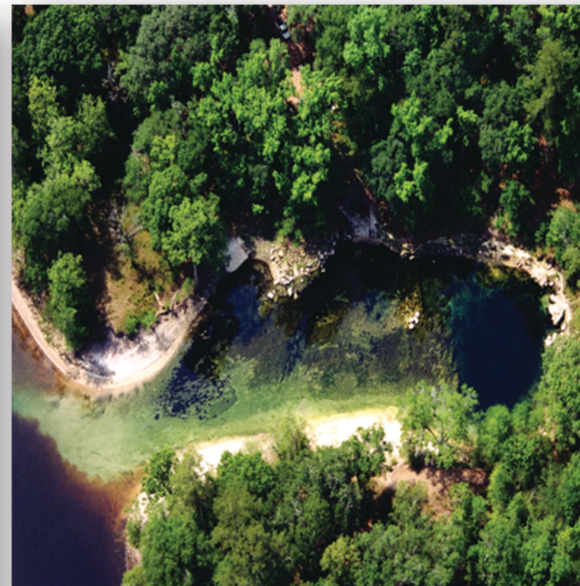
Florida Spring Classification System and Spring Glossary

FLORIDA GEOLOGICAL SURVEY

SPECIAL PUBLICATION NO. 52

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STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL PROTECTION
David B. Struhs, *Secretary*

DIVISION OF RESOURCE ASSESSMENT AND MANAGEMENT
Edwin J. Conklin, *Director*

FLORIDA GEOLOGICAL SURVEY
Walter Schmidt, *State Geologist and Chief*

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FLORIDA SPRING CLASSIFICATION SYSTEM AND SPRING GLOSSARY

Compiled by Rick Copeland

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PREFACE

FLORIDA GEOLOGICAL SURVEY

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The Florida Geological Survey, Division of Resource Assessment and Management, Department of Environmental Protection, is publishing as Special Publication No. 52, *Florida Spring Classification System and Spring Glossary*, compiled by Rick Copeland.

The publication is a result of the Florida Springs Initiative. It introduces a spring classification system and glossary for use by the citizens of the state of Florida. Hopefully, the classification system, as well as the glossary, will assist Floridians in improving their overall understanding of the springs of the state and increase the consistency in the usage of commonly used terms associated with our springs. The information will be useful for the citizens, including the academic, scientific, and engineering communities of the state.

Walter Schmidt, Ph.D.
State Geologist and Chief
Florida Geological Survey

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Florida Spring Classification System and Spring Glossary

Compiled by Rick Copeland, PG 126

Introduction and Background

In May 2002, a Florida springs workshop was held in Ocala, Florida. It was sponsored jointly by the Hydrogeology Consortium, the Florida State University, and the Florida Geological Survey (FGS). The purpose of the workshop was to provide a forum to facilitate discussion among scientists, resource managers and the public regarding the significance of springs as valuable natural systems. Springs must be preserved and protected for the benefit of the ecology, environment, economic well being, and quality of life in the state of Florida.

The workshop was divided into three panels: (1) Inventory of Springs in Florida, (2) Delineation of Springshed Boundaries, and (3) Measures for Protecting and Managing Florida Springs. Invited speakers discussed aspects of each panel theme and each panel later split into breakout sessions to discuss the issues further. Finally, each panel made recommendations to the larger group regarding panel themes. The workshop proceedings (DeHan, 2002) were published by the Florida Geological Survey in compact disk format.

Included among the recommendations of the "Inventory of Springs in Florida" panel was the need for the development of consistent terms as applied to spring usage in Florida and the development of a spring database. The FGS agreed to take the lead in the development of both.

As a result of recommendations from Panel 1, the FGS agreed to form a committee to address spring nomenclature and to develop and maintain a spring database to be used by the citizens of Florida. The purpose of this document is to present the results of the deliberations of the nomenclature committee. A document describing the spring database will be prepared and published separately.

The Florida Springs Nomenclature Committee (FSNC) was formed in the fall of 2002 and was made up of representatives from the FGS, the U.S. Geological Survey, the state's water management districts, the state university system, the hydrogeological consultant community, and the general public. The FSNC met on September 24, 2002, on the University of Florida campus in Gainesville. Thereafter, members communicated with each other via e-mail throughout the fall of that year. The committee consisted of:

Rick Copeland, Florida Geological Survey, Chairman of the FSNC
Kyle Champion, SDII Global Inc.
Angela Chelette, Northwest Florida Water Management District
Tom Greenhalgh, Florida Geological Survey
Eric DeHaven, Southwest Florida Water Management District

Dave DeWitt, Southwest Florida Water Management District
Tim Hazlett, Hazlett-Kincaid Inc.
David Hornsby, Suwannee River Water Management District
Brian Katz, U.S. Geological Survey
Todd Kincaid, Hazlett-Kincaid Inc.
Gary Maddox, Florida Department of Environmental Protection
Jon Martin, University of Florida
Harley Means, Florida Geological Survey
Doug Munch, St. Johns River Water Management District
Tom Pratt, Northwest Florida Water Management District
Tom Scott, Florida Geological Survey
William Shirling, Citizen
Rick Spechler, U.S. Geological Survey
David Toth, St. Johns River Water Management District
Sam Upchurch, SDII Global Inc.
Warren Zwanka, Suwannee River Water Management District

In addition to developing a glossary of terms, the FSNC also identified the need to develop a spring classification system. The purpose of the classification system is to allow the citizens of Florida to easily classify springs into one of a minimum number of categories. It is hoped that the classification system, as well as the glossary, will assist Floridians in improving their overall understanding of springs and to increase consistency in the usage of terms associated with Florida's springs.

