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Offshore Investigations on Wilkes Land-Victoria Land Margin, Antarctica

In January 1984, the U. S. Geological Survey research vessel *S. P. Lee* carried out investigations of the Antarctic continental margin in the Wilkes Land and Victoria Land areas, using 24-channel and high-resolution seismic, sonobuoy refraction, gravity, magnetic, and bottom-sampling methods. This investigation augmented previous surveys of the Dumont d'Urville area by the French Petroleum Institute and explored new areas west and east to the boundary between the onshore Wilkes basin and the Victoria Land highlands. These surveys defined sediment thickness distribution and seismic stratigraphy in this frontier area. The tectonic style of the boundary between the East Antarctic craton and the younger crust of West Antarctica in the Ross Sea is revealed by one multichannel seismic line across this important boundary.

The initial breakup of Antarctica from Australia occurred as a slowly spreading phase during the middle Cretaceous. According to Deep Sea Drilling Project results on the Tasman Rise, conditions of restricted circulation existed in the growing basin between the continents before the late Eocene. After the late Eocene, the major oceanic circulation pattern was established. Before that time, conditions were favorable for preservation of organic-carbon deposits on the sea floor. Among the questions to be addressed with this data are the following. (1) How do apparent subsidence rates of this passive margin compare with others around the world? (2) Does the onshore subglacial Wilkes basin continue onto the continental shelf? (3) Do Antarctic counterpart basins to the Otway and Ceduna basins of Australia exist? (4) What is the effect of the icecap on the stratigraphy of this margin? (5) Do the two major Tertiary ice advances have conspicuous seismic-stratigraphic signatures?

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Pull-Apart Basins Along Blanco Transform

A series of rhombohedral basins along the 300-km (185-mi) long Blanco transform, surveyed recently by Sea Beam, provide good oceanic analogues to pull-apart basins described along major strike-slip/oblique-slip boundaries on the continent such as the San Andreas and Dead Sea areas. In the Blanco region, continual reorientation of the transform in response to changes in plate motion during the past few million years provides a mechanism for the formation of these basins. In plan view, the Blanco transform is similar to the Gulf of California; that is, there is a series of long strike-slip faults separated by short tensional basins (up to 20 km, 12 mi, long) with structures oriented at a high angle to the master faults. There are some preliminary indications that magmatic activity is occurring in some of the Blanco basins. In the region of the Cascadia depression, previous workers have documented at least 1 cm/yr of crustal sinking within the Holocene. The presence of turbidites and ash layers in this region should provide fruitful ground for detailed studies of the interplay between sedimentation and tectonics and lead toward a better understanding of the evolution of pull-apart structures.

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California Blueschists and the Tectonostratigraphic Terrane Concept

Glaucophane and related schists are present as tectonic fragments in ophiolite-decorated suture zones and as discrete lithotectonic belts along the accreted Mesozoic/Tertiary California margin. Occurrences include parts of the Klamath Mountains, the western Sierran foothills, the Coast Ranges, faulted margins of the Mojave Desert, the Transverse Ranges, and the southern California borderland. Blueschist assemblages formed under high-pressure, low-temperature metamorphic conditions, reflecting the thermal regime of subduction zone environments. Considerable underflow accompanied rifting, drifting, and assembly of far-traveled tectonostratigraphic terranes, as documented by sea-floor magnetic anomaly patterns and age relationships of the oceanic crust-capped lithosphere; the eastern limbs of paleo-Pacific plates (Farallon-Cocos, Kula, etc), have been extensively or completely overridden by the westward encroaching North American plate—7,000 km (4,300 mi) since the Early Cretaceous, and nearly 10,000 km (6,200 mi) since the Jurassic. Thus, although substantial northward drift brought exotic oceanic and continental materials to the growing California crust and caused extensive dislocation in the late Mesozoic and Cenozoic, much plate motion evidently involved a large component of convergence and eastward underflow, as indicated by preserved remnants of high-pressure mineral assemblages scattered throughout California, as well as by the construction of roughly contemporaneous calc-alkaline volcanic-plutonic belts. Subduction appears to have been the dominant process attending accretion of the California continental margin.

