Adjacent to Southwestern Florida Platform

Three distinct carbonate deposits have been identified on the slope and adjacent sea floor of the Southwestern Florida platform: (1) reef talus, recognized by shape and location, found on the upper slope of the Yucatan Channel and also east of the Marquesas Keys; (2) hemipelagic sediments, with complex sigmoid-oblique bed forms, filling the intervening gap between the channel and Keys and forming two lobes on the floor of the northern Florida Straits; and (3) turbidite deposits, with chaotic internal bed forms, covering siliciclastic Mississippi fan sediments at the base of the canyons in the Florida escarpment. The source of the talus, eroded and transported during the many storms which frequent the region, is the reef complexes which have formed on the platform rim. The sediment of the other two deposits is of foraminiferal tests, produced in nutrient-rich waters at the shelf edge. This sediment is deposited on the outer shelf and is vigorously transported southward as evidenced by 5 m (16 ft) high asymmetric sand waves.

Geophysical, geochemical, and sedimentological data suggest that the spatial relationships of these deposits are related to sea level variations. During extreme lowstands, with much of the shelf exposed, the dominant sedimentation is siliciclastic deposition on the abyssal floor, and slope talus development at the edge of the shelf. During a subsequent rise in sea level, after carbonate production on the shelf is initiated, sediment is transported southward to the head of the canyons and funneled to the abyssal floor. Subsequent rising sea level shifts the axis of transport farther on the shelf, bypassing the canyons and funneling the sediment through breaks in the carbonate reef-banks at the southern edge of the platform. At the sites of both the hemipelagic and the turbidite deposition, high-resolution seismic data indicate that at least three cycles of deposition have occurred. In the abyss, this cyclic nature has produced alternating layers of carbonate and noncarbonate sediments, recognizable in the sedimentary record as chaotic limestone units interlayered with fine shales. The hemipelagic deposits would be almost indistinguishable in the geologic record from deep sea foraminiferal oozes.

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Shallow Geology of North Aleutian Shelf Area, Bering Sea, Alaska

In 1981, the geological hazards analysis group of the U.S. Geological Survey's Conservation Division collected 4,009 line-km (2,491 line-mi) of high-resolution seismic reflection data in the south-central Bering Sea. The survey area is bounded on the south by the Alaska Peninsula and Unimak Island and on the north, east, and west by lat. 56°30'N., long. 160°45'W., and long. 165°W., respectively. The U.S. Department of the Interior has tentatively selected this area for inclusion in Outer Continental Shelf Oil and Gas Lease Sale 92 scheduled to be held in 1985. This study was part of the surface and shallow subsurface geological investigation of the sale area.

The seismic systems used in this study include a seismic reflection profiler that comprises an array of four 15-in.^{3} waterguns with both analog and 12-fold processed formats, an 800-joule minisparker, a 3.5-kHz profiler, a narrow-bean fathometer, and a side-scan sonar.

A bathymetric map constructed from these data reveals a prominent, 20-m (33 ft) high, gentle scarp which trends obliquely across the survey area. Two fields of 10-m (33 ft) high, undulating features, which might be either waveforms or relic glacial moraines, were detected. Several linear moraine deposits, and several sag depressions related to the presence of near-surface faults were also found in the area.

Holocene sediment consists predominantly of silt and fine to coarse-grained sand. The silt component increases toward the western end of the survey area, and gravel is locally present in the eastern end.

A Holocene isopach map reveals that sediment distribution is current-controlled. Contemporary current-related features consist of ripple marks, sediment waves, and scour zones. These features generally occur within 60 km (37 mi) of the shore and in water depths of less than 70 m (230 ft). Although current flow generally parallels the shore, side-scan sonographs indicate that the current direction which produced these features is strongly influenced by small and intermediate scale bathymetric features.

