E108 Trench 02	53	73	197.99	138	65	A Tuyere (cylindrical)
	35	PG/04/35	NE01	N104/E108 Trench 02	37	76	197.94	143	65	Fragment of a Tuyere
	36	PG/04/36	NE01	N104/E108 Trench 01	30	0	197.98	142	65	Fragment of a Tuyere
	37	PG/04/37	NE01	N104/E108 Trench 02	90	04	198.29	94	62	Iron Ore? [c]
	38	PG/04/38	NE01	N105/E108 Trench 01	84	10	198.10	110	65	A Tuyere (cylindrical)
	39	PG/04/39	NE01	N104/E108 Trench 02	48	73	197.99	120	65	A Tuyere (cylindrical)
	40	PG/04/40	NE01	N104/E108 Trench 02	58	70	198.12	117	65	A Tuyere (cylindrical)
	41	PG/04/41	NE01	N104/E108 Trench 02	40	100	197.91	115	65	A Tuyere (cylindrical)

[a] This confirms that tuyeres were placed at the front wall of the furnace as parallel to each other as at Degigaha-ala-kanda furnaces (Forenius and Solangaarachchi 1994).

[b] Part of the Field # 32 sent for analyzing (Sample # SIT22-24). Whole tuyeres or fragments of tuyeres registered from Field # 32 to Field # 44 were unearthed *in situ*. In the text, this tuyere layer mentioned as the lower/second layer of tuyeres. Part of the Field # 32 sent for analyzing (Sample # SIT22-24).

[c] Squared block (Sample # SIT22-04). But did not answer to the magnet.

Table E-1. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	42	PG/04/42	NE01	N105/E108 Trench 01	45	05	197.98	108	65	A Tuyere (cylindrical)
	43	PG/04/43	NE01	N105/E108 Trench 01	40	10	197.98	108	65	A Tuyere (cylindrical)
	44	PG/04/44	NE01	N105/E108 Trench 01	40	20	197.94	118	65	A Tuyere (cylindrical)
	45	PG/04/45	NE01	N105/E108 Trench 01	65	02	197.82	140	72	Clay Plaster[a] (from the furnace bottom)
	46	PG/04/46	NE01	N105/E108 Trench 01	26	70	197.83	135	71	Block of Bottom Slag
	47	PG/04/47	NE01	N101/E103 Mound A	10	20	199.48	118	N/A	Iron Ore[b]
	48	PG/04/48	NE01	N104/E108 Trench 02	10	20	197.94	140	65	Pieces of Quartz[c]
	49	PG/04/49	NE01	N104/E108 Trench 02	90	80	198.98	35	75	Iron Slag[d]
	50	PG/04/50	NE01	N105/E109 Trench 01	10	58	198.27	114	65	Iron Slag[e]
	51	PG/04/51	NE01	N104/E109 Trench 02	25	60	197.83	120	73	Upper Layer of the Bottom Slag[f]

[a] Inner has thin clay plaster. Outer is in pale grayish yellow (Sample # SIT22-27).

[b] Rusty black, small rounded lumps (Sample # SIT22-02). Attached to the bottom slag.

[c] Snow white color with small patches (Sample # SIT22-28/Lab # 13).

[d] Attached to the upper part of the furnace and unevenly solidified block (Sample # SIT22-08/Lab # 01).

[e] Attached to the middle part of the furnace and unevenly solidified block (Sample # SIT22-09/Lab # 02).

[f] Solid block and has some holes. Outer is in reddish black color with inner black core (Sample # SIT22-10/Lab # 03).

Table E-1. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	52	PG/04/52	NE01	N104/E108 Trench 02	80	90	197.85	118	71	Iron Slag[a]
	53	PG/04/53	NE01	N101/E113 Mound A	20	15	199.48	N/A	62?	Tapped Iron Slag[b]
	54	PG/04/54	NE01	N105/E104 Trench 01	20	40	199.28	20	62	Tapped Slag with Grass Imprints[c]
	55	PG/04/55	NE01	N105/E108 Trench 01	20	48	197.53	58	62	Iron Slag[d]
	56	PG/04/56	NE01	N105/E108 Trench 01	60	98	197.56	74	62	Iron Slag[e]
	57	PG/04/57	NE01	N104/E109 Trench 02	14	90	198.93	25	57	Fragment of the Furnace Wall [f] (Upper Back)
	58	PG/04/58	NE01	N105/E109 Trench 01	12	45	197.53	58	57	Fragment of the Furnace Wall [g] (Middle)
	59	PG/04/59	NE01	N105/E109 Trench 01	10	25	197.11	93	57	Fragment of the Furnace Wall[h] (Lower)

[a] Solid block. Color ranges from reddish brown to black (Sample # SIT22-12/Lab # 05).

[b] Poured solid block (Sample # SIT22-13/Lab # 10).

[c] Solid block with grass imprints (Sample # SIT22-14/Lab # 11).

[d] Solid block with bubbles and attached to the furnace wall (Sample # SIT22-15/Lab # 12).

[e] Solid flat block (Sample # SIT22-17/Lab # 06).

[f] Outside has quite large pieces of quartz and inner has higher percentage of clay (Sample # SIT22-18).

[g] Outside yellowish brown in color and inner has reddish brown burnt clay plaster (Sample # SIT22-19).

[h] Outside has reddish brown heavily burnt clay and inner has reddish brown burnt clay plaster (Sample # SIT22-19).

Table E-2. Artifacts analysis at SIT 6

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	01	PG/04/106	NW01	N403/W399 Test Pit 01	55	30	200.54	03	02	Iron Nail
	02	PG/04/107	NW01	N403/W399 Test Pit 01	40	60	200.42	18	02	Iron Nail
	03	PG/04/108	NW01	N403/W399 Test Pit 01	40	80	200.45	14	02	Piece of a Pedestal of a Pottery [a]
	04	PG/04/109	NW01	N402/W398 Test Pit 01	90	40	200.41	18	02	Piece of a Bone
	05	PG/04/110	NW01	N403/W398 Test Pit 01	70	100	200.40	18	02	Iron Nail
	06	PG/04/111	NW01	N402/W399 Test Pit 01	20	80	200.36	30	03	Tooth
	07	PG/04/112	NW01	N403/W399 Test Pit 01	05	60	200.28	29	03	Piece of a Bone
	08	PG/04/113	NW01	N403/W399 Test Pit 01	80	75	200.26	31	03	Iron Nail
	09	PG/04/114	NW01	N402/W398 Test Pit 01	20	60	200.19	25	04	Piece of a Clear Quartz
	10	PG/04/115	NW01	N403/W399 Test Pit 01	90	75	200.27	33	03	Iron Object
	11	PG/04/116	NW01	N403/W399 Test Pit 01	78	70	200.25	34	03	Unidentified Object
	12	PG/04/117	NW01	N402/W398 Test Pit 01	56	30	199.99	46	04	Piece of BRW
	13	PG/04/118	NW01	N402/W398 Test Pit 01	84	86	199.98	45	04	Iron Nail

[a] Remained only 1/5 of the pedestal.

Table E-2. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	14	PG/04/119	NW01	N402/W398 Test Pit 01	80	85	199.91	53	04	Iron Slag [a]
	15	PG/04/120	NW01	N402/W398 Test Pit 01	55	40	198.87	54	04	A Bead (green)
	16	PG/04/121	NW01	N402/W398 Test Pit 01	23	40	199.87	53	04	Iron Nail
	17	PG/04/122	NW01	N402/W398 Test Pit 01	70	45	199.82	58	04	Iron Slag [b]
	18	PG/04/123	NW01	N402/W398 Test Pit 01	46	50	199.97	71	04	Grinding Stone
	19	PG/04/124	NW01	N402/W398 Test Pit 01	10	52	199.95	69	04	Iron Nail
	20	PG/04/125	NW01	N402/W398 Test Pit 01	94	91	200.09	35	04	Iron Nail
	21	PG/04/126	NW01	N402/W399 Test Pit 01	55	40	199.91	74	04	Grinding Stone
	22	PG/04/127	NW01	N403/W399 Test Pit 01	35	45	199.99	77	04	Copper Object/Pendent
	23	PG/04/128	NW01	N403/W399 Test Pit 01	90	75	199.89	77	04	Iron Nail
	24	PG/04/129	NW01	N402/W398 Test Pit 01	40	60	199.88	74	04	Iron Nail
	25	PG/04/130	NW01	N403/W398 Test Pit 01	80	17	199.80	71	04	Iron Nail
	26	PG/04/131	NW01	N402/W398 Test Pit 01	56	56	199.69	80	04	Unidentified Green Object/ Bead?

[a] Reddish Brown in color. Similar to laterite rock (Sample # SIT06-02).

[b] Flat block (Sample # SIT06-03).

Table E-2. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	27	PG/04/132	NW01	N402/W399 Test Pit 01	35	72	199.62	93	07	Iron Ore[a]
	28	PG/04/133	NW01	N402/W398 Test Pit 01	50	23	198.51	109	07	Iron Nail
	29	PG/04/134	NW01	N402/W398 Test Pit 01	70	70	198.66	106	07	Unidentified Iron Object (fragment)
	30	PG/04/135	NW01	N403/W398 Test Pit 01	50	03	198.64	114	09	Grinding Stone
	31	PG/04/136	NW01	N403/W398 Test Pit 01	23	33	198.58	110	09	Piece of Chert
	32	PG/04/137	NW01	N402/W398 Test Pit 01	25	35	197.98	208	13	Piece of Fine Ware (Buff Ware)
	33	PG/04/138	NW01	N402/W398 Test Pit 01	30	38	197.97	211	13	Piece of Quartz

[a]Squared block (Sample# SIT06-01).

Table E-3. Artifacts analysis at SIT 7

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	01	PG/04/64	NW01	N301/W295 Test Pit 01	23	33	199.18	05	02	Iron Ore[a]
	02	PG/04/65	NW01	N301/W295 Test Pit 01	50	50	199.17	05	02	Iron Slag[b]
	03	PG/04/66	NW01	N301/W296 Test Pit 01	30	68	199.18	12	02	Piece of Chert
	04	PG/04/67	NW01	N301/W296 Test Pit 01	80	82	199.07	20	04	Iron Ore
	05	PG/04/68	NW01	N301/W295 Test Pit 01	50	62	199.08	16	03	Piece of Clear Quartz
	06	PG/04/69	NW01	N301/W295 Test Pit 01	30	22	199.09	16	04	Piece of Chert
	07	PG/04/70	NW01	N302/W295 Test Pit 01	05	20	199.00	20	02	Piece of a Crucible[c]
	08	PG/04/71	NW01	N301/W297 Test Pit 01	90	40	199.00	0	01	Piece of a Crucible[d]
	09	PG/04/72	SW03	S245/W298 Test Pit 02	45	90	200.17	35	09	Fragment of a Polished BW[e]
	10	PG/04/73	SW03	S244/W298 Test Pit 02	50	03	200.09	35	09	Fragment of a BRW[f]

[a] Round shaped, pale red in color (Sample # SIT07-01).

[b] Solid without any bubble (Sample # SIT07-03).

[c] Field #s 07 & 08 are first crucible specimens unearthed in the region. Field # 07 is cylindrical and grayish black in color (Sample # SIT07-05).

[d] Cylindrical and grayish black in color (Sample # SIT07-06).

[e] Black Ware/ Black Polished ware ceramics are rare find among others and it is reported around 10-11centuries AD.

[f] Black and Red Ware pottery were spread from proto historic iron age to 4th century AD in the region.

Table E-3. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	11	PG/04/74	SW03	S244/W298 Test Pit 02	10	65	200.05	52	09	Fragment of a Bone [a]
	12	PG/04/75	SW03	S245/W298 Test Pit 02	40	70	200.05	52	09	Fragment of a Bone
	13	PG/04/76	SW03	S244/W298 Test Pit 02	20	70	200.05	52	09	Piece of Chert
	14	PG/04/77	SW03	S244/W298 Test Pit 02	20	80	200.05	52	09	Piece of Clear Quartz
	15	PG/04/78	SW03	S244/W298 Test Pit 02	10	45	200.22	30	09	Charcoal Sample
	16	PG/04/79	SW03	S244/W298 Test Pit 02	12	65	200.05	48	09	Piece of Chert
	17	PG/04/80	SW03	S244/W298 Test Pit 02	25	65	200.02	53	09	Piece of Glass [b]
	18	PG/04/81	SW03	S244/W298 Test Pit 02	68	30	200.10	45	09	Piece of Mineral
	19	PG/04/82	SW03	S244/W298 Test Pit 02	44	22	200.05	50	09	Piece of Clear Quartz
	20	PG/04/83	SW03	S244/W298 Test Pit 02	90	90	200.05	47	09	Fragment of a Polished RW [c]
	21	PG/04/84	SW03	S244/W298 Test Pit 02	50	50	200.02	3	09	Pieces of Bones
	22	PG/04/85	SW03	S245/W298 Test Pit 02	65	10	200.97	57	09	Piece of a Bone

[a] Context/s # 09, 10 & 11 at Test Pit #02 were rich in fragmented human bones. Most of them were in brittle condition.

[b] Thin fragment, amber green in color.

[c] Polished Red Ware also among luxury ceramics recorded in the region.

Table E-3. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	23	PG/04/86	SW03	S245/W298 Test Pit 02	60	35	200.94	60	10	Iron Ore
	24	PG/04/87	SW03	S245/W298 Test Pit 02	70	90	200.92	62	10	Piece of a Terracotta Figurine [a]
	25	PG/04/88	SW03	S244/W298 Test Pit 02	35	96	200.91	63	10	Grinding Stone[b]
	26	PG/04/89	SW03	S244/W298 Test Pit 02	58	95	200.90	65	10	Piece of a Terracotta Figurine
	27	PG/04/90	SW03	S245/W298 Test Pit 02	90	28	200.22	64	10	Piece of a Bone
	28	PG/04/91	SW03	S245/W298 Test Pit 02	93	35	200.89	65	10	Piece of Chert
	29	PG/04/92	SW03	S244/W298 Test Pit 02	24	96	200.77	77	11	Fragments of a Pottery
	30	PG/04/93	SW03	S244/W298 Test Pit 02	20	70	200.75	79	11	Piece of Chert
	31	PG/04/94	SW03	S245/W298 Test Pit 02	40	14	199.98	50	10	Piece of a Bone
	32	PG/04/95	SW03	S245/W298 Test Pit 02	27	16	199.99	49	10	Iron Slag[c]
	33	PG/04/96	SW03	S244/W298 Test Pit 02	13	15	200.97	56	10	Iron Slag
	34	PG/04/97	SW03	S245/W298 Test Pit 02	38	60	199.64	85	12	Iron Slag

[a] As told by villagers, SIT 7 is one of the settlement sites that they collected terracotta figurines, what they called "*mati-bonikko*" (clay-dools) at the site.

[b] Dress stones or Grinding Stones are significant finds among other artifacts at most settlement sites in the KOB.

[c] Solid block without any bubbles (Sample # SIT07-04).

Table E-3. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	35	PG/04/98	SW03	S245/W298 Test Pit 02	40	95	199.55	104	12	Polished BW
	36	PG/04/99	SW03	S245/W298 Test Pit 02	70	10	199.54	105	12	Grinding Stone
	37	PG/04/100	SW03	S245/W298 Test Pit 02	60	10	199.56	94	12	Decorated, Polished BW [a]
	38	PG/04/101	SW03	S244/W298 Test Pit 02	45	30	199.37	118	12	Fragment of a Bone (Right Humerus) [b]
	39	PG/04/102	SW03	S244/W298 Test Pit 02	50	20	199.48	105	12	Iron Slag
	40	PG/04/103	SW03	S244/W298 Test Pit 02	35	60	199.37	118	12	Iron Ore [c]
	41	PG/04/104	SW03	S245/W298 Test Pit 02	92	35	200.41	08	08	Copper Object
	42	PG/04/105	SW03	S244/W298 Test Pit 02	90	10	199.32	119	09	Piece of a Bone [d]
2005	51[e]	PG/05/01	SW02	S262/W292 Test Pit 03	80	80	199.91	0	20 [f]	Iron Ore
	52	PG/05/02	SW02	S262/W291 Test Pit 03	45	20	199.87	05	20	Iron Slag

[a] This decoration is considered as paddle impression marks that .

[b] This bone sample laid with a fragmented tray bowl just above the context 13.

[c] Corroded, squared shape block (Sample #SIT07-02).

[d] Found inside the broken tray bowl that mentioned in 49 (field # 38).

[e] Field numbers were started from number 51 for second field season.

[f] Context numbers were started from number 20 in the second field season.

Table E-3. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	53	PG/05/03	SW02	S262/W291 Test Pit 03	60	25	199.87	05	20	Grinding Stone
	54	PG/05/04	SW02	S262/W292 Test Pit 03	65	73	199.84	06	20	Iron Slag
2005	55	PG/05/05	SW02	S262/W292 Test Pit 03	10	65	199.83	06	20	Iron Slag
	56	PG/05/06	SW02	S262/W291 Test Pit 03	70	63	199.80	07	20	Piece of a Bone
	57	PG/05/07	SW02	S262/W291 Test Pit 03	30	62	199.77	14	20	Painted Potsherd
	58	PG/05/08	SW02	S262/W291 Test Pit 03	35	57	199.77	18	21	Painted Potsherd
	59	PG/05/09	SW02	S262/W292 Test Pit 03	60	75	199.75	16	21	Iron Slag
	60	PG/05/10	SW02	S262/W292 Test Pit 03	19	65	199.75	16	21	Piece of a Bone
	61	PG/05/11	SW02	S262/W291 Test Pit 03	40	40	199.76	15	21	Piece of a Bone
	62	PG/05/12	SW02	S262/W291 Test Pit 02	33	87	199.73	19	21	Iron Slag
	63	PG/05/13	SW02	S262/W291 Test Pit 03	30	38	199.73	21	21	Decorated Bodysherd
	64	PG/05/14	SW02	S262/W291 Test Pit 03	35	30	199.72	25	23	Iron Ore
	65	PG/05/15	SW02	S262/W291 Test Pit 03	65	90	199.72	23	23	Piece of a Bone
	66	PG/05/16	SW02	S262/W291 Test Pit 03	65	85	199.68	25	23	Piece of a Porcelain[a]

[a]White porcelain (kraak ware), earliest type of white porcelain exported from far east (especially from China) around 10-12 centuries AD.

Table E-3. Continued.

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2005	67	PG/05/17	SW02	S262/W292 Test Pit 03	15	90	199.65	27	23	Piece of a Bone
	68	PG/05/18	SW02	S262/W291 Test Pit 03	51	93	199.62	31	23	Piece of a Bone
	69	PG/05/19	SW02	S262/W292 Test Pit 03	50	95	199.45	46	23	Piece of Chert
	70	PG/05/20	SW02	S237/W270 Test Pit 04	74	67	200.74	18	30	Iron Ore
	71	PG/05/21	SW04	S237/W270 Test Pit 04	70	75	200.73	21	30	Iron Slag
	72	PG/05/22	SW04	S237/W270 Test Pit 04	28	10	200.53	35	31	Iron Slag
	73	PG/05/23	SW04	S237/W270 Test Pit 04	02	85	200.53	35	31	Piece of Chert
	74	PG/05/24	SW04	S237/W270 Test Pit 04	20	95	200.51	42	32	Piece of Quartz
	75	PG/05/25	SW04	S237/W270 Test Pit 04	70	25	200.47	40	32	Piece of Quartz

Table E-4. Artifacts analysis at SIT 25

Excavation Season	Field #	Catalog#	Grid #	Pit # (Location)	x cm	y cm	Z (msl) m	z (bs) cm	Context #	Artifact Recovered
2004	01	PG/04/60	NW01	N208/W198 Trench 01	40	42	198.96	85	07	Iron Slag[a]
	02	PG/04/61	NW01	N213/W191 Mound 01	10	20	200.92	0	01	Iron Slag[b]
	03	PG/04/62	NW01	N204/W193 Mound 01	23	34	199.61	0	01	Fragments of Furnace Wall/s[c]
	04	PG/04/63	NW01	N214/W194 Mound 01	15	75	200.14	0	01	Fragment of a Crucible[d]

Note: * All collected and unearthed samples at SIT25 are worn and broken due to the floodwater. During rainy seasons the excavated mound totally covers as water level at the reservoir reach to its higher level.

[a]Yellowish gray triangular shaped block (Sample # SIT25-01).

[b] Solidified block (Sample # SIT25-02).

[c] Both are worn and have thin plaster inner coat (Sample # SIT25-03).

[d] Broken, worn, lower part of a crucible (Sample # SIT25-04).

APPENDIX F
CONTEXT DESCRIPTION AND ASSOCIATED ARTIFACTS

Table F-1. Context description and associated artifacts at SIT 22

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	1	Disturbed Top Soil Layer (by present activities)	Trench 01	0-25	Dark Reddish Brown 5YR 2.5/2, clay 60%, silt 25%, sand 10%, gravel 4%, stone 1%	Iron slags, Tuyere pieces, Debris of Furnace walls, 716=Potsherds 1=Bead,
	2	Disturbed Soil Layer	Trench 01	0-64	Dark Reddish Brown 2.5 YR 2.5/4 clay 60%, silt 15%, sand 5%, gravel 2%, stone 3%, iron slag 25%	Iron slag, Tuyere pieces, Debris of Furnace walls, 131=Potsherds
	3	Top Soil with humus	Trench 01 N105/E106	0-5	Black 10 YR 2/1, silt 60%, sand 20%, clay 20%,	None
	4	Soil Layer/ Iron Slag layer	Trench 01	24-98	Reddish Brown 5 YR 3/4, slag 75%, clay 20%, stone 5%,	Fused iron slags, Tuyere pieces, 1= Octagonal shaped tuyere,
	51	Top Soil with humus (similar to Con. 3)	Trench 02	0-5	Dark Brown 7.5 YR 3/4, silt 60%, sand 25%, clay 15%,	1= Tuyere Fragment

Table F-1. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	52	Soil Layer (extend of Con. 1)	Trench 02	0-25	Dark Reddish Brown 5YR 2.5/2, clay 60%, silt 25%, sand 5%, gravel 2%,	Iron ore, Iron slags, Tuyere pieces, Debris of Furnace walls, Potsherds [a]
	53	Soil Layer rich in limestone	Trench 02 Test Pit 01 N104/E114	30-53	Dark Brown 7.5YR 3/4, clay 50%, limestone 30%, sand 20%,	Iron ore, 14=Potshards,
	54	Clay Layer with limestone (similar to "*vav matta*")	Trench 02 N104/E113	33-45	Dark Yellowish Brown 10YR ¾, clay 80%, limestone 15%, stone 3%, sand 2%,	Halfly reduced iron ore, Iron slag, charcoal,
	55	Fused Iron Slag with Two Blocks of Quartz	Trench 02 Test Pit 01 N104/E115	17-37	N/A	Blocks of iron slags, Debris of a furnace wall, Charcoal,
	56	Hard Soil Patch attached to Limestone (similar to Con. 53)	Trench 03 N103/E112	26-40	Dark Brown 7.5YR 3/4, clay 50%, limestone 25%, sand 20%, stone 5%,	halfly reduced iron ore, 19=Potsherds, Debris of a furnace wall, Charcoal,

[a] Potsherds of Con. 52 were counted under Con. 01 as both numbers represent the same context.

Table F-1. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	57	Furnace Superstructure	Trench 01 N104/E108 N104/E109 N105/E108 N105/E109 N105/E109	22-142 Trench 2	Dark Reddish Brown 7.5 YR 3/4 (composition of the furnace are provided in chapter 7 & 8)	Iron ore, Iron slags, 5=Potsherds,
	58	Sandy Soil Layer	Trench 01 Trench 02 Middle of the Furnace (Con. 57)	22-47 (65-80)	Dark Gray 5 YR 4/1, sand 75%, silt 15%, stone 5%, clay 5%,	Charcoal, Iron slags, 1= Tuyere fragment, 2-Potsherds, 1= Furnace wall fragment,
	59	Black Soil Layer	Trench 01 Trench 02 N104/E107 N105/E107	65-70	Brown 7.5YR 3/4, clay 75%, sand 20%, stone 4%, limestone 1%,	2=Potsherds, 1= Tuyere fragment,
	60	Soil Layer	Trench 01 Trench 02 N104/E107 N104/E108	130 (92-100)	Very Dark Gray 7.5YR 3/4, clay 90%, limestone 8%, stone 2%, N105/E108	5=Unbroken tuyeres, 1= Tuyere fragment, Debris of a furnace, Charcoal, 2=Potsherds

Table F-1. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	61	Debris of the Second Furnace?	Trench 02 N104/E108 N104/E109	135	Dark Reddish Brown 7. 5 YR 3/4,	Iron slag, Large pieces of furnace walls (with plaster that is similar to Con. 56),
	62	Soil Layer rich in Iron Slags (extension of Con. 4)	Trench 01 Trench 02	24-98	Dark Reddish Gray 5 YR 4/2, iron slags 60%, burnt clay 25%, sand 10% limestone 3%, stone 2%,	Block of iron slag, Pieces of furnace walls, Tuyere pieces, Potsherds, Charcoal, Fragmented parallel tuyere,
	63	Disturbed Soil Layer (similar to Con. 2)	Trench 01 Trench 02 Test Pit 01	0-64	Reddish Yellow 7.5 YR 6/8, clay 40%, limestone 40%, sand 5%, sand 5%,	Fragments of furnace walls, Iron ore Iron slag, Limestone and Clay mixture, Potsherds [a]
	64	Soil Layer	Trench 01 Trench 02	112-132	Olive Yellow 2.5 Y 6/6, clay 80%, stone10%, limestone 5%, sand 5%,	5=Potsherds (worn),

[a] Potsherds of Con. 63 were counted under Con. 02 as both numbers represent the same context.

Table F-1. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	65	Soil Layer	Trench 02 N105/E108	120-143 (102-112)	Dark Reddish Brown 2.5 YR 6/6, clay 70%, stone10% smelting debris 15%, sand 5%,	9=Unbroken tuyeres, 3= Broken tuyeres, Iron Slag, Fragments of furnace wall, 190=Potsherds
	66	Soil Layer with Quartz	Trench 01 Trench 02 Below & behind the Furnace (Con. 57)	132-147	Dark Yellowish Brown 10 YR 4/8, clay 60%, stone20%, sand 15%, limestone 5%,	None
	67	Burnt Soil Layer	Trench 01 Trench 02	144-147	Very Dark Brown 10 YR 2/2, clay 70%, stone15%, sand 10%, limestone 5%	04=Potsherds (worn),
	68	Semicircular Burnt Soil Patch	Trench 01 Trench 02 N104/E107 N104/E108 N105/E107 N105/E108	138-148	Black 5YR 2.5/1, stone 50%, sand 40%, clay 10%,	Iron ore, Iron slag,
	69	Soil Layer rich in Gravel and Quartz	Trench 01 Trench 02 N104/E109 N105/E107 N105/E108 Behind the Furnace	140-148	Yellowish Red 5YR 4/6, gravel 45%, quartz 30%, sand 10%, clay 10%,	None,

Table F-1. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	70	Soil Layer	Trench 01 N105/E107 N105/E108 Below the Furnace 57	148-152	Brownish Yellow 10YR 6/8 larger piece of quartz 80%, sand 15%, clay 5%,	None,
	71	Lower Layer of Semicircular/ convex Bottom Slag	Trench 01 Trench 02 N104/E108 N104/E109 N105/E108 N105/E108 Inside the Furnace	120-135	Very Pale Brown 10YR 7/4,	No other cultural remains,
	72	Clay Plaster (thin)	Trench 01 Trench 02 N104/E108 N104/E109 N105/E108 N105/E109 Bottom of the Furnace	132-142	Yellowish Gray 5Y 7/2, clay 80%, sand 15%, stone 5%,	Few pieces of iron slag,

Table F-1. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	73	Upper Layer of Concave Bottom Slag Crust	Trench 01 Trench 02 N104/E108 N104/E109 N105/E108 N105/E109 Eastern strip at The Bottom of the Furnace 57	112-120	Dark Gray 7.5 YR 4/0,	No other cultural remains,
	74	Cut Mark of the Furnace (Con. 57)	N104/E108 N104/E109 N105/E108 N105/E109 Goes through Contexts 64, 66 (69) up to Context 70	112-144	N/A	N/A
	75	Hard Clay Layer	Trench 01 N105/E108 Inside the Furnace (Con. 57)	47-68cm	Yellowish Red 5YR 4/6,	Few pieces of tuyere fragments, Furnace wall pieces, Iron slags,
	76	Bed Rock	Eastern end of Trench 01 Trench 02 Test Pit 01 Slopes from East to West	10-70	N/A	None

Table F-2. Context description and associated artifacts at SIT 6

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	1	Top Soil with Quartz	all over the Test Pit 01	0-5	7.5YR 3/4 Dark Brown, silt 70%, clay 25%, sand 5%,	Brickbats,
	2	Soil Layer with Stones	all over the Test Pit 01	5-45	5 YR 3/4 Dark Reddish Brown, silt 40%, clay 40%, sand 10%, stone 10%	Brickbats, Tile pieces, 3=Iron nails, Bone pieces,
	3	Sand Layer	all over the Test Pit 01	25-85	7.5 YR 3/4 Dark Reddish Brown, sand 60%, clay 30%, stone 10%	133=Potsherds Brickbats, Tile pieces, 1=Iron nail, Bone pieces,
	4	Clay Layer	N402/W398 N403/W398	55-115	5 YR 3/3 Dark Reddish Brown, clay 60%, sand 40%,	616=Potsherds 1=Bead, 7=Iron nails, Iron slags, Charcoal,
	5	Remains of a Brick Structure	N402/W398 N403/W398	28	7.5 YR 3/4 Dark Reddish Brown,	Brickbats, Tile pieces,
	6	Stone Paving	N402/W399 N403/W399	5	N/A	N/A
	7	Clay Layer with Large Stone Slabs	N402/W399 N403/W399	103-145	2.5 YR 6/3 Light Reddish Brown clay 70%, sand 30%,	Brickbats, 1=Iron nail, 1=Iron ore, Unidentified iron object,
	8	Remains of a Brick Structure	N402/W398 N403/W398	105	7.5 YR 3/4 Dark Reddish Brown,	N/A

Table F-2. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	9	Soil Layer with Large Stone Slabs	N403/W398	115-145	2.5 YR 6/4 Light Reddish Brown clay 70%, sand 30%,	Iron Nails Large Bricks
	10	Remains of a Brick Structure	N403/W398	115-135	7.5 YR 3/4 Dark Reddish Brown,	Large Bricks
	10a	Remains of a Brick Structure	N402/W398	115-135	7.5 YR 3/4 Dark Reddish Brown,	Large Bricks
	11	Soil Layer (hard) with Limestone	N403/W398	135-208	10 YR 5/6 Yellowish Brown, clay 90%, limestone 10%,	21=Potsherds
	12	Soil Layer with Mica Sand	N403/W398	125-165	5YR 4/6 Yellowish Red, sand 70%, silt 30%,	None
	13	Soil Layer with Gravel	N402/W398	150-220 [a]	7.5YR 6/4 Light Brown, gravel 50%, quartz 20%, sand 30%,	Quartz 24=Potsherds Chert Charcoal
	14	Stone Paving	N402/W398	135-205	N/A	N/A
	15	Stone Paving	N403/W398	135-185	N/A	N/A
	16	Stone Paving	N402/W398	135-185	N/A	N/A
	17	Brickbats Filling	N403/W398	65-125	N/A	N/A
	18	Brickbats Filling	N402/W398	65-125	N/A	N/A
	19	Cut Mark	N403/W398	10-20	N/A	N/A
	20	Cut Mark	N402/W398	10-20	N/A	N/A

[a] It was a huge task for removing stone slabs to continue the excavation further down as most parts of them buried outside the text unit limits. So decided to stop excavation further.

