Diatomite in Upper Eocene Jackson Group, Fayette County, Texas

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EXTENDED ABSTRACT

Deposits of diatomite and diatom-rich sediments are present in Upper Eocene strata of the Jackson Group in Fayette County, Texas (Fig. 1). Diatoms and siliceous sponge spicules occur in Upper Eocene sediment in several areas of East and Central Texas, but only southern Fayette County is known to contain sediment with diatoms being the dominant component of the sediment. Diatomite sediment has not previously been reported in Paleogene strata of the northwestern Gulf of Mexico. The diatomite was recognized while exploring for volcanic ash beds suitable for radiometric dating.

The diatomite occurs in an upward-shallowing portion of a thick parasequence deposit. The Upper Eocene Jackson Group in Texas (Fig. 2) contains multiple cyclic deposits of mudstone capped with sandstones. Many of the sandstones were subaerially exposed and cemented with silica (McBride et al., 2012; Yancey and Heintz, 2015). Jackson Group strata in Texas contain many volcanic ash beds (Heintz et al., 2015) and diatoms are present in marine sediments containing volcanic ash glass shards, a probable source of the dissolved silica used for formation of opaline diatom frustules. The presence of elevated levels of dissolved silica in water is also indicated by the common co-occurrence of siliceous sponge spicules in the sediments.

A 6 m (20 ft) section of diatom-bearing sediment was sampled and studied to determine character of the sediment and depositional environment (Fig. 3). The section is dominantly diatomite with some thin layers of quartzose sand/silt. Beds of both lithologies are laminated and laterally extensive within the outcrop area (Fig. 4). Diatomite layers throughout the exposure have similar character, consisting of 30–40% clay mud, composed of kaolinite and secondary smectite, and 50–70% diatoms, with small amounts of silt. The diatomite has varve-like lamination with diatom laminae separated by very thin silt laminae (Fig. 5). The thin sandstones have variable thickness, planar lamination with minimal cross-bedding, a grain size of very fine sand or coarse silt, and contain some volcanic glass shards. The minerals quartz, sanidine, and cristobalite are identified in the sediment and small amounts of carbonate occur in basal strata of the section.

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Diatomite in Late Eocene Jackson Group, Fayette County, Texas

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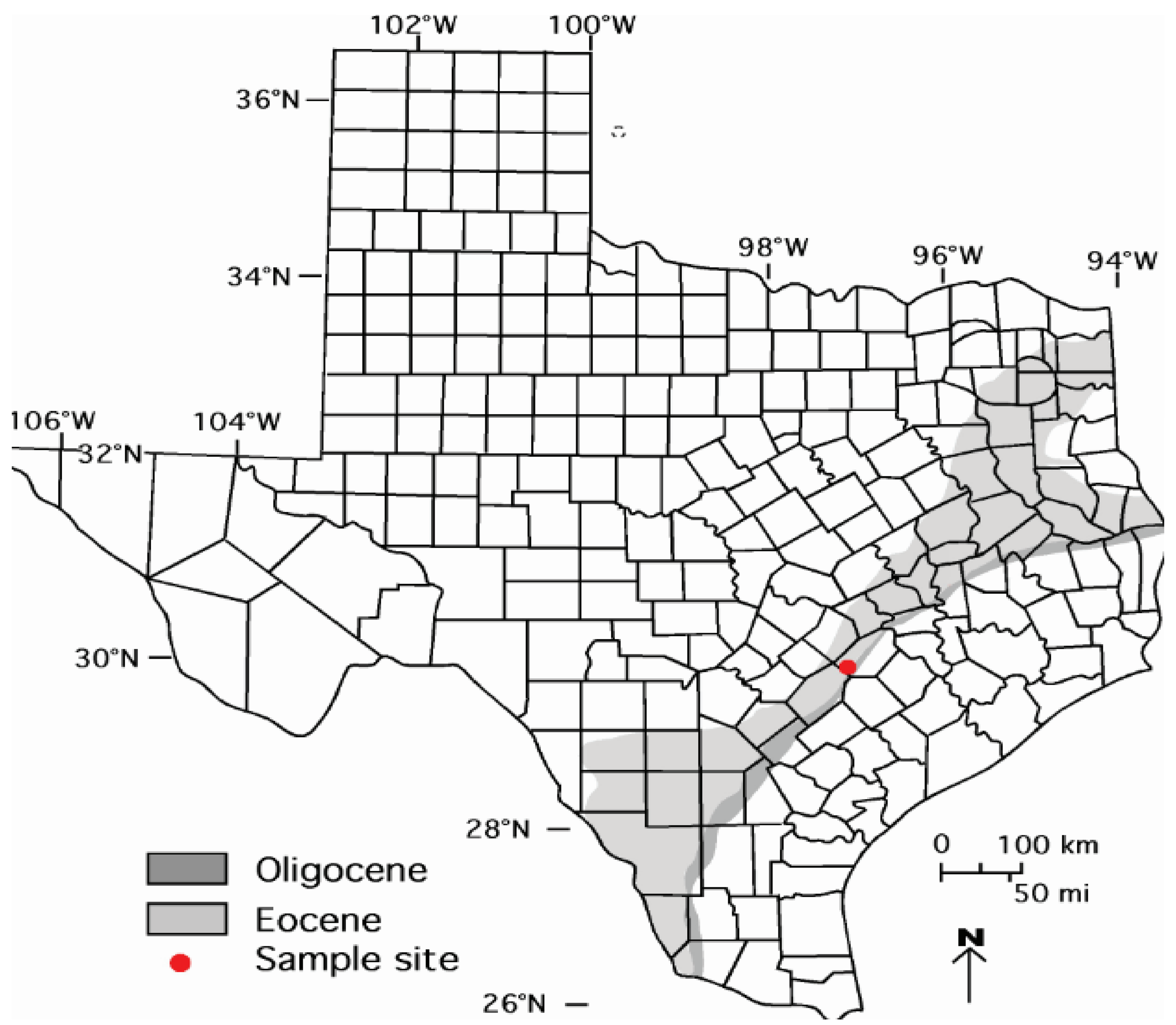
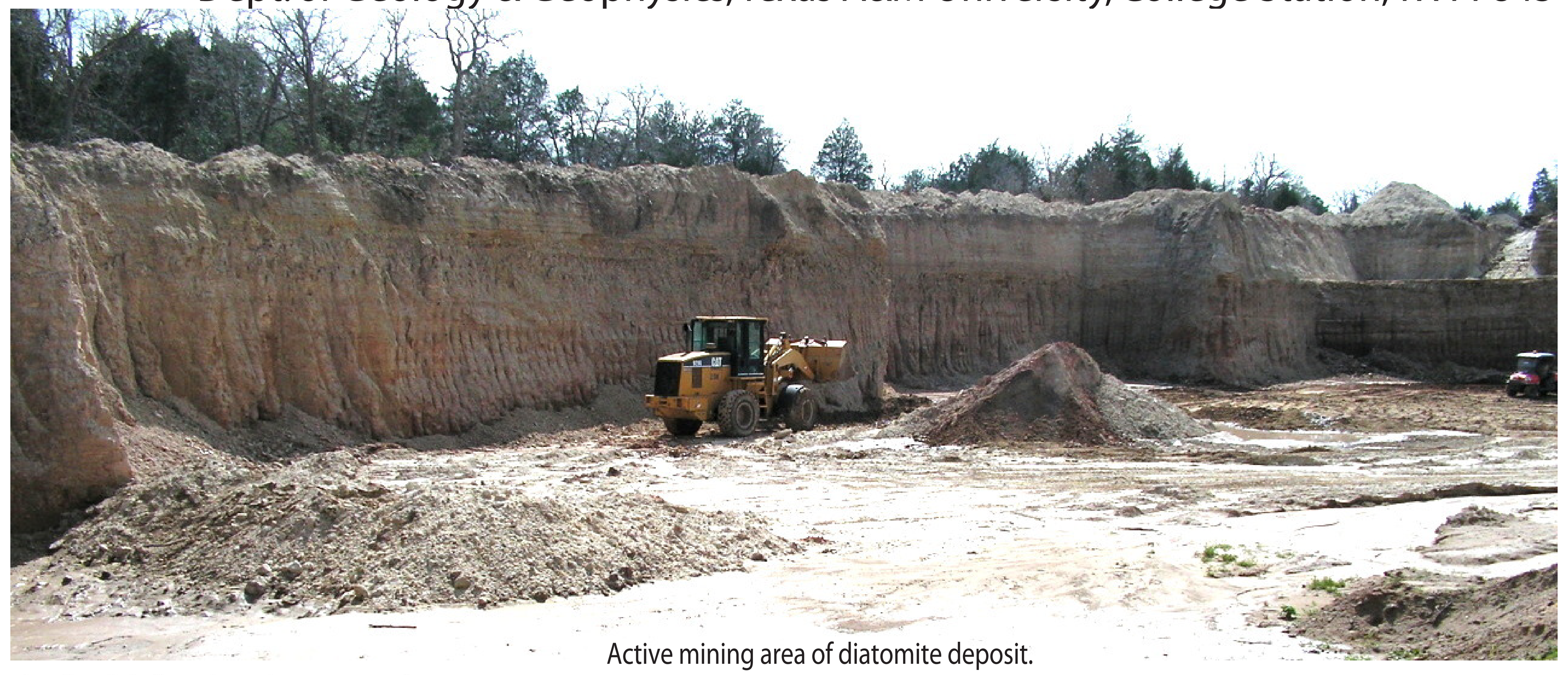
Abstract

