

# **THE ROLE OF MICROPALEONTOLOGY IN ASSISTING WITH THE CHARACTERIZATION OF THE GEOLOGY BENEATH FAILED NEW ORLEANS LEVEES, LOUISIANA**

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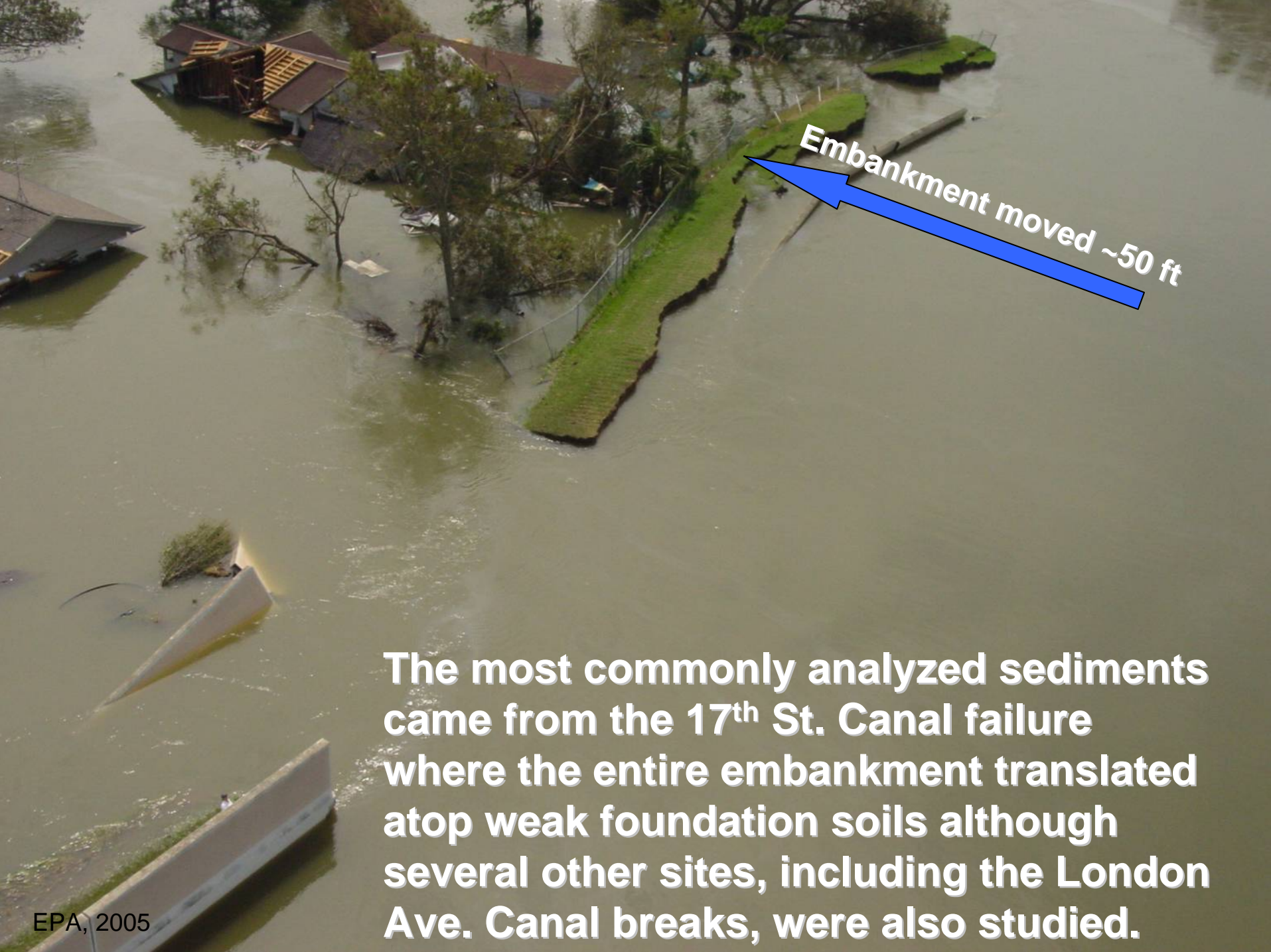
**University of Missouri – Rolla**

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# Investigation of Failed New Orleans Levees

- In Jan-Feb 2006, we participated in the National Science Foundation's Independent Levee Investigation Team (ILIT) administered through the University of California-Berkeley.
- Drilling was conducted to enhance site characterization and recover specimens for laboratory testing. These included tests to determine the mechanical and hydrologic properties of the soils underlying the failure sites.
- Micropaleontology was also conducted in conjunction with C14 dating to ascertain the depositional environment of the soils along with the likely rates of deposition.
- The presence of some fossils can be useful in determining the recurrence frequency of damaging events, such as hurricanes.



