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Florida Mountains, Southwest New Mexico: Part of Cordilleran Overthrust Belt or Foreland Block Uplift?

Several workers have proposed during the past 12 years that the Florida Mountains, about 15 mi (24 km) southeast of Deming, New Mexico, were involved in regional Cordilleran overthrusting. Consequently much oil and gas exploration is now based on the premise that the south Florida Mountains fault is a thrust fault that marks the northeastern edge of the "overthrust belt of southwestern New Mexico."

The overthrust model requires large-scale horizontal movements, versus dominantly vertical movements of the block uplift model. Stratigraphic separations in the southern Florida Mountains indicate a minimum of 4,000 ft (1,219 m) vertical displacement. There is no evidence for more than about 1,000 ft (304 m) of horizontal displacement on the south Florida Mountains fault, and perhaps 2,000 ft (610 m) of horizontal displacement on some of the small thrust faults in the 1-mi-wide area along the northeast side of the south Florida Mountains fault. The south Florida Mountains fault steepens at depth whereas overthrusting requires that the fault flatten at depth. Overthrusting generally involves thick, 25,000 to 50,000 ft (7,620 to 15,240 m) geosynclinal sequences. In contrast, basement-cored uplifts involve crystalline basement rocks and typically, a thin sedimentary sequence. Precambrian plutonic rocks are against, and locally over, about 4,000 ft (1,219 m) of Paleozoic carbonate rocks along the south Florida Mountains fault. Regional surveys indicate that the Florida Mountains area has been relative high since Pennsylvanian time. Foreland block uplift areas typically have shown a long history of structurally positive tendencies evidenced by thinning of units and the presence of unconformities over positive areas. Thrust faults formed during overthrusting due to extensive horizontal compression should, if curved, be concave upward. Faults produced by vertical basement uplift should be concave downward. The south Florida Mountains reverse fault is steeper at depth and concave downward. The imbricate thrust faults to the northeast are either concave downward or nearly horizontal. Regional overthrusting should produce telescoping of facies and stratigraphic anomalies yet to be observed or reported in publications on southwest New Mexico geology.

Our current study demonstrates that Laramide deformation in the Florida Mountains is probably not a continuation of the Cordilleran overthrust belt. Evidence suggests that the deformation resembles the basement-cored block uplifts of the Rocky Mountain foreland.

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Relation of Illite/Smectite Diagenesis and Development of Structure in the Northern Gulf of Mexico Basin

Water expelled from smectite into the pore system of the host shale during the process of diagenesis may migrate out of the shale early or may be totally or partly trapped and released slowly through time. In areas such as the northern Gulf of Mexico basin, where much of the water is partly trapped, clay diagenesis data indicate a close relation between high fluid pressure buildup and the smectite-illite transformation process.

Abnormal pressures affect, in part, the type and quantity of hydrocarbons accumulated since pressure controls the direction of fluid flow and partly controls the geometry of structures formed in basins where shale tectonism is the primary mechanism for structural development. In basins of these types, contemporaneous faults and related anticlines are the most common types of productive structures found. The depth to which faults can penetrate and the angle of dip that faults assume at depth is dependent largely upon fluid pressure in the sedimentary section at the time of faulting. Some faults formed in the overpressured Tertiary section of Texas have been observed to flatten and become bedding plane types at depths near of above the temperature level required for thermal generation of hydrocarbons. This observation suggests faults of these types play a minor role in draining hydrocarbons from deep shales within basins where thick overpressured sedimentary sections are present at shallow depths and where shale tectonism is the primary mechanism for structural development.

Microfracturing resulting from increased fluid pressure is indicated to be a primary mechanism for flushing fluids from deep basins where thick abnormally pressured sedimentary sections are present. This flushing process would be enhanced by clay diagenesis since water supplied from smectite would cause the process to continue for longer periods of time and to extend to greater depths than could be attained if only remnants of the original pore water were present in the section. Large volumes of diagenetic water present within the microfracturing interval could also act as a vehicle for primary hydrocarbon migration provided hydrocarbons are present in a form and in sufficient quantities to be transported.

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A Coordinated Geological-Geophysical Approach to Finding Stratigraphic Traps

Many stratigraphic traps have been found on the gently dipping flanks of the stable sedimentary basins in the United States. Many more remain to be found. The sedimentary environment is becoming well known in most of these basins. This information combined with detailed studies of the already discovered and developed stratigraphic traps allows one to anticipate the type of trap and the tools needed to detect these traps in most areas being explored.

Studies of clastic, erosional, and carbonate stratigraphic traps indicate that most have a detectable anomaly associated with them. Some have a minor structural anomaly that is near the level of seismic structural resolution. These and others commonly have interval thinning in the sediments overlying the trap that is detectable using well data isopach and/or seismic isochron techniques. Most have a high impedance contrast reservoir unit that is thick enough to be detected using seismic waveform and reflection amplitude techniques. A coordinated use of these geological and geophysical tools is discussed briefly in this paper.

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Carbonate Facies Patterns and Oil Shale Genesis in Eocene Green River Formation, Fossil Basin, Wyoming

Facies patterns and associated vertical sequences of kerogenous carbonates (oil shales) of the Green River Formation in Fossil basin, Wyoming, provide new insights into the deposition of oil shale. Unique to Fossil basin is a facies pattern consisting of kerogen-rich calcimicrite at the basin's depocenter succeeded laterally by laminated calcimicrite, bioturbated calcimicrite, and finally calcareous siliciclastics. This same pattern occurs cyclically as a vertical sequence with oil shale at the base.