Table F-3. Context description and associated artifacts at SIT 7

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	1	Top Soil with humus	Test Pit 01	0-5	Black 7.5YR 2/0, sand 60%, silt 30%, clay 10%,	Fragment of a crucible, 157=Potsherds Iron slags,
	2	Soil Layer	Test Pit 01	4-30	Very Dark Grayish Brown 2.5 YR 3/2, sand 50%, clay 50%,	Fragment of a crucible, 288=Potsherds Iron slags,
	3	Sandstone	Test Pit 01	22-34	Light Olive Brown 2.5 YR 5/6, sand 70%, stone 20%, mica 10%,	None
	4	Soil Layer	Test Pit 01	20-35	Very Dark Grayish Brown 2.5 YR 3/2, clay 60%, silt 20%, sand 20%	647=Potsherds Quartz, Iron ore, Iron slag, Chert,
	5	Sandy Limestone	Test Pit 01 N302/W297	46-54	Pale Yellow 5 Y 8/4 limestone 90%, clay 10%,	None
	6	Soil Layer with Mica Sand	Test Pit 01 N302/W296	52-74	Pale Yellowish 2.5 YR 5/4, sand 70%, mica 20%, stone 10%,	None
	16	Bed Rock	Test Pit 01	20-N/A [a]	N/A	None

[a] After reaching to the bedrock, the excavation was not conducted further.

Table F-3. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	7	Top Soil with humus	Test Pit 02	4-26	Black 7.5YR 2/0, silt 80%, clay 15%, sand 5%,	None,
	8	Soil Layer	Test Pit 02	4-42	Black 10YR 2/1, clay 60%, silt 30%, sand 10%,	204=Potsherds
	9	Soil Layer	Test Pit 02	23-64	Black 10YR 2/1, clay 60%, silt 30%, sand 10%,	873=Potsherds (Larger rims & bodysherds, Decayed bone Fragment)
	10	Soil Layer	Test Pit 02	55-82	Very dark Brown 10YR 2/2, clay 75%, sand 15%, stone 5%, silt 5%,	Iron ore, Iron slags, Chert pieces, Dressed Stone, 870=Potsherds
	11	Sandy Layer	Test Pit 02	70-116	Reddish Black 10R 2.5/1, sand 40%, clay 35%, stone 20%, silt 5%,	Chert pieces, Quartz pieces, 282=Potsherds (larger),

Table F-3. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	12	Clay Layer	Test Pit 02 S244/W299	94-122	Very Dark Gray 10YR 3/1 clay 45%, sand 25%, gravel 15%, stone 10%, silt 5%,	441=Potshards (larger), 1=Decorated & polished BW, 1= human bone (humerus), Iron slag,
	13	Laid Stone	Test Pit 02	68-78	N/A	None
	14	Soil Layer	Test Pit 02 S244/W298 S244/W299	114-132	Light Olive Brown 2.5 Y 5/4, clay 45%, gravel 45%, stone 5%, sand 5%,	None
	15	Silt Layer	Test Pit 02	94-136 [a]	Light Yellow Brown 5 YR 6/4 silt 60%, clay 20% quartz 15%,sand 5%	None

[a] Excavation was not continued further as three non cultural layers were laid followed by each other.

Table F-3. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2005	20 [a]	Clay Layer	Test Pit 03	0-48	Black 5 YR 2.5/1 clay 60%, sand 30%, silt 5%, limestone 3%, gravel 2%,	394=Potshards
	21	Sand layer	Test Pit 03	10-30	Very Dark Brown 10 YR 2/2 sand 80%, clay 10%, limestone 5%, silt 4%, quartz 1%,	429=Potshards
	22	Gathered Stones	Test Pit 03	16-26	N/A	N/A
	23	Clay Layer	Test Pit 03	18-78	Very Dark Gray 5 YR 3/1 clay 60%, sand 30%, silt 10%,	80=Potshards
	24	Soil Layer	Test Pit 03	32-140	Dark Olive Gray 5 Y 3/2, clay 65%, limestone 20%, sand 10%, mica 5%,	None
	25	Soil Layer rich in limestone	Test Pit 03	46-152 [b]	Pale Yellow 2.5 Y 8/3 limestone 90%, clay 10%,	None

[a] Contexts numbers were started from 20 in the second excavation season of the site.

[b] Excavation was not continued further.

Table F-3. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2005	30 [a]	Clay Layer	Test Pit 04 S237/W270	5-10	Black 5 YR 2.5/1 clay 65%, sand 30%, quartz 3%, limestone 2%,	165=Potsherds
	31	Clay Layer	Test Pit 04 S237/W270	4-38	Black 5 YR 2.5/1 clay 60%, sand 40%,	71=Potsherds
	32	Soil Layer	Test Pit 04 S237/W270	36-45	Dark Olive Gray 5 Y 3/2, clay 40%, sand 30%, limestone 15%, gravel 10%, quartz 5%,	None
	33	Clay Layer	Test Pit 04 S237/W270	43-62 [b]	Olive Yellow 2.5 YR 6/8, clay 40%, sand 30%, quartz 20%, gravel 5%, limestone 5%,	None

[a] When new test pit was started, new context numbering system was assigned.

[b] Excavation was not continued further.

Table F-4. Context description and associated artifacts at SIT 25

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	1	Top Soil with humus and gravel	Test Pit 01	0-10	1.5YR 5/2 Brown, sand 70%, silt 20%, stone 10%	Fragments of furnace walls, Iron slags, Fragment of a crucible, 09=potsherds,
	2	Sand Layer	Test Pit 01	4-12	10 YR 5/6 Yellowish Brown, sand 80%, clay 15%, stone 5%	None
	3	Clay Layer with furnace remains	Test Pit 01	8-20	7.5 YR 4/6 Strong Brown, clay 75%, sand 20%, stone 5%	Fragments of furnace walls, Iron slags, 03=brittle potsherds,
	4	Soil Layer with furnace remains and decayed wood	Test Pit 01	10-40	5 YR 3/4 Reddish Brown, clay 50%, sand 45%, stone 5%	Fragments of furnace walls, Iron slags,
	5	Clay Layer	Test Pit 01	10-20	10 R 2.5/1 Reddish Black, clay 90%, sand 10%,	Brittle pieces of a furnace wall,
	6	Clay Layer "*vav matta*"	Test Pit 01	40-80	5 YR 4/4 Olive, clay 80%, limestone 5%, mica 5%, stone 5%, shells 3%, sand 2%,	None

Table F-4 Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	7	Soil Layer	Test Pit 01	40-120	2.5 Y 8/4 Pale Yellow, clay 70%, mica 15%, silt 10%, stone 4%, sand 1%,	1=slag piece, Fragments of a furnace wall, burnt clay pieces,
	8	Soil Layer laid over the bed rock	Test Pit 01 Trench 01	60-100	10 YR 5/6 Yellowish Brown, sand 50%, sandstone 20%, stone 10%, gravel 10%, mica 5%, silt 5%,	None
	9	Bed Rock	Trench 01	100-N/A [a]	N/A	None
	51	Top Soil with humus and gravel	Test Pit 02	0-10	1.5YR 5/2 Brown, sand 70%, silt 20%, stone 10%	7=iron slags 11=potsherds
	52	Burnt Soil Patch	Test Pit 02	10-22	10YR 2/2 Very dark Brown, clay 50%, silt 25%, sand 25%,	Blocks of burnt clay
	53	Soil Layer	Test Pit 02	10-40	5YR 4/6 Yellowish Red, silt 50%, clay 40% sand 10%,	10=iron slags
	54	Soil Layer with gravel & quartz	Trench 01	20-60	5YR 3/4 Dark Reddish Brown, gravel 50%, quartz 20%, sand 20%, clay 10%,	None

[a] Excavation was not conducted further.

Table F-4. Continued.

Excavation Season	Context	Description	Location	Depth bs/cm	Munsell Reading & Soil Composition	Artifacts Recovered
2004	55	Paved Stone & Blocks of Slags	Test Pit 02	10-20	N/A	blocks of fussed Iron slags
	56	Soil Layer Rich with Iron Slags	Test Pit 02	20-40	5YR 3/4 Dark Reddish Brown, clay 60%, silt 30%, sand 5%, stone 5%,	20=iron slags
	57	Burnt Soil Patch	Test Pit 02	10-30	5YR 2.5/1 Black, charcoal 70%, stone 15%, silt 10%, sand 3%, clay 2%,	Burnt clay,

APPENDIX G[1]

CHEMICAL CHARACTERIZATION OF ORE, SLAG AND IRON FROM AN ADVANCED BLOOMERY PROCESS IN THE SIGIRIYA-DAMBULLA REGION

Dag Noreus

Abstract

An advanced bloomery process using magnetite ore has been identified at a large scale production site at Alakolavava (KO 14) in the Sigiriya-Dambulla region. The use of magnetite in bloomery furnaces has so far only been found in a few exceptional cases. Modern archaeometallurgists have assumed that the dense magnetite ore would be difficult to be reduced with this technique. At KO 14, however, a large amount of crushed magnetite was found around the excavated furnaces, magnetite grains of the same particle size were found adhering to several of the slag pieces in the surrounding slag heaps. This means that KO 14 is one of the few sites where it will be possible to study the bloomery process in some detail by allowing the essential combination of the chemical analysis of both ore and slag.

The crushed ore at KO 14 was found to be extremely rich, with an average iron oxide content of around 98% wt. A very high iron content in the ore is, however, a prerequisite for obtaining a high yield with the bloomery process, as the impurities in the ore are removed by forming different iron-rich silicates with low melting points. These dark and heavy "iron forming silicates" are what we generally mean by iron slag,

[1] This report is mainly based on data at Alakolavava, Dehigaha-ala-kanda iron smelting site (KO14/SIT01) that have been revealed during SARCP 1991-1992. Analysis of this report were done by Prof. Dag Noreus at the Arrhenius Laboratory in Stockholm University, Sweden. This report was first used for my MPhil dissertation in 1999 (Solangaarachchi 1999).
Noreus, D. 1999. Chemical Characterization of Ore, Slag and Iron from an Advanced Bloomery Process in the Sigiriya-Dambulla Region. In *Early iron smelting technology in the Sigiriya-Dambulla Region: Dehigaha-ala-kanda at Alakolavava*. The thesis submitted for the degree of Master of Philosophy (MPhil) to the Postgraduate Institute of Archaeology. Sri Lanka: University of Kelaniya.

they are the main constituents in the large slag heaps identifying the early historic iron production sites.

Interestingly, aluminum was found to be the main impurity in the ore from the KO 14 site. This is a troublesome impurity, as it causes networks to be formed in the slag, making its separation from the reduced iron, difficult. According to the slag analysis the viscosity of the slag has been lowered during the smelting process by intentional fluxing with silicon and calcium-containing minerals.

By comparing the slag composition with samples taken from smaller smelting sites, as for example Yakkure or Gonavava, it can be concluded that the smelters at KO 14 had a better technology with higher yields and that they were very skilled in separating the slag from the reduced iron bloom. Unfortunately, only one piece of iron has so far been found at KO 14, enclosed in a piece of slag. The iron was, however of high purity, indicating that it would be an ideal product for making steel by cementation in the so called Wootz process.

Introduction

In the Sigiriya area a bloomery iron production site KO 14 at Alakolavava, have recently been excavated. The first striking impression is the enormous size of the iron production. The amount of slag remaining must be estimated in thousands of tons, indicating large-scale industrial production of iron. In Scandinavia slag heaps are measured in tons or may be tens of tons. To find parallels to the KO 14 site, one has to look at the largest iron production sites in Europe, which were organized by the Roman Empire.

Another striking feature is the massiveness of some of the slag pieces in the heaps, indicating an advanced stage in the bloomery technique. The very iron rich, heavy and dark slag is a typical waste product from the bloomery furnace, in contrast to the lighter, usually green or blue-colored silica glass that is produced by the later blast furnace technique. The bloomery process is a complex technique of which we have only limited knowledge at present. To illustrate the problems, a short outline of the bloomery process, as it is known today, will be given below.

Iron ore contains, in addition to various iron oxides, quartz (i.e. silicon dioxide) a number of alumina varieties, alkali and alkali earth silicates, and also minerals containing elements such as manganese, phosphorus and titanium. In the bloomery furnace the iron oxides are reduced with carbon monoxide, CO, formed from the wood or charcoal mixed with the ore and the air blown through the ignited mixture. The reducing conditions (measured by the oxygen potential) depend on the CO content in the furnace gas and on the temperature. The CO content, in turn, is a function of the temperature and the amount of air blown into the furnace, But the temperature will also be dependent on the airflow into the furnace. Other factors of importance are for example the grain size and quality of both ore and charcoal. To master these very complicated cross-correlations of the different variables, called for a lot of skill and experience from our early historic iron smelter in his efforts to find the proper reducing conditions. And correct reducing conditions would be important. If the reduction was too mild, then the yield would go down as iron remain in its oxide form; if on the other hand the reduction was too vigorous, then the iron could pick up carbon from the furnace gas and from pig iron, an iron quality that is unsuitable for smithery. Even worse, detrimental impurities such as phosphorus could be reduced and alloyed into the iron.

The second factor of paramount importance is the separation of the other impurities in the ore, mainly quartz and various silicates. In the bloomery process, this is done by forming a low-melting iron silicate slag that can be drained out of the solid iron bloom. Here too, the success was dependent on the skill of the smelter, as the temperature had to be controlled within a narrow range. At about 1150°C the slag starts to melt, and 1540°C is the melting point of pure iron; a temperature that will be lowered if the iron takes up carbon. At these temperatures the slag is still viscous and the iron soft, so the separation is by no means simple. This is also reflected by the fact that all early historic iron contains slag inclusions to some extent.

For the melting point of the slag to be low, it has to be rich in iron. The major slag components are low-melting fayalite (Fe_2SiO_4) and other iron silicates. A consequence of this is that a lot of iron will be trapped in the slag, and the bloomery process is only possible when a very iron-rich ore is available. Else, the ore must be subjected to some kind of enrichment process.

To get more insight in to the bloomery process once carried out at KO 14, samples were taken from the slag heaps for chemical and micro structural analysis. Crushed magnetite ore (Fe_30_4) was found around the excavated furnaces and also adhered to several slag blocks in the slag heaps. The grain size of the ore was in the order of a few millimeters and smaller.

Ore was also found, mixed with quartz, in what seemed to be waste heaps below a rock with so called conical holes. The shape of the holes indicates that they once were a support for some revolving machinery used for crushing and maybe also for separating the ore from the gangue.

Magnetite, which is a very dense iron oxide, has been considered to be difficult to be reduced in the bloomery furnace. The most common ore used in this connection is haematite Fe_2O_3 obtained by roasting bog or lake ore. This is in contrast a very fine powder, which offers a large surface area to the reducing furnace gas. Samples were also taken from furnace walls, tuyeres and from other iron production sites in the vicinity. Ranjith Dias who is a researcher on geology also collected different mineral samples from the area in order to search for ore and possible fluxing materials.

The atomic structure was investigated by Guinier-Hagg X-ray powder diffraction using CuK_{a1} radiation, which is a fast and convenient method to record high resolution X-ray diffractograms on photographic film. The films were evaluated by a computerized microdensitometer (Johansson et al. 1980/1289). Silicon was added as internal standard to calibrate the system.

An advantage with the Guinier-Hagg technique is that only very small sample amounts are needed, which makes it sufficient to remove single grains from the slag to be analyzed and identified.

The chemical composition and micro structure were analyzed with a Jeol 820 scanning electron microscope with an energy dispersive spectrometry equipment (LINK AN 10000), which allowed elements heavier than oxygen to be detected. The chemical compositions presented in the tables have therefore been recalculated according to the assumed oxidation state. For analysis the samples were cast in a conductive resin and polished to get a flat surface and sputtered with a conducting carbon film. The chemical composition was measured over an area of a few square millimeters in order to get a better average of the phases present in the samples.

Results and discussion

Ore analysis

X-ray diffraction confirmed that the crushed ore at KO-14 was magnetite. This is, however, easier verified with an ordinary permanent magnet, which strongly attracts the magnetite.

The chemical analysis revealed all ore samples to have a very high purity as presented in Table G-1. The iron oxide content is around 98. The impurity level is not very far above the detection limit of the LINK-system. This unfortunately introduces some uncertainly in the evaluation. The detection limit for the heavier elements is around 0.1% and for the lighter elements, as for example magnesium, it is around 0.2%. This is the reason for the seemingly irregular presence of some of the impurity elements in the tables. The samples labeled IRN are iron ore samples collected by Dias (an independent researcher) in the vicinity of KO-14.

Interestingly aluminum is dominant in the ore. This is a troublesome element as it will promote polymerization of the slag and make it more difficult to be removed from the iron bloom. We shall see later in the slag analysis, that the smelters added silicon and calcium containing fluxes.

Slag analysis

X-ray diffraction was rather uniformative concerning the slag bulk samples. The diffraction patterns contained diffraction lines from fayalite only (Fe2Si04). Samples from the other sites also contained wustite (FeO). The X-ray diffraction was more useful for identifying grains on the pieces of slag where remains from the last added ore and possibly also flux were adhering to the surface. Here grains of quartz (SiO_2) and feldspar $KAISi_30_8$ could be identified in addition to the magnetite.

Looking at the slag pieces in the slag heaps gives initially a very confused picture. The slag pieces seem to exist in all kinds of irregular shapes and sizes. Two features are, however, frequently occurring. One is that slag pieces having solidified in contact with a moist or wet grass bed, leaves imprints in the slag surface from the grass and small bubbles in the slag from the escaping humidity. The other is that pieces of large and more solid slag blocks seem to have solidified against a more flat surface (the bedrock?).

In Table G-2 the chemical compositions in the samples taken from KO 14 are compared with samples collected at other sites. The iron oxide contents in the slags from KO 14 are unusually low for being bloomery slags, indicating that the smelters deliberately worked at increasing the yield. The iron plus manganese content, as manganese substitutes iron in the slag, is usually above 55% in Europe the Roman Age material (Tylecote1979). When bloomery slag solidifies, it usually forms a fayalite phase (Fe_2SiO_4), an iron rich wustite phase (FeO) and an iron poor glassy phase. In the last phase the impurities are usually enriched. The glassy phase is usually X-ray amorphous and not detectable with X-ray diffraction. Wustite forms a very characteristic dendrite structure, which is easily seen through microscopy. In the samples from KO 14 this phase was not found but only fayalite and the glassy phase (Figure G-1).

For comparison, a picture from a more iron rich slag taken at Kiralessa is shown in (Figure G-2). Here the dendrite structure of the wustite phase is clearly seen. Silicon is the main impurity in the slag in contrast to aluminum in the ore. This means that a silicon containing flux has been added, during the process, to facilitate the slag separation. Rather high calcium content also indicates that it has been an intentional addition to lower the viscosity of the slag. In spite of this the smelters must have been exceptionally skilful as the low iron content and the still very high aluminum content in the slag would have forced them to work very quick and at a high temperature, in order to remove the slag from the bloom, before it became viscous in the final stages of the process.

The KO 14 slag has low manganese content in agreement with the ore analysis. Since manganese is significantly more difficult to reduce than iron, it will end up in the slag. Some of the slags from the other sites are fairly high in manganese indicating the use of a different source of ore.

A further problem with the dense slag is that it will cause a significant build-up of pressure as slag is gathering in the furnace. Since the over-pressure available from leather bellows, that are assumed to have been used, is very limited, the process would have stopped when the slag level reached slightly above the tuyeres, if there were no means of slag drainage available. From European material, slag tapping into a slag pit below the furnace or tapping out on the ground in front of the furnace can be distinguished. To determine what method has been in use at the KO-14 site, is still not possible. The porous slag with grass imprints indicates a slag tapping. Whether this has been done continuously during the process, or whether it is the result of the opening and emptying of the furnace to remove the bloom, it is not possible to say from the analysis alone.

The tapped slag seems to have a slighter lower iron content than the assumed bottom slag. This can be a result of an intentional increase in the reducing condition during the process, or a simple consequence of that the lower viscosity iron rich slag being the first to settle on the furnace bottom.

The results allow us, however, to speculate somewhat on the yield from the process. The average aluminum content has increased with a factor of ten from the ore to the slag, and this gives an upper limit of the yield if no other aluminum containing additions have been made.

On one slag sample where ore still remained on the surface, there were some grains of potash feldspar ($KAISi_30_4$), as identified with X-ray diffraction. A few pieces of feldspar were also found around the excavated furnaces. The crystals are, however, very white and conspicuous so they may have been selected by chance. The low potassium content in the slag gives an upper limit to its use for increasing the silicon content. It should also be noted that potassium is expected to enter the slag via potash (K_2CO_3) from the fuel, so that this source of aluminum can probably be neglected in this rough calculation. A more difficult problem is to estimate the aluminum entering the slag from the furnace walls, which have a high aluminum content. As the liquid slag is chemically very aggressive, it will react with the furnace walls, and the resulting reaction products will mix with the reduction slag formed by the impurities in the ore and the flux. My belief after having seen the excavated furnaces in relation to the amount of slag is, however, that most of the aluminum in the slag came from the ore.

The level of titanium is unfortunately barely detected in the ore, but when compared with the level in the slag it indicates also a very high iron yield. The impurity levels of titanium in the furnace walls are low. Calcium containing marble samples collected in the area, which might have been used as flux, were found to be free of titanium (Table G-3 and G-4).

All this taken together indicates that the yield at KO 14 has been very high. A careful estimate is that the amount of raw bloomery iron produced, would have been in the order of 5 to 10 times larger than the amount of slag remaining on the site. A more | sensitive analyzing method for some of the pertinent impurities such as titanium and manganese could give a better estimate in a future detailed study.

Iron analysis

So far only one piece of iron enclosed in a piece of slag has accidentally been found. The iron had fused into a solid lump (~ 10 gram) and had itself several slag inclusions.

In the solid iron no impurities could be detected, indicating that it is suitable for subsequent steel manufacture, for example cementation in the so called Wootz process (Tylecote1979). More iron samples ought, however, to be present in the slag heaps on the site, which can be used in order to get a better statistical background for evaluating the quality of the iron. Also the carbon content should be analyzed to see if the fairly strong reducing conditions in the furnaces already produced a more "steely" iron.

Final comments

This short report has hopefully indicated the considerable complexity of the bloomery process. The number of delicate chemical equilibrium the ancient smelter had to control makes this direct iron production process more difficult to comprehend than the later, indirect iron production process in the blast furnace. The label “primitive irons melting” has no relevance when considering the skill and experience demanded of the ancient smelter to successfully produce iron. The complexity is reflected also by the fact that none of the different experimental groups, which exist today are trying to make iron by the ancient technique or has been able to reproduce usable iron of any quality. Most of this work has, however, been done by trial and error methods, with no correlation to modern inorganic and solid state chemistry research. It could be mentioned that it took about a thousand years, from the time our ancestors could produce iron, until they had established a technique to make quality iron and steel that could compete with bronze and thereby initiate the real iron age.

What is needed to elucidate in the bloomery process is an intimate co-operation between archaeologists and inorganic chemists. This is needed not only for helping the archaeologist but also for the inorganic chemist to develop an understanding of the different reactions involved in the process. The chemist must know from where in the furnace the samples are coming. Of interest would be the interfaces between the slag and the furnace lining and between the slag and the ore; the composition of ore, furnace walls, slag etc. As the bloomery process involves a number of very heterogeneous reactions, samples must be taken from different parts of the slag for a study of how the reducing conditions have varied, as can be estimated by comparing the ratio of the different iron oxides to the iron silicates in the slag. It would also be important to improve the understanding of the separation of the slag by differential scanning in calorimetric (DSC) studies of the smelting process of the slag. This must also be related to the softening range of furnace details such as the tuyeres.

Finally, to interpret the different samples the chemist must have as good an outlying of the process as can be obtained from the archaeological excavation; for example occurrence of slag tapping, configuration of air inlets etc. If supplementary information could be extracted from ethnographical sources this would be extremely helpful. With information like this, and in close collaboration with the field archaeologist, there are good possibilities of getting a more detailed understanding of the bloomery process also in terms of understanding the chemistry. Such an attempt has so far not been successful, mainly due to the lack of appreciation of the complexity of the bloomery process and a lack of inorganic chemists with a strong incentive for developing an understanding of the process.

To launch a project with the aim of understanding the bloomery process is therefore a challenge and an opportunity to develop both archaeology as well as inorganic chemistry, in particular silicate and oxide chemistry that are areas of major importance also in other fields of our modern society. Such a project, if giving successful results, will also bring the research group in question to the forefront in archaeometallurgy world-wide. And it would then be possible to evaluate other bloomery production sites too, and to estimate iron production quantities as well as diffusion of iron production techniques and innovations.

References

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2. R.F. Tylecote, "A History of Metallurgy", Mid-Country Press, London 1979.

Table G-1. Analysis report of iron ore samples at Dehigaha-ala-kanda (SIT1/KO14) and surroundings

WEIGHT %	Fe_3O_4	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
KO 14 1	98.3	--	--	1.3	--	0.4	--	--	--
	98.0	--	--	1.6	--	0.4	--	--	--
KO 14 2B	98.6	--	0.4	0.9	--	0.1	--	--	--
	96.5	--	0.3	3.0	--	0.1	--	--	--
KO 14 12 B	97.7	--	0.2	1.4	--	0.4	0.3	--	--
KO 14 14 B	98.4	--	--	1.1	--	0.1	0.4	--	--
	98.5	--	0.1	0.8	--	0.1	0.5	--	--
KO 14 14 BX	99.0	--	0.2	0.5	--	0.1	0.3	--	--
	98.1	--	0.2	1.1	--	0.2	0.4	--	--
KO 14 18	97.9	--	--	2.0	--	0.1	--	--	--
	96.7	--	0.2	2.5	--	0.2	0.4	--	--
KO 61A	98.8	--	0.1	0.7	--	--	0.4	--	--
	99.4	--	0.1	0.4	--	--	--	0.1	--
POT A	96.1	--	0.3	3.5	--	--	--	0.1	--
	98.9	--	0.2	0.9	--	--	--	--	--
	96.3	--	0.2	3.2	--	0.2	--	--	--
KO 2B	97.4	--	0.2	1.7	--	--	0.4	--	--
KO 22	96.9	--	0.6	2.2	--	0.1	--	--	--
IRN 1.1	98.3	--	--	1.2	--	0.1	0.4	--	--
	98.2	--	--	1.3	--	0.1	0.4	--	--
IRN 1.2	86.1	--	0.5	10.4	--	1.3	1.7	--	--
	98.1	--	0.1	1.7	--	--	--	--	--
IRN 1.3	99.0	--	--	0.6	--	--	0.4	--	--
	98.7	--	--	0.8	--	1.1	0.4	--	--
*	2.4	--	0.5	--	59.3	--	--	37.8	--
IRN 3.1	95.6	--	--	1.7	1.6	0.3	--	0.8	--
	94.0	--	0.7	4.4	--	0.9	--	--	--
	96.7	--	0.3	2.7	--	0.3	--	--	--
IRN 2.1	97.5	--	0.2	0.7	1.1	0.1	--	0.4	--
	98.8	--	--	0.6	--	0.1	0.5	--	--

Comments

KO 14	Alakolavava
KO 61A	Vavala Yaya, iron ore from a large slag block.
POT A	Potana, small pieces of ore from a monastic rock shelter site with iron production. Surface finds outside the inhabitation site.
KO 2B	Unregistered, shortly south of KO 2 and a few hundred meters west of KO 7.
KO 22	Vavala, ore close to a conical hole, inside the monastery area.
IRN	Iron ore samples collected near Alakolavava smelting site. Inclusions of calcium phosphate were found in some samples.

