ern shoreline was probably everywhere microtidal as a result of dissipation of tidal energy across the very shallow eastern shelf of the basin.

The Arafura Sea displays a tidal pattern that may be similar to that of many ancient epeiric seas. Though smaller and shallower, it is thought to be a good modern analog for the interior Cretaceous seaway.

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Organic Matter in Sediments Underlying Ross Ice Shelf

Eleven gravity cores (maximum penetration 102 cm) were obtained in December 1977 below the Ross Ice Shelf at Site J9. The sediments proved to be middle Miocene glaciomarine mud. The sediments may reflect a recent grounding of the Ross Ice Shelf which probably resulted in the erosion of the Pliocene-Pleistocene section. The sediment cores contained two lithologic units: an upper, light olive-gray unit from 5 to 20 cm thick, and a lower darker unit.

Concentrations and stable isotope compositions of the total organic carbon were determined for 13 samples in two of the cores. Three samples from the upper unit contained 0.17, 0.18, an 0.19% organic carbon with $\delta^{13}C_{PDB}$ compositions of -25.5, -25.3, and -24.3‰, respectively. Ten samples from the lower unit contained more than twice as much organic carbon, ranging from 0.35 to 0.46%, and slightly lower $\delta^{13}C_{PDB}$ values, ranging from -25.1 to -26.1 ‰. The amounts and isotopic compositions of the organic carbon in these sediments are probably controlled by the relative amounts of kerogen derived by erosion of rocks from the Transantarctic Mountains and organic carbon fixed by photosynthetic organisms in the Miocene ocean.

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Generation, Migration, and Entrapment of Petroleum in Extensional Basins

The interplay of tectonics, thermal regime, and depositional history generally determines the petroleum potential of individual basins. The application of these factors to a review of several extensional basin systems (Rhine graben, North Sea basin, Reconcavo basin, Gulf of Suez basin, Red Sea basin, Bass basin, and Gippsland basin) provides the basis for this analysis.

Extensional tectonic systems provide a mechanism for thinning the crust and upper mantle (the lithosphere). The result is a progressive rift-basin evolution starting with graben formation and ending in the development of continental margins. However, if tensional stress stops at any stage, a post-rift phase of subsidence, regulated by thermal decay, begins.

Sedimentary rocks deposited prior to extension (pre-rift sediments) are preserved in the graben areas but eroded from the horsts. Rift sediments (usually clastics) deposited during extension are eroded from the uplifted areas, but carbonate rocks and evaporites may be deposited if the climatic environment is favorable. Sediment deposition is continued after extension stops (post-rift sediments).

Source beds can be in the pre-rift, rift, or post-rift sediments but generation does not occur until they are buried to the depth of the generative window. Generation is aided by the high heat flow caused by the thinned crust. The kind of petroleum generated is dependent on the type of organic material present and the deepest zone of generation reached.

Extensive normal faults contribute to trap geometry but inhibit long distance migration. Consequently, except in the post-rift section, entrapment of petroleum requires that the source and reservoir rocks are in close proximity, which can be accomplished by faulting, interfingering, or the superposition of source rocks on reservoir rocks at unconformities. The most favorable conditions for generating and trapping large oil fields are commonly in or near the deepest part of the basin.

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Sedimentation, Biostratigraphy, and Source-Rock Potential of Deseret Starved Basin (Mississippian), Western United States

Dark, organic-rich starved-basin sediments of the basal, phosphatic member of the Deseret Limestone and equivalents were deposited west of a westward-prograding carbonate platform in Osagean to early Meramecian time. These sediments comprise mainly pelletal, peloidal, oolitic, and conglomeratic phosphorite; phosphatic shale enclosing large calcareous concretions; bedded spiculitic and radiolarian chert; cherty micritic limestone; siltstone; and mudstone. The starved basin extends for more than 700 km from southeastern Nevada to southeastern Idaho. Rate of sedimentation of starved-basin sediments is calculated from the conodont zonation to be about 10 m/m.y. Slope sediments that intertongue westward with basinal sediments and eastward with carbonate-platform sediments consist mainly of thin-bedded clinoform micrite interbedded with some debris-flow encrinite. These sediments were deposited on a gentle foreslope of 5° or less at a rate of 16 to 18.5 m/m.y. Time-equivalent carbonate-platform sediments were deposited at a rate of about 113 to 130 m/m.y.

The biota of the basinal sediments is mainly planktonic radiolarians, nektonic goniatites and conodonts, benthonic agglutinate foraminifera and sponges, and infaunal traces of burrowing organisms. The sparse shelly fauna consists mainly of small solitary corals and a few brachiopods. The bathymetry of the foreslope and shelf, considered together with the character and biota of the basin sediments, suggests that the floor of the central basin lay in the dysaerobic zone at a depth of about 300 m.

