18. Ross E. Wells, Thurman Consultants, Denver
Igneous Tectonics at Slater Dome, Moffat County, Colorado

Slater Dome, a sharp anticlinal feature in eastern Moffat County, Colorado, is believed due to local thickness variations in a sill intruded near the base of the Mesaverde. There is sufficient well control to establish, in part, the attitude of the upper surface of the sill. Available evidence for the igneous origin of the structure is presented and the time of gas accumulation considered in relation to the period of deformation.

19. Wallace G. Bell, Gulf Oil Corporation, Casper
Tectonic Setting of Happy Springs and Near-by Structures in Sweetwater Uplift Area, Central Wyoming

The Happy Springs, Crooks Gap, Kirk, and Sheep Creek oil fields are situated along the Green Mountain-Crooks Mountain trend in southeastern Fremont County, Wyoming.

Structurally, the fields lie within the southwestern part of the Wind River basin, near the western end of the so-called "Sweetwater arch."

The main structural features of the area were formed by Laramide compressive forces and consist of (1) several easterly trending shear zones, and (2) a series of northwest-trending folds and associated thrust faults. The folds and shear faults formed concomitantly in response to Laramide compressive forces. The shear faults divide the area into several elongate blocks and developed to accommodate different deformational patterns within the blocks.

The Happy Springs and adjacent fields consist of tightly folded, thrust-faulted, northwest-trending anticlines formed *en échelon* on the south side of an easterly trending shear zone. These folds represent crustal shortening in the block lying south of the shear zone. The features in which crustal shortening is manifested in the block north of the shear zone are located about 10 miles west of the Happy Springs area in the large Mormon Trail anticline and thrust fault. The shear zone is a line of release that developed between the two blocks when they responded differentially to compressive forces.

The main accumulation of oil in the Happy Springs and Kirk fields is in the deformed strata along the foot-wall of the shear zone.

20. Donald L. Everhart, U. S. Atomic Energy Commission, Denver
Tectonic Control of Uranium Deposition in Rocky Mountain Region

Significant uranium deposits are distributed in a complex pattern throughout the eastern and southern, the central, and the northern Rocky Mountains; and the Black Hills uplift, Dakota plains, and Wyoming basins. Consideration of uranium deposits in the Colorado Plateau is not included in this paper.

In considering the wide variety of known types of uranium deposits, under any scheme of classification, it is noted that nearly all types occur in the Rocky Mountain region. It seems likely that there is also considerable variety in the genetic history of uranium emplacement in the various types. However, tectonic influence appears to be consistently important throughout the entire pattern of distribution.

The relation of ore deposition to regional structural features is illustrated by the concentration of uranium minerals: (1) along or near major tensional faults; (2) along or near major lineaments; (3) at the flanks of structural basins, and (4) on structural terraces.

The striking influence of the broad tectonic framework of the earth's crust on world-wide uranium distribution patterns supports the conclusion that the Rocky Mountains region is but one segment of one of the world's great uranium "provinces." The variety of ore types within this area is the result of complex redistribution processes following the introduction of uranium into the upper parts of the earth's crust by juvenile solutions along controlling structure. Sedimentation, ground-water movement, and the transfer of organic material, all influenced in turn by tectonic history, have had an important bearing on uranium concentration in many parts of the large area discussed.

21. Y. William Isachsen, U. S. Atomic Energy Commission, Grand Junction
Regional Influence of Tectonics on Uranium Occurrences in Colorado Plateau Area

Most uranium deposits of the Colorado Plateau are restricted to lenticular sandstones and conglomerates, and are characterized by relatively obvious *local* sedimentary controls. An argument can be made, however, that the *areal* and *regional* controls of uranium deposition are probably more closely related to the tectonic framework of the Plateau than to sedimentation. In addition, significant examples can be cited where even *local* controls are tectonic, such as the Woodrow Mine near Laguna, New Mexico, where ore is restricted to a breccia pipe, the Rajah Mine south of Gateway, Colorado, where ore occurs in and adjacent to a fault breccia, several fault-controlled deposits in Cane Creek Canyon, southeast Utah, and a deposit in Big Indian Wash, southeast Utah, that appears to be localized along a reflected deep-seated fault. Local control of uranium in the Todilto limestone north of Grants, New Mexico, is exercised by fractures and associated small folds and wrinkles in the limestone rather than by sedimentary features. Many additional examples are added when it is argued that the curved fractures bordering ore "rolls" pre-dated mineralization and thus restricted the distribution of ore.