Table G-2. Analysis report of iron slag samples at Dehigaha-ala-kanda (SIT 1/KO14)

WEIGHT %	FeO	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
KO 14 2 Slag with	40.3	--	24.2	19.4	4.6	0.9	2.3	5.9	2.4
Grass imprints	39.7	0.3	25.4	16.8	4.9	1.3	1.5	7.7	2.4
KO 14 6B --"--	42.5	0.3	25.0	15.6	1.9	1.8	2.7	7.9	2.2
	41.7	0.3	26.3	15.6	1.5	1.6	2.9	8.0	2.1
KO 14 8 --"--	42.8	0.8	24.1	16.3	5.1	1.6	0.8	7.8	5.1
KO 14 9 --"--	40.4	0.7	23.8	18.5	4.3	1.1	1.2	7.5	2.4
	34.7	0.6	17.8	35.8	2.8	1.7	1.7	4.3	0.7
KO 14 10 --"--	38.9	1.0	24.6	18.6	2.3	1.1	2.0	7.7	3.8
	33.9	0.9	26.2	20.0	3.2	1.1	1.5	8.7	4.5
KO 14 11 --"--	37.0	1.0	25.0	24.3	2.7	0.7	1.3	4.3	3.7
	38.0	1.5	25.8	19.8	4.3	0.8	1.3	4.7	3.6
KO 14 12 --"--	35.9	--	26.6	15.7	2.5	3.7	1.5	11.0	3.1
	31.7	0.4	28.4	17.6	4.3	1.5	1.4	12.5	2.3
KO 14 13 --"--	42.9	--	22.5	16.0	3.2	1.2	2.5	9.6	2.1
	40.1	--	24.9	16.2	3.3	0.6	1.9	9.3	3.6
KO 14 16B --"--	41.0	--	23.6	16.6	1.0	9.9	1.1	4.3	2.5
	39.0	--	25.4	17.7	--	7.9	--	7.0	3.0
KO 14-1 Slag from Solid block	51.4	--	27.3	8.4	1.5	1.7	0.9	6.55	2.3
KO 14 20B --"--	50.6	--	21.7	13.2	4.1	1.8	1.5	4.7	2.3
	48.2	0.3	22.6	13.7	4.1	1.5	1.5	5.1	3.0
	45.7	--	22.7	14.6	4.9	1.7	1.2	5.8	3.4
KO 61B Slag with	53.1	7.6	13.9	16.0	1.9	0.7	1.7	3.1	2.0
Grass imprint	42.6	8.5	19.6	14.8	2.7	0.9	2.3	5.2	3.3
KO 61C Solid slag	51.9	5.3	20.0	13.2	2.6	0.6	1.0	2.2	3.2
	56.9	4.3	15.2	14.4	2.0	0.8	1.2	2.1	3.1
	43.6	4.0	15.4	27.9	2.3	0.6	1.5	1.9	2.8
KO 62 SLAG *	44.8	3.2	4.6	45.2	--	--	--	0.3	--
**	54.8	1.8	4.9	35.2	--	--	--	--	0.4
	50.1	4.4	13.3	27.3	1.0	0.2	0.9	--	2.8

Table G-3. Analysis report of iron slag samples in the Sigiri Oya Basin

WEIGHT %	FeO	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
SO 66 --"--	63.0	1.3	18.3	8.2	1.3	0.5	3.1	2.7	1.6
	38.3	0.4	14.1	38.5	2.4	0.9	1.2	2.1	2.2
	58.2	2.4	17.9	15.0	2.4	--	1.4	2.7	--
	54.1	1.9	16.5	17.7	2.6	--	1.7	4.3	1.2
POT B --"--	54.0	4.8	15.9	18.4	--	0.4	1.0	1.7	3.8

Comments

KO 14 Alakolavava, the mound-A slag heap, slag with remaining ore.

KO 14 11 Slag from the top of the mound-A slag heap.

KO 14 12 Slag collected 1.2 m down in the mound-A slag heap.

KO 14 13 Slag collected 2.2 m down in the mound-A Slag heap.

KO 61 B Vavala Yaya, slag with grass imprints.

KO 61 C Vavala Yaya, solid slag almost free of gas bubbles.

KO 62 Dikyaya, solid slag with gas bubbles * 1.8% Ba

** 2.8% Ba

SO 66 Mapagala, porous, heterogeneous- smithing slag?

SO 72 North of Wilpitare Vava, slag with grass imprints.

POT B Potana, slag with grass imprints from the monastic rock shelter site with iron production.

Table G-4. Analysis report of iron slag samples around Sigiriya

WEIGHT %		FeO	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
MO 13A Slag in a		48.3	7.5	16.0	18.1	1.4	0.6	2.1	2.9	3.0
Tuyere		43.2	7.1	16.5	22.3	1.9	0.3	2.1	1.6	3.9
MO 13B Slag		52.2	6.8	15.5	22.1	--	0.6	--	1.6	1.1
		47.4	7.3	19.8	19.3	--	0.5	0.9	1.9	3.0
KO 26A Slag		48.3	6.7	19.2	19.3	--	0.5	1.6	2.7	1.6
		42.9	6.1	20.5	18.3	2.9	0.5	1.1	4.7	3.0
		51.6	6.8	19.3	14.9	1.3	0.3	1.7	2.8	1.2
KO 26B Slag in a		58.4	1.5	20.1	14.5	--	0.4	--	3.4	1.7
Tuyere		49.9	1.4	22.2	17.5	--	0.3	--	5.3	3.4
		59.5	1.6	21.4	11.9	--	--	--	3.7	1.9
SO 5 Slag		56.0	3.0	21.4	11.3	--	0.5	1.5	5.6	0.7
		50.9	2.1	20.1	18.3	--	0.5	--	3.0	5.1
		53.2	3.3	21.4	12.9	2.0	--	1.5	3.9	1.8
KO 59A Slag in a Tuyere		45.0	--	22.9	12.7	5.0	0.5	1.1	7.8	4.9
KO 59B Slag		57.9	--	19.6	10.6	2.8	0.6	1.8	5.0	1.6
		60.1	--	17.5	10.4	2.3	0.9	1.4	5.1	2.3
AL 25 --"--		60.8	2.5	22.4	9.5	--	--	--	3.1	1.6
		55.7	1.9	21.2	12.3	1.2	0.5	--	4.8	2.3
MO 10A --"--	*	43.4	4.8	20.9	19.0	1.0	0.3	2.8	4.4	2.8
	**	43.3	4.7	23.4	14.6	1.3	0.4	2.7	5.7	3.2
MO 10B --"--	*	47.3	4.4	16.8	21.2	1.4	0.4	2.4	3.9	0.8
YAK X --"--	*	61.3	3.6	13.3	13.6	1.8	0.3	1.6	2.5	1.1
	**	52.8	4.4	18.8	15.1	1.6	0.4	1.6	3.2	1.3
DO 1 --"-- Kiralessa		55.6	4.6	23.3	7.3	0.5	0.5	1.1	5.7	1.4

Comments

MO 13 A Gonavava, slag in a tuyere south west of Pussela-ela (Jothiyanandas lot).

MO 13 B Gonavava, slag.

KO 26 A Slag found in a slope.

KO 26 B Slag in a tuyere from the same slope as A.

SO 5 Tammanagala, slag with grass imprints from a habitation site, ceramic dated to around the birth of Christ.

KO 59 A Vavala, (Punchibanda's garden)

KO 59 B Vavala, --"--

AL 25 Aligala, surface find.

MO 10 A Yakkure, big slag blocks	*	0.6% Ba
	**	0.7% Ba

MO 10 B Yakkure, slag from the surface of the "inscription site" * 1.3% Ba

YAK X Yakkure, slag from "Premananda's field"	* 1.0% Ba
	** 0.8% Ba

Table G-5. Analysis report of clay samples at Dehigaha-ala-kanda (SIT1/KO14)

WEIGHT %		FeO	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
KO 14 3 Furnace	*	2.2	--	27.7	50.4	--	--	--	9.9	1.0
Wall		3.2	--	20.3	62.3	--	--	--	5.7	0.7
KO 14 6 --"--	*	0.5	--	51.1	33.1	--	--	--	5.6	3.0
KO 14 7 --"--	*	8.5	--	58.2	20.6	--	0.8	0.8	2.2	7.8
	**	16.5	0.2	45.7	24.1	--	0.9	2.3	2.1	6.2
KO 14 16 --"--	*	10.6	--	37.0	41.1	--	1.4	1.5	1.9	4.5
KO 14 17B --"--		6.1	--	39.3	24.2	2.2	2.1	2.8	14.8	8.5
KO 14 19 --"--		9.9	--	43.2	38.1	--	1.0	2.0	1.4	3.8
KO 14 20 --"--		5.4	--	62.4	21.7	--	0.6	1.6	1.1	7.2
KO 14 6 Tuyere		29.6	--	37.2	28.1	--	0.1	1.4	2.7	--

Table G-6. Analysis report of marble samples at Dehigaha-ala-kanda (SIT1/KO14)

WEIGHT %			FeO	MnO	SiO_2	Al_2O_3	P_2O_5	TiO_2	MgO	CaO	K_2O
MLB 1.1			--	--	--	3.2	--	--	34.9	61.9	--
			--	--	1.5	10.2	--	--	30.0	58.3	--
MLB 2.1			--	--	--	--	--	--	7.19	92.9	--
MLB 3.1			--	--	1.5	5.8	--	--	17.8	74.8	--
MLB 4.1			0.8	--	3.3	5.2	--	--	--	90.7	--
MLB 5.1			0.9	--	2.6	2.2	--	--	4.59	89.8	--
MLB 6.1			1.0	--	2.6	2.4	--	--	3.29	90.8	--
KO 14 3	*	1.8% Na,									
KO 14 6	*	6.7% Na.									
KO 14 7	*	1.0% Na									
	**	2.0% Na									
KO 14 16	*	2.0% Na									

Figure G-1. Electron microscopy picture of a typical reduction slag at SIT 22/KO 14.

The brighter crystals with sharp edges are fayalite on a darker background of the glassy phase where the heavier elements are concentrated, will appear brighter on the pictures with this technique.

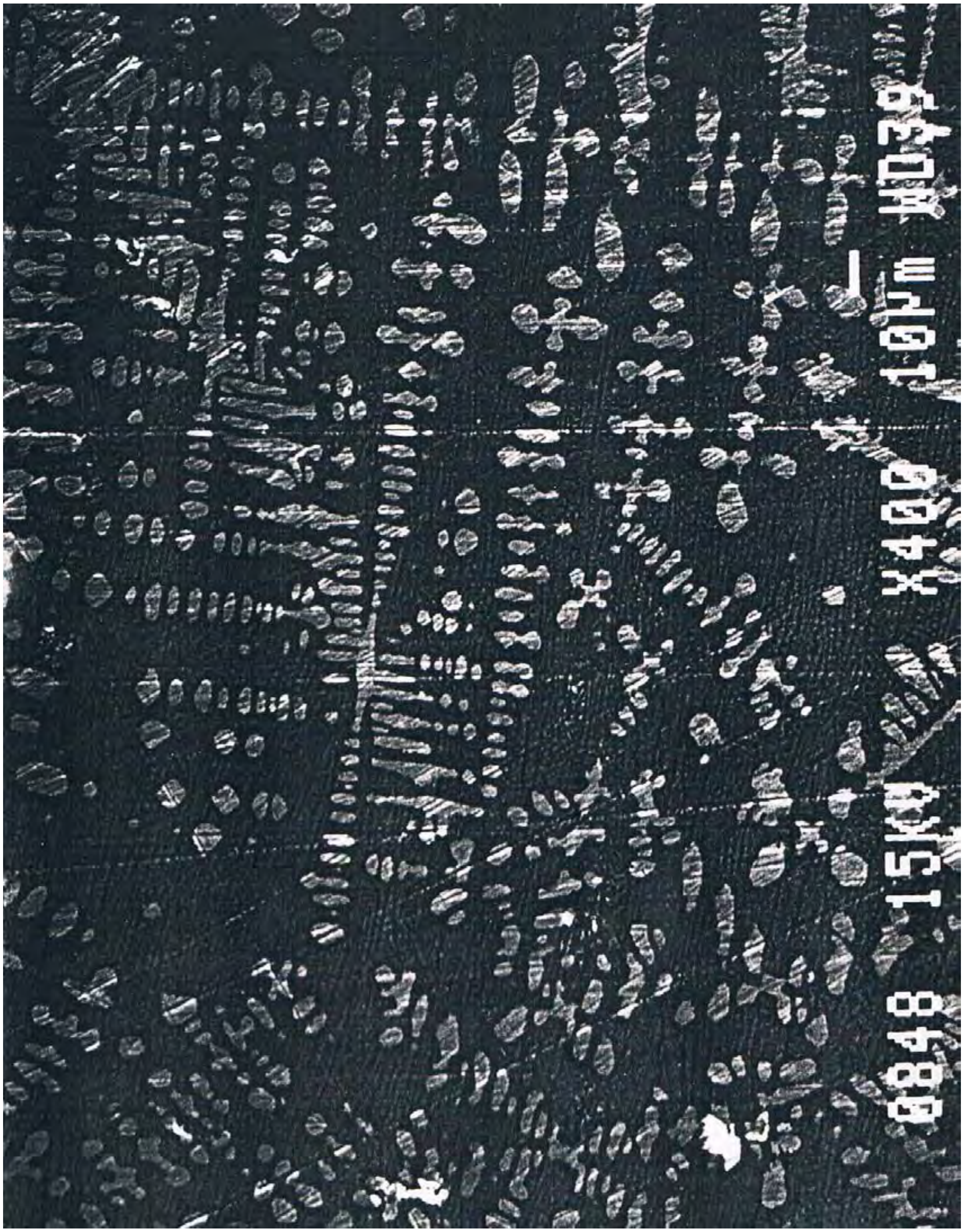


Figure G-2. Electron microscopy picture of an iron slag from Kiralessa.

The dendritic wustite phase forms bright fish bone patterns on a background of finely dispersed fayalite and glassy phase.

APPENDIX H
METALLURGICAL ANALYSIS OF THE SIT PROJECT

Appendix H consists with two separate sections. The first part provides the catalogue of collected samples that were sent for metallurgical analyses. The second part provides the results of analysis. Metallurgical analysis provided here were done by Prof. Dag Noreus and his students at the Arrhenius Laboratory in Stockholm University, Sweden.

Catalog of Collected Samples

Iron Ore

Table H-1A. Collected iron ore samples at Dikyaya-kanda iron smelting site (SIT 22)- 7 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 22-01	F#16	-	Solid Iron Ore	behind the furnace	53
SIT 22-02	F#47	-	Pieces of Iron Ore	attached to a block of the bottom slag	surface
SIT 22-03	F#07	-	Solid Iron Ore	behind the furnace	30
SIT 22-04	F#37	-	Halfly Reduced Ore	in front of the furnace	94
SIT 22-05	F#06	-	Halfly Reduced Ore	behind the furnace	20
SIT 22-06	F#10	-	Iron Ore	behind the furnace	45
SIT 22-07	F#09	-	Iron Ore	in front of the furnace	48

Table H-1B. Collected iron ore samples at Kosgaha-ala-ulpotha settlement site (SIT 7)- 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 07-01	F#01	-	Solid Iron Ore	Test Pit # 01	05
SIT 07-02	F#40	-	Solid Iron Ore	Test Pit # 02	119

Table H-1C. Collected iron ore samples at Vavala Monastery site (SIT 6)- 1 sample

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 06-01	F#27	-	Solid Iron Ore	Test Pit # 01	93

Table H-1D. Collected iron ore samples during the SIT survey (2004-2006)- 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 20-01	-	-	Solid Iron Ore	south-east to the SIT 01/KO 14	surface
SIT 33-01	-	-	Solid Iron Ore	east to the SIT 01/KO 14	surface

Iron Slag

Table H-2A. Collected iron slag samples at Dikyaya-kanda iron smelting site (SIT 22)- 10 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 22-08	F#49	L# 01	Iron Slag	attached to the upper part of the furnace	35
SIT 22-09	F#50	L# 02	Iron Slag	attached to the middle part of the furnace	114
SIT 22-10	F#51	L# 03	Bottom Slag	upper layer of the solid bottom slag	117
SIT 22-11	F#46	L# 04	Bottom Slag	lower layer of the solid bottom slag	128
SIT 22-12	F#52	L# 05	Bottom Slag	lower layer of the solid bottom slag (attached to the front wall)	118
SIT 22-13	F#53	L# 10	Tapped Slag	associated with smelting remains	surface
SIT 22-14	F#54	L# 11	Tapped Slag (with grass imprints)	associated with smelting remains	20
SIT 22-15	F#55	L# 12	Iron Slag	attached to the furnace wall	58
SIT 22-16	F#14	-	Iron Slag	attached to the furnace wall	32
SIT 22-17	F#56	L# 06	Iron Slag	associated with smelting remains	74

Table H-2B. Collected iron slag samples at Kosgaha-ala-ulpotha settlement site (SIT 7)- 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 07-03	F#02	-	Iron Slag	Test Pit # 01	05
SIT 07-04	F#32	-	Iron Slag	Test Pit # 02	49

Table H-2C. Collected iron slag samples at Vavala Monastery site (SIT 6)- 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 06-02	F#14	-	Iron Slag	Test Pit # 01	53
SIT 06-03	F#17	-	Iron Slag	Test Pit # 01	58

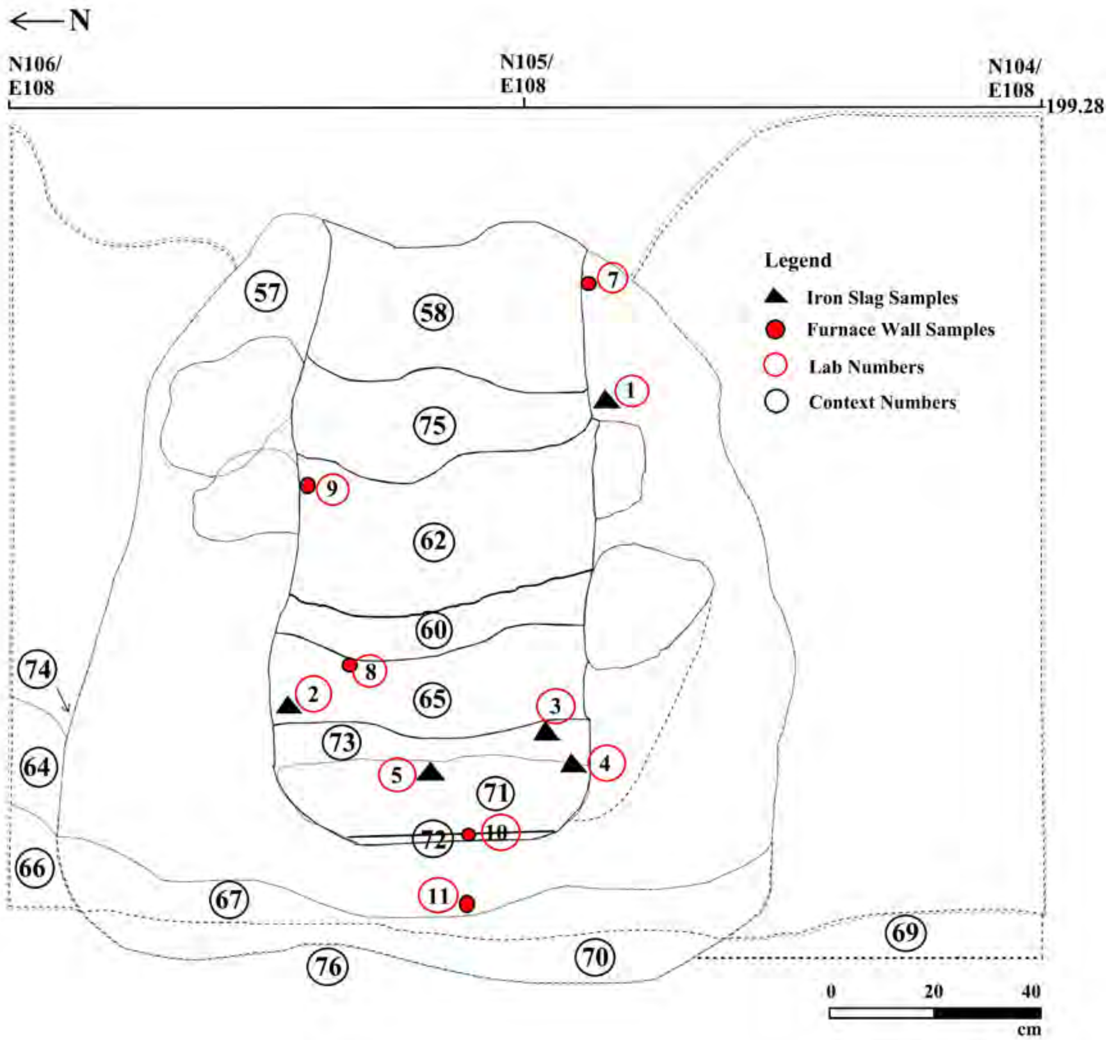


Figure H-1. Locations of collected furnace samples.

Table H-2D. Collected iron slag samples at Vavala Vava iron smelting site (SIT 25)- 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 25-01	F#01	-	Iron Slag	Trench # 01	85
SIT 25-02	F#02	-	Iron Slag	Close to the Trench # 01	surface

Table H-2E. Collected iron slag samples at Alakolavava, "Gravel Site" iron smelting site (SIT 32). During the SIT survey- 1 sample

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 32-01	-	-	Iron Slag	attached to a tuyere	surface

Furnace Wall Samples

Table H-3A. Collected furnace wall samples at Dikyaya-kanda iron smelting site (SIT 22)- 4 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 22-18	F#57	L# 07	Back Wall	upper part of the furnace	25
SIT 22-19	F#58	L# 09	Back Wall	middle part of the furnace	58
SIT 22-20	F#59	L# 08	Back Wall	lower part of the furnace	93
SIT 22-21	F#22	-	Front Wall	lower layer of the furnace	107

Table H-3B. Collected furnace wall samples at Vavala Vava iron smelting site (SIT 25)- 1 sample

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 25-03	F#03	-	Fragment of a Furnace Wall	Trench #01 at the Mound # 01	surface

Tuyere Samples

Table H-4A. Collected tuyere samples at Dikyaya-kanda iron smelting site (SIT 22)- 4 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 22-22	F#04	-	Octagonal/Squared Tuyere Fragment	behind the furnace	27
SIT 22-23	F#29	-	Tuyere Fragment	laid on the front wall (in situ)	125
SIT 22-24	F#32	-	Tuyere Fragment	laid on the front wall (in situ)	120
SIT 22-25	F#19	-	Tuyere Fragment	in front of the furnace	78

Table H-4B. Collected tuyere samples at Alakolavava, "Gravel Site" iron smelting site (SIT 32). During the SIT survey - 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 32-02	-	-	Tuyere Fragment	associated with smelting remains	surface
SIT 32-03	-	-	Tuyere Fragment	associated with smelting remains	surface

Plaster Samples

Table H-5A. Collected plaster samples at Dikyaya-kanda iron smelting site (SIT 22)- 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 22-26	F#20	-	Plaster of the furnace	back wall	85
SIT 22-27	F#45	-	Clay Plaster	bottom of the furnace/below the block of the bottom slag	140

Quartz/Marble Samples

Table H-6A. Collected Quartz/Marble samples at Dikyaya-kanda iron smelting site (SIT 22)- 1 sample

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 22-28	F#48	L#13	Quartz/Marble	in front of the furnace associated with smelting remains	125

Crucible Samples [a]

Table H-7A. Collected crucible samples at Kosgaha-ala-ulpotha settlement site (SIT 7)- 2 samples

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 07-05	F#07	-	Fragment of a Crucible	Test Pit # 01	20
SIT 07-06	F#08	-	Fragment of a Crucible	Test Pit # 01	surface

Table H-7B. Collected crucible samples at Vavala Vava iron smelting site (SIT 25)- 1 sample

Sample #	Field #	Lab #	Description	Location	bs/cm
SIT 25-04	F#04	-	Fragment of a Crucible	Test Pit # 01at Mound #01	surface

[a] These are the first material evidence for the crucible steel production in the area (Solangaarachchi 2008).

Result of Analysis

Iron Ore

Table H-8. Analysis of iron ore at SIT 22

		Atom%	
	SIT22-01	SIT22-02	SIT22-04
Fe	93.721	0	91.046
Na	0*	64.908*	0*
Mg	0.815*	0*	0*
Al	2.833	0*	0.919
Si	0.597	1.756	3.735
P	0.108*	5.322	2.771
S	0.243*	1.079*	0.017*
Cl	0.077*	7.177	0*
K	0.159*	0.762	0.017*
Ca	0.082*	0.402	0*
Sc	0.055*	0.231*	0.178*
Ti	0.72	4.715	0*
V	0*	6.768	0.111*
Cr	0.081*	0.178*	0.136*
Mn	0*	0.334*	0.11*
Sr	0.265*	0.144*	0.269*
Co	0*	6.226	0*
Ni	0.244*	0*	0.158*

Note: Area scan * = less than 2 sigma.

Iron Slags

Table H-9. Analysis of iron slags at SIT 22

	Atom%				
	SIT22-08	SIT22-09	SIT22-10	SIT22-11	SIT22-13
Fe	37.84	42.385	64.604	52.918	49.204
Na	12.711*	0.756*	0*	3.751*	1.018*
Mg	2.385	2.221	0.87*	1.502	1.958
Al	7.408	8.088	7.794	7.37	7.727
Si	20.496	20.014	11.086	19.21	24.555
P	7.215	7.906	3.672	3.083	4.329
S	0.266	2.57	0.54	0.168*	0.05*
Cl	0*	0.734	0.149*	0.092*	0
K	1.923	0.582	1.499	1.61	1.963
Ca	3.745	6.056	2.477	5.088	4.296
Sc	0	0.05*	0*	0*	0*
Ti	0.742	5.211	4.353	2.176	0.659
V	0.013*	0*	0.041*	0.085*	0.021*
Cr	0*	0.132*	0.017*	0.007	0.019*
Mn	4.357	2.588	2.609	2.336	3.239
Sr	0.172*	0.266	0.289*	0.135*	0.141*
Co	0.063*	0*	0*	0.152*	0*
Ni	0.28	0.224*	0*	0.105*	0.144*

Note: Area scan * = less than 2 sigma.

Crucibles

Table H-10. Analysis of a crucible sample (SIT 07-05) collected at SIT 7

		Atom%							
Spectrum	In states	O	Na	Mg	Al	Si	K	Ca	Fe
Spectrum 1	yes	67.69	0.74	0.22	10.47	17.55	1.11	0.46	1.76
Spectrum 2	no	44.97	2.44	0.88	11.55	30.25	3.59	5.21	1.11
Spectrum 3	no	47.35	0.26	0.51	22.17	25.23	3.06	0.47	0.95
Spectrum 4	no	73.78	0.16	0.13	0.33	22.34	0.08	0.22	2.95
Spectrum 5	no	66.31	-0.07	0.08	4.97	26.46	0.73	-0.22	1.74
Mean		67.69	0.74	0.22	10.47	17.55	1.11	0.46	1.76
Std. Deviation		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max.		67.69	0.74	0.22	10.47	17.55	1.11	0.46	1.76
Min.		67.69	0.74	0.22	10.47	17.55	1.11	0.46	1.76

Note: Processing option: all elements analyzed (normalized).