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Rifting, Drifting, and Crustal Accretion in Taiwan

Permian and younger rocks in Taiwan record the effects of rifting plus passive margin deposition, sea-floor spreading, convergence and/or oblique closure, volcanic plus plutonic arc construction, arrival of ophiolitic materials, and suturing of exotic trench-argillite and andesitic arc assemblages. Large portions of the sialic crust formed essentially in situ, then were deformed and thrust landward during subsequent tectonic events; however, far-traveled terranes and oceanic fragments played a substantial role in the accretionary process. Recognized and suspected exotics include: (1) lower or middle Mesozoic amphibolites plus serpentinites (now high-rank metaophiolites), situated anomalously in the upper Mesozoic Tailuko metamorphosed miogeoclinal and/or continental slope belt; (2) upper Mesozoic Yuli high-pressure, low-temperature metamorphic trench-argillite melange complex; (3) Mio-Pliocene tectonic blocks of blueschistic ophiolite emplaced in the east-central part of the Yuli terrane; (4) ophiolitic olistostromal debris supplied in the Pliocene to the Lichi Melange of the Coastal Range from Miocene oceanic crust of the South China Sea; and (5) the Neogene calc-alkaline Luzon arc which collided with the sialic crust-capped Asiatic plate in the Plio-Pleistocene. The Cenozoic slate series is an additional, largely fault-bounded parautochthonous terrane deposited as the Tertiary miogeoclinal cover along the Asiatic continental margin and thrust westward during the Plio-Pleistocene arc collision. Taiwan thus represents an intricate Phanerozoic collage of lithotectonic belts, produced by various accretionary processes.

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Late Paleozoic Structural Evolution of Permian Basin

The Permian basin of West Texas and New Mexico is one of the premier hydrocarbon provinces of the world; nonetheless, little regional subsurface structural information about it has been published. Mapping at 1:250,000 on the Ellenburger horizon (Lower Ordovician), compiled for the Tectonic Map of Texas, discloses the overall geometry of Paleozoic deformation in the area.

The southern Permian basin is underlain by the NNW-trending Central Basin disturbed belt of Wolfcamp age (Lower Permian), the deep Delaware basin to its west, and the shallower Midland basin to its east. The disturbed belt is highly segmented with zones of left-lateral offset. Major segments from south to north are: the Puckett-Grey Ranch zone; the Fort Stockton uplift; the Monahans transverse zone; the Andector ridges and the Eunice ridge; the Hobbs transverse zone; and the Tatum ridges, which abut the broad Roosevelt uplift to the north. East-west compression is inferred, with shortening increasing from the Tatum ridges south to the Fort Stockton uplift. The segment boundaries and transverse elements are inferred zones of strike-slip faulting. These fault zones extend both southeast and west of the disturbed belt into discrete strike-slip faults with local uplifts in compressive bends (such as the Big Lake uplift). The Midland basin is much shallower than the Delaware basin, and the uplift-to-basin transition is gradual. A belt of subtle domes and anticlines, extending northeast from Andrews County, overlies a major basement discontinuity (the Grenville Front).

The disturbed belt may have originated along rift zones of either Precambrian or Cambrian age. The extent of Lower and Middle Pennsylvanian deformation is unclear; much of the Val Verde basin–Ozona arch structure may have formed then. The main Wolfcamp deformation over-

thrust the West Texas crustal block against the Delaware block, with local denudation of the uplifted edge and eastward-directed backthrusting into the Midland basin. Later in the Permian, the area was the center of a subcontinental bowl of subsidence—the Permian basin proper. The disturbed belt formed a pedestal for the carbonate accumulations which created the Central Basin platform.

The major pre-Permian reservoirs of the Permian basin lie in large structural and unconformity-bounded traps on uplift ridges and domes. Further work on the regional structural style may help to predict fracture trends, to assess the timing of oil migration, and to evaluate intrareservoir variations in the overlying Permian giant oil fields.

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Potiguar Basin: Geologic Model and Habitat of Oil of a Brazilian Equatorial Basin

The Potiguar basin integrates the eastern part of the Brazilian equatorial Atlantic-type margin. The rifting stage of this basin occurred during the Neocomian and Aptian. The drifting stage and sea-floor spreading began in the Late Albian. The rifting stage clearly was intracratonic during the Neocomian and is recognized as a mosaic of half-grabens trending mostly northeast-southwest and filled with syntectonic lacustrine siliciclastics. The half-graben pattern exhibits rotation of beds into the major fault zone, and the preserved uplifted margins display either paleostructures or paleogeomorphic features with hydrocarbons. A regional pre-Aptian unconformity preceded the Aptian proto-oceanic rifting stage which was characterized by syntectonic fluvio-deltaic sediments. The Aptian tectonics were represented by reactivation of former lineaments superimposed by predominant east-west normal faulting. Structural highs during this stage are so far the most prolific oil accumulations. The most important source beds and reservoir rocks are both Neocomian and Aptian sediments. Geochemistry and hydrodynamics have shown that hydrocarbon migration was driven through fracture or fault zones in both Aptian or Albian plays. Lithofacies maps support this interpretation because pools occur whenever adjacent downthrown blocks present a high shale content.

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New Method in X-Ray Quantitative Mineralogical Determination of Sedimentary Rocks

A new method in quantitative x-ray diffractometry has been developed which uses no "standard" minerals for calibration. Thus, this new method is diametrically different from the classical internal method of Klug and Alexander, which requires the similarity (in chemical composition, crystallinity, and degree of preferred orientation) of minerals used as "the standards" and in the unknowns. The method is based on the interrelationship between the weight percentages of constituent minerals in a rock and relative intensities of x-ray peaks arising from these minerals.