A 6 m (20 feet) section of diatomite was sampled and studied to determine the character of the sediment and its depositional environment. The section is dominantly diatomite with some thin layers of storm sand and sand laminae. Diatomite layers throughout the section are similar, consisting of 50-60 % diatoms, 20-30 % clay and silt, and 5-10 % silicate grains. The diatomite is laminated and has planar bedding with numerous very thin laminae of silt grains and some volcanic glass shards separating diatom-rich layers. The minerals smectite, quartz, and sanidine and opal-A are present in the sediment. The diatomite has low density and high porosity resulting from framework support provided by diatom skeletons, unfilled interiors of diatoms, and leaching/oxidation of carbonaceous and soluble materials. The diatom skeletons are unaltered and have an opal-A composition and a glassy appearance. Samples taken within 8 m (20 feet) of the ground surface are oxidized and contain macroporosity created by oxidation and leaching. Unfilled horizonal burrows are common in diatomite. Sediment taken from lower levels has a darker reddish-brown color from iron oxide staining. The sediments were deposited in an inner shelf marine depositional environment. Most diatoms are preserved with both valves together and long chains of Paralia diatoms are a dominant component of the diatom assemblage.

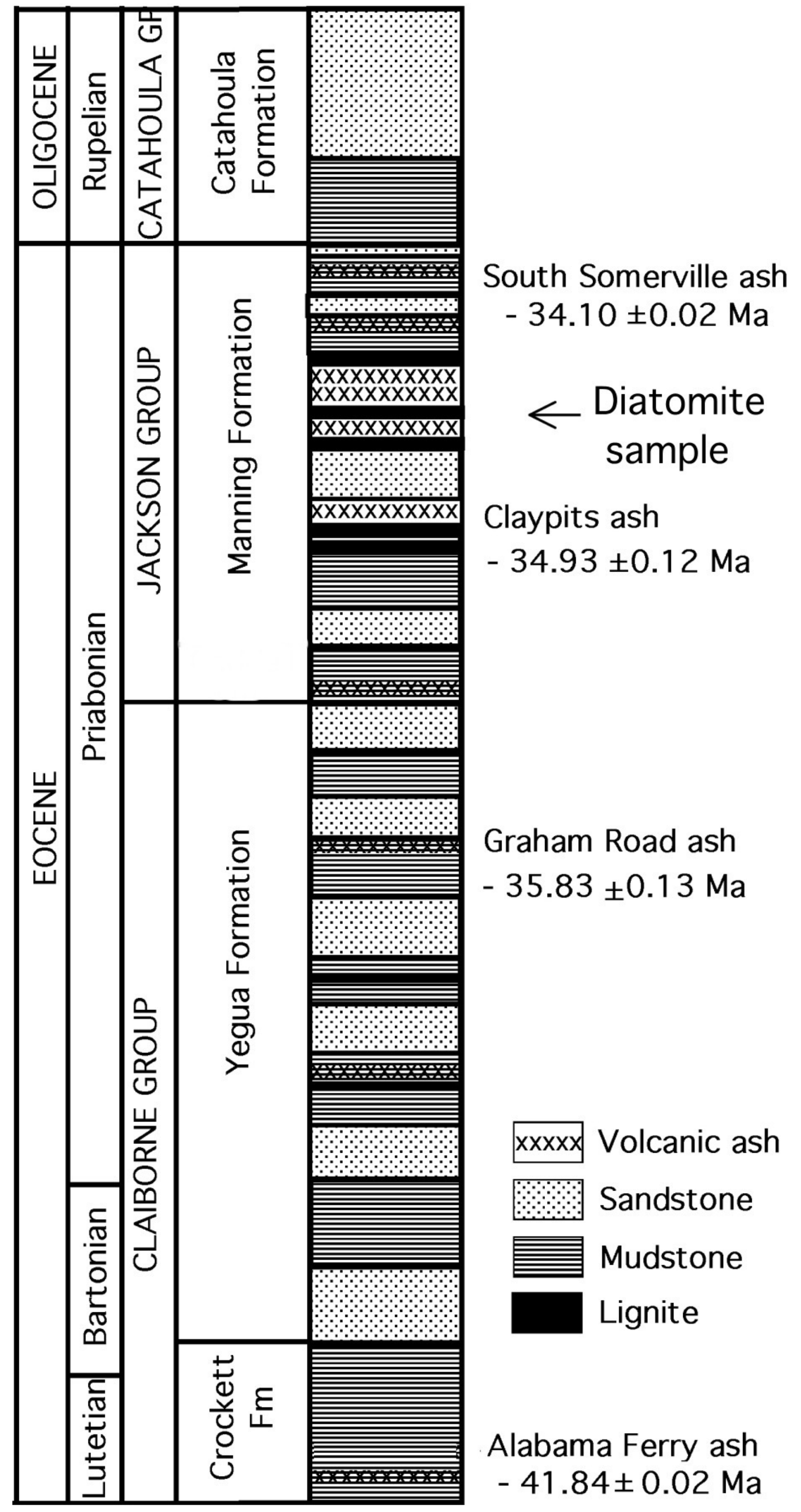
The discovery of diatomite in Texas is a great surprise, especially in quantity large enough to be a commercial product. The presence of fully marine deposits is also surprising in an part of the section often considered to be nonmarine.



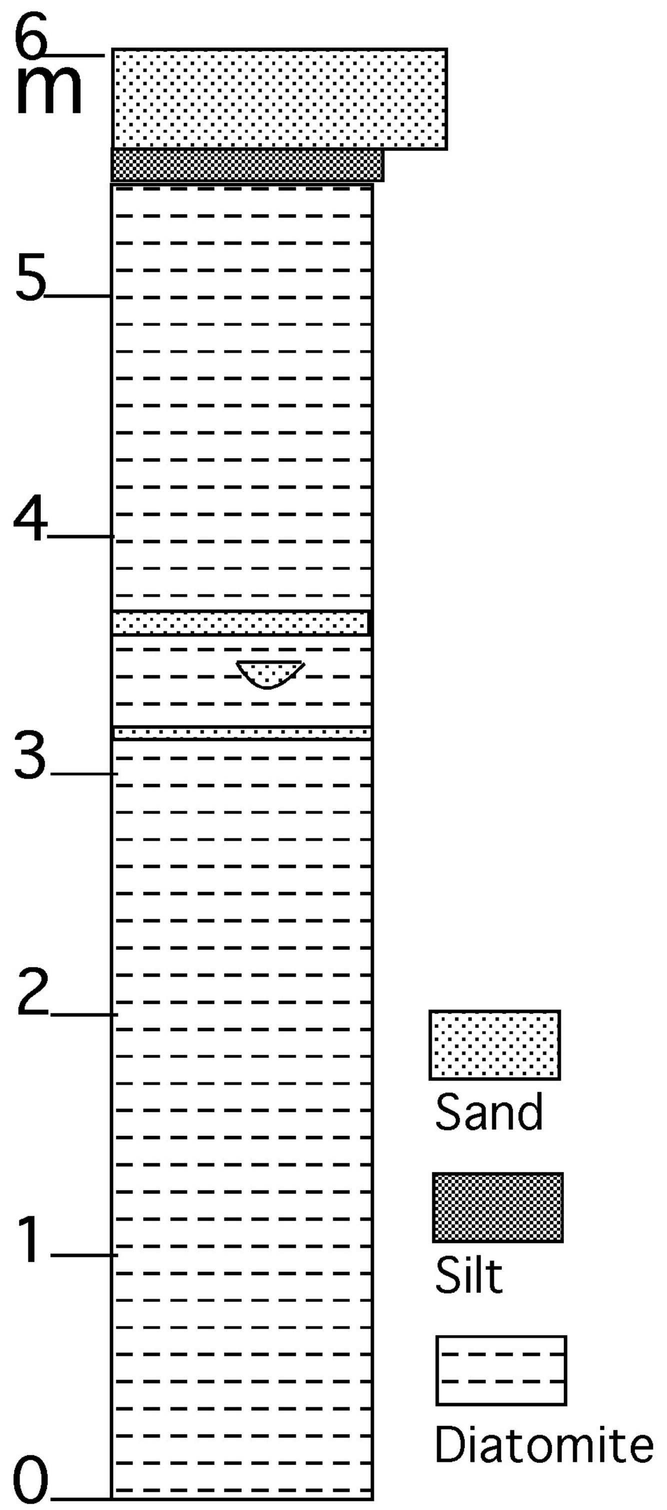
Location of study area.



Active mining area of diatomite deposit.



Stratigraphic occurrence of diatomite deposit.



Stratigraphic section of the diatomite deposit.

Sediments

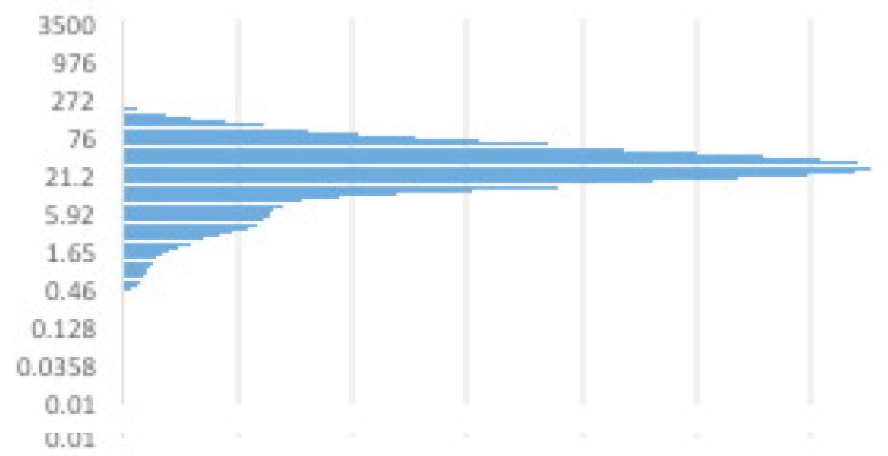
Diatomite deposit exposed along the north wall of quarry, Flatonia, Texas, where the deposit is capped with a sandstone bed (dark band). White band (center) is a storm sand; light material at top is spoil. Scale bar 5 m.

