for example, how much oil can a particular source unit be expected to produce?

Organic geochemistry is developing all the signs of a mature discipline with several widely accepted textbooks and journals, increasing numbers of industry-oriented publications, and reputable service companies. An encouraging sign is the increasing number of interlaboratory standards currently being exchanged. I am very optimistic about the future applications of organic geochemistry as an exploration tool.

BARRELL, S. S., Univ. South Carolina, Columbia, SC

Hydrocarbon Accumulation in Pennsylvanian-Age Ten Sleep Sandstone: The Trapper Creek Tar Sand Deposit, Big Horn Basin, Wyoming

Preliminary investigations indicate a potential tar sand accumulation in the Trapper Creek deposit of more than 2.13 million tons of mineralized material with a yield of 0.92 bbl per ton of 5.2° API oil for an approximate resource of 1.96 million bbl of recoverable petroleum. Remote sensing data suggest that the accumulation is in part controlled by two major and four minor lineaments which traverse the area. Stratigraphic and lithologic criteria can be used to infer a Minnelusa-type mode of occurrence. Ancillary stream sediment and outcrop geochemistry data yield locally anomalous but uneconomic concentrations of Mg, Ca, Ti, Mn, Ag, Cu, Mo, V, K, and Si, which may have significance in the identification of similar hydrocarbon accumulations along the west flank of the Bighorn Mountains.

BARRETT, MARY L., Mobil Exploration and Producing Services Inc., Dallas, TX (present address: Johns Hopkins Univ., Baltimore, MD)

Distribution of Thermal Maturity in Central Graben, North Sea

The distribution of oil and gas fields in the northern North Sea closely reflects the structural patterns of Mesozoic-graben development. Late Mesozoic–Tertiary basin subsidence in the Central graben has resulted in a very favorable burial history for source rock maturation.

Time-stratigraphic information and present-day average temperature gradients were used from several wells to calculate depths of oil and gas windows in the area. By intersecting this depth-to-generation trend with the Late Jurassic–Cretaceous unconformity surface, the resulting map view reflects thermal maturation at this structural level plus the underlying Kimmeridge Clay. Average depths to the onset of moderate hydrocarbon generation range from 8,000 to 10,000 ft (2.438 to 3,048 m).

A combination of rapid sedimentation and sufficient subsurface temperatures in the Central graben promoted early source rock maturity as compared with the northern North Sea as a whole. The absolute timing of oil generation could in part be dependent on the magnitude of paleotemperature changes possibly associated with thermal subsidence of the basin. Early oil generation and migration may have promoted preservation of high chalk porosities as discussed in published works on the Ekofisk area.

BARRON, ERIC J., and WARREN M. WASHINGTON, Natl. Center Atmospheric Research, Boulder, CO

Numerical Climate Modeling: An Exploration Frontier in Petroleum Source Rock Prediction

Regions of persistent high organic productivity (e.g., coastal upwelling regions) and environmental conditions conducive for organic matter preservation provide a setting for petroleum source bed formation. Both productivity and preservation of organic matter are strongly related to the atmospheric and oceanic circulation. Accurate predictions of ancient circulation patterns will therefore be useful as source rock predictors.

In the past, predictions of ancient circulation patterns and upwelling regions have been based on an analogy with the modern circulation. The approach is essentially one of moving the continents "beneath" the present-day atmospheric circulation. Because topography, continental positions, and sea level almost certainly modify the nature of the circulation, the utility of such a simple research approach is suspect. The most promising approach is through the use of numerical climate models based on the dynamic and thermodynamic equations thought to govern the circulation, given specific geologic boundary conditions.

A mathematical general circulation model of the atmosphere, capable of using realistic geographic surface boundary conditions, has been employed to examine the sensitivity of the circulation to changes in continental position, sea level, topography and land-sea thermal contrast based on mid-Cretaceous geography. Each experiment consisted of a single change in a boundary condition in the following order: (1) a present-day control; (2) the present-day with no topography; (3) rotation of present-day "flat" continents to mid-Cretaceous positions; (4) reduction of Cretaceous land area associated with higher sea level; (5) addition of Cretaceous topography; and (6) addition of a warm Cretaceous ocean. The results are of particular significance because they illustrate (a) the importance of geography as a control on the nature of the circulation and (b) the potential usefulness of numerical climate modeling in petroleum source rock prediction.

(1) Experiments with no topography (flat, sea level continents) are nearly identical, exhibiting only minor differences from a "classical" pattern of atmospheric circulation. This pattern consists of an equatorial low, high pressure centered just equatorward of 30° lat., a low pressure belt centered near 60° and a polar high.

(2) Topography and land-sea thermal contrasts substantially alter the atmospheric circulation patterns in two important aspects. First, these variables reduce the zonality of the surface pressure and wind patterns, resulting in regional convergences and divergences which would not be predicted by a simple qualitative analogy with present-day patterns. Second, the mean latitudinal position of low and high pressure regions (hence easterly and westerly wind patterns) and the intensity of these features were altered by including topography and land-sea thermal contrasts. For example, the Tethyan ocean and the topography of the bordering continents result in a 10° equatorward shift of the Northern Hemisphere subtropical high. Such a shift has considerable implications for the climate of the regions bordering the Tethys ocean. Cretaceous upwelling areas may have been substantially displaced in latitude with respect to present-day patterns.

The model results illustrate the importance of geographic variables as controls on circulation patterns. These results can be compared with the geologic record and evaluated as a petroleum source rock prediction tool.

BARWIS, J. H., Shell Oil Co., Houston, TX, and M. O. HAYES, Research Planning Inst., Columbia, SC

Genesis and Preservation of Antidune Stratification in Modern and Ancient Washover Deposits