



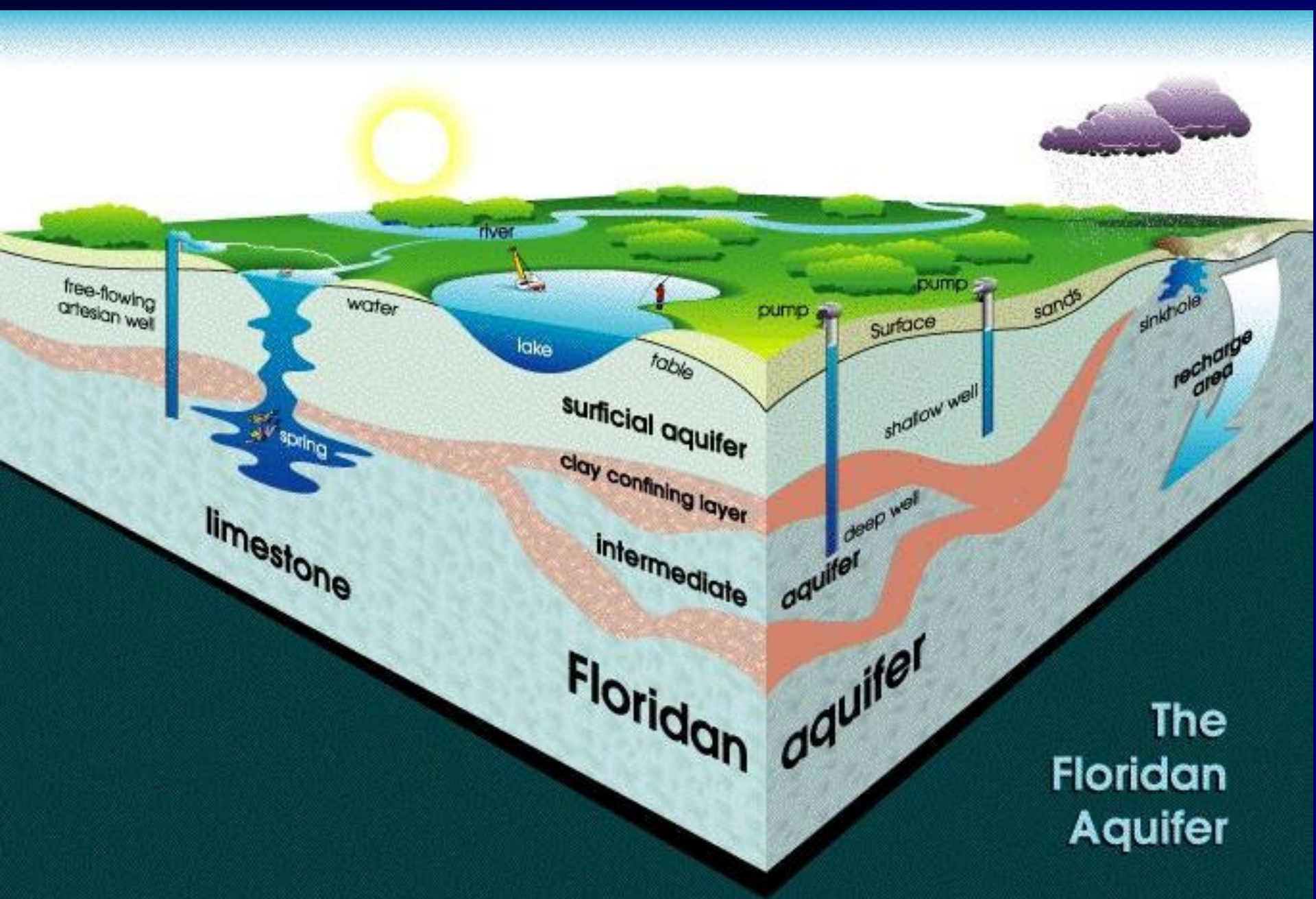
Florida Aquifer Geology

March 2024

**Status & Trend Networks
Sampler Training Workshop**

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DEAR / WMS



The
Floridan
Aquifer

Aquifer Basics – Essential Definitions

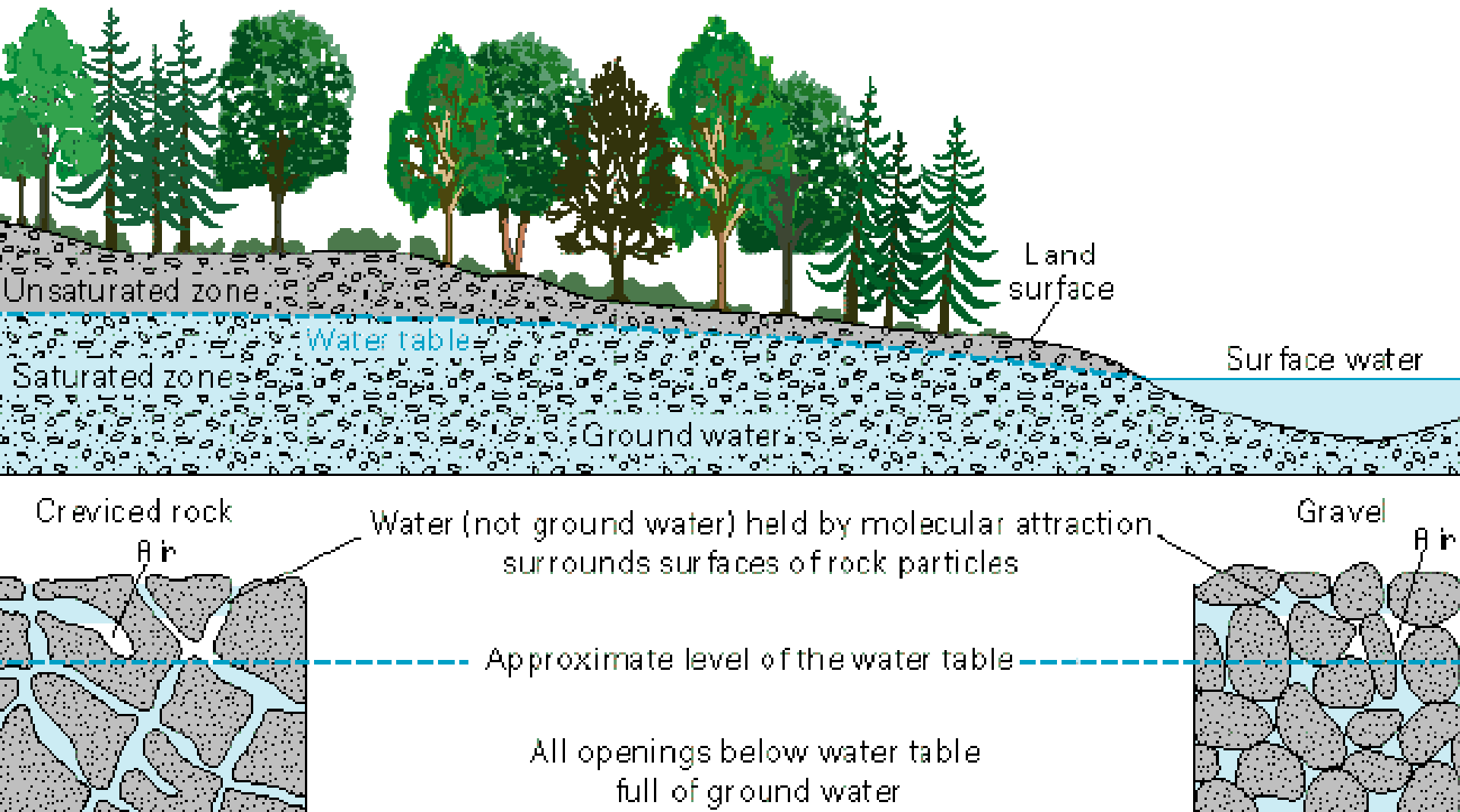
An aquifer is a rock or sediment layer that contains and transmits groundwater.