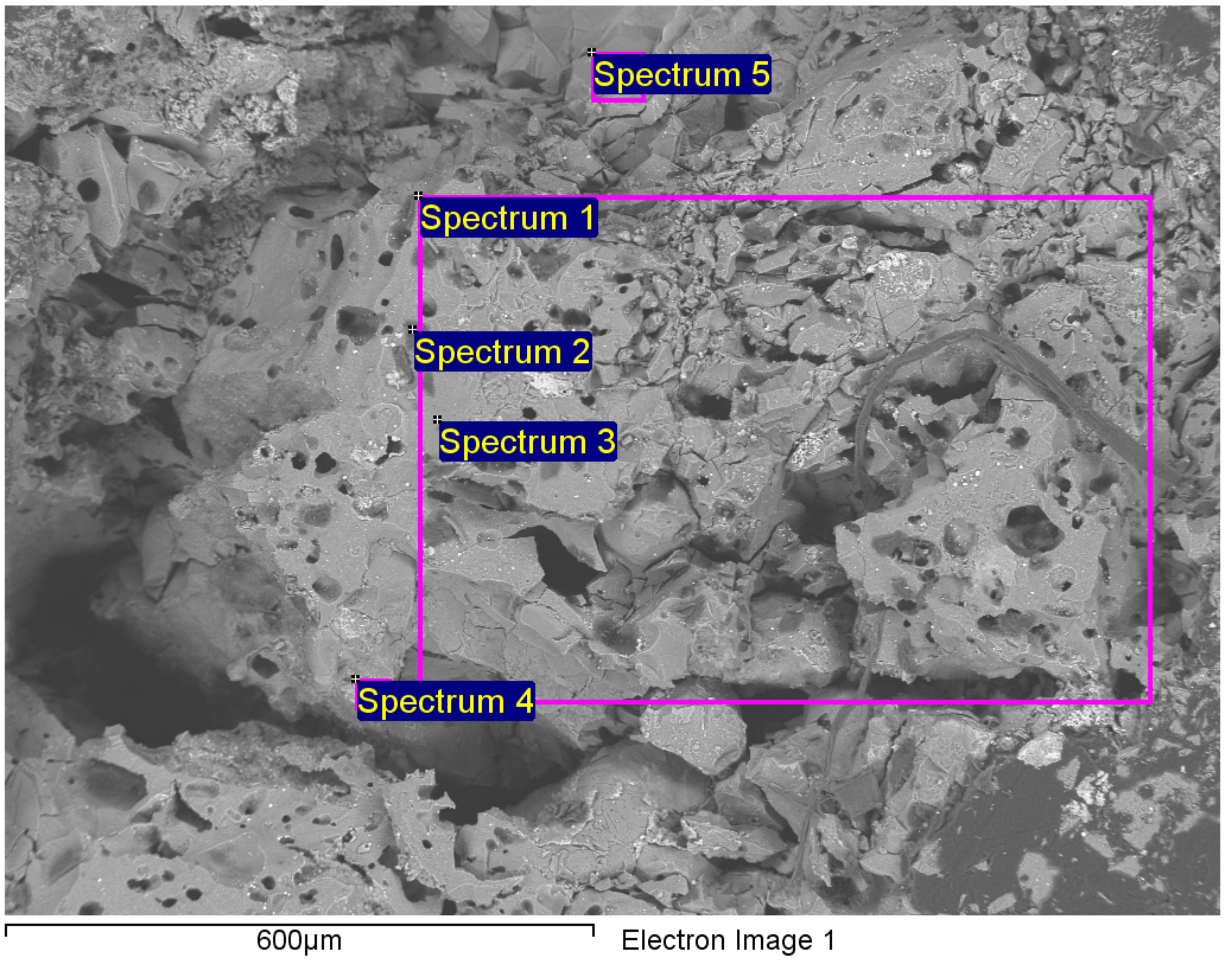


Figure H-2. Electron image of crucible sample (SIT 07-05).

Table H-11. Analysis of a crucible sample (SIT 07-06) collected at SIT 7

		Atom%						
Spectrum	In states	O	Al	Si	K	Ca	Ti	Fe
Spectrum 1	yes	68.32	9.91	17.44	0.66	0.59	0.88	2.21
Spectrum 2	no	63.37	8.41	22.44	5.55	0.09	0.06	0.08
Spectrum 3	no	63.28	8.37	22.43	5.68	0.02	0.14	0.08
Spectrum 4	no	64.79	9.57	22.84	1.82	0.56	0.09	0.34
Spectrum 5	no	66.22	10.54	21.09	-0.06	2.16	-0.02	0.07
Mean		68.32	9.91	17.44	0.66	0.59	0.88	2.21
Std. Deviation		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max.		68.32	9.91	17.44	0.66	0.59	0.88	2.21
Min.		68.32	9.91	17.44	0.66	0.59	0.88	2.21

Note: Processing option: all elements analyzed (normalized).

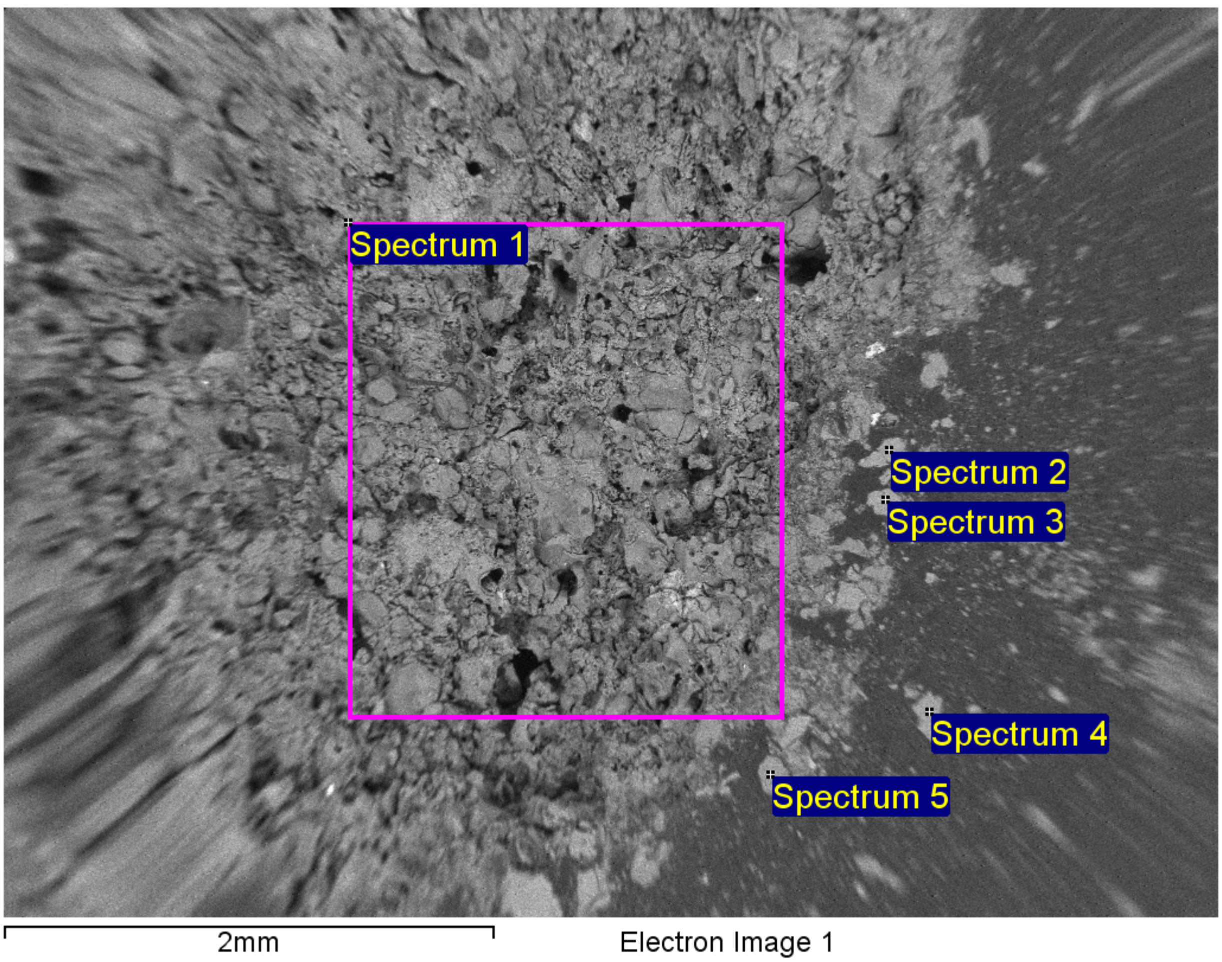


Figure H-3. Electron image of crucible sample (SIT 07-06).

Table H-12. Analysis of a crucible sample (SIT 25-04) collected at SIT 25

		Atom%						
Spectrum	In states	O	Mg	Al	Si	K	Ca	Fe
Spectrum 1	yes	64.14	0.56	7.92	19.73	3.88	0.38	3.39
Spectrum 2	no	61.23	12.71	7.34	14.37	3.00	0.15	1.18
Spectrum 3	no	70.03	-0.06	0.27	29.64	-0.02	0.04	0.09
Spectrum 4	no	63.72	1.09	10.59	17.34	1.25	1.01	5.00
Spectrum 5	no	66.04	1.46	9.94	17.48	1.34	0.52	3.22
Mean		65.03	3.15	7.21	19.71	1.89	0.42	2.58
Std. Deviation		3.28	5.37	4.11	5.87	1.55	0.38	1.94
Max.		70.03	12.71	10.59	29.64	3.88	1.01	5.00
Min.		61.23	-0.06	0.27	14.37	-0.02	0.04	0.09

Note: Processing option: all elements analyzed (normalized).

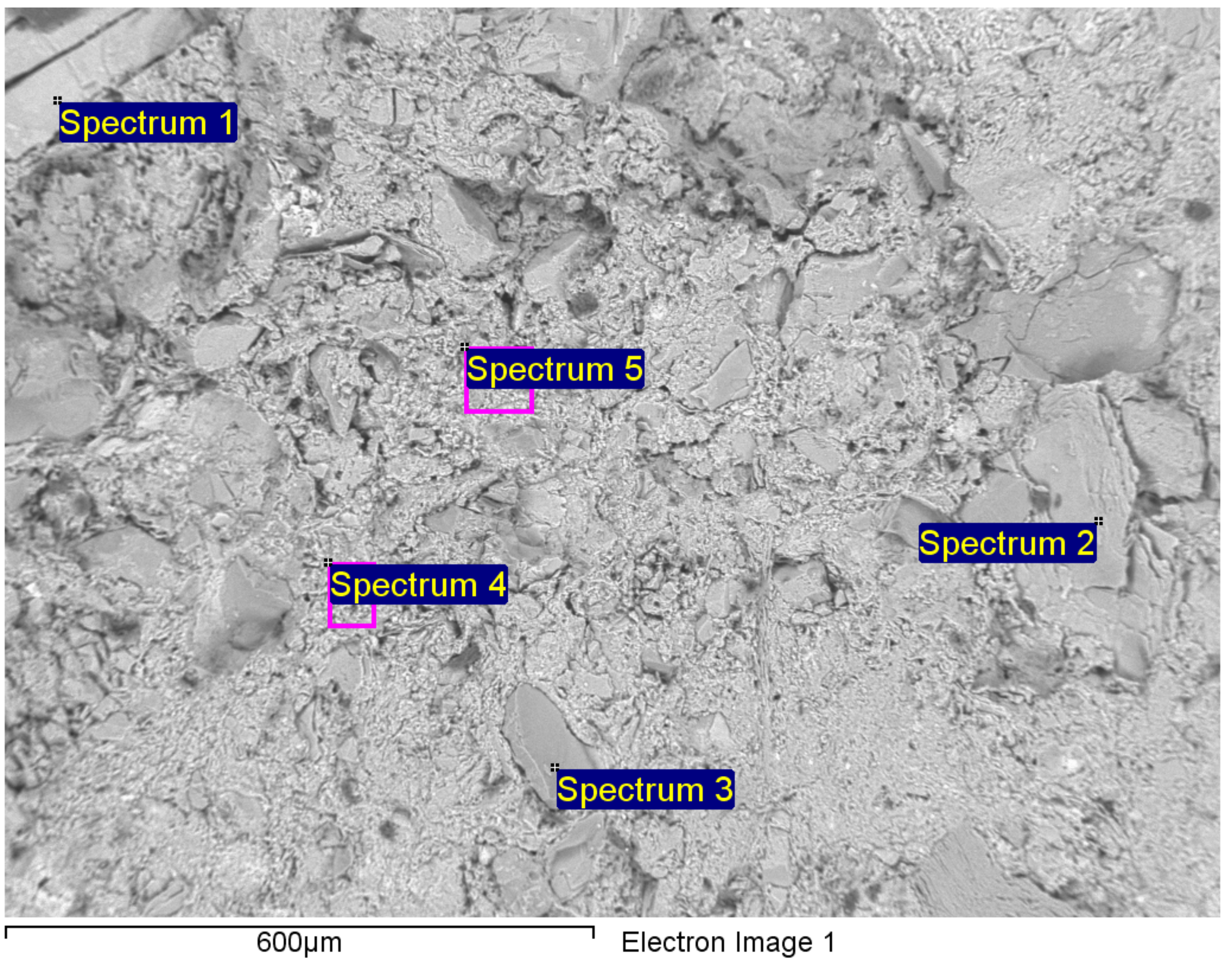


Figure H-4. Electron image of crucible sample (SIT 25-04).

APPENDIX I
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Radiocarbon analysis results provided here were conducted by Beta Analytic, Inc. at Miami, Florida in the USA.

Table I-1. Selected samples for radiocarbon dating from the SIT project during 2004-2006

Sample #	Beta Lab #	Description	Location	Context	bs cm	MSL m	Quantity gm
SIT-22/04-01	201941	Charcoal	N105/E108 Trench # 01 (in front of the Furnace)	65	142	197.85	30
SIT-22/04-02	201942	Charcoal	N105/E108 Trench # 01 (inside the Furnace)	58	78	198.62	10
SIT-22/04-03	201943	Charcoal	N105/E108 Trench # 01 (in front of the Furnace)	68	139	197.98	08
SIT-22/04-04	201944	Charcoal	N104/E108 Trench # 02 (inside the Furnace)	62	130	198.06	32
SIT-07/04-05	201945	Bone [a]	S244/W298 Test Pit # 02 (next to a storage pot?)	12	119	199.32	61
SIT-07/04-06	201946	Charcoal	S244/W298 Test Pit # 02 (with potsherds)	11	77	199.77	04
SIT-06/04-07	201947	Charcoal	N403/W398 Test Pit # 01 (below stone slabs)	13	208	197.98	08
SIT-06/04-08	201948	Charcoal	N402/W398 Test Pit # 01 (below stone slabs)	13	211	198.59	03

[a] After conducting pretreatment at Beta Analytic, Inc. it was not yielded collagen for dating the sample.

Table I-2. Dated samples and results for the SIT 2004-2006

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 201941 SAMPLE : SIT-22/04-01 ANALYSIS : Radiometric-Standard delivery (with extended counting) MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 30 to 260 (Cal BP 1920 to 1690) AND Cal AD 290 to 320 (Cal BP 1660 to 1630)	1900 +/- 60 BP	-27.3 o/oo	1860 +/- 60 BP
Beta - 201942 SAMPLE : SIT-22/04-02 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 130 to 370 (Cal BP 1820 to 1580)	1780 +/- 40 BP	-25.2 o/oo	1780 +/- 40 BP
Beta - 201943 SAMPLE : SIT-22/04-03 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 150 to 390 (Cal BP 1800 to 1560)	1790 +/- 40 BP	-26.7 o/oo	1760 +/- 40 BP
Beta - 201944 SAMPLE : SIT-22/04-04 ANALYSIS : Radiometric-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 260 to 290 (Cal BP 1690 to 1660) AND Cal AD 320 to 570 (Cal BP 1630 to 1380)	1630 +/- 60 BP	-25.6 o/oo	1620 +/- 60 BP
Beta - 201946 SAMPLE : SIT-07/04-06 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 790 to 1000 (Cal BP 1160 to 950)	1150 +/- 40 BP	-26.4 o/oo	1130 +/- 40 BP
Beta - 201947 SAMPLE : SIT-06/04-07 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 60 to Cal AD 90 (Cal BP 2010 to 1860)	1990 +/- 40 BP	-25.0 o/oo	1990 +/- 40 BP
Beta - 201948 SAMPLE : SIT-06/04-08 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 10 to Cal AD 140 (Cal BP 1960 to 1810)	1940 +/- 40 BP	-25.5 o/oo	1930 +/- 40 BP

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-27.3:lab. mult=1)

Laboratory number: **Beta-201941**

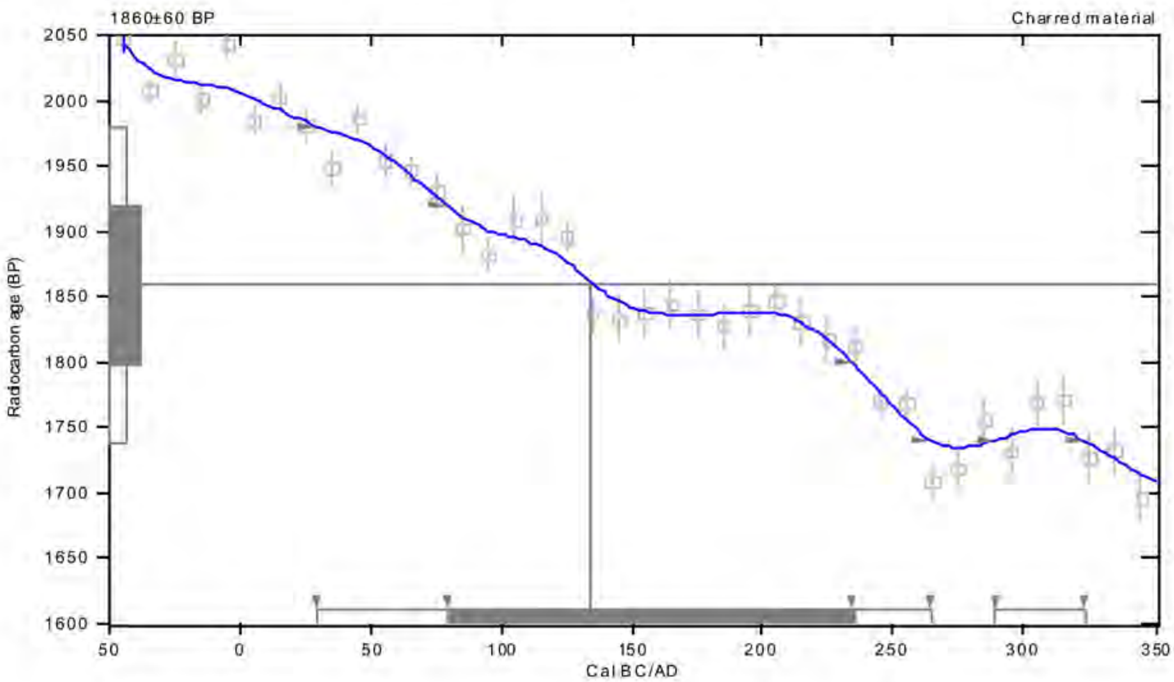
Conventional radiocarbon age: **1860±60 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 30 to 260 (Cal BP 1920 to 1690) and Cal AD 290 to 320 (Cal BP 1660 to 1630)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 130 (Cal BP 1820)

1 Sigma calibrated result: (68% probability) Cal AD 80 to 230 (Cal BP 1870 to 1720)



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Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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Figure I-1. Dikyaya-kanda iron smelting site- Sample # SIT-22/04-01 (Charcoal). Beta-201941.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.2:lab. mult=1)

Laboratory number: **Beta-201942**

Conventional radiocarbon age: **1780±40 BP**

2 Sigma calibrated result: **Cal AD 130 to 370 (Cal BP 1820 to 1580)**
(95% probability)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 240 (Cal BP 1710)

1 Sigma calibrated results: Cal AD 220 to 260 (Cal BP 1730 to 1690) and
(68% probability) Cal AD 290 to 320 (Cal BP 1660 to 1630)

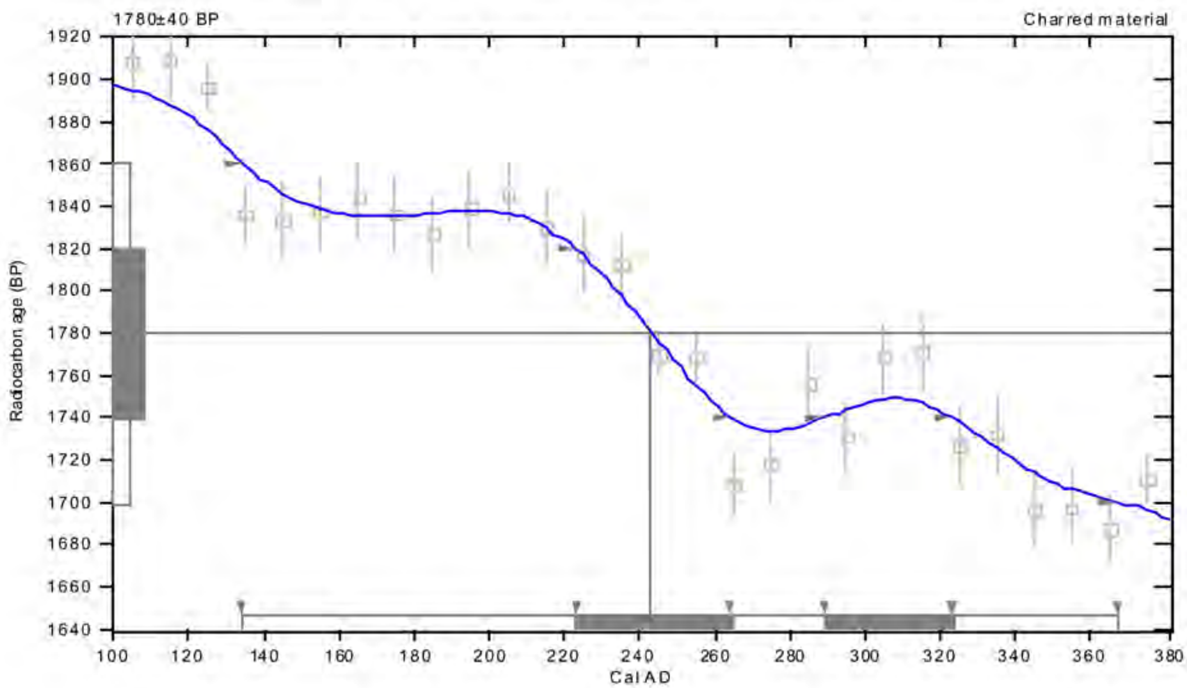

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Figure I-2. Dikyaya-kanda iron smelting site. Sample # SIT-22/04-02 (Charcoal). Beta-201942.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.7:lab. mult=1)

Laboratory number: **Beta-201943**

Conventional radiocarbon age: **1760±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 150 to 390 (Cal BP 1800 to 1560)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 250 (Cal BP 1700)

1 Sigma calibrated result: (68% probability) Cal AD 230 to 340 (Cal BP 1720 to 1610)

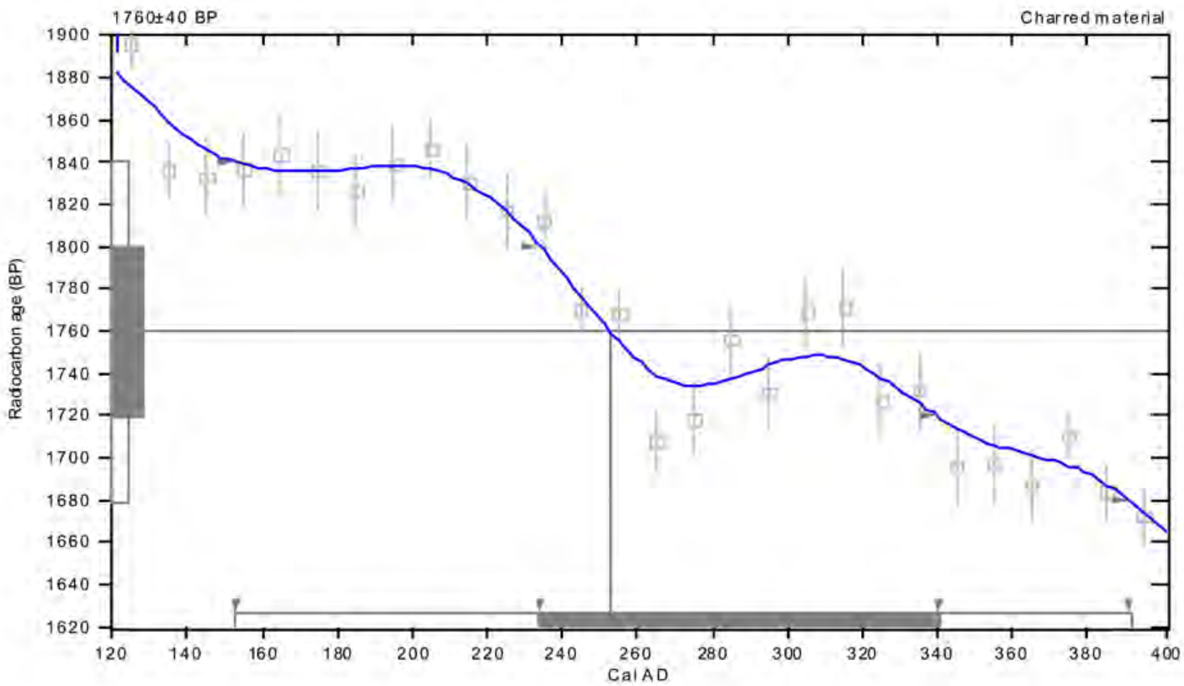

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Figure I-3. Dikyaya-kanda iron smelting site- Sample # SIT-22/04-03 (Charcoal). Beta-201943.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.6:lab. mult=1)

Laboratory number: **Beta-201944**

Conventional radiocarbon age: **1620±60 BP**

2 Sigma calibrated results: (95% probability) **Cal AD 260 to 290 (Cal BP 1690 to 1660) and Cal AD 320 to 570 (Cal BP 1630 to 1380)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 420 (Cal BP 1530)

1 Sigma calibrated result: (68% probability) Cal AD 390 to 530 (Cal BP 1560 to 1420)

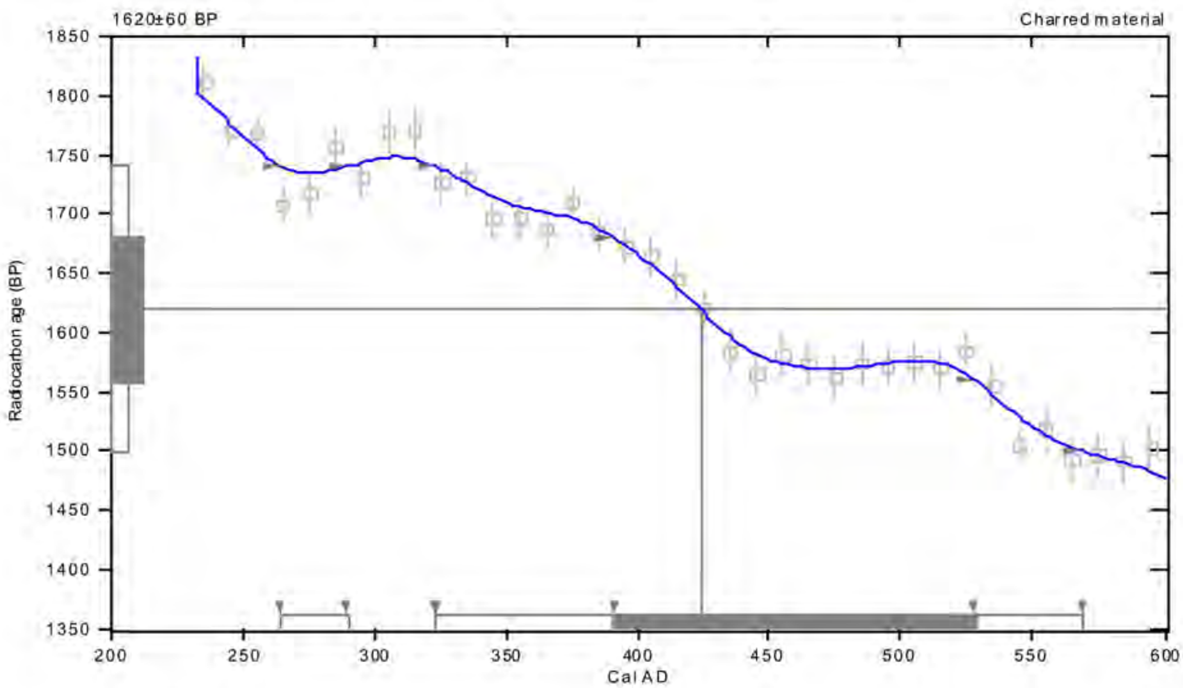

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Figure I-4. Dikyaya-kanda iron smelting site- Sample # SIT-22/04-04 (Charcoal). Beta-201944.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.4:lab. mult=1)

Laboratory number: **Beta-201946**

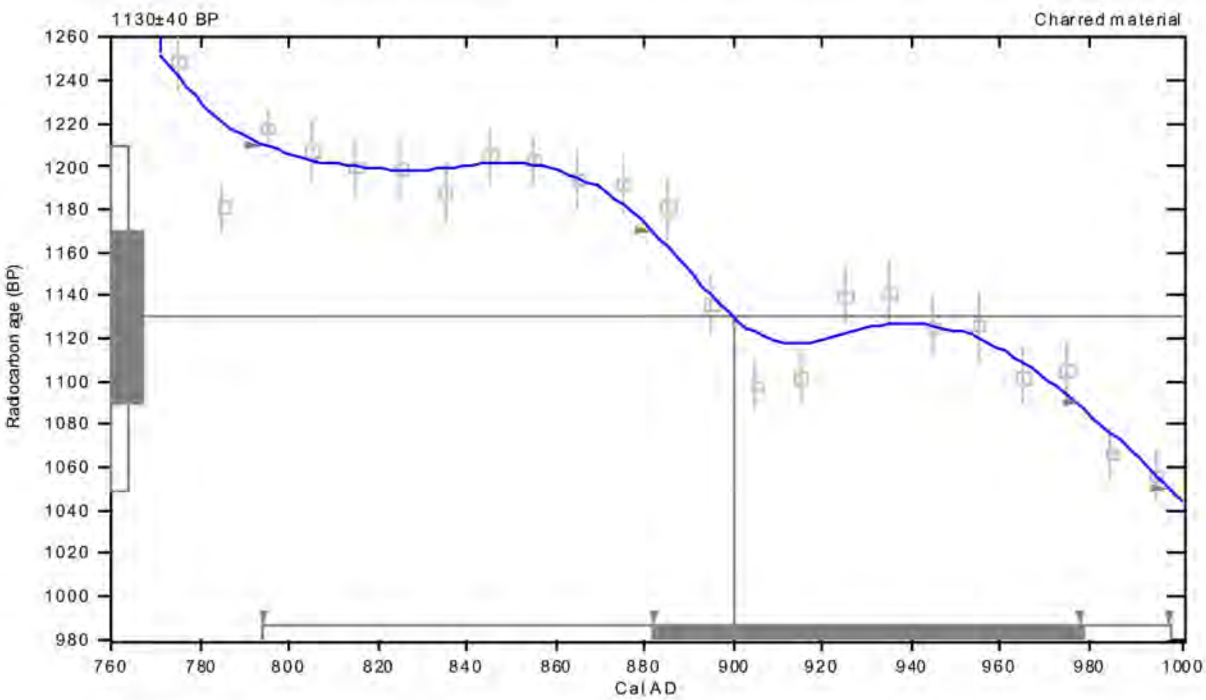
Conventional radiocarbon age: **1130±40 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 790 to 1000 (Cal BP 1160 to 950)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 900 (Cal BP 1050)