The diatomite consists of thin bedded and laminated layers composed of abundant diatoms mixed in a ~ 3:2 ratio with clay-silt and small amounts of fine sand, with small amounts of silicate grains present in most diatomite beds.. Thin laminae of fine sand occurs between thicker diatomite bed. Bedding is laterally continuous at small and large scales throughout the section and the sediment breaks into equant blocks by separation along sand laminae. There is little difference in sediment grain size apart from the transition to the capping sandstone. Diatomite has a light reddish color when fresh that fades to gray on exposure. Well sorted storm sands have very fine sand grain size and appear white in contrast to reddish diatomite. Diatomite quarried for use is very light weight, with high porosity.

Measuring and describing the section.

Diatomite and storm sands in 2 m to 4 m position in section. White band near top is storm sand; sand-filled gutter above hammer. Diatomite deformed around gutter.

Thin bedded and laminatd diatomite sediment at 3.8 m level in section. Divisions on staff at 10 cm intervals.



Grain size of diatomite sediment, measured wet with Mastersizer, TAMU, College Station. Grain size scale in micron on vertical axis, mode at ~40 micron .

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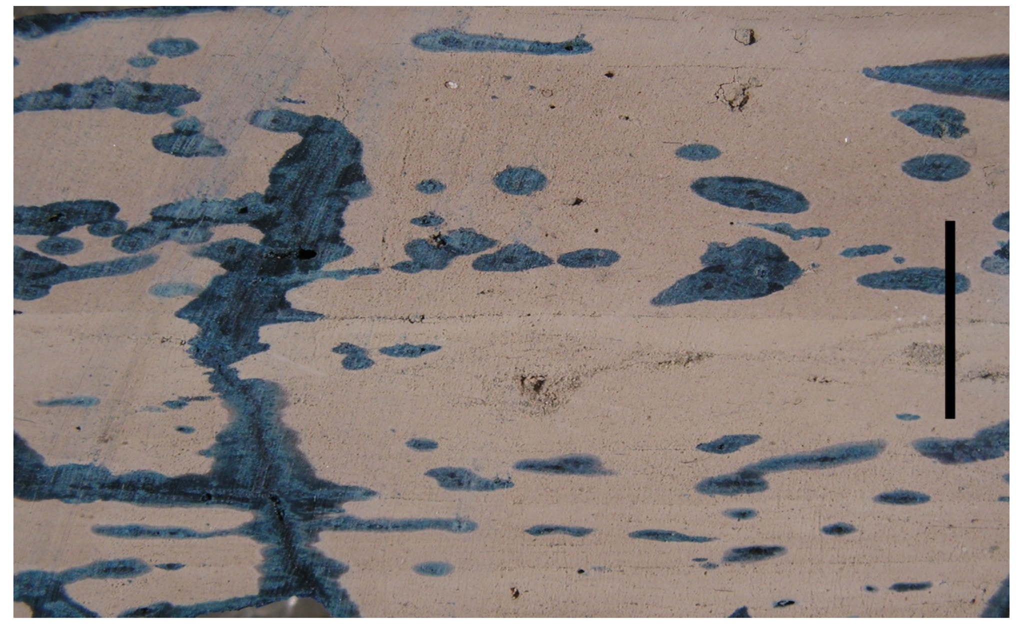
Sediment porosity

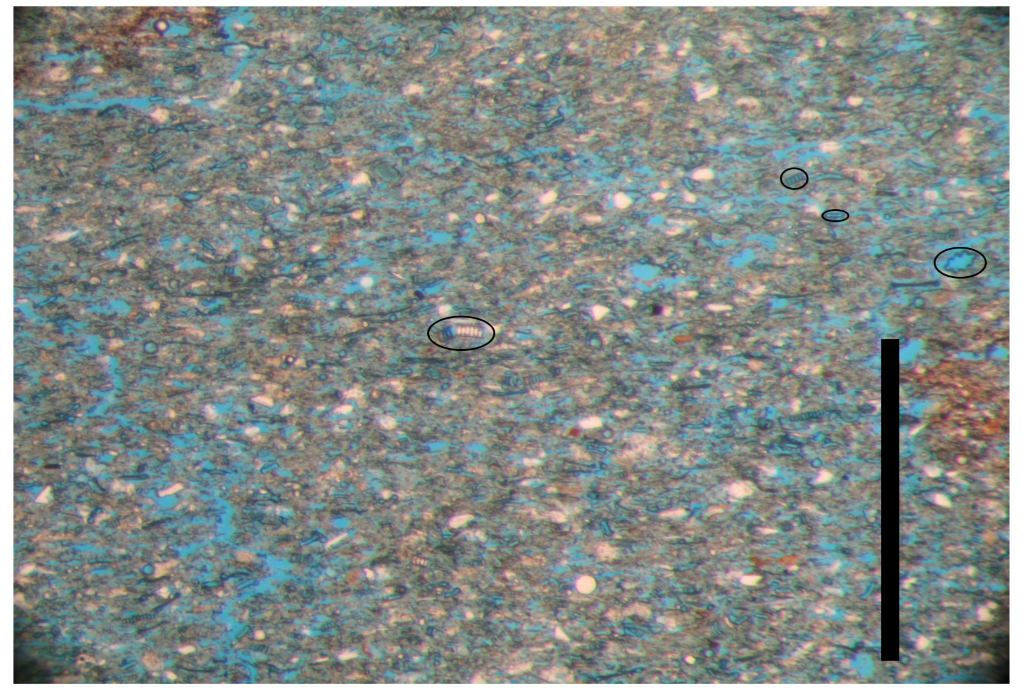
The diatomite has total MICP porosity of 63-65 % volume, measured by Doug McCarty, Chevron ETC, Houston, Texas. There is macroporosity produced by removal of soluble and oxidizable particles and unfilled pores in sand and silt layers, macroporosity produced by loose packing of diatoms and unfilled diatom skeletons, and micoporosity in the mud matrix. Storm sands and silt layers are unconsolidated, with minimal matrix between grains. The presenceof large pores and openings in th sediment allows for rapid uptake of fluids.