An aquitard is a rock or sediment layer that slows down or prevents groundwater flow.

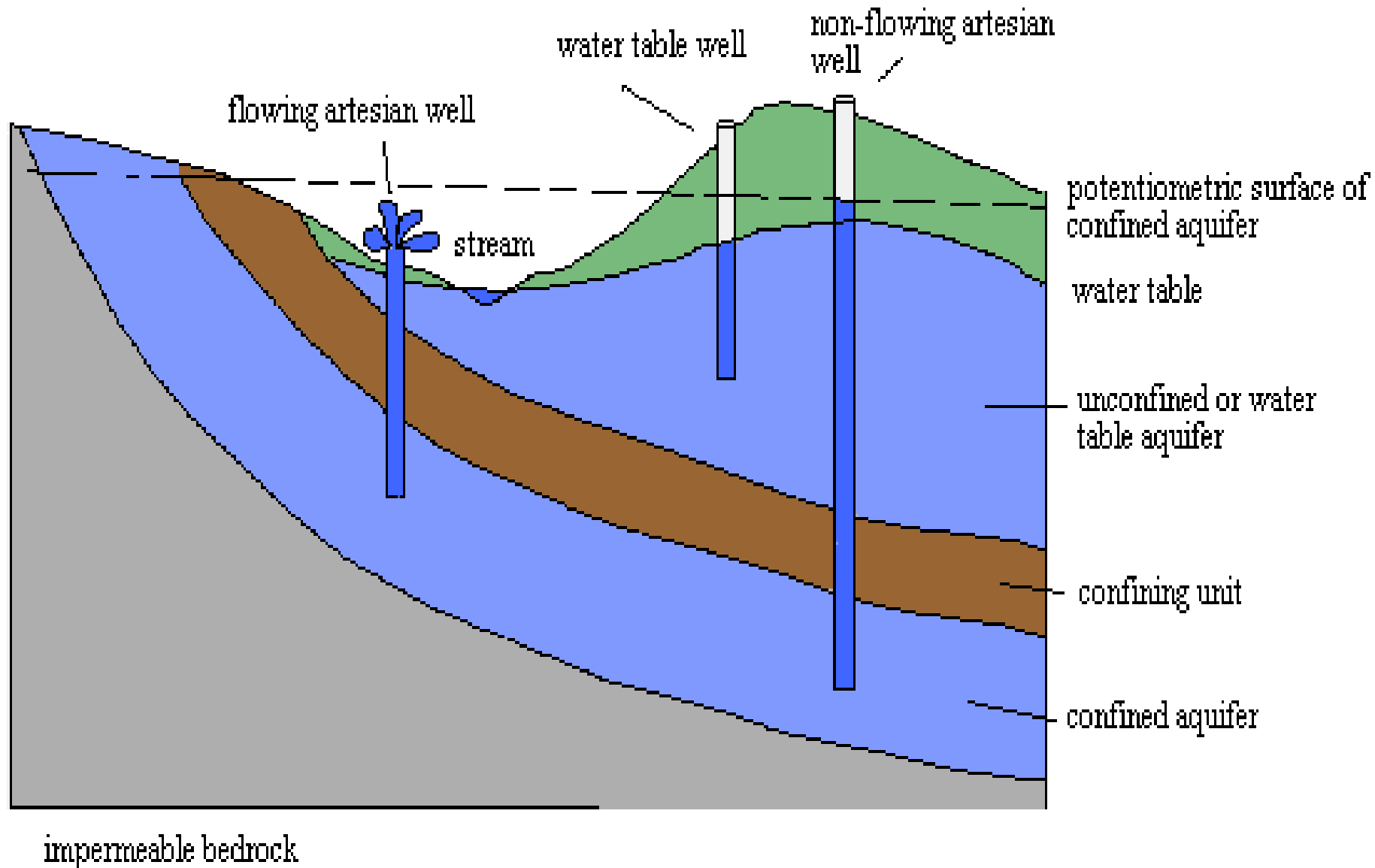
A confined aquifer is confined beneath an aquitard, whereas an unconfined aquifer has no overlying aquitard layer. Confined aquifers build up (artesian) pressure due to the force of gravity.