Embankment moved ~50 ft

The most commonly analyzed sediments came from the 17<sup>th</sup> St. Canal failure where the entire embankment translated atop weak foundation soils although several other sites, including the London Ave. Canal breaks, were also studied.

# Micropaleontology

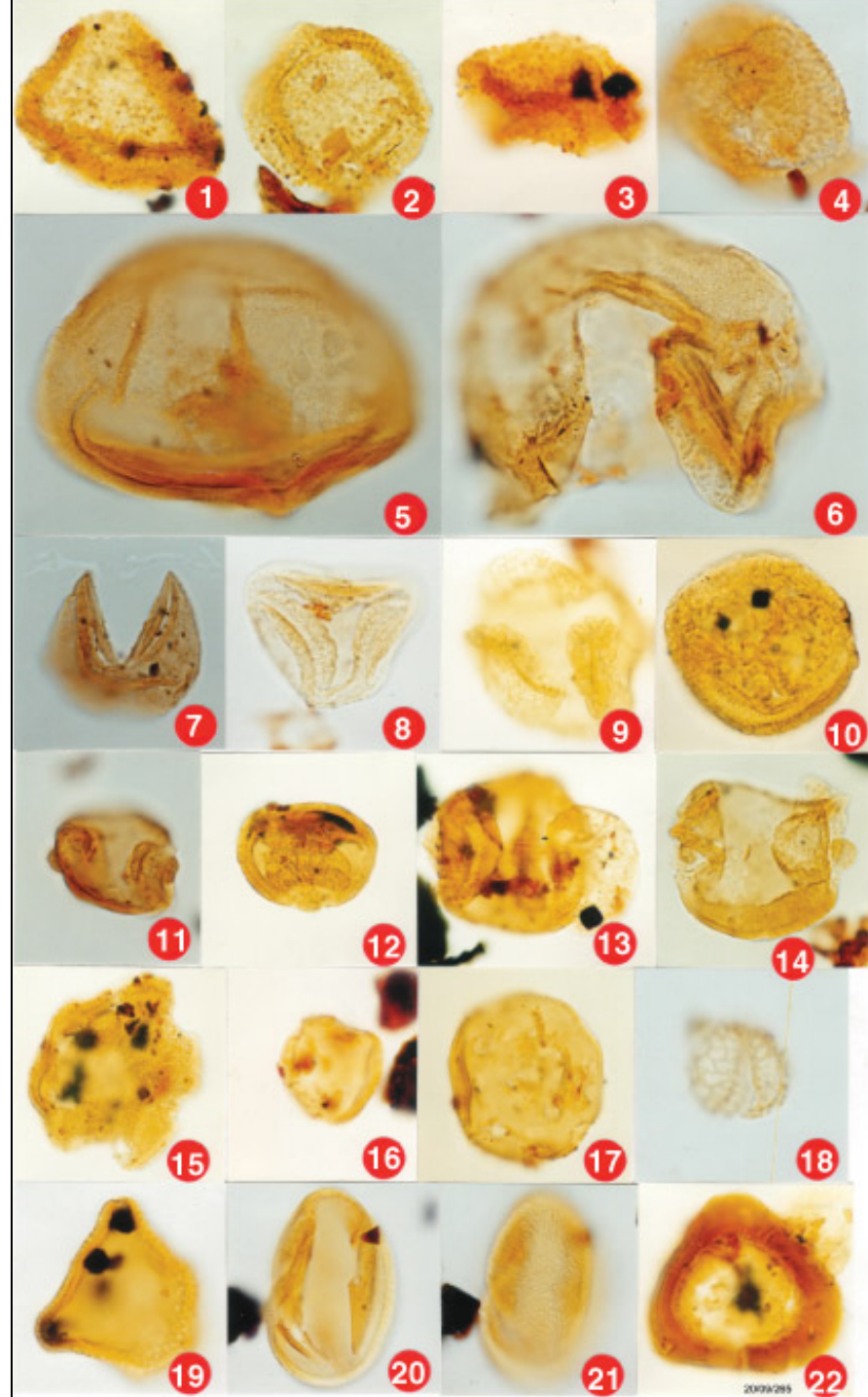
- **Micropaleontology deals with the identification and study of very small fossils including palynomorphs, foraminifera, and several others.**
- **Micropaleontology provides a valuable tool to engineers and researchers looking to study the depositional environment of soils at a site.**
- **For our needs, these fossils can be indicative of the frequency of hurricanes, but they can also be used to study earthquakes, tsunamis, and other geologic events.**



