

# GEOLOGIC RESOURCES IN FLORIDA

# TOP THREE INDUSTRIES IN THE STATE

(1) Tourism

(2) Agriculture

(3) Mining

# RELEVANCE TO GEOLOGY

**Tourism-** Any beachfront development or Disney development will need to be assessed for its environmental impact and geologic hazards.



u23225958 fotosearch.com

# TOURISM

In addition to water, geologic hazards and coastal erosion issues, construction of new buildings requires sand, gravel and cement (all of which are produced in the state by.....)

You guessed it. Geologists!

# AGRICULTURE

In 2005, Florida had 42,500 commercial farms, utilizing 10 million acres to continue to produce a variety of food products.

~56 percent of the total U.S. value of production for oranges (\$843 million)

~52 percent of the total U.S. value of production for grapefruit (\$208 million)

~53 percent of the total U.S. value of production for tangerines (\$68.4 million)

~53 percent of the total U.S. value of production for sugarcane for sugar and seed (\$433 million as of 2004)

~49 percent of the total U.S. value of sales for fresh market tomatoes (\$805 million)

~44 percent of the total U.S. value of sales for bell peppers (\$213 million)

~31 percent of the total U.S. value of sales for cucumbers for fresh market (\$73.7 million)

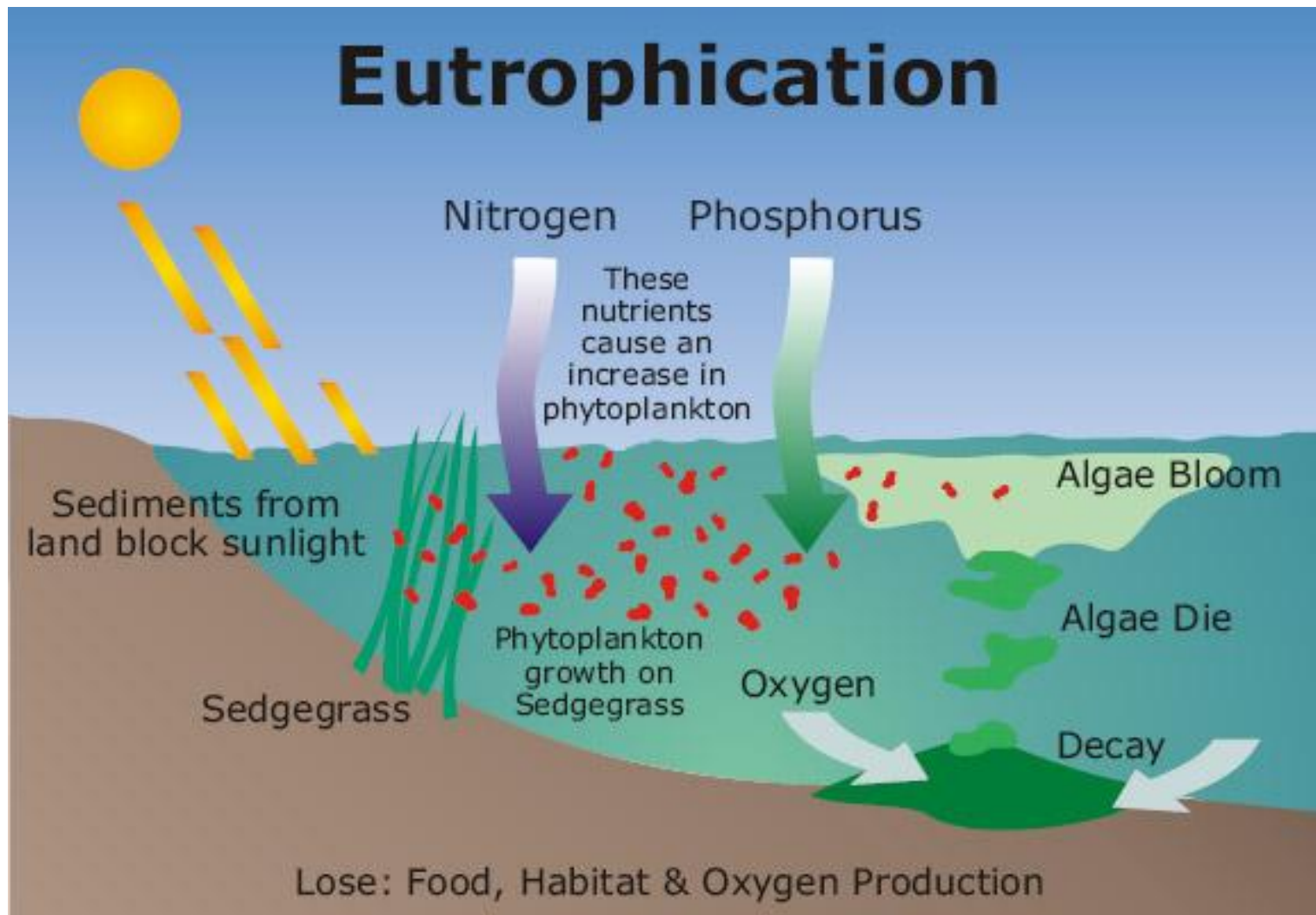
~31 percent of the total U.S. value of sales for watermelons (\$127 million)

# SO WHAT IS THE RELEVANCE OF GEOLOGY TO AGRICULTURE?

- (1) Water: The agricultural industry is a major stress on ground and surface water systems in the state.
- (2) The production of so much food requires an equally large volume of water
- (3) Fertilizer- One of the 'staple' fertilizers is phosphate (see next page)
- (4) Contamination by runoff- Nitrogen fertilizers are a hazard to surface and subsurface water. The slimy green scum is a seasonal feature on the St. Johns River, and also carries a potential public health concern because the blooms can produce toxins that affect both fish and people.
- (5) Red tide blooms in the ocean kills the fish induced by phosphorus-laden runoff.