Groundwater samples collected for the Status Network or the Groundwater Trend Network are from both unconfined and confined aquifers.

Unconfined Aquifer



Confined Aquifer



Aquifer Basics - Confined vs Unconfined

Porosity is the amount of pore (void) space between the grains of a rock or sediment sample. Porosity values range from 0% up to 35%.

Permeability is the ability of a sample to transmit ground water through interconnected pores. Permeability can be measured in a rock (drill core) sample in the laboratory.

A productive aquifer such as the Floridan aquifer in north Florida, or the Biscayne Aquifer in south Florida, has both high porosity and high permeability.

Aquifer Basics - Rock types

Hydrogeologists have defined at least (5) types of water-yielding aquifers in North America.

1. **Sandstone** aquifers – Ogallala Aquifer, Great Plains, central US; Wilcox Aquifer western TN
2. ***Carbonate rock** (limestone, dolostone) aquifers – Floridan Aquifer, SE USA; Biscayne Aquifer, S.FL
3. ***Unconsolidated sand and gravel** aquifers – SE Coastal Plain states such as AR, LA, MS, AL, GA
4. ***Interbedded clastic (sand/silt) + carbonate aquifer** common in south FL
5. **Volcanic rock** (basalt) aquifer – Washington state

* occurs in Florida

Florida Aquifer Basics - Rock Types

Carbonate rock (limestone, dolostone) aquifers are the most common and productive in Florida. The Floridan and Biscayne aquifers are examples.

Carbonate rocks are made up of calcite (CaCO_3) or dolomite ($\text{CaMg}(\text{CO}_3)_2$) and were once tropical carbonate sediments. Over time, acidic ground water creates openings in carbonate rock. This process has formed Florida's productive (high porosity) aquifers.



