of the Middle Devonian Elk Point Group. The Deadwood clastics are quartzose sandstone, sand, subordinate shale, and conglomerate. Locally, in the northernmost part of the area, they have been removed by pre-Devonian erosion. The carbonate sequence of the Elk Point Group is divided into lower and upper subgroups. The Lower Elk Point subgroup contains the Meadow Lake Formation (new) which is subdivided into lower and upper members. The basal formation of the Upper Elk Point subgroup, the Winnipegosis is present in the area. The younger formations of these southwest-dipping Devonian strata are absent owing to erosion or nondeposition. The Devonian carbonate rocks are overlain unconformably by clastic sediments of the Lower Cretaceous Mannville Group.

The common occurrence of fractured and brecciated carbonate rocks within the Meadow Lake Formation indicates salt solution and can be correlated with the extensive rock salt deposits of the Lower Elk Point subgroup in central Alberta. The depositional edge of one of these salt deposits, the Cold Lake Salt, can be traced.

Accessory copper, lead, and zinc minerals are present locally in clastic rocks of the Deadwood Formation and also in the Devonian carbonate rocks. Gas shows have been reported from the upper member of the Meadow Lake Formation. Meadow Lake limestone of economic significance was recently discovered near Pinehouse Lake.

GAUTIER, DONALD L., U.S. Geol. Survey, Denver, Colo., and Univ. Colorado, Boulder, Colo.

Post-Depositional Control of Gas-Reservoir Quality in Eagle Sandstone of Bearpaw Mountains, North-Central Montana

The Eagle Sandstone of Late Cretaceous age is an important conventional reservoir for biogenic gas (isotopically light methane) near the Bearpaw Mountains. A petrologic examination of cores from producing wells was undertaken to establish the petrologic features which significantly affect reservoir quality in a conventional shallow gas reservoir, and to provide a framework for the investigation of lower quality reservoirs on the east.

Petrologic studies indicate that the quality of most Eagle Sandstone reservoirs in the Bearpaw Mountains area is controlled by a consistent sequence of postdepositional events. Most sandstones were tightly sealed early in their burial history by authigenic calcite, which filled intergranular pores and partially replaced some framework grains. In some sandstones, minor quartz cement partly preceded the precipitation of calcite. Subsequent to calcite precipitation, siderite or ankerite formed as numerous patches which were localized by altering biotite. This iron-rich carbonate may occupy as much as 3 or 4% of the rock volume. Later, most calcite was removed through dissolution that resulted in abundant intergranular and intragranular porosity. The newly developed porosity further facilitated the movement of interstitial waters, which produced extreme dissolution effects in susceptible framework grains such as andesine. Later in the burial history of the Eagle Sandstone, clay minerals were formed in intergranular pores and to a lesser extent in intragranular pores. Although kaolin is the dominant clay, iron-rich chlorite and mixed-layer mica-smectite are locally important.

The following conclusions can be made. (1) The highly porous and permeable nature of the Eagle Sandstone in conventional reservoirs is due predominantly to the dissolution of authigenic and detrital components. (2) The formation of dissolution porosity occurred at relatively shallow depths in thermally immature rocks and was not directly related to burial diagenesis of clays in associated shale sequences. (3) The common occurrence of acid-soluble iron-rich phases should be considered when using acid treatments. (4) In some conventional Eagle reservoirs, migration and/or expansion of clay-size components may cause formation damage if clays are not stabilized.

GLAESER, J. DOUGLAS, J. D. Glaser and Associates, New York, N.Y., and Duke Univ., Durham, N.C.

Environments for Sedimentary Uranium in Triassic-Jurassic Basins, Eastern North America

The association of feldspar-rich alluvial-fan deposits with lake sediments formed in anoxic conditions is one of the most intriguing and least understood settings for sedimentary uranium accumulation. The Triassic-Jurassic basins formed during early rifting of North America's eastern margin all contain extensive accumulations of alluvial deposits which intertongue with basin-center black shales and, in places, coals. These basins lie adjacent to, or just beneath, the prograded seaward-thickening sedimentary coastal plain wedge which blankets the trailing continent margin. Many analogies in basinal development, sedimentary fill, climatic controls, and presence of evaporites can be drawn between these basins and the spreading centers of the Red Sea and Gulf of California–Salton Trough.

In addition to extensive interfingering between oxidized and reduced sedimentary deposits, the Triassic-Jurassic basins contain the first major rock groups in the Phanerozoic of the Appalachian region having ubiquitous feldspar and feldspar-weathering products. These basins apparently received significant input from exposed Acadian and younger Paleozoic batholiths and granitic intrusions developed during the terminal evolution of the Appalachian geosyncline. Wide variations in source-rock types are directly reflected in both the sediment fills and uranium potentials within and among these Triassic-Jurassic basins.

GLASS, GARY B., Wyoming Geol. Survey, Laramie, Wyo.

Coal Development in Powder River Basin of Wyoming

Thick Tertiary age coals make the Powder River basin of northeastern Wyoming the most prolific coal-bearing area in the United States, with an estimated remaining coal resource of more than 609 billion tons. The reserve base from the remaining resources is conservatively estimated at 45.6 billion tons. Whereas 23 billion tons of this reserve base is believed strippable, another 22.6 billion tons is probably recoverable by underground mining.

