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High Precision Absolute Age Determinations Within the Plio-Pleistocene in Gulf of Mexico

Absolute ages can be determined from Plio-Pleistocene sequences in the Gulf Coast using an $^{18}O/^{16}O$ analytical approach. The technique is based on the fact that glacial/interglacial cycles possess uniquely shaped "fingerprints." The character of the isotopic record in the Gulf of Mexico is exaggerated because the Gulf has periodically received extreme riverine discharges of meltwater products from the Laurentide ice sheet which covered large portions of North America during the Plio-Pleistocene. The ^{18}O record thus allows age determinations with a precision of $\pm 20{,}000$ to $\pm 50{,}000$ years in the Plio-Pleistocene. Close sampling via sidewall cores is required for initial calibration in a given basin. Sections ranging from middle shelf to bathyal depths can be reliably zoned, independent of regional or local biostratigraphic and lithostratigraphic zonations. Once an absolute age framework is established, stratigraphic correlations, sedimentation rates, and structural effects on sediment distribution can be determined. The technique has been developed using holes drilled from the MV *Eureka* (part of an early Shell Oil offshore study in the Gulf) as well as strategically placed piston cores and DSDP sites. Both benthic and planktonic foraminiferal shell carbonate should be suitable for these age determinations. A similar Plio-Pleistocene zonation can be established worldwide based on analysis of DSDP material. Preliminary data suggest that a similar zonation may be established throughout the Tertiary and perhaps the Mesozoic. Effects of diagenesis are unknown.

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Interactive Flattening as an Exploration Tool

As exploration progresses in a basin, the effort to find new reserves compels the explorationist to look for traps too subtle to have been discovered in earlier efforts. Many such traps are rendered obscure by diapirism or regional deformation. The most common approach used in finding these traps entails the preparation of isopach maps and cross sections referenced to a common stratigraphic marker. Although these methods are generally effective in revealing paleostructural trends, they are tedious and require initial determination of the best horizons to use. An analogous situation often confronts the geophysicist in areas with minor structural relief and relatively major velocity anomalies.

A faster and often more revealing technique involves interactive flattening of cross sections or seismic data on a microcomputer. This allows the explorationist to view any horizon as a paleostructural reference, thereby eliminating horizons that do not effectively depict the underlying structural trends. This technique can also provide a clearer understanding of basin development in areas that were significantly deformed after producing zones were deposited.

The utility of interactive flattening in the delineation of subtle traps is shown in the restoration of the paleostructure of salt domes in Louisiana, where significant accumulations occur on the flanks of younger structures. Examples of basin development are derived from offshore California, where wrench faulting has obscured the structural setting that existed during the deposition of important Miocene reservoirs. The application of flattening seismic profiles to remove false structure induced by shallow velocity changes is illustrated for several areas in the Mid-Continent.

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Depositional and Provenance Controls on Diagenesis of Sandstones Associated with Green River Formation of Wyoming

Synchronous sandstones associated with the lacustrine Eocene Green River Formation of Wyoming from three distinct provenance areas and two general depositional environments were studied to determine provenance and depositional controls on diagenesis.

Quartzitic fluvial sands in an area dominated by ground water flow were cemented early with calcite. Marginal lacustrine sands of the same detrital mineralogy became cemented with calcite and ankerite. Lacustrine sandstones with a micritic matrix contain no porosity, whereas fluvial sandstones with well developed secondary porosity registered porosities as high as 25% and permeabilities above 2,300 md.

Arkosic sands deposited from rivers meandering across a fluvial floodplain developed mostly authigenic clay cement from the dissolution of feldspars. In contrast, arkosic beach sands intercalated with lacustrine carbonates were cemented with ankerite.

Volcanogenic fluvial sands were cemented with zeolite and clay minerals, reducing the effective porosity to zero. On the other hand, environmentally controlled carbonate forms the principal cement of marginal lucustrine volcanogenic sandstones. Cementation by carbonate halted the degradation process of volcanic rock fragments to pore-filling clays and zeolites. Furthermore, some of these rocks exhibit excellent secondary porosity and permeability.

In conclusion, provenance set the stage for diagenesis by providing the raw materials for subsequent sandstone alteration. However, depositional environment can cause sands of similar detrital mineralogy to follow different diagenetic courses leading to the development of significantly different porosity and permeability characteristics. Diagenetically produced porosity differences in a marginal lacustrine setting can yield a wide variety of reservoirs, seals, and traps.

WISE, SHERWOOD W., JR., Florida State Univ., Tallahassee, FL, and DSDP LEG 93 SHIPBOARD SCIENTIFIC STAFF

Lower Cretaceous Deep-Sea Fan Complex Beneath the Lower Continental Rise Off North Carolina

Deep Sea Drilling Project Hole 603B, the first deep (1,585 m, 5,200 ft) penetration of the lower continental rise off the eastern United States, intersected an extensive (218 m, 715 ft) Lower Cretaceous deep-sea fan complex. Drilled 435 km (270 mi) east of Cape Hatteras, North Carolina, about 320 km (200 mi) seaward of the Lower Cretaceous shelf break, the continuously cored Hauterivian to Barremian turbidite sequence consists of 47% terrigenous sand. The sand turbidites are generally poorly consolidated and porous except where locally cemented by calcite. The sands appear fresh and are dominated by subangular quartz with abundant feldspar, mica, heavy minerals, wood fragments (locally up to 20%), glauconite, and shallow-water bioclastics. The turbidites exhibit the entire range of Bouma textures and include plastically deformed blocks of sediments up to 25 cm (10 in.) across which indicate channelization and slumping within the fan. Interbedded with the sand turbidites are pelagic limestones and black claystone turbidites, the latter containing up to 13.6% organic carbon in overlying units.

The relatively immature micaceous sands were apparently derived from deep erosion of the piedmont which fed large deltas that prograded across the continental shelf at several points along the central eastern seaboard. There they overwhelmed the fringing reef/carbonate bank and spilled their loads into the deep sea. Coeval deltaic or fan deposits within the circum-North Atlantic (for example, Wealden beds of England or DSDP Site 370/416 off Morocco) suggest either that eustatic sea levels were not rising appreciably (as is generally believed) or that there was synchronous or coincidental uplift and drainage diversion in these various areas.

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Geothermal Gradients of Texas—A New Look

The heat flow equation shows that geothermal gradient varies directly with conductive heat flow and inversely with thermal conductivity. Because of the second of these functions, geothermal gradient values have limited validity wherever bottom-hole temperature (BHT) readings are reduced without regard for ambient rock type. Thus, I present a geothermal gradient map of Texas using new data from selected geologic formations of generally uniform rock type. Four carbonate rock units provide the data base for most of the state inland of the Lower Cretaceous shelf edge. These include, for the inner Gulf Coast Basin region, the Jurassic Smackover Formation and the Cretaceous Sligo and Edwards Formations. For most of the remainder of the state west of the Balcones/Ouachita trend, data were obtained for the Ordovician Ellenburger Group. Coastward of the Cretaceous shelf edge, data from the 1976 AAPG and U. S. Geol. Survey map were employed owing to the paucity