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Mixed Carbonate and Clastic Sedimentation: North Insular Shelf of Puerto Rico

Light-colored carbonate sands and dark-colored muddy clastic sands are deposited in distinct and sharply defined bands across the narrow (less than 3 km, 1.9 mi) and steep insular shelf of northern Puerto Rico. The narrow bands of clastic sands are found adjacent to the mouths of each of the rivers. These bands are in textural equilibrium with the present-day physical conditions on the shelf and are deposited as a result of successive hurricane-related flooding events. Dominant sand-sized components are quartz, feldspar, and rock fragments. The rate of sedimentation in the intervening cross-shelf strips of carbonate sediment is much lower, and the shelf sediment cover here is not in textural equilibrium with the physical environment. Dominant sand-sized components are mollusk, algae, coral, and bryozoan fragments. The boundary between carbonate and clastic bands is very sharp, often occurring within 100 m (330 ft).

The small carbonate fraction of the rapidly deposited clastic sediment and the particles making up the slowly deposited carbonate sediment exhibit strong differences in physical condition. The clastic calcareous fraction is fresh in appearance, highly angular if fragmented, and has original coloration. The relict calcareous material is old appearing, commonly stained and rounded, and has a dull luster. Polished surfaces and highly rounded grains characterize adjacent calcareous beach sands. The striking difference in the physical condition of the carbonate grains in clastic and carbonate sediments is a function of differing lengths of sea-floor exposure.

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Regional Stratigraphic and Depositional Study of Rock Units in Upper Garden Gulch and Parachute Creek Members of Green River Formation, Piceance Creek Basin, Colorado

The Eocene Green River Formation in the Piceance Creek basin, Colorado, is well known for its thick sequence of rich oil shale and associated saline minerals. In the subsurface, rocks of economic interest extend from the upper part of the Garden Gulch Member to the top of the Parachute Creek Member. These rocks are lacustrine deposits that represent open-and near-shore sedimentation in ancient Lake Uinta. The depocenter of the lake formed in the northern part of the basin where rates of subsidence exceeded rates of sedimentation. The Garden Gulch and Parachute Creek Members can be divided into a series of laterally gradational rock units that can be traced from the eastern part of the Piceance Creek basin westward into the south-central part of the Uinta basin, Utah. Along the margins of the Piceance Creek basin, the lower and middle units consist of fissile argillaceous shale of low organic content, silty claystone, and siltstone. Toward the depositional center of the basin, these rocks grade into a thick sequence of carbonate-rich, kerogenous shale and lean marlstone that is interbedded with a saline facies composed of nahcolite, dawsonite, and halite. The gradational boundary between these facies represents the contact between the Garden Gulch and Parachute Creek Members. In the subsurface, the contact can be recognized by a change from a low to high resistivity log response which reflects the transition from clay-rich to carbonate-rich rock. The regional thickness distribution pattern of individual units suggest that, during the middle Eocene, Lake Uinta gradually expanded from a shallow, relatively fresh, semirestricted body of water to a saline, alkaline lake that occupied a closed basin. A pronounced thickening of the lowermost units along the southern margin of the basin is attributed to streams that prograded northward into the basin from the southern and southwestern margin of the lake. The middle and upper units, however, thin toward the basin edge, suggesting the lake gradually expanded to the south. During the late Eocene, open-lacustrine sedimentation shifted from the Piceance Creek basin westward into the Uinta basin, Utah, due to a large influx of siliciclastic sediment (Uinta Formation). Structural analysis of individual units indicates that present day intrabasinal tectonic features were not in existence during Parachute Creek time.