The following proposed spring classification system and spring glossary were developed by the FSNC. They are offered as provisional working models to be tested by Florida's citizens, with special emphasis on the hydrogeologic community.

Florida Spring Classification System

The proposed classification system is based on an assumption that karst activities have influenced almost all springs in Florida. Thus the system is based on geomorphology. Because of the simplicity of the system, the use of spring descriptors is encouraged. Hopefully, the system will be simple to use and will allow all springs in Florida to be categorized with little confusion.

Under the proposed system, all springs in Florida can be classified into one of four categories, based on the spring's point of discharge. Is the point of discharge a vent (see glossary) or is it a seep (see glossary), and is the point of discharge located onshore or offshore? Since all springs are either vents or seeps, the classification can be simplified into the following.

Vent	**Seep**
Onshore	**Onshore**
Offshore	**Offshore**

Spring throat opening size is an extremely important characteristic of Florida springs. The FSNC defines a spring vent (see glossary) as an opening that concentrates ground-water discharge to the Earth's surface, including the bottom of the ocean. The opening is significantly larger than that of the average pore space of the surrounding aquifer matrix. As an example, a vent occasionally is considered to be a cave and ground-water flow from the vent is typically turbulent. On the other hand, a spring seep (see glossary) is one or more small openings in which water discharges diffusely (or "oozes") from the ground-water environment. The diffuse discharge originates from the intergranular porous spaces in the aquifer matrix. Flow is typically laminar.

FSNC members believe that chemical and flow characteristics of groundwater discharging from offshore springs are typically very different from those discharging onshore. The point of discharge of an onshore spring is landward of the mean low-tide level, while the point of discharge of an offshore spring is considered to be seaward of the mean low tide-level.

Regarding water chemistry, offshore springs typically have different chemical characteristics than do onshore springs. As an example, concentrations of total dissolved solids are significantly higher in groundwater discharging from offshore springs, as compared to those located onshore (Champion and Starks, 2001; Scott et al., 2002).

With regard to the volume of ground-water flow, the effects of ocean tides influence the discharge characteristics of offshore springs more than they do onshore springs. For example, the discharge of groundwater from the offshore vents associated with the Spring Creek Springs Group in Wakulla County can vary considerably, depending on the tide stage. Ground-water discharge is significantly greater during low tide, as compared to high tide. In fact, in some of the vents during high tide, water can actually reverse flow (Lane, 2001; Rosenau et al., 1977). Although tides influence the discharge and stage of certain onshore springs, compared to offshore springs the influences are relatively minor.

It should be reiterated that, because of the simplicity of the proposed system, descriptors should be used whenever possible when classifying a spring. Table 1 depicts examples.

Florida Spring Glossary

Glossary Introduction

The FSNC believes that only a minimum number of terms should be included. Most definitions used in the glossary were either taken or modified from the following resources: (1) the Lexicon of Cave and Karst Terminology with Special Reference to Environmental Karst Hydrology (Field, 1999), (2) the Dictionary of Geological Terms by the American Geological Institute (AGI) (Bates and Jackson, 1984), (3) the Sinkhole Glossary (SDII Global Corporation, 2002), and (4) Glossary of Karst Terminology

(Monroe, 1970). On occasion other sources were used and are noted in the glossary. Often, the FSNC made its own definition, or modified definitions from the other sources. If a definition was generated or significantly modified by the committee, it appears in the glossary as (FSNC, 2003).

Table 1. Florida's Spring Classification System

SPRING		
	Onshore	**Offshore**
Vent	*Onshore Vent* Examples Karst spring Resurgence (River Rise) Estavelle (intermittent resurgence or exsurgence) Subaqueous riverine vent Subaqueous lacustrine vent Sand boil	*Offshore Vent* Examples Offshore karst spring Unnamed offshore vent Offshore estavelle vent
Seep	*Onshore Seep* Examples Subaerial riverine seep Subaqueous lacustrine seep	*Offshore Seep* Examples Unnamed offshore seep Offshore estavelle seep

Special Terms

The FSNC believes the meanings of key spring terms and an understanding as to how they differ are extremely important for the hydrogeology community in its efforts to better appreciate the dynamics of Florida's springs. These **special terms** (underlined in the glossary) are listed below in alphabetical order:

karst window,
offshore spring,
onshore spring,
seep (or spring seep),
spring,
spring group,

spring magnitude,
spring run,
springshed (or spring recharge basin), and
vent (or spring vent).

Glossary

alluvial sinkhole – An alluvial sinkhole is an ancient or relict sinkhole (paleosinkhole) that has been filled with soil and/or sediment. It may or may not have a surficial expression. See also *paleosinkhole* and *relict sinkhole* (SDII Global Corp., 2002).

