of occurrence of the secondary structures, like the primary structures, varies with lithology. Crystal-growth disruption (sulfides and carbonate clots) in the oil shale increases with increasing organic content. In a vertical sequence of oil shale in the Parachute Creek Member, crystal-growth disruption of laminae increases upward through the section, and loop and fault structures decrease. Contortion of laminae is almost exclusive to the oil shale, and bioturbation is restricted to claystone and very limy claystone.

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DIPMETER INTERPRETATION OF STRUCTURAL AND STRATIGRAPHIC FEATURES IN ROCKY MOUNTAINS

No abstract available.

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ORIGIN OF Ca, Fe, AND Mg CARBONATES IN OIL SHALES OF EOCENE GREEN RIVER FORMATION IN COLORADO, WYOMING, AND UTAH

Calcium and magnesium carbonates are perhaps the most widespread minerals in the oil-shale sequence of the Green River Formation. Crystallography and chemical composition of the principal carbonate minerals in the oil shale indicate a wide range in mineral composition that includes calcite, Mg-calcite, dolomite which is iron-free and has normal 1:1 Ca:Mg, dolomite with low iron and excess Ca, ankerites with excess Ca, siderite, magnesiosiderite with low Ca, and aragonite.

Recognition of the ubiquitous presence of Mg-calcite in these rocks seems important in reconstructing a plausible depositional model for the sedimentary environment and origin of the kerogen-rich shales. Recent studies show the ability of algae and many invertebrates to precipitate high Mg-calcite in aqueous saline environments. Biogenic precipitation of calcite in the hypersaline waters of the Green River lake may account for the higher Mg-content of laminae adjacent to and within high-kerogen zones than in low-kerogen zones.

Subsequent to the inferred biologic precipitation or accumulation of high Mg-calcite in the upper levels of the lake, the Mg-calcite sank to a lower zone of extreme salinity after death of the organism. Postdepositional processes in the lower zone of accumulation may have converted high Mg-calcite to low Mg-calcite and dolomite, as suggested by the presence of this mineral assemblage in many of the samples studied. Development of ankerite, siderite, and magnesiosiderite is believed to be authigenic or diagenetic. Metastable carbonate minerals such as Mg-calcite plus dolomite with excess Ca, or Mg-calcite plus ankerite with excess Ca have been identified in a single polymineralic grain. This finding makes untenable an interpretation of the oil-shale mineral assemblage based on conventional equilibrium conditions for the system $CaCO_3$-$MgCO_3$-$MgCO_3$-$FeCO_3$ at 25°C.

We find no compelling mineralogic or chemical evidence that indicates precipitation of calcite and protodolomite at the basin margin followed by reworking and transport of the carbonate sediments to the basin center, as other workers have recently proposed for their playa-lake model.

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MINERALOGIC EVIDENCE FOR BURIED HYDROCARBONS—NEW EXPLORATION TOOL

Imperfect rock seals above petroleum deposits may allow large volumes of low-molecular-weight hydrocarbons to slowly leak and diffuse to the surface. The seeping hydrocarbons chemically alter and incorporate into near-surface and surface rocks as pore-filling cements that are isotopically and chemically distinctive and geographically identifiable because their compositions and densities markedly contrast with surrounding rocks. Strong empirical evidence indicates that gases diffuse directly through the overburden, and leakage of liquid hydrocarbons is controlled by salinity variations in formation waters which affects their solubilities and promotes chemical reactivity. Highly reducing hydrocarbons and associated compounds cause discoloration of surface strata by reduction and dissolution of iron. Near the surface, hydrocarbons are oxidized; expansion of depressurized gas evaporates ground waters concentrating and precipitating dissolved solutes with unique isotopic signatures.

Such alteration and mineralization phenomena have been documented in outcrops of a Permian redbed sequence overlying several prolific oil accumulations in southern and central Oklahoma, but especially at the Cement anticline. Recognition of similar phenomena elsewhere could lead to new discoveries.

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EVAPORITE DEPOSITS OF NORTHERN GREAT PLAINS: COMPARISON OF DEPOSITIONAL SETTINGS

The stratigraphic succession in the northern Great Plains is punctuated by many evaporite deposits of varying thickness and areal extent. They are most predominant in rocks of Paleozoic age and particular in the Devonian and Mississippian Systems. The youngest known deposits are associated with redbeds which have been assigned Late Triassic to Early Jurassic ages. Most of the evaporites in the northern Great Plains are composed of calcium sulfate; halite is somewhat less common, and there are small amounts of soluble potassium chlorides.

Recent geochemical investigations of the distributions of Sr^{+2} in modern evaporites and brines indicate that the mass ratios of Sr^{+2}/Ca^{+2} in calcium sulfate deposits may be employed to assist in the identification of the hydrologic environment in which an evaporite was precipitated and indirectly to distinguish depositional settings. The data from these investigations have been applied to selected evaporites in the northern Great Plains and corroborate the interpretations of the depositional settings as obtained from an examination of the lithologic associations.

The brines from which the evaporites in the northern Great Plains were precipitated may be thought of as having existed in one of two hydrologic environments: (1) interstitially in siliciclastic or carbonate sediments, or (2) as standing water in topographic depressions that underwent intermittent replenishment by less saline waters. The depositional settings as interpreted from lithologic associations and the results of geochemical analyses include: (1) arid supratidal flat, (2) barred-marine basins, ranging from structur-