1 Sigma calibrated result: (68% probability) Cal AD 880 to 980 (Cal BP 1070 to 970)



References:

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INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

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Figure I-5. Kosgaha-ala-ulpotha settlement- Sample # SIT-07/04-06 (Charcoal). Beta-201946.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-201947**

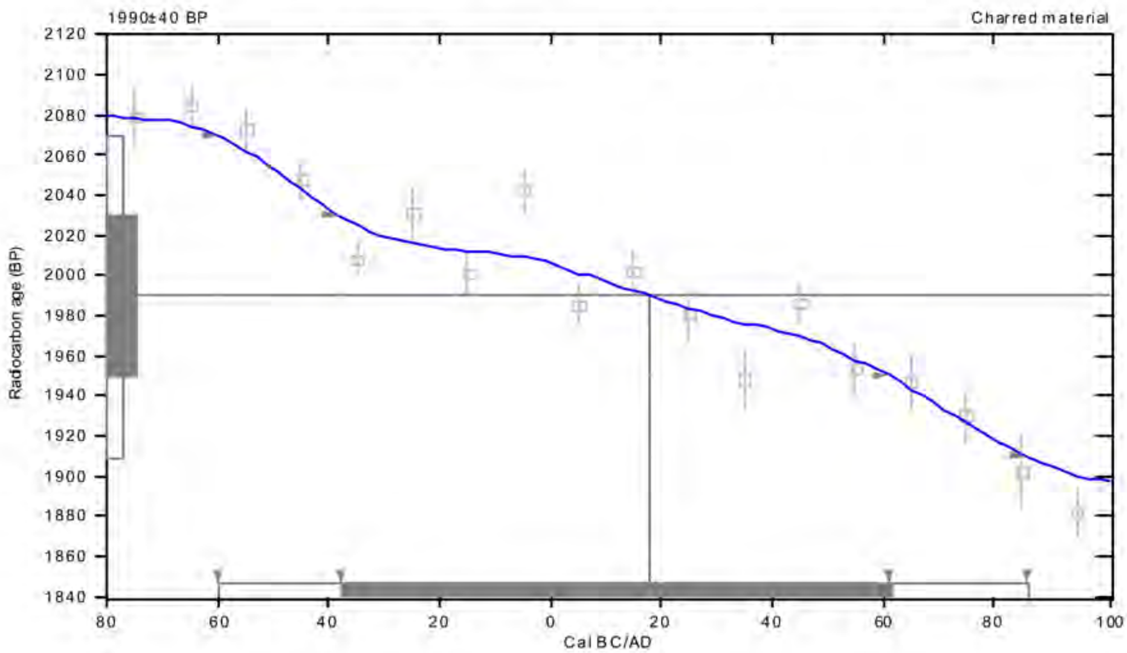
Conventional radiocarbon age: **1990±40 BP**

2 Sigma calibrated result: (95% probability) **Cal BC 60 to Cal AD 90 (Cal BP 2010 to 1860)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 20 (Cal BP 1930)

1 Sigma calibrated result: (68% probability) Cal BC 40 to Cal AD 60 (Cal BP 1990 to 1890)



References:

Database used
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Figure I-6. Vavala Monastery- Sample # SIT-06/04-07 (Charcoal). Beta-201947.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.5:lab. mult=1)

Laboratory number: **Beta-201948**

Conventional radiocarbon age: **1930±40 BP**

2 Sigma calibrated result: (95% probability) **Cal BC 10 to Cal AD 140 (Cal BP 1960 to 1810)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 70 (Cal BP 1880)

1 Sigma calibrated result: (68% probability) Cal AD 40 to 110 (Cal BP 1900 to 1840)

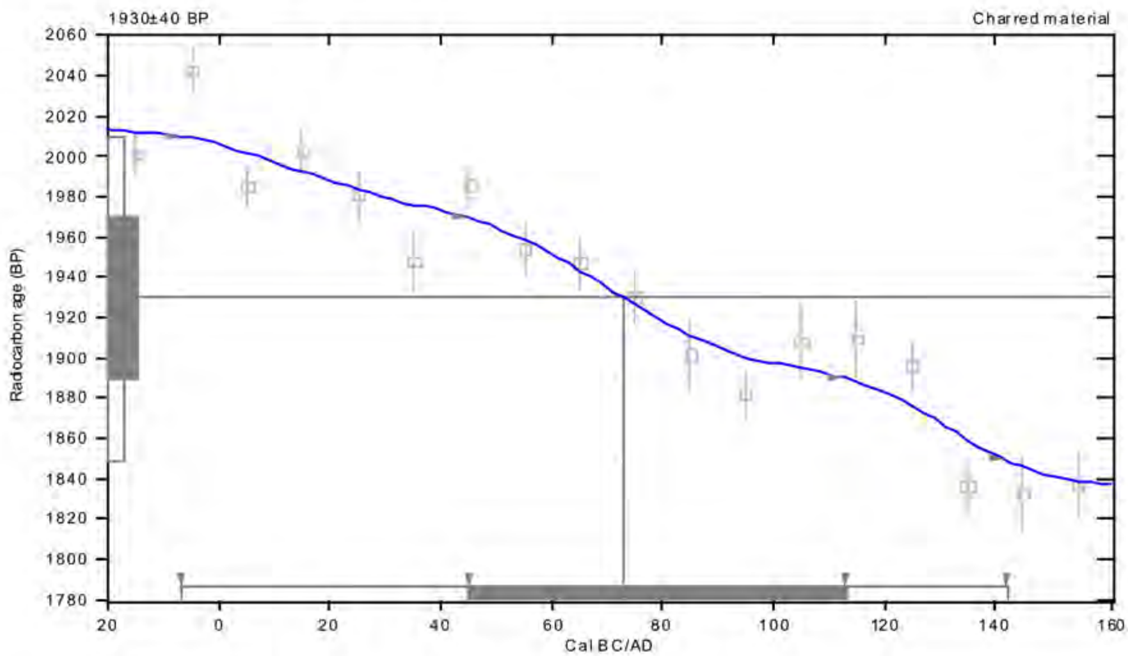

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Figure I-7. Vavala Monastery- Sample # SIT-06/04-08 (Charcoal). Beta-201948.

APPENDIX J
POTTERY WARE ANALYSIS

Pottery workshops were conducted to analyze every potsherds that were unearthed from SIT project in 2004, 2005 and 2006. Data provided here were revealed through step-by-step analyses workshops conducted by the final year archaeology undergraduate students at the University of Kelaniya, directed by me.

Analyses of Sherds

All potsherds were first analyzed according to their body appearance in main six categories; Red Ware (RW), Black Ware (BW), Black & Red Ware (BRW), Black & Gray Ware (BGW), Gray Ware (GW), Gray & Red Ware (GRW), and their sub divisions. Body texture (nature of the core), major body treatments (painted or polished) were used to determine their sub division.

Statistics of Rimsherds and Bodysherds

They were separated and analyzed as diagnostic rimsherds (DR) and non-diagnostic rimsherds (NDR), decorated bodysherds (DB) and non-decorated bodysherds (NDB).

Analyses of Rimsherds

Detailed analyses were conducted for diagnostic rimsherds (DR) to find out their rim forms and applied surface treatments and tempered material/s. In addition all of them were measured and drawn to make the typology (Appendix K).

Table J-1A. Ware analyses at Dikyaya-kanda iron smelting site (SIT 22)

Ware	Context 02/63		Context 01/52		Context 65		Context 62	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	68	596	59	1093	90	672	05	55
RW Polished	-	-	-	-	05	56	-	-
RW Painted	-	-	19	146	10	304	05	105
RW Black Core	08	31	70	628	24	330	01	02
RW Gray Core	-	-	72	650	-	-	-	-
Black Ware (BW)	06	76	24	152	04	30	03	30
BW Polished	01	04	01	04	-	-	-	-
BW Painted	-	-	08	87	-	-	-	-
BW Red Core	-	-	01	04	-	-	-	-
BW Gray Core	-	-	05	12	-	-	-	-
Black & Gray Ware (BGW)	-	-	50	276	-	-	-	-
Black & Red Ware (BRW)	01	02	19	154	04	27	-	-
BRW Polished	-	-	03	88	06	80	-	-
BRW Painted	-	-	03	03	-	-	-	-
Gray Ware (GW)	14	80	99	533	16	108	-	-
GW Polished	-	-	05	28	05	90	-	-
GW Painted	-	-	01	02	-	-	-	-
GW Black Core	01	26	-	-	-	-	-	-
Gray & Red Ware (GRW)	32	312	268	1103	13	136	-	-
GRW Polished	-	-	05	66	02	12	-	-
GRW Painted	-	-	04	36	04	64	-	-
Other Ware:								
RW Black Core Painted	-	-	-	-	02	112	-	-
GW Black Core Polished	-	-	-	-	05	90	-	-
Total	131	1127	716	5065	190	2111	14	192

Table J-1A. Continued.

Ware	Context 53		Context 56		Context 57		Context 58	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	07	90	13	82	03	148	02	24
RW Polished	-	-	-	-	-	-	-	-
RW Painted	-	-	-	-	-	-	-	-
RW Black Core	05	34	03	62	01	26	-	-
RW Gray Core	-	-	-	-	-	-	-	-
Black Ware (BW)	-	-	01	05	-	-	-	-
BW Polished	-	-	-	-	-	-	-	-
BW Painted	-	-	-	-	-	-	-	-
BW Red Core	-	-	-	-	-	-	-	-
BW Gray Core	-	-	-	-	-	-	-	-
Black & Gray Ware (BGW)	-	-	-	-	-	-	-	-
Black & Red Ware (BRW)	01	35	-	-	-	-	-	-
BRW Polished	-	-	-	-	-	-	-	-
BRW Painted	-	-	-	-	-	-	-	-
Gray Ware (GW)	01	04	-	-	-	-	-	-
GW Polished	-	-	-	-	01	24	-	-
GW Painted	-	-	-	-	-	-	-	-
GW Black Core	-	-	-	-	-	-	-	-
Gray & Red Ware (GRW)	-	-	02	04	-	-	-	-
GRW Polished	-	-	-	-	-	-	-	-
GRW Painted	-	-	-	-	-	-	-	-
Other Ware:								
RW Black Core Painted	-	-	-	-	-	-	-	-
GW Black Core Polished	-	-	-	-	-	-	-	-
Total	14	163	19	153	05	198	02	24

Table J-1A. Continued.

Ware	Context 59		Context 60		Context 64		Context 67	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	02	30	02	10	03	148	02	24
RW Polished	-	-	-	-	-	-	-	-
RW Painted	-	-	-	-	-	-	-	-
RW Black Core	-	-	-	-	01	26	-	-
RW Gray Core	-	-	-	-	-	-	-	-
Black Ware (BW)	-	-	-	-	-	-	-	-
BW Polished	-	-	-	-	-	-	-	-
BW Painted	-	-	-	-	-	-	-	-
BW Red Core	-	-	-	-	-	-	-	-
BW Gray Core	-	-	-	-	-	-	-	-
Black & Gray Ware (BGW)	-	-	-	-	-	-	-	-
Black & Red Ware (BRW)	-	-	-	-	-	-	02	15
BRW Polished	-	-	-	-	-	-	-	-
BRW Painted	-	-	-	-	-	-	-	-
Gray Ware (GW)	-	-	-	-	-	-	-	-
GW Polished	-	-	-	-	01	24	-	-
GW Painted	-	-	-	-	-	-	-	-
GW Black Core	-	-	-	-	-	-	-	-
Gray & Red Ware (GRW)	-	-	-	-	-	-	-	-
GRW Polished	-	-	-	-	-	-	-	-
GRW Painted	-	-	-	-	-	-	-	-
Other Ware:								
RW Black Core Painted	-	-	-	-	-	-	-	-
GW Black Core Polished	-	-	-	-	-	-	-	-
Total	02	30	02	10	05	198	04	39

Table J-1B. Quantity and percentage of major ceramic wares at SIT 22

Wares [a]	RW (Red Ware)	BW (Black ware)	BRW (Black & Red Ware)	BGW (Black & Gray Ware)	GW (Gray Ware)	GRW (Gray & Red Ware)
Total [b]	482	54	39	50	149	330
Percentage	43.66%	4.88%	3.53%	4.53%	13.5%	29.9%

[a] Sub categories are counted under their major category.

[b] Total number of sherds unearthed at SIT 22 is 1104 and the total weight is 9308gms (9.308kg).

Table J-1C. Major categories of sherds unearthed at SIT 22

Context	Diagnostic Rims (DR)		Non-Diagnostic Rims (NDR)		Decorated Bodysherds (DB)		Non-Decorated Bodysherds (NDB)	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
02/63	08	130	14	156	02	40	107	801
01/52	11	284	90	822	45	524	570	3435
65	07	280	09	90	08	353	166	1288
62	05	78	-	-	01	26	08	88
53	01	04	-	-	01	08	12	149
56	-	-	01	08	01	49	17	96
57	02	116	-	-	-	-	03	82
58	01	22	-	-	-	-	01	02
59	-	-	-	-	-	-	02	30
60	-	-	-	-	-	-	02	10
64	-	-	-	-	-	-	05	198
67	-	-	-	-	-	-	04	39
Total	35	914	114	1176	58	1000	897	6218
Percentage	3.17%		10.33%		5.25%		81.25%	

Table J-1D. Rimsherds analyses at SIT 22

Bag #	Sherd #	Con. #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
02	p-04	02	16	0.5	0.8	-	-	√	painted	-	√	√	√	limestone	*Mudiya*
02	p-05	02	22	0.7	1.5	-	-	√	-	painted	√	-	√	limestone	*Mudiya*
09	p-09	02	22	0.4	0.7	-	-	√	polished	-	-	√	√	-	*Mudiya*
09	p-10	02	32	0.4	1.4	-	-	√	-	-	√	-	√	limestone	*appallaya*
11	p-11	02	33	0.4	1.4	-	-	√	-	polished	√	-	√	limestone	*atiliya*
11	p-19	02	20	0.9	1.8	-	-	√	-	painted	√	-	√	limestone	*atiliya*
13	p-22	02	32	0.5	1.3	-	-	√	-	slipped	√	-	√	-	*atiliya*
14	p-35	02	34	0.6	0.8	√	-	-	slipped	slipped	√	-	√	-	*appallaya*
19	p-37	52	24	0.4	1.2	-	-	√	-	-	√	-	√	limestone	*atiliya*
20	p-26	52	16	0.8	1.7	-	-	√	slipped	-	√	-	√	-	*atiliya*
20	p-27	52	28	0.6	1.4	-	-	√	-	-	√	-	√	limestone	*atiliya*
21	p-01	52	18	1.3	2.5	√	-	-	painted	-	√	-	√	limestone	*atiliya*
21	p-02	52	34	0.5	0.8	√	-	-	-	-	-	-	√	limestone	*appallaya*
24	p-39	52	24	0.5	1.3	-	-	√	-	-	√	-	√	limestone	*atiliya*
28	p-20	52	22	0.3	1.0	-	-	√	-	-	√	-	√	-	*atiliya*
28	p-21	52	24	0.4	0.9	-	-	√	-	-	√	-	√	limestone	*appallaya*
31	p-40	52	24	0.5	1.4	-	-	√	-	-	√	-	√	limestone	*atiliya*
31	p-41	52	24	0.5	1.3	-	-	√	-	-	√	-	√	limestone	*atiliya*
33	p-03	52	20	0.6	1.2	-	-	√	-	-	-	-	√	limestone	*atiliya*
38	p-42	52	32	1.0	1.7	-	-	√	-	polished	√	-	√	-	*appallaya*
38	p-43	52	24	0.5	1.7	-	-	√	polished	polished	√	-	√	-	*atiliya*
38	p-44	52	32	0.5	0.8	-	-	√	-	-	√	-	√	limestone	*kundahattiya*
44	p-33	53	12	0.8	1.3	-	-	√	-	painted	√	-	√	limestone	*appallaya*
44	p-34	58	18	0.6	2.1	√	-	-	-	-	-	-	√	limestone	*appallaya*
49	p-12	57	28	1.1	2.5	-	√	-	-	painted	√	-	√	limestone	*Mudiya*
49	p-13	57	30	0.6	1.5	-	√	-	-	-	√	-	√	limestone	*appallaya*
51	p-24	62	32	0.5	1.2	-	√	-	-	-	√	-	√	limestone	*appallaya*

Table J-1D. Continued.

Bag #	Sherd #	Con. #	O D cm	W T cm	L T cm	Rim Form In.	Rim Form St.	Rim Form Ex.	Surface Treatment In.	Surface Treatment Ex.	Temper Sand	Temper Mica	Temper Quartz	Temper Other	Type of Vessel
51	p-25	62	24	1.2	2.0	-	√	-	painted	painted	-	-	√	limestone	*atiliya*
52	p-23	62	46	0.5	1.6	-	√	-	-	-	√	-	√	limestone	*appallaya*
55	p-14	65	22	0.8	1.5	-	-	√	painted	painted	-	√	√	-	*atiliya*
55	p-15	65	24	0.5	1.5	-	-	√	-	slipped	√	-	√	limestone	*atiliya*
55	p-16	65	28	0.8	1.5	-	-	√	-	painted	√	-	√	limestone	*atiliya*
57	p-17	65	28	0.8	1.7	√	-	-	painted	painted	√	-	√	limestone	*atiliya*
57	p-18	65	26	0.8	1.5	-	-	√	painted	painted	√	-	√	-	*appallaya*
58	p-38	65	32	1.0	1.9	-	-	√	-	-	√	-	√	-	*tatiya*
S1	p-47	sc	-	1.0	2.4	-	√	-	painted	painted	√	-	√	-	*atiliya*
S1	p-48	sc	32	1.2	2.3	√	-	-	painted	painted	√	-	√	limestone	*appallaya*
S1	p-49	sc	24	0.4	1.6	-	-	√	-	polished	√	-	√	limestone	*atiliya*
S1	p-50	sc	22	0.3	1.5	√	-	-	-	slipped	-	-	√	limestone	*haliya*
S1	p-51	sc	24	0.5	1.4	-	√	-	-	slipped	√	-	√	limestone	*atiliya*
S1	p-52	sc	32	0.6	1.6	-	-	√	-	polished	√	-	√	-	*atiliya*
S1	p-53	sc		0.8	1.4	-	-	√	painted	polished	√	-	√	limestone	*atiliya*
S1	p-54	sc	53	0.9	2.0	-	-	√	polished	polished	√	-	√	limestone	*koraha*
S1	p-55	sc	28	0.8	1.8	-	-	√	-	-	√	-	√	limestone	*atiliya*
S1	p-56	sc	32	1.0	2.0	-	-	√	-	-	-	-	√	limestone	*atiliya*
S1	p-57	sc	24	0.8	1.5	-	-	√	-	-	√	-	√	-	*atiliya*
S1	p-59	sc	28	0.9	1.8	-	-	√	-	-	√	-	√	-	*atiliya*
S1	p-60	sc	24	1.4	2.3	-	-	√	-	-	√	-	√	limestone	*haliya*
S1	p-61	sc	22	0.8	1.5	-	√	-	-	-	√	-	√	limestone	*atiliya*
S1	p-63	sc	20	1.3	1.8	-	-	√	-	-	-	-	√	limestone	*atiliya*
S1	p-64	sc	22	0.8	1.9	-	-	√	-	-	√	-	√	limestone	*atiliya*
S1	p-68	sc	24	0.8	1.5	√	-	-	-	-	√	-	√	limestone	*atiliya*
S1	p-67	sc	28	0.8	1.4	-	-	√	-	-	√	-	√	limestone	*atiliya*

Table J-2A. Ware analyses at Vavala Monastery site (SIT 6)

Ware	Context 03		Context 04		Context 11		Context 13	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	72	368	218	1764	05	54	06	46
RW Polished	05	130	75	1141	01	24	01	28
RW Painted	22	232	44	770	03	34	06	48
RW Black Core	01	04	23	220	-	-	-	-
RW Gray Core	14	98	06	84	-	-	-	-
Black Ware (BW)	05	18	39	142	02	14	-	-
BW Polished	03	38	24	164	-	-	-	-
BW Painted	01	08	08	178	-	-	-	-
BW Red Core	-	-	02	12	-	-	-	-
Black & Gray Ware (BGW)	-	-	-	-	-	-	-	-
Black & Red Ware (BRW)	01	06	28	252	01	08	02	14
BRW Polished	-	-	12	232	04	38	01	02
BRW Painted	-	-	07	60	-	-	-	-
Gray Ware (GW)	03	16	31	124	-	-	-	-
GW Polished	-	-	17	294	-	-	-	-
GW Painted	-	-	06	56	-	-	-	-
Gray & Red Ware (GRW)	-	-	23	140	02	24	-	-
GRW Polished	-	-	13	218	01	02	01	02
GRW Painted	-	-	02	10	01	04	07	30
Other Ware:								
RW Gray Core Painted	06	56	02	118	01	04	-	-
RW Gray Core Polished	-	-	05	234	-	-	-	-
RW Black Core Polished	-	-	08	120	-	-	-	-
RW Black Core Painted	-	-	05	468	-	-	-	-
GW Black Core Polished	-	-	-	-	-	-	-	-
Buff Ware	-	-	01	02	-	-	-	-
Brown Ware	-	-	15	120	-	-	-	-
Brown Ware Painted	-	-	02	24	-	-	-	-
Total	133	974	616	6947	21	206	24	170

Table J-2B. Quantity and percentage of major ceramic wares at SIT 6

Wares [a]	RW (Red Ware)	BW (Black ware)	BRW (Black & Red Ware)	GW (Gray Ware)	GRW (Gray & Red Ware)	Other Ware [b]
Total [c]	529	84	56	57	50	18
Percentage	66.62%	10.58%	7.05%	7.18%	6.3%	2.27%

[a] Sub categories are counted under their major category.

[b] 01 sherd of Buff Ware and 17 sherds of Brown Ware are counted as Other Ware category.

[c] Total number of sherds unearthed at SIT 06 is 794 and the total weight is 8797gms (8.797kg).

Table J-2C. Major categories of sherds unearthed at SIT 6

Context	Diagnostic Rims (DR)		Non-Diagnostic Rims (NDR)		Decorated Bodysherds (DB)		Non-Decorated Bodysherds (NDB)	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
03	01	88	20	178	22	194	90	514
04	23	694	51	570	100	2164	442	3519
11	-	-	04	38	09	94	08	74
13	01	14	01	08	08	64	14	84
Total	25	796	76	794	139	2516	554	4191
Percentage	3.15%		9.57%		17.51%		69.77%	

Table J-2D. Rimsherds analyses at SIT 06

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
02	p-185	03	50	0.8	2.3	-	-	√	polished	polished	√	-	-	limestone gravel	*hattiya*
04	p-220	04	24	0.6	1.7	√	-	-	polished	polished	√	√	√	limestone	*hattiya*
04	p-221	04	24	0.6	1.5	-	-	√	painted	-	√	-	-	limestone	*hattiya*
04	p-222	04	18	0.5	2.0	-	-	√	polished	-	√	-	-	limestone gravel	*haliya*
04	p-223	04	20	0.7	1.5	√	-	-	-	-	√	-	√	limestone gravel	*mudiya*
04	p-224	04	12	0.4	1.0	√	-	-	-	-	-	√	-	limestone	*hattiya*
05	p-226	04	20	0.8	1.5	-	-	√	-	painted	√	-	√	limestone	*hattiya*
05	p-225	04	16	0.5	2.1	√	-	-	painted	painted	√	-	√	limestone	*haliya*
06	p-195	04	24	0.5	0.7	-	-	√	painted	polished	√	√	-	limestone	*tatiya*
06	p-196	04	18	0.6	2.1	-	-	√	polished	polished	√	-	√	limestone	*haliya*
06	p-197	04	14	0.4	1.4	-	-	√	-	-	√	√	√	limestone	atiliya
06	p-198	04	14	0.7	1.3	√	-	-	painted	polished	√	-	√	limestone	*hattiya*
06	p-199	04	12	0.5	1.3	-	-	√	-	-	√	√	√	-	*hattiya*
06	p-200	04	12	0.5	0.7	-	-	√	painted	painted	√	-	√	-	*muttiya*
07	p-190	04	28	0.6	1.4	-	-	√	painted	-	√	√	-	limestone gravel	Tray bowl
07	p-191	04	32	0.6	2.5	√	-	-	polished	-	√	-	√	limestone	*appallaya*
07	p-192	04	19	0.4	0.8	-	-	√	-	-	√	-	-	limestone	*tatiya*
07	p-193	04	20	0.6	0.9	-	-	√	-	-	√	-	-	limestone	*hattiya*
07	p-194	04	22	0.7	1.5	-	-	√	polished	polished	√	-	-	limestone	*hattiya*

Table J-2D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
09	p-227	04		0.5	1.0	-	-	√	-	-	√	-	-	limestone gravel	
09	p-202	04	12	0.9	1.6	√	-	-	polished	polished	√	√	√	limestone	*hattiya*
11	p-229	04	24	0.5	1.6	√	-	-	polished	polished	√	√	√	-	*baraniya*
11	p-230	04	22	0.7	1.4	-	-	√	polished	polished	√	√	√	limestone	*hattiya*
11	p-231	04	16	0.8	1.1	-	-	√	-	-	√	√	-	limestone	*hattiya*
14	p-215	13	12	0.6	1.5	-	-	√	-	-	√	√	-	limestone	*mudiya*

Table J-3A. Ware analyses at Kosgaha-ala-ulpotha settlement site (SIT 7)

Ware	Context 01		Context 02		Context 04		Context 08	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	80	404	128	808	310	1824	83	610
RW Polished	04	30	13	118	14	151	09	78
RW Painted	02	03	13	302	31	326	03	14
RW Black Core	11	51	16	162	19	194	11	104
RW Gray Core	-	-	-	-	-	-	-	-
Black Ware (BW)	10	30	05	18	13	43	03	44
BW Polished	05	28	02	24	09	40	02	12
BW Painted	-	-	02	08	01	08	-	-
BW Red Core	-	-	-	-	-	-	-	-
Black & Gray Ware (BGW)	-	-	-	-	-	-	-	-
Black & Red Ware (BRW)	-	-	07	78	23	160	09	66
BRW Polished	02	06	-	-	06	82	-	-
BRW Painted	-	-	-	-	07	64	-	-
Gray Ware (GW)	17	56	30	209	27	190	15	300
GW Polished	-	-	02	24	11	84	01	38
GW Painted	-	-	01	12	07	70	07	84
Gray & Red Ware (GRW)	21	138	47	326	104	624	39	288
GRW Polished	02	03	13	94	31	114	03	20
GRW Painted	02	03	09	60	17	224	14	114
Other Ware:								
RW Gray Core Painted	-	-	-	-	-	-	-	-
RW Gray Core Polished	-	-	-	-	-	-	-	-
RW Black Core Polished	-	-	-	-	07	56	-	-
RW Black Core Painted	01	12	-	-	10	130	05	120
GW Black Core Polished	-	-	-	-	-	-	-	-
Buff Ware	-	-	-	-	-	-	-	-
Brown Ware	-	-	-	-	-	-	-	-
Brown Ware Painted	-	-	-	-	-	-	-	-
Total	157	764	288	2243	647	4384	204	1892

Table J-3A. Continued.

Ware	Context 09		Context 10		Context 11		Context 12	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	368	2342	376	742	61	310	47	341
RW Polished	38	364	84	560	14	84	80	404
RW Painted	90	1116	72	548	65	734	134	1092
RW Black Core	23	222	33	196	05	122	-	-
RW Gray Core	06	54	11	68	-	-	-	-
Black Ware (BW)	25	134	32	120	02	10	02	04
BW Polished	29	150	14	80	09	62	02	02
BW Painted	02	12	-	-	-	-	04	28
BW Red Core	03	18	06	22	-	-	-	-
Black & Red Ware (BRW)	09	252	14	118	-	-	05	22
BRW Polished	05	52	-	-	-	-	03	10
BRW Painted	11	74	03	64	01	02	04	20
Gray Ware (GW)	49	492	93	476	22	172	10	60
GW Polished	09	152	51	330	15	98	11	71
GW Painted	23	188	30	158	15	144	20	108
Gray & Red Ware (GRW)	55	304	06	22	22	210	18	86
GRW Polished	40	222	10	50	07	44	15	164
GRW Painted	07	64	05	76	09	102	46	332
Other Ware:								
RW Gray Core Painted	07	99	05	46	-	-	-	-
RW Black Core Polished	23	182	10	68	-	-	-	-
RW Black Core Painted	26	108	06	84	09	104	11	108
BW Red Core Polished	03	14	02	06	06	61	-	-
BW Red Core Painted	02	12	04	14	01	06	-	-
GW Red Core Painted	20	102	03	34	01	24		
Red & Brown Ware Painted	-	-	-	-	-	-	05	54
Brown Ware	-	-	-	-	-	-	10	34
Brown Ware Painted	-	-	-	-	08	88	03	10
Brown Ware Polished	-	-	-	-	10	44	11	74
Total	873	6729	870	3882	282	2421	441	3024

Table J-3A. Continued.

