patch reefs only stood 1 to 3 m (3 to 10 ft) above the sea floor, it is obvious from the external morphology of individual Archaeocyathids and the number of overturned and restored colonies that the patch reefs encountered higher energy conditions as they grew. Thus, these Archaeocyathid patch reefs apparently created many small, discontinuous obstructions to currents and waves.

Two distinctly different faunas associated with the environments around these reef complexes show a similar change in dominance diversity (d). The faunal assemblages on the flanks of each complex illustrate a general decrease in the abundance of the dominant species or a more equitable distribution of individuals per species with distance from the complex. However, the composition of each faunal association remains consistent with distance from the complex. The gradual lowering of dominance diversity with distance from the complex could be related to a subtle but gradual change in the marine environment.

In each assemblage, the high degree of dominance close to the reef appears to approach a geometric distribution of the individuals per species. Faunal assemblages in which the distribution of the individuals per species approaches a geometric distribution are indicative of physically disturbed habitats. The decrease in dominance farther from the complex suggests that these areas could have been under less physical stress.

Currents diverted by a small patch reef would flow over and around this obstruction, thereby creating a zone of higher physical energy around the reef. In each of the lower Forteau reefs examined, the interreef faunal distribution could be related to a zone of higher physical disturbance directly around the reef. Thus, changes in the local physical-sedimentological environment produced by the reefs appear to have affected the ecological structure of the interreef faunas.

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Vertically Accreted Foreshore to Shoreface Deposits of Sego Sandstone (Campanian), Northwest Colorado

Exposures of the Sego Sandstone, on the northern flank of Rangely dome, Colorado, represent a thick (50 m [165 ft]) sequence of shoreline sandstone. The Sego Sandstone generally represents a progradational sequence. However, the interplay between sediment supply and subsidence resulted in stabilization of shoreline position. Deltaic distributaries were not observed, suggesting interdeltaic deposition.

The initial progradational phase within this sandstone complex is represented by three facies. (1) Basal facies composed of bioturbated shale with occasional silt stringers. (2) Medial facies, averaging 5 m (16 ft) in thickness, grading upward from the underlying shales, and composed entirely of ripple-stratified fine sandstone. Starved ripples at the base of this sequence grade vertically into flaser and amalgamated ripples. Channels filled with clay and ripple-stratified sand oriented south-easterly are present. (3) Upper facies is composed of fine-grained sandstone exhibiting basal hummocky cross-bedding that grades vertically into small-scale troughs and planer stratification. This facies is capped by a thin (35 cm [14 in.]) coal. Maximum observed thickness for this facies is 7 m (23 ft), with thinning toward the northwest.

Facies 1 represents the marine shale deposits of the Buck Tongue. Facies 2 is an ebb delta system believed to have functioned concurrently with the prograding shoreface (facies 3).

Stabilized shoreline conditions are characterized by four facies. (1) The basal unit is composed of fine to medium-grained sandstone. Trough and tabular cross-bedding is abundant, as is ripple stratification. Individual beds are 10 to 50 cm (4 to 20 in.) thick and the unit thickness is 10 to 20 m (33 to 66 ft). No apparent vertical trends with respect to either grain size or sequence of sedimentary structures were observed. (2) The second facies is fine grained, predominantly ripple stratified with some tabular and low angle bimodal cross-beds. Sand-filled channels with *Ophiomorpha* are present. This facies is 9 m (29.5 ft) thick and onlaps with a portion of facies 1. (3) The third unit is fine to medium grained, and as with facies 1, contains abundant trough and tabular cross-bedding as well as abundant ripple stratification. Paleocurrent data suggests a northwesterly transport direction for facies 3 as opposed to a southwesterly direction for facies 1. Bedding is between 10 to 50 cm (4 to 20 in.) thick with unit thickness of from 0 to 12 m (0 to 39 ft). This unit thins northwestward. (4) The upper unit thickens northwestward and is composed of bioturbated shales, humates, and very fine-grained sandstone.