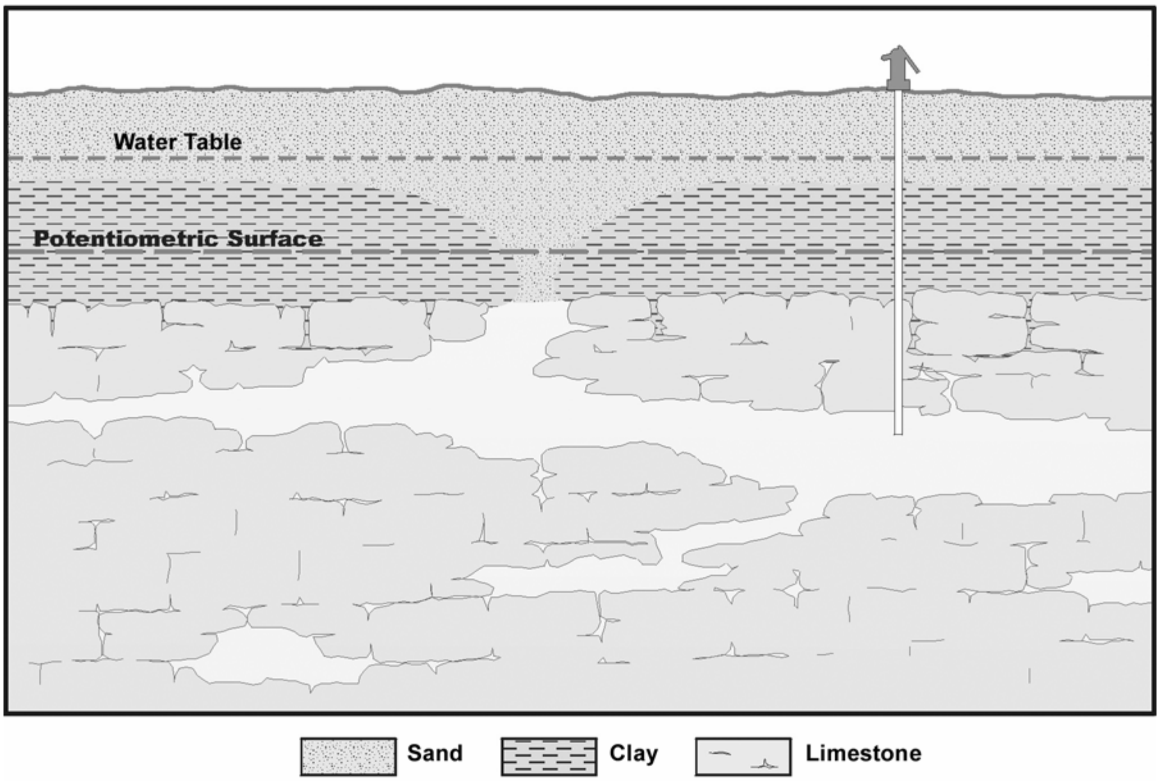

Figure 1. Alluvial Sinkhole
(Modified from SDII Global Corp., 2002)

artesian – A modifier that describes a condition in which the potentiometric surface is above elevation of the top of the aquifer (Modified from Field, 1999). It is synonymous with *confined*.

aquifer – A body of soil, sediment, or rock that is saturated with water and sufficiently permeable to allow production of water from wells (SDII Global Corp., 2002).

blind valley – A stream valley that terminates abruptly at a sinkhole, swallow hole, or swallet (where the stream disappears underground) (SDII Global Corp., 2002).

caliche – See *duricrust*.

cave – A natural underground opening or series of openings and passages large enough to be entered by an adult person (Modified from Monroe, 1970).

cavern – A cave or conduit system with larger than average size that has been created by the dissolution of limestone or other soluble rock (SDII Global Corp., 2002).

cavernous porosity – A pore system having large, cavernous openings; the lower size limit, for field analysis, is practically set at approximately the smallest opening that an adult person may enter (Field, 1999).

"chimney" sink – A cover-collapse sinkhole that forms near a vertical shaft or "chimney", typically developing where bedrock is near land surface.

These features are common in the Gainesville area of Florida (Modified from SDII Global Corp., 2002).

collapse sinkhole – A type of sinkhole formed by collapse of the cover materials (soil, sediment, or rock) into an underground void created by the dissolution of limestone or dolostone. See *rock- collapse sinkhole* and *cover-collapse sinkhole* (SDII Global Corp., 2002).

conduit; karst conduit – Large dissolutional voids, including enlarged fissures and tabular tunnels.

In some usage, the term is restricted to voids that are water-filled. Conduits may include all voids greater than 10 mm (one cm) in diameter, but another classification scheme places them between arbitrary limits of 100 mm to 10 m. Whichever value is accepted in a particular context, smaller voids are commonly termed subconduits (Field, 1999).

conduit flow; karst conduit flow – Underground water flow within conduits. Conduit flow is generally turbulent, but can also be laminar (Field, 1999).

confined – See *artesian*.

cover – Materials consisting of soil, sediment, or rock that overlies the soluble rock (limestone, dolostone etc.) in a karst terrane.