Although flexures and faults in many places control or influence primary ore distribution, joints do not. This is probably because joints are not through-going structures, but are restricted to brittle beds within the sedimentary pile, being absent from most of the numerous intercalated mudstones.

Perhaps the best example of *areal* tectonic control on the Plateau is shown in the Big Indian Wash-Lisbon Valley uranium district. Here, all ore bodies are elongated approximately parallel with the strike of the beds along the Lisbon Valley anticline, and all except one occur in the elevation interval 6,200–6,700 feet above sea-level. The single exception, which is about 5,840 feet above sea-level, lies along the Lisbon Valley fault in the southern part of the district. A general anticlinal control appears also to exist in the Uravan Mineral Belt.

On the regional scale, the peripheral distribution of most Plateau ore deposits about laccolithic mountains, plus a suggested zonal relationship between copper and uranium around the La Sal laccoliths, suggests that the intrusives may have both a structural and a petrogenic relationship to mineralization.

Still broader structures appear to limit the occurrence and distribution of uranium in the Colorado Plateau. Significant deposits are not known to occur throughout the Plateau; rather they are restricted to the northwest-trending San Juan segment (as named by Vincent C. Kelley), which contains all the laccoliths. This structural segment is bounded by the Uncompahgre lineament on the northeast and by the Zuni lineament on the southwest.

22. James Gilluly, U. S. Geological Survey, Denver
Summary and Recapitulation of Tectonic Papers

Brief review of the papers which were presented and synthesis of the ideas expressed.

23. John de la Montagne, Colorado School of Mines, Golden
Episodes in Tertiary Tectonic History of Saratoga-North Park Area, Wyoming and Colorado

A synclinal area between the Medicine Bow and Park ranges demonstrates several principles in the tectonic history of the southern Rocky Mountains. The area is of interest because: (1) it illustrates the episodic nature of tectonic events in this region; (2) the succession of fossiliferous Tertiary sediments are unusually complete and provide excellent clues to the timing and nature of these events; and (3) several structural elements in this area have trends independent of the regional structural patterns. Early Tertiary phases of tectonic activity were compressional in origin, but late Tertiary phases were both compressional and tensional.

An early Tertiary compressional phase produced the bold outlines of the present ranges and basins and induced erosion of all sediments from the structurally elevated areas. Débris which formed the Paleocene Coalmont and equivalent formations filled the basins and overlapped the truncated edges of older formations. North Park basin continued to sink following this deposition.

A second compressional episode involved Paleocene sediments in the movements, and culminated with extensive faulting during Eocene time. Although most of these thrusts parallel range flanks, the Independence fault which forms the north boundary of North Park basin displays evidence for movement of over 4 miles in a direction transverse to previous structural trends. The position of this fault within a complex zone between two regions possessing opposite structural asymmetry may explain, in part, its diverse trend.

Normal faults, warps, and folds affecting late Miocene rocks, and probably concurrent with regional uplift, distinctly modified the geologic regime during a third tectonic episode. Horsts rose 800 feet along range flanks as adjacent wedges of late Miocene rocks were downfaulted and preserved in linear troughs. The North Park syncline formed athwart the axis of North Park basin and transected some pre-existent north-trending range flank structures. These late Tertiary movements should be stressed because they emphasize the probability that similar movements modified adjacent areas where late Tertiary sedimentary sequences are either less complete or absent.