**These dark organic rich clays have been immersed below the water table in a low oxygen environment since deposition and are ideal candidates for the recovery of palynomorphs.**

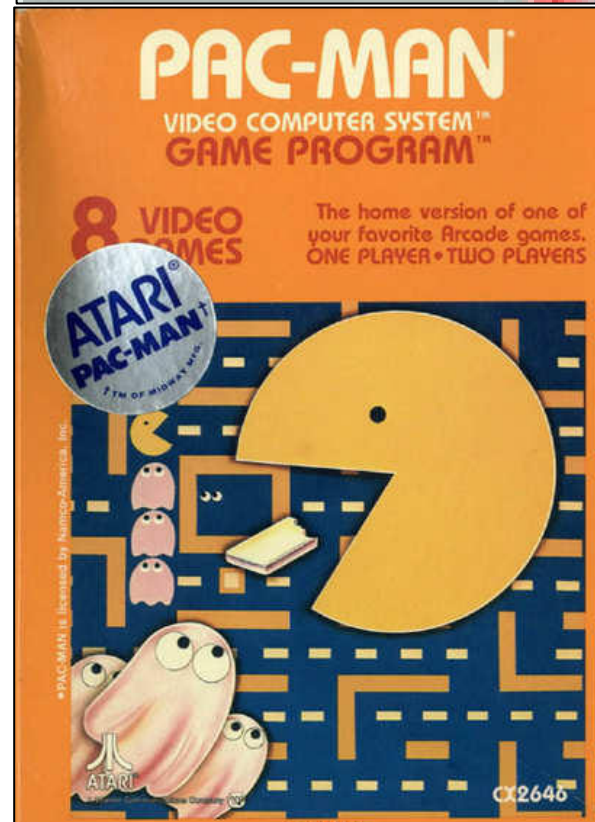
# Palynology

- Palynology is the identification and study of organic walled microfossils, commonly pollens and spores.
- Fossils are called palynomorphs.
- Palynomorphs are generally very small and a small soil sample will usually contain hundreds, if not thousands, of specimens.
- Palynomorphs tend to survive conditions that obliterate macrofossils.



# *Cupressacites* sp. (Cypress)

- Extensive swamps of **bald cypress** once covered much of New Orleans and the south shores of Lake Pontchartrain, during the late Holocene up through initial development in the 20<sup>th</sup> Century.
- These trees belong to the genus *Cupressacities*.
- *Cupressacities* pollen has a distinctive appearance, looking much like Pac-Man with his mouth open.



1878

# Hardee Map

City Engineer Hardee's map shows the cypress swamps that once covered a large portion of what now composes the Lakeview and Gentilly neighborhoods of New Orleans along the south shores of Lake Pontchartrain.







Zoomed view of 1878 map showing cypress swamps along south shore of Lake Pontchartrain.

# Cypress Swamps

- Ample amounts of cypress pollen were identified in our samples, which is not surprising, given the abundance of cypress swamps in the Mississippi Deltaic Plain.
- Cypress thrive in freshwater and will **DIE** if exposed to salt water for prolonged periods of time.
- Other interesting palynomorphs that were very out of place turned up in our samples...





**Drilling into the foundation soils beneath both failed and intact levees routinely brought up cores of cypress wood, peat, and highly organic clays, indicative of old swamps.**





**Closeup of a cypress wood core from beneath the 17<sup>th</sup> St. Canal levees.**

# Dinocysts/Dinoflagellates

- Dinoflagellates are a single celled algae belonging to the Kingdom Protista and are commonly preserved palynomorphs.
- These organisms live in salty or brackish water with limited occurrence in freshwater settings.
- These organisms are often the culprits that make people sick after drinking bad water.



# Dinocysts/Dinoflagellates

- The presence of dinoflagellates wasn't a huge surprise, given the proximity of the area to brackish Lake Pontchartrain. Tropical storm surges likely transported these from the lake and then retreated.
- On the other hand, several **marine** species of dinocysts that live **exclusively** in open seas were also recovered.
- This is indicative of **POWERFUL** hurricanes transporting waters from the open ocean far inland.
- These were discovered in **ALL** the soil samples analyzed, indicating a relatively high frequency of powerful hurricanes, in a geologic time scale.
- These dinocysts were distributed throughout the city in different depositional environments and at all depths.

