Fossils were dolomitized at 250°C (482°F) in Ca/MgCl solutions for periods of time from 4.5 to 320 hours. Aragonitic corals, gastropods, and pelecypods formed stoichiometric, microcrystalline, xenotopic dolomite and low Mg-calcite (LMC). The dolomite was not pseudomorphic after the aragonite. The conversion of AR → LMC is more rapid than the AR → DOL in these experiments. For instance, gastropods run for 23 hours formed dolomite and LMC in a ratio of 1/10, at 170 hours the ratio was 1/4, and at 340 hours the ratio was 1/1.

HMC coralline algae, forams, and echinoderm fragments were dolomitized before and after conversion to LMC. The dolomite formed was cryptocrystalline and pseudomorphic after the forams and echinoderms regardless of the mineralogy. We attributed this to the cryptocrystalline nature of the substrate.

Oyster fragments composed of microcrystalline LMC formed non-stoichiometric, poorly ordered dolomite even after 320 hours. None of the other reactants were as resistant to dolomitization.

Our results indicate that grain size is more important than mineralogy in determining the fabric of dolomite replacement crystals. Both HMC and LMC can be pseudomorphically replaced. Pseudormophic replacement requires (1) abundant nucleation sites and (2) a regular crystallographic relationship between the calcite and dolomite. Argonite was not pseudomorphically replaced, probably because it was microcrystalline rather than cryptocrystalline. Also, most of the aragonite converted to LMC prior to dolomitization.

Selective replacement characteristics of many natural dolomites are readily explained as being an effect of the grain size of the material replaced. Freshwater diagenesis of a sediment prior to dolomitization may retard dolomitization if the grain size of the $CaCO_3$ is increased. However, conversion of LMC without appreciable increase in grain size may not retard dolomitization.

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Petroleum Exploration and Resource Potential of Offshore Newfoundland and Labrador

The continental margin of Newfoundland and Labrador, encompassing a total area of 714, 000 mi^2 (1,849,252 km^2) has been the target of exploratory activity since the early 1960s.

Exploratory drilling began on the Grand Banks in 1966 and by 1974 a total of 40 dry wells had been drilled. This lack of success, accompanied by escalating drilling costs, resulted in the curtailment of exploratory activities. In 1979 wildcat drilling resumed on the Grand Banks and the Hibernia field was discovered with the drilling of the P-15 well. This well, with an estimated flow potential of more than 20,000 BOPD, was the first oil well drilled on the Atlantic shelf of North America capable of commercial production. Truly a "giant," the Hibernia structure has a resource potential of 1.85 billion bbl of oil and 2.0 tcf of gas at a probability level of 50%. Six significant oil discoveries have been made on the Grand Banks. Of these, the Hibernia, Nautilus, Hebron, and Ben Nevis discoveries are located in highly faulted hinge zones on the western and eastern flanks of the northward plunging Avalon basin graben. The South Tempest structure is located on a ridge complex to the east of the Avalon basin. The Adolphus well drilled a salt piercement structure in the basin depocenter. The reservoirs are fluvial-deltaic and shoreline sandstones of Jurassic and Cretaceous age.

Since 1971, 25 wells drilled on the Labrador Shelf resulted in one oil and five gas discoveries. The reservoirs are Paleozoic carbonates and Lower Cretaceous, Paleocene, and Eocene sandstones. All are capping or draping basement horst blocks.

By the end of 1982, total exploratory efforts had resulted in the drilling of 86 wells and the acquisition of approximately 240,000 line-mi of marine reflection seismic. Provincial land permits on the continental margin are held by ten permittees. This land position represents 54 million acres (22 million ha.) and 133 exploratory permits. A total resource potential of these structures has been estimated at 14.7 billion bbl of oil and 88.6 tcf of gas at a 50% probability level. A commercial discovery was long in coming but the recent high success rates confirm this margin as a major frontier of enormous potential.