Calcite – CaCO_3 – the mineral that makes up Florida limestone



Locality: Citrus County, FL

Calcite – CaCO_3 – the mineral that makes up Florida limestone



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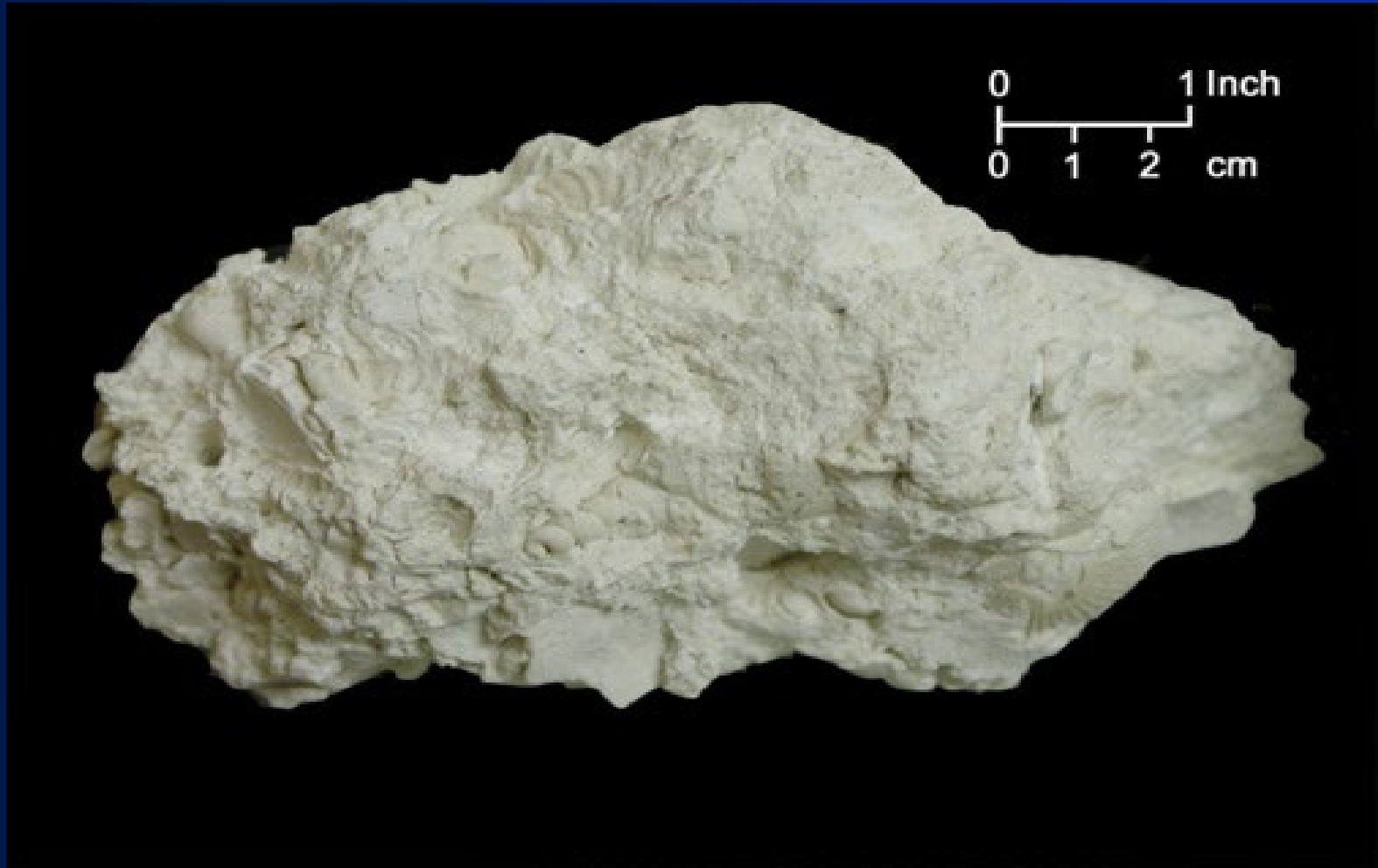
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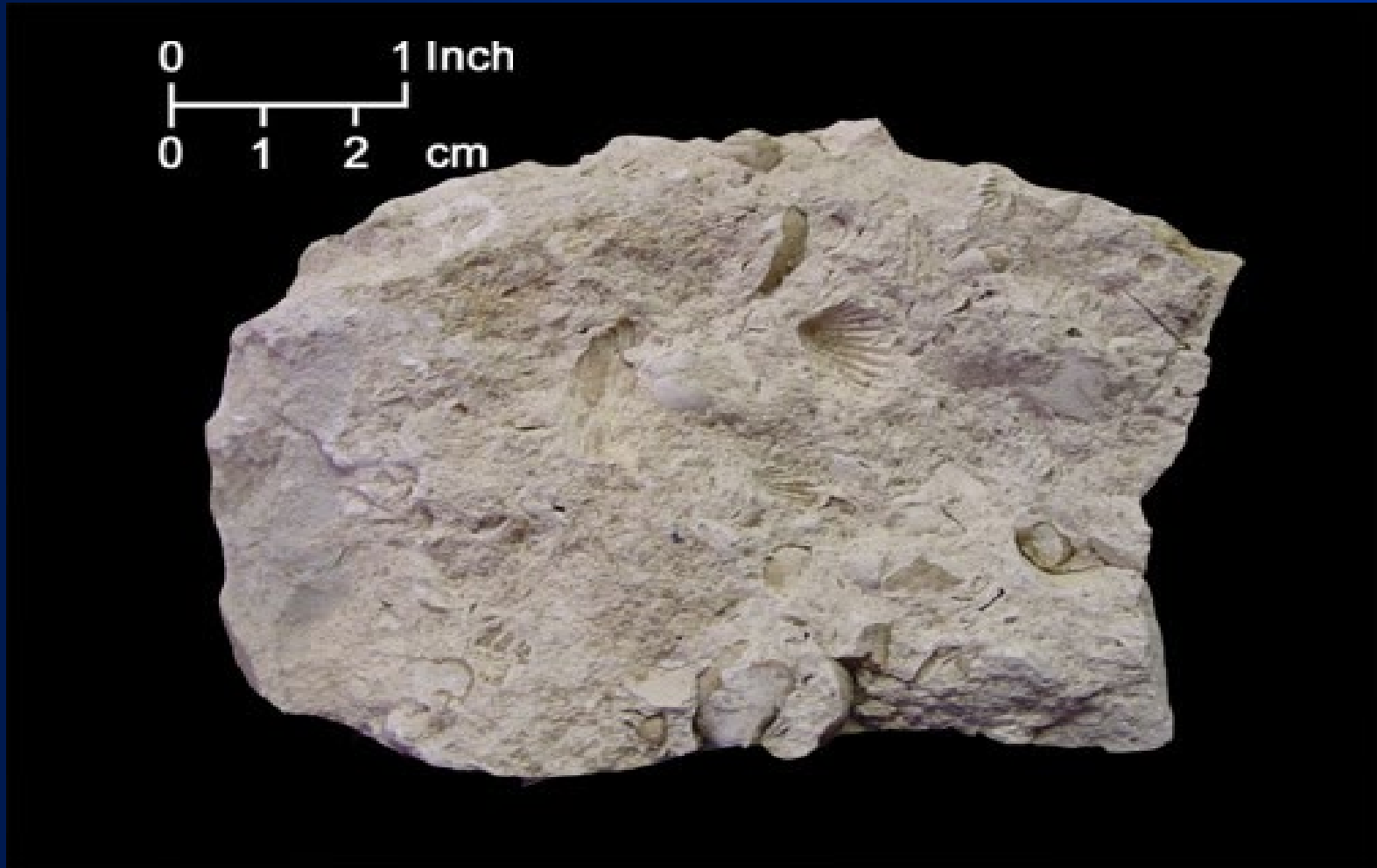
Cave Pearls
Locality: Citrus County, FL