If the concentration in percent of mineral m in sample s is denoted as X_{ms}, the mass absorption coefficient as μ_s, the intensity of a diffraction peak as I_{ms}, and the instrumental (including structural and compositional characteristics of the constituent minerals) constant as K_m, then the weight percentages of minerals in a rock can be obtained easily through a least-squares analysis, $X_{ms} = K_s / I'_{ms}$, where $I' = I_{ms} / \mu_s$. The μ_s can be measured readily from the Compton scattering intensity with an x-ray spectrometer.

Examples from a synthetic mixture, carbonate rock, and mudrock illustrate this new approach.

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Sedimentation in a Transgressed Interdistributary Bay on Mississippi-Lafourche Delta Lobe

Caminada Bay is a shallow south Louisiana bay, located between the distributary levees and beach-ridge plain of the late Lafourche Mississippi delta (900-500 y.B.P.) on the west and the Bayou Des Families levees (3,000-2,000 y.B.P.) on the east. Small distributaries traversed the region of the present-day bay, probably during both early and late Lafourche time. The Lafourche delta actively prograded until about 500 y.B.P. when it was abandoned by the Mississippi River; the area of the present bay then entered its transgressive phase. Grand Isle, which separates Caminada Bay from the Gulf of Mexico, was subsequently built by sand derived from local distributary-mouth bars and erosion of the Lafourche beach-ridge plain to the west. As a consequence of the cutoff in fluvial sediment supply and continued subsidence, the lower delta plain of the Lafourche lobe is currently being transformed into the rapidly expanding Caminada Bay.

Visual description, x-ray radiography, and resin peels of 23 vibracores (4 to 8 m, 13 to 26 ft, in depth) reveal the following vertical succession of sedimentary units beneath the bay: (1) basal paleobay deposits, (2) an intermediate unit representing Lafourche delta lobe progradation, and (3) upper transgressive bay deposits.

The deepest unit penetrated (paleobay deposits) consists of mottled or bioturbated very fine sand and clay and shell beds. The intermediate unit (delta lobe) consists of intricately interlaminated very fine to fine sand, silt, and clay. It features lenticular, wavy, and flaser bedding. The upper transgressive unit consists of banded organic-rich clay with in-situ and detrital peat. Expansion of the bay by wave erosion of the many marsh islands removes most of the organic-rich upper unit. A thin unit of bioturbated muds is currently being emplaced on the bay floor.

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Seismic Stratigraphic Interpretation of Mississippi Fan, Gulf of Mexico

Examination of extensive multichannel and single-channel seismic data across the Mississippi Fan, Gulf of Mexico, reveals that at least 7 seismic sequences comprise the upper Pliocene-Pleistocene section of this giant fan. These sequences are divided into 2 groups based on continuity and amplitude of reflectors. The lower 3 sequences are generally characterized by high-amplitude, parallel to subparallel, continuous reflectors overlain in places by a hummocky clinoform reflection configuration. The reflection patterns suggest distal turbidites deposited in a relatively low-energy environment. In contrast, the upper 4 sequences are generally thicker and characterized by regionally extensive chaotic units interbedded with thin, high-amplitude, parallel to subparallel reflection packages. The chaotic zones grade laterally into more continuous, parallel to gently diverging reflection patterns, probably a lower energy, more distal turbidite facies. Isopach and structure maps of each sequence indicate a seaward and eastward migration in the Pliocene-Pleistocene depocenter during fan development.

Channel, levee, slump, turbidite, and hemipelagic deposits are interpreted within each sequence. Channel/levee deposits are extensive, showing great variability in their morphology and distribution. On the upper fan, the channels are large with well-developed levee sequences. On the middle and lower fan, the channel sequences are smaller, confined mainly to the apex of lobes, and show little evidence of migration and abandonment during lobe development. Slumping off the slope apparently contributed a significant percentage of the material deposited on the upper fan. In addition, the truncation of prominent reflectors and the mounded, chaotic and diffracted patterns on the middle and lower fan suggest that slumping was continually active during fan development.

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Appraisal of Coal Resources from Uranium Drill-Hole Logs, Southern San Juan Basin, New Mexico

Geophysical logs from uranium drill holes in the Grants region are a valuable source of information on coal resources. Coal occurs in the southern San Juan basin of New Mexico in the Upper Cretaceous Gallup Sandstone, Crevasse Canyon Formation, and Menefee Formation. Uranium has been mined from the Upper Jurassic Morrison Formation that underlies the coal-bearing Cretaceous formations and is separated from them by approximately 1,000 ft (300 m) of section.

Permission was obtained from Santa Fe Mining, Inc., Pathfinder