Sample File	HGTC #	Sample Tray	Inst. Porosity	Est. Porosity	Inst. Total Intrusion	Bulk Density	App. Density
E1840	#1	1	63.34	?	0.6603	0.959	2.616
E1841	#2	2	65.52	?	0.7715	0.849	2.463

Porosity and density data of diatomi (D. McCarty, Chevron)



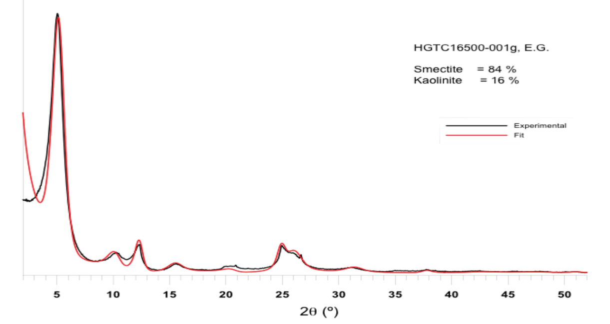
Diatomite sediment with pores filled by blue epoxy along fractures and in open burrows of sediment. Sample from 1.7 m in section.



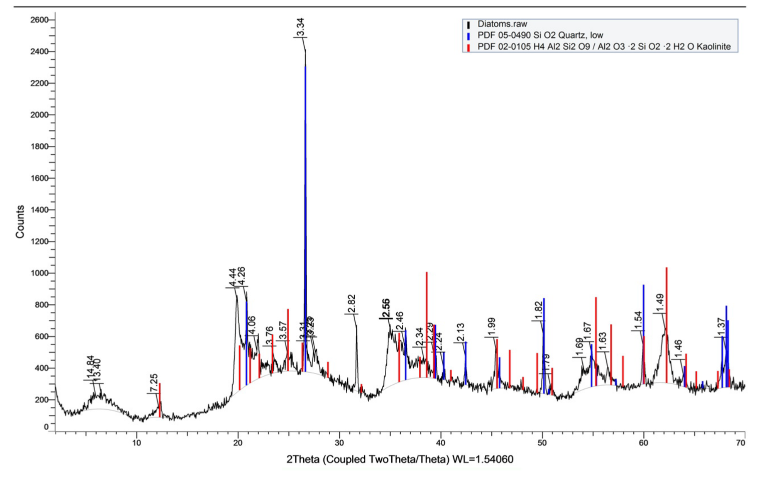
Thin section of diatomite with blue epoxy impregnating pores. White spots are open spaces inside diatoms (some circled) and scattered small silicate grains. Pore space is colored blue. Sample at 1.7 m in section. Scale bar 1 mm.

Mineralogy & Diagensis

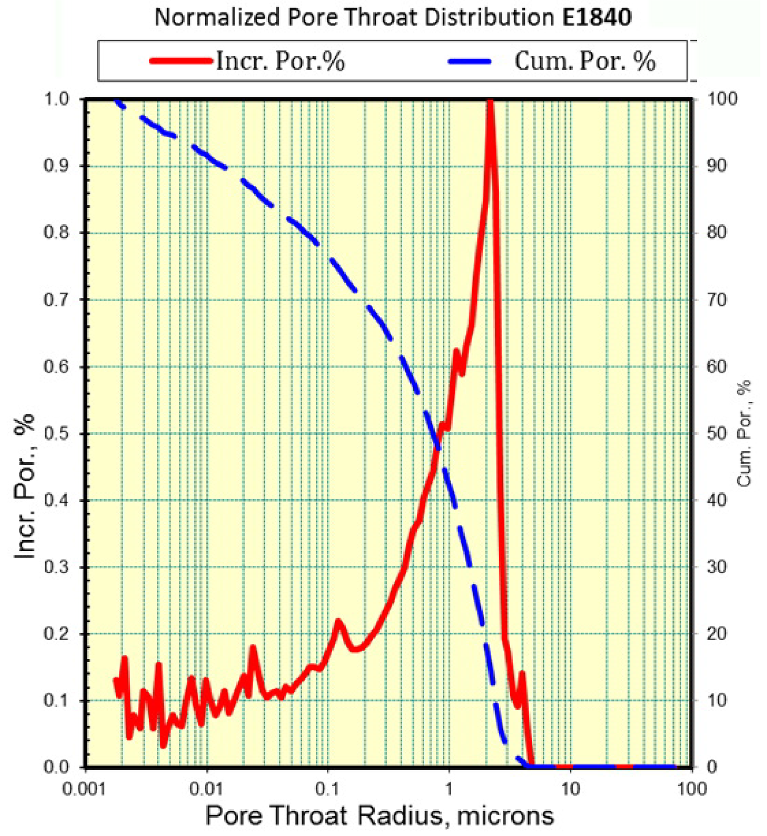
Primary minerals in the diatomite are opal-A, quartz, smectite, and kaolinite. Small amounts of sanidine and other feldspars and mica are present. The diatoms are unaltered opal-A, shown as the raised background level of X-ray pattern (confirmed by D. McCarty) and quartz is present as detrital grains, including the storm sands. Clays include both smectite and kaolinite. Diagenetic gypsum and iron oxyhydroxide is present. Pyrite has been oxidized and lost. Some silica replacement of calcite has occurred.



