

Florida's springs are among the State's most valued natural and scenic resources. Springs are an important part of Florida's history, dating back to the days of early Spanish explorers including Ponce de León, who came in 1513 seeking "the Fountain of Youth." Archeological evidence indicates that Indian villages were located near springs; native Floridians used the springs for their water supply and fished in the streams formed by the springs. Many of Florida's springs are tourist attractions; the best known is Silver Springs which has been a location for movie and television productions. Most of Florida's springs are located in the northern half of the state (fig. 1). Springs are the surface evidence of a vast underground water resource, the Floridan aquifer system, which supplies most of the State's drinking water. The large quantities of water discharged from Florida springs indicate the large capacity of the underground aquifer system to store and transmit water.

Springs provide base flow for many of the streams and rivers that are used for boating, fishing, swimming, scuba diving, and snorkeling. The nearly constant temperature of spring water creates an ideal habitat for many plants and animals; one example is the manatee, which seeks out the warmer waters of spring "runs" during cooler winter months. The 320 known springs in the State discharge about 12,300 cubic feet per second (ft<sup>3</sup>/s) or nearly 8 billion gallons per day. This exceeds the 7.5 billion gallons per day of freshwater used in the State (from ground-water and

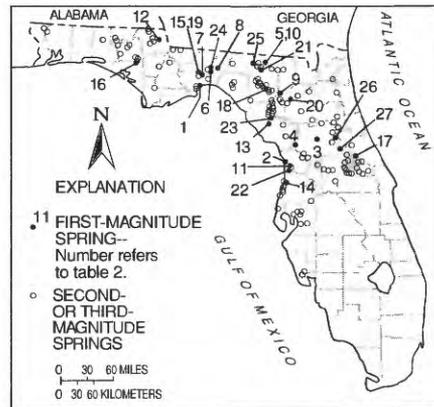


Figure 1. Location of selected springs in Florida.

surface-water sources) for public supply, agricultural, industrial, domestic, and thermo-electric power purposes in 1990.

## How Springs are Formed

Florida has an abundance of springs because the State is underlain by a thick sequence of limestone and dolomite—rocks that are easily dissolved by the rainwater that seeps into the ground. Carbon dioxide carried by the recharging rainwater forms carbonic acid, a weak acid that dissolves the rocks, thus creating cavities and caverns. The result is a landform called karst, which is characterized by the presence of springs and sinkholes and the absence of a well-developed surface-drainage system. Instead, most of the surface drainage enters the rocks of the Floridan aquifer system (fig. 2). A spring is formed when the ground water,

which is under pressure, flows out through a natural opening in the ground.

## Source of Spring Water

The source of Florida's spring water is rain that falls on land surrounding the spring. Contrary to popular belief, underground rivers do not bring water into Florida from other states. Instead, rainwater replenishes the aquifers which in turn supply the springs with water. Water in the aquifer flows through the permeable rocks and the various-sized openings in the rocks. Although many caverns in the aquifer can be quite large and interconnected, there are no underground rivers as such.

## Characteristics of Springs

Springs can be classified on the basis of several characteristics including the following: the discharge of the spring; the aquifer supplying the spring; or the water temperature of the spring. The most common classification of Florida's springs is by discharge. O.E. Meinzer, a pioneer ground-water scientist of the U.S. Geological Survey, devised a classification system in 1927 based on discharge; the system relates magnitudes to ranges of discharge (table 1). Discharge from Florida's springs can range from less than 1 pint per minute to more than 1 billion gallons per day.

Table 1. Classification system for springs according to average discharge [ft<sup>3</sup>/s, cubic feet per second; Mgal/d, million gallons per day]

Magnitude	Average Flow
1	100 ft <sup>3</sup> /s or more (65 Mgal/d)
2	10-100 ft <sup>3</sup> /s (6.5-65 Mgal/d)
3	1-10 ft <sup>3</sup> /s (0.65-6.5 Mgal/d)
4-8	less than 1 ft <sup>3</sup> /s (0.65 Mgal/d)