In Florida, the cover includes the sand and clay deposits that overlie the limestone (Modified from SDII Global Corp., 2002).

cover-collapse sinkhole – A sinkhole formed by cover materials (sand, clay, etc.) raveling into a void in the underlying limestone (Modified from SDII Global Corp., 2002).

cover-subsidence sinkhole – A collapse sinkhole that forms when the upper surface of the limestone is dissolved away, and the cover materials slowly subside to occupy the space once occupied by limestone.

Voids may not be well developed in cover-subsidence sinkholes because of the continued downward movement of cover materials. See also *solution sinkhole* and *sag depressions* (SDII Global Corp., 2002).

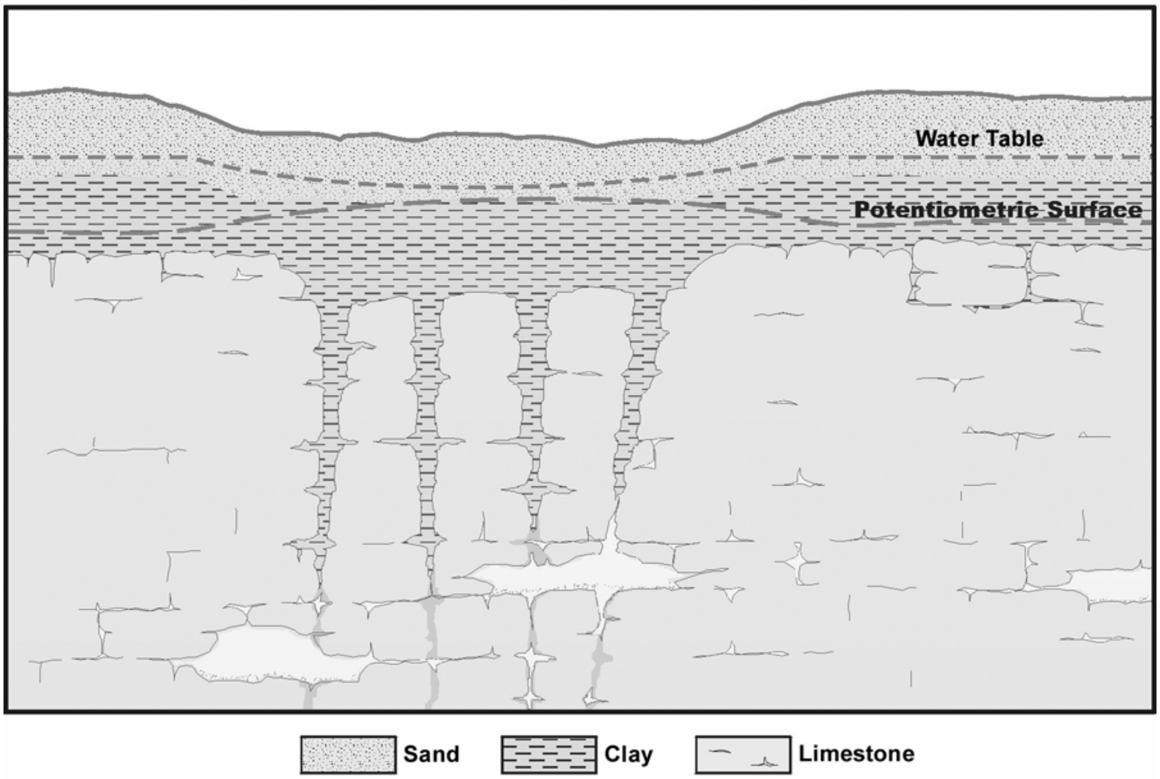

Figure 2. Cover-Subsidence Sinkhole
(Modified from SDII Global Corp. , 2002)

diffuse flow – Ground-water flow conditions that are generally slow-moving, may be laminar (Reynolds number much less than 1.0), has uniform discharge, and a slow response to storms (Modified from Field, 1999).

discharge – The rate of flow at a given instant in terms of volume per unit of time (Modified from Bates and Jackson, 1984). It is synonymous with flux.

doline – A bowl- or funnel-shaped hollow in limestone topography, ranging in diameter from a few meters to a kilometer, and in depth up to several hundred meters (Modified from Monroe, 1970). A doline is synonymous with *sinkhole*.

dolostone – A sedimentary rock composed predominantly of the mineral dolomite ($Ca,Mg(CO_3)_2$). While soluble, dolostone is less likely to contain well developed karst features than limestone (Modified from SDII Global Corp., 2002).

duricrust – A deposit of precipitated minerals, mainly calcite, formed in the soil or near-surface layers in arid or semi-arid zones at the horizon where ascendant capillary water evaporates and salts held in solution are deposited.

In Florida, seasonal rainfall and intense evaporation may form similar semi-concreted soils within the epikarst (Modified from Field, 1999).

epikarst – **1**. The zone of weathering that penetrates the upper surface of a limestone stratum. Weathering of limestone results in development of rubble, fine-grained, carbonate-rich silt, clay, and karren (including pinnacles and valleys in the limestone rock surface) (Modified from SDII Global Corp., 2002). **2**. An intensely dissolved zone consisting of an intricate network of intersecting roofless, dissolution-widened fissures, cavities, and tubes dissolved into the uppermost part of the carbonate bedrock.

