shear stresses are only incidental to maintaining equilibrium conditions.

The Front Range, judged from the configuration of the associated major faults where they are best known, is more likely the result of vertical uplift of the crust than of horizontal compression. Other ranges in the eastern Rocky Mountains appear to have similar structural origins. An understanding of stress distributions related to vertical uplift may aid in the interpretation of potential oil-producing structures related to these ranges.

Wednesday Afternoon, April 26

Presiding: W. W. MALLORY, H. H. R. SHARKEY

21. Dawson Formation as Expression of Laramide Tectonics: HARRY W. OBORNE, Consulting Geologist, 114 Wood Terrace Drive, Colorado Springs, Colorado.

The Dawson formation was named the Dawson arkose in 1915 by Richardson, the type locality being at Dawson Butte, 6 miles southwest of Castle Rock. Because much of the stratigraphic section contains more fine clastics and carbonaceous material than arkose, the change in name seems desirable.

The writer has differentiated at least six sedimentary members of the Dawson on the southwest flank of the Denver basin in addition to rhyolite flows near and possibly at the top of the formation. On the southeast flank of the basin, eight members have been recognized. Another member develops near the southern end of the southwest flank and spans the trough area of the present basin in its southern part. At the northern end of the present outcrop area, a considerable interval of coarse clastic sediments changes rather abruptly to gray shale with minor amounts of arkose.

The Dawson formation on the southwestern flank of the Denver basin is interpreted as a series of alluvial fans and bajada deposits with some intercalated mud flows, all of which were being spread out by streams from the rising Laramide mountains on the west. These fans were formed in varying areas at differing times as uplift was locally intensified or diminished by the shifting of centers of middle Laramide tectonism. Most of the fans coalesce along strike. The section is replete with unconformities. Sediments just east of the fans are mainly fluviatile, becoming lacustrine and paludal in the eastern parts of the basin. The present northwestern limit of the outcrop area contains mainly gray shale of lacustrine origin.

Total thickness is in excess of 2,000 feet, but at no one locality on the west flank of the basin are all of the members present because of the oscillatory nature of the fan-forming processes. The formation thins to the north, southeast, and east from the area of its maximum deposition near Sedalia toward the areas of finer-grained sediments.

The age of the Dawson was accepted as Eocene by Richardson. He considered it to be the southward and southeastward equivalent of the Arapahoe and Denver formations. Lavington (in 1942) believed there was an unconformity between the Denver and the Dawson, and that the Dawson overlapped the Denver. The present investigation disclosed typical Dawson unconformably overlying the Denver formation. The Dawson unconformably overlies all formations from the Pierre shale to the Denver formation in the Colorado Springs area.

Palynological examinations of cuttings from about 750 feet above the base of the Dawson indicate "late Late Cretaceous" age. Earlier work on fossil leaves from near the top of the formation was reported by Richardson to suggest a Green River Eocene age for the containing strata.

The Dawson is in fault contact with the older sediments and with Precambrian rocks along much of the mountain front. In places, the Dawson strata at or near the faults are nearly horizontal while at other localities they are steeply dipping, vertical, or overturned. Folding and faulting are present in the basin to a greater extent than has been heretofore recognized. Some of the folds have dips of as much as 45°. Faults are of both normal and thrust types.

Deformation took place before, during, and after the deposition of the Dawson. The Dawson formation is thus a good expression of Laramide tectonics both in its origin and in its present structural expression.

22. Development of Geologic Structure in Middle Rocky Mountains: D. L. BLACKSTONE, JR., University of Wyoming, Laramie, Wyoming

Hydrocarbons in commercial quantities are produced within this province from rocks ranging in age from Cambrian to Eocene, and from many different types of traps. The geologic environment which led to the origin and entrapment has been influenced by structural history; by climatic factors resulting from crustal movement; and by evolution of organisms.

Some extant mountain ranges and intermontane basins began to evolve in middle Precambrian time. Intermittent vertical oscillation of the foreland contemporaneous with the dominant subsidence of the trough in western Wyoming and southeastern Idaho characterized the events of Paleozoic time to Pennsylvanian. A northwest-trending structural grain related to the Ancestral Rockies evolved in Pennsylvanian time. Major structural relief developed in central and northern Montana along the Sweetgrass and Big Snowy arches before Late Jurassic time, and gave rise to conditions conducive to hydrocarbon accumulations in stratigraphic-type traps.

Major deformation of the Middle Rocky Mountain province resulted from a series of episodes initiated in the Cordilleran trough during middle Cretaceous time and continuing to a climax in Early Eocene time. Intermontane basins were filled with rocks of local derivation of both continental and lacustrine character at least 18,000 feet thick.

The present overthrust belt of southeast Idaho, western Wyoming, and southwestern Montana developed from a geosynclinal prism of sediments which had accumulated during Paleozoic and earlier Mesozoic time.

The structural elements of the province can be classified in three general categories. The first consists of the east-west-trending fold and fault complexes such as the Big Snowy arch, the Lake Basin fault zone, and the Uinta Mountain uplift all of which are located along sites of late Precambrian subsidence. The second comprises large northwest-trending crustal folds, the crests of which have been eroded to the Precambrian cores and the troughs of which have been the sites of accumulation of thick sedimentary sequences of local derivation. The third includes the low-angle thrusts and long sinuous folds of the overthrust belt in which only the sedimentary veneer is involved.

The mechanisms responsible for the formation of these three categories of structure are not readily ascertainable. The structures may have resulted from differing responses to a regional tangential stress system, in which case the patterns of Precambrian deformation influenced the Laramide deformation to a very large degree. The overthrust belt may have had a separate and unique origin not dependent on lateral compression. Be-