# EUTROPHICATION



# SOME EXAMPLES





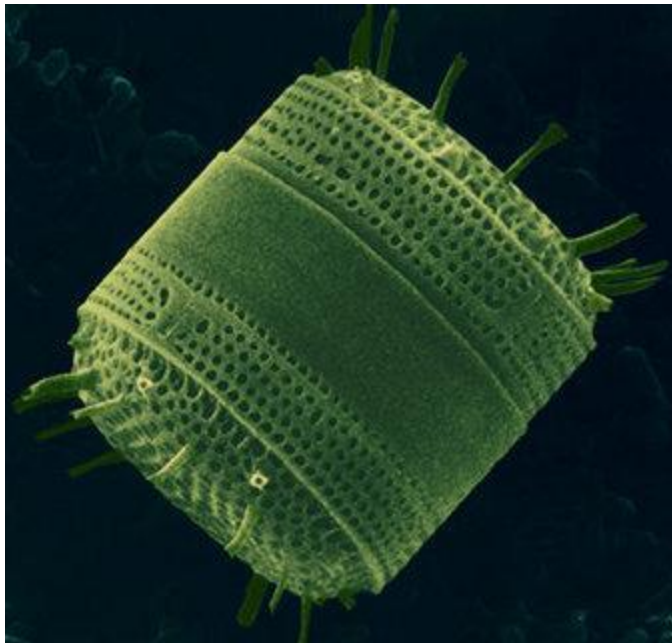
# ECONOMIC GEOLOGY OF FLORIDA

- (1) Oil & Gas Resources
- (2) Phosphate Mining
- (3) Crushed/Decorative Stone
- (4) Sand and Gravel
- (5) Cement
- (6) Clays
- (7) Heavy Minerals
- (8) Peat
- (9) Uranium

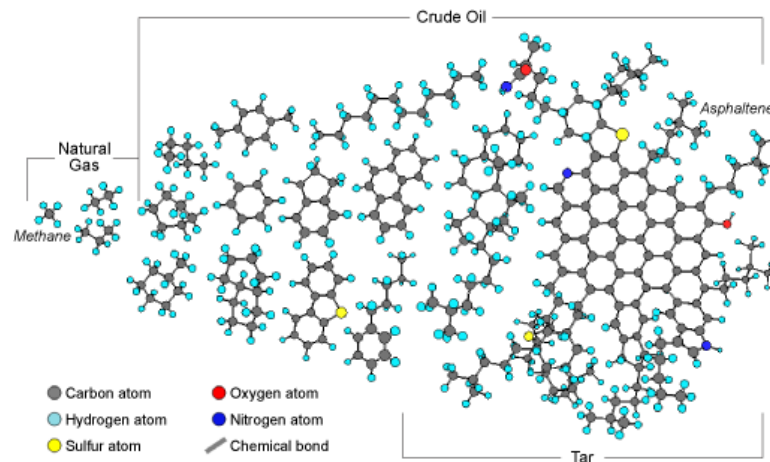
# A QUICK LOOK AT PETROLEUM

In order to get viable oil and gas deposits you need the following:

- (1) **Source rock-** organically-rich material from which to produce kerogen (oil does not come from dead dinosaurs!).
- (2) Oil and Gas are produced from dead plant and animal matter that is constantly raining down on the ocean floor.



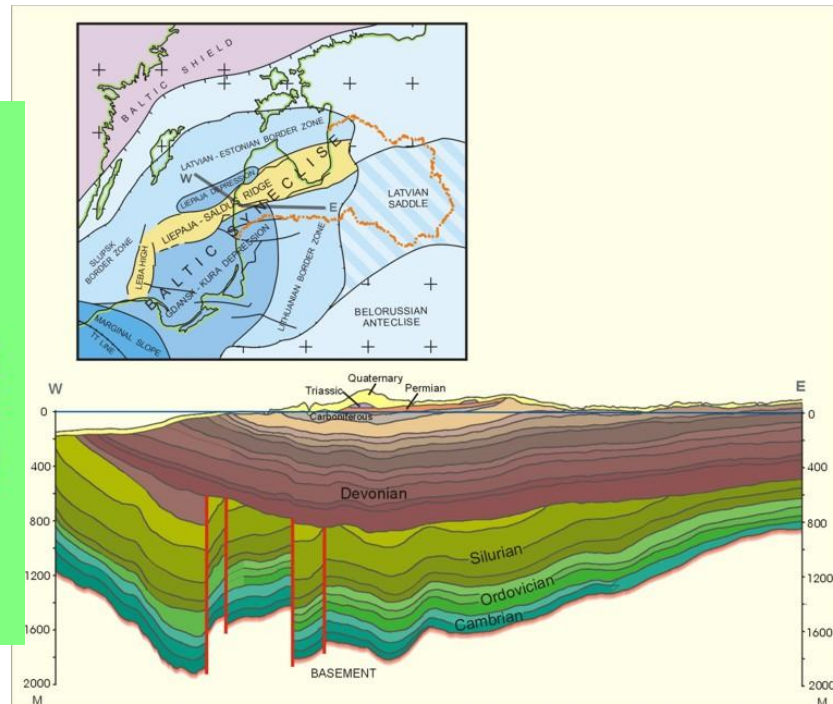
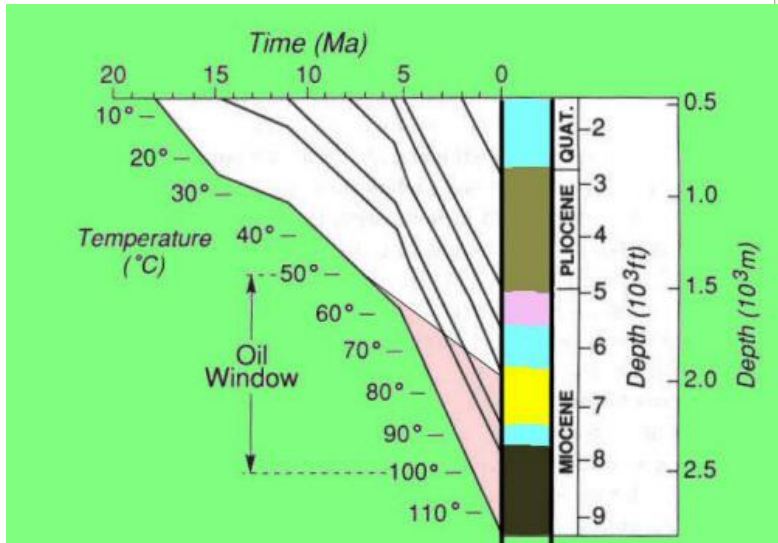
Examples of Some Organic Compounds in Petroleum



# HEAT & TIME

Neither oil nor gas will form unless the proper temperatures for a period of time are reached (and not exceeded!).

Burial is generally the most effective way to heat and requires a thick sequence of sedimentary rocks called 'basins'.



