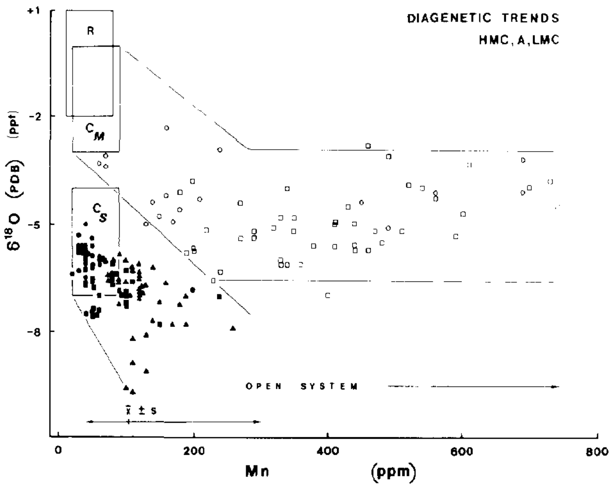

diagenetic system, is about −1 ppt for the originally low −Mg calcite components and about −2 ppt for the originally high −Mg calcite and aragonite components. Conversely, for the Burlington Limestone components, which stabilized in an open diagenetic system, the average diagenetic shift in $\delta^{18}O$ is about −3 ppt for the originally low −Mg calcite components and about −4 ppt for the originally high −Mg calcite components.

The $\delta^{13}C$ values of the components are bimodally distributed. This distribution is independent of geologic age, inferred original mineralogy of the component, degree of diagenetic alteration, and the type of diagenetic system, with components from both formations contributing to the light (+0.5 ± 0.4 ppt) and heavy (+3.1 ± 0.7 ppt) ^{13}C groups. Both groups also show a decrease in ^{13}C of about 1 ppt with stabilization of the carbonates in the diagenetic system.

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Thermal History by Fission-Track Dating, Tejon Oil Field Area, California

Data that have been obtained from deep drill holes in several areas where the approximate duration of heating events is known suggest that fission tracks in apatite and zircon are totally annealed when the grains are heated at temperatures of 135 to 105°C and 200 to 175°C, respectively, over periods of 10^6 to 10^8 years. Annealing can pose problems for determining the primary ages of samples, but if offers a powerful method for studies of their thermal and tectonic history. This paper explores the application of this method to determining the thermal history of sedimentary basins using detrital grains separated from drill-hole samples.

Detrital apatite and zircon have been separated from Eocene to Miocene sandstone recovered from deep drill holes in the southern San Joaquin Valley of California (Tejon oil field area). The Tejon area is divided by the seismically active White Wolf fault. Fission-track data show that apatite in the downthrown block immediately northwest of the fault is totally annealed at a maximum paleotemperature (reconstructed from laumontite geothermometry) of 135 to 140°C, suggesting heating of 10^6 years' duration. The higher paleotemperature ($>$ 150°C) indicated for total annealing of apatite in the upthrown block shows that these samples could have been at the suggested maximum paleotemperatures for no more than 10^5 years. The relative short duration of heating over the whole Tejon area is supported by the lack of annealing in zircon, even at paleotemperatures as high as 179°C. These conclusions are consistent with the thermal history suggested by laumontite crystallization viewed with stratigraphic and structural evidence.

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Spatial Variations in Sand-Wave Size and Migration Rate: Implications for Shoal Dynamics

Spatial patterns of sand-wave size and migration rate were carefully monitored using side-scan sonar and narrow-beam echo sounding on Southwest Middle Ground Shoal in Vineyard Sound, Massachusetts, from March 22 to November 16, 1978. Navigation was provided by an acoustic-transponder system with a positioning accuracy of 3 m.

Sand waves migrate obliquely upshoal from depths greater than 19 m to depths less than 11 m. Erosion at depths less than 16 m is caused by a downcurrent increase in the sediment-transport rate, represented by a twofold increase in bed-form height that more than offsets a small decrease in migration rate. Deposition farther downcurrent, above 16 m, is caused by a downcurrent decrease in sediment-transport rate, manifested by downcurrent decreases in both bed-form height and migration rate. These bed-form-size trends are consistent with a kinematic control on bed-form size that causes bed forms to grow or shrink while they acquire or lose sediment owing to erosion or deposition.

The observed pattern of erosion on the shoal's lower flanks, and of deposition on the upper flanks and crest (a constructional phase of shoal dynamics), may be seasonal because the period of our study did not include the more energetic winter months. Alternatively, this constructional pattern may occur during all seasons, and only be balanced by such major storm events as hurricanes, which would transfer sediment from the shoal crest to its lower flanks.

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Statvik Field of Norwegian North Sea—Exploration Study of Unconformity Trap

The Statvik field is situated in block 34/10 in the Norwegian sector of the North Sea approximately 20 km east of the Statfjord field. The main reservoir is the Middle Jurassic Brent sandstone which is truncated by the late Kimmerian unconformity. the unconformity is overlain by Upper Cretaceous shales. The delta structure is one of the biggest structures at the late Kimmerian unconformity level in this part of the North Sea.

In the early exploration phase the crucial question was whether the Jurassic reservoir rocks had been eroded during the late Kimmerian orogenic event. Early generation seismic showed no reflectors below the unconformity. A square km seismic reflection survey was shot in 1974 and interpretation of this data gave indications of a thick Jurassic sequence below the unconformity.