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Paleoenvironments of Lower Cretaceous DeQueen Formation of Southwestern Arkansas

The Lower Cretaceous DeQueen Formation crops out in a narrow sinuous band extending east-west from Pike County, Arkansas, to near Broken Bow, Oklahoma. Natural exposures are poor, but quarrying has exposed excellent vertical sections of the formation about 75 ft (23 m) thick at several localities. The DeQueen is composed of a lower sulfate facies and an upper sandstone-limestone-shale facies. The lower facies which is correlated with the subsurface Ferry Lake Anhydrite, is about 40 ft (12 m) thick. It is 60% gypsum and 40% dark shale, with minor interbedded mudstones. The upper facies, which is also about 40 ft (12 m) thick, is unconformably overlain by Upper Cretaceous clastic sediments. The upper facies is predominantly shale, with interbedded thin beds of sandstone, sandy limestone, and celestite. This facies is equivalent to the lowermost beds of the Mooringsport Formation of the subsurface.

The environments of deposition of units within the lower sulfate facies have been interpreted from a sparse faunal assemblage, sedimentary structures, and trace fossils. However, the most intensive study has been concerned with the more richly fossiliferous beds of the upper facies of the DeQueen. Present in this unit are well-preserved pseudomorphs of displacive halite hoppers, calcite pseudomorphs after gypsum, and preserved intrastratal gypsum nodules. Oscillation ripples, current ripples, and a variety of trace fossils are very common in these beds also. Body fossil assemblages range from a less diverse restricted pelecypod-ostracod assemblage to a more diverse gastropod-pelecypod-ostracod-serpulid worm assemblage. Marine and terrestrial vertebrates are also common in these upper beds.

All of the above information has been incorporated with subsurface data in order to reconstruct the local and regional depositional framework of the DeQueen and its subsurface equivalents. A better understanding of the depositional environment of these rocks will promote interest in, and may lead to the development of, undiscovered hydrocarbon reserves within less-well-known downdip areas.

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Implications for Role of Density Currents in Generation of Hummocky Cross-Stratified Beds in an Upper Devonian Shallow-Marine Sequence, New York

The processes responsible for sediment deposition and the development of internal morphology of hummocky cross-stratified units (HCS) have been the subject of considerable controversy. The results of the present study of the Ithaca Member of the Upper Devonian Genessee Formation in western New York

State suggest a probable density-flow mechanism for the deposition of the sandstones which were subsequently modified to form HCS units.

A 150-m (500-ft) thick section of flat Ithaca sediments is well exposed in the Finger Lakes region where the formation can be traced for kilometers both parallel and normal to the paleoshoreline. This shallow marine sequence is composed largely of fine sandstones and mudstones deposited in an Upper Devonian epicontinental sea. Detailed examination of the sandstone beds at the base of the Ithaca Member reveals a marked transition over a distance of 40 km (25 mi) normal to the shoreline from a hummocky cross-stratified sequence within the more proximal facies to a sequence of interbedded sandstones and shales displaying turbidite features in the more distal western exposures. The section also indicates shallowing paleodepths upsection, with vertical sequences suggesting a progression of environments increasingly dominated by the encroaching shoreline of a regressing sea.

One explanation for the observed lateral transition of sedimentary features normal to paleoshoreline is that the hummocky cross-stratified beds and the turbidites were deposited concurrently. Subsequent reworking of the HCS unit by storm waves would account for its variant internal sedimentary features. This is in accord with the results presented in 1979 by Hamblin and Walker.

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Clay-Mineral Relationships in Some Low-Permeability Hydrocarbon Reservoirs and Their Use as Predictive Resource Tools

Detailed mineralogical characterizations, using X-ray diffraction and scanning electron microscopy of sand-shale and carbonate-shale-bentonite sequences, of some classic low permeability hydrocarbon reservoirs reveal basic clay-mineral relationships that are helpful in evaluating the extent of diagenesis and petroleum resource potential.