Major structural elements of the Baltic region and Geological cross-section of Baltic Syncline in Latvia

# TRANSITION TO GAS

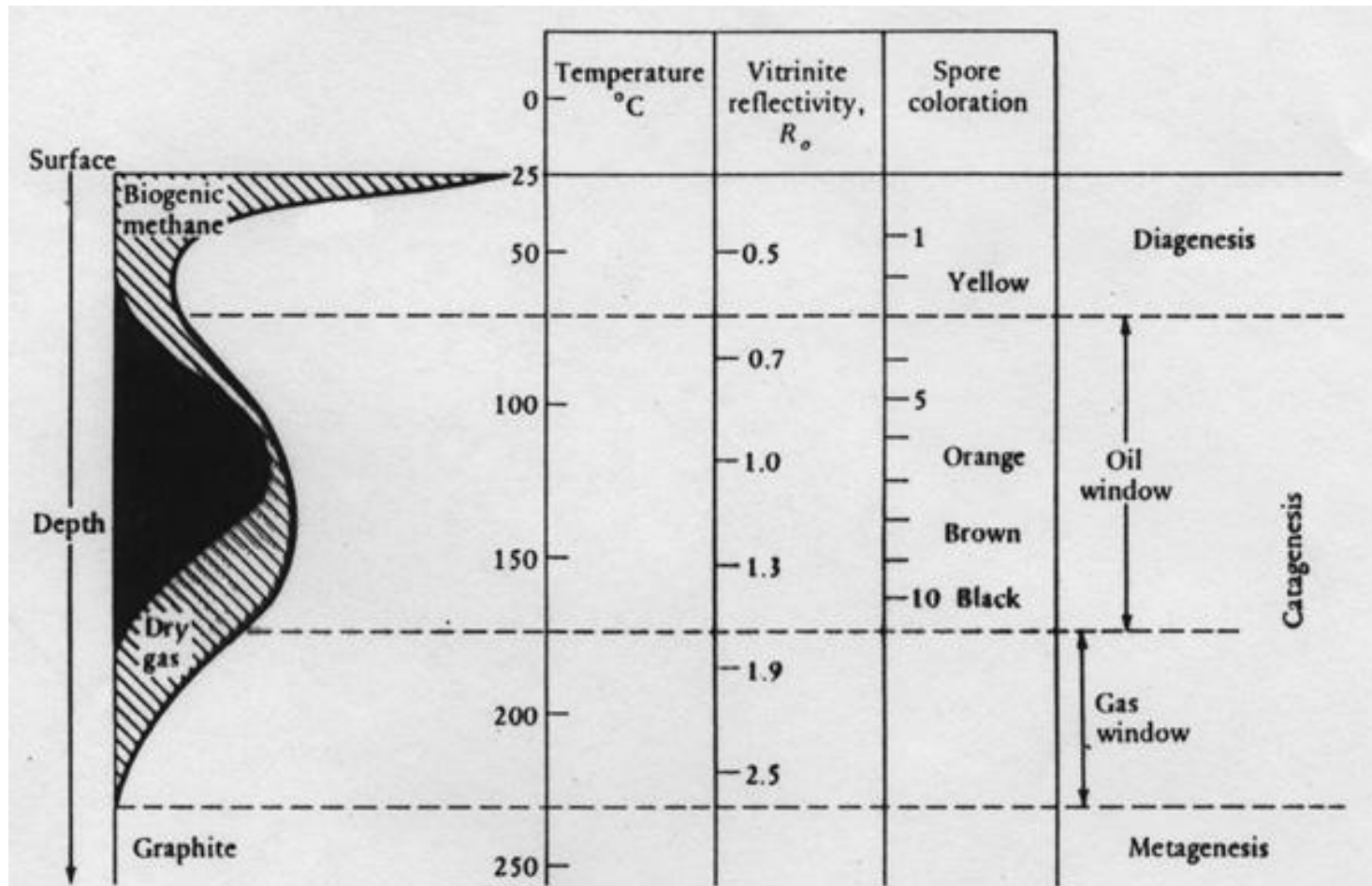


FIGURE 5.14 Correlation between hydrocarbon generation, temperature, and some paleothermometers.

# RESERVOIRS & TRAPS

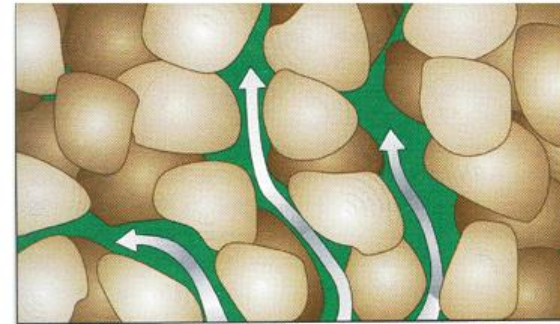
Once oil and gas form, they need to be moved into reservoir rocks and trapped (sealed) until us helpful human geologists come to get them.

Reservoir- Storage rock. It requires good porosity and permeability. A good reservoir rock will be relatively thick, permeable and saturated with oil.

Trap: A rock or a structural feature that acts as a barrier to petroleum and gas migration.



# RESERVOIR ROCK



*Connected pores give a rock permeability.*

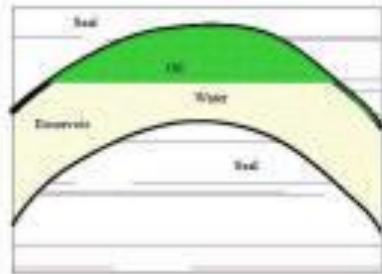
The cliffs here are a splendid example of Jurassic marine shoal sands. This formation is an important oil reservoir rock underground in the North Sea

# TYPES OF TRAPS

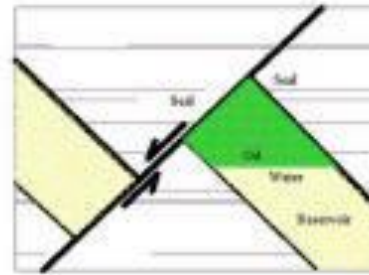
There are many types of petroleum traps.

- (1) Structural traps (faults, folds)
- (2) Pinchout traps
- (3) Stratigraphic traps