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Regional Distribution of Hydrocarbon Fluid Inclusions in Carbonate Fracture Filling Cements: Geohistory Analysis and Timing of Oil Migration, Oman Foredeep

Fractured, reservoir limestones in Oman and the United Arab Emirates include the Shuaiba (lower Aptian) and Mauddud (upper Aptian-lower Cenomanian). Deposition of these bioturbated, argillaceous foraminiferal-peloidal wackestones and packstones ceased in the Early Cretaceous as the Oman foredeep subsided and filled with pelagic sediment. Petrography and geohistory analysis of four wells and one outcrop suite reveals five stages of diagenesis, fracturing, and fluid migration. (1) Shelf emergence: early cementation associated with regional unconformities overlying both limestones; (2) pre-orogenic shelf emergence, late Cenomanian to Turonian: fractures cutting Stage 1 cements are healed by very cloudy, cleaved, and twinned calcite containing microfractures with yellow-white fluorescent, hydrocarbon fluid inclusions; (3) initial foredeep downwarp of 0 to 800 m (0 to 2,624 ft), Coniacian to early Campanian: fractures crosscutting Stage 2 fractures are healed with cloudy, cleaved, and sometimes twinned calcite containing dull-blue fluorescent, hydrocarbon fluid inclusions; (4) rapid subsidence and filling with 600 to 3,400 m (1,970 to 11,155 ft) of flysch, exotic blocks, and thrust toes, Campanian to Maestrichtian: burial and tectonic stylolites crosscut Stage 2 and 3 fractures; and (5) uplift of the Oman Mountains after 3,900+ m (12,795+ ft) burial by early Tertiary: fractures crosscutting all diagenetic features are filled with clear untwinned and uncleaved calcite containing only nonfluorescent, aqueous fluid inclusions. If we can correlate earliest stylolite formation with a minimum burial load of ~800 m (~2,625 ft), then the hydrocarbon inclusions in Stage 2 fractures must predate all of Stage 4 and most of Stage 3. In the deepest portions of the foredeep, close to the Oman Mountain front, this limits the presence of oil in fracture porosity to late Turonian-early Campanian time. Farther to the west, in the shallower parts of the foredeep, this constraint relaxes, and oil migration occurred as late as early Tertiary.

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Illite/Smectite Diagenesis and Hydrocarbon Generation in Cretaceous Mowry and Skull Creek Shales of Northern Rocky Mountains–Great Plains Region

The Lower Cretaceous Mowry and Skull Creek Shales and their equivalents are among the major source rocks in the northern Rocky Mountains-Great Plains region. They are the major source of hydrocarbons in the Lower Cretaceous Muddy Sandstone of the Powder River basin. This sandstone has a geographic distribution similar to that of the Mowry and much of the Skull Creek.

Illite/smectite mixed-layer clay in the Mowry and Skull Creek Shales of eastern Montana and western North Dakota is unaltered. No significant amounts of hydrocarbons have ever been found in the Muddy Sandstone of this area. Hydrocarbons in the Muddy Sandstone occur within or immediately adjacent to areas in which the smectite component of the illite/smectite in the Mowry and Skull Creek Shales has undergone alteration to illite during burial diagenesis. Anomalous decreases in the total organic carbon content of the Mowry and Skull Creek Shales lie within areas of illite/smectite alteration and coincide with the deeper parts of structural basins which developed after deposition of the Mowry and Skull Creek. These regional variations in illite/smectite alteration and total organic carbon content reflect thermal maturation and are not provenance controlled. They are useful indicators of areas where the potential source rocks have been subjected to temperatures adequate to generate hydrocarbons. The degree of illite/smectite diagenesis in the Mowry and Skull Creek of the northern Rocky Mountains-Great Plains region is thus of exploration significance in the search of hydrocarbons in this area.

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Permian Upper Yates Formation Carbonate/Siliciclastic Depositional Patterns, Northwestern Shelf, Guadalupe Mountains, New Mexico

Sedimentological field study of the upper three sandstones of the upper Yates Formation (Permian, Guadalupian), Guadalupe Mountains, New Mexico, has shed considerable light on the shelf depositional environment, morphologic profile, and temporal relationships of alternating carbonate and siliciclastic deposition. Outcrops were examined in detail, and 31 stratigraphic sections were measured, described, and correlated within the region 5 km (3 mi) shelfward of the Capitan reef and encompassing an area of 180 km^2 (69 mi^2).