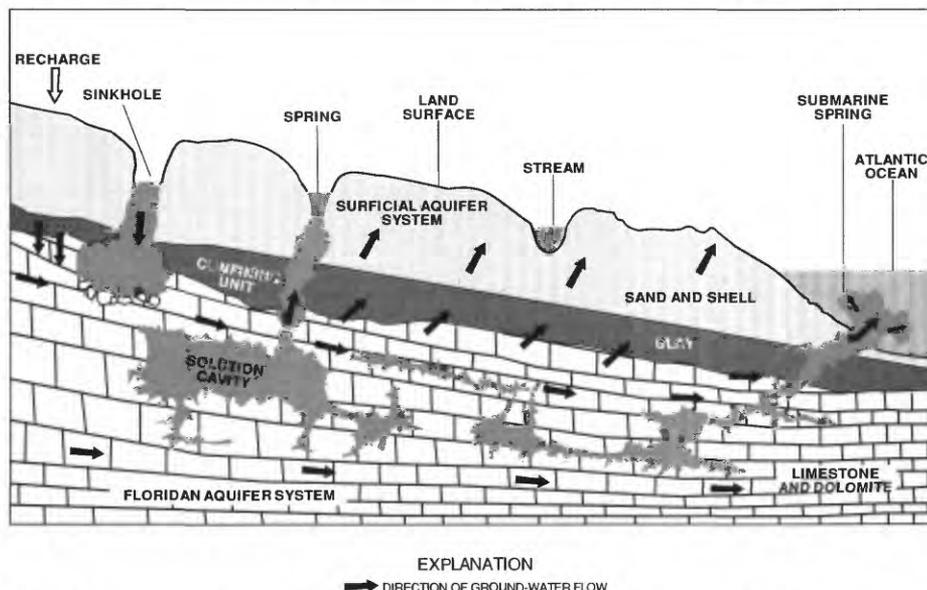


Figure 2. Generalized cross-section showing the geohydrology and springs of Florida.

The amount of water that flows from springs depends on many factors, including the size of the caverns within the rocks, the water pressure in the aquifer, the size of the spring basin, and the amount of rainfall. Human activities also can influence the volume of water that discharges from a spring—ground-water withdrawals in an area can reduce the pressure in an aquifer, causing water levels in the aquifer system to drop and ultimately decreasing the flow from the spring.

Florida has more first-magnitude springs than any other state in the Nation. The sum of the average flow from Florida's 27 first-magnitude springs (table 2, fig. 1) is estimated to be 9,400 ft<sup>3</sup>/s (6,075 Mgal/d), or about 76 percent of the average flow of all the known springs in Florida. Several first-magnitude springs are nationally or even internationally known, such as Silver Springs, Rainbow Springs, Wakulla Springs, and Weeki Wachee Springs. About 70 springs are second-magnitude springs; these collectively discharge about 2,600 ft<sup>3</sup>/s (1,680 Mgal/d) or about 21 percent of the total discharge from all known Florida springs. More than 190 springs are third-magnitude or less; these collectively discharge more than 300 ft<sup>3</sup>/s (194 Mgal/d), or about 3 percent of total discharge from all Florida springs.

Spring Creek Springs and Crystal River Springs are the two largest springs in Florida. Discharge measured from Spring Creek Springs (a group of eight known spring vents) in 1974 was about 2,000 ft<sup>3</sup>/s (1,293 Mgal/d). The average discharge from Crystal River Springs is 878 ft<sup>3</sup>/s (567 Mgal/d) from 30 individual spring vents. Both of these springs are located near the coast. The discharge of springs near the coast commonly is affected by tides.

Silver Springs in Marion County is the largest inland spring in the State (based on average discharge). Measured discharge from this spring ranges from 517 to 1,290 ft<sup>3</sup>/s (334 to 834 Mgal/d), and the average discharge is 799 ft<sup>3</sup>/s (516 Mgal/d) based on records from 1933 to 1993. The highest recorded discharge from any inland Florida spring is 1,910 ft<sup>3</sup>/s (1,234 Mgal/d), measured at Wakulla Springs. This maximum discharge is about 50 percent greater than the maximum measured discharge from Silver Springs (1,290 ft<sup>3</sup>/s, 834 Mgal/d). Wakulla Springs also has the greatest range in discharge of all Florida springs, from 25 ft<sup>3</sup>/s to 1,910 ft<sup>3</sup>/s (16 to 1,234 Mgal/d); however, the average discharge (391 ft<sup>3</sup>/s, 253 Mgal/d) is less than half that of Silver Springs (799 ft<sup>3</sup>/s, 516 Mgal/d).