Facies 2 represents a sand tidal flat situated behind the coastal barrier (facies 1). The lack of well-developed trends either in grain size or sedimentary structures within facies 1 indicates that the bar formed from the amalgamation of diverse environments. Overlying both the bar and tidal flat facies is the spit (facies 3) and lagoonal muds and washovers (facies 4). This shoreline sequence is overlain by fluvial deposits of the Mesaverde Group.

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Detailed Reservoir Analysis using EPT-Cyberlook and Dipmeter Computations

In recent years, a tremendous amount of work by oil companies has been done to evaluate tertiary flood programs in heavy oil reservoirs. One of the keys to understanding how a flood will behave, and therefore an input to the modeling, is a basic knowledge of the depositional environment and reservoir geometry. This often requires the analysis of a large amount of information. The core analysis alone on a multiple well project can be extremely time consuming if it is to be done with any significant detail.

This paper outlines the basis for a technique which allows a fairly detailed analysis of the reservoir potential and depositional environment. Using field generated Cyberlook logs and the dipmeter programs of Cluster and Geodip, a fairly rapid interpretation can be made which will confirm the depositional environment, the reservoir potential, and the orientation of any permeability barriers within the reservoir.

Several examples are presented where the Electromagnetic Propagation log is used in the Cyberlook to identify the mobile oil potential of the reservoir. This computation is then compared to Cluster and Geodip plots and, where anomalies occur, either changes in Rw or oil viscosity are implied. Reservoir geometry is then estimated from knowledge of the depositional environment and the dipmeter computations.

With these tools at hand, it is now possible to predict not only which hydrocarbons will move, but the general direction of movement during initial production or flooding of the reservoir.

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Plate Tectonics and Offshore Boundary Delimitation: Tunisia-Libya Case at the International Court of Justice

Advances in the technology for exploiting resources of the oceans, particularly recovery of hydrocarbons and minerals in deep water, is benefiting a growing number of nations. At the same time, however, economic and political pressures have induced concern and there is now a much increased emphasis on jurisdiction to divide the offshore areas between the 132 coastal nations. Negotiations affect research operations at sea and, in consequence, marine scientists have been made aware of offshore problems as highlighted by the Law of the Sea Treaty (UNCLOS III) and complications arising from the legal versus scientific definitions of continental shelves and margins. Most scientists, however, are not familiar with juridical considerations in the delimitations of offshore state boundaries.

As to prevailing trends, many jurists contend that existing state practice and decisional law pertaining to maritime delimitation problems are presently adequate to provide a legal framework for negotiation and third-party adjudications. It also has been suggested that in delimiting maritime boundaries primacy must be accorded to geographic factors, and that support be given to the equidistance-proportionality method as a means of giving effect to geographic factors. But what about geology?

The first major offshore boundary case of international scope where plate tectonics has constituted a significant argument is the one recently brought before the International Court of Justice by Libya and Tunisia concerning the delimitation of their continental shelves. Of the two parties, Libya placed the greatest emphasis on this concept as a means to determine natural prolongation of its land territory into and under the sea. Tunisia contested Libya's use of the whole of the African continental landmass as a reference unit; in Tunisia's view, considerations of geography, geomorphology, and bathymetry are at least as relevant as are those of geology. In its landmark judgement (February 1982)—which almost certainly will have far-reaching consequences in future such boundary delimitation cases—the court pronounced that "It is the outcome, not the evolution in the long-distant past, which is of importance," and that it is the present-day configuration of the coasts and sea bed which are the main factors to be considered, not geology.