Ocala Limestone – dominant carbonate rock in the Upper Floridan Aquifer



Locality: Alachua County, FL

Avon Park Dolostone – dominant carbonate rock in Lower Floridan Aquifer



Locality: Citrus County, FL

Coquina – common shallow aquifer rock in eastern and southern Florida



Locality: St. Johns County. FL

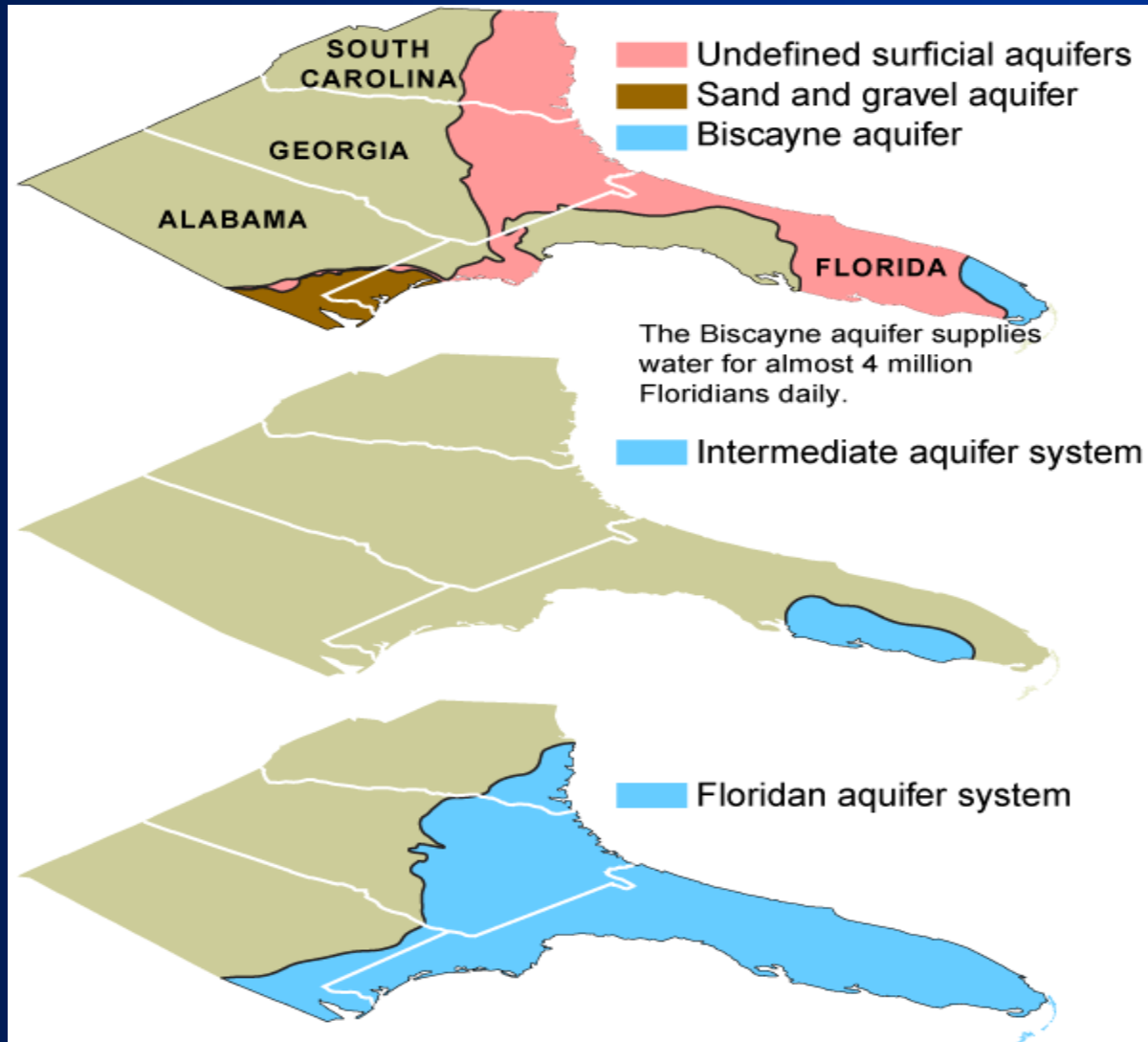
Coquina walls of historic fort, Castillo de San Marcos
National Monument, St Augustine, Florida, USA
Initial construction 1672 – 1695



Locations of Florida's Major Aquifers

1. Sand and Gravel Aquifer - western panhandle
2. Floridan Aquifer - north/central Florida (carbonate)
3. Biscayne Aquifer - southeast Florida (carbonate)

Aquifers of Florida



Florida's Aquifer Basics - Rock Types

The **Sand and Gravel** aquifer of the western panhandle is an aquifer that consists of unconsolidated to poorly consolidated layers of silt, sand, and gravel.