The dissolution features in the epikarst zone are organized to move infiltrating water laterally to down-gradient seeps and springs or to collector structures such as shafts that conduct the water farther into the subsurface (Huntoon, 2002).

estavelle – **1**. A spring that reverses flow because of relative changes in the elevation of ground-water potentials and stream stage (SDII Global Corp., 2002). **2**. An intermittent spring resurgence or exsurgence, active only in wet seasons (Modified from Field, 1999).

Generally, an estavelle is located near streams or rivers. When the water level of the stream is high (e.g. during flood stage), surface water directly recharges the aquifer.

exsurgence – A spring or seep in karstic terrane not clearly connected with swallets (or *ponors*) at a higher level (Field, 1999).

fissure – Any discontinuity within the rock mass that is either initially open or capable of being opened by dissolution to provide a route for water movement.

Fissures in this sense, applied generally in karst, therefore include the primary sedimentary bedding planes as well as tectonic faults and joints. More specifically, the term has been used to describe voids with an average width dimension of 10 to 100 mm (Modified from Field, 1999).

fracture – Cracks formed in soils, sediment or rocks by natural stresses.

In Florida, many fractures have been developed to relieve stress caused by Earth tides (SDII Global Corp., 2002). It is synonymous with *joint*.

fracture trace – A confirmed pattern observed through remote sensing (aerial photography or satellite imagery) that owes its origin to jointing or fracturing in the underlying soils, sediments, or bedrock. See *photolineament* (SDII Global Corp., 2002).

grotto – A cave chamber or room preceded by a narrower passage (Modified from Field, 1999).

joint – See fracture.

karren – Features that develop on the upper surface of a limestone or other soluble rock as it is weathered.

These features are prevalent in the Quilin area in China and in western Ireland. In Ireland they are sometimes referred to as burren. In Florida, karren are usually buried under the cover materials and consists of pinnacles and depressions in the rock surface. The depressions may or may not be related to sinkhole activity (Modified from SDII Global Corp., 2002).

karst – A term describing landforms that have been modified by dissolution of soluble rock (limestone or dolostone) (Modified from SDII Global Corp., 2002).

karst terrane – A terrane, generally underlain by limestone or dolostone, in which the topography is chiefly formed by the dissolution of rocks, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves (FSNC, 2003).

karst window – **1**. A depression opening that reveals portions of a subterranean flow, or the unroofed portion of a cave (a vertical window). **2**. An opening in natural limestone walls, formed by the joining of subterranean karst grottos as a result of dissolution processes (a horizontal window). Both terms are modified from Field (1999).

Note also that the FSNC believes that flow through an exposed conduit in the aquifer is different from flow onto the Earth's surface. For this reason, the FSNC does not consider a karst window to be a spring. It is an exception to the definition of a spring (See *spring*).

karstic aquifer – An aquifer containing soluble rocks with a permeability structure that includes abundant interconnected conduits dissolved from the host rock.

The interconnected conduits are organized and facilitate the circulation of fluid in the down-gradient direction, wherein the permeability structure evolved as a consequence of dissolution by fluid (Modified from Huntoon, 1995).

laminar flow – Flow in which the head loss is proportional to the first power of velocity.

Water flowing in a laminar manner will have streamlines that remain distinct and that flow direction at every point remains unchanged with time. Darcy's Law strictly applies under laminar flow conditions only (Modified from Field, 1999).

limestone – A sedimentary rock primarily composed of the mineral calcite ($CaCO_3$). Limestone is soluble and often develops karst features when weathered (Modified from SDII Global Corp., 2002).

magnitude – See *Spring magnitude*.

nonartesian – A condition in which the upper surface of the zone of saturation forms a water table under atmospheric pressure.

The term is synonymous with *unconfined* (Field, 1999).

offshore spring – The point of discharge of the spring is seaward of the mean low-tide level (FSNC, 2003).

onshore spring – The point of discharge of the spring is landward of the mean low-tide level (FSNC, 2003).

overflow stream – A stream valley that is down gradient of a swallow hole, swallet, or blind valley and that carries water only when the recharge capacity of the swallow hole is exceeded.

In Florida, the term is sometimes used to identify an overflow, or paleo-overflow, stream valley (Modified from SDII Global Corp., 2002).

paleokarst – This term describes either an ancient karst terrane or the presence of features associated with an ancient karst terrane.

The term is used to describe old sinkholes and other karst features that are no longer actively forming. In west-central Florida, the term is used to refer to sinkholes that formed decades to millions of years ago and are no longer active (Modified from SDII Global Corp., 2002).

paleosinkhole – An ancient sinkhole that is no longer active.

See *relict sinkhole* and *alluvial sinkhole* (SDII Global Corp., 2002).

photolineament – A natural linear feature on the land surface that has been identified from aerial photographs or other images.

Photolineaments are identified by alignments within or between lakes and wetlands, sinkholes, stream segments, soils, and vegetation patterns. Photolineaments are also known as photolinears**.** Note that photolinears may or may not represent geologic features, so the term is not synonymous with fracture trace. See *fracture trace* (Modified from SDII Global Corp., 2002).

pipe – In karst terminology, it is a semi-circular conduit through which water and soil can pass.

Pipes are often nearly vertical and they have steep (nearly vertical) sides (SDII Global Corp., 2002).

polje – A large flat-bottom sinkhole complex formed by the coalescence of several smaller sinkholes.