# Structural Traps

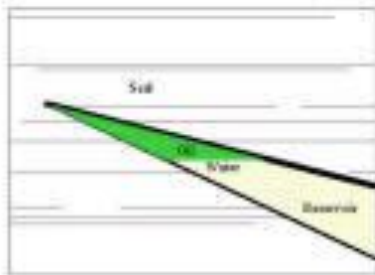


Anticline

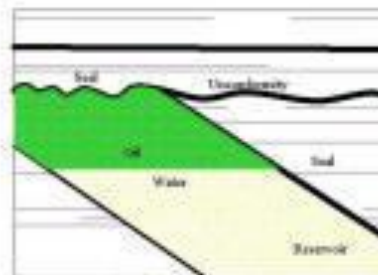


Fault

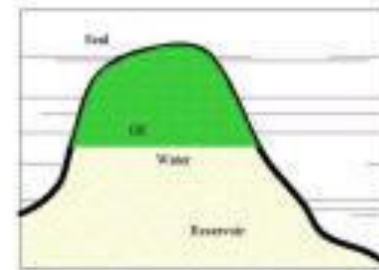
# Stratigraphic Traps



Pinchout



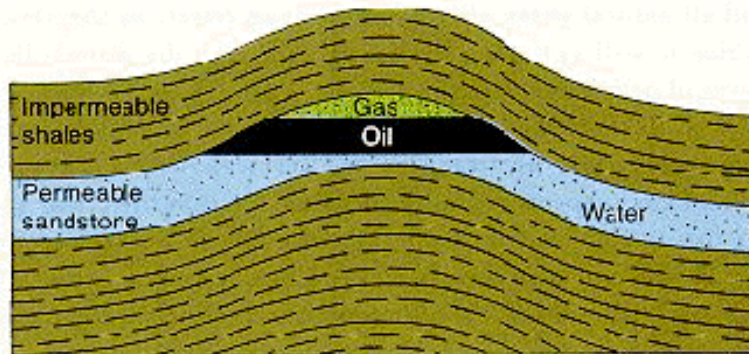
Unconformity



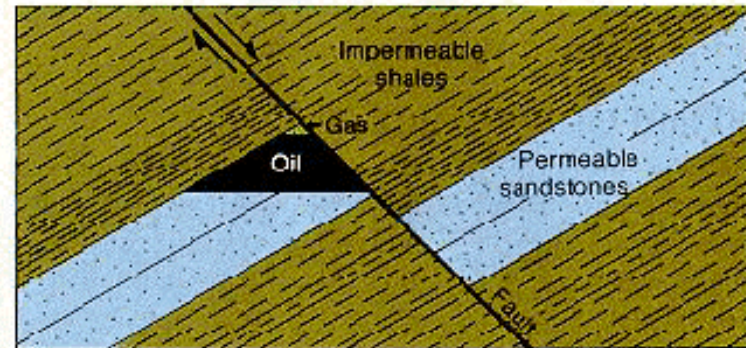
Reef



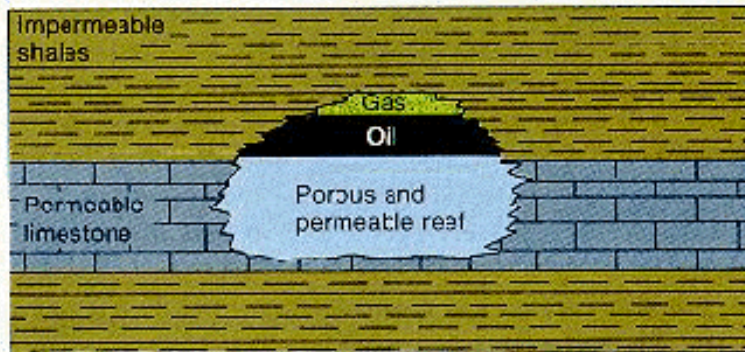
# OIL TRAPS



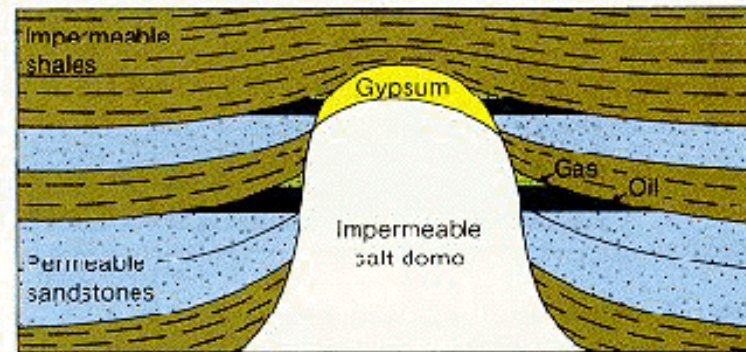
A



C



B



D

**Figure 13.4** Types of petroleum traps. (A) A simple fold trap. (B) Petroleum accumulated in a fossilized ancient coral reef. (C) A fault trap. (D) Petroleum trapped against an impermeable salt dome, which has risen up from a buried evaporite deposit.

# A PERFECT STORM

Without any one of the three key ingredients, there will be no economic reserves. Oil and gas may form, but will not accumulate in an easy to remove manner.



Tar Sands: Prolific potential source of petroleum.

Most petroleum in tar sands or shale oil, but it's expensive to produce.

Oil price high=exploration of these types of plays.



# OIL AND GAS IN FLORIDA

Oil and Gas Production in Florida began in 1943 in Collier County

Production is from porous limestone of the Sunniland (Cretaceous-age formation) in south florida

Southern florida traps are mainly structural and stratigraphic.

Jay Field (Panhandle)-Jurassic Smackover and Norphlet sandstone

Current production in southern Florida and the Panhandle

Production is the result of rifting and drifting during Pangea breakup and the large basins that formed during rifting.