Numerous springs and seeps probably occur off the coast of Florida, but most are difficult to detect. Presently (1995), the locations of 15 submarine springs are documented. Most are located off the west coast of the State, but at least one, Crescent Beach Spring, is 2.5 mi. off the northeast coast. Many of these submarine springs are located near the coast, mainly in bays or estuaries; a few others are as much as 20 miles offshore. Submarine springs sometimes can be detected by the appearance of a "boil" or "slick" at the water surface.

**Table 2.** Summary of discharge and water-quality data collected at Florida's 27 first-magnitude springs

[Map number refers to figure 1. All values are averages. ft<sup>3</sup>/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter]

Map Number	Name	County	Average discharge ft <sup>3</sup> /s	Specific conductance (µS/cm)	Chloride (mg/L)	Sulfate (mg/L)
1	Spring Creek Springs	Wakulla	2,000	4,300	1,200	280
2	Crystal River Springs	Citrus	878	4,300	1,400	200
3	Silver Springs	Marion	799	410	9.5	42
4	Rainbow Springs	Marion	711	140	3.5	5.5
5	Alapaha Rise	Hamilton	608	230	6.8	21
6	St. Marks Spring	Leon	517	260	5.7	8.7
7	Wakulla Springs	Wakulla	391	270	5.8	10
8	Wacissa Springs	Jefferson	388	270	5.3	5.4
9	Ichetucknee Springs	Columbia	360	300	5.3	9.4
10	Holton Spring	Hamilton	243	230	11	25
11	Homosassa Springs	Citrus	192	2,700	780	110
12	Blue Springs	Jackson	189	210	2.6	.3
13	Manatee Spring	Levy	178	410	5.9	24
14	Weeki Wachee Springs	Hernando	174	280	6.3	7.5
15	River Sink Spring	Wakulla	164	190	7.8	12
16	Gainer Springs	Bay	159	120	2.4	.6
17	Blue Spring	Volusia	158	1,700	420	53
18	Troy Spring	Lafayette	152	330	4.1	8.0
19	Kini Springs	Wakulla	150	200	7.9	13
20	Hornsby Spring	Alachua	148	400	12	53
21	Falmouth Spring	Suwannee	145	340	4.2	9.7
22	Chassahowitzka Springs	Citrus	139	520	78	16
23	Fannin Springs	Levy	113	360	4.9	11
24	Natural Bridge Spring	Leon	109	250	5.5	7.3
25	Blue Spring	Madison	106	270	4.4	12
26	Silver Glen Springs	Marion	106	2,000	460	180
27	Alexander Springs	Lake	102	1,100	230	59

## Water Quality of Springs

The quality of water discharged by springs can vary greatly because of factors such as the quality of the water that recharges the aquifer and the type of rocks with which the ground water is in contact. The rate of flow and the length of the flowpath through the aquifer affects the amount of time the water is in contact with the rock, and thus, the amount of minerals that the water can dissolve. The quality of the water also can be affected by the mixing of freshwater with pockets of ancient seawater in the aquifer or with modern seawater along the coast.

Water from springs usually is remarkably clear. Water from some springs, however, may be "tea-colored," indicating the presence of tannic acid. Many surface waters in Florida contain natural tannic acids. If surface water enters the aquifer near a spring, the water can move quickly through the aquifer and discharge at the spring vent. The discharge of highly colored water from springs can indicate that water is flowing quickly through large channels within the aquifer without being filtered through the limestone.

The quality of spring water represents the general water quality of the ground-water system. Most spring water is of excellent quality. The specific conductance of spring water generally is less than 500 microsiemens per centimeter, indicating that small amounts of minerals are dissolved in the water (table 2). Chloride and sulfate concentrations generally are less than 12 and 60 milligrams per liter, respectively. Spring-water temperatures range from 66 °F to 97 °F. The temperature of spring water in north Florida averages about 70 °F and about 75 °F in central Florida. Higher water temperatures in some Florida springs indicate that the water originates from deeper parts of the Floridan aquifer system. For example, the temperature of water discharging from Mud Hole Spring, a submarine spring located off the southwest coast of Florida, is about 97 °F.

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## For Further Information

Information on reports and data collected by the U.S. Geological Survey may be obtained from:

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