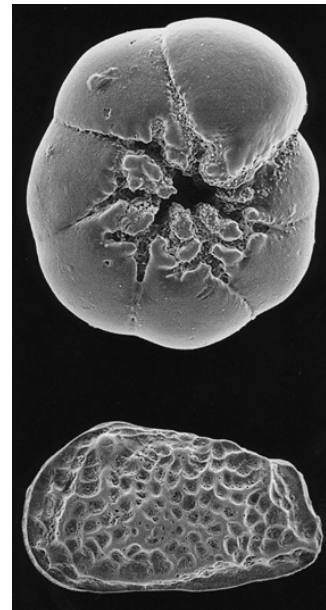
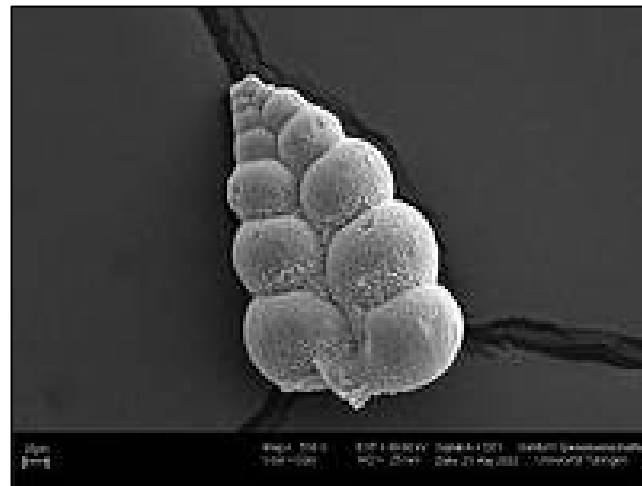
# Identification of Foraminifera (Forams)





# Foraminifera...

- Are unicellular protists that secrete a mineralized shell or test, usually of a microscopic scale.
- Grow exclusively in salty and brackish waters with none living in freshwater.
- Are usually small and need to be viewed under a microscope for proper identification. Some specimens are of a macro scale although most appear as grains of sand to the naked eye.



# Foraminifera

- **Foraminiferal tests were recovered in sand from the Pine Island Trend, a prehistoric spit of micaceous quartz beach sand originating from the Pearl River in Mississippi.**
- **This spit helped to separate Lake Pontchartrain from the Gulf of Mexico during mid Holocene time.**
- **This deposit underlies the Lakeview and Gentilly neighborhoods of lower New Orleans.**



**These sandy cores were recovered just below the interface of the prehistoric swamp and the Pine Island Trend and contained numerous foraminifera. These sands are dirty and contain numerous shells fragmented by storms. The Pine Island trend sands become very clean and are not recoverable using a standard Shelby tubes due to their low cohesion a few feet below the interface.**

# Foraminifera

- **Agglutinated, planispiral, and uniserial foraminifera were discovered where the sand grades into the silts and clays deposited in the low energy environments of Lake Pontchartrain.**
- **Although foraminifera are abundant at these locations, their diversity is low.**
- **This is indicative a stressed environment and is not surprising, given the brackish nature of Lake Pontchartrain.**

# Other Fossils

- **Macrofossils of the phylum *Mollusca*, including classes *Gastropoda* and *Bivalvia* are common in sands of the Pine Island Trend (Rowett, 1958).**
- **Most recovered samples contained heavily damaged shells or fragments.**



**Bivalve shells ejected by high pore pressures emanating from toe thrusts on landside of failed levee at the 17 Street Canal (detail view at upper left). These came from a distinctive horizon at a depth of 2 to 5 feet below the pre-failure grade.**

# Highly Organic Plastic Clays

- **Zones and lenses of highly organic plastic clay were commonly recovered during drilling.**
- **These zones are often indicative of hurricanes bringing in brackish water, which flocculates clays in the swamps, allowing them to precipitate.**
- **These clays often flocculate as clumps or “berries.”**