Poljes are flat-bottomed because of subsequent sedimentation, usually by a lake. Payne's Prairie in Alachua County is an example (Modified from SDII Global Corp., 2002).

ponor – Hole in the bottom or side of a closed depression through which water passes to or from an underground channel (Field, 1999). It is synonymous with *swallow hole*.

raveling – Raveling is the process by which water transports soil particles downward into cavities in the underlying strata. Because sand is typically damp and the grains are angular, in Florida they do not easily ravel without moving water.

Because of their cohesiveness, clay-rich strata are more difficult to ravel than sandy soils (SDII Global Corp., 2002).

relict sinkhole – A relict (or relic) sinkhole is an ancient sinkhole that is no longer active.

It may be expressed as a sinkhole lake, depression in the land surface, or loose soils in the subsurface. See *paleosinkhole* and *alluvial sinkhole* (Modified from SDII Global Corp., 2002).

resurgence – re-emergence of groundwater through a karst feature, a part or all of whose waters are derived from surface inflow into ponors at higher levels (Modified from Field, 1999).

river rise – see *resurgence* (Field, 1999).

rock-collapse sinkhole – A collapse sinkhole formed when the limestone, or other soluble rock, cavern ceiling fails and collapses into a void (Modified from SDII Global Corp., 2002).

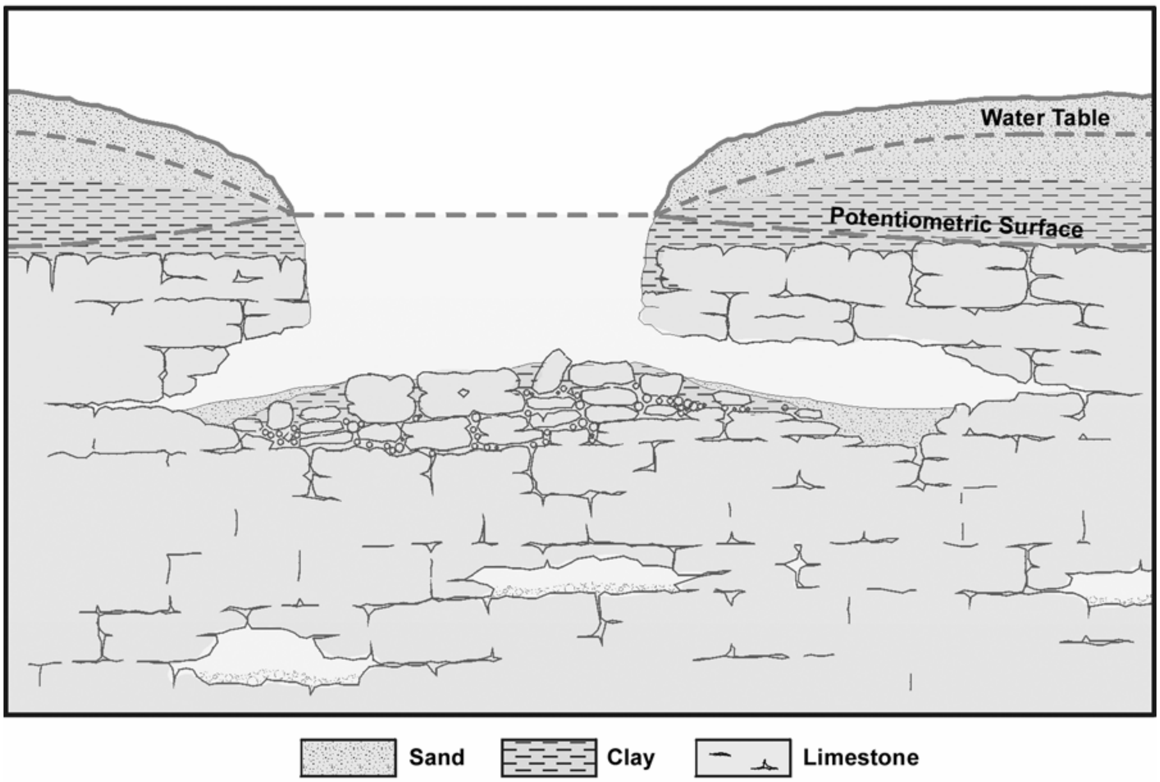

Figure 3. Rock-Collapse Sinkhole
(Modified from SDII Global Corp. 2002)

rubble – In the context of karst, rubble describes the gravel-like debris that forms as limestone is weathered (Modified from SDII Global Corp., 2002).

sag depression – A sag depression is often the surficial manifestation of a solution or cover subsidence sinkhole.

As the underlying bedrock is dissolved away, the cover materials slowly sag, creating a depression. Owing to the shallow water table, sags often become small, circular wetlands (SDII Global Corp., 2002).

sand boil – A spring in which the vent has been filled in with sand.

Spring discharge continuously suspends the sand particles that cover the spring. Thus the spring has a "boiling" appearance (FSNC, 2003).

seep – **1**. To move slowly through small openings of a porous material (Field, 1999). **2**. With regard to springs in Florida, a seep is also a noun that infers one or more small openings in which water discharges diffusely (“oozes”) from the ground-water environment.

