(pinnacle reefs?) in a pelletal and bioclastic limestone; and (4) a deep-water basin in northern Alberta and British Columbia, with tight crinoidal limestone.

These maps are a first step in basin analysis, and also outline possible traps for further evaluation. Preparation of such regional percentage maps is virtually impossible without computer assistance.

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Seismic Inversion by Modeling

Direct estimates of subsurface material properties are obtained by rigorous inversion of conventional seismic data. The inversion procedure employs an iterative model perturbation technique to fine the earth model whose response best fits the input data in a least mean-squared sense. The method is applicable to 1-D, 2-D, or 3-D fluid or solid earth models, and to shot record or CDP stacked data. The synthetic response computed in the inversion process is a rigorous solution of the wave equation appropriate for the chosen earth model and data type.

For 1-D earth models and synthetic CDP stacked data representing various reflection sequences, the modeling method accurately recovers the true acoustic impedance profile. When a nonrigorous recursive technique is applied to the same models, accurate results are obtained only for weak reflection sequences. Also, the modeling technique exhibits greater stability in the presence of noise. For poststack inversion of field data, the processing sequence leading to the CDP stacked trace is of key importance.

For 1-D earth models and shot record input data, the modeling method accurately recovers both density and velocity profiles. A key issue in prestack inversion of field data is the generation of synthetic shot records consistent with data collection geometry.

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Geothermal Gradients, Organic Metamorphism, and Mineral Diagenesis in Tertiary Rocks, Santa Ynez Mountains, California

Organic metamorphism, as expressed by vitrinite reflectance, may be used to correlate mineral diagenesis with the thermal history of a sedimentary basin. Levels of organic metamorphism were compared with diagenetic minerals in three Paleogene sandstone and shale sections of the Santa Ynez Mountains and were used to determine paleotemperatures by means of the established time-temperature-reflectance relation. Calculated paleogeothermal gradients range from 31.0 to 40.3°C/km in the eastern end of the basin to 47.2 to 51.0°C/km in the west.

Changes in the geothermal gradient in the Santa Ynez Mountains through the Tertiary were modeled using present surface temperatures and heat generation at the earth's center as boundary conditions. For instantaneous and continuous deposition, the governing equation is a linear parabolic partial differential equation. To model continuous deposition, a small dispersion coefficient term is used. The equations were solved by finite difference numerical techniques involving matrix solution by the Thomas algorithm. In instantaneous deposition, thermal equilibration is rapid in terms of geologic time, with temperatures restored to their presedimentation levels after 500,000 years. For continuous deposition, sedimentation rates of the Paleogene strata are slow enough to allow for nearly complete thermal equilibration during deposition.

The first appearance of laumontite in the eastern and central parts of the basin occurs at vitrinite reflectivities of 1.1 and 1.3% R_O (200°C) respectively, while laumontite first occurs at vitrinite reflectance of 0.5% R_O (110°C) in the western end of the basin. Variation in the ratio of fluid pressure to total pressure may be responsible for the observed distribution of laumontite. The transition from a mixed-layer illite/smectite illite-chlorite asemblage to an illite-chlorite assemblage in the interbedded shales occurs at vitrinite reflectance of 2.4% R_O (235°C) in the eastern part of the basin.

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Geology of Hibernia Discovery

Chevron discovered the Hibernia oil field in 1979 by drilling the Chevron et al Hibernia P-15 well, on the Grand Banks, 195 mi (314 km) east of St. John's, Newfoundland. Delineation drilling, completed during 1980 and the early part of 1981, has confirmed the presence of a giant oil field which, in all probability, will contain recoverable reserves in excess of one billion bbl.

The oil field is located near the western edge of the Jeanne d'Arc subbasin, a southwestern extension of the much larger East Newfoundland basin. These depocenters developed as a consequence of Mesozoic extensional rift tectonics and contain up to 40,000 ft (12,192 m) of Mesozoic and Cenozoic sediments.

The Hibernia structure is a large north-northeast trending rollover anticline, bounded on the west by a major listric growth fault, and dissected into a number of separate blocks by transverse faults. The crest of the structure is truncated by a major middle Cretaceous unconformity.

The most potentially productive reservoirs are sandstones of Lower Cretaceous age which appear to be deltaic in origin. Porosities vary from 17% to more than 30%; permeabilities range from 200 md to 1,300 md.

The discovery and early delineation wells each have an indicated productivity in excess of 20,000 bbl per day.

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Interstitial Water Chemistry of DSDP Holes on Guatemala Transect (Leg 67) Related to Occurrence of Methane Clathrates (Gas Hydrates)

High gas-concentrations, and methane/ethane ratios approaching the DSDP-safety limit, caused premature termination of drilling on Sites 496 to 498 (2,064 to 5,497-m water depth) on the Pacific continental slope off Guatemala. Methane concentrations in organic-matter-rich Quaternary to Miocene middle and lower trench slope sediments cause the formation of clathrates that were recovered for the first time in volcanic ash from two drill holes. The potential clathrate-bearing zone (below 80 to 100 m subbottom depth) is associated with a spectacular decrease in interstitial water chlorinity, which drops below half the chlorinity of seawater at the bottom of the holes (near 400 m subbottom). It is proposed that the crystallization of gas hydrates, which like ice exclude salts from the crystal lattice, causes upward ejection (relative to the subsiding solids) of dissolved salts. This is supported by positive ^{18}O-isotopes ($\delta_{18}O_{smow}$ up to +1.96 at bottom of hole 497), which make freshening of the pore waters by influx of meteoric water unlikely. If our hypothesis is correct, lowered chlorinities in sections of subtropical continental margins (high organic matter content!) might thus serve as an indicator for the occurrence of clathrates. Organic matter oxidation is associated with strong sulfate depletion (within one or a few meters from the sea floor), a pronounced increase in alkalinity (maximum between 50 and 250 m subbottom) and ammonia as well as phosphate (maxima between 100 and 200 m). Calcium and strontium remain uniformly low throughout the holes, Mg decreases markedly with decreasing chlorinity. The fact that chlorinity does not drop to zero in the clathrate zone suggests that only a portion of the pore water is tied up in clathrate formation.

