is less common. Recrystallization of the $CaCO_3$ mud matrix also is a common source for secondary porosity development. The combined amounts of primary and secondary porosity and the resulting permeability values may be large. In Greater Aneth field, Four Corners area, porosity values range from 3.5 to 26.2 percent, with an average of 10 percent. Permeability values reach a maximum of 932 md, with an average of 25 md. Estimated primary and secondary petroleum reserves may amount to 500 million bbl.

Porosity destruction is caused primarily by secondary sparry calcite vug filling. Extensive leaching in the upper zones of an algal bank forms solutions which are oversaturated in $CaCO_3$. When these supersaturated solutions percolate downward into the lower zones of the mound, precipitation of sparry calcite commonly begins. A rarer type of porosity destruction is that which results from a total collapse of the algal fabric. A relatively rapid diagenetic hardening of the $CaCO_3$ mud matrix apparently is required to prevent collapse of the algal fabric under the weight of overlying sediment. In some places, anhydrite caused porosity occlusion. In one example, the porosity in a core had been destroyed completely by vug fillings composed of isolated small dolomite rhombohedra.

Synecological fossil assemblages associated with algal mounds or mound-associated facies have different compositions in mounds of different stratigraphic and regional settings. The following groups of fossils were recorded in algal banks: Foraminifera, including ophthalmid and encrusting Foraminifera, and fusulinids, ostracods, fenestellid and fistuliporoid Bryozoa, crinoids, echinoids, gastropods, tetracorals, brachiopods, sponges, *Chaetetes* (tabulate corals), *Komia* (questionable stromatoporoid), *Girvanella* (blue-green algae), and *Ungdarella* (red algae).

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Luminescence Petrography of Sandstones

(No abstract submitted)

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Observations on Sandstone Cementation

Comparative study of Permian and modern caliche, laterite, bauxite, and beach rock have shown that vadose cement, regardless of composition, can be distinguished from cementation below the water table or sediment-water interface.

Phreatic and connate cementation which occurs beneath the water table or sediment-water interface is more coarsely crystalline than vadose cement and is interstice-filling rather than grain-coating. Early carbonate cement precipitated from water-filled voids at shallow depths consists of sparry calcite and may push apart and replace quartz and feldspar to produce "floating" textures. Silica cement occurs as void-filling overgrowths on quartz grains. After deep burial uncemented sand grains become tightly packed, the depositional texture is modified, and late aqueous cement occupies smaller interstices.

The following characteristics and stages of intensity of vadose cementation can be distinguished.

1. *Initial stage.*—The original depositional texture is lost as precipitation of fine-grained evaporitic films of carbonate, iron oxide, or aluminum hydroxide forces the grains apart so that films separate grains at former contact points. Sedimentary structures such as beach laminae and current ripple cross-bedding still may be preserved in this stage.

2. *Intermediate stage.*—"Floating" textures are produced as grains become pushed apart by evaporite cement and by replacement of quartz and feldspar by carbonate. Coalescence of evaporite films around clusters of grains forms small pisolitic concretions. Sedimentary structures become obliterated or greatly obscured.

3. *Late stage.*—Extreme floating textures and large composite pisolites form by addition of more cement and replacement of quartz and feldspar. Brecciated caliche anticlines (also known as teepee structures) are formed by expansion resulting from the addition of large volumes of carbonate cement.

Extreme caution must be employed in interpreting the genetic significance of rocks classified as sandy micrite, wackestone, and boundstone or biolithite. Transformation of quartzose sand into sandy carbonate, consisting of up to 90% fine-grained carbonate (micrite) which commonly is pisolitic (strongly resembling algal boundstone), is well documented by numerous examples. Similarly, accumulations of oöliths, clasts, skeletal fragments, pellets, and calcarenaceous material may be transformed into rocks which could be identified as oömicrite, intramicrite, biomicrite, pelmicrite, wackestone, and boundstone or biolithite (pisolitic) by vadose processes (calichefication).

Many so-called oölitic iron ores represent vadose concentrations of iron oxide and hydroxide.

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Canadian (Early Ordovician) El Paso Group, Southern Franklin Mountains, El Paso County, Texas

The El Paso Group and at least the upper part of the underlying Bliss Sandstone at their type sections in the southeastern Franklin Mountains probably is the most complete Canadian section exposed in northern Chihuahua, New Mexico, and west Texas.

The El Paso Group represents deposits of a general, but complex, west-to-east transgression of the Cambrian and Early Ordovician seas across Arizona, New Mexico, and west Texas. The group thins to a featheredge in central New Mexico as a result of post-Canadian erosion of the upper part of the sequence.

Flower (1964) has given 10 formational names for the El Paso Group that represent not only rock-stratigraphic units, but also distinct sequential biostratigraphic units.

Seven of these El Paso Group units are regional in extent and recognizable in the southern Franklin Mountains. They are (in order from oldest to youngest): the early Canadian Sierrite Formation; the middle Canadian Cooks, Victorio Hills, and Jose Formations; and the late Canadian McKelligon Canyon, Scenic Drive, and Florida Mountains Formations. The basal middle Canadian Big Hatchet Formation may be present and unrecognized because of facies changes in the southern Franklin Mountains area. The uppermost middle Canadian Mud Springs Mountain and Snake Hills Formations are believed to be absent because of nondeposition or erosion.

The El Paso Group overlies the Bliss Sandstone disconformably. The Late Ordovician Montoya Group overlies the El Paso Group with a regional angular unconformity in the west Texas-New Mexico area. The