Organic-carbon and hydrocarbon content of outcropping phosphatic shales that have been deeply weathered, leached, and biodegraded are difficult to evaluate. Analyses generally produce values that are much lower than values that can be expected in the subsurface, where the same rocks have generated or are generating petroleum. Nevertheless, the following organic-carbon yields have been obtained from carefully selected outcrop samples: 1.50 to 7.95% (4.29 median) for phosphatic shales, 0.67 to 5.11% (2.64 median) for phosphorites, and 0.40 to 3.17% (1.25 median) for micrites. Hydrocarbon analyses range from 50 to 300 ppm in areas where conodont CAI values range from 1.5 to 4.

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Use of Devonian Conodonts in Petroleum Exploration, Western United States

Forty-eight Devonian conodont zones are now recognized worldwide: 11 zones in the Lower Devonian, 10 zones in the Middle Devonian, and 27 zones in the Upper Devonian. Only five of these zones have not yet been recognized in the western United States. Conodonts, which range from Cambrian to Triassic, attained their maximum faunal diversity and abundance during the Late Devonian, when each conodont zone lasted about 0.5 m.y. Because each zone represents such a short interval of geologic time, conodonts provide an indispensable tool for petroleum exploration in the Rocky Mountain, Overthrust belt, and Great Basin regions.

Conodont color-alteration index (CAI) values have been used successfully to predict cool areas of potential production in otherwise thermally overcooked regions. Their use has also been demonstrated as follows.

1. Conodonts, by providing virtual time planes, suggest the complex relations between source beds in the Pilot basin and reservoir rocks in the enclosing carbonate platform.
2. Conodonts have been used to determine rates of sedimentation of source rocks and other synorogenic sediments of the Antler orogeny. These rates range from 1 to 400 m/m.y. They also demonstrate that deposition was episodic and that there were times and areas of nondeposition within marine basins.
3. Conodonts precisely date Antler orogenic events, which governed eustacy and caused marine transgressions and regressions on the craton. For example, the emplacement of the Roberts Mountains thrust took approximately 8 m.y.
4. Conodonts are used for biofacies analysis and for paleotectonic reconstructions. For example, within the Late Devonian *Polygnathus styriacus* Zone, eight different conodont biofacies, with almost mutually exclusive faunas, have been used to reconstruct five paleotectonic settings ranging from peritidal to offshore pelagic.

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Organic Model for Roll-Front Uranium Deposits

The almost universal association of uranium with humic-type organic matter in sedimentary deposits has long been recognized. This close relation is often overlooked in some sandstone uranium deposits owing to the difficulty in recognizing the unstructured organic material, the lack of analyses for organic carbon, or the labile nature of the immature humic substance. A colloidal suspension of humic acids derived from decaying vegetal matter can be made to flocculate by a drop in pH, by local changes in cation concentration, or by adsorption on clays. Evidence shows that the roll-type deposits are essentially "organic rolls" in which the humic acids were precipitated primarily by the drop in pH associated with the redox interface. Once precipitated the humic substances are particularly efficient in the collection of metals from very dilute solutions such as natural waters.

In actively migrating oxidation fronts, the humic matter and some of the uranium appears to be remobilized and concentrated downdip from the "radiometric front." This may explain the poor correlation between organic matter and uranium in some of the Texas deposits. The humic substances, however, are believed to be an essential prerequisite for the original accumulation of the uranium in the roll fronts.

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Geologic-Seismic Exploration Model for Reworked Deltaic Sandstones—Excellent Subsurface Reservoir

Reworked deltaic sands are produced by the reworking of abandoned deltaic lobes. Criteria and models are developed for the recognition of reworked deltaic sand bodies on subsurface log and seismic data. A geologic-seismic model and a subsurface prospect example is presented.

A reworked deltaic sand sequence is composed of four depositional components. From base to top these are, prodelta shale, distributary mouth bar sandstone, reworked deltaic sandstone, and transgressive marine shale. The basal prodelta shales possess lower velocities and commonly lower density and resistivity, and are generally very thick—greater than 300 ft (91 m) and commonly 3,000 ft (914 m) or more. The thickness of overlying distributary mouth bar sands generally ranges between 200 and 400 ft (61 and 122 m) and they are depopod-shaped—2 to 4 mi (3.2 to 6.4 km) along depositional dip and 2 to 6 mi (3.2 to 9.6 km) along depositional strike. Mouth bar sands display moderate to poor sorting in contrast to the overlying reworked deltaic sands which are well sorted, possess excellent porosity and permeability, and make better reservoirs. Reworked sands are elongated along depositional strike—5 to 15 mi (8 to 24 km) long and 0.25 to 0.5 mi (0.4 to 0.8 km) wide. Their thickness ranges between 20 and 60 ft (6 and 18 m). Marine shales overlying the reworked deltaic sands possess higher velocities and exhibit higher resistivity on electric logs. They are calcareous, contain abundant oyster fragments, and reflect deposition initially in shallow brackish waters and later in deep open-marine waters.

The contrasting lithologies, velocity differences, and the geometries of various depositional units of reworked detrital sand sequences provide excellent clues for their recognition on log and seismic data.

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