# OFFSHORE DRILLING

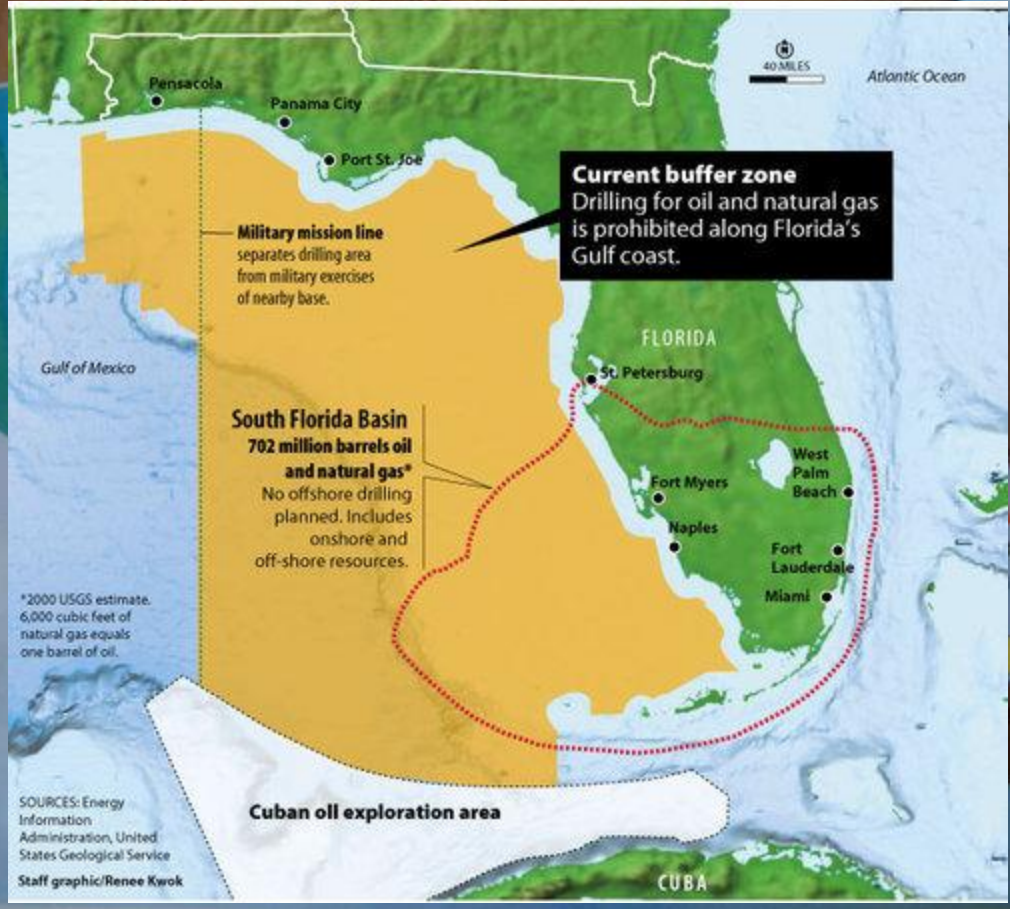
Politically Charged issue

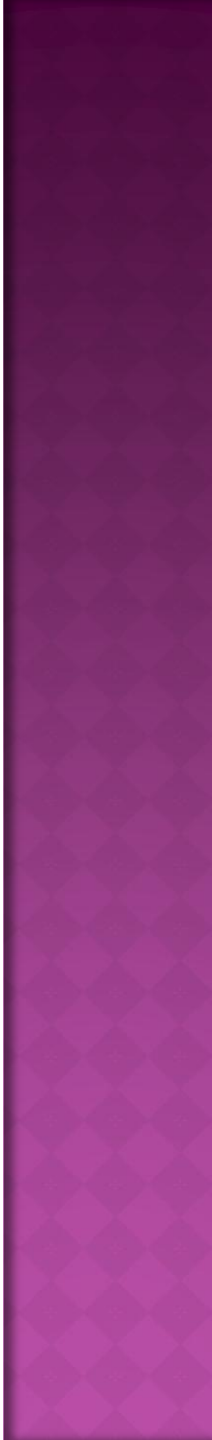
Offshore drilling was stopped in 1990

Previous attempts at offshore drilling showed only a single significant oil show.

Latest research indicates a decent gas potential in the Panhandle region and possible oil in southern Florida.

**Opinion:** Petroleum production is much safer today (in terms of environmental impact)....still #1 industry is tourism and the amount of petroleum is miniscule in comparison to tourism \$\$.











# PEAT

**Peat** forms when plant material, usually in marshy areas, is inhibited from decaying fully by acidic and anaerobic conditions. It is composed mainly of marshland vegetation: trees, grasses, fungi, as well as other types of organic remains, such as insects, and animal corpses. (1<sup>st</sup> stage in coal development)

Florida is the #2 producer of peat in the country.

Mainly used in agriculture, it can also be used as an alternative energy source.

# URANIUM

Although not a large topic of discussion, the phosphate in Florida contains (on average) about 100 ppm of uranium.

A metric ton will thus contain about one pound of uranium ore.

In 1979, reserves of uranium in Florida were estimated to be on the order of 225,000 tons!

This is a tremendous resource for nuclear energy.

# PHOSPHATE INDUSTRY

What are Phosphates?

What are phosphates used for?

How do phosphates form?

Where are the major phosphate resources in Florida?

Current Operations

# WHAT ARE PHOSPHATES?

Phosphorites are a rock type comprised primarily of  $P_2O_5$



Phosphorite in  
Kazakhstan  
(Cambrian-age)

Phosphorites are mined primarily for phosphorus which is used in agriculture as a fertilizer.

In your body, phosphorus is present in your genes, your teeth, and your bones -- even your muscles work because of the phosphorus in adenosine triphosphate.

In agriculture, phosphorus can often be a limiting nutrient for plant growth and so addition of phosphorus will encourage growth.

The phosphate molecule is negatively charged and is often combined with other elements to make salts such as

Orthophosphates Buffering - detergents, baking

Pyrophosphates Sequestering - water treatment, metal cleaning

Tripolyphosphates Dispersant - meat processing, dish detergent Polyphosphates

Dispersant - kaolin production, processed cheese

1  $\text{PO}_4^{-3}$  Orthophosphates

Based on number of P atoms

2  $\text{P}_2\text{O}_7^{-4}$  Pyrophosphates

3  $\text{p}_3\text{O}_{10}^{-5}$  Tripolyphosphates

>3  $\text{P}_n\text{O}_{(3n+1)}^{-(n+2)}$  Polyphosphates



# OTHER USES

Phosphoric acid-based chemical polishes are used primarily to chemically polish (brighten) aluminum and aluminum alloys.

Many phosphorus-containing materials are used as flame-retardants for textiles, plastics, coatings, paper, sealants and mastics.

"Phosphates and phosphoric acid have many uses in the treatment of potable (drinking) water.

Cleaning solutions with phosphates help clean mildew and stubborn stains on vinyl siding.