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Flexure of Anadarko Basin

The Anadarko basin in Oklahoma has long been a major oil and gas producing region and contains the deepest wells drilled in North America. The region has had a long sedimentary-tectonic history reaching back to the Proterozoic and was the site of an early Paleozoic basin. The present shape of the Anadarko basin, however, was developed in late Paleozoic times as a result of the uplift of the Wichita Mountains. COCORP seismic reflection profiles show at least 8 to 9 km (5 to 5.6 mi) of overthrusting northward, and the Anadarko basin was developed as a result of flexural bending of the lithosphere due to this shortening. Downwarping of the basin can be observed to extend for over 300 km (185 mi) northward, indicating a high flexural rigidity (Te > 40 km [25 mi]). However, nearer the Wichita front, the basin steepens rapidly as the post-Mississippian sediments thicken to over 20,000 ft (6,100 m). The shape of the bending is such that it cannot be explained by the use of a constant rigidity elastic plate model. We have modeled the post-Mississippian development of the Anadarko basin as the result of flexure of an elastic-plastic plate due to vertical and horizontal loading caused by the Wichita Mountains. Implications of these results for the development of the Anadarko basin and the mechanical properties of continental lithosphere will be discussed.

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Mid-Cenozoic Tectonic Timing, Trans-Pecos Texas

This work attempts to establish the age and chronologic sequence of mid-Cenozoic tectonic events in Trans-Pecos Texas through the use of radiometric dates, and new or revised structural, lithostratigraphic, and vertebrate biostratigraphic information. Late Mesozoic to early Cenozoic Laramide faulting, folding, and jointing superimposed on older trends, established the fabric governing younger structures. Late Oligocene events, occurring about 28 to 26 m.y.B.P., include right-lateral divergent wrench faulting, local compression, and the last episodes of silicic intrusion-extrusion. The major period of basin-and-range faulting began about 19 m.y.B.P., accompanied by late and mafic minor intrusion. This paper follows the sequence of tectonic events established by Muehlberger in 1980 and DeCamp in 1981 for Trans-Pecos Texas.

A widespread low relief surface was cut across Laramide structures as deformation decreased in the Eocene. Integrated, perennial streams flowing southeastward began extensive laterally continuous aggradation in the area south and southwest of the stable Diablo uplift. Mainly fine, volcaniclastic sediments accumulated on surfaces of continued low relief. Initially, sediment sources were distant but became progressively more local. Episodic ignimbrites and flows covered large areas with increasing frequency. Eocene climate in Trans-Pecos Texas was humid and subtropical, but an irregular trend toward increasing dryness was evident by 31 m.y.B.P.

Sedimentary bodies younger than middle Oligocene have little lateral continuity. Deposited under semiarid conditions, as destructional volcanic sediment aprons, alluvial fans, or bolson fills, these units show progressive divergence from depositional styles of early Tertiary sediments. Early Arikareean (early late Oligocene) right-lateral divergent wrench faulting interrupted long-established drainage patterns. The faulting, dated by intrusions and biostratigraphy at about 28 to 26 m.y.B.P., closed the interval of laterally continuous, and preceded that of discontinuous, deposition. The irregular Terlingua monocline, long considered a Laramide structure, is re-interpreted as another example of Trans-Pecos Texas linear east-west tectonic elements discussed by Dickerson in 1981. The structure is a large monocline cut by a set of en echelon–left normal faults and smaller monoclines, modified by compression. Formation of the large monocline involved rocks as young as late Eocene–early Oligocene. The Terlingua monocline provides clear evidence of the sequence of events and some indication of timing. Later Arikareean sediments lie on uneven eroded older rocks, disturbed by early stages of this wrench faulting. About 23 m.y.B.P. downfaulted basins began to retain bolson/alluvial fan sediments. Deposition may have resulted from progressive deformation of the change to mafic volcanism. Increasing aridity may also have been a factor.

Basin-and-range faulting affected Trans-Pecos Texas during the Hemingfordian (early Miocene), and continues. This tectonism faulted the later Arikareean-Hemingfordian alluvium by reactivating old faults and creating new ones. Basin-and-range faulting shifted, deepened, and more completely restricted basins of deposition by forming a series of northwest oriented grabens which received great thicknesses of later Miocene and younger alluvium. (See Figure on page 615).

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Stromatoporoid Biostratigraphy—A Case History