Discharge is from intergranular pore spaces in the matrix and flow is typically laminar (FSNC, 2003).

seepage – The infiltration or percolation of water through rock or soil to or from the Earth’s surface and is usually restricted to the very slow movement of groundwater (Field, 1999).

sink – See *sinkhole*.

sinkhole – A landform created by subsidence of soil, sediment, or rock as underlying strata are dissolved by ground water.

Sinkholes can form by collapse into subterranean voids created by dissolution of limestone or dolostone or by subsidence as these strata are slowly dissolved away (Modified from SDII Global Corp., 2002).

siphon – **1**. In speleology, a cave passage in which the ceiling dips below a water surface (Monroe, 1970). **2**. A flooded cave passage. A gallery (conduit) in the form of a “U” with water moving only under pressure when the siphon is completely filled (Field, 1999). **3**. Site and origin of an intermittent spring; section of a flooded cave or sump flooded passage (Field, 1999).

soil piping – Laterally limited, vertical areas of loose soil often caused by downward vertical movement of the soil (raveling). See *pipe* (Modified from SDII Global Corp., 2002).

solution sinkhole – Sinkhole formed by the slow subsidence of soil or sediment as the upper surface of the underlying, water-soluble sediment or rock is removed by dissolution. See *cover-subsidence sinkhole* (SDII Global Corp., 2002).

source aquifer – The aquifer from which the water in a spring originates (FSNC, 2003).

spring – A point where underground water emerges onto the Earth’s surface (including the bottom of the ocean).

The image of a trickle of water springing from a hillside hardly matches that of a vast cave pouring forth a river, but both are called springs. Springs may be exsurgences or resurgences, depending upon the source of their water. They may also be part-time exsurgences and part-time resurgences. In some usages “spring” is restricted to the water that outflows, in other usages the word can refer to the water, the outlet, or the locality of the outflow (Field, 1999).

Note that the FSNC believes that flow through an exposed conduit in an aquifer is different from flow onto the earth’s surface. For this reason, the FSNC does not consider a karst window to be a spring. It is an exception to the definition of a spring.

spring boil – Variable discharge from a spring in which hydrostatic pressure is great enough to cause a turbulent discharge (Modified from Field, 1999).

spring complex – See *Spring Group*. The FSNC encourages the use of spring group and discourages the use of this term.

spring group – A collection of individual spring vents and seeps that lie within a discrete spring recharge basin (or springshed).

The individual vents and seeps of onshore spring groups almost always share a common spring run, or a tributary to the run. Spring group vents and seeps are often spread over an area of several square miles.

It should be emphasized that the term spring group will be restricted to those vents and seeps that discharge a well-defined spring recharge basin. The spring vents or seeps within a springshed may be referred to as springs. As an example, the Rainbow Springs Group will include several spring vents that drain the Rainbow Springs Group basin, and discharge into the Rainbow River spring run.

Note that a spring recharge basin is defined only by potentiometric data and not by chemical or other physical characteristics of the spring discharge. However, chemical and additional physical data can, and should, be used to better define individual spring vent basins within a spring group basin. This type of mapping was conducted for the Rainbow Springs Group in Marion County by Jones et al., (1996).

All springsheds have not been mapped. Therefore, if a springshed is not mapped, then it is acceptable to use the term "springs" to refer to multiple vents discharging into a common spring run.

spring magnitude – A category based on the volume of flow from a spring per unit time.

The classification system (Table 2) used in Florida is based on Meinzer (1927).

Table 2. Spring Magnitude

	Flow	
Magnitude	Metric Units	English Units
1	≥ 2.832 cms	≥ 100 cfs (≥ 64.6 mgd)
2	≥ 0.283 to 2.832 cms	≥ 10 to100 cfs (≥ 6.46 to 64.6 mgd)
3	≥ 0.028 to 0.283 cms	≥ 1 to 10 cfs (≥ 0.646 to 6.46 mgd)
4	≥ 0.0063 to 0.028 cms	≥ 100 gpm to 1 cfs (≥ 100 to 448gpm)
5	≥ 0.631 to 6.308 lps	≥ 10 to 100 gpm
6	≥ 0.063 to 0.631 lps	≥ 1 to 10 gpm
7	≥ 0.473 to 3.785 lpm	≥ 1 pint/min to 1 gpm
8	< 0.473 lpm	< 1 pint/min

cms = cubic meters per second
cfs = cubic feet per second
mgd = million gallons per day
gpm = gallons per minute
lps = liters per second
pint/min = pints per minute
lpm = liters per minute

Notes regarding magnitude – One discharge measurement is enough to place a spring into one of the eight magnitude categories. However, springs have dynamic flows. A spring categorized as being a first-magnitude spring at one moment in time may not continue to remain in the same category. Therefore, the magnitude of the spring is to be based on the median value of all discharge measurements for the period of record (FSNC, 2003). The median of a set of scores is the middle value when the scores are arranged in increasing (or decreasing) order (Modified from Triola, 1998).

