zone that bows up the upper plate of the Keystone thrust. The Red Springs thrust is interpreted as the Keystone thrust, which was broken and differentially rotated during Neogene oroclinal bending associated with the Las Vegas shear zone. The structural relationships in the Spring Mountains do not require any Mesozoic or Cenozoic deformational episodes other than the well-known Sevier and basin-range events.

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Carboniferous Tectonics, Stratigraphy, and Mississippian-Pennsylvanian Boundary, Western Interior United States

Current proposals for the mid-Carboniferous boundary at the first occurrence of *Declinognathodus noduliferus* place this boundary within rocks previously considered Morrowan by many workers in the Western Interior. This placement is higher than that of the Mississippian-Pennsylvanian systemic boundary between the Big Snowy and Amsden Groups in Montana by E. K. Maughan and A. E. Roberts, which is approximately coincident with the transition from Foraminifera Zone 18 to 19 and the first occurrence of *Adetognathus unicornis* and *Rhachistognathus muricatur*, based on paleontologic identifications by B. R. Wardlaw. An episode of differential regional uplift in the west, which seems to have been coincident with a major mid-Carboniferous event during the Allegheny orogeny and continent-wide epeirogeny, interrupted the deposition of Mississippian dominantly carbonate sediments. It created a regional erosional unconformity, and it initiated the deposition of Pennsylvanian dominantly siliciclastic sediments. Uppermost Big Snowy strata indicate regression of the sea from the western continental shelf and weathering and erosion of rocks exposed there, coincident with the approximately 320 Ma global sea level decrease shown by P. R. Vail. Lowermost Amsden strata record alluviation in valleys on the subaerially exposed continental shelf, and subsequent transgression of the sea. Valleys in the shelf margin were inundated first, and the sea then transgressed onto the adjacent platforms and shelves. This lithostratigraphic placement of the boundary corresponds to the criteria originally indicated by T. C. Chamberlin and R. D. Salisbury in 1906 for dividing the Carboniferous in North America; this is the Mississippian-Pennsylvanian boundary indicated by M. G. Cheney in 1945 to correspond to the Namurian A-B boundary in western Europe. Also, this boundary is about coincident with the base of the Pennsylvanian System stratotype in Virginia and West Virginia proposed by K. J. Englund in 1979.

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Lineaments and Their Tectonic Implications in Rocky Mountains and Adjacent Plains Region

Two orthogonal sets of lineaments in Phanerozoic rocks of the Rocky Mountains and adjacent plains region probably reflect recurrent structural movement along corresponding fractures in the underlying igneous and metamorphic rocks. The lineaments seem to have been primarily paleotopographic features that affected the depositional and erosional margins, thicknesses, and the distribution of lithofacies of Phanerozoic strata. One set is oriented approximately N5-15°E and N75-85°W; the other set is oriented about N50-60°E and N30-40°W.

At small scales, the crosscutting lineaments of either set indicate primarily vertical movements of rectangular blocks along through-going rectilinear fractures in the basement rocks. At larger scales, the differential movement of these blocks apparently was propagated upward through the strata and formed a variety of structures, many of which are en echelon. Blocks in the region moved at different times, and they commonly rotated about horizontal axes, as indicated by lateral differences in rates of associated sedimentation and by structural features along the lineaments. Through most of the Phanerozoic, the movements seem to have been mainly along the diagonal set (northeast, northwest) of lineaments, but the cardinal set (north-south, east-west) also influenced the development of Laramide structures and the present landscape in the Rocky Mountain region. The structural stresses, which were released along the two sets of lineaments, may reflect plate movements, and they probably are related to orogenies caused either by plate collisions or by rifting and continental fragmentation.

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Pressure Cycles Related to Gas Generation in Coals and Their Relation to Deep Basin Gas Accumulations

Bedded humic coals generate, store, and expel large amounts of gas when they achieve ranks greater than those approximating a high-volatile A bituminous containing 37.8% volatile matter. Gas volumes generated in excess of temperature- and pressure-dependent storage capacity are expelled into nearby sandstone reservoirs. High-volume rates of generation and/or expulsion lead to associated high formation fluid pressures both in the coals and associated sandstones. Lowering of temperature may decrease the generation rate and increase the coal storage capacity resulting in reabsorption of previously generated gas from adjacent sandstones. Cooling-related reabsorption processes may contribute to the formation of fluid under-pressures. The generation-expulsion and cooling-reabsorption processes may cause pressure cycles within a basin that create and control both overpressured and underpressured "basin bottom" gas accumulations in complex and interrelated coal-bed and sandstone reservoirs. Examples of the phenomena are present in the Mesaverde Group of the Green River and San Juan basins, Wyoming and New Mexico.

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Regional Hydrocarbon Generation, Migration, and Accumulation Pattern of Cretaceous Strata, Powder River Basin

A "cell" of abnormally high fluid pressure in the deep part of the Powder River basin is centered in an area where oil-generation-prone source rocks in the Skull Creek (oldest), Mowry, and Niobrara (youngest) formations are presently at their maximum hydrocarbon-volume generation rate. The overpressures are believed to be caused by the high conversion rate of solid kerogen in the source rocks to an increased volume of potentially expellable fluid hydrocarbons. In this area, hydrocarbons appear to be the principal mobile fluid species present in reservoirs within or proximal to the actively generating source rocks.

Maximum generation pressures within the source rocks have caused vertical expulsion through a pressure-induced microfracture system and have charged the first available underlying and/or overlying sandstone carrier-reservoir bed. Hydrocarbons generated in the Skull Creek have been expelled downward into the Dakota Sandstone and upward into the Muddy Sandstone. Hydrocarbons generated in the Mowry have been expelled downward into the Muddy or upward into lower Frontier sandstones. Hydrocarbons generated in the Niobrara have been expelled downward into upper Frontier sandstones or upward into the first available overlying sandstone in the Upper Cretaceous. The first chargeable sandstone overlying the Niobrara, in ascending order, may be the (1) Shannon, (2) Sussex, (3) Parkman, (4) Teapot, or (5) Tekla, depending on the east limit of each sandstone with respect to vertical fracture migration through the Cody Shale from the underlying area of mature overpressured Niobrara source rocks.

Vertical charge into each of the various carrier-reservoir sandstone units from their related source rock has been followed by a process of dominantly lateral updip migration within the carrier-reservoir bed toward sites of entrapment. Purely updip migration paths have been modified by both stratigraphic complexity and ground-water hydrodynamic flow. Stratigraphic-type traps terminating migration paths predominate on the north flank of the basin. Anticlinal traps predominate on the western and southern flanks.

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Biostratigraphic Units and Tectonism in Mid-Cretaceous Foreland of Wyoming, Colorado, and Adjoining Areas

Chronolithologic units and unconformities in mid-Cretaceous formations of the central Rocky Mountains region indicate widespread marine transgressions and regressions as well as recurrent deformation of the foreland in the Western Interior during Cenomanian, Turonian, and Coniacian times (88-96 Ma). The stratigraphic record of the widely recognized Cenomanian and early Turonian transgression, middle Turonian