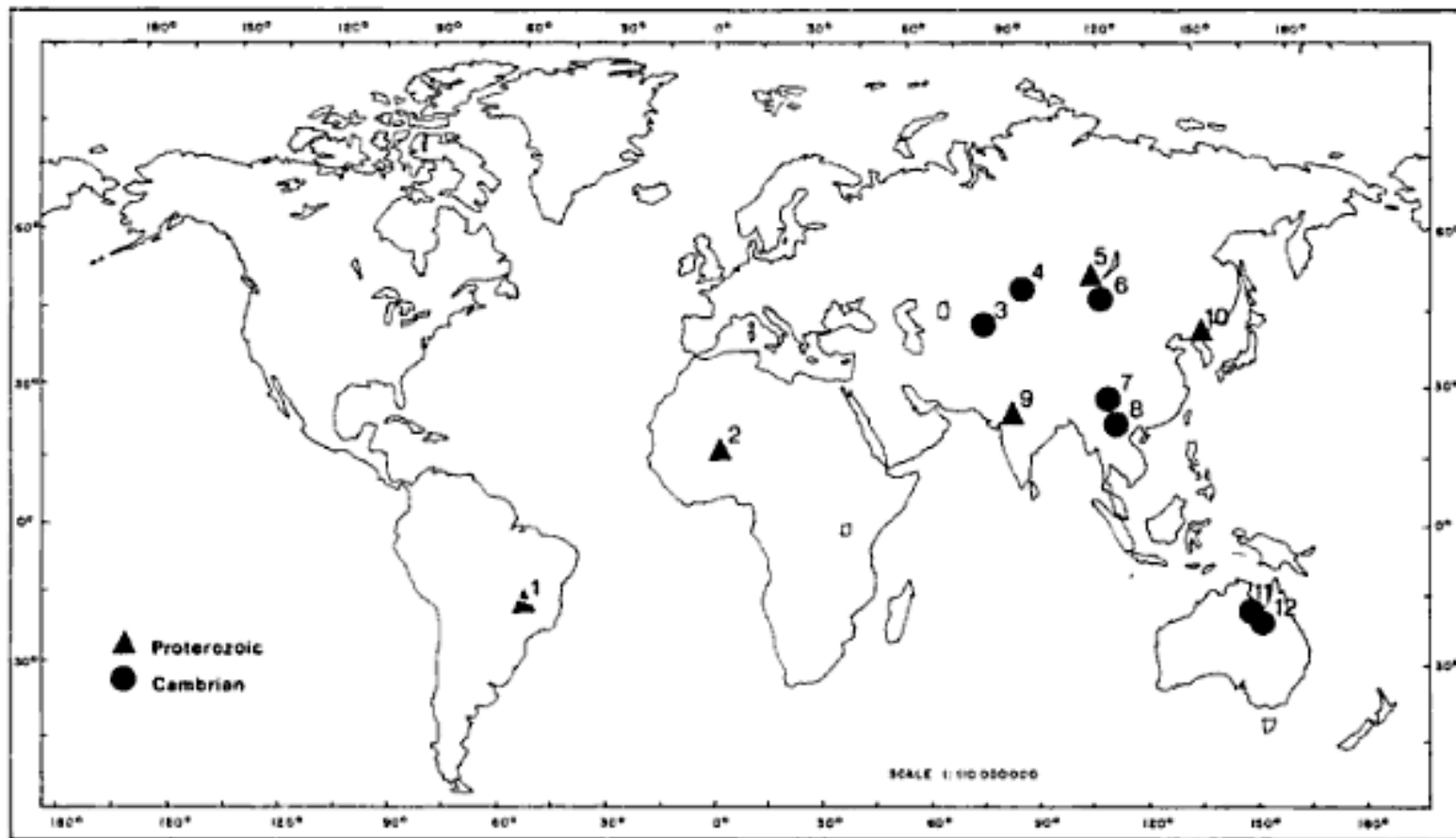
Common food additive

# HOW DO PHOSPHATES FORM?

## Global Phosphorogenic Events in Earth History

Cambrian and Late Neoproterozoic- Early hard shells were calcium phosphate rather than calcium carbonate (Lingula)

Many organisms (today) also incorporate calcium phosphate in their 'hard parts' including humans.

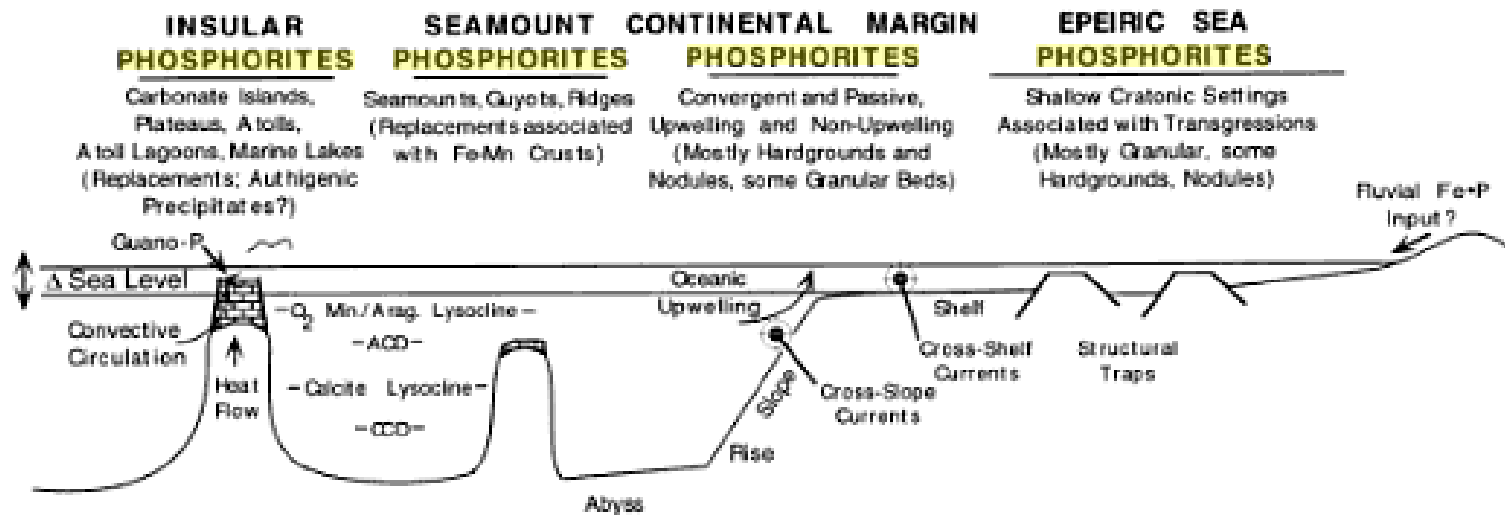


**Fig. 2.1. Distribution of major Proterozoic-Cambrian phosphorite resources.**

# OTHER PHOSPHOROGENIC PERIODS

Cretaceous to Eocene and Miocene- Time interval important for Floridian deposits.

The formation of major phosphorite deposits is controversial, but there are several suggestions/models.



**EXAMPLES:**

Modern  
Palau Is.  
Clipperton Atoll (?)

Ancient  
South Pacific:  
Naru, Benaba, Kita  
Daito Jima, Makatea,  
Line Islands

Indian Ocean:  
Aldabra and  
Christmas Is.

Modern  
Pacific Seamounts?  
(no data)

Ancient  
Pacific Seamounts  
Queensland Plateau

Modern  
Peru-Chile, Namibia,  
W. India, Baja California,  
E. Australia

Ancient  
Monterey Fm.,  
Phosphoria Fm.(?),  
SEUSA

Modern  
Absent

Ancient  
Many, e.g. see Glenn et al., 1994a;  
Cook and McElhinny, 1979

Figure P5 Tectonic and oceanographic settings of marine phosphorites as derived from studies of the modern and ancient record (after Glenn et al., 1994a, reprinted with permission of Birkhäuser Verlag AG).