It is recognized that historically, many springs in Florida have kept one magnitude category, even though the discharge may have changed considerably from when it was first assigned a magnitude. For this reason, a historical category is acceptable in the Florida Springs Classification System. For example, the discharge of a spring may have been taken in 1946. At that time it was classified as a first-magnitude spring. No other measurement was taken until 2001. During that year, three discharge measurements were taken. The median value of all four measurements reveals that the spring should be re-classified to a second-magnitude spring in 2001. Nevertheless, it can still be considered a historical first-magnitude spring. The term "historical" refers to the period of time prior to the adoption of the Florida Springs Classification System (2003).

The location of a discharge measurement is critical for defining the magnitude of a spring. Whenever possible, a discharge measurement should be restricted to a vent or seep. However, this is often impractical. For example, the only place to take a measurement may be in a spring run downstream where multiple springs have discharged into the run. For this reason, whenever a discharge measurement or water sample is taken, the springs (vents or seeps) included in the measurement need to be reported. The exact location of the discharge measurement (using a Global Positional System with approved locational specifications) and a standardized locational reference point for each measurement is encouraged.

spring pool – A small body of water, either artificially impounded or naturally occurring, that encompasses one or more spring vents.

It contains spring discharge that flows into a spring run (FSNC, 2003).

<u>spring recharge basin</u> – Those areas within ground- and surface-water basins that contribute to the discharge of the spring. The position of the divide is orthogonal to isopotential lines (Hydrogeology Consortium, 2002). It is synonymous with *springshed*.

Note that the position of the recharge basin boundary is time dependent. That is, the boundary is representative of a "snapshot" in time, rather than permanent. Thus, the boundaries of springsheds are dynamic and vary as a result of a changing potentiometric surface. If a spring is found to drain one springshed during times of high potentiometry, and another basin during low times, then the spring should be connected with two spring basins in the spring database (FSNC, 2003).

Whenever practical, descriptive aspects of the recharge basin should be noted in the spring database. The following are examples. The relative recharge to groundwater within the basin should be noted. Those portions of the basin where confined and unconfined ground-water conditions exist should also be recorded. Finally, groundwater vulnerability within the springshed should be noted if possible. A potential tool to predict vulnerability is the Florida Aquifer Vulnerability Assessment (FAVA) model (Baker et al., 2002).

spring run – **1**. A body of flowing water that originates from a karst spring (Field, 1999). **2**. A stream (river, creek, etc.) whose primary (>50%) source of water is from a spring, springs, or spring group (FSNC, 2003).

For example, the Wakulla River, where the predominant source of water is from Wakulla Spring, is a spring run. However, farther down stream, where surface water tributaries, contribute 50% or greater of the flow, the Wakulla River is no longer considered a spring run. A detailed hydrogeologic (e.g., the collection of discharge and seepage data) study may be needed in order to identify boundaries of a spring run (FSNC, 2003).

spring seep – See *seep*.

spring vent – See *vent*.

springs – Multiple spring vents or seeps located in proximity to each other.

The usage of this term is discouraged, but for pragmatic reasons, it cannot be entirely dropped. For example, several vents may discharge into a common spring run and the collection of scientific data (e.g. water samples or discharge measurements) cannot be obtained from individual vents located in the run. However, it may be practical to obtain a composite water sample or composite flow measurement representing several vents. Under this situation, the term springs is acceptable. However, a list of each vent or seep represented by the composite sample should be recorded by the sampler, and ultimately placed into the spring database (FSNC, 2003).

steephead – A deeply cut valley, generally short, terminating at its upslope end in an amphitheater, at the foot of which a stream may emerge (e.g., ocean, lake, river, or stream) (Field, 1999) .

springshed – See *spring recharge basin*.

subaqueous spring – A spring that discharges below the surface of a water body (Field, 1999).

The term infers a pre-existing receiving surface-water body and is synonymous with *submerged* (FSNC, 2003).

submerged – See *subaqueous*.

submarine spring – See *offshore spring*.

swallet – See *swallow hole*.

swallow hole – A place where water disappears underground in a limestone region.

A swallow hole generally implies water loss in a closed depression or blind valley, whereas a swallet may refer to water loss into alluvium at a streambed, even though there is no depression (Field, 1999).

tidal spring – A spring whose discharge is controlled by tidal cycles.

Near the coast, tidal springs may alternately discharge saline and fresh water. Inland, the pattern of fresh water discharge may simply reflect tidal changes in the potentiometric surface (SDII Global Corp., 2002).

turbulent flow – The flow conditions in which inertial forces predominate over viscous forces and in which head loss is not linearly related to velocity.

It is typical of flow in surface-water bodies and subsurface conduits in karst terranes, provided that the conduits have a minimum diameter of approximately 2-5 mm, although some research suggests that 5-15 mm may be more appropriate (Modified from Field, 1999).

trace – See *overflow stream* (SDII Global Corp., 2002).

uvala – Large, complex sinkholes with irregular bottoms, formed by the coalescence of several smaller closed depressions.

The bottom of an uvala is characterized by multiple sinkholes and an irregular bottom (Modified from SDII Global Corp., 2002).

unconfined – See *nonartesian*.

vent – An opening that concentrates ground-water discharge at the Earth's surface, including the bottom of the ocean.

The spring point of discharge is significantly larger than that of the average pore space in the surrounding rock and is often considered a cave or fissure. Flow from the opening is mostly turbulent (FSNC, 2003).

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