Significant statistical results support the idea that lithology of seal is of considerable importance. Sealing capacity is also correlated with seal thickness and depth.

These statistical results have been helpful in creating a quantitative assessment of hydrocarbon retention expectation for exploration prospect appraisals.

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Waulsortian Mounds and Lithoherms Compared

Lithified bioherms (lithoherms) in the northern Straits of Florida have been compared with the Waulsortian mounds of the Early Carboniferous of Europe. The lithoherms occur at 400 to 600 m in the presence of moderate bottom currents. A zoned coral-octacoral-crinoid community appears to build into the current as concomitant cementation provides a diagenetic framework. Coral debris, pelagics, bank-derived muds and cements compose the mound material. Exposed downcurrent surfaces are undergoing bioerosion.

The ancient mounds in the Belgium type area are composite structures with a lower (Tournaisian) sparry "blue vein" facies of fenestellid bryozoans cemented by marine calcite crusts and relatively little micrite. This is overlain by a Visean phase of micritic facies, still rich in fenestellids, with steep depositional slopes suggestive of subsea cementation. Outside Belgium, the mounds are predominantly micritic. They contain stromatactoid cavities which have also been associated with marine cementation. Work by others suggest that filamentous algae, including *Girvanella,* had some part in local generation of lime mud. Mound facies pass laterally into shaly limestones and shales with chert, which locally may be rich in algae.

Early Carboniferous continental reconstructions place the ancient mounds in a general equatorial carbonate margin or near margin. The paleo-oceanographic consequences suggest a light shallow mixed layer within which shallow equatorial upwelling could maintain moderate surface biologic productivity while not mixing deeply enough to fully oxygenate the slope and basin bottoms.

Ancient mounds, in contrast to the modern lithoherms, appear to have accumulated largely from submarine cementation of products of in-situ origin, in a setting of slower currents and possibly reduced oxygen levels on a bottom that may have been shallow enough to extend at times into the lower photic zone.

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Faunal Succession Within Deep-Water Coral Mounds North of Little Bahama Bank

Deep-water coral mounds of 5 to 40 m relief occur at depths of 1,000 to 1,300 m over a 2,500 sq km area of the lower slope north of Little Bahama Bank. These coral/gorgonian buildups, apparently unlithified, have yielded radiocarbon ages of 860 ± 50 and 940 ± 40 years for the best preserved corals and gorgonians, and preliminary dates of 22,100 years for the most intensively bored corals, the youngest deep-water coral mounds ever reported. Eight genera of deep-water coral represent the highest diversity recorded from a single locality. These ahermatypes are predominantly solitary, although branching and weakly branched forms are also present. The colonial ahermatypes from the mounds possess large-diameter corallites and relatively few corallites per specimen. Several of the coral general, most notably *Thecopsammia,* have significant stereomal deposits in the skeleton, a feature common among deep-water corals. The scleractinians are associated with a diverse fauna. The primary framework builders of the mounds, however, appear to be branching corals and gorgonians.

Based on the relative amounts of boring and Mn-oxide coating on coral specimens recovered from dredge hauls, there appears to be a crude faunal succession within the mounds. Branching colonial corals and gorgonians seem to be the pioneer forms, colonizing hardgrounds. These initial coral thickets form a baffle for sediment as well as substrates for later stages of attached and free-lying ahermatypes such as *Desmophyllum, Stephanocyathus,* and *Deltocyathus.* Thus the mounds grow through a combination of sediment trapping and colonization by a greater diversity of coral and other invertebrates. The coarse nature of intermound sediments and the presence of scour and ripple marks in underwater photographs indicate that bottom currents are vital to the development of these deep-water coral structures.

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Permian and Triassic Boundary of Southwestern Utah

The Permian and Triassic boundary, southwestern Utah, is marked by a topographic unconformity associated with a number of minor unconformities. The Harrisburg Member, Kaibab Formation, is the uppermost Permian unit. At its base a chert limestone is overlain by a gypsum in the west and a collapse breccia in the east. A fossiliferous limestone overlying the gypsum and collapse breccia is contorted over the collapse breccia, and is of a constant thickness suggesting that the evaporites were dissolved after its deposition. Above the medial limestone a siltstone is overlain by a limestone that partly fills topographic depressions in the medial limestone. Dissolution of the gypsum continued producing additional relief that was filled by another siltstone and limestone sequence. In the Beaver Dam Mountains gypsums are present above the medial limestone. Conglomeratic lenses (Rock Canyon Conglomerate) derived from the west and southwest are equivalent to both the Permian and Triassic sediments representing a major erosional cycle after the last retreat of the Permian seas and the advance of the Middle Triassic seas. The Timpoweap Member, Moenkopi Formation, was deposited on top of the underlying limestones and conglomerates developing a horizontal plane. It thins to a featheredge west of the Hurricane Cliffs and east of the Utah-Arizona state line suggesting that a positive area was present west of the Hurricane Cliffs during the Early Triassic. Thinning of the lower Red Member of the Moenkopi Formation also occurs west of the Hurricane Cliffs but in places it is absent, reflecting the topographic nature of the Permian and Triassic boundary. It was not until the deposition of the Virgin Limestone member of the Moenkopi Formation that Triassic seas covered the western part of Utah.