To produce enough groundwater for urbanized areas in this region (e.g., Pensacola), water from multiple shallow supply wells is blended/treated at central locations prior to public distribution.

Florida's Aquifer Basics – Rock Types

The **Floridan aquifer** is a carbonate rock aquifer found throughout Florida. In south and extreme western Florida, the Floridan is too saline to use for potable or agricultural water sources.

It consists of limestone and dolostone layers hundreds of feet thick that range from 20 to 50 million years old. Minor amounts of evaporite minerals (e.g., gypsum) are also present.

Florida's Aquifer Basics - Rock Types

Interbedded clastic + carbonate aquifers consist of discontinuous limestone and/or dolostone layers interbedded with sand, silt and clay layers. Much of southern Florida has this type of aquifer.

Few of these aquifers are given formal names, although their local presence is well documented by WMD and USGS hydrologists.

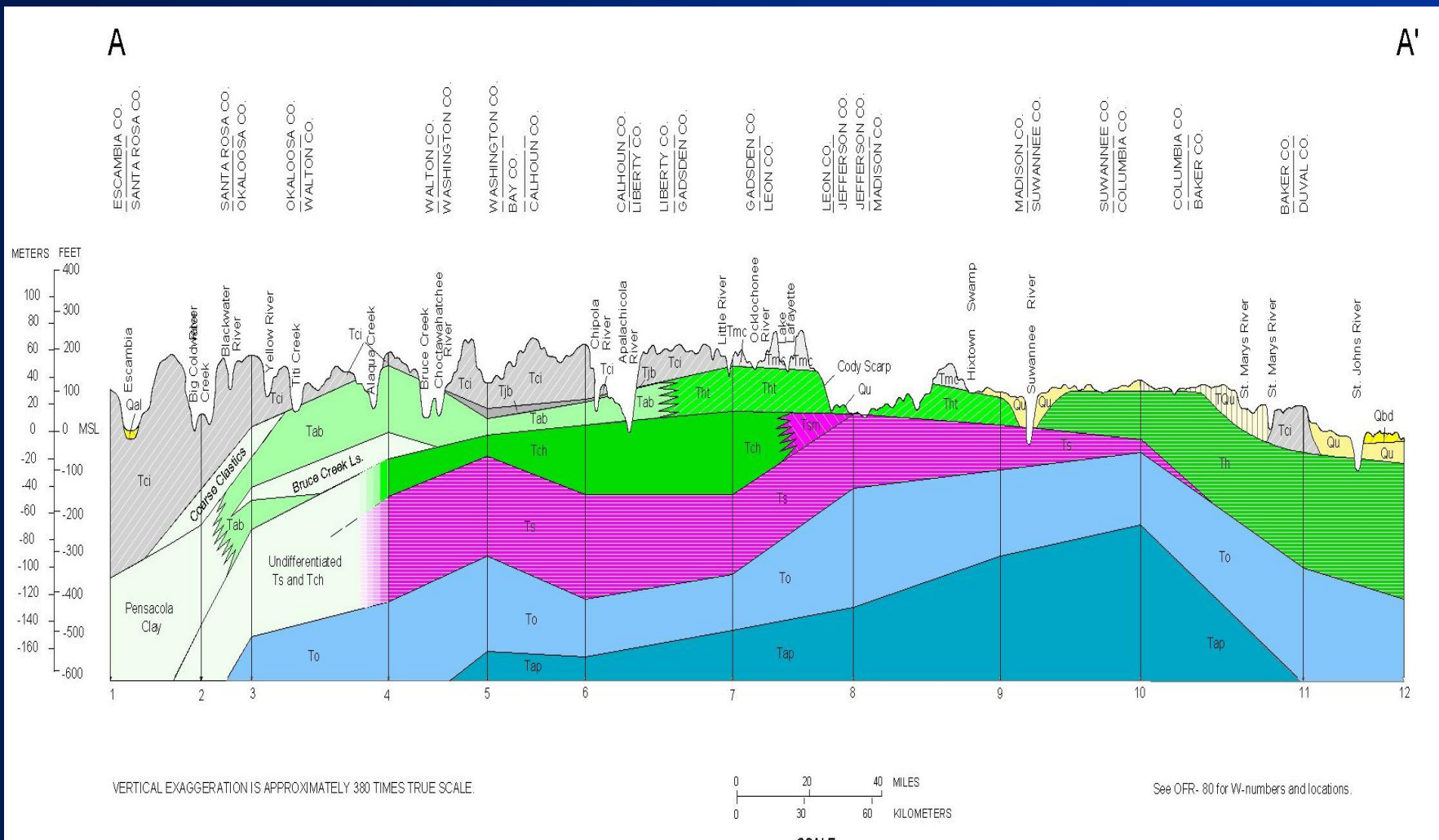
Geological Cross-Sections of Florida

The next two slides are geological cross-sections. The A - A' cross-section extends from Pensacola to Jacksonville. The B - B' cross-section extends from Lake City south to Miami.