# FLORIDA'S ARE CONTINENTAL MARGIN DEPOSITS

Apatite, the principal mineral, is the tenth most abundant mineral and occurs in a rock types. There are practically no phosphate deposits that contain 37%  $P_2O_5$ ; most are in the 10-20% range or lower (Florida is typically around 7% in the ground).

SEUS province contains about 10 billion tones of resources and reserves. Florida's economic reserves are estimated at 1-4 billion tons.

Preservation of deposits depends on tectonic setting (includes burial), climate, sea level, and oceanic circulation.

Miocene was a time of major climatic, tectonic, and oceanographic changes.

Francolite is the main phosphate mineral in sedimentary phosphatic rocks.



# MINERALS

Apatite



$\text{Ca}_5(\text{PO}_4)_3(\text{OH}, \text{F}, \text{Cl})$ , Calcium (Fluoro, Chloro, Hydroxyl) Phosphate



Francolite



# MAJOR SOURCE IN FLORIDA: HAWTHORNE GROUP

Environment: Both high and low energy on shore and shelf environments

Found in all rock types present (limestone, dolostone, mudstones and sands).

Age is not well constrained

- a) Base is Latest Oligocene based on microfossils
- b) Top is Early Pliocene based on Bone Valley fossils
- c) Main Phosphogenesis seems to be early to mid-Middle Miocene

# MAJOR MINING REGIONS

## a) Paleotopographic highs and lows

### (1) Highs

- (a) Ocala
- (b) Brevard
- (c) Sanford
- (d) St. Johns Platform

### (2) Lows

- (a) Jacksonville Basin (SE Georgia Embayment)
- (b) Florida Platform
- (c) Okeechobee Basin

# MAP

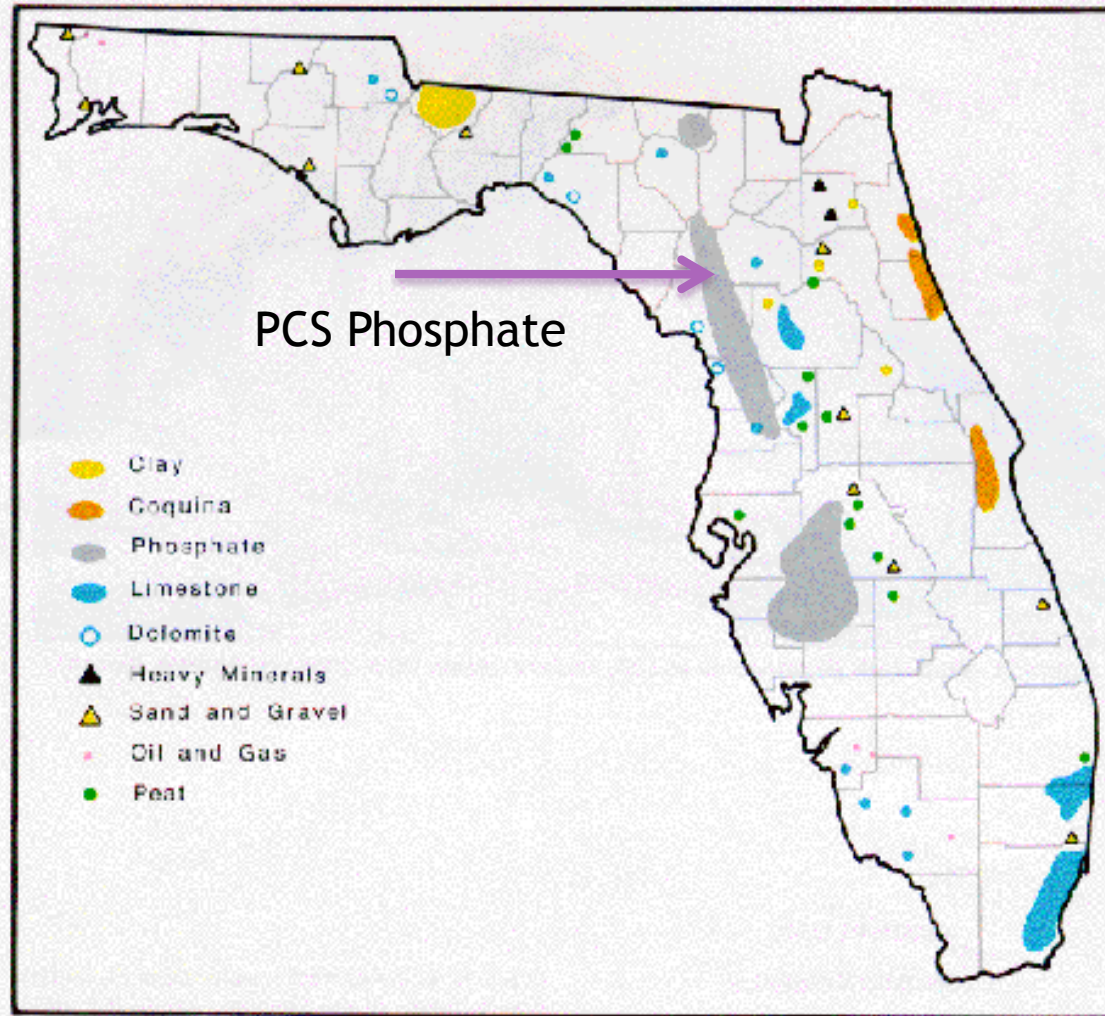
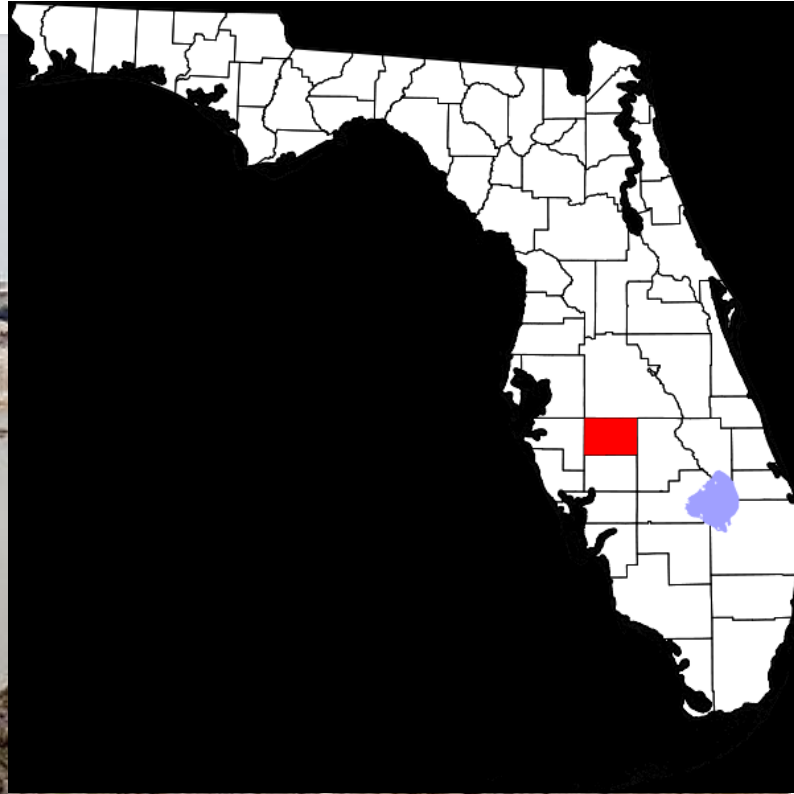


Figure 22. Generalized map of mineral mining areas in Florida. Compiled by Steven Spencer.