Faults are present in the southwestern portion of the survey area where they occur in a 30 km (19 mi) wide, east-west trending zone. This zone is an eastward extension of the St. George graben system. Within it, faults trend approximately east-west and sense of movement is exclusively normal. There are also several examples of growth faults. Acoustic anomalies, which may represent gas, are present throughout much of the survey area and occur at two different relatively shallow depths. No relationship appears to exist between acoustic anomalies and faults.

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Tectonostratigraphic Terranes of the Frontier Circum-Pacific Region

Many major exploration frontiers around the Pacific are in regions where complex geologic relations reflect plate-tectonic processes, crustal mobility, and accretion of exotic terranes. A preliminary map at a scale of 1:20,000,000 portrays the location and character of major terranes, as well as the position of suture zones and ophiolitic belts.

The destruction of the proto-Pacific ocean (Panthalassa) involved accretion of terranes to cratonal regions such as Gondwana and Laurasia. In eastern Australia, accretion occurred in the Lachlan foldbelt during the early Paleozoic, followed by accretion within the New England foldbelt from late Paleozoic to early Mesozoic time. Terranes in southwestern New Zealand and eastern Antarctica were also probably accreted during the Paleozoic. The southern margin of Siberia, extending into China, underwent a protracted period of accretion from the late Precambrian through the early Mesozoic. Mid-Paleozoic accretion is reflected in the Innuitian foldbelt of the Arctic Ocean, the "Black Clastic" unit of the northern Rocky Mountains, and the Antler orogeny of the western U.S. cordillera.

The Mesozoic breakup of Pangaea and the acceleration of subduction aided in the rifting and dispersal of terranes from equatorial paleolatitudes. Fragments of these terranes now compose much of the continental margins of the Pacific basin, including New Zealand, Indochina, southern China, southeast Siberia, the North American cordillera, and South America.

Combined paleomagnetic, paleobiogeographic, and lithologic data substantiate that some terranes have been displaced thousands of kilometers, but adequate data of these kinds are still lacking for many terranes. Some terranes are presently being further fragmented by post-accretionary dispersion processes such as strike-slip faulting in western North America and Japan. Although the character and distribution of terranes in the western U.S. are fairly well documented, details are needed for other terranes around the Pacific basin. Interpretation of structure and stratigraphy at depth will be aided by more data on the timing of

accretion and the nature of deformation associated with accretion and dispersion. Such data are needed for further define specific exploration targets in the circum-Pacific region.

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Clay Mineral Reactions in Clastic Diagenesis

Studies of clastic sediments have documented the formation and transformation of clay mineral assemblages during burial diagenesis. The transformation of smectite to illite in shale by its reaction with the decomposition products of detrital K-feldspar and mica results in the production of new pore water at depth. The overall reaction mobilizes all the major chemical components in the shale, most of which are consumed in the formation of the diagenetic assemblage illite/smectite + chlorite + quartz. However, part of all the components is undoubtedly transported from the shale to sandstone units and is involved in cementation, replacement, and diagenetic clay mineral formation in these reservoir rocks.

In contrast to burial diagenetic reactions in shale, where the sequence is monotonic and reasonably predictable, diagenetic reactions in sandstone are frequently variable. This variability is probably attributable to the fact that sandstones are open systems in which the reactions that proceed are controlled in part by the influx of new pore water, the chemistry of which is determined by an outside source.

The useful understanding role of clay minerals in hydrocarbon exploration will follow from a determination of the system shale/sandstone/organic material. We need to tie in the nature and timing of shale mineral reactions and their control on the fluid and mass transfer from shale to sandstone.

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Petroleum Exploration Characteristics of Small Depressions, East China

In eastern China there are more than 100 Mesozoic-Cenozoic continental depressions; some of these have areas ranging from several hundred square kilometers to 2,000 km² (772 mi²). Many oil fields have been discovered in these depressions.

From the geologic and exploration histories of the Qianjiang, Miyang, and Damintun depressions the writer has summarized five essential features in exploring small depressions.

