of the deep Anadarko basin at 22,000 ft (6,706 m). The data reveal systematic changes in geochemical parameters with increasing depth and maturity level. Such changes are consistent with maturation effects seen in other basins around the world.

Vitrinite reflectance data for progressively deeper wells yielded mean R_o values of 0.60, 0.88, 1.23, 1.86, and 2.03%. These values are indicative of maturation levels ranging from the main zone of oil generation to the zone of dry gas generation. Bitumen ratios (expressed as milligrams of soluble organic matter per gram of total organic carbon) agree well with these maturation levels. Infrared spectroscopy, used to assess the changes in functional groups of the soluble organic matter and kerogen, shows a corresponding increase in the aromaticity of the organic compounds with increasing maturity level. Elemental analysis of kerogen (carbon, hydrogen, nitrogen, and oxygen) and gas chromatography of whole-rock bitumen extracts exhibit maturation effects similar to those noted in other basins.

In addition, organic matter (O.M.) isolated by conventional palynologic techniques was examined under white light and shows progressive changes from yellow-amber and translucent O.M. at $R_o = 0.60\%$, to dark brown, partially translucent and partially opaque O.M. at $R_o = 0.88\%$. Samples with R_o values of 1.23% and greater are completely opaque. Visual kerogen studies support the obtained geochemical parameters.

JONES, R. W., Chevron Oil Field Research Co., La Habra, CA

Comparison of Carbonate and Shale Source Rocks

As with shales, the source potential of carbonate rocks depends primarily upon the organic facies rather than the mineral matrix. Where the depositional and early diagenetic environment is highly oxygenated, the total organic carbon (TOC) is low, with a negligible generative capacity for hydrocarbons, despite a relatively high hydrocarbon/TOC ratio in the immature state. An anoxic depositional and early diagenetic environment can result in the deposition of organic-rich, fine-grained carbonate rocks that are excellent potential source rocks.

Excellent oil-prone source rocks, whether with carbonate or clay mineral matrices, have many characteristics in common. Both form in anoxic environments, are generally laminated and heterogeneous, have moderate to high TOC, and contain high quality organic matter (OM).

Gas-prone organic facies are rare in carbonate rocks because such facies are usually dominated by terrestrial organic matter deposited in a dominantly clay matrix. Most carbonate rocks contain nongenerative organic facies as do most siliceous rocks. Oxygen-rich depositional environments for carbonates are found from sea level (reefs) to the ocean depths (*Globigerina* ooze).

Despite the basic commonality between organic-rich oil-prone carbonate and shale source rocks, some significant differences exist. Oils derived from carbonate rocks are often richer in cyclic hydrocarbons and sulfur compounds than oils derived from shales due to the dearth of terrestrial plant waxes in the OM and less iron in the pore water. In addition, the generally earlier decrease of porosity and permeability and the greater contrast between the physical properties of the OM and the rock matrix in carbonate source rocks often result in different primary migration characteristics.

KABACK, DAWN S., Conoco Exploration Research, Ponca City, OK

Regional Hydrogeochemical Exploration for Sandstone Uranium Deposits in South Texas—The Solution-Mineral Equilibria Approach

Because the chemical composition of groundwater in contact with a buried uranium deposit should be quite distinct from that of groundwater flowing through barren rock, analysis of the groundwater may provide 3-dimensional information useful to the explorationist. Because of the complex geochemistry of uranium, analysis for uranium only will not lead to an appropriate interpretation. The solution-mineral equilibria approach, using the computer program WATEQF, has shown to be useful for a regional exploration program in south Texas. The technique has outlined areas with known mineralization and with a high potential for mineralization.

Groundwater samples were collected and analyzed for a single aquifer in existing water wells on a 1-2-mi grid over an area of approximately 169 mi^2 (438 km^2). The WATEQF computer program uses the chemical analyses to calculate saturation indices, which describe the state of saturation of the groundwater with respect to a particular mineral. In the study area, saturation indices for the uranium minerals coffinite and uraninite were highest over the most prospective areas.

Hydrogeochemical information obtained in this study supports our geologic data that the known mineralization occurs as small reduced islands in oxidized ground. The solution-mineral equilibria approach suggests that larger deposits may exist downdip of the present-day redox front, which has moved updip since the main mineralizing event. Updip movement of the redox front may have resulted from leakage of H_2S from downdip faults.

KALKREUTH, WOLFGANG, Geol. Survey Canada, Calgary, Alberta, Canada, and GEORGE MACAULEY, Consulting Geologist, Calgary, Alberta, Canada

Organic Petrology of Selected Oil Shale Samples from Lower Carboniferous Albert Formation, New Brunswick, Canada

Incident light microscopy was used to describe maturation and composition of organic material in oil shale samples from the Lower Carboniferous Albert Formation of New Brunswick.

The maturation level was determined in normal (white) light by measuring vitrinite reflectance and in fluorescent light by measuring fluorescence spectra of alginite B. Results indicate low to intermediate maturation for all of the samples. Composition was determined by maceral analysis. Alginite B is the major organic component in all samples having significant oil potential. Oil yields obtained from the Fischer Assay process, and oil and gas potentials from Rock-Eval analyses correlate to the amounts of alginite B and bituminite determined in the samples.

In some of the samples characterized by similar high concentrations of alginite B, decrease in Fischer Assay yields and oil and gas potentials is related to an increase in maturation, as expressed by increase in the fluorescence parameter λ_{max} and red/green quotient of alginite B.

Incident light microscopy, particularly with fluorescent light, offers a valuable tool for the identification of the organic matter in oil shales and for the evaluation of their oil and gas potentials.

KATZ, B. J., R. N. PHEIFER, and D. J. SCHUNK, Texaco USA, Bellaire, TX

Interpretation of Nonlinear Vitrinite Reflectance Profiles

Investigations have established that within basins that experience continuous sedimentation, maturation profiles are linear when vitrinite reflectance values are plotted on a logarithmic scale. Not unusual, however, are nonlinear profiles where discontinuities and/or reversals are present. Common geologic interpretations of discontinuities in such profiles include unconformities, faults, and intrusions. Faults and intrusions usually can be confirmed by paleontology, logging, and seismic techniques, and will not be considered further. Although unconformities can commonly be recognized by such techniques, their magnitude in terms of eroded section is usually difficult to measure or interpret. Time-temperature modeling presents an approach to quantifying the amount of erosion at unconformities.

Frequently, the estimate of the amount of erosion at an unconformity is determined using the graphical technique developed by Dow. However, modeling suggests that this graphical approach would be valid only when the vitrinite reflectance discontinuity is located at or near the surface, with no significant reburial after its development. Our models show that with reburial and time, the discontinuity in vitrinite reflectance values would diminish. The result is an apparent decrease in the estimate of eroded section as reburial continues.

Many nonlinear vitrinite reflectance profiles cannot be accurately modeled. This may result from the lack of sufficient data to correctly interpret the geology, stratigraphy, and/or thermal history of the basin being examined.