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Facies Characteristics of Modern Size-Graded Shelf Deposits, Northwestern Gulf of Mexico

General decrease in grain size of modern surficial sediments with increasing water depth across the continental shelf off south-central Texas suggests that the sediments are in equilibrium with the hydraulic regime during fair weather conditions. The stratigraphic record, however, indicates storm-dominated shelf sedimentation resulting in zonation of sedimentary structures, bed types, and bed sequences. Three facies are defined.

Lower shoreface (water depth: 10 to 30 m): sediment has a significant fine sand component and occasional thin shell beds. Bioturbation is generally high with a diverse trace assemblage. Sand beds exhibit parallel to subparallel lamination with erosional basal contacts. Bedding relations define two major seqeunces: (1) thin, clean, laminated sand → thick, sandless, nonbioturbated mud → heavily bioturbated muddy sand with mottled tecture, and (2) thick, clean, laminated sand → interlaminated mud and sand → muddy sand with mottled texture. Both sequences are cyclic and result from variation in hydraulic energy related to storm events.

Midshelf (30 to 120 m): clayey silt sediment containing little sand and no shell beds. Sediments are moderately bioturbated; trace diversity is intermediate. The only physical structures are occasional parallel-laminated sand beds. Bed-type diversity is intermediate. Moderately thick mud beds are separated by thinly laminated or bioturbated, storm-related sand beds.

Outer shelf (120 to 200 m): clayey silt sediment (clay content greater than on the midshelf). Bioturbation and trace diversity are low. Bed-type diversity is low, and bedding relations simple. Thick, very thinly but faintly laminated, slightly bioturbated mud beds are separated by thin, heavily bioturbated, relatively clean sand beds (distal storm layers).

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Erosion of Old Slump-Scar on Nova Scotian Slope and Possible Mid-Slope Depositional Lobe

High-resolution seismic profiles and a long-range sidescan sonar (*Gloria* II) records have been used together to interpret a complex erosional pattern on the Nova Scotian continental slope. A steep uppermost-slope (200 to 500 m depth) is dissected by numerous small gullies which converge to form a single flat-bottomed, erosional channel below 700 m depth. The sidescan record shows these features to be confined to a lobate area, approximately 8 km wide. Seismic profiles outside this area show a smoother topography with greater continuity of parallel subbottom reflectors. The eroded area is interpreted as an old slump-scar which has been secondarily eroded by a gulley-channel system. Cores from the area are compatible with this interpretation.

At about 1,000 m depth, the incised channel cannot be recognized on either the seismic profile or the sidescan record. However, a profile in the predicted path of the channel shows a broad mound, approximately 5 km wide, with a relief of about 20 m. This has a rather similar profile to a suprafan of a submarine fan, with a small channel on the surface, possible buried channels and erosional surfaces in the subbottom. It is suggested that sediment from the channel system has been deposited in this deeper area to form a depositional lobe.

The mid-slope position of this possible depositional system has major implications for interpretation of ancient basin-margin sequences and the later erosion of a slump scar is important in terms of a potential hazard for placing bottom structures.

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Geology-Petrophysics of Levelland 12-Acre Tertiary Pilot, West Texas

The Levelland 12-acre (4.8 ha.) pilot was drilled during the latter part of 1972 on a double five-spot pattern, and underwent waterflooding from March 1973 until August 1979. On August 3, 1979, carbon dioxide flooding was initiated.

The purpose of this study was to define a stratigraphic zonation for the San Andres Formation (Permian) in and around the pilot, to obtain an accurate, quantitative, reservoir description to aid engineers achieve a historical match of the waterflood, and to evaluate the tertiary recovery efficiency of carbon dioxide flooding.

Excellent core control demonstrated that sedimentary deposition had occurred in an arid coastal carbonate-evaporite province similar to that which exists today on the Trucial Coast, Persian Gulf. Stratigraphic zonation was made using core data in conjunction with log data. A quantitative reservoir description was achieved by the following steps: (1) porosity calibration of the gamma ray-neutron logs; (2) permeability calculation from the calibrated porosity using available core data; (3) determination of the permeability cutoff for net pay; (4) determination of connate-water saturation from applicable native state cores; (5) determination of the reservoir zonation, and (6) computer generation of ϕH, KH, and H maps for individual reservoir zones and combinations of reservoir zones.

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Modern Carbonate Shelf-Slope Boundaries

The shelf-slope boundary along modern carbonate buildups on a worldwide basis demonstrates a high variability in morphology, structure, biogenic barriers, sediments, depth of occurrence, dominant processes, and general geologic history. This boundary is defined as the zone of maximum gradient change between the nearly horizontal shallow-water shelf