The calcimicrites at the depocenter increase in dolomite content dramatically in the upper third of the section, and oil shale units become more widespread. There is an accompanying increase in saline minerals as well as zeolites indicating hypersalinity.

Bioturbation is absent from both oil shale and dolomicrites. The marginal bioturbated facies are always dominated by calcimicrite, even in the upper third of the section. Well-preserved fossil fish occur in kerogen-rich calcimicrites, but never in dolomicrites.

The facies patterns and vertical sequences in Fossil basin are interpreted as being deposited in a closed-basin occupied by a lake with an ephemeral and hypersaline hypolimnion that underwent frequent vertical fluctuations that affected large areas of the lake bottom. The "transgression-regression" of the hypolimnion over large areas of lake bottom was possible because of a low topographic gradient on the lake bottom. Deposition of oil shale occurred within the denser, cooler, and hypersaline hypolimnion waters—laminated calcimicrite in a zone of chemocline fluctuation—and bioturbated calcimicrite was deposited in fresher nearshore zones. Kerogen-rich carbonates became more widespread in the later stages of the lake when it evolved into a shallow hypersaline lake. This suggests that kerogen deposition was controlled by high salinity rather than anoxic conditions.

It is concluded that the carbonate facies patterns, vertical sequences, and oil shale genesis required a dynamic and fluctuating lake as well as a fluctuating chemocline level in a closed basin with a low topographic gradient. This differs from the static, anoxic, and deep basin model frequently postulated for Green River Formation oil shale deposition.

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Recurrent Motion on Precambrian-Age Basement Faults, Palo Duro Basin, Texas Panhandle

The distribution of Late Precambrian(?) through Quaternary strata in the Palo Duro basin and surrounding uplifts documents recurrent motion on Precambrian-age basement faults. Basement blocks have been uplifted with little tilting or folding of overlying strata along a system of northwest-southeast oriented faults, part of a regional trend extending from central Colorado to southwestern Oklahoma. The orientation of basement terranes in Colorado and that of a 50-mi (80-km) long mylonite zone in east-central New Mexico suggest a Precambrian age for the faults.

An Arkosic sandstone overlies basement and underlies a Cambrian(?) quartzose sandstone in a few Palo Duro basin wells. It may represent debris shed from active fault blocks during the opening of the southern Oklahoma aulocogen in the Late Precambrian or Early Cambrian. Ordovician carbonates thin or are missing beneath Mississippian carbonates on some fault blocks, indicating a post-Ordovician–pre-Mississippian period of faulting.

The greatest amount of deformation occurred during the Pennsylvanian. Thickness, distribution, and facies of sediments were controlled by the location of active faults. Lower Pennsylvanian strata thin by up to 50% across some structures. Fault blocks provided sources of arkosic debris and loci for carbonate buildups throughout the Pennsylvanian and Early Permian. Around the periphery of the basin, Late Pennsylvanian or Early Permian faulting caused a wedging out of older units beneath the Wolfcamp.

Permian, Triassic, and Neogene units, along with present topography, all have been subtly affected by basement structures. The entire section thins over basement highs. Middle and Upper Permian evaporites are thicker in structural lows. The overlying Dockum Group (Triassic) and Ogallala Formation (Neogene), both nonmarine clastic units, become finer grained over basement highs. Present topographic highs coincide with some basement highs. Also, in some places remarkably straight stream segments parallel basement faults. Low-level seismic activity, primarily north and west of the Palo Duro basin, suggests continuing motion on at least some of the faults.

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Results of Ocean Margin Drilling Program Synthesis of Gulf of Mexico Basin

A series of 23 maps plus three cross sections synthesize and integrate for the first time geologic and geophysical data from both the deep central Gulf of Mexico basin and the periphery of the basin. These maps and sections are part of the Ocean Margin Drilling Program synthesis of the Gulf of Mexico basin, a joint project sponsored by the National Science Foundation/Joint Oceanographic Institutions, Inc., and a consortium of petroleum companies. The study area is bounded by 30°/31° on the north, 98° on the west, 82° on the east, and 18° on the south (excluding Cuba and the Yucatan basin). Maps include a regional tectonic map; a map of all seismic refraction data; six structure maps (basement, top Jurassic, top Early Cretaceous, top Late Cretaceous, top Paleogene, and top Neogene); six lithofacies maps (Oxfordian [Late Jurassic], Aptian-Cenomanian [Early Cretaceous], Coniacian-Santonian [Lake Cretaceous], Early Eocene, Miocene, and Pleistocene); and nine isopach maps (total sediment, pre-top Early Cretaceous, post-top Early Cretaceous, Late Jurassic, Early Cretaceous, Lake Cretaceous, Paleogene, Neogene, and Pleistocene). Also included are two N-S cross sections and one E-W cross section. This project is an attempt to synthesize all data available in the public domain. Data for the deep central Gulf are based mainly on regional multifold seismic lines, while data from the periphery are based mainly on the published literature. These maps and sections present for the first time an integrated and comprehensive look at the structure and stratigraphy of the entire central Gulf basin as well as document many details of the early history and later filling of the basin.

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Dolomite Selectivity, An Experimental Approach

Hydrothermal dolomitization of corals, gastropods, pelecypods, echinoderms, forams, and coralline algae indicates that grain size is more important than mineralogy in determining (1) whether or not a fossil will be dolomitized and (2) whether or not the dolomite will pseudomorphically replace a fossil.

Dolomite commonly selectively replaces matrix and/or specific fossils. When dolomite replaces fossils, certain fossils retain their optical characteristics (i.e., pseudomorphic replacement). These selective characteristics have been attributed to both grain size and mineralogy and have been used to make inferences about the predolomitization diagenetic history of sediments.