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Recognition of Unconformity-Sourced Aquifer Cements and Later Burial Cements, Mississippian Newman Limestone, Kentucky

The Mississippian Newman Limestone in eastern Kentucky contains aquifer-related cements and deeper burial cements. These cements were differentiated by trace elements, cathodoluminescence, staining, and fluid inclusions. Aquifer cements are nonferroan and show a nonluminescent to dull to nonluminescent to bright cathodoluminescent zonation. They fill leached ooid and fossil molds, indicating that pore waters were initially undersaturated with calcium carbonate. Within a regional paleoaquifer, early nonluminescent cement (34 ppm Mn, 33 ppm Fe average) precipitated from oxidizing waters that later became reducing to form dull cement (average 181 ppm Mn, 565 ppm Fe). A second nonluminescent cement was formed following later recharge. Aquifer stagnation, prior to or during burial, was accompanied by bright cementation (2,139 ppm Mn, 252 ppm Fe average). Waters were sourced from post-Newman unconformities. Aquifer cement, which decreases away from recharge areas, was determined by initially staining for late-burial calcite; image analysis was then used to determine the amount of early cement by subtracting late-burial cement from total cement. Later, iron-rich burial cements (778 ppm Mn, 4,295 ppm Fe average) filled the following pore space: (1) remnant intergranular, (2) fractures in compacted skeletal grains, (3) cavities caused by spalling ooid cortices and early cement rims, and (4) tectonic fractures, which are lined with saddle dolomite and pyrite. Secondary fluid inclusions suggest that late-stage fluids were chemically complex brines with temperatures that ranged from 50°C to 160°C and averaged 100°C. These techniques may help to evaluate porosity loss by shallow cementation in paleoaquifers (potential pore plugging prior to hydrocarbon migration) vs. cementation by deeper burial processes.

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Stromatoporoid-Algal-Facies Hydrocarbon Traps in Upper Devonian (Fammenian) Wabamun Group, North-Central Alberta, Canada

Recent oil and gas discoveries in the Upper Devonian (Fammenian) Wabamun Group of the Peace River arch area, north-central Alberta, have led to a reevaluation of stratigraphic and structural trapping mechanisms. These discoveries have occurred at a number of different intervals within the Wabamun. In the Tangent, Teepee, and Eaglesham areas, fractured and dolomitized mudstones, and grainstones produce hydrocarbons. At Normandville, however, fractured stromatoporoid-algal boundstones form the reservoir. Stromatoporoid-algal boundstones in the Wabamun Group have not been reported previously in this area. The stromatoporoids consist of predominantly massive and bulbous growth forms that created shoals and mounds in the Wabamun epeiric sea. Encrusting algae constitute an additional major component of the boundstone. Sparry-calcite cemented pelletal, skeletal, and oolitic grainstones form the surrounding matrix.

Although Wabamun carbonates are predominantly well-cemented mudstones and grainstones, the reemergence of relatively primitive stromatoporoid forms in the Late Devonian, after the extinction of the numerous Frasnian stromatoporoid families, provides potential for an interesting new exploration target.

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Accumulation of Mixed Carbonate and Siliciclastic Muds on Continental Shelf of Eastern Spain

The continental shelf of eastern Spain (extending from the Ebro River southward through the Gulf of Valencia) is accumulating a mixture of carbonate and siliciclastic sediment. Twenty-eight cores were analyzed to characterize sediment size and composition and to measure mixing and accumulation rates. Sandy mud consisting of about 40% carbonate and 60% siliciclastic sediment is accumulating over a transgressive sand and gravel layer that is exposed landward of the 20-m isobath. Profiles of Pb-210 and Cs-137 indicate that much of the mud deposit has an apparent accumulation rate of about 1 mm/yr. The observed accumulation is slow compared to dispersal systems associated with larger fluvial sources of siliciclastic sediment. The slow accumulation rates combined with moderate sediment mixing rates (measured from Th-234 profiles) predict preservation of homogeneous strata, which is observed in x-radiographs. Although the siliciclastic accumulation is relatively slow, the carbonate accumulation rates are similar to values for low-latitude carbonate environments. The slow accumulation of siliciclastic sediment combined with apparently high productivity of carbonate sediment results in the mixed carbonate and siliciclastic deposit. The special characteristics of the study area are: (a) siliciclastic sediment flux to the shelf is small but significant; (b) physical-oceanographic regime is quiescent enough to allow much of the fine sediment to accumulate on the shelf; and (c) shelf waters are warm (for mid-latitudes) allowing rapid production of carbonate sediment.

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Economic Analysis of American Petroleum Exploration

A mathematical model, with 86% accuracy, has been developed to explain discoveries or additions to proven petroleum reserves. In the model, the quantity of petroleum discovered directly depends on property acquisition, exploration, and development expenditures. Also, petroleum discoveries indirectly depend on the petroleum stock remaining to be discovered. The empirical data base is a survey of corporate expenditure data for the years 1979-82. Unlike most previous models in this field, this model is based on economic theory and economic production-function mathematics. Allowing a dual application of the model, not only is it useful for forecasting petroleum additions, but it also addresses some fundamental questions concerning petroleum exploration and discovery. Five primary questions concerning the structure of the American petroleum industry are: (1) Which firms are more efficient in petroleum exploration and discovery, large or small? (2) Are governmental lease policies efficient? (3) How should a firm optimally allocate its resources to maximize petroleum discoveries? (4) In what ways does a declining stock affect discoveries? (5) Have increasing prices effected a structural change in the petroleum exploration industry? The dual nature of the model, the explanatory accuracy, and the one-equation simplicity, all encourage increased application of this type of analysis to the natural-resource industries.

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Comparison Between Immature Vitrinite and Solid Bitumen, Green River Formation, Piceance Creek Basin, Colorado

A major problem in organic petrography is the inability to distinguish immature vitrinite from solid bitumen. For this study, several samples of coal and solid bitumen, found interlayered with oil shales of the Green River Formation, were collected from three continuous cores. Each sample was analyzed under oil immersion with reflected light, with fluorescence (blue light), and by Rock-Eval.

In the uppermost part of the cores, the vitrinite and solid bitumen have identical reflectance values under oil immersion (R_o), and the structureless (nonbanded, noncellular) vitrinite is optically indistinguishable from the bitumen. Observation with blue light reveals some details in both the vitrinite and the bitumen; solid bitumen appears more granular than the vitrinite. With the yellow filter, vitrinite shows some banding and spores are visible. Without the filter, the bitumen has an orange-brown hue, whereas the vitrinite is a bright blue. Rock-Eval analysis indicated a much higher hydrogen index for the bitumen (800-850) than for the coal (400-450). The total organic carbon (TOC) was higher for the coal (50-55) than for the bitumen (20-25).

In the cores examined, the vitrinite reflectance changes downhole from 0.20 to 0.55; however, the R_o for the bitumen remains constant. Because reflectance values for vitrinite and solid bitumen can be the same or very similar, a researcher should not rely on reflectance values alone to distinguish vitrinite from solid bitumen.