which can be performed at the wellsite during drilling, and by study of the relationship of the ratios, initial evaluation of the reservoir characteristics is possible.

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Fluid-Bearing Capacity of Strandline Sand Deposits—Implication for Hydrocarbon Exploration

The fluid-bearing capacity of the Holocene coastal sand deposits of central South Carolina was determined in order to estimate their potential oil-in-place reservoir capacity. These sand bodies, which vary considerably in size, thickness, shape, and continuity, were deposited in a variety of depositional settings including barrier islands, tidal deltas, exposed sand flats, tidal sand ridges, and tidal point bars. Minimum potential sand thickness and conservative mud cutoff values of 10-15% were used to define each sand body type. Average thickness values ranged from 20 ft (6 m) for barrier islands to 15 ft (4.5 m) for exposed sand flats. Within the study area, barrier islands have average sand volumes of 1.3×10^5 acre-ft (1.6×10^8 m^3), and tidal delta sands average 1.0×10^5 acre-ft (1.2×10^8 cm^3).

Potential oil reserve values averaged 7 million bbl for individual barrier islands and 5 million bbl for individual ebb-tidal deltas. If the Holocene sand deposits of the central 50 mi (80 km) of the South Carolina coast were preserved in place, 150-200 million bbl of oil could be contained within the reservoir-quality sands. Of course, these values represent only one small segment of geologic time, approximately 5,000 years.

These calculations were based on typical reservoir characteristics and recovery factors found in Cretaceous sandstones buried at 5,000 ft (1,500 m) in the Rocky Mountain area. Average reservoir values used included porosity of 25%, oil saturation of 65%, formation volume factor of 1.3, and 10% of the sand body occupied by hydrocarbons.

A better understanding of these strandline sand deposits could improve exploration and future development of these significant, potentially oil-bearing sands.

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Morphostratigraphy of Foraminifera Via Automated Image Analysis

Morphologic variability of foraminifera is a virtually unexploited resource for definition of biozones, morphozones, and phylozones. The morphologic information contained within foraminiferal tests can result in a zonation based on subspecific characters and therefore can more finely divide stratigraphic sequences in comparison with more conventional biostratigraphic techniques. This morphozonation is extremely valuable for time intervals characterized by long ranging species and thick sedimentary sequences with few evolutionary marker events. Biozones can be used to identify sequences within a basin which have common ecomorphologic imprints. Through this precise measurement and determination of a common original shape, morphozones afford the possibility of evaluating diagenetic gradients.

The advantage of using foraminiferal morphometrics lies in great abundance of forams in relatively small samples, thus permitting measurement and evaluation of large numbers of forams in a narrow chronostratigraphic range. Measurement of such samples requires the use of automated image analysis procedures, by which large numbers of specimens can be measured in a short period of time. The development of automated image analyzers now allows for rapid and precise analysis of foraminiferal morphological changes. Our image analyzer is a TV signal fast analog-to-digital converter installed in a Z80-based microprocessor. It is capable of locating and digitizing foraminifera at the rate of more than 150 specimens per hour. The subsequent analysis of shape changes is via closed-form Fourier series and multivariate statistical techniques. Through the use of both image analysis and statistical methods, a precise quantification of morphological change is possible.

We have analyzed more than 12,000 specimens of 15 species of planktonic and benthic foraminifera from Holocene and Pleistocene sedimentary environments. The results clearly indicate that the quantification of morphological change is capable of precisely delineating common shapes within a zone which are related to changing environmental or evolutionary influences.

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Isotopic Provenance of Sandstones from the Displaced Tyee Formation, Oregon Coast Range

A significant component of the Eocene Tyee Formation of Eocene age in the Oregon Coast Range was not derived from local source areas but appears to have come from terranes that presently lie far to the east. Traditional basin analyses, including studies of paleocurrents, lithofacies, and sandstone compositions, have generally been interpreted as indicating local derivation from the Klamath Mountains which lie to the south. However, isotopic analyses of whole-rock sandstone samples and mineral separates preclude derivation solely from the Klamath region.

Sandstone samples collected throughout the Tyee basin were analyzed for Sm-Nd, Rb-Sr, K-Ar, and ^{18}O. Whole-rock negative ϵ_{Nd} values (-7.1 to -7.3) coupled with positive ϵ_{Sr} values imply a source area underlain by Precambrian continental crust. Whole-rock Rb-Sr data fall along a trend dissimilar to data from Klamath-derived sandstones. Detrital K-feldspar has $^{87}Sr/^{86}Sr$ ratios that are too high to have been derived from plutonic rocks in the Klamaths. Consistent Rb-Sr ages for white mica from samples throughout the basin indicate a Late Jurassic age, and K-Ar ages have been uniformly reset to about 68 Ma, an overprint not recognized in the Klamath terranes. $\delta^{18}O$ values of white micas cluster around 9.5 per mil, and are similar to values for S-type granites like those in the Idaho batholith but higher than those of normal I-type granites. Also, these values are much lower than those of white micas from metamorphic rocks in the Klamath Mountains.

These data preclude the Klamath Mountains as the principal source for detritus feeding the Tyee basin. The most likely source region is the Idaho batholith. Derivation of abundant sediment from this eastern source area suggests that during deposition the Oregon Coast Range basin lay much farther east and has subsequently moved westward to its present position. Such a major displacement is consistent with the inferred tectonic rotational history that has been suggested for the Oregon Coast Range since the time of deposition of the Tyee Formation.

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Geothermal Energy Resources in Trans-Pecos Texas—Characteristics and Potential for Development

Convective geothermal systems in Trans-Pecos Texas, and Chihuahua and Coahuila, Mexico, are potential energy resources. The geothermal systems, which lie along a narrow belt near the Rio Grande River, are characterized by hot springs and shallow hot wells located along normal faults. The hot water is meteoric water that has circulated to depths of 2-3 km (1-2 mi), been heated, and risen to the surface through fractures along fault zones. The heat source is the Earth's normal thermal gradient, which is as high as 40°C/km (202°F/100 ft); no young magma bodies are involved. Maximum measured temperatures are 90°C (194°F) at a hot spring in Chihuahua, about 80°C (176°F) in 2 wells in the Sierra Vieja, and about 75°C (167°F) in several wells east of El Paso. Many springs have temperatures in the range 35-50°C (95-122°F). Maximum subsurface temperatures estimated from chemical geothermometers are 100-160°C (212-320°F); most are considerably lower. Chemical constraints on use should be negligible except for the El Paso-area waters, which have moderately high dissolved solids (10,000 mg/L). Hydrologic data to evaluate possible production rates are generally sparse. None of the waters are hot enough to generate electricity by currently available technology. The highest temperature waters could be used for industrial or space heating, but, except for the area near El Paso, they are too far from population centers.