Clay mineralogy of diatomite (D. McCarty, Chevron)



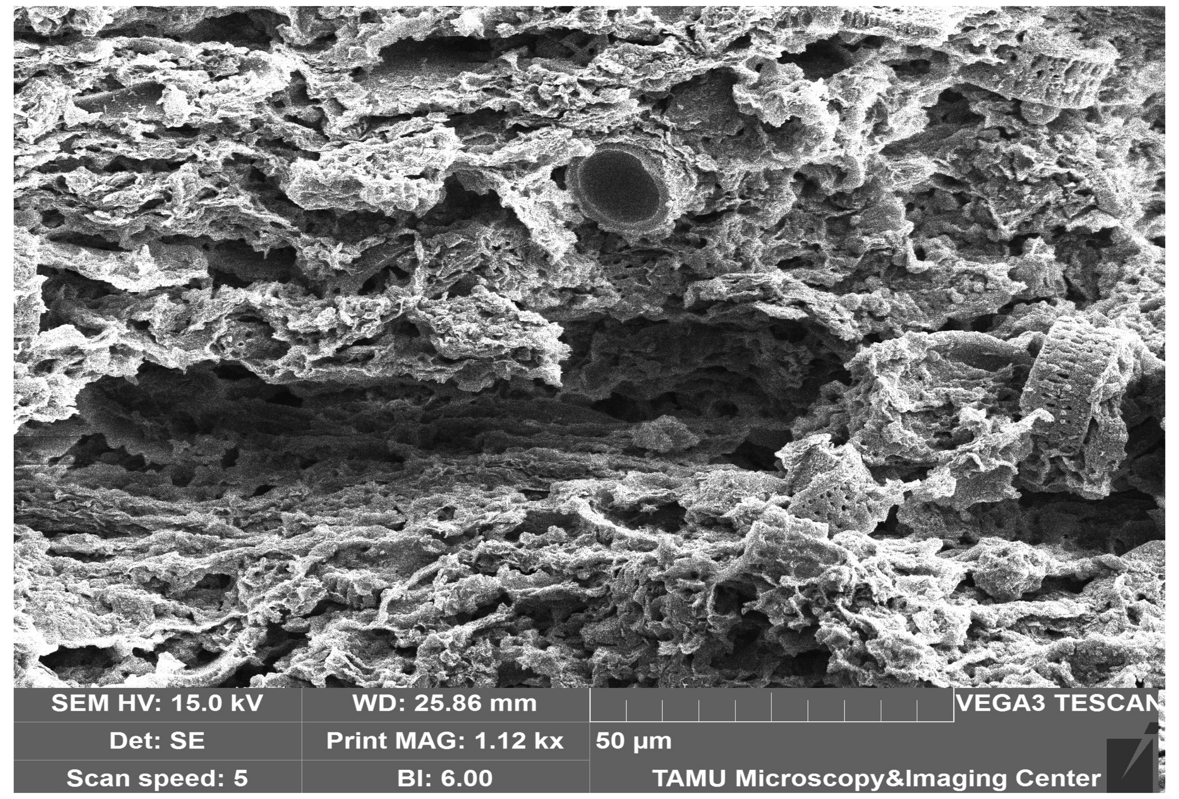
XRD pattern of diatomite sediment, showing raised background level of opaline mineral (Y. Deng, TAMU)



Pore throat radius of microporosity (D. McCarty, Chevron)

Depositional Environment

Sedimentology and fossil content show that the diatomite is a shallow marine deposit that accumulated on an inner continental shelf setting. The sediments are part of a regressive sequence shoaling to a shorezone environment. Diatomite accumulated in waters within and below the zone affected by storm wave base,indicated by lensing, laterally continuous sand layers, and gutter cast. Fossil content is mostly marine centric diatoms, with sparse radiolaria present. The presence of radiolaria demonstrates marine setting with water mass in direct connection with open ocean waters. The diatom assemblage contains many pennate diatoms, along with the diatom genus Terpsinoe, indicating proximity to a shoreline, also shown by common sponge spicules. There are common trace fossils of horizontal small diameter burrows.



Diatom-generated porosity in diatomite sediment. Diatoms present are mostly Paralia, the most common diatom of the assemblage. Note that diatom skeletons are unfilled

Horizontal burrow system in diatomite. Burrows occur as open tunnels that appear to have been filled with pyrite, now lost to diagenisis. Sample at 4.8 m in section. Scale bar 1 cm.

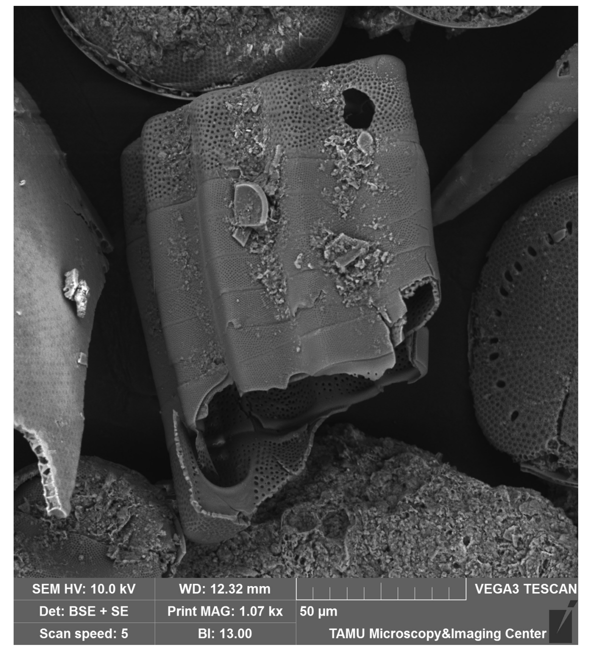
Acknowledgments

This study benefited from the help of msny people. We are grateul to the quarry owner for access and help in collecting samples. Diane Winter gave much time to documentint the diatom assemblage and Doug McCarty provided important data on sediment porosity and composition. Youjun Deng, Jack Baldauf, and John Pantano, all TAMU, provided guidance and help at many times.

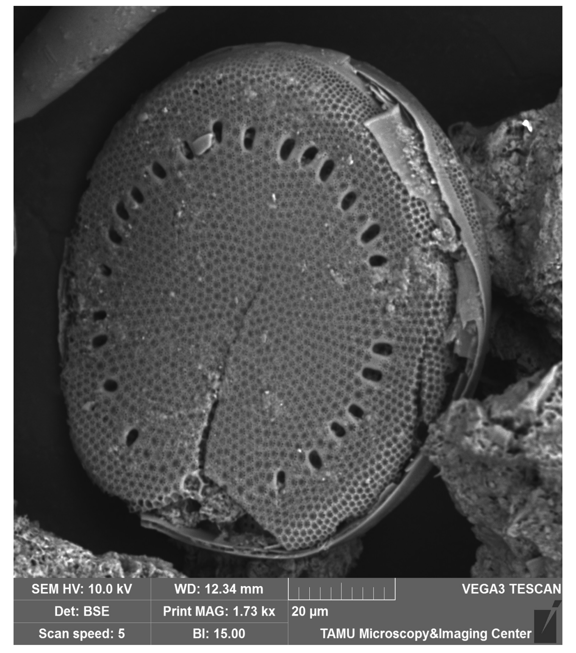
Microfossils

Diatoms and other fossils present in the microfossil assemblage. SEM fossil images made at Imaging Center, TAMU; light microscope photos by Diane Winter. Diatom identifications mostly by Diane Winter, including all nonmarine taxa, and identifications made by members of study group (T. Yancey, G. Nzoumba) are confirmed by Diane Winter. The assemblage is dominated by chain diatom Paralia and by centrics, both small and large. Sponge spicules common in assemblage.