The first well was drilled during the summer of 1978. It showed a 165-m thick hydrocarbon column in sandstones of Middle Jurassic age. The predrilling interpretation was largely correct. An active period with continuous drilling followed; by August 1979, 8 wells had been drilled on the structure. During the summer of 1979 a 3-D seismic survey covering 190 km^2 was shot. Interpretation and drilling were simultaneous. Before drilling, probable recoverable reserves were calculated to be 1,600 million bbl. After drilling the estimate was revised to 1,200 million bbl. The field has now been declared commercial and a successful exploration period has been terminated. This discovery has opened new possibilities in an area under active exploration.

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Study of Subtle Traps Using Horizontal Seismic Sections

A three-dimensional seismic survey, after proper design, data collection, and data processing, yields a three-dimensionally migrated data volume. Horizontal, or Seiscrop™, sections sliced from this data volume provide a direct horizontal view of the subsurface from which structural interpretation can be straightforward.

In the absence of structure, Seiscrop sections display stratigraphic or paleogeomorphic features directly. However, structural deformation can be removed from the data by flattening. Horizon Seiscrop sections, sliced from the flattened volume, permit stratigraphic and other depositional features to be recognized and studied in detail without the confusion of structure.

Using horizontal seismic sections primarily from the Gulf of Thailand, a variety of small and subtle traps have been identified. These include small fault traps, sand channels, and sandbars. The acoustic nature of these features has been further studied using seismic logs, derived by wave equation inversion. Reservoirs thicker than 30 ft (9 m) have proved mappable.

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Surface Detection of Free Hydrocarbon Microseepage from Subsurface Petroleum Accumulation: Case Study

In January 1979, PEMEX began a 2-year test project designed to evaluate the surface detection of free hydrocarbon microseepage as an integrated exploration tool. The tests were performed by analyzing samples collected over fields selected to represent various hydrocarbon entrapment conditions (differing hydrocarbon type, differing trap mechanisms, varying depths, etc). All analyses were performed in the field, and the sample types, sample depths, and collection procedures were varied to determine the best procedures for detecting microseepage anomalies.

In addition to summarizing the various sample collection and analytical procedures utilized in the field operation, results are presented from one of the successful tests conducted over a known producing structure. The analytical field procedures used were C_1-C_7 gas chromatography and C_{10+} spectrum fluorescence analysis of cuttings and core samples collected at varying depths between 2 and 30 m. The structure selected is a lenticular anticline that produces oil from an Austin equivalent at 2,500 m and dry gas from the Jurassic at approximately 3,500 m.

The 350 surface samples definitely indicate that methane is seeping into the near-surface sediments and forming a distinct anomaly directly above the two superimposed reservoirs. Apparently, only the methane is able to migrate through the stratigraphic section, and the heavier components, if they were able to escape from the Cretaceous reservoir, have been stripped and retained by the sediments.

The surface anomaly appears to contain elements of both a circular halo and a centralized anomaly that overlies the apex of the producing structure. The intensity of the anomaly was of a sufficient degree that its detection should have been possible using blind reconnaissance sampling.

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Structural Deformation in Northern Gulf of Alaska: Transition from Transform to Convergent Plate Motion

Multichannel seismic reflection data reveal the late Cenozoic structure along the continental margin in the northern Gulf of Alaska, where transform motion along the Queen Charlotte-Fairweather fault system gives way to convergent motion along the Aleutian Trench. The active trace of the Fairweather fault system lies generally near the outer shelf and upper slope but, south of Sitka, broad folds and associated faults in late Cenozoic strata seaward of the active trace may indicate additional fault splays beneath the continental slope. The intensity of deformation in these strata decreases to the north, and slope deposits seaward of the Fairweather fault are undeformed between Sitka and Cross Sound. Between Cross Sound and Icy Bay (the Yakutat segment), Eocene and younger shelf strata are relatively undeformed along the continental slope. Late Cenozoic abyssal strata, which partly onlap the continental slope, are relatively undeformed except for local recent deformation seaward of Fairweather Ground. The observed structure along the Yakutat segment of the continental margin is more readily explained by strike-slip motion between the Yakutat segment and the Pacific plate than by oblique subduction of the Pacific plate as deduced from plate tectonic models. Between Icy Bay and Kayak Island (the Yakataga segment), northeast-trending faults and folds that deform Cenozoic strata beneath the shelf and slope suggest relatively continuous late Cenozoic convergence between the Yakataga and Yakutat segments of the continental margin. Thus, the Yakutat segment may have been coupled to the Pacific plate during much of the late Cenozoic.

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Results of DSDP Leg 77 in Deep Southeastern Gulf of Mexico—How Good Was our Seismic Stratigraphic Interpretation Ahead of the Drill?

A detailed seismic stratigraphic interpretation of an extensive grid of multifold seismic reflection data provides the basis for a model of the pre-middle Cretaceous sedimentary history of the southeastern Gulf of Mexico. The study area is located in the deep-water part of the western Straits of Florida between the Campeche and Florida Banks north of Cuba. The model predicts that: (1) block-faulted basement topography represents the top of a rifted and attenuated continental (transitional) crust; (2) a syn-rift sedimentary sequence possibly consisting of volcanic and nonmarine rocks of Triassic to Middle Jurassic fills in rift basins and covers the rift topography; (3) a post-rift sedimentary sequence representing a transition upward from shallow- to deep-marine rocks of Late Jurassic