East-West Geologic Cross Section

Pensacola

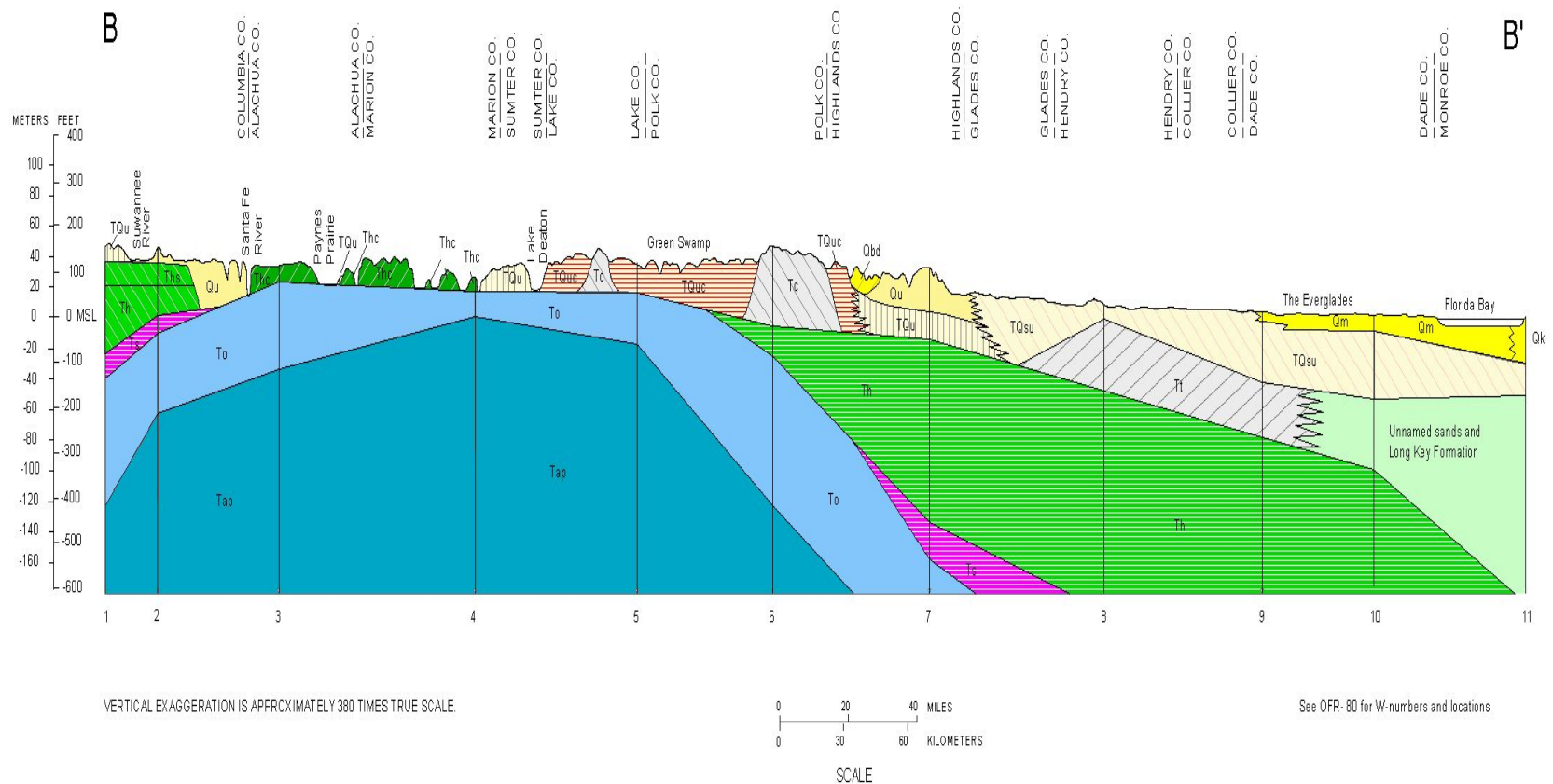
Jacksonville



North-South Geologic Cross Section

Lake City

Miami



Groundwater Chemistry

Water is described as the universal solvent, because water dissolves all minerals given enough time. Carbonate minerals (calcite and dolomite) are especially susceptible.

Thus groundwater contains, in the dissolved fraction, calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), chloride (Cl^{-}), bicarbonate (CO_3^{2-}), sodium (Na^{+}), and sulfate (SO_4^{2-}).

Groundwater Chemistry

Water is not considered drinkable (pōtable) if the quantity of dissolved minerals (total dissolved solids) exceeds 1,000 mg/L (milligrams/liter).

Slightly saline water is used in areas of Florida where fresh water is not available. Reverse osmosis water plants now number well over 200 and are located throughout Florida.

Typical Floridan Aquifer and Sand and Gravel Aquifer Water Chemistry

These groundwater data are in mg/Liter, which is equivalent to parts per million. Note how the host sedimentary material affects water chemistry.

<u>Aquifer</u>	<u>Calcium</u>	<u>Magnesium</u>	<u>Iron</u>	<u>Sodium</u>	<u>Bicarbonate</u>
Floridan	52	15	0.2	11	146
Sand/Gravel	4	1	2	5	5

Typical Floridan Aquifer and Sand and Gravel Aquifer Field Analytes

<u>Aquifer</u>	<u>pH</u>	<u>Conductance</u>	<u>Temp</u>
Floridan	7.4	385	22°C
Sand/Gravel	4.9	50	24°C

Some Florida Panhandle wells have naturally low pH values (below 5.0), and high amounts of iron, which stains plumbing fixtures. Iron can be reduced by treatment.