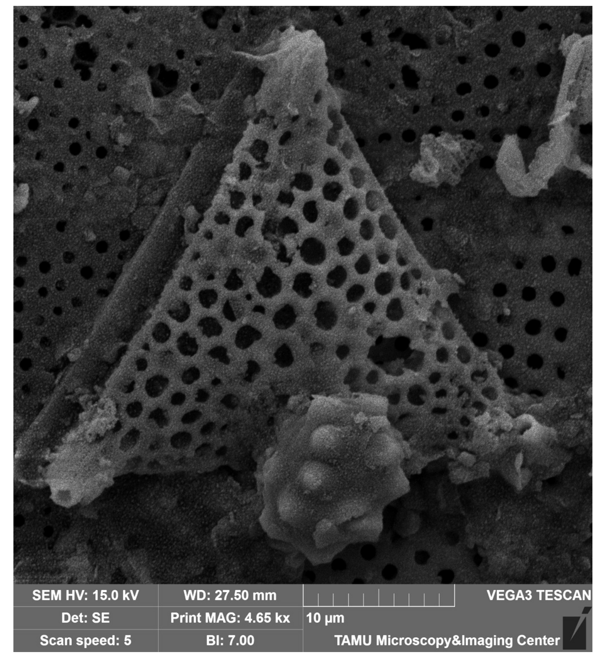
Coscinodiscus. marine diatom



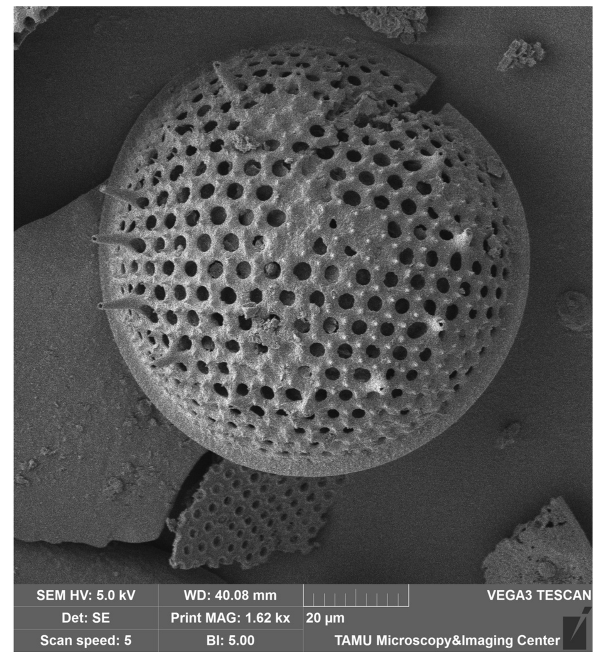
Terpsinoe. benthic shoreline diatom



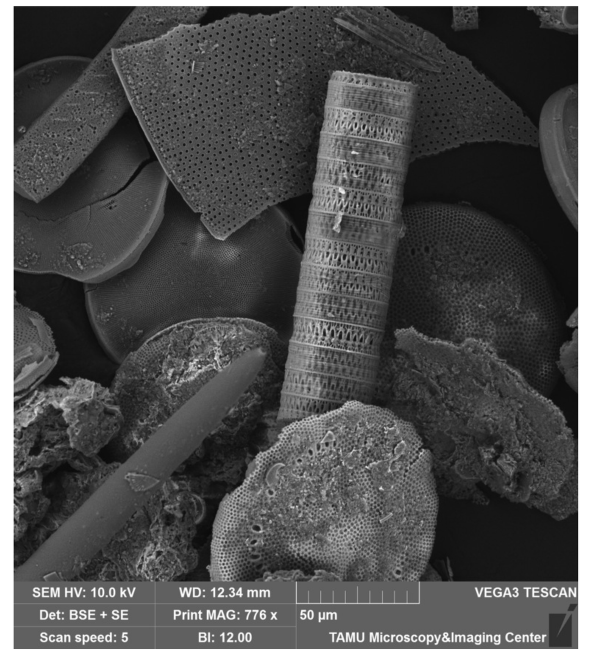
Brightwellia. marine diatom



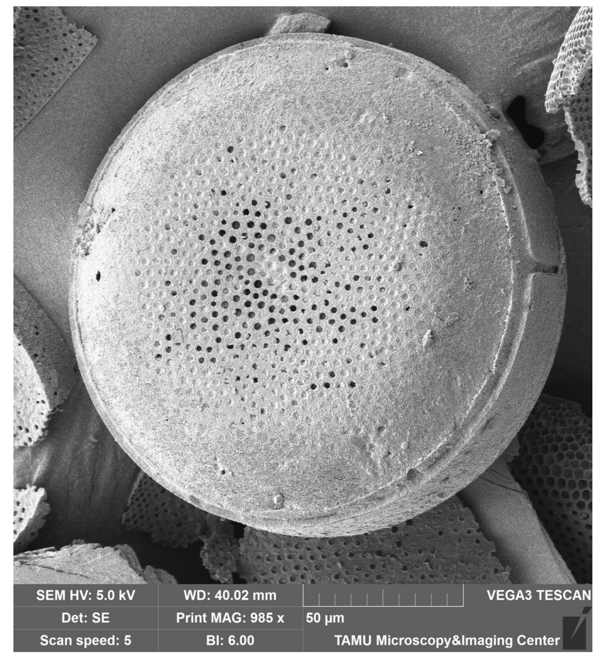
Triceratium. marine diatom



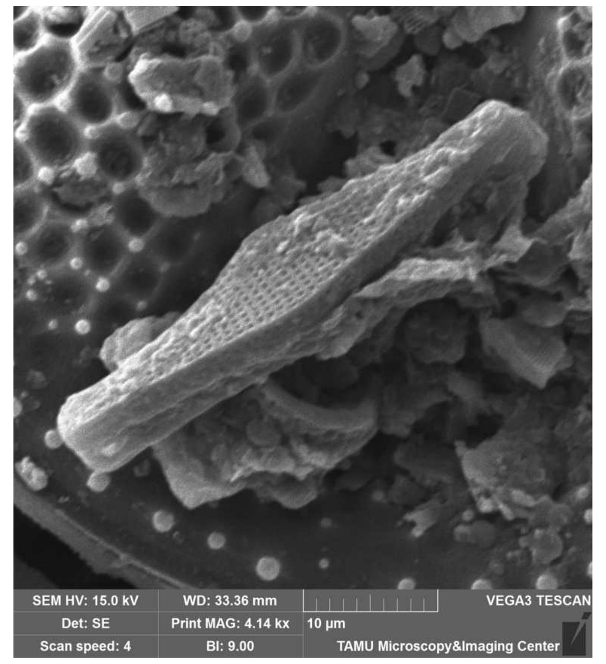
Stephanopyxis. marine diatom



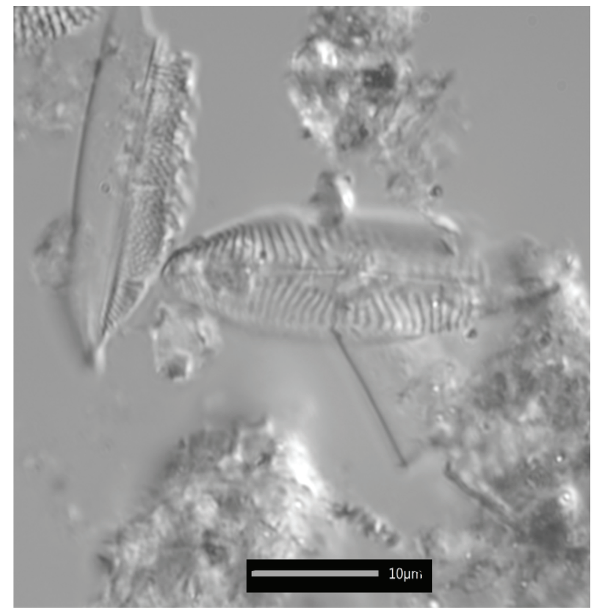
