By studying polished mudrock sections with BSE and EDX, the sizes, shape, orientation, textural relations and internal compositional variation of the clay minerals can be observed in situ. Preliminary evidence suggests that the clay stacks are authigenic and may have formed at shallow burial depths during early diagenesis. In addition, sand- and silt-sized clay pellets (glauconite) composed chiefly of iron-bearing dioctahedral mica were observed in the sediment. The irregular shapes and textural intergrowths of many pellets suggest that active outward growth occurred, probably by a combination of displacement and replacement in the surrounding matrix material.

LAW, B. E., and WARREN W. DICKINSON, U.S. Geol. Survey, Denver, CO

Conceptual Model of Gas-Seal Development, Green River Basin, Wyoming

Previous work in the Green River basin of Wyoming indicates that overpressuring is the result of gas generation in low-permeability rock sequences. We concur, but suggest that an equally important aspect of overpressuring is the development of an effective seal.

Most porosity in these tight reservoirs results from dissolution of mineral grains and cements. The effectiveness of this porosity-enhancing process is dependent, in part, on the ability of pore fluids to transport dissolved products away from the sites of dissolution. We suggest that, in low-permeability rocks, at depths beginning at subsurface temperatures of 190°-200°F (88°-93°C), rates of thermogenic gas generation exceed gas loss, causing fluid pressure to increase. In the larger pores, free water is forced upward into zones of lower pressure. As a result, a water block is formed, with water-bearing reservoirs updip and gas-bearing reservoirs downdip. In the active gas-generating zone, the remaining water is irreducible. This water is immobile and incapable of removing dissolution products. Thus, while other porosity-reducing processes continue, porosity-enhancing processes become ineffective, resulting in a pore network with very low porosity and permeability.

The initial stages of our model take place in a subsiding basin where subsurface temperatures are at equilibrium with organic matter metamorphism. However, most basins currently are not at equilbrium, and the relationships of organic maturation, temperature, and overpressuring are obscured due to local or regional uplift and temporal variations of paleotemperature. Despite these modifications, the seal, as proposed here, is retained. We suggest that the San Juan basin of New Mexico and Colorado is a postequilibrium example of our model. This basin has progressed through the overpressured equilibrium stage and is now abnormally low pressured due to cooling and gas-volume contraction accompanying regional uplift. However, the gas seal developed during the overpressured stage is present as a low-permeability updip water block.

LAW, B. E., U.S. Geol. Survey, Denver, CO

Relationships of Source Rock, Thermal Maturity, and Overpressuring to Gas Generation and Occurrence in Low-Permeability Upper Cretaceous and Lower Tertiary Rocks, Greater Green River Basin, Wyoming, Colorado, and Utah

Most hydrocarbon production from low-permeability Upper Cretaceous and lower Tertiary reservoirs in the Greater Green River basin of Wyoming, Colorado, and Utah is gas. The most likely sources of the gas are the interbedded coal beds and other carbonaceous lithologies. A source-rock evaluation of these rocks indicates predominantly humic, type III organic matter capable of generating mainly gas.

The relatively closed nature of these low-permeability rocks facilitates examination of the geologic processes involved in gas generation and occurrence. All gas accumulations are associated with overpressuring. Thermal generation of gas is the main cause of overpressuring and is directly related to organic richness, level of organic maturation, and temperature. Distances of gas migration, in most areas, do not exceed a few hundred feet. Consequently, the temporal relationships of gas generation and migration with respect to the development of structural and stratigraphic traps are not as important as in more conventional reservoirs. On the basis of the premise of minimal gas migration, the initiation, or threshold of significantly large volumes of thermogenic gas occurs at a temperature of about 190°-200°F (88°-93°C) and a vitrinite reflectance of about 0.80 R_o.

LAW, BEN E., U.S. Geol. Survey, Denver, CO

Biogenic Gas Accumulations in Large-Scale Compaction Structures, Powder River Basin, Wyoming and Montana

The coal-bearing lower Tertiary Fort Union and Wasatch Formations in the Powder River basin of Wyoming and Montana are potentially important sources of biogenic gas. The presence of gas seeps, flowing gas wells, and gas shows in shallow drill holes indicates that these rocks contain economically recoverable methane resources. Chemical and isotopic analyses of coal-derived gas and gas produced from sandstone reservoirs in these rocks indicate that the gases are basically identical and are biogenic ($\delta^{13}C$ values range from −53.59 to -60.85 ‰ and C_1-C_{1-5} values range from 0.97 to 0.99).

The search for shallow biogenic gas accumulations may be facilitated by the recognition of the significance of compaction anticlinal folds. The development of compaction structures occurs penecontemporaneously in response to abrupt lithofacies changes associated with specific environments of deposition. Measured relief of these anticlines is as much as 250 ft (76 m).

Compaction folds may provide early formed structural traps in cases where the overlying folded strata contain suitable sandstone reservoirs. In other cases, compaction folds may reflect the presence of stratigraphic traps in the structural core of the fold. For example, the compaction contrasts inherent in a fluvial system of lenticular channel sandstones and fine-grained overbank deposits may be the eventual site of compaction folding. In either case, compaction folds may indicate the presence of very early formed structural and/or stratigraphic traps, and these folds can be mapped on the surface and in the subsurface. They are in stratigraphic proximity to excellent gas source rock (coal), providing optimal conditions for early entrapment of biogenic gas.

LEFEVER, JULIE A., North Dakota Geol. Survey, Grand Forks, ND, RICHARD D. LEFEVER, Univ. North Dakota, Grand Forks, ND, and SIDNEY B. ANDERSON, North Dakota Geol. Survey, Grand Forks, ND

Mississippian Frobisher-Alida-Kisbey Sandstone, North-Central North Dakota

Argillaceous and arenaceous marker beds and lenses are common in the Frobisher-Alida interval of the Mississippian Madison. These markers are used to define "pay" zones in Bottineau, Renville, and Burke Counties. One of these regional markers is the Kisbey sandstone, also referred to as the MC-4 bed or the K-2 marker. The Kisbey sandstone has a characteristic log pattern and can be traced from southeastern Saskatchewan into north-central North Dakota. It occupies a specific stratigraphic position between the "Mohall' and "Glenburn" porosity zones and averages 15 ft (4.5 m) thick. Lithologically similar to other arenaceous units locally present within the Frobisher-Alida, the Kisbey generally is a gray to buff, medium to fine-grained, well-sorted, subangular to rounded, quartzose sandstone. Primary structures include lenticular bedding, ripple marks, and small-scale cross-bedding. Dolomite or anhydrite cement are also present locally.

The ability of the Kisbey to act as a reservoir rock is demonstrated by several fields in southeastern Saskatchewan and by the North Haas field in Bottineau County, North Dakota. Nineteen wells in the North Haas field produce or have produced from the Kisbey sandstone. Oil migrating through the "Glenburn" porosity in the Haas field has charged the porous and permeable Kisbey sandstone. Updip, the "Mohall" and "Glenburn" zones become progressively more anhydritic until the Kisbey is bounded above and below by anhydrite. An updip porosity loss acts as the final trapping mechanism.

The principal factor which determines the reservoir quality of the Kisbey sandstone is the presence or absence of cement or argillaceous material.