of secondary leached porosity.

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Eocene-Oligocene Boundary in Southwest Alabama

The stratigraphic position of the Eocene-Oligocene boundary in southwest Alabama, based on macrofossils, differs from that based on planktonic foraminifers. To resolve the dilemma, the Yazoo and Red Bluff Clays and the associated foraminifers were studied at St. Stephens Quarry, Washington County, Alabama. On the basis of planktonic foraminiferal vertical distribution at this locality, the Eocene-Oligocene boundary is at the top of the Shubuta Member of the Yazoo Clay. *Cribrohantkenina inflata* (Howe), *Hantkenina alabamensis* Cushman, *Hantkenina longispina* Cushman, and the *Globorotalia cerroazulensis* group became extinct, and *Globigerina ampliapertura* Bolli and *Globigerina gortanii* (Borsetti) first appear near this horizon. This planktonic foraminiferal vertical distribution allows assignment of the upper Yazoo Clay to the *Globorotalia cerroazulensis* (s.l.) Interval Zone and the Red Bluff Clay to the *Cassigerinella chipolensis–Pseudohastigerina micra* Interval Zone.

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Facies Distribution of Hosston Sand, Central Texas—Implications to Low-Temperature Geothermal Waters

Electric-log patterns indicate that the Hosston Formation of central Texas consists of four principal facies: (A) massive sandstones greater than 80 ft (24 m) thick, (B) distinct sandstones 10 to 80 ft (3 to 24 m) thick interbedded with sharply defined shale breaks, (C) sandstones less than 10 ft (3 m) thick intercalated with shale and siltstone beds, and (D) thin calcareous (dolomitic?) beds with interbedded shale and siltstone. Facies A shows characteristics of fluvial sands, B of either deltaic or strand associations, C of interdistributary and overbank mud and silt deposits, and D of shallow intertidal to supratidal low-energy environments.

Cross sections show facies A and B to be concentrated on and north of the San Marcos platform, whereas facies D is present farther downdip. Distinctive sequences of facies B with superposed facies D occur between these two belts. Facies C is somewhat erratic in its distribution.

Warm waters are currently being produced from the A and B facies. The nature and distribution of the C and D facies probably preclude their use as a geothermal resource.

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Field Relations and Petrology of Catahoula Formation in Parts of Lavaca, Gonzales, and Fayette Counties, Texas

The Catahoula Formation is unique in that it records the last significant influx of volcanic detritus supplied to Gulf Coast sediments. The study area is situated on the northeast flank of the San Marcos arch in Lavaca, Gonzales, and Fayette Counties, Texas. The Catahoula Formation was mapped and subdivided into a basal Chita Sandstone Member (fluvial channel facies) and an overlying and/or laterally contiguous Onalaska Clay Member (floodplain and levee facies). The basal unit of the Chita sandstone is typically a channel deposit of light-gray, conglomeratic sandstone lying unconformably on limonitic claystones and very fine-grained sandstones of the upper Eocene Whitsett Formation. The basal Chita sandstone unit consists of graded to poorly laminated beds containing lag deposits of silicified wood and/or mudstone clasts. Chita sandstone units grade laterally and vertically into tuffaceous, very fine-grained sandstone, siltstone, and claystone units of the Onalaska Clay Member which is conformably overlain by channel deposits of upper Miocene Oakville Sandstone. The Oakville Sandstone is comprised of lenses of coarse-grained calclithite beds (sandstone containing an abundance of carbonate rock fragments). The Oakville calclithite beds record an episode of early Miocene uplift of the Edwards plateau along the ancestral Balcones fault zone.

Chita units consist of well-sorted to poorly sorted, silty fine-grained to pebbly coarse-grained, lenticular sandstone exhibiting fining-upward cycles of festoon cross-beds, plane beds, and ripples. A volcanic provenance contribution is suggested by (1) abundant volcanic quartz (22% of total quartz); (2) lithic fragments consisting mostly of silicic shards, felsite clasts, and tuffaceous clay clasts; (3) fresh sanidine (sanidine/orthoclase ratio = 1.2); and (4) a heavy-mineral suite dominated by euhedral, elongated zircons. Onalaska clay units consist of tuffaceous mudstone and clay-ball litharenite beds.

Differing heavy-mineral suites and quartz-feldspar-lithic modes in the Catahoula Formation and coeval Gueydan Formation support the hypothesis that the San Marcos arch was a drainage divide in middle Tertiary time. In the study area north of the San Marcos arch Catahoula sandstones contain a mean Q:F:L ratio of 80Q:5F:15L and a zircon-tourmaline-rutile index of 90%. South of the San Marcos arch (data from Lindemann and McBride) Gueydan sandstones contain a mean Q:F:L ratio of 31Q:28F:41L and a zircon-tourmaline-rutile index of 33%.

Abundant Ca-montmorillonite, reworked biomicrite clasts, montmorillonite rim cement, caliche beds, and wood replaced by length-slow chalcedony in the Catahoula Formation all support an alkaline diagenetic environment. Pervasive opal and chalcedony pore-filling cements are restricted to surficial outcrops and reflect Pleistocene and/or Holocene leaching of volcanic ash under alkaline conditions. It is likely that leaching of volcanic ash in the Catahoula Formation could result in uranium mineralization in Catahoula channel and overbank facies.