**Clay “berries” and shell fragments recovered during the processing of a sandy soil for foraminifera analysis**



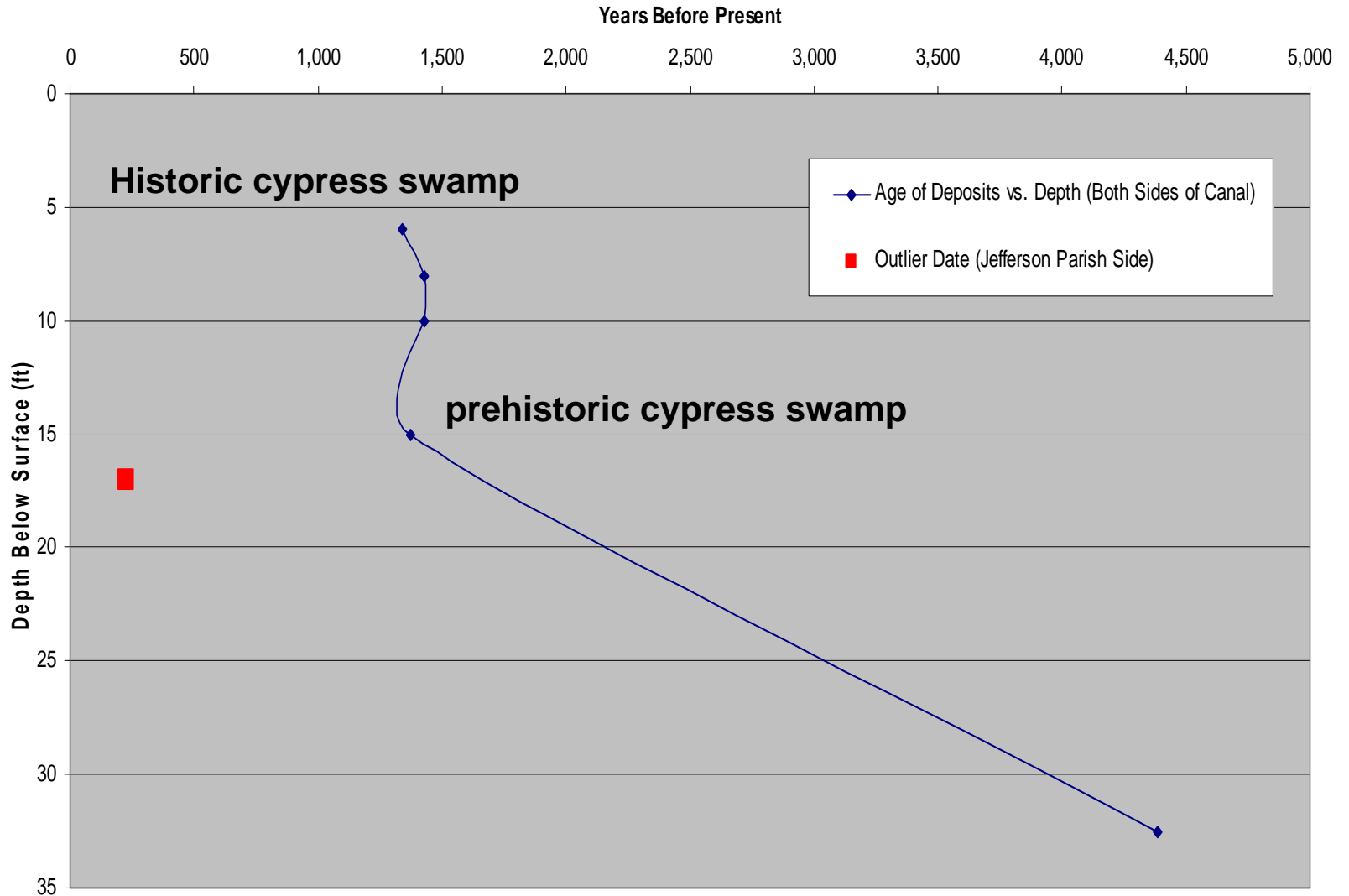


**Clay “berries” and shell fragments recovered during the processing of a sandy soil for foraminifera analysis**

# **Carbon 14 Dating of Soils Beneath the 17<sup>th</sup> St. Canal Failure**

- **Six samples recovered beneath both the Orleans and Jefferson Parish sides of the 17<sup>th</sup> St. Canal failure were sent to the NSF-Arizona AMS Laboratory for C14 dating.**
- **These dates spanned a historic swamp, prehistoric swamp, and the Pine Island Trend sands.**
- **The soils in this area appear to have been deposited in the last 4500 years.**

# Age of Deposits vs. Depth in Vicinity of 17th St. Canal Breach



**C14 dates and depths suggest a rapidly filling paludal environment during the late Holocene.**

# Conclusions

- **Micropaleontology has multiple applications in the field of engineering geology and should not be overlooked, especially on important projects in HIGH RISK areas such as New Orleans.**
- **It can be used to determine the depositional environment of soils by determining the family, genus, and species of organisms living at the time of deposition.**
- **It can be used to determine the recurrence interval of damaging events, including, but not limited to, hurricanes, tsunamis, earthquakes, and landslides.**