Ware	Context 20		Context 21		Context 23		Context 30	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	170	608	122	880	20	224	115	582
RW Polished	33	282	42	400	06	51	04	28
RW Painted	70	106	61	842	11	74	02	24
RW Black Core	-	-	03	66	-	-	-	-
RW Gray Core	06	72	-	-	01	06	03	48
Black Ware (BW)	03	08	03	08	02	14	04	30
BW Polished	-	-	02	24	-	-	01	04
BW Painted	-	-	-	-	-	-	-	-
BW Red Core	-	-	-	-	-	-	-	-
Black & Gray Ware (BGW)	-	-	-	-	-	-	-	-
Black & Red Ware (BRW)	02	04	02	20	04	46	03	14
BRW Polished	02	02	03	60	-	-	-	-
BRW Painted	-	-	-	-	-	-	-	-
Gray Ware (GW)	-	-	30	278	07	72	09	48
GW Polished	14	218	30	332	04	36	-	-
GW Painted	17	106	05	242	03	20	-	-
Gray & Red Ware (GRW)	25	134	61	482	11	120	21	106
GRW Polished	36	278	29	242	05	30	02	18
GRW Painted	08	98	34	432	06	112	01	04
Other Ware:								
RW Gray Core Painted	06	114	-	-	-	-	-	-
RW Gray Core Polished	01	26	-	-	-	-	-	-
RW Black Core Polished	-	-	-	-	-	-	-	-
RW Black Core Painted	-	-	02	104	-	-	-	-
GW Black Core Polished	-	-	-	-	-	-	-	-
Fine Ware	01	04	-	-	-	-	-	-
Brown Ware	-	-	-	-	-	-	-	-
Brown Ware Painted	-	-	-	-	-	-	-	-
Total	394	2060	429	4412	80	805	165	906

Table J-3A. Continued.

Ware	Context 31 Quantity	Weight/gms
Red Ware (RW)	26	162
RW Polished	04	24
RW Painted	05	44
RW Black Core	-	-
RW Gray Core	-	-
Black Ware (BW)	-	-
BW Polished	-	-
BW Painted	-	-
BW Red Core	-	-
Black & Gray Ware (BGW)	-	-
Black & Red Ware (BRW)	-	-
BRW Polished	-	-
BRW Painted	-	-
Gray Ware (GW)	12	124
GW Polished	08	96
GW Painted	-	-
Gray & Red Ware (GRW)	11	64
GRW Polished	04	34
GRW Painted	01	10
Other Ware:		
RW Gray Core Painted	-	-
RW Gray Core Polished	-	-
RW Black Core Polished	-	-
RW Black Core Painted	-	-
GW Black Core Polished	-	-
Buff Ware	-	-
Brown Ware	-	-
Brown Ware Painted	-	-
Total	71	558

Table J-3B. Quantity and percentage of major ceramic wares at SIT 7

Wares [a]	RW (Red Ware)	BW (Black ware)	BRW (Black & Red Ware)	GW (Gray Ware)	GRW (Gray & Red Ware)	Other Ware [b]
Total [c]	3087	215	125	629	797	48
Percentage	62.99%	4.39%	2.55%	12.83%	16.26%	0.98%

[a] Sub categories are counted under their major category.

[b] 01 sherd of Fine Ware, 10 sherds of Brown Ware 11 sherds of Painted Brown Ware, 21 sherds of Polished Brown Ware and 05 sherds of RBW (Red & Brown Ware) are counted as Other Ware category.

[c] Total number of sherds unearthed at SIT 07 is 4901 and the total weight is 34,080gms (34.080kg).

Table J-3C. Major categories of sherds unearthed at SIT 7

Context	Diagnostic Rims (DR)		Non-Diagnostic Rims (NDR)		Decorated Bodysherds (DB)		Non-Decorated Bodysherds (NDB)	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
01	01	01	15	156	10	76	137	576
02	13	372	47	648	19	220	183	962
04	09	310	83	1198	37	562	529	2230
08	08	352	33	470	19	306	142	806
09	23	992	83	1310	109	828	729	2726
10	15	522	58	640	124	880	592	2116
11	06	352	25	250	44	482	170	878
12	12	392	23	288	159	1154	258	1262
20	42	850	35	280	113	808	246	1203
21	39	1240	30	260	178	1756	194	1082
23	04	72	03	12	46	576	20	146
30	07	146	07	72	13	102	44	224
31	06	134	18	126	19	186	122	488
Total	185	5735	460	5710	890	7936	3366	14699
Percentage	3.77%		9.39%		18.16%		68.68%	

Table J-3D. Rimsherds analyses at SIT 7

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form In.	Rim Form St.	Rim Form Ex.	Surface Treatment In.	Surface Treatment Ex.	Temper Sand	Temper Mica	Temper Quartz	Temper Other	Type of Vessel
02	p-82	02	12	0.5	0.8	-	-	√	-	-	-	√	√	limestone	*hattiya*
04	p-86	02	16	0.8	2.8	-	-	√	-	-	√	√	√	limestone	*hattiya*
09	p-87	02	22	1.0	2.4	√	-	-	-	-	-	√	√	limestone	*hattiya*
09	p-88	02	18	0.4	1.8	-	-	√	-	polished	-	√	√	limestone	*tatiya*
11	p-89	02	16	0.5	1.5	-	√	-	-	-	-	√	√	-	*hattiya*
05	p-83	02	32	0.7	1.9	√	-	-	painted	painted	√	√	√	limestone	*tatiya*
05	p-84	02	22	0.7	1.4	√	-	-	painted	-	√	√	√	-	*tatiya*
05	p-85	02	16	0.6	1.6	√	-	-	polished	-	√	√	√	-	*hattiya*
06	p-80	02	28	0.8	1.5	-	√	-	-	polished	√	√	-	-	*hattiya*
06	p-81	02	14	0.8	1.2	√	-	-	-	-	√	√	-	limestone	*hattiya*
07	p-71	02	24	0.4	1.3	-	-	√	painted	painted	√	√	√	-	*hattiya*
07	p-72	02	24	0.8	1.8	√	-	-	polished	painted	√	√	√	-	*tatiya*
07	p-73	02	16	0.6	1.6	√	-	-	-	-	√	√	-	limestone	*hattiya*
07	p-74	02	18	0.7	1.7	√	-	-	painted	painted	√	√	√	limestone	*hattiya*
07	p-76	04	18	0.5	1.0	-	-	√	-	polished	√	√	-	-	*tatiya*
07	p-77	04	24	0.6	1.2	√	-	-	painted	-	√	√	-	-	*tatiya*
07	p-78	04	28	0.7	1.5	-	-	√	painted	-	√	√	√	-	*tatiya*
07	p-79	04	14	0.5	1.0	-	-	√	polished	painted	√	√	√	-	*tatiya*
10	p-104	04	14	0.6	1.8	-	-	√	-	-	√	-	√	-	*tatiya*
10	p-105	04	28	0.8	2.2	-	-	√	-	-	√	-	√	-	*tatiya*
10	p-106	04	28	0.5	1.4	-	-	√	-	-	√	√	√	limestone	*tatiya*
10	p-107	04	22	0.5	1.2	-	-	√	-	-	√	-	√	-	*tatiya*
10	p-108	04	20	0.7	2.3	√	-	-	-	-	-	√	√	limestone	*tatiya*
01	p-134	08	28	0.7	2.5	-	-	√	-	-	√	√	-	limestone	*nebiliya*
01	p-135	08	28	0.9	2.6	-	-	√	-	-	√	√	-	gravel	*tatiya*
01	p-136	08	28	0.7	1.2	-	-	√	-	-	√	√	-	gravel	*tatiya*
01	p-137	08	34	1.2	2.2	-	-	√	-	-	√	√	-	gravel	*tatiya*

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
01	p-138	08	28	0.8	1.8	-	-	√	-	-	√	√	-	limestone gravel	*tatiya*
02	p-158	08	24	0.4	1.3	-	-	√	painted	-	√	√	-	limestone	*tatiya*
02	p-159	08	14	0.6	1.4	-	-	√	-	painted	√	√	√	-	*muttiya*
02	p-160	08	36	1.0	2.2	-	√	-	-	painted	√	√	-	limestone gravel	*tatiya*
03	p-174	09	22	0.5	1.4	-	-	√	painted	painted	√	√	-	limestone	*tatiya*
03	p-175	09	20	0.5	2.2	-	-	√	-	-	√	√	√	-	*haliya*
03	p-176	09	22	0.7	1.6	-	-	√	-	painted	√	√	√	-	*nebiliya*
03	p-177	09	16	0.6	1.4	-	-	√	polished	-	√	√	-	limestone gravel	*tatiya*
03	p-178	09	20	0.7	1.2	-	-	√	-	-	√	√	-	limestone	*tatiya*
03	p-179	09	20	0.7	2.2	√	-	-	-	-	-	√	-	limestone gravel	*tatiya*
03	p-181	09	14	0.5	0.9	-	-	√	-	-	√	√	-	limestone gravel	*muttiya*
04	p-167	09	22	0.6	2.8	√	√	-	-	painted	√	√	-	limestone gravel	*haliya*
04	p-168	09	20	0.4	1.2	√	-	-	painted	-	√	-	√	limestone	*tatiya*
04	p-169	09	24	0.5	1.3	-	-	√	-	polished	√	√	√	limestone	*tatiya*
04	p-170	09	16	0.5	1.5	-	-	√	painted	painted	√	√	-	limestone gravel	*atiliya*
04	p-171	09	20	0.4	2.5	-	-	√	-	-	√	√	√	-	*haliya*
04	p-172	09	14	0.7	1.5	-	-	√	painted	painted	√	√	-	-	*muttiya*
05	p-139	09	12	1.0	2.2	-	-	√	painted	painted	√	√	√	limestone gravel	*tatiya*
05	p-140	09	16	0.6	1.4	-	-	√	-	polished	√	√	-	-	*muttiya*

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
05	p-141	09	12	0.4	1.0	-	-	√	-	polished	√	√	-	limestone	*muttiya*
05	p-142	09	16	1.0	3.2	√	-	-	-	-	√	√	√	limestone gravel	*muttiya*
05	p-143	09	14	0.7	1.3	-	√	-	polished	painted	√	√	√	limestone	*kalaya*
05	p-144	09	12	0.4	1.0	-	√	-	-	-	√	√	-	-	*muttiya*
05	p-145	09	18	0.6	1.1	-	-	√	painted	-	√	√	-	-	*tatiya*
07	p-123	10	38	0.8	2.1	-	-	√	-	-	√	√	√	limestone	*koraha*
07	p-124	10	32	0.8	1.8	-	-	√	painted	-	√	√	-	limestone	*muttiya*
07	p-125	10	16	0.6	1.8	-	-	√	-	painted	√	-	√	gravel	*kalaya*
07	p-126	10	22	0.5	1.6	-	-	√	painted	painted	√	√	-	limestone	*kalaya*
07	p-127	10	22	0.5	2.0	√	-	-	-	painted	√	√	-	-	*kalaya*
07	p-128	10	12	0.6	1.0	-	-	√	-	-	√	-	√	limestone	*kalaya*
07	p-129	10	12	0.8	1.4	√	-	-	-	polished	√	√	-	limestone	*kalaya*
07	p-130	10	22	0.4	1.4	√	-	-	-	polished	√	√	-	-	*baraniya*
06	p-146	09	16	0.5	1.5	-	-	√	painted	painted	√	√	√	gravel	*kalaya*
06	p-149	09	22	0.4	1.9	-	-	√	polished	painted	√	√	√	limestone	*kalaya*
08	p-147	10	22	0.4	2.1	√	-	-	-	-	√	√	-	limestone	*haliya*
08	p-148	10	16	0.6	0.9	-	√	-	-	-	√	√	-	-	*muttiya*
08	p-150	10	24	0.8	1.5	-	-	√	-	painted	√	√	-	limestone gravel	*baraniya*
08	p-151	10	24	0.7	1.8	-	√	-	painted	painted	√	-	-	limestone gravel	*atiliya*
08	p-152	10	32	0.8	2.3	√	-	-	-	-	√	√	√	limestone	*muttiya*
08	p-153	10	22	0.7	2.0	√	-	-	painted	painted	√	√	-	limestone	*atiliya*
08	p-154	10	14	0.5	1.1	√	-	-	painted	painted	√	-	√	limestone	*atiliya*
08	p-155	10	18	0.5	1.4	√	-	-	-	painted	√	√	-	limestone	*atiliya*

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
09	p-131	11	24	0.7	1.8	√	-	-	-	-	√	√	-	limestone	*baraniya*
09	p-132	11	20	0.5	1.1	-	-	√	painted	painted	√	√	-	limestone	Bowls/*Patra*
09	p-133	11	12	0.7	2.5	-	-	√	-	painted	√	√	-	limestone gravel	*muttiya*
10	p-182	11	34	0.7	2.7	-	-	√	painted	painted	√	-	√	limestone	*tatiya*
11	p-156	11	24	0.6	2.0	√	-	-	painted	painted	-	√	√	limestone gravel	*baraniya*
11	p-157	12	12	0.7	1.4	-	-	√	-	painted	√	√	-	limestone	*muttiya*
12	p-203	12	26	0.6	1.6	-	-	√	painted	painted	√	√	√	-	*appallaya*
12	p-204	12	26	0.5	1.3	√	-	-	painted	painted	√	√	-	limestone	*baraniya*
12	p-205	12	16	0.8	2.2	-	√	-	painted	-	√	-	√	limestone	*muttiya*
12	p-206	12	24	0.7	1.6	√	-	-	painted	painted	√	√	√	limestone	*tatiya*
12	p-207	12	22	0.5	1.5	√	-	-	painted	painted	√	√	-	limestone gravel	*tatiya*
12	p-208	12	20	0.5	0.8	√	-	-	painted	painted	√	√	√	limestone	Bowls/*Patra*
13	p-209	12	32	0.6	1.5	-	-	√	polished	-	√	-	-	limestone	*tatiya*
13	p-210	12	12	0.8	1.8	√	-	-	painted	painted	√	-	-	limestone gravel	*muttiya*
13	p-211	12	28	0.6	1.8	√	-	-	painted	polished	√	√	√	limestone	*appallaya*
13	p-212	12	24	0.6	1.1	-	-	√	painted	painted	√	-	√	limestone	*tatiya*
13	p-213	12	28	0.6	1.3	√	-	-	painted	painted	√	√	-	-	*tatiya*
13	p-214	12	18	0.5	1.6	-	√	-	painted	polished	√	√	√	limestone	*haliya*
13	p-218	12	14	0.8	2.2	√	-	-	-	painted	√	√	-	limestone	*muttiya*
13	p-217	12	16	0.8	1.8	√	-	-	-	-	√	-	√	limestone gravel	*muttiya*

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
01	p-(1)[a]	20	54	0.6	1.8	-	-	√	polished	-	√	√	-	limestone	*koraha*
01	p-(2)	20	12	0.6	1.8	√	-	-	painted	painted	√	√	-	limestone	*muttiya*
01	p-(3)	20	24	0.7	2.2	√	-	-	-	painted	√	-	-	limestone	*baraniya*
01	p-(4)	20	30	0.6	1.8	√	-	-	-	-	√	-	√	limestone	*tatiya*
01	p-(5)	20	46	0.8	1.7	√	-	-	painted	-	√	√	-	limestone	*koraha*
01	p-(6)	20	18	0.5	0.8	-	-	√	-	-	√	√	-	limestone	*muttiya*
01	p-(7)	20	16	0.5	1.4	√	-	-	polished	-	√	√	-	-	*tatiya*
01	p-(8)	20	20	0.6	1.9	-	-	√	painted	-	√	√	-	limestone	*muttiya*
01	p-(9)	20	22	0.9	1.4	√	-	-	painted	painted	√	√	√	limestone	*tatiya*
01	p-(10)	20	16	0.5	1.3	-	-	√	painted	painted	√	√	√	limestone	*tatiya*
01	p-(11)	20	46	1.0	1.7	-	-	√	-	-	√	√	√	limestone	*bujama*
01	p-(12)	20	38	1.1	1.5	-	-	√	polished	-	√	-	√	limestone	*bujama*
01	p-(13)	20	16	0.5	1.0	-	-	√	painted	-	√	-	√	limestone	*tatiya*
01	p-(14)	20	20	0.9	1.5	√	-	-	-	-	√	√	√	limestone	*tatiya*
01	p-(15)	20	44	0.8	1.9	-	-	√	-	-	√	√	-	limestone	*koraha*
01	p-(16)	20	22	0.4	1.3	√	-	-	painted	-	√	√	-	limestone	*muttiya*
01	p-(17)	20	40	0.6	1.8	√	-	-	painted	painted	√	√	-	-	*bujama*
01	p-(18)	20	16	0.6	1.3	√	-	-	-	-	√	√	-	limestone	*tatiya*
01	p-(19)	20	20	0.7	1.9	√	-	-	painted	painted	√	√	-	limestone	*tatiya*
01	p-(20)	20	22	0.9	1.9	√	-	-	polished	-	√	√	-	limestone	*baraniya*
01	p-(21)	20	22	0.6	1.3	√	-	-	painted	-	√	√	-	limestone	*tatiya*
02	p-(22)	20	22	0.9	1.5	√	-	-	painted	-	√	√	-	-	*muttiya*
02	p-(23)	20	38	0.7	2.1	√	-	-	painted	painted	√	√	-	limestone	*bujama*

[a] P number with parentheses were used for potsherds unearthed in 2005; eg. (p-01).

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
02	p-(24)	20	38	0.6	1.4	√	-	-	painted	-	√	√	-	limestone	*koraha*
02	p-(25)	20	16	0.7	1.7	√	-	-	-	-	√	√	-	limestone	*tatiya*
02	p-(26)	20	24	0.9	1.5	√	-	-	painted	-	√	√	√	limestone	*tatiya*
02	p-(27)	20	22	0.4	0.9	-	√	-	-	-	-	√	-	limestone	*tatiya*
02	p-(28)	20	16	0.8	1.3	-	-	√	painted	-	-	√	-	limestone	*haliya*
02	p-(29)	20	18	0.7	1.9	√	-	-	-	-	√	√	-	limestone	*haliya*
02	p-(30)	20	24	0.7	1.7	√	-	-	-	polished	√	√	-	limestone	*tatiya*
02	p-(31)	20	30	0.7	1.7	√	-	-	painted	painted	√	√	-	limestone	*tatiya*
02	p-(32)	20	54	0.7	1.4	-	-	√	-	-	√	√	-	limestone	*koraha*
02	p-(33)	20	22	0.5	1.5	√	-	-	polished	-	-	√	-	limestone	*tatiya*
02	p-(34)	20	26	0.5	1.0	-	-	√	-	-	√	√	-	limestone	*haliya*
02	p-(35)	20	44	0.5	1.1	-	-	√	-	-	√	-	-	limestone	*koraha*
02	p-(36)	20	22	0.9	1.9	√	-	-	polished	polished	√	√	-	limestone	*haliya*
02	p-(37)	20	38	0.4	1.4	-	-	√	polished	polished	√	-	-	limestone gravel	*bujama*
02	p-(38)	20	16	0.6	1.6	-	-	√	-	-	√	√	√	limestone	*haliya*
02	p-(39)	20	14	0.6	1.1	-	-	√	-	-	√	√	-	limestone	*haliya*
02	p-(40)	20	10	0.5	1.3	-	-	√	painted	-	√	√	-	limestone	*muttiya*
03	p-(41)	21	20	0.5	1.8	-	√	-	painted	polished	-	√	-	limestone	*tatiya*
03	p-(42)	21	18	0.6	2.1	√	-	-	painted	-	-	√	-	limestone	*haliya*
03	p-(43)	21	22	0.6	1.3	-	-	√	polished	-	√	√	√	limestone	*tatiya*
03	p-(44)	21	26	0.4	1.0	√	-	-	painted	painted	√	√	-	limestone	*baraniya*
03	p-(45)	21	24	0.7	1.9	√	-	-	polished	polished	√	√	-	limestone	*haliya*
03	p-(46)	21	24	0.9	1.7	√	-	-	painted	polished	√	√	√	limestone	*tatiya*
03	p-(47)	21	22	0.9	1.3	-	-	√	polished	polished	-	√	-	limestone	*haliya*

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form In.	Rim Form St.	Rim Form Ex.	Surface Treatment In.	Surface Treatment Ex.	Temper Sand	Temper Mica	Temper Quartz	Temper Other	Type of Vessel
03	p-(48)	21		0.6	1.6	√	-	-	-	polished	√	√	-	limestone	*haliya*
03	p-(49)	21		0.9	1.8	√	-	-	-	painted	√	√	-	-	*tatiya*
03	p-(50)	21		0.6	1.6	√	-	-	painted	-	√	√	-	limestone	*haliya*
03	p-(51)	21		0.8	1.1	-	-	√	-	-	√	√	-	limestone gravel	*tatiya*
03	p-(52)	21		0.7	1.6	√	-	-	painted	painted	√	√	-	limestone	*tatiya*
03	p-(53)	21	16	0.6	1.3	√	-	-	-	-	√	√	-	limestone	*haliya*
03	p-(54)	21		0.6	1.8	√	-	-	polished	polished	√	√	-	-	
03	p-(55)	21	30	0.3	1.7	√	-	-	polished	polished	√	√	-	limestone	*kundahattiya*
03	p-(56)	21		0.7	1.5	√	-	-	polished	polished	-	√	-	limestone	*tatiya*
03	p-(57)	21		0.6	0.9	-	-	√	-	-	-	√	-	limestone	*haliya*
03	p-(58)	21	24	0.9	0.9	-	-	√	-	-	-	√	-	limestone	*tatiya*
04	p-(60)	21	36	0.7	1.7	-	-	√	painted	-	√	√	√	limestone	*tatiya*
04	p-(61)	21		0.8	1.6	-	-	√	painted	-	√	√	-	limestone	*tatiya*
04	p-(62)	21	36	0.8	1.5	√	-	-	polished	-	√	√	√	limestone gravel	*tatiya*
04	p-(63)	21		1.1	1.6	√	-	-	painted	painted	√	√	-	limestone	*haliya*
04	p-(64)	21	18	0.8	1.5	-	-	√	painted	painted	√	√	-	limestone gravel	*tatiya*
04	p-(65)	21	20	1.0	1.5	√	-	-	painted	painted	√	√	√	limestone gravel	*baraniya*
04	p-(66)	21		0.8	2.5	√	-	-	-	-	√	√	√	limestone	*haliya*
04	p-(67)	21		0.5	1.1	-	-	√	polished	-	√	√	-	limestone	*tatiya*
04	p-(68)	21	22	0.7	1.8	√	-	-	-	-	√	√	√	limestone	*haliya*
04	p-(69)	21	24	0.5	1.2	-	-	√	-	-	√	√	-	limestone	*tatiya*
04	p-(70)	21	34	0.5	1.2	-	-	√	-	-	√	√	-	limestone	*tatiya*

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form In.	Rim Form St.	Rim Form Ex.	Surface Treatment In.	Surface Treatment Ex.	Temper Sand	Temper Mica	Temper Quartz	Temper Other	Type of Vessel
04	p-(71)	21	14	0.8	1.0	-	-	√	-	painted	√	√	√	limestone	*tatiya*
04	p-(72)	21	22	0.7	2.1	-	√	-	-	-	√	√	-	limestone	*tatiya*
04	p-(73)	21	20	0.4	1.3	√	-	-	polished	polished	√	√	-	limestone	*haliya*
04	p-(74)	21	18	1.0	1.3	-	-	√	-	-	√	√	√	limestone gravel	*haliya*
04	p-(75)	21	16	0.7	1.3	√	-	-	painted	painted	√	√	-	limestone	*tatiya*
04	p-(76)	21	14	1.0	1.6	√	-	-	painted	painted	√	√	-	limestone	*haliya*
04	p-(77)	21	36	0.6	1.3	-	-	√	painted	-	√	√	-	limestone	*tatiya*
04	p-(78)	21	24	0.5	1.8	√	-	-	painted	painted	√	√	-	limestone	*haliya*
04	p-(79)	21	32	0.5	1.8	√	-	-	painted	painted	√	√	-	limestone	*bujama*
04	p-(80)	21	26	0.7	1.8	√	-	-	painted	-	√	√	√	limestone	*baraniya*
05	p-(81)	21	26	0.6	1.9	√	-	-	painted	painted	√	√	-	limestone	*haliya*
05	p-(82)	21	22	0.5	0.7	-	-	√	painted	painted	√	√	√	limestone	*tatiya*
06	p-(83)	21	24	0.7	1.3	√	-	-	-	-	√	√	-	limestone gravel	*haliya*
06	p-(84)	21	22	1.0	1.2	-	-	√	-	-	√	√	-	limestone	*haliya*
07	p-(85)	31	20	0.6	2.1	√	-	-	-	-	√	√	-	limestone	*tatiya*
07	p-(86)	31	16	0.7	1.5	√	-	-	painted	painted	√	√	-	limestone	*atiliya*
07	p-(87)	31	14	0.6	1.6	√	-	-	-	-	√	√	-	limestone	*atiliya*
05	p-(88)	31	16	0.5	1.5	√	-	-	-	-	√	√	√	limestone gravel	*tatiya*
07	p-(89)	31	22	0.6	1.6	√	-	-	-	-	√	√	-	limestone	*tatiya*
07	p-(90)	31	14	0.6	0.8	√	-	-	-	-	√	√	√	limestone	*atiliya*
08	p-(91)	30	12	1.2	2.4	-	-	√	-	-	√	√	-	limestone gravel	*tatiya*
08	p-(92)	30	12	0.7	1.4	-	√	-	painted	-	√	√	-	limestone	*atiliya*

Table J-3D. Continued.

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
08	p-(93)	30	12	0.7	1.2	-	√	-	-	-	√	√	-	limestone	*atiliya*
08	p-(94)	30	20	0.5	1.8	-	√	-	-	polished	√	√	√	limestone	*tatiya*
08	p-(95)	30	16	0.6	1.4	-	-	√	-	-	√	√	√	limestone	*atiliya*
08	p-(96)	30	14	0.8	1.8	√	-	-	-	-	√	√	-	limestone	*tatiya*
08	p-(97)	30	22	0.5	1.3	√	-	-	-	-	√	√	-	limestone	*tatiya*

Table J-4A. Ware analyses at Vavala Vava iron smelting site (SIT 25)

Ware	Context 01		Context 03		Context 51	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
Red Ware (RW)	09	133	03	32	11	289
Percentage	39.13%		13.04%		47.83%	

Table J-4B. Quantity and percentage of major ceramic wares at SIT 25

Wares	RW (Red Ware)
Total	23
Percentage	100%

Table J-4C. Major categories of sherds unearthed at SIT 25

Context	Diagnostic Rims (DR)		Non-Diagnostic Rims (NDR)		Decorated Bodysherds (DB)		Non-Decorated Bodysherds (NDB)	
	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms	Quantity	Weight/gms
01	-	-	03	51	-	-	06	82
03	-	-	-	-	-	-	03	32
51	01	40	01	15	07	174	02	60
Total	01	-	04	-	07	-	11	-
Percentage	4.35%		17.39%		30.43%		47.83%	

Table J-4D. Rimsherds analyses at SIT 25

Bag #	Sherd #	Con #	O D cm	W T cm	L T cm	Rim Form			Surface Treatment		Temper				Type of Vessel
						In.	St.	Ex.	In.	Ex.	Sand	Mica	Quartz	Other	
01	p-184	51	12	0.7	1.2	√	-	-	-	-	-	-	√	limestone gravel	*tatiya*

APPENDIX K
TYPOLOGY OF POTTERY

The pottery typology (2004) I made for the SIT project mainly followed Bandaranayake's pottery typology of the Sigiriya Citadel (Bandaranayake 1984a) and Jayaweera's typology on the pottery wares found during the SARCP Project (Jayaweera 1992; 1993). As in these typologies, I also paid attention on form, function, size and orifice diameter of the vessels to build up this typology.

Bowls, pots, jars, lids, bases and strainers are the main pottery groups discovered during the SIT project. When we noticed slight variations in rims within the same category, these rims put into a new subtype and given a new number under the main category. I provide here, a brief description of these groups.

Group 1: Bowls

Tray bowls with and without rims are categorized under this type. They were divided into sub types: *kabala* and *kusalana* (Group A and Type 1-3 in Bandaranayake 1984a), *tatiya* (Group B and Type 6-10 in ibid.) and *patra* (Group H and Type 28 in ibid.) according to their size and diameter.

Type 1A 1 to 1A 3

Small bowls (*patra*) without rims have almost vertical neck. The necks slightly curve inwards. Their diameters measured between 20-24 cm are categorized under these types.

Type 2A 1 to 5H 1

Tray bowls (*tatiya*) with a neck and diameter in between 18-36 cm are considered in this sub type. 2A 1 and 2B 1 have almost vertical necks and 3A 1 to 3A 2 have slightly curve inward rims. 3A 3 to 3B 4 have curve outward rims. 4A 1 to 5H 1 are tray bowls that have curve outward rims. Among them, 4A 1, 4B 2, 5F 3, have deeply curve outwards rims. 4A 2 and 5H 1 have fairly vertical rims. Upper part of the rims in 5D 1, 5E 1 and 5G 1 sub types curve inward, the middle parts curve outward.

