regression, and late Turonian and Coniacian transgression was modified in several areas by episodes of slight uplift and attendant erosion. The most evident tectonism was in western Montana during the middle to late Cenomanian (93-94 Ma), in western Wyoming and adjoining areas during the early Turonian to earliest middle Turonian (90-91 Ma), in north-central Colorado, eastern Wyoming, and northwestern Wyoming in the early late Turonian (89.8 Ma), and in northeastern Colorado, Wyoming, and southwestern Montana in the late late Turonian (89.3 Ma). Crestlines of most of the swells trend generally either northwest or northeast. The tectonism of the mid-Cretaceous foreland corresponds in age to displacements of thrusts in the Sevier orogenic belt of southwestern Wyoming and southeastern Idaho. Furthermore, much of the foreland deformation probably reflects episodes of eastward thrusting in the thrust belt.

MERRY, R. D., and V. E. LARSEN,* CSM Research Inst., Golden, CO

Thermal Maturity of Bowie Coals in Southern Portion of Piceance Basin, Colorado

Although the thermal maturity of coals is determined primarily by age and depth of burial, shallow Cretaceous coals in the Piceance basin of Colorado display anomalously high thermal maturities, indicating that age and present depth of burial are not adequate to explain their high thermal maturities. The objective of this study was to investigate the physical factors that may have contributed to the high thermal maturity of the Piceance basin coals. Vitrinite reflectance (R_0), which increases with coal rank and provides a quantitative index of thermal maturity, was used to measure the thermal maturity of the coals.

An examination of published R_0 data and R_0 analyses of coal samples from mines, outcrops, and well cuttings indicated that most of the thermal maturity of these coals is due to the thickness of overburden that covered the coals in Pliocene time. A plot of vitrinite reflectance versus reconstructed depth of burial during Pliocene time shows a reasonably good fit, however, some R_0 values are too high to be explained solely by depth of burial. A map of R_0 "residuals" was constructed using data obtained by subtracting predicted R_0 values from actual values. When compared with a geothermal gradient map, most of the positive R_0 residuals correlated with "hot spots" that were related to known igneous intrusives. Some anomalous hot spots may be related to unknown buried intrusives. A residual R_0 map, modified on the basis of the geothermal gradient map, was combined with the preliminary R_0 map (based on reconstructed Pliocene depth of burial) to show that the resultant R_0 is due to depth of burial and geothermal hot spots.

A final thermal maturity map was used to select areas in the Piceance basin that are most likely to contain thermally mature coals. The same procedure can be used to predict the thermal maturity of coals in other basins.

MOHAMMAD, HASAN, Utah State Geol. and Mineral Survey, Salt Lake City, UT

Wall-Rock Alteration and Uranium Mineralization in Parts of Thomas Range Mining District, San Juan County, Utah, and Its Significance in Mineral Exploration

Several important uranium deposits associated with fluorspar and beryllium are located in parts of Thomas Range area. The mineralization is found in dolomites and dolomitic limestones of Paleozoic age and sandstones, tuffs, and rhyolites belonging to the Tertiary Spor Mountain and Topaz Mountain Formations.

The pipes, veins, and nodules of fluorspar are replaced by uranium. Veins and disseminations of radioactive fluorspar and opal and overgrowths of secondary minerals are found in rhyolites, tuffs, carbonate rocks, and breccias. The radioactivity in sandstones and conglomerates emanates from weeksite, beta-uranophane, zircon, gummite, etc. Uraninite occurs as rare inclusions in fluorite, gummite, and zircon. It also occurs as highly oxidized rare aphanitic grains disseminated in a few ore deposits. The results of the present investigations may influence the initiation of future exploration programs in the Thomas Range mining district.

Hydrothermal fluids of deep-seated magmatic origin rich in U, V, Th, Be, and F reacted with the country rocks. The nature and sequence of wall-rock alteration and its paragenetic relationship with the ores have been determined. The mineralization is confined to the altered zones. The ore bodies in the sedimentary rocks and the breccias are located in the fault zones. More than 1,000 faults are present in the area, greatly complicating mineral prospecting. The wall-rock alteration is very conspicuous and can be used as a valuable tool in mineral exploration.

MOORE, W. RICHARD, Independent, Denver, CO

Permian Tectonism in Rocky Mountain Foreland and Its Importance in Exploration for Minnelusa and Lyons Sandstones

Permian sandstones are important producers of oil in the Powder River and Denver basins of the Rocky Mountain foreland region. In the Powder River basin, Wolfcampian Minnelusa Sandstone produces oil from structural and stratigraphic traps on both sides of the basin axis, whereas in the Denver basin, the Leonardian Lyons Sandstone produces oil mainly from structural traps on the west flank of the basin. Two fields, North Fork–Cellars Ranch in the Powder River basin, and Black Hollow in the Denver basin, are examples of Permian growth of structural features.

At North Fork–Cellars Ranch, a period of Permian structural growth and resultant differential sedimentation is documented by structure and isopach maps of the Minnelusa and overlying Goose Egg Formation. Structural growth began at the end of Minnelusa deposition and resulted in deposition of a much thicker Goose Egg section on the west flank of the field. At Black Hollow, mapping indicates structural growth was initiated before deposition of the Lyons Sandstone and continued throughout Leonardian time. In both fields growth abruptly ceased in the Late Permian.

Both North Fork–Cellars Ranch and Black Hollow are located on structural highs, or arches, which trend east-west across the Powder River and Denver basins. These arches were present during the pre-Laramide migration of Paleozoic-sourced hydrocarbons into the basins and acted as pathways for migration. Exploration for Permian reservoirs in the two basins should be concentrated on the arches, as the early formed traps were present when migration began.

MORIARTY, BRUCE, and ROBERT GRUNDY, Redstone Energy Corp., Denver, CO

Seismic Exploration for Pennsylvanian Algal Mounds, Paradox Basin

During the past 2 years, several new field discoveries were drilled in Pennsylvanian algal mounds of the Paradox basin. Most of these discoveries were based, at least partially, on state-of-the-art seismic data. New field production comes from either the Ismay or Desert Creek zones of the Paradox Formation. The algal mounds correlate laterally with either marine shelf or penesaline facies. Detection of the Ismay and Desert Creek buildups is difficult because of their limited thickness. Therefore, the acquisition of good signal-to-noise high-frequency data and stratigraphic processing for frequency enhancement are both critical for successful seismic exploration in the Paradox basin. Bug, Patterson, Ismay, Cache, and Rockwell Springs fields are characteristic of Desert Creek and Ismay stratigraphic trapping.

NAPP, KENNETH F., and FRANK G. ETHRIDGE, Colorado State Univ., Fort Collins, CO

Depositional Systems of Fountain Formation and Its Basinal Equivalents, Northwestern Denver Basin, Colorado

The objective of this study is to provide a better understanding of the depositional systems of the Pennsylvanian Fountain Formation in north-central Colorado. The study area is bounded by T4N, T11N, R66W, and R70W, encompassing portions of the foothills outcrop belt and the Denver basin.

The sedimentary sequence observed in surface exposures displays little vertical variation. It is composed of vertically stacked, fining-upward, gravel to siltstone and mudstone cycles containing trough and planar cross-beds, horizontal beds, root structures, and nodular limestone. This succession represents deposition in Donjek-type braided streams and abandoned channel-fill sequences, and the development of soil horizons on a subaerial alluvial fan or alluvial plain.

In the subsurface, the vertical succession begins with a basal coarse-grained 140-ft (43-m) thick interval that is identical on the rocks found in