

tions enriched in a single maceral group (algae, altered algae, particulate liptinites, amorphous liptinites, amorphous humic matter, vitrinite, and inertinite). Their composition and maturation level were defined by transmitted light, fluorescence, and vitrinite reflectance. These measurements were repeated after pyrolysis.

The proportion of volatilized material ranges between 84 and 5% for algae and inertinite, respectively. The hydrocarbon yield ranges between 660 and 13 mg hydrocarbons/g organic matter for amorphous liptinites and inertinites, respectively. The residue after pyrolysis resembles inertinite ranging from micrinite to inertodetrinite except for vitrinites (and inertinites) which retain their textural characteristics. These types of inertinites occur in over-mature sequences. The yields obtained by pyrolysis may be used to estimate the relative potential of the different maceral types. They possibly represent maximal values.

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#### Diagenesis of Frontier Formation, Moxa Arch, Wyoming—Function of Sandstone Geometry, Texture, and Composition of Fluid Flux

The lower Frontier Formation, Moxa arch, Wyoming, consists of sandstones and mudstones deposited in a wave-dominated delta and strand-plain system which prograded into the western margin of the interior Cretaceous seaway. Depositional environments in this system were offshore marine, marine sand ridges, marine shoreline, distributary channel, fluvial, and flood basin. Sediment from the Sevier orogene was sorted into different compositional and textural assemblages in depositional environments with different energies. Because of original differences in physical and compositional characteristics, diagenesis proceeded along different paths in different facies. The most important facets of original detrital composition affecting diagenesis are original clay content and the monocrystalline quartz/chert ratio.

Diagenesis was also very sensitive to fluid flux. Sedimentary textures and sand-body geometries were important controls of fluid flow during dewatering. In the southern part of the study area, erosion eliminated the shoreline interval leaving only thin fluvial sandstones overlying offshore marine rocks. To the north, the shoreline facies was not eroded and the sandstone interval is thicker. On the assumption that sandstones received the discharge from equal volumes of shale, the thinner fluvial sandstones to the south experienced a far greater throughput per unit volume of sand and a higher rate of flow than did the thicker combined fluvial and shoreline sequence to the north. As a result, the southern sandstones are extremely porous and permeable and show signs of extensive leaching, whereas in the north there is more evidence of in-situ reactions resulting in the development of abundant authigenic and neomorphosed clays. Here, porosity and permeability are poorer.

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#### Depositional Environments of Tyler Formation in Fryburg and Rocky Ridge Area, North Dakota

The Tyler Formation in southwestern North Dakota is a regressive barrier-island system dominated by two environments: (1) lagoon and (2) barrier-beach complex. The barrier islands formed along an east-west line in Golden Valley, Billings, and Stark Counties. Thickening eastward (5 to 20 ft), a gradational, coarsening-upward sequence of very fine to medium-grained, well-sorted quartzose sandstone is developed in the Medora, Fryburg, and Green River fields. Where there is good develop-

ment of a shoreline, massive fine-grained, well-sorted sandstones with discontinuous, wavy carbonaceous laminae (foreshore environment) overlie fine-grained, well-sorted, cross-laminated, and bioturbated sandstones (shoreface environment).

Northward, several offshore sand bars developed in a predominantly shallow restricted sea, typified by medium-gray to grayish-black ripple cross-laminated argillaceous limestones and shales. On the south, in a landward direction, barrier-island sands interfinger with grayish-black carbonaceous lagoonal shales, coal, and mudstone marsh deposits and varicolored mudstone tidal-flat deposits. The sandstones present in the Rocky Ridge vicinity are characteristically medium grained and silty, and exhibit unidirectional cross-stratification. They are interpreted as channel deposits dissecting a landward facies of the lagoonal environment.

The upper Tyler Formation is a regressive sequence characterized by anhydritic mudstones, desiccation features, and local chickenwire anhydrites overlying dark-gray fossiliferous, argillaceous limestones and shales.

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#### Role of Organic and Inorganic Reactions in Development of Secondary Porosity in Sandstones

The development of secondary porosity in many sandstones is the result of aluminosilicate and/or carbonate dissolution. The dissolution of aluminosilicates and creation of secondary porosity is a problem of aluminum mobility. Our experimental data demonstrate that it is possible to increase significantly the mobility of aluminum and to transport it as an organic complex in aliphatic acid solutions. The same aliphatic acid solutions have the capability of destroying carbonate cements and debris.

Carothers and Kaharka have shown that concentrations of aliphatic acid anions range up to 5,000 ppm over the temperature range 80 to 200°C in some oil field formation waters. Our experiments show that acetic acid solutions at the same concentrations and over the same temperature range can increase the solubility of aluminum by a half an order of magnitude, whereas oxalic acid solutions increase the solubility of aluminum by an order of magnitude. The textural relations observed in the experiments are identical to those observed in sandstones containing secondary porosity as a result of aluminosilicate dissolution.

A natural consequence of the burial of sedimentary prisms is the maturation of organic material. These maturation reactions result in the evolution of significant amounts of organic acids and carbon dioxide. The experiments suggest that the development of secondary porosity in a sandstone as a result of aluminosilicate or carbonate dissolution is the natural consequence of the interaction of organic and inorganic reactions during progressive diagenesis. The degree to which secondary porosity develops depends on the ratio of organic to inorganic matter, the sequence, rates and magnitude of diagenetic reactions, fluid flux, and sand/shale geometry.

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#### Effective Exploration Strategy—Stratigraphic and Paleogeographic Controls on Hydrocarbon Migration in Denver Basin

Current exploration strategies generally focus on trap identification and the organic richness and maturity of source rocks. Yet, examination of producing basins worldwide commonly indicates a non-uniform distribution of production in basins, which is not related just to trap and source location. Clearly, exploration based on such a strategy may focus efforts on an area where traps