equivalent depths in most of the Palo Duro basin are only marginally mature.

Although thermal maturity seems to be mirrored by the present geothermal gradient, and source rock quality appears related to depositional setting (depth of water), successful exploration outside currently productive areas will require a detailed analysis of organic geochemistry and depositional facies.

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Pore Size Distributions by Analysis of Back-Scattered Electron and Fluorescence Images

Computerized image analysis provides direct, rapid, and highly accurate measurement of pore size in thin or plane sections. The method can be applied to a wide range of rock types and requires only conventional sample-preparation techniques. Back-scattered electron or fluorescence microscopy images of impregnated samples are scanned, converted to digital form, and stored and processed on a microcomputer. Individual picture points from a matrix of up to 600,000 elements per scan are classified as rock or pore based on gray level. Pore size is obtained by area measurements of individuals pores and by Feret's diameter, the maximum spacing between parallel tangents to a pore in up to 56 directions. The measurements are readily summarized as pore size distributions.

Cumulative porosity vs. pore diameter crossplots indicate how porosity is distributed and can be used to aid reservoir evaluation and production assessment. The crossplots can also be used to determine the amount of porosity contributed by different pore types. Individual pores, or groups of pores classified by size or shape, can be interactively identified on the image analyzer monitor, enabling the user to make a visual association of pore type with size. Rocks having a wide range of pore size can be analyzed at more than one level of magnification, and the data can be merged to form a composite pore size distribution for the sample.

Pore size distributions of carbonate rocks containing complex pore systems show changes in slope that are indicative of pore type. Other carbonates, including fine crystalline dolomites and microcrystalline limestones, show relatively uniform pore size distributions, which reflect a single pore type.

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Paleozoic Producing Sequences in Ghadames Basin of Libya, Tunisia, and Algeria: New Stratigraphic Concepts for Hydrocarbon Exploration

The Ghadames basin covers an area of more than 3 million km^2 in Libya, Tunisia, and Algeria. Although the basin has been productive since the mid-1950s, recent construction of a pipeline in western Libya has spurred additional exploration. The results of this increased drilling activity and the incorporation of earlier work have provided new data that indicate the following. (1) The clastic sequence underlying the Tanezzuft shales has porous and permeable fairways that may be related to the Hogar glaciation to the south. (2) The clastic sequence overlying the Tanezzuft shales was deposited as a northerly sourced fluvial-deltaic clastic wedge, which thins and becomes less porous to the south. Only in the area of the Gargaf arch does this sequence become cleaner and more porous; there, a shoreline-sand depositional sequence dominates. An easterly source of the clastics is indicated.

With the lack of large structures in the basin, the facies model presented here for the depositional history provides indications of more productive porous and permeable fairways.

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Marine Diagenesis on Enewetak Atoll

Marine waters currently circulate through Eocene and Miocene limestones deposited in slope, fore-reef, and reef-related environments on Enewetak Atoll. Subsurface core samples (375-1,400 m deep) demonstrate that marine waters have extensively altered the original carbonate sediments. Evidence supporting alteration by marine water includes: (1) calcite cements with isotopic compositions characteristic of a marine origin ($\delta^{13}C = 1.3$ to 2.5 ‰; $\delta^{18}O = -1.8$ to 0.4 ‰ PDB), (2) dolomites with average isotopic compositions that are in equilibrium with cold normal-marine waters ($\delta^{13}C = 2.3$ ‰; $\delta^{18}O = 2.5$ ‰ PDB), (3) consistent magnesium concentrations in fossil coralline algae, and (4) a lack of diagnostic evidence for meteoric diagenesis. Products of marine diagenesis on Enewetak Atoll are dependent on the $CaCO_3$ saturation state of the diagenetic waters. Above the aragonite saturation depth (350 m), marine diagenesis is dominated by aragonite and high-magnesian-calcite cementation. Between aragonite and calcite saturation depths, marine waters apparently have dissolved aragonite and precipitated low-magnesian, radiaxial calcite cements. Below the calcite saturation depth (1,000 m), deep marine waters have apparently dissolved some calcite and have precipitated dolomite. Effective marine diagenesis requires limestones with good permeability and a hydraulic drive, such as tidal pumping or thermal convection, to move large volumes of marine water through the rock.

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Computer Mapping of Silurian Pinnacle Reefs in Northern Michigan

Current availability of high-quality well completion records accessed via computer data bases in Michigan has allowed further exploitation of the northern Michigan reef trend. Integration of these data with computer mapping enables investigation of large regions in terms of structural and stratigraphic relationships. Inferiority of subsea structure maps is clearly demonstrated because of contamination by irrecoverable surface elevation errors. Use of thickness maps of reef units and Middle Silurian salt deposits has resulted in delineation of new regional reef patterns and an increased resolution of local reef development. Case studies from the Michigan reef trend demonstrate the use of "play maps," where computer-generated maps are constructed in yearly intervals to test exploration strategies for less developed regions.

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Thermal History of Sandstones and Shales: Oxygen Isotope and K/Ar Evidence

The combined use of oxygen isotope and K/Ar dating can yield information about the diagenetic history of clay minerals in shales and sandstones. In the Tertiary shale sequences of the United States Gulf Coast, in which the dominant detrital clay mineral is mixed-layer illite/smectite, the progressive conversion of expandable clay layers to illite layers can be monitored by the isotope systematics. Oxygen isotopes of fine-grained clay and quartz approach equilibrium with one another, raising the (as yet unrealized) possibility of an O-isotope geothermometer. Fine-grained quartz becomes isotopically zoned as detrital grains are overgrown by diagenetic quartz that forms, accompanying the smectite-to-illite transformation. The K/Ar clock of the diagenetically formed illite layers is set to zero age at the time of diagenesis (although that of existing illite layers within the crystals remains unaffected), and it is therefore possible to estimate the mean time of diagenesis in such shale sequences.

Illite is a common cement in sandstones. The time of cementation by illite can be estimated from K/Ar systematics in cases, such as that of the Permian Rotliegendes of the North Sea, where the clay-sized fraction of the original detritus was relatively free of illite or other K-bearing phases. Conditions of cementation can be inferred from oxygen isotope measurements, augmented by knowledge of the geologic/tectonic history of the sandstone. In the case of the Rotliegendes, the timing and conditions of illite cementation were relatively uniform within fault blocks but varied from block to block. Oxygen isotope measurements indicate that meteoric water components were important in illite formation at times when nearby sections of the Rotliegendes were exposed to the surface by uplift and erosion.

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Crust Type and Structure, Northern Gulf of Mexico: an Ocean Bottom Seismograph–Air Gun Seismic Transect