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STABLE OXYGEN ISOTOPIC COMPOSITION OF CARBONATE ROCKS IN GREEN RIVER FORMATION, EASTERN UTAH AND WESTERN COLORADO

Stable oxygen isotope ratios and calcite-dolomite ratios were determined for 40 samples of various lacustrine carbonate rocks from the Green River Formation (Eocene) of the eastern Uinta basin and the central Piceance Creek basin. Petrographic studies indicate there are five main carbonate rock types: (1) micrite and dolomicrite; (2) algal biolithite; (3) oolite and pisolite; (4) structureless microcrystalline carbonate aggregate (pellet); and (5) kerogen-rich dolomitic claystone (oil shale). The respective δO^{18}_{PDB} isotopic ranges in per mille for these rocks are: -3.27 to -15.85; -2.43 to -7.19; $+2.73$ to -4.54; $+2.60$ to -3.43; and $+0.67$ to -9.51. The percent dolomite in the carbonate fraction is from 0 to 100.

These isotopic values, which are similar to values obtained by other workers for lacustrine carbonate of various ages, suggest that the oxygen isotopes in the carbonate material comprising the algal biolithite, oolite, pisolite, and oil shale were biologically fractionated to isotopically heavier values relative to the inorganically precipitated micrite. The similarity in isotopic values between the structureless microcrystalline carbonate (+2.60 to -3.43) and the oolite (+2.73 to -4.54) also suggests that the former may be a dolomitized and recrystalized form of the latter. No correlation between percent dolomite in the carbonate fraction and the oxygen isotopic composition was found for the oolite, pisolite, and algal biolithite rocks, suggesting that the dolomite in these samples formed by diagenetic replacement of primarily precipitated calcite. A positive correlation was found for the oil shale and some of the micrite, suggesting that the dolomite in these samples was primary.

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RESISTIVITY MAPPING OF SANDSTONE STRATIGRAPHIC TRAPS

Many Cretaceous stratigraphic oil accumulations of Wyoming may be mapped with log resistivity, because the clay-rich edges of sandstone bodies have lower resistivity and the clay poor centers of the sandstones have higher resistivity. Although many factors affect log resistivity, variation of the clay content of a sandstone body causes several orders of magnitude change in resistivity in and around a given stratigraphic trap.

Resistivity maps generally agree with SP isopach maps, but tend to show the location of the most porous and permeable clay-poor sandstones, rather than the total sand thickness. Resistivity maps are also useful when no SP is evident outside the developed sand body or when clay fill makes SP unreliable.

Although the presence of carbonate cement, coals, and lignites, *etc.*, complicate interpretation of resistivity maps in some formations, the tool is usually effective in simple clay-quartz formations. The tool is particularly useful during development drilling of a stratigraphic trap.

The use of resistivity mapping is illustrated with a number of Muddy and Dakota stratigraphic oil fields in the Powder River basin of Wyoming at Hilight, Recluse, South Glenrock, Gas Draw, and Coyote Creek.

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PETROLOGY AND HYDROCARBON POTENTIAL OF MISSISSIPPIAN RATCLIFFE BEDS IN SOUTH-CENTRAL SASKATCHEWAN, CANADA

A detailed petrologic investigation of a Mississippian carbonate-evaporite rock unit interrelates depositional environment, sequence of diagenesis and porosity-permeability in each of 8 rock types distinguished. Structural considerations are introduced and hydrocarbon potential assessed.

Deposited on the northern slopes of the Williston basin, the strata of the Ratcliffe Beds in this area include 3 basin-fringing evaporites, the Midale, the Oungre, and the upper Ratcliffe evaporites. Successively younger evaporites overlap toward the southwest and in much of the western part of the area the Ratcliffe Beds are exclusively carbonates.

Most of the original sediments of the microcrystalline limestones, saccharoidal dolomites, and the sparry, oolitic, pelletoid limestone were deposited in an open marine, shallow-water environment. The bedded anhydrites, dolomitic anhydrites, and anhydritic dolomites were formed in supratidal evaporitic pans, maritime lakes, or lagoons. The microcrystalline dolomites and associated nodular anhydrite reflect a supratidal environment.

The microcrystalline dolomites and associated anhydrite nodules are both early diagenetic in origin, having formed under sabkhalike conditions. The saccharoidal dolomites are late diagenetic; formed after the initial lithification of the sediments by refluxing magnesium-rich, hypersaline waters, derived from supratidal zones. The accompanying anhydrite masses probably had a similar origin.

Intercrystalline porosity combined with small interconnected vugs in the dolomites make this the best reservoir rock in the area studied. Solution vugs in the limestone also may provide effective porosity for hydrocarbons. The oil accumulation is due to structural-stratigraphic trapping.

The collapse of the Ratcliffe Beds into salt-leached areas has affected the structural pattern and influenced hydrocarbon accumulation. Possibilities of further oil discoveries in this area are good.

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STRUCTURAL GEOLOGY OF CRAZY MOUNTAINS BASIN

The Crazy Mountains basin is a physiographic depression, as well as a structural basin in south-central Montana. The basin is bounded on the north by the Castle Mountains, Shawmut anticlinal trend, and the Huntley-Lake basin fault zone; on the west by the Bridger and Big Belt Mountains, on the south by the Nye-Bowler lineament and the Beartooth Range; and on the east by the Pryor-Big Horn uplift. Separation of the Crazy Mountains basin from the Big Horn basin to the south is arbitrarily placed along the Nye-Bowler lineament.

The Crazy Mountains are a passive intrusive complex occupying the deeper part of the basin. This setting is analogous to the Raton basin of the Colorado and its associated Spanish Peaks intrusives.

The structural pattern of the Crazy Mountains basin is somewhat enigmatic, being most varied and diverse. Structures within the basin resulted from the superposition of Laramide compression on an earlier fragmented Precambrian crystalline basement. The resulting structures are folds related to thrusting; drape folds over faults with dip-slip movement; and en échelon folds with "gash" fractures related both to left-lateral and right-lateral transcurrent fault movement.

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PETROLEUM EXPLORATION AND NEW BASEMENT TECTONICS

Mounting evidence from important geologic studies of many types—surface geology, standard airphoto interpretation, space photography, gravity, magnetics, and side-looking radar imagery—demonstrates that the earth's Precambrian crust is profoundly and systematically fractured. These basement fractures fall into a few sets of parallel structures that have been reactivated by local and regional tectonism at various times subsequent to their formation. Thus, they control, to a very large degree, all geologic structures, particularly structures in the sedimentary blanket overlying Precambrian basement. An understanding of basement fracturing is thus of enormous importance in petroleum exploration and will become a major exploration technique in the coming years. Strain theory is relegated