of fracturing, 55°W, 55°E, 15°E, presented here in order of decreasing dominancy. These directions show up in relation to directions of illumination. Along a line of illumination there will be two triangular areas, one on either side of the line, in which the maximum enhancement of linear features will occur. These areas are the zones of maximum shadow effects. When radar imagery is acquired with two directions of illumination, the two directions should not be at 180° to one another. The second direction of illumination should be about 120° from the first direction of illumination. In an area in which Landsat data are available, the direction of illumination for the radar imagery should be acquired 120° from the direction of illumination of the Landsat data.

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Dolomitization and Dedolomitization Models in a Fractured Reservoir, Reed City Oil Field, Michigan

Hydrocarbon production in the Michigan basin is essentially from pinnacle reefs or fractured reservoirs. The latter represents linear production zones which only recently have been demonstrated as related to shear faults and accompanying shear folds.

Dolomite distribution of the Middle Devonian Traverse, Dundee, and Detroit River producing formations in several linear fields were studied by X-ray diffraction of well samples at 20 to 60-ft (6 to 18 m) intervals. The epigenetically formed porous dolomite reservoir rock is intimately related to the shear faults (channelways for rising high Mg/Ca ratio fluids) and to the resulting shear folds, the latter showing dolomite/calcite ratios increasing generally from outer closure to the fold axes.

The Reed City field (anticline) of western Michigan represents a dramatic exception to this picture with the dolomite/calcite ratio increasing from outer closure to maximum part way up the limbs then decreasing to the axis. The Traverse Formation (highest stratigraphically) shows dedolomitization throughout 540 ft (165 m); the Dundee, throughout the entire 60 ft (18 m); and the Detroit River (the lowest target) in the upper 20 ft (6 m) but not in the lowest 30 ft (9 m). This lowest zone is the only unit not dedolomitized, a fact perhaps commensurate with its low stratigraphic position at the bottom of (and apparently beyond the reach of) the descending high-calcium, low-magnesium waters what brought about the dedolomitization.

A change from dolomite to calcite is witnessed by zonation of dolomite rhombs, which show on staining a ferroan dolomite core followed by successive layers of ferroan calcite and calcite in the outer layer. The individual calcite rhombs are usually pseudomorphic after the dolomite. Clear dolomite rhombs (dolomitizing stage) and calcite rhombs (dedolomitizing stage) often occur along microstylolites.

The presence of anhydrite and gypsum in this field likely supplied the $CaSO_4$ considered important to the dedolomitization process with the general reaction: $CaSO_4 + CaMg(CO_3)_2 = 2CaCO_3 + MgSO_4$. Iron found in the ferroan dolomite, ferroan calcite, and iron hydroxide in the dedolomitized rock probably came from pyrite, an important constituent of the original microcrystalline limestone country rock. The dedolomitization model would call for a shallow water to exposed oxidizing environment, possible with the position of this area astride the "West Michigan Barrier" that separates a lagoonal facies from a more open sea facies to the east. Thus, waters with a high Ca/Mg ratio passed down the same shear faults that earlier were channelways for the rising high Mg/Ca ratio waters.

On the bases of isopach, structure and dolomite/calcite (Isodol) maps, one can piece together a reasonably chronological sequence of pre-Dundee shear faulting and folding, post-Traverse upward migration of dolomitizing fluids, upward migration of hydrocarbons along the shear faults, downward-moving dedolomitizing fluids, and a later episode of faulting (especially shear cross-faults).

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Geochemical Evaluation of Proposed Ore Genesis Models for Colorado Plateau Tabular-Type Uranium-Vanadium Deposits

The elemental, isotopic, and mineralogic examination of core samples from the Tony M orebody, a typical Colorado Plateau tabular-type, uranium-vanadium deposit, located in the Henry structural basin of south-central Utah, allows a critical evaluation of proposed ore genesis models. Uranium mineralization is concentrated into two horizontally oriented tabular horizons hosted within the Salt Wash member of the Jurassic Morrison Formation. The ore zones are not strata bound and rise stratigraphically toward the center of the ancestral Henry basin. Preservation of fossil plant debris and the lack of oxidative destruction of iron disulfide minerals in the interval between the uranium-enriched units argue this zone is not the oxidized tongue formed by a roll-type mineralizing process. The selenium-molybdenum trace element pattern is also inconsistent with the roll-front model.

The necessary interbedding of gray lacustrine mudstones and nearshore lacustrine sandstones, as required by the lacustrine-humate model, is present within the Tony M deposit. However, absence of quantitatively significant amounts of transported humic substances either associated or remote from mineralization suggests that mudstone-derived organic acids were not involved in uranium localization.

Vanadium oxide is the major vanadium-bearing phase within the lower uranium lense whereas vanadium is partitioned within chlorite in the supra-adjacent barren zone. Such a sharp vertical break in vanadium mineralogy implies vanadium deposition within two chemically different environments.

The lower ore zone is characterized by isotopically light ($\delta^{34}S \cong -26‰ - 46‰$) FeS_2. Bacterial sulfate reduction is shown to be the most likely fractionating agent. The uniformity of the sulfur isotopic composition of the iron disulfide minerals requires a non-depletable sulfate reservoir. Dissolution of gypsum ($\delta^{34}S \cong +14‰$) occurring below the Tony M orebody is demonstrated to be a plausible sulfur source thereby establishing the presence of a sulfate brine. From this data we conclude that the solution-interface model, which postulates uraniferous meteoric fresh water flowing over a denser brine, best explains the genesis of this deposit.

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A Spectrum of Late Paleozoic Siliciclastic Shelf-Bars, Sacramento Mountains, New Mexico

Study of several Pennsylvanian-Permian shelf sandstones in the northern Sacramento Mountains, New Mexico, suggests that siliciclastic shelf-bars were migrating on a high-energy shelf adjacent to the Pedernal uplift. These shelf-bars had sufficient relief, 2 to 6 m (6.5 to 20 ft), to provide the clear-water, agitated conditions requisite to carbonate grain-shoal development in areas of low clastic influx. The carbonate and siliclastic cycles can be