set and opening on fractures, factors very important to production in fractured reservoirs.

The appropriateness of a numerical model depends completely on the specified input which consists of: (1) the boundary condition that produced the structure, and (2) the material behavior of the rock. Consequently, it is possible that a model with improper input may produce the desired fold geometry yet provide inaccurate information pertinent to fracture prediction. Thus, debate over the nature of boundary conditions, such as exists in thrust terrane, has implications even in the realm of fracture prediction.

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Clay Mineral Catalysis and Petroleum Generation

Kerogen, the major organic component of sediments and sedimentary rocks, is the immediate precursor of petroleum hydrocarbons. Recent studies of kerogen maturation during burial diagenesis show that decarboxylation of fatty acid constituents and C-C bond cleavage of hydrocarbon groups, both attached to the kerogen polymer, lead ultimately to petroleum-hydrocarbon formation. The low temperature range over which this occurs (60 to 110°C, 140 to 230°F) has suggested that the clay mineral matrix may play a role in catalyzing these important reactions.

Kinetic studies of clay-organic reactions have demonstrated the effectiveness of clay catalysis in organic acid decarboxylation and cracking reactions and suggest the mechanisms involved.

Kinetic constants deduced for these reactions from the natural maturation of kerogen during diagenesis reveal a further complication in sediments. Because kerogen is a solid, relatively immobile polymer, structural rearrangement is necessary to bring reacting groups in contact with catalytic sites. Mechanical movement plays a role in promoting catalytic activity.

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Stages of Eocene Lake Uinta, Piceance Creek Basin, Colorado

Recent stratigraphic studies have greatly improved our knowledge of the relation between the facies of the Green River Formation in the Piceance Creek basin, thus allowing for a more precise interpretation of the development of Eocene Lake Uinta through time.

In general, the evolution of Lake Uinta can be divided into six main stages. During the first stage, which is represented by almost half of the preserved Green River section in the central part of the Piceance Creek basin, there were two lakes, one located in the Uinta basin and one in the Piceance Creek basin. Freshwater mollusks occur throughout the stratigraphic section representing this period of time, suggesting that the lake was at least periodically fresh. These two lakes should probably not be rightfully called Lake Uinta, since a single lake did not exist. The second stage begins with the Long Point transgression in which the lake in the Piceance Creek basin transgressed across the Douglas Creek arch and connected with the lake in the Uinta basin. The area under water was quadrupled, and Lake Uinta, as envisioned by Bradley, came into being. During the following stages, Lake Uinta extended unbroken between the two basins. Low-grade, clay-rich oil shale is the dominant lithology from this stage, with the exception of some nearshore areas where shallow shelves began to form. Freshwater mollusks are found in rocks of the second stage, but are not common in rocks of later stages of Lake Uinta in the Piceance Creek basin. The third stage began with an abrupt increase in the kerogen content of the offshore oil shales. In the marginal lacustrine areas, however, there was no noticeable change. Here, marginal shelves, which began to form immediately after maximum Long Point transgression, continued to prograde into the lake. Large fluctuations in water level are suggested by rapid changes in facies on the marginal shelves. Thick, ripple-laminated sandstones were deposited during rising water, and deep meandering channels formed when water level dropped.

The water level appears to have been much more stable during the fourth stage. Thick stromatolites and tufa mounds interlayered with laminated carbonate-rich mudstone are the dominant lithologies found in the marginal shelf deposits. Laminated, kerogen-rich, dolomitic oil shale was deposited in the center of the lake. Carbonate content increased in all Lake Uinta sediments during this stage; and for the first time, the saline mineral nahcolite is found associated with oil shale. At the beginning of the fifth stage, water level gradually rose, bringing intermitted oil-shale deposition over about the outer half of the marginal shelves. Nahcolite deposition in the offshore oil shales ceased during transgression but began again once water level stabilized. In fact, most of the nahcolite and halite in Lake Uinta sediments were deposited during this comparatively long stage. This higher lake level brought some peculiar changes to the marginal shelves. Oil shale is commonly interlayed with ripple-laminated siltstones and fine sandstones, ranging in thickness from a few inches to as much as 70 ft (21 m). These clastic sequences can be traced toward the center of the lake where they form lean zones in the oil-shale section.

The final stage of Lake Uinta in the Piceance Creek basin begins with a major transgression, represented approximately by the base of the Mahogany Ledge, a rich oil-shale sequence. Lake Uinta expanded to its maximum extent in the early part of this stage, possibly expanding to near the limits of the sedimentary basin. Infilling of the lake began at maximum transgression when a rapidly prograding shelf complex, composed largely of volcanoclastic sediments, started at the north shore of Lake Uinta and reached the southwest corner of the basin before halting. Lake Uinta evidently persisted in this limited area considerably longer than elsewhere in the basin.

The stratigraphic model presented here demonstrates that Lake Uinta evolved with time, and that each succeeding stage represented an accumulation of characteristics acquired during the preceding stages. Geochemical models that have been proposed to explain the unique oil shale and saline deposits from Lake Uinta should be reexamined in light of this more complete stratigraphic picture.

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Structural and Thermal History of Piceance Creek Basin, Colorado, in Relationship to Hydrocarbon Occurrence in Mesaverde Group

The purpose of this study was to reconstruct the structural and thermal history of the Piceance Creek basin to try to predict the occurrences of hydrocarbons in the Upper Cretaceous Mesaverde Group. A vitrinite reflectance map of basin-wide coal zone and several coal rank cross sections using vitrinite data was constructed. Isopach maps were used to reconstruct the burial history. In general, the Mesaverde Group can be divided into two parts: a lower mixed marine and nonmarine part, and an upper, largely nonmarine section. Vitrinite reflectance values range from R_o .50 to R_o 2.1, and indicate that both the nonmarine and marine Mesaverde are within the range of thermal gas generation throughout the basin, with the possible exception of the upper part of the nonmarine Mesaverde along the extreme west and