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Diagenetic Effects and Pore System Evolution

Permeability/porosity relations obtained from core measurements and well logs from numerous sandstone hydrocarbon reservoirs in North America were used to quantitatively study diagenetic alterations of pore systems. Results were most favorable for rocks in which no early cementation or secondary replacement occurred and for which the pore system could be characterized sedimentologically.

Geologic modeling of permeability/porosity crossplots may reveal secondary permeability that results from microstructural damage, fracturing, and/or directional dissolution. Secondary permeability type may be determined from examination of the core or porecasts. Analyses of permeability/porosity crossplots may establish the relative timing of the various diagenetic modifications.

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Geochronology Bearing on Age of Monterey Formation, California

The name Monterey Formation or Monterey Shale has been applied to lithologically similar pelitic marine rocks of Miocene age exposed in the coastal regions of California. These rocks, characterized by unusually high proportions of silica, have been variously termed diatomite, porcelanite, porcelaeous shale and mudstone, chert, and cherty shale. The type area for the Monterey Formation was designated near Monterey, California.

Although the Monterey Formation in general contains numerous ash, tuff, and bentonite beds, only a few of these volcanic units have been dated. It has been necessary to make use of both the isotopically dated horizons and Kleinpell's Miocene benthonic foraminiferal stages to construct a time-stratigraphic framework for the Monterey Formation at different locations. Ages for the various stage and zone boundaries, based on published and unpublished data, are as follows:

Repettian-Stratotype *B. oblique ("Delmontian"),* ca. 5 m.y.B.P.; Stratotype *B. oblique*-Mohnian, ca. 7 m.y.B.P.; Mohnian-Luisian, ca. 12 m.y.B.P.; Luisian-Relizian, 14.0 to 14.9 m.y.B.P.; Relizian-Saucesian, 15.7 m.y.B.P.

At the type area, an ash from the Canyon del Rey Diatomite Member, the uppermost member of the Monterey Formation, was dated at 11.3 $\pm$ 0.9 m.y. (F-T on zircon). Coupled with a Luisian age for the oldest strata, the type Monterey Formation spans, at most, the time interval from 15 to 10 m.y.B.P. In contrast, the Monterey Shale in the Palos Verde Hills encompasses the time interval from 15 to 5 m.y.B.P. based on isotopic data from the Altamira Shale, Valmonte Diatomite, and Malaga Mudstone Members, which contain foraminiferal assemblages characteristic of the Relizian, Luisian, and Mohnian Stages, and the *B. oblique* zone ("Delmontian").

At other localities where biostratigraphic and isotopic data are available, the rocks termed Monterey are not exact time equivalents of the type foramation, an observation made earlier by both Kleinpell and Bramlette.

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Novel Approach to Eh-pH Diagrams and Their Relation to Uranium In-Situ Leaching

When constructing Eh-pH diagrams, workers have previously assumed a fixed total concentration of a substance in solution, and calculations (assuming equilibrium) were made to predict mineral phases and aqueous species at various Eh-pH conditions. When dissolving a solid compound (as in in-situ leaching), it seems more plausible to assume a solid phase in solution at various Eh-pH conditions and allow the aqueous species the freedom to assume thier equilibrium concentrations.

The computer program EHPHUR was written to thermodynamically simulate the dissolution of a solid phase leading to diagrams which differ markedly from conventional Eh-pH diagrams. The name proposed for these new diagrams is dissolution diagrams. The assumptions include unit activity of uraninite, and fixed amounts of O_2, CO_2, and H_2S at 25°C and 1 atm. The parameters were chosen to simulate in-situ leaching systems currently in use.

Using these diagrams, thermodynamic arguments can be presented which are consistent with the results of kinetic experiments, for example: the first and zero order dependence of the uraninite dissolution rate on the carbonate concentration; the decrease in the dissolution rate as the pH approaches 6.0; and the dependence of the rate on the oxygen and hydrogen ion concentrations. Apparent optimum pH values for in-situ leaching are discussed.

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Methane from Coal Beds—an Exploration Approach

Vast amounts of methane are trapped in much of the unmined and unminable coal in the United States. This virtually untapped unconventional source of clean energy should become economically viable within the next few years. Consequently, it should be viewed as an important new exploration frontier.

An approach to coal-bed methane exploration involves a combination of coal and conventional gas exploration strategies. Because coal beds are both the source and the reservoir of the gas formed during the coalification process, the subsurface extents of the coal beds define the geologic dimensions of the resources of coal-bed methane. The amount of producible methane in a given coal bed is highly variable, being a function of the depth of burial, the rank of the coal, the degree of fracturing, and the permeability of the contiguous strata. Consequently, the successful search for producible quantities of coal-bed methane requires an understanding of the depositional and diagenetic history of coal.

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Geomorphic Features of Shelf-Slope Revealed by Sidescan Sonar Images

Recently acquired sidescan sonar images reveal, for the first time, the landscape pattern and the detailed geomorphology of the North Atlantic shelf-slope break off the United States and other areas extending from the edge of the continental shelf to the upper slope. Long-range (GLORIA II) images that have swath widths of as much as 40 km show small-scale regional features; midrange images that have swath widths of as much as 5 km show features as small as 3 m across.

The midrange images show that the outer edge of the shelf, deeply embayed by submarine canyons, outlines a nearly flat surface marked by complex ripple patterns. In places, the slopes converging toward adjacent canyons are also complexly rippled; this feature suggests that the shelf surface and the upper canyon slopes are mutually stable under common