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Radiolarian Ratios and Pleistocene-Holocene Boundary

The ratios among general types of radiolarians are useful tools in the correlation of late Quaternary sediments in piston cores from the continental margin off the west coast of Guatemala. Cores from the outer slope and lower inner slope contain practically no calcareous microfossils because of solution, so that methods of using planktonic forams to locate the Pleistocene-Holocene boundary are useless. Upper-slope cores, however, show a down-core increase in the abundance of planktonic forams. Previous workers have correlated a similar increase in foram abundance offshore Oregon with the Pleistocene-Holocene boundary. The ratio of nassellarian (cone-shaped) radiolarians versus spumellarian (spherical) radiolarians decreases abruptly down core to a distinct minimum in cores from the upper slope as well as in cores from deeper water. This radiolarian minimum occurs just below the increase in planktonic foram abundance and makes a good marker for identifying the Pleistocene-Holocene boundary in deeper water cores which contain no forams.

The radiolarian ratio minimum (which shows a dominance of spumellarian radiolarians in the late Pleistocene) might be a response to a lowering of sea level, to changes in climate or circulation, or to the core sites being closer to shoreline during times of lowered sea level. The last explanation is supported by a study of radiolarian populations from the south Texas outer continental shelf of the Gulf of Mexico, which shows an increase in spumellarian abundance inshore.

This radiolarian ratio is useful not only in locating the Pleistocene-Holocene boundary in noncalcareous sediments, but also might be a tool for qualitatively indicating proximity to shoreline in older samples.

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Meridionally Ornamented Hedbergellid Foraminifers from Western Atlantic, Deep Sea Drilling Project Leg 43, Site 386

Meridionally ornamented hedbergellids have been described from the upper Albian–Cenomanian of Lybia (*Hedbergella lybica* Barr 1972), the Cenomanian of Lebanon (*H. costellata* Saint-Marc 1973), and from the middle and upper Albian of the southeastern Atlantic, Deep Sea Drilling Project, Leg 40, Sites 363 and 364 (*H. costellata, H. angolae* Caron 1978). From Site 363 Caron reported meridional ornamentation of *Hedbergella bornholmensis* Douglas 1969 and *Whitenella baltica* Douglas 1969, for which there was no indication in the definition of these species from the Turonian-Coniacian of Bornholm Island in the Baltic Sea.

Meridionally ornamented hedbergellids were encountered in samples from the upper Albian–lower Cenomanian of the western Atlantic, Deep Sea Drilling Project Leg 43, Site 386 (Bermuda basin). The most common ornaments are blunt spines which join to form costellae that become meridionally oriented. Such orientation and costellation are common but apparently random and gradational from spinosity alone. Apertural flaps are unusually long, often cross the umbilicus, and frequently join to restrict or close the umbilicus, producing umbilical character that is not really satisfactorily hedbergellid, ticinellid, or margiontruncanid. Other properties of specific level show considerable variation.

Depsite reports of somewhat earlier and considerably later occurrences, meridionally costate hedbergellids appear to be most common in upper Albian to lower Cenomanian rocks and have promise of biostratigraphic utility. Several species have been described on essentially the same properties and taxonomic utility has suffered. It is suggested that the distinctions are subspecific in many examples, arising from phenotypic response to ecologic factors, and that the species could be treated as "forma" of *Hedbergella lybica* Barr, the first of the kind to be defined.

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Distribution and Significance of Coarse Biogenic and Clastic Deposits on Texas Inner Shelf

Sediments of the Texas inner shelf are fine grained; coarse clasts (>0.5 mm) are uncommon (<1%) over much of the area. Higher concentrations of coarse material, however, occur in discrete areas which apparently represent positions of former deltas. Coarsest constituents are predominantly whole shells and shell fragments with subordinate amounts of lithic clasts. The calcareous skeletal debris represents a mixture of extant shelf fauna and relict brackish-water mollusks including *Ragina* sp. and *Crassostrea virginica.* Rounded sandstone and mudstone clasts up to 7 cm long and caliche nodules are common in some areas. Maps showing (1) coarse-fraction percent, (2) distribution of brackish-water mollusks, and (3) rock fragments show similar trends outlining ancestral Rio Grande, Brazos-Colorado, and Trinity deltas. A patchy, arcuate trend between Pass Cavallo and Aransas Pass is enigmatic. Criteria used to determine relative ages of shell debris for each of the four trends are degree of abrasion, fragmentation, etching, boring, and discoloration.

Possible explanations for concentration of coarse material include high productivity, low rates of terrigenous clastic sedimentation, selective deposition by modern shelf processes, and reworking of locally shelly relict deposits exposed on the seafloor during the Holocene transgression. However, no single explanation adequately accounts for areal variations in coarse material. Reworking of delta-plain and estuarine deposits during and following sea-level rise is common to all areas which at present are also sites of insignificant coarse-sediment influx. Sabine-Bolivar trends are interpreted as transgressive lags derived from erosion of a late Pleistocene Trinity delta previously dissected by the Sabine River during Wisconsin glaciation. In contrast, Brazos-Colorado and Rio Grande trends are interpreted as possibly compound strandline features associated with subsidence, erosion, and retreat of Holocene deltas. Upwelling of nutrient-rich shelf waters and freshwater inflow also may have increased productivity of shelf benthos near the Rio Grande delta.