Gas-potential units of the El Paso Natural Gas 1 Wagon Wheel and BELCO 3-38 (formerly INEXCO 1-A WASP) wells, Green River basin, Wyoming, contain shales composed primarily of altered detrital clay suites of various origins and compositions that are consistently different than authigenic clays formed within adjacent sandstones. Commonly, discrete illite is abundant in the shales as a major detrital component; the percentage of illite is lower in the sandstones. Chlorite typically comprises a high percentage of the clay-size ($<2\mu m$) material of sandstones and is primarily authigenic, however, little chlorite ($<8\%$) is inherent in the shales. Authigenic interstratified illite-smectite (I/S) formed in relatively clean sandstones is typically less illitic and more restricted in composition range than I/S clay of various origins within shales or shale-laminated sandstones.

Therefore, because of these primary differences in clay mineral assemblages between sandstones and shales from these units, log interpretations of low permeability sand reservoirs should not be extrapolated from the log response of adjacent shales. The composition of I/S clay from relatively cleaner sands also may give a better indication of diagenetic "minimums."

Indigenous gas and oil are produced from low-permeability chalk beds of the Upper Cretaceous Niobrara Formation within the Denver basin of eastern Colorado and western Kansas. Clay-mineral studies of I/S clay in insoluble residues of shaly chalk sampled throughout the basin show that the starting composition of the I/S clay in these strata is highly variable due to a complex mixing of I/S clays from many different sources at the time of deposition. However, the composition of I/S clay from thin bentonites in these strata is quite consistent throughout a section from any one specific location and/or depth, and these clays become progressively more illitic and ordered with increasing temperature due to increased burial. At approximately 60% illite layers in I/S, the I/S of bentonites proceed from random ($R = 0$) to short-range ordered ($R = 1$) interstratification. I/S clay formed in thin, discrete bentonite beds within Niobrara strata, where original starting compositions were nearly fixed and uniform and there was little or no contribution from detrital clays, is the best indicator of the extent of diagenetic reactions. The presence (or absence) of regular interstratified clay minerals in thin bentonite beds of the Niobrara can, therefore, be used as relative geothermometers for constructing predictable petroleum resource maturation maps of the Denver basin and adjacent areas.

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Patterns of Uranium Mineralization in Reading Prong

Recent studies of uranium occurrences in the Precambrian crystalline terrain of the Reading Prong show a definite correlation between the presence of uranium and late stage magmatic activity during the Grenville orogeny. All uranium concentrations examined show a close spatial association with catazonally emplaced granitic, alaskitic, or pegmatitic rock of anatectic origin. Published age dates indicate that uranium concentrations developed during the period 975 to 950 m.y. The ultimate source of the uranium is a granitic magma formed by partial melting of the metasediments in the root zones of the Reading Prong. Emplacement of granitic layers into a variable metamorphic sequence has resulted in different types of uranium occurrences. (1) Anatectic granite association: granitic stocks and sheets intruded into the metasedimentary section near the zone of anatexis may show internal enrichments of uranium. (2) Magnetite association: magnetite ore bodies provide locally reducing conditions ("oxygen-sink") to precipitate uranium released from nearby intrusions. (3) Metasedimentary contact association: granitic intrusion into a lower pressure zone in a metasedimentary sequence may result in release and concentration of uranium from a fluid phase along the intrusive contact. (4) Skarn association: similar to type 3, uranium concentrations may develop where uraniferous granites intrude a calc-silicate assemblage. (5) Massive sulfide assemblage: uranium concentrations can develop in the reducing environment where a granitic magma intrudes or abuts a massive sulfide body.

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Burial Cementation—Is It Important? A Case Study—Stuart City Trend, South-Central Texas

The Stuart City trend is a shelf-edge buildup of Lower Cretaceous bioclastic and reefal carbonates that is currently buried to depths of between 3,300 and 5,000 m (11,000 and 16,000 ft). Compaction and cementation have generally reduced rock porosities to less than 9%. Sediments were cemented in the marine environment by finely crystalline bladed, isopachous cement and volumetrically important (14 volume %) coarse to very coarsely crystalline, fibrous to bladed, isopachous, Mg-calcite cement. These cements have been neomorphically altered