In 1977, coal production from seven strip mines amounted to 23 million tons or 50% of the state's total production that year. The Amax Coal Co. Belle Ayr mine alone accounted for 13.3 million tons. With expansion of the Belle Ayr mine to 17 million tons, the addition of three new mines, and the expansion of other existing mines, production in 1978 probably exceeded 39.2 million tons or about 63% of the state's 1978 production. Forecast annual production from the Powder River basin is 81.1 million tons by 1980 and 123.1 million tons by 1985. Of this tonnage, 95% is derived from the subbituminous Wyodak-Anderson coal bed, which ranges from 20 to 120 ft (6 to 36 m) thick in the east-central part of the basin.

In addition to conventional strip mining activity, two in-situ coal gasification projects are under way in the basin.

GLOPPEN, TOR GUNNAR, Statoil, Stavanger, Norway, and RON STEEL, Univ. Bergen, Bergen, Norway

Alluvial Fans and Their Deposits in Devonian Hornelen Basin, Norway

Conglomerate alluvial-fan bodies are well exposed around the fault margins of Hornelen basin. Detailed mapping of the bodies and of their internal facies variation together with logging of laterally equivalent profiles allows reconstruction of fan processes, geometry, internal cyclicity, and relation to contemporaneous flood-basin deposits. Of particular interest is fan-to-fan variation through Hornelen basin's 25 km succession, as illustrated by six examples from the northern and southern margins.

Some fan bodies, particularly with small radius (<2 km), and a rapid change in downfan maximum particle size (>30 cm/km) are entirely dominated by debris flows. The latter are commonly poorly sorted and massive or inversely graded. The ratio of bed thickness to maximum particle size in debris flows is usually less than 3. Other fans, usually thinner bodies, with greater radius (<6 km) and less abrupt downfan grain-size gradients, contain a significant amount of fluvial (braided stream) or sheet-flood deposits, which are usually concentrated in the middle or lower fan reaches.

GUTSCHICK, RAYMOND C., Univ. Notre Dame, Notre Dame, Ind., CHARLES A. SANDBERG, U.S. Geol. Survey, Denver, Colo., and WILLIAM J. SANDO, U.S. Geol. Survey, Washington, D.C.

Mississippian Carbonate Shelf Margin Along Overthrust Belt from Montana to Nevada

A constructional carbonate platform and a generally north-trending shelf margin in Utah and southwestern Idaho were bordered on the west by a starved basin, flysch trough, and orogenic highland during Kinderhookian to middle Meramecian time. The Antler orogeny produced epeirogenic movements, which resulted in sea-level changes that caused the carbonate platform episodically to prograde and retreat. At different times the shelf was bordered either by a narrow foreslope or by a broad ramp. The sequential history is as follows: (1) Late Devonian thrusting raised the continental margin to produce the Antler orogenic highlands, which in earliest Mississippian time had a low eastern coastal plain that bordered a narrow, shallow marine basin lacking a distinct eastern shelf. (2) Widespread marine inundation of the craton on the east was followed by a stillstand, during which a low shelf margin that turned abruptly eastward in Montana was developed and deposition of clinoform micritic limestone beds occurred in moderately deep water across a very broad ramp. (3) Increased downwarping produced an incipient starved basin, separated by a shallow carbonate bank from the flysch trough on the west and by a broad ramp from the northeast-trending shelf margin on the east; coarse encrinites were deposited alternately with micrites on the ramp. (4) Maximum deepening and expansion of the starved basin were accompanied on the west by deepening of the carbonate bank and on the east by westward progradation of a carbonate platform with a narrow, steep foreslope. (5) Lowering of sea level produced a karst plateau on the former carbonate platform and caused cratonic sands to be carried westward into the basin. Meanwhile, filling of the flysch trough allowed an eastward spillover of distal flysch sediments into the basin. The starved-basin sediments, which have organic-carbon values as high as 7% in outcrop, are considered to be source rocks. Coarse sediments of the carbonate platform, particularly where dolomitized, may serve as petroleum reservoirs.

HANLEY, JOHN H., U.S. Geol. Survey, Denver, Colo.

Application of Nonmarine Mollusca to Paleoenvironmental Interpretation and Correlation of Paleogene Rocks

Nonmarine mollusks, the most consistently occurring element of Mesozoic and Cenozoic nonmarine macrofaunas, are abundant and locally dominant in many preserved terrestrial and freshwater "paleocommunities." Maximum interpretive potential of mollusk assemblages is derived from detailed analysis of several biologic and physical factors: (1) taxonomy based on modern malacologic and paleontologic concepts that include differentiation of genetic and nongenetic morphologic variability; (2) biostratonomy (the history of the faunal assemblage from death to final burial); (3) community structure; (4) time-space variability of assemblages relative to a detailed lithostratigraphic framework; and (5) rock types, fabric, and structures of the enclosing sedimentary rock. Collectively, these factors indicate whether the faunal assemblage was preserved in the original environment in which it lived. Failure to gather and/or interpret adequately these data has promoted the widely held misconception that mollusks are of little value in the interpretation of depositional environments, biostratigraphy, correlation, and age determination of nonmarine rocks.

Two examples of the interpretive value of Paleocene and Eocene nonmarine mollusks are (1) depositional environments and regional paleoenvironmental reconstruction of part of the Green River and Wasatch Formations, southwestern Wyoming and northwestern Col-