The three sandstones in the upper 15 to 30 m (49 to 98 ft) of the Yates are continuously traceable across the study area as thin, nonchanneled sheet sandstones 0.5 to 8 m (1.6 to 26 ft) thick. They exhibit no deepening or "shoaling-upward" sequences; no beach or tidal sedimentation features; and no vertical repetitive sedimentation patterns. Primary sedimentary structures are rare, obscure, small scale ($\leq$ 20 cm; 8 in., height), and discontinuous. All structures indicate subaqueous deposition. From the sandstones nearest the Capitan, the shelfward progression of sedimentary structures indicates shelfward diminution of hydraulic energy. Sandstones are largely abiotic suggesting maintenance of inhospitable marine conditions (mesohaline?) during siliciclastic deposition.

Evidence for a marginal mound shelf profile during sandstone deposition is inconclusive. A localized area of fenestral porosity in the lowermost sandstone unit, and a narrow region of probable fossil caliche along the Yates/Tansill formational contact of the upper sandstone, both suggest local emergence of a paleotopographic high located 1.5 to 3.0 km (.9 to 1.8 mi) and 1.5 to 3.25 km (.9 to 2 mi) respectively, shelfward of the Capitan. All three sandstones continuously overlie the area of the marginal mound as inferred from the underlying carbonate facies, hence a marginal mound was not present or had no affect on transport of siliciclastics across the outer 5 km (3 mi) of the shelf.

Each sandstone is characterized by a sharp, subplanar erosional base, and typically grades upward into peritidal carbonates, which exhibit along the shelf crest of the marginal mound one or more 1 to 2 m (3 to 6 ft) shoaling-upward hemicycles which commonly built up to depositional fill-level in response to episodic shelf subsidence of 1 to 2 m (3 to 6 ft). The eroded fill-level carbonates of the shelf crest underlying two of the three sandstone intervals were diagenetically micritized analogous to incipient pedogenesis prior to subsidence and burial by subaqueously deposited siliciclastics. Local emergence of 1 to 2 m (3 to 6 ft) relief could explain the inferred pedogenesis, with siliciclastic deposition being favored by subsidence and greater water depth which governed siliciclastic transport processes.

The following depositional sequence is repeated twice in the study interval: subaqueous deposition of siliciclastics across the eroded surface of the underlying carbonate unit; upward siliciclastic gradation into peritidal carbonates characterized by one or more 1 to 2 m (3 to 6 ft) shoaling-upward hemicyclic deposits which proceeded to fill-level; local emergence with concomitant subaerial erosion and micritization; subsidence and renewed subaqueous siliciclastic deposition. Reconnaissance observations from the middle Yates and lower Tansill reveal numerous analogous sandstone/carbonate relationships.

The sandstone intervals interbedded with shelf crest carbonate facies comprise sandstone/carbonate shoaling-upward hemicycles; contrary to current interpretation the sandstone represents the basal "deeper" water deposition, the carbonates represent the "shoal water" deposition.

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Importance of Radar Look Direction in Petroleum Exploration

Structural features which can be readily mapped from radar imagery are those features which are represented by some elements of physical relief. These structural features are usually fractures or physical discontinuities in the rock materials, which can be seen because of the effects of selective or differential erosion. These effects are seen on radar imagery in two distinct manners. First is the linearity of physical features, and second is the discontinuity of tone, shape, texture, and/or pattern. The discontinuity of tone, shape, texture, or pattern is created by differential erosion of the terrain on one side of a fracture in respect to the other side.

The ability of a remote sensing system to enhance minor physical features is the most important aspect in mapping structural features. The available tonal contrast is of secondary importance. The direction of illumination is also important in the mapping of structural features as determined by studies on the Alaskan Peninsula.

Maps showing the major structural features of the study area were compiled from real aperture radar imagery, synthetic aperture radar imagery, and Landsat MSS imagery. Three simple frequency diagrams were produced from maps of the study area showing the major structural features. The frequency diagram of the linear features taken from real aperture radar imagery, shows a strong bimodal distribution. The two major directions indicated are approximately 50°W and 50°E. The frequency diagram of the linear features taken from synthetic aperture radar imagery also shows two major directions of orientation. The two major directions are approximately 70°W and 20°E. The frequency distribution for Landsat MSS imagery is trimodal showing major orientations of approximately 60°W, 10°E, and 60°E. All three frequency diagrams are strikingly different.

What is shown in the frequency diagram is preferential enhancement of linear features by a particular direction of illumination. Field reconnaissance indicated three major directions