

of corrosion after subaerial exposure for at least 3 m.y. Their preservation is attributed to encasement by subsequent gypsum cements. Although these botryoidal, banded aragonite cements are strontium-rich (7,000 ppm) and resemble modern marine examples, they were precipitated in secondarily enlarged pores that formed during erosional episodes. Multiple cycles of enrichment in oxygen and carbon stable isotopes are recorded in the aragonite cement layers. The $\delta^{18}\text{O}$ values of these cycles range from -0.9 to +6.8‰, whereas the $\delta^{13}\text{C}$ values range from +0.6 to +3.8‰ (PDB). These cyclic variations, indicated by isotopic data together with the petrology of the cements, are believed to record major changes in salinity, temperature, and organic productivity of the Mediterranean waters during the Miocene-Pliocene transition. These Messinian reefs were subaerially exposed and later overlapped by the upper evaporite unit with multiple cycles of marine hypersaline carbonate and evaporite deposition separated by periods of erosion. Aragonite cements formed in the enlarged cavities of the lower Messinian reefs during time of deposition of the upper evaporite and recorded the changes in Mediterranean water chemistry. This cementation is believed to have continued into the early Pliocene when colder Atlantic waters invaded the Mediterranean, ending reef growth and evaporite deposition.

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Applications of Digital Terrain Data to Multisensor Image Analysis

Some of the key factors for detection of facies changes in sedimentary environments, such as changes in surface composition and texture, are parameters that can be detected using the remote sensing techniques presently available. For example, multipolarization aircraft synthetic aperture radar (SAR), Landsat 4 Thematic Mapper (TM), and airborne Thermal Infrared Multispectral Scanner (TIMS) images were acquired over the Deadman Butte area of the Wind River basin, Wyoming. The SAR images were acquired at L-band (wavelength = 24.6 cm) simultaneously in 4 polarization states (HH, HV, VH, VV). The 6 visible and near infrared TM bands range in wavelength from 0.45 to 2.35 μm , and the 6 TIMS bandpasses range from 8 to 12 μm . Thus, reflected and emitted radiation, and radar backscatter from geologic targets can be simultaneously analyzed using a coregistered image data set. In this way, lithologic variations can be mapped based on compositional information derived from the TM and TIMS data and detailed surface scattering information derived from the multipolarization SAR data. In addition, coregistration of the image data set to digital terrain data results in the ability to generate a stratigraphic column based on the remote sensing data, and to perform detailed structural analyses.

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Intimate Relationships: Growth Faulting and Diapirism in South Louisiana

Data published during the recent past have improved understanding of initiation of salt and shale diapirism and of growth faulting on the central Gulf continental slope. Growth faults appear on diapir flanks during initial development, as well as along upper-slope depocenter flanks and the continental shelf edge. Rapid deposition, differential loading and subsidence on the upper slope and outer shelf enhances segmentation of salt ridge or massifs into individual diapiric spines, causing additional diapir-related growth faulting. Most growth faults originating on the slope remain active and, projected upward 5,000-20,000 ft, provide the structural framework within which south Louisiana petroleum exploration takes place.

Study of 31 piercement and 19 semipiercement salt domes plus 117 nonpiercement domes formed by salt and/or shale diapirs reveals important growth fault variations genetically related to diapiric structure type. Fault patterns associated with piercement and semipiercement salt domes are different and more complex than those on nonpiercement features. Counter-regional faults, commonly in compensating or crossing patterns, are far more common; fault splitting and crestal grabens are particularly common on semipiercement structures. Local growth faults related to differing flank subsidence rates around high-relief diapirs play a major role on these structures. In contrast, fault patterns are less complex on nonpiercement diapiric structures. Counter-regional faults, compensat-

ing and crossing systems and splitting are less common; most major faults appear to be regional growth faults only indirectly related to diapir development. Implications for additional deep exploration diapiric structures exist.

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Jurassic Salt Tectonism Within Mt. Enterprise Fault System, Rusk County, Texas

A synthesis of seismic, bore-hole, and gravity data in southeastern Rusk County, Texas, indicates that faulting within the Mt. Enterprise fault system was the result of Jurassic salt tectonism. Faults were developed in response to salt movement and subsequent collapse of the overlying section into areas of salt withdrawal, resulting in the formation of a graben containing no Louann Salt. An abnormally thick Bossier Formation within the graben indicates a Late Jurassic age for significant structural deformation within the fault zone.

The potential exists for numerous untested traps within the Jurassic section associated with salt-generated structures along the Mt. Enterprise fault system.

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Hydrocarbon Migration and Diagenesis in Miocene Marine-Shelf Deposits

Miocene marine-shelf deposits typically found in the Gulf Coast basin are composed of thin (0.1-10.0 cm), horizontally bedded or cross-stratified quartzarenites to subarkoses, laminated silty clays up to 50 cm thick, and bioturbated admixtures of these 2 end members. Some of the coarser grained sand units may contain appreciable quantities (up to 50%) of shell fragments. These lithotypes exert a significant control on the diagenetic mineral products and amount of secondary porosity observed in specimens that have been subjected to temperatures in excess of 120°C. Low-magnesian calcite, maximum microcline, high albite, and a kaolin mineral (possibly dickite) are the major diagenetic products in the sandstones. A regular mixed-layered illite/smectite (rectorite) is dominant in the clay-rich materials. Secondary porosity is most common in those rocks that originally contained numerous shell fragments. Quartz overgrowths are ubiquitous. The diagenetic differences are striking when the closeness of the sand and clay association is considered. The thin clay seams may have obtained small quantities of potassium from some of the associated sands. The sands illustrate considerable reaction with connate fluids, during the albitization process. Kaolinitic minerals are most abundant in the sand with the highest original porosity. The original composition and diagenetic products define the optimum conditions for hydrocarbon migration.

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Practical Guide to Dipmeter Applications in Gulf Coast

The dipmeter is truly a jambalaya of geologic information. Consider the many situations where knowledge of inclination and direction would be useful. Determination of structural dip and identification of faults and unconformities caused by abrupt changes in that dip are well-known uses. Furthermore, bending of beds resulting from drag of postdepositional faults and roll of contemporaneous faults allows determination of the exact depth, strike, and downthrown direction of the beds. Dip and direction define drape over bars and within channels, foresetting of fans, and compaction under sands. This can identify the type, trend, and pinch-out direction of these sand bodies. The knowledge of paleocurrent direction and strength, available from very short-interval dipmeter computations, combined with an understanding of the relationship to the drapes provides a powerful tool for defining stratigraphic traps.

The dipmeter's extremely fine vertical resolution and multidirectional sensors allow precise determination of bed thickness, laminations, vertical grain-size profiles, bore-hole geometry, and fractures. The recently introduced Dual Dipmeter service, with 8 sensors and 0.1-in. sampling rate, adds an order of magnitude increase in this type of information.