Groundwater Chemistry

Definitions of water hardness vary, but water is soft if it contains <75 mg/L as CaCO_3 , moderately hard from 75-150 mg/L, hard between 150-300 mg/L, and very hard if >300 mg/L as CaCO_3

Very hard water is not desirable for domestic uses, as it leaves scale inside pipes, boilers, and tanks. Hard water can be softened, though some hardness filters add sodium to the water.

Groundwater Quality Problems

The growth of population (20,148,654 in 2016; est > 22,000,000 in 2022), plus existing industry and agriculture, stresses the state's surface and groundwater resources.

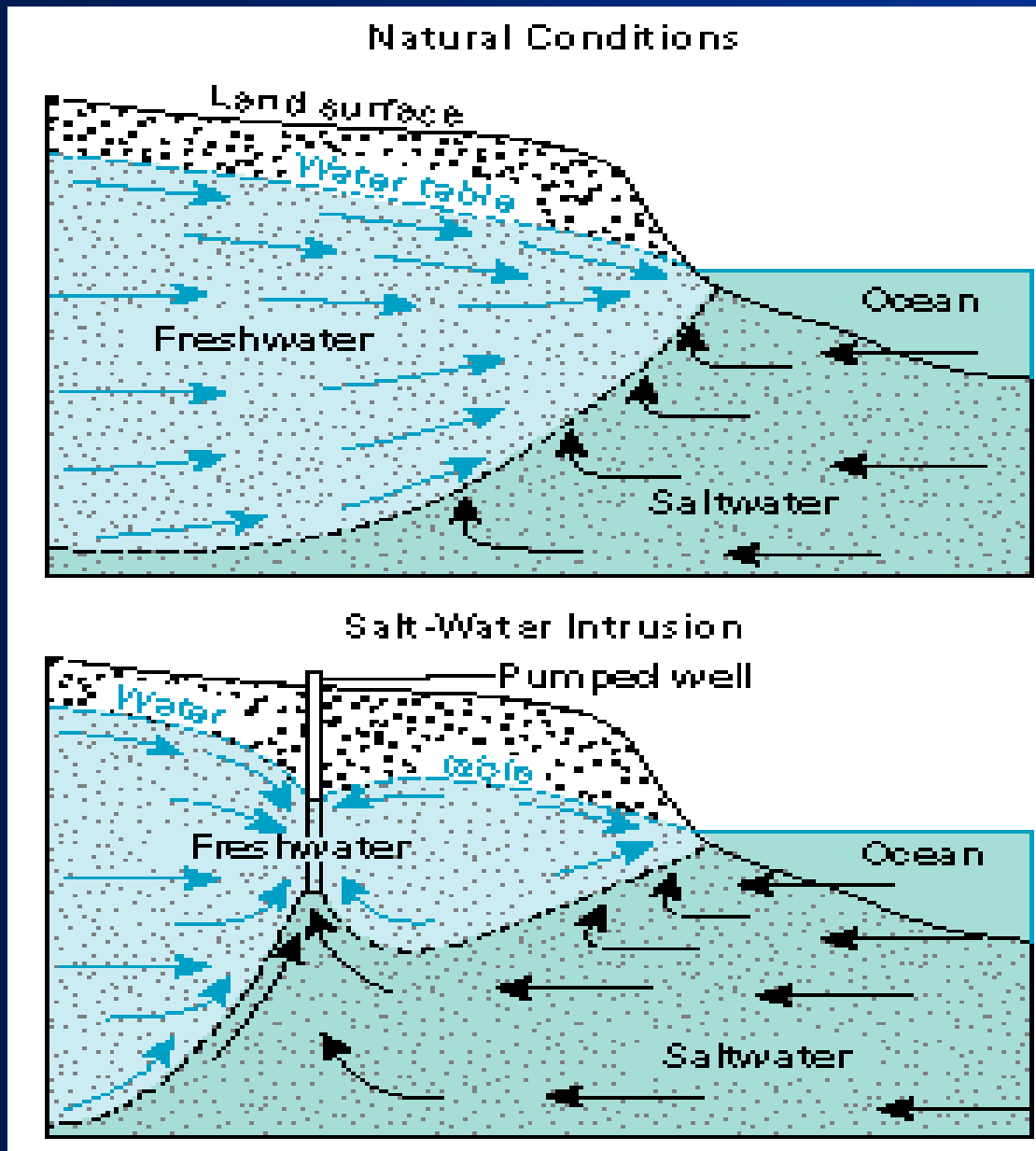
Municipal and industrial wastes, along with fertilizer and pesticides, have locally infiltrated aquifers and degraded groundwater.

Other problems include underground sewer pipe leakage, faulty septic tanks, landfill leachate, and reduced recharge areas due to development.

Groundwater Quality Problems

In some Florida coastal areas, groundwater pumping has caused salt water to laterally and vertically intrude freshwater aquifers. This process is monitored by the USGS, the five Water Management Districts, and now DEP. Sea level rise has been occurring for about 20,000 years in Florida

Salt Water Intrusion



Counties with
real or potential
salt water
intrusion
problems

Dade

Palm Beach

Broward

Levy

Manatee

Hillsborough

Duval

Walton

The End