Paralia. marine diatom



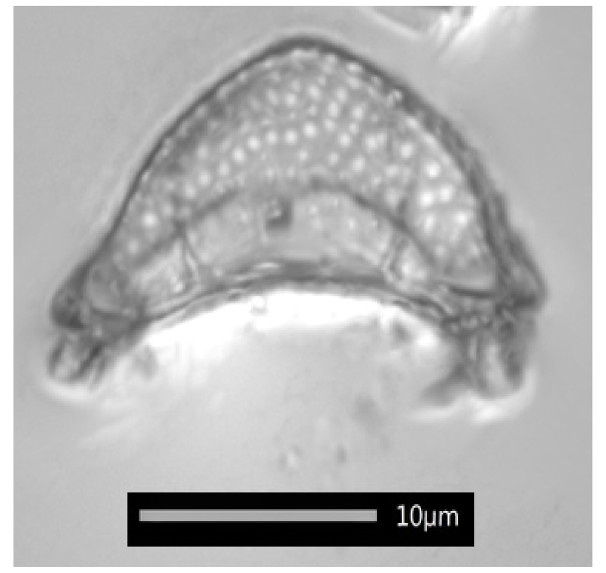
Melosira. marine diatom



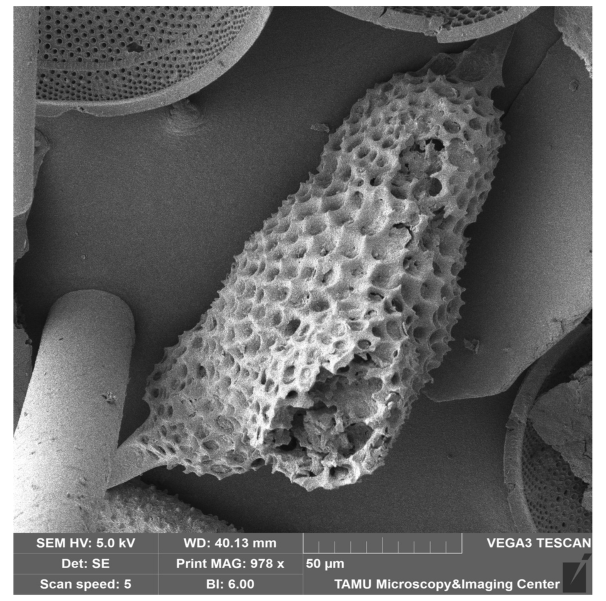
Raphoneis. freshwater diatom



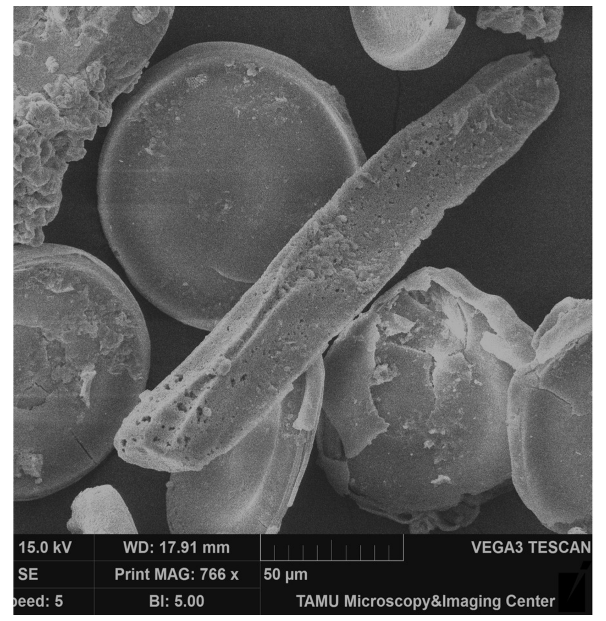
Navicula. freshwater diatom (D. Winter photo)



Biddulphia. benthic diatom (D. Winter photo)



Radiolarian. open ocean



Mystery fossil. silica replacement of calcite