# BIGGEST MINE



Open pit mine in Hardee County Florida: 75% of US phosphate is mined in Central Florida!





Aerial Photo of Phosphate Mine in Central Florida





# MAJOR COMPANIES IN FLORIDA

PCS Phosphate

Mosaic Fertilizer

CF Industry Holdings

# ENVIRONMENTAL ISSUES

The New York Times

U.S.

WORLD U.S. N.Y. / REGION BUSINESS TECHNOLOGY SCIENCE HEALTH SPORTS O  
POLITICS WASHINGTON EDUCATION



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L

## Florida Counties Try to Contain Phosphate Mines

Open pit mining is a destructive process- removes topsoil, creates contaminated ponds and results in destructive runoff.



# HEAVY MINERAL INDUSTRY

Dupont Dominates the US Heavy Mineral Industry

Major Source is the “Trail Ridge Deposit” in Florida

Titanium is one of the key elements targeted by the heavy mineral industry

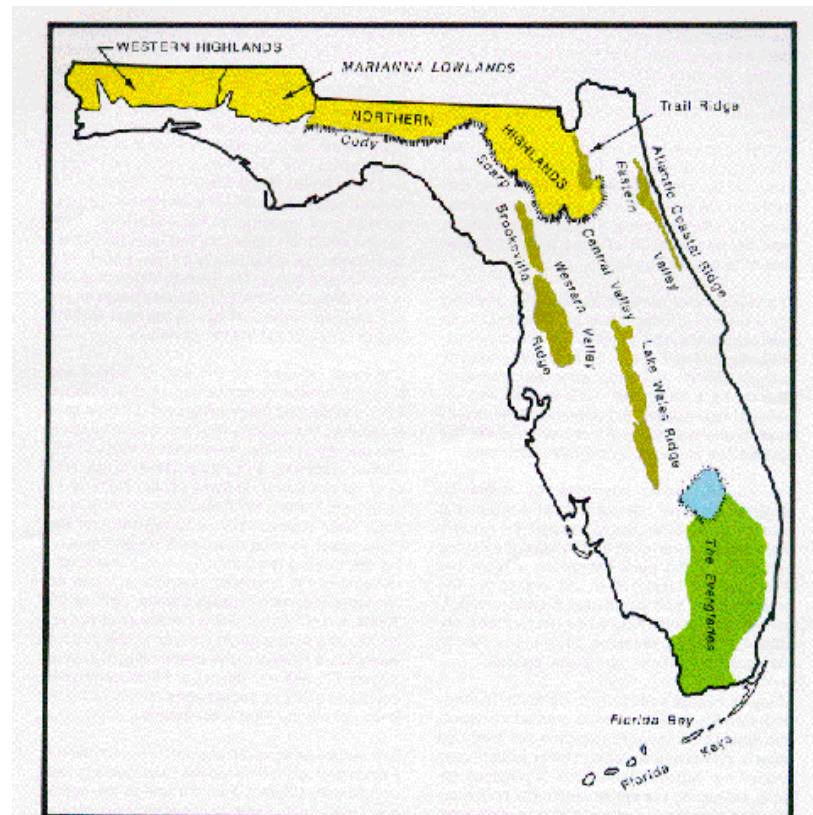


Figure 17. Major topographic features formed or shaped by Pleistocene seas. Illustration by Frank R. Rupert.



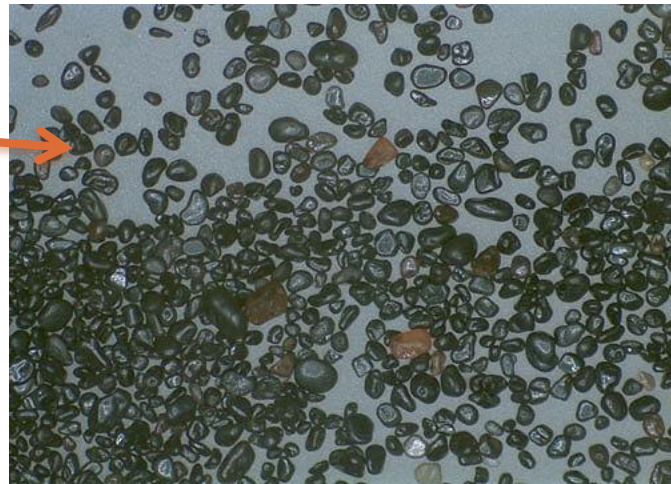
# Major Minerals in Trail Ridge

Ilmenite

Rutile

Zircon

Sphene



# CHEMISTRY

Zircon-  $\text{ZrSiO}_4$

Ilmenite-  $\text{FeTiO}_3$

Rutile-  $\text{TiO}_2$

Sphene (titanite)- $\text{CaTiSiO}_5$

# SETTING OF TRAIL RIDGE

Beach Sands deposited during Pleistocene high stands of sea level

Or maybe, these deposits were uplifted during karstification of Florida following sea level drops during the Pleistocene glaciations!

# HEAVY MINERAL USES

**Titanium:** These minerals are used to produce titanium dioxide (TiO<sub>2</sub>) pigment, titanium metal and welding rod coatings. TiO<sub>2</sub> pigment is characterized by its purity, refractive index, particle size, and surface properties. The titanium oxide pigment is processed into a non-toxic white pigment for use in the paints, plastics, paper, ink, textile and ceramics industries. Titanium metal is used as a strong, lightweight, corrosion resistant metal for use in aircraft and spacecraft bodies.

**Zircon:** is used in refractories in foundry sand moulds, zircon sand in glazes used in pottery and ceramic applications. Zircon is also used as a corrosion resistant metal used in nuclear reactors and chemical processing equipment.