(1) Because the distance of oil migration is less than 50 km (31 mi) in continental basins, exploration in small depressions should be guided by the idea that source beds control hydrocarbon distribution.

(2) Locate the deep part of the depression by gravimetric and magnetic prospecting with some seismic profiling and drill stratigraphic wells in the deeper part to evaluate the capacity of oil generation and to record other geologic and geophysical parameters.

(3) Drill wildcats not only on the anticlines but also on structural noses and monoclines, because nonanticlinal pools commonly predominate (about 70% or more of reserve) in small depressions.

(4) If a few wildcats are dry holes and no sand beds are encountered during the early stages of exploration, negative conclusions should not be made in a hurry. If a possible source bed exists, further exploration should be conducted even if the area of the depression is less than 1,000 km² (386 mi²).

(5) In mature small depressions, exploration should be directed mainly to finding various subtle traps in the same way as exploring in large depressions.

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Belayim Marine Oil Field of Egypt: A Case History

Belayim Marine 1 drilled in 1961 encountered oil in a Miocene sand-shale section. The well logged a clear oil-water contact in the lowest sand bed which at the time was believed to be the common oil-water contact for all the interbedded sequence. Based on the results of this well and other subsequent wells drilled inside the oil-water contour, the oil reserves were volumetrically calculated and a development program was effected. In 1978, when the field came back under the Egyptian control, a number of reservoir studies indicated that the oil in place is at least double the amount calculated. The additional reserves could not be accommodated in the rock volume sitting above the logged oil-water line. It was suggested then that the logged oil-water line is valid only for the lowest sand bed and higher sand beds can have their own oil-water lines. The concept when checked by drilling proved to be valid. The additional reserves are now under development.

If the actual size of the field has been known at an earlier stage, a different and more rational development program could have been adopted. It is therefore highly recommended that in similar reservoirs in interbedded successions possible oil-water lines be thoroughly defined for the different sands at an early stage of development.

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Organic Geochemistry of Recent Marine Ooids as a Key to Origin of Petroleum in Oolite Reservoirs

Organic geochemical investigation of recent marine ooids (457 ± 76 to $1{,}516 \pm 86$ years) from the Schooner Cays area, Bahamas, has yielded data that suggest a probable source bed function for their ancient equivalents. Chromatographic analysis of gas desorbed from the ooids reveals the presence of C_1 to C_{5+} compounds believed to be authigenic. These include between 1.7 and 3.6×10^{-5} gm C_1 to C_4 saturated hydrocarbons per gram organic carbon. Total organic carbon (TOC) content varies between 1.23 and 4.13 wt. %, depending on the purity of the sample, with the lowest values reflecting an increased contribution of skeletal debris to the ooids. Total organic extract (TOE) values range from 550 to 650 ppm and show a slight transformation in the direction of oil formation. The organic matter isolated from ooids (termed protokerogen) is dominantly of algal facies. Elemental composition of this protokerogen showed mean atomic H/C, O/C, and N/C ratios of 1.76, 0.24, and 0.19, respectively. Following pyrolysis, CR/CT ratios were found to be very low, with a mean of 0.18. All the results, including a thermal alteration index (TAI) of 1 to 1.5 on Staplin's scale and a very strong green to blue-green fluorescence under ultraviolet light excitation, point toward an immature, high grade, kerogen-type material with enormous potential for generating hydrocarbons. Additional experiments using a high pressure cell to simulate diagenesis in the ooids showed profound changes in their organic geochemistry with the contained organic matter following the predicted evolution path for type II kerogen. There is strong evidence that with deeper burial and prolonged exposure to higher temperatures, and perhaps to catalytic influence of the clay minerals (0.05%) and traces of metals (e.g., Ti, Mn, Sr, V) found in ooids, the organic matter will generate significant amounts of hydrocarbons. In those oolites with a favorable history of porosity development, the hydrocarbons would migrate along the continuous groundmass of organic matter within the ooids and into the pore spaces to accumulate as petroleum.