Group 2: Rice Strainers

Rice strainers with and without rims are categorized under this type. Their diameters measured between 22-54 cm. According to their size and form, they are divided into sub types: *nabiliya* and *koraha* (Type 16 in Bandaranayake 1984a).

Type 6A 1 to 7A 1

Rice strainers that have an orifice diameter in between 22-30 cm are categorized under these sub types. These small vessels can be identified as nabiliya type pottery is found in most habitation sites. All *nabiliya* type vessels were found at Kosgaha-ala-ulpotha settlement site (SIT 7). Rims of 6A 1, 6B 1 and 6C 1 slightly curve outwards, 7A 1 is a comparatively shallow vessel and its rim deeply curve outwards.

Type 8A 1 to 13A 1

Besides 10A 1 (Sub type 10A 1), all other vessels in these sub types belong to *koraha* type rice strainers. The orifice diameters of these types measured between 32-54 cm. Sub types 12A 1, 12A 2 and 13A 1 can be identified as being without rims. All other vessels in this category have rims. The Type 13A 1 is the only *koraha* type pottery (orifice diameter 53 cm) that came from the Dikyaya-kanda iron smelting site (SIT 22).

Group 3: Pots

Cooking Pots, Plain Pots and Water Pots are categorized under this type. Their diameters measured between 10-46 cm. According to their size and the form, cooking pots were divided into sub types: *hattiya* and *kundahattiya* (Group D and Type 15 in Bandaranayake 1984a);

atiliya/haliya, *appala* (Group E and Type 15 in ibid.); *kalagediya*, *muttiya, kotale* (Group F and Type 18-23 in ibid.).

Type 14A 1 to 15A 1 and 17A 1 to 17I 2

The orifice diameters of these types measured between 16-46 cm. Sub type 14C 1 is the vessel that has a largest orifice diameter (46cm). Besides 14A 1 (32cm), other larger vessel types (*appalaya* and *kundahattiya*) recorded in this type were unearthed from the SIT 22. The Vavala monastery site (SIT 6) and Kosgaha-ala-ulpotha settlement site (SIT 7) are rich in *atiliya/haliya* and *hattiya* sub types.

Type 18A 1 to 18B 2

Liquid storage *kalagediya* and *muttiya* type vessels are categorized under orifice diameters of these types measured between 16-46 cm. Sub type 14C 1 is the vessel that has the largest orifice diameter (46cm). Besides 14A 1 (32cm), other larger vessel types (*appalaya* and *kundahattiya*) recorded in this category were unearthed from the SIT 22. The Vavala monastery site (SIT 6) and the Kosgaha-ala-ulpotha settlement site (SIT 7) are rich in *atiliya/haliya* and hattiya sub types. The orifice diameters of these types measured between 12-16 cm. While 18A 1 was recorded at the monastery site (SIT 6), all other subtypes came from SIT 7.

Group 4: Jars

In this group of vessel the Body diameter comparatively differs a great deal from their orifice diameters. Mostly non-liquid storage vessels are commonly named as baraniya and bujama (Group G and Type 24-37 in Bandaranayake 1984a) under this group. Their diameters measured between 20-46 cm.

Type 16A 1 to 16D 6

Orifice diameters of these types measured between 20-38 cm. Sub type 16B 1 is the vessel that has the largest orifice diameter (38 cm). This type came from SIT 22. Besides vessels 16B 1, 16A 5 and 16D 5, all other vessel types were recorded from the Kosgaha-ala-ulpotha settlement site (SIT 7). Deeply inward curve rims and bodies in larger diameters are the main characteristic of these pottery types.

Type 16E 1 to 16H 6

Orifice diameters of these types measured between 36-46 cm. All vessels in these categories were identified as the *bujama* type. They were recorded at settlement sites. According to Jayaweera's classification (Jayaweera 1992), the type 16E 1 that came from SIT 7 is identified as the pottery type that represents the period before the 5th century AD. Those vessels have fairly straight rims and smaller diameters compared to those vessels of Type 16A 1 to 16D 6.

Group 5: Lids

This group is commonly named as *mudiya* and *karamudiya* (Group J and Type 30-38 in Bandaranayake 1984a). Their diameters measured between 12-24 cm.

Type 19A 1 to 19C 6

Orifice diameters of these types measured between 12-24 cm. While type 19A 1 and 19 B 1 were recorded at SIT 6, the type 19C 1 were recorded at SIT 22.

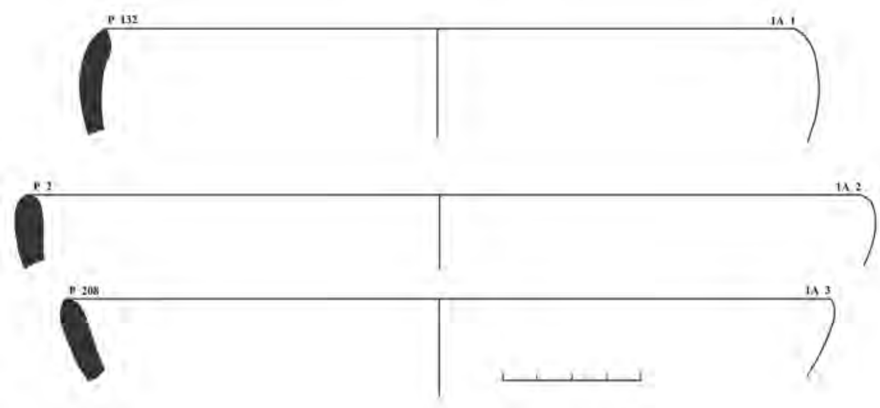

Figure K-1. Pottery typology (1A 1- 1A 3), Bowls (*patra*).

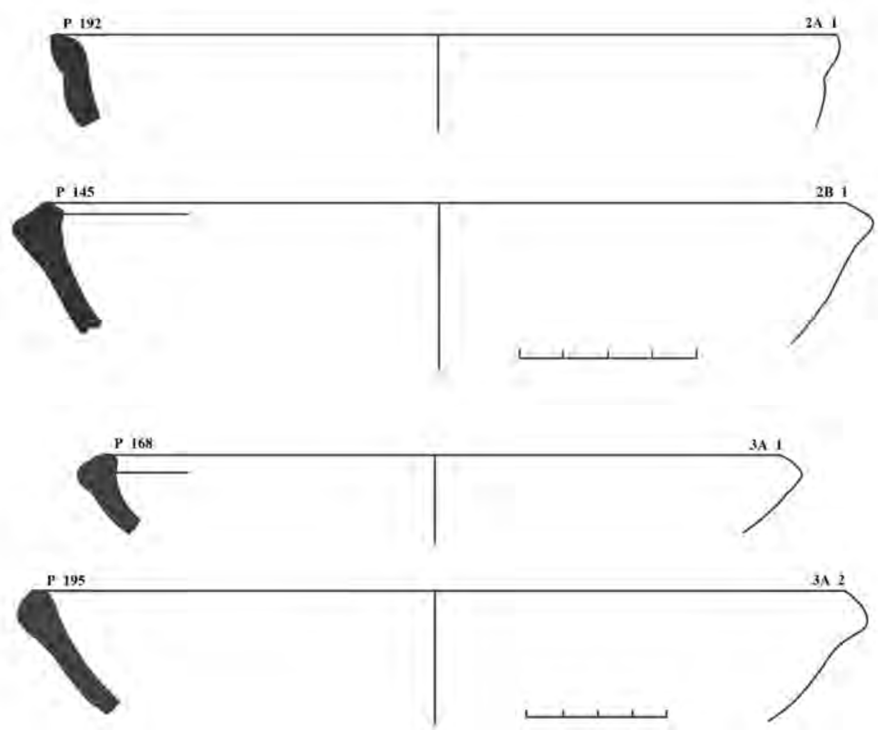

Figure K-2. Pottery typology (2A 1- 3A 2), Tray Bowls.

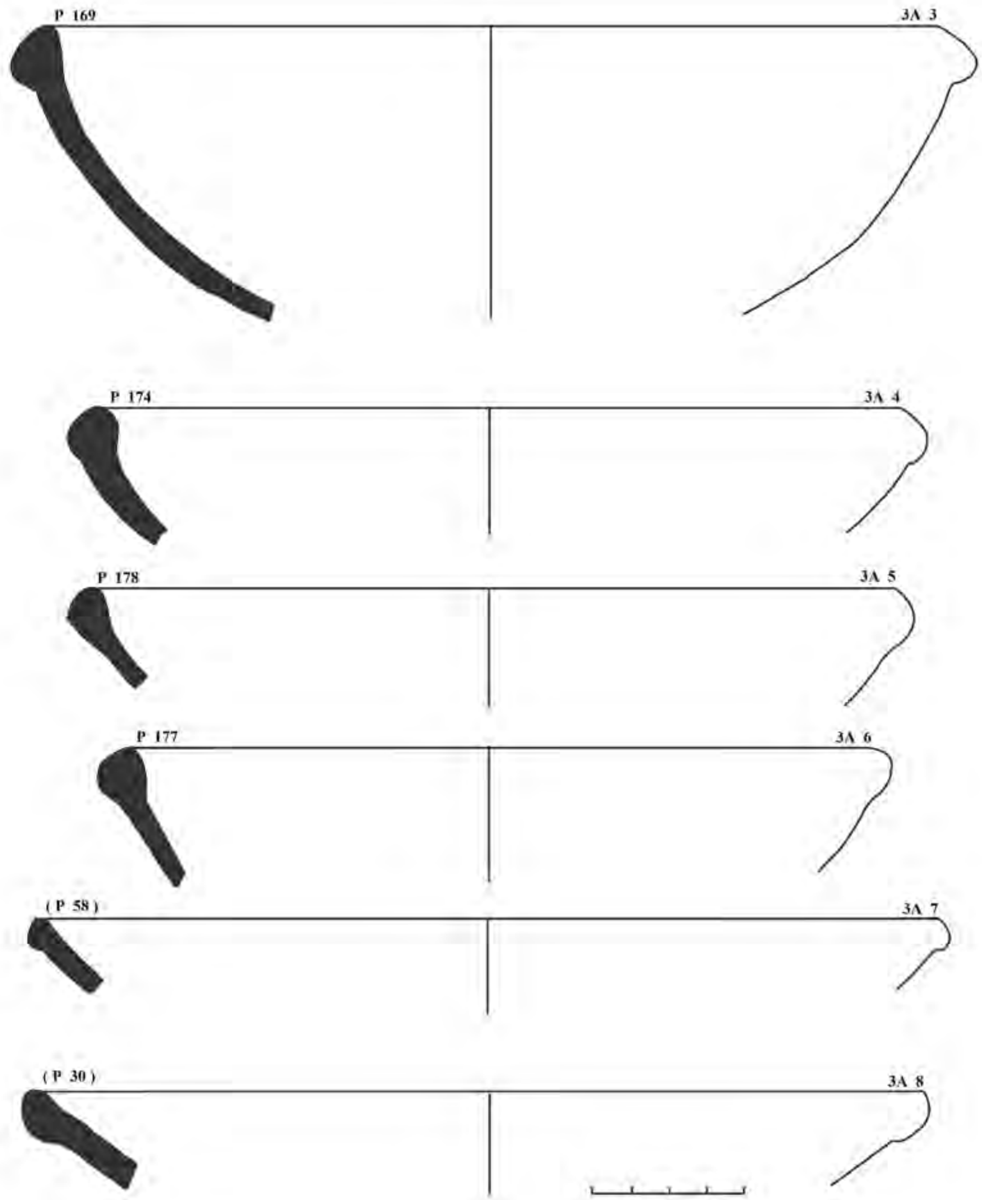

Figure K-3. Pottery typology (3A 3- 3A 8), Tray Bowls.

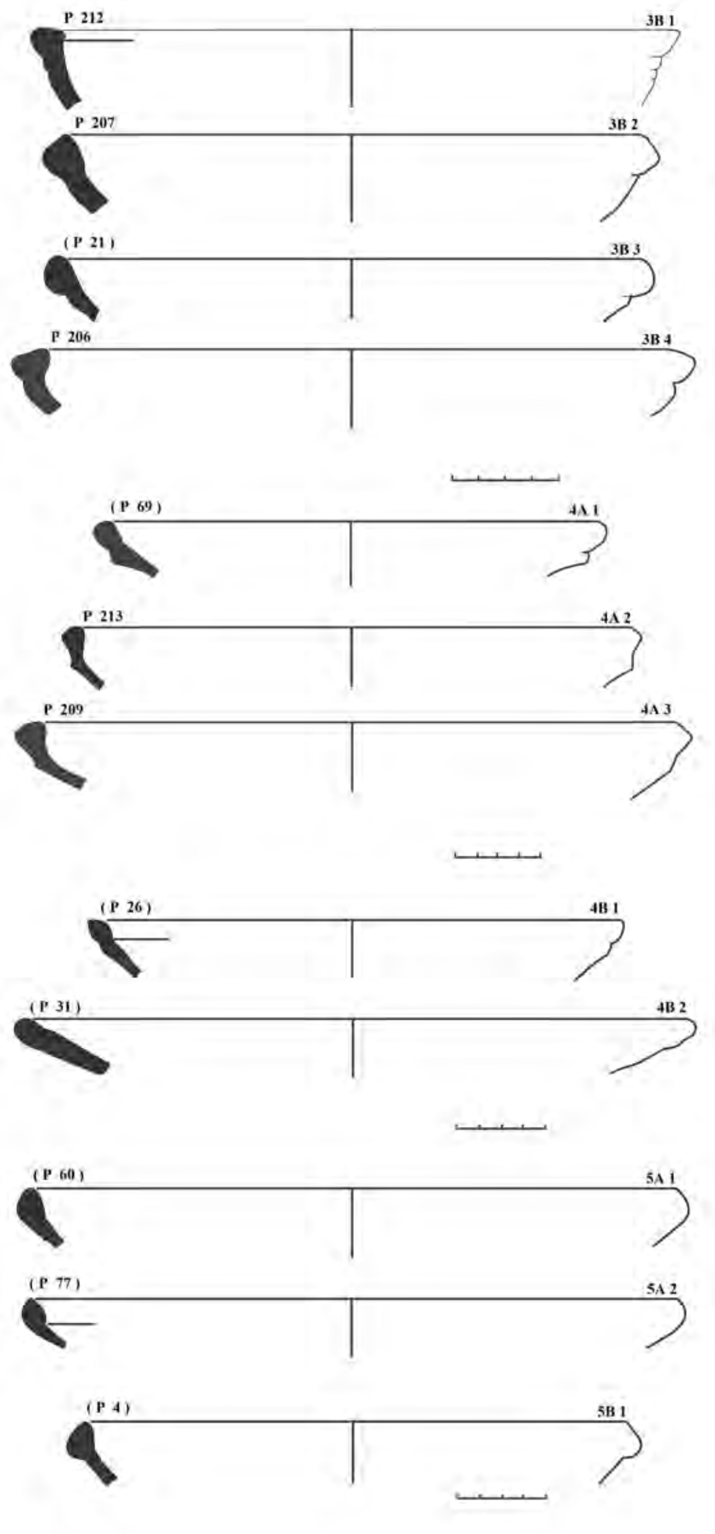

Figure K-4. Pottery typology (3B 1- 5B 1), Tray Bowls.

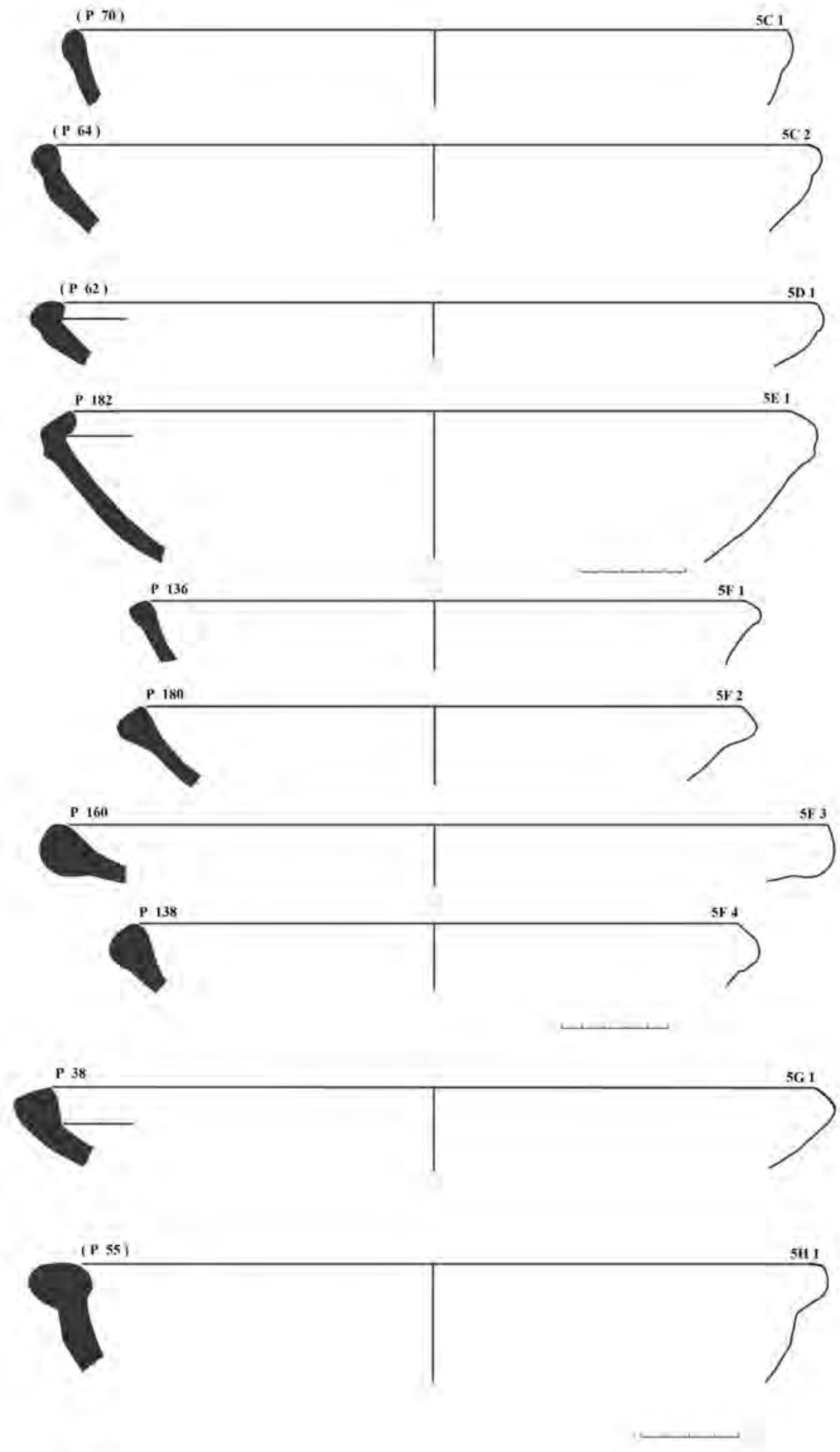

Figure K-5. Pottery typology (5C 1- 5H 1), Tray Bowls.

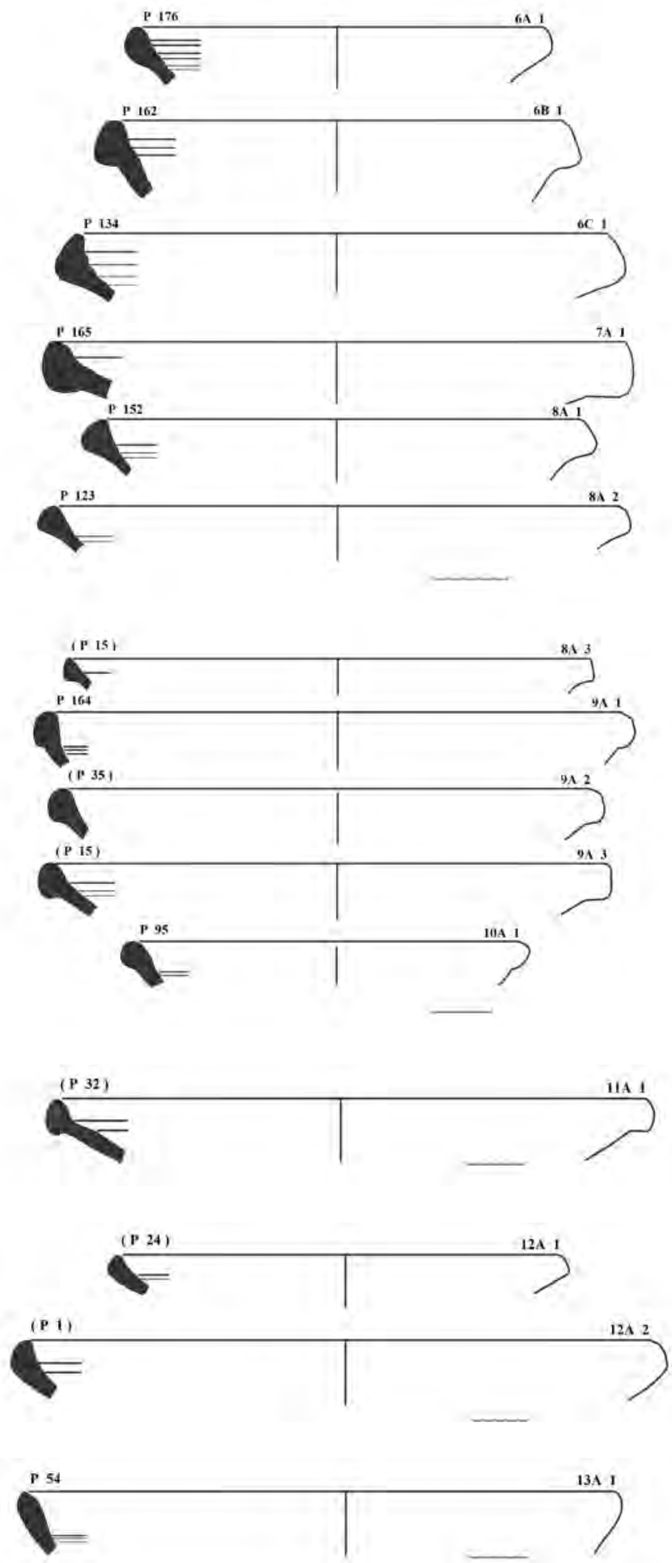

Figure K-6. Pottery typology (6A 1- 13A 1), Rice Strainers.

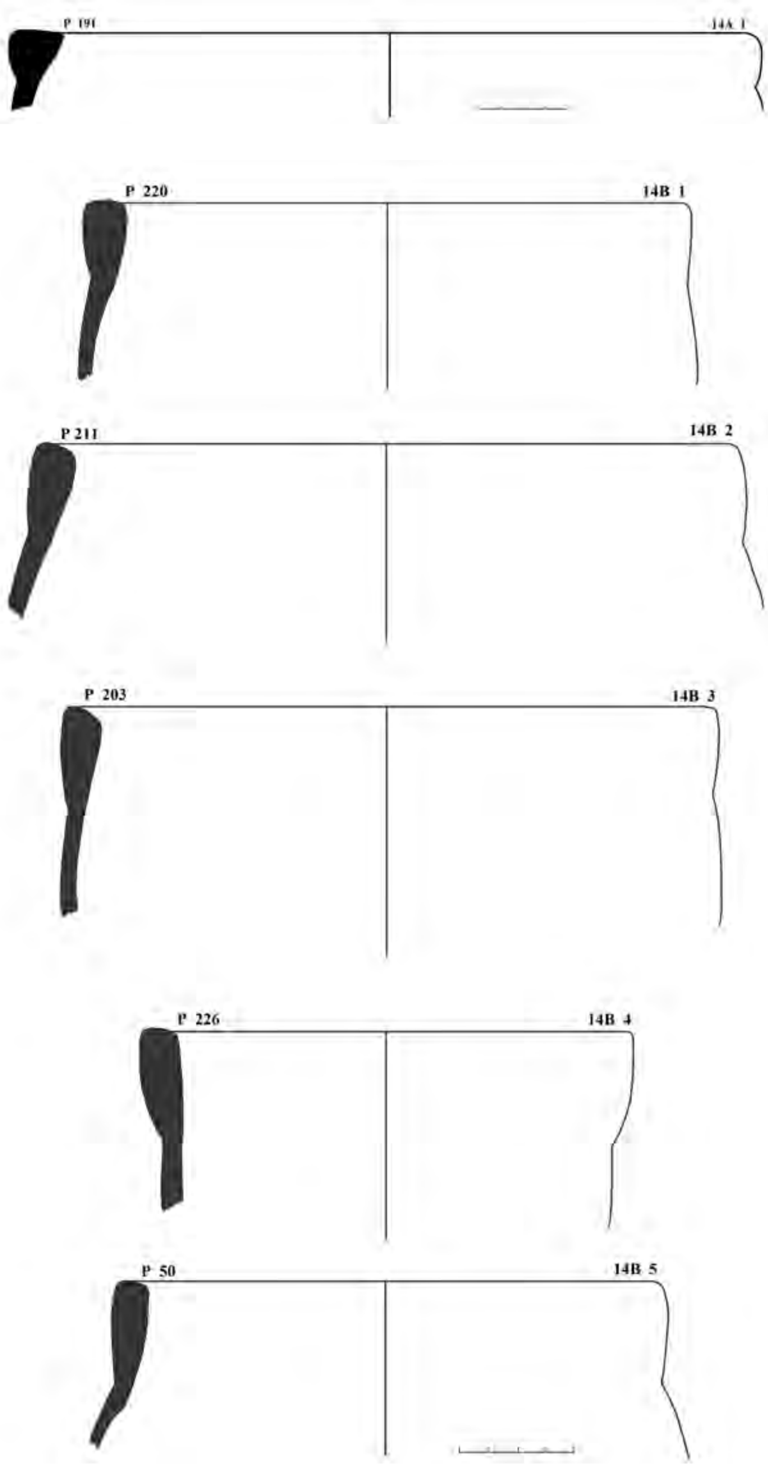

Figure K-7. Pottery typology (14A 1- 14B 5), Pots.

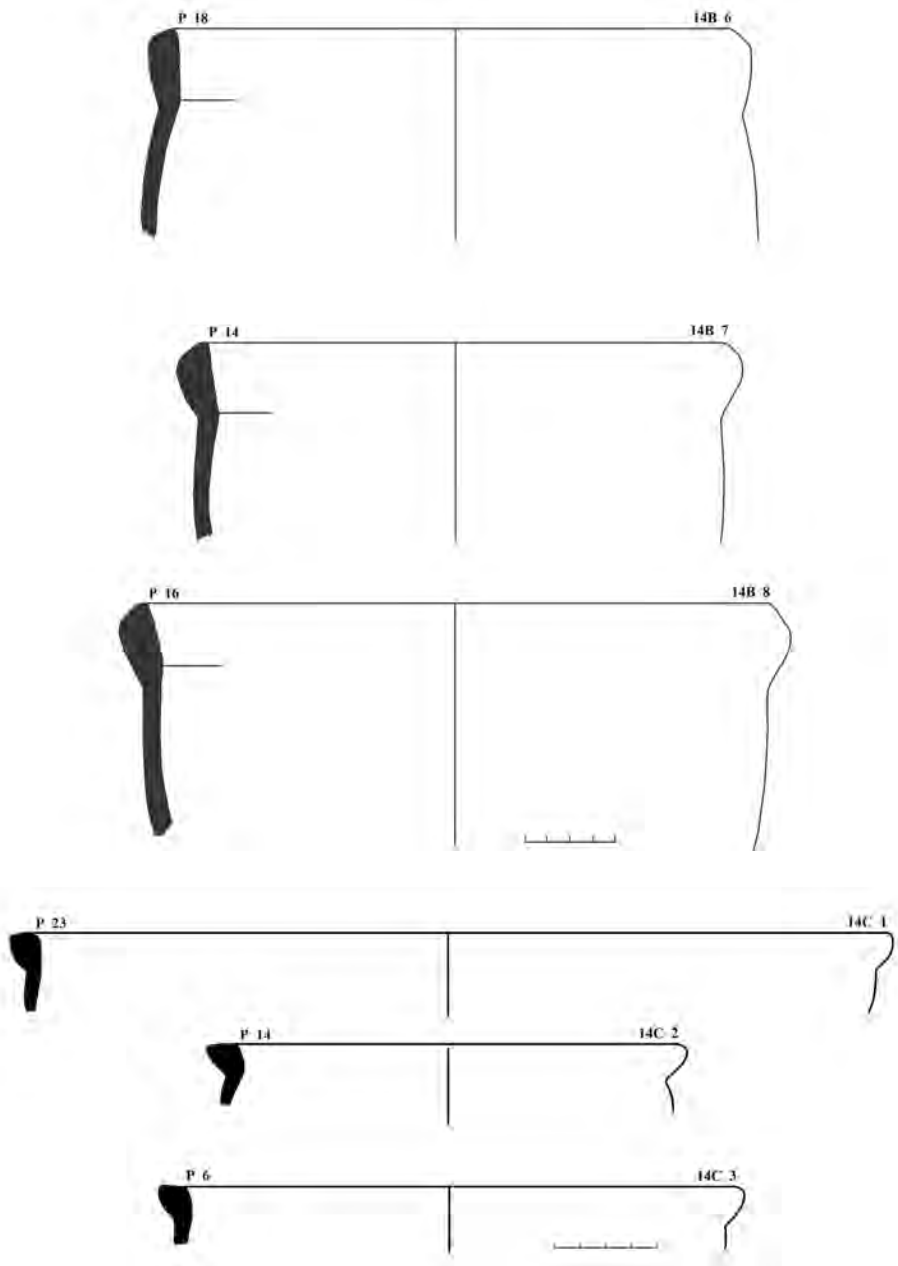

Figure K-8. Pottery typology (14B 6- 14C 3), Pots.

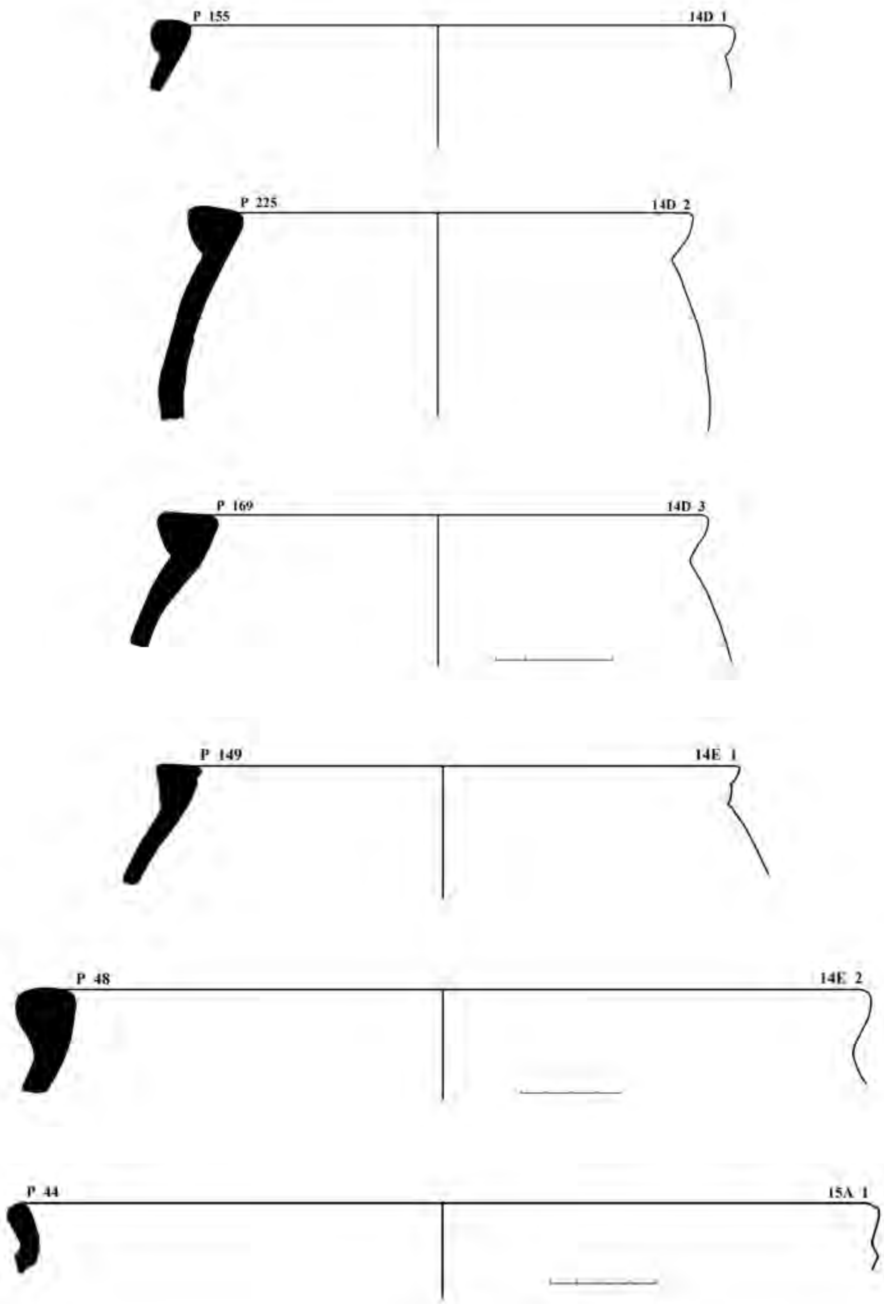

Figure K-9. Pottery typology (14D 1- 15A 1), Pots.

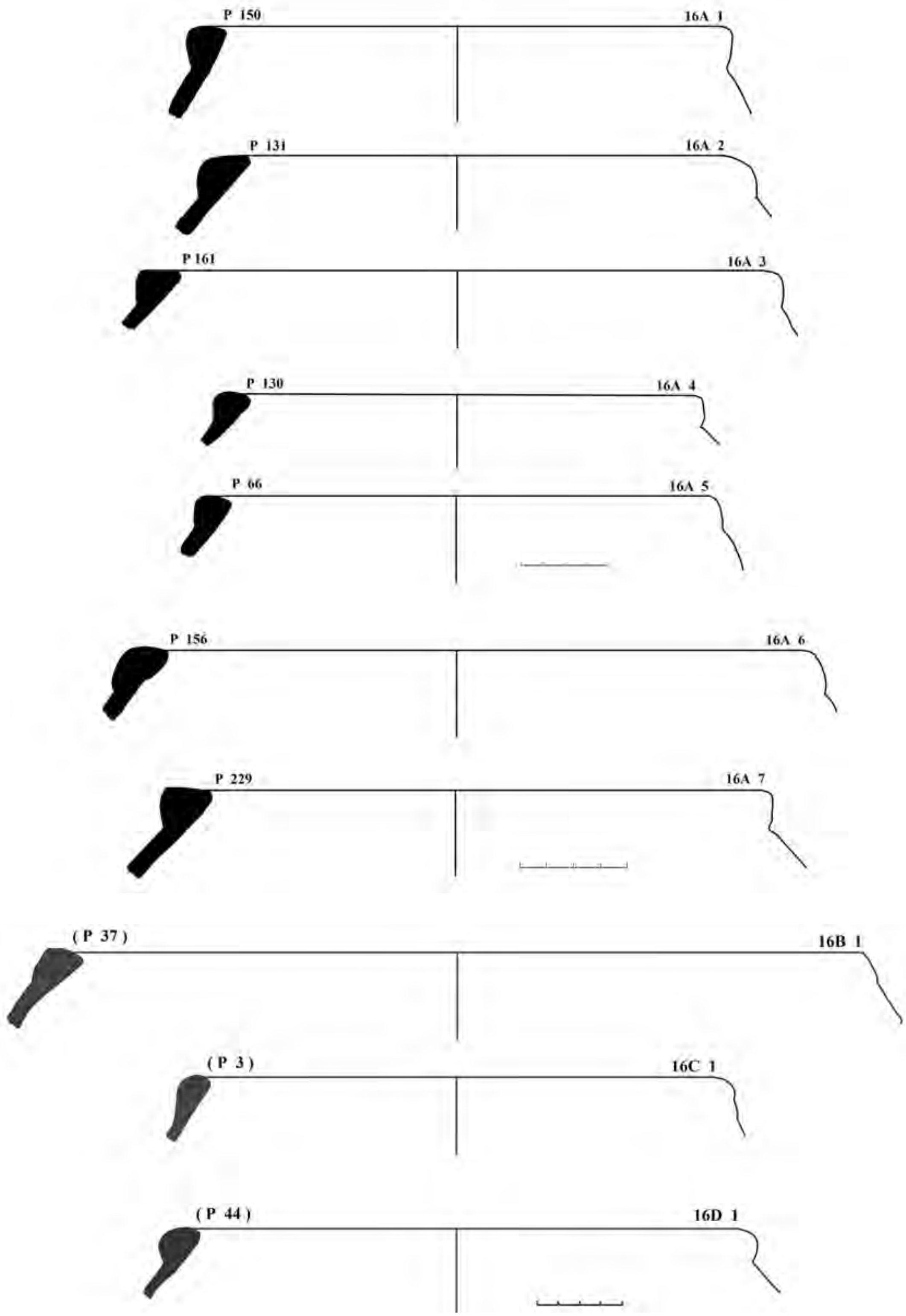

Figure K-10. Pottery typology (16A 1- 16D 1), Jars.

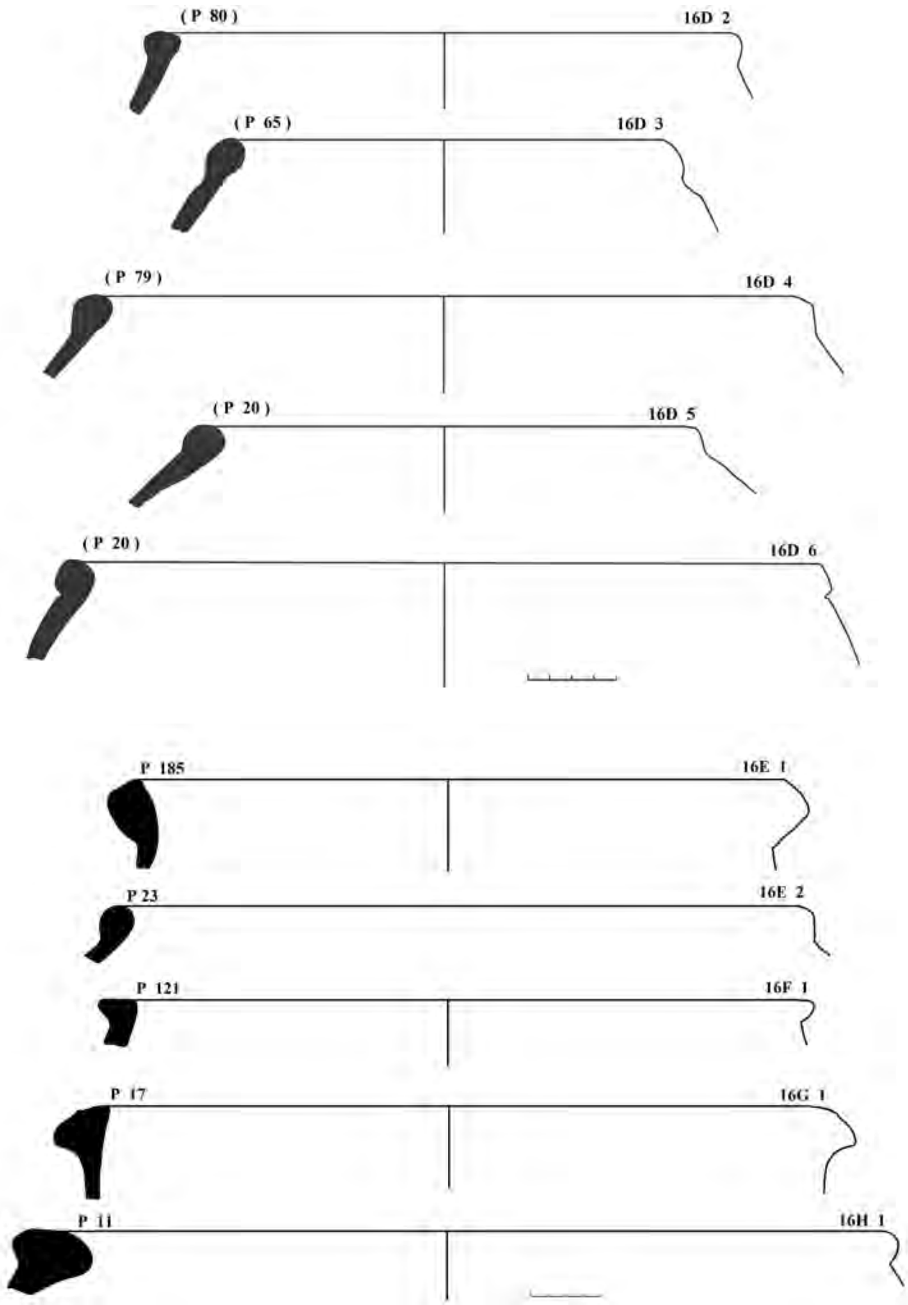

Figure K-11. Pottery typology (16D 2- 16H 1), Jars.

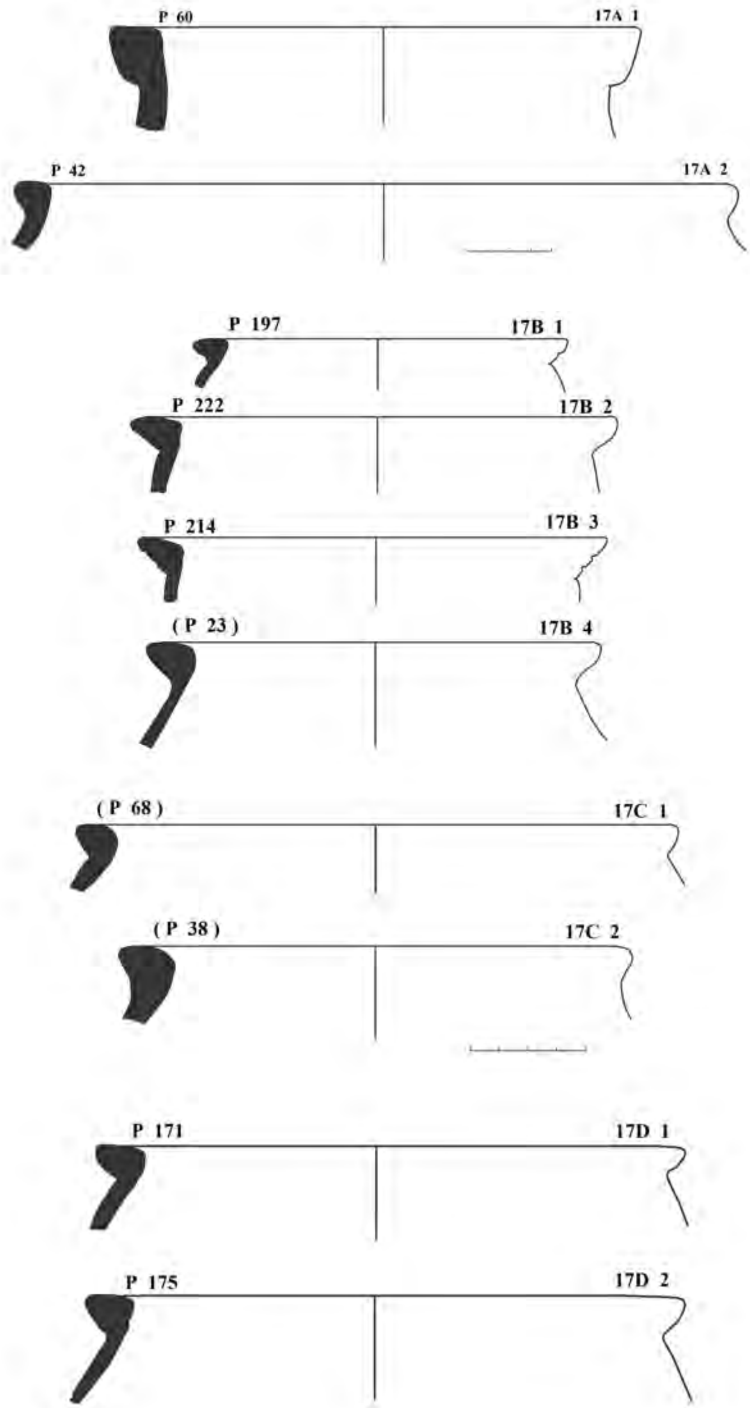

Figure K-12. Pottery typology (17A 1- 17D 2), Pots.

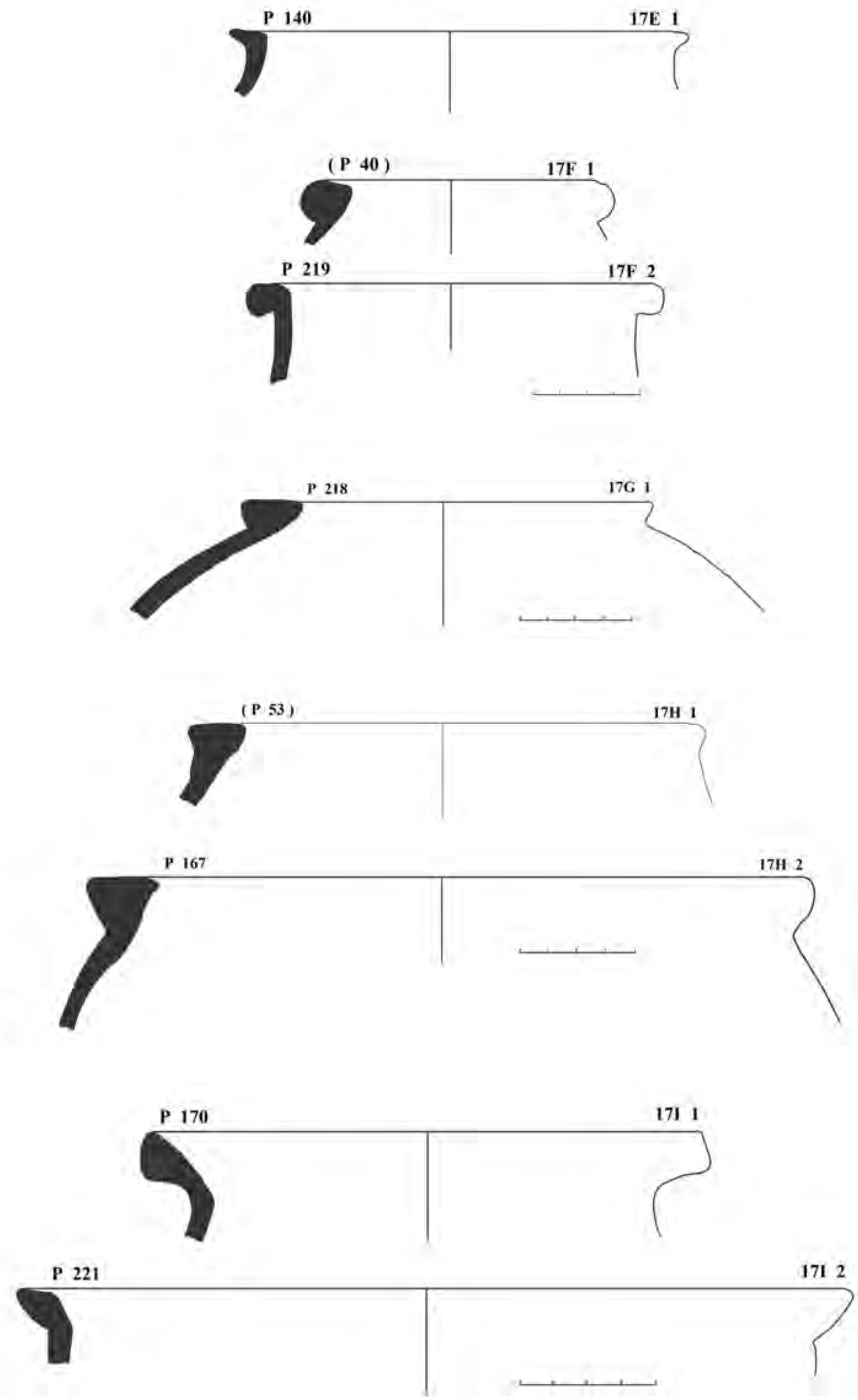

Figure K-13. Pottery typology (17E 1- 17I 2), Pots.

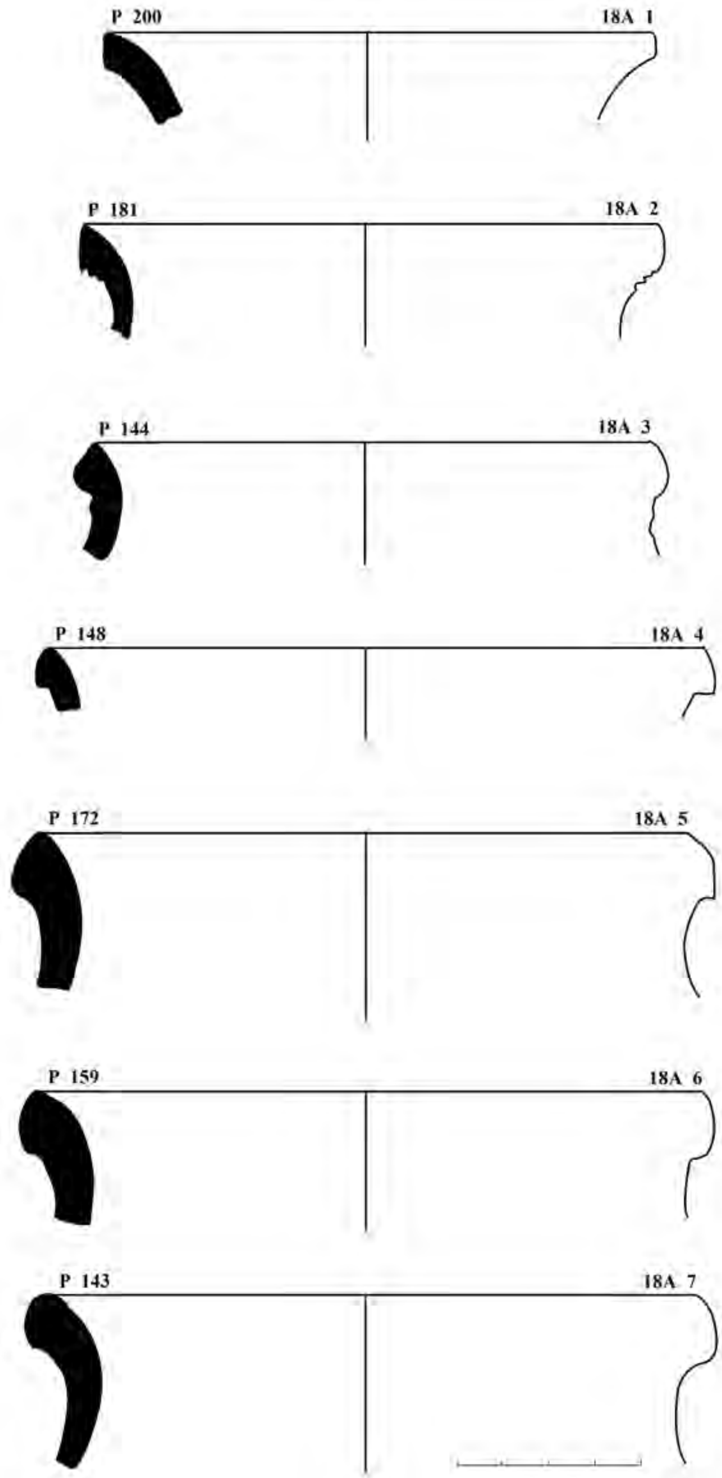

Figure K-14. Pottery typology (18A 1- 18A 7), Pots.

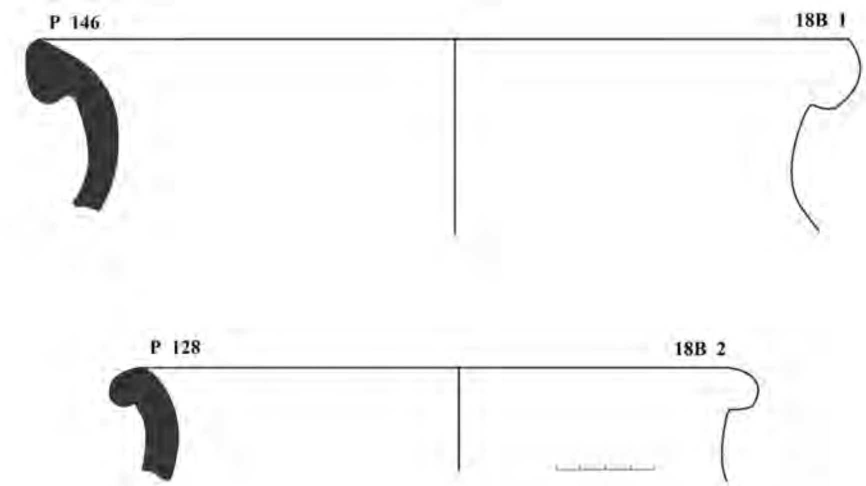

Figure K-15. Pottery typology (18B 1- 18B 2), Pots.

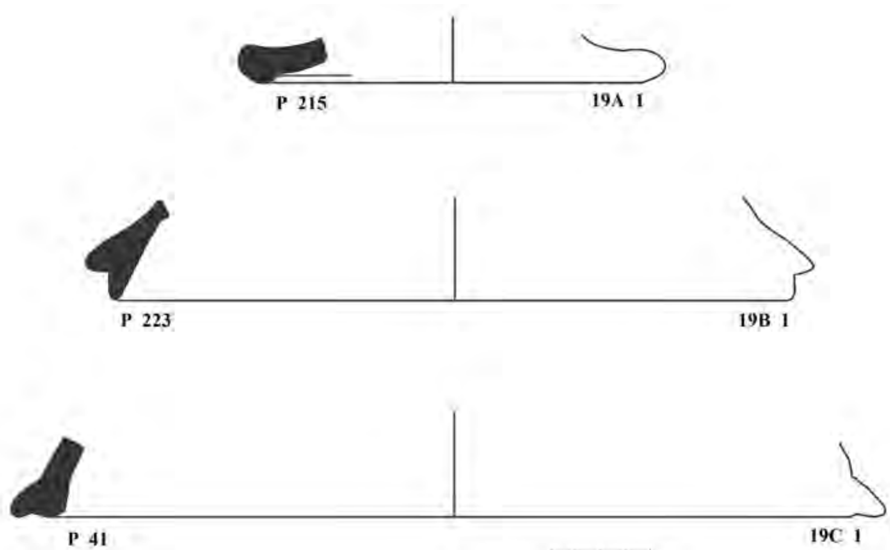

Figure K-16. Pottery typology (19A 1- 19C 1), Lids.

APPENDIX L
ROCK INSCRIPTION IN THE KOB

Vavala Vava Monastery Cave Inscription (Inscription # 01)

Period: 3rd century B.C. - 1st Century A.D.

Published: Sigiriya Cultural Triangle Project estampage No. E 9 (Ranawella in Bandaranayake 1982).

Figure L-1. Estampage of the cave inscription (Ins. No. 01) at *seenu-gala* (Bell Rock) (Ranawella in Bandaranayake 1984:210). Photograph of the inscription and its location are provided in Figure 6-14A and Figure 6-15.

Text

Damaguta teraha (lene)

Translation

(The cave) of the Damaguta Tero.

Vavala Vava Monastery Cave Inscription (Inscription # 02)

Period: 3rd century B.C. - 1st Century A.D.

Published: Sigiriya Cultural Triangle Project estampage No. E 8 (Ranawella in Bandaranayake 1984).

Figure L-2. Estampage of the cave inscription (Ins. No. 02) at *Amaragala lene* (Ranawella in Bandaranayake 1984:211). Photograph of the inscription and its location are provided in Figure 6-14B and Figure 6-15.

Text

Gapati Mohamita putaha Parumaka Amarasa dobatikana agata anagata catudi(sa) sagasa niyate.

Translation

(The cave) of two brothers (elder of the two being) Parumaka Amara son of Gapati (the householder) Mahamita is dedicated to the Sanga of the four quarters present and absent.

Vavala Vava Rock/Cave Inscription[1] (Inscription # 03)

Period: in August 10th regnal year of King Kithsirimevan (306 A.D.).

Published: Not Previously Published.

Figure L-3. Estampage of the rock inscription (Ins. No. 03) that is located on a rock boulder at one of the caves at Vavala Monastery. The inscription has three lines in 4.62m length and 0.6m width. It was carved just outer limit of the cave (Figure 7-16A). The location is provided in Figure 7-14C and Figure 7-15. Photograph of this estampage is provided by Dr. Malini Dias.

Text

1. Siddham [!] Sarimekavaṇa Aba maha raja cata legitaka dasa avanaka vasahi Nikamaṇiya cada puṇamesi dutiye paka divasa Kara Cudaka Sumana vaviya Dakapedi gamahi vasana Jeṭa Sonadevayaha guha-
2. –(pavata ca) Lekiya Nakaye vevakubara ca vayadevi Lekiya Sivayaha (vapi)…
3. Siyariyaha ca kubara Butiya veva saga aba vaṭitaye devamaha maha pala…….

Translation

1. Prosperity! On the second day of the fortnight of the waxing moon in the month of Nikiṇi in the tenth regnal year of King Siri Meghavanṇṇa Abhaya, the reservoir of Kara Cudaka S(u)mana, the (rock) cave of Chief Sōnadeva, living at Dakapedi gama,
2. The reservoir and paddy field of Scribe Nᾱga, the reservoir of elderly Scribe Siva,
3. The paddy field of Siyariya, the reservoir of Bhūti, were given (by us) for the maintenance of the monks' residence. The great merit…….

Remarks

The king mentioned here is Siri Meghavanna Abhaya, son of King Mahᾱsen. The script was written in later Brahmi of the first decade of the fourth century AD and old Sinhalese language.

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[1] This inscription was read and translated by Dr. Malini Dias for this research. It is not previously published. But mentioned on SARCP publication in 1990 (Manatunga 1990). It was previously read by Dr. Benille Priyanka for Manatunga 1990 (pers. Comm.).

Vavala Vava Cave Inscription (Inscription # 04)

Period: 3rd century B.C. - 1st Century A.D.

Published: Estampage No. 8 (Kodituwakku 2006:47).

Figure L-4. Estampage of the cave inscription (Ins. No. 04) at *Mangala lene* (Mangala Cave) (Kodituvakku 2006). Location of the inscription is provided in Figure 6-14B.

Text

1. Abha (Raku)vika jigataya va
2. Bharasha………………….. sha puta nava……

Translation

1. (The cave) of Abha (Raku)vika's daughter and Nava
2. the son of Bharasha……(is dedicated to the Sanga).

Remarks

This inscription was written from right to left. Therefore it has to be read from right to left (Kodituwakku 2006). Original reading of the inscription was in Sinhalese language. I made this translation for this study.

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