12. HOWARD R. RITZMA, Consulting Geologist, Denver, Colorado

STRUCTURAL AND STRATIGRAPHIC DEVELOPMENT, WASHAKIE AND SAND WASH BASINS, WYOMING AND COLORADO

The Washakie and Sand Wash basins, southeast segments of the overall Green River basin, are located in central-southern Wyoming and northwestern Colorado. The two basins are bounded by and contain structural elements of varying age. These are: Rock Springs uplift and Wamsutter arch (Late Eocene-Oligocene) to west and north, Sierra Madre and Park Range uplifts (Late Cretaceous-Paleocene) to east, and the White River, Axial and Uinta Mountain uplifts (Paleocene-Eocene) from southeast through southwest. The basins are separated by a low arch and fault zone of late Tertiary age, which parallels the Wyoming-Colorado boundary.

The present obvious structural trends are the composite of many less obvious structural episodes of Late-Cretaceous-Paleocene, early Late Cretaceous, Early Cretaceous, Permian-Pennsylvanian and early Paleozoic time. Structural elements related to these older orogenic episodes are now mostly concealed beneath younger sediments and basin downwarping. Evidence for many structural episodes, particularly those of the early Paleozoic, have been all but effaced by erosion related to younger orogeny. Maximum structural activity occurred from latest Cretaceous through Mid-Eocene time.

The full sedimentary column (Eocene and older) in the Sand Wash basin exceeds 32,000 feet apportioned approximately as follows:

pre-Pennsylvanian	3%
Pennsylvanian-Early Cretaceous	15%
Late Cretaceous	46%
Paleocene-Eocene	36%

The maximum sedimentary column in the Washakie basin may exceed 36,000 feet in the central and northern parts of the basin. Several thousands of feet of late Tertiary sediments and igneous extrusives occur in limited areas of both basins.

Precambrian structural trends are imperfectly known in the bounding Uinta, Park Range and Sierra Madre uplifts, but have had obvious, important influence on subsequent structural trends and movements to the present.

13. WILLIAM J. McMANNIS, Montana State College, Bozeman, Montana

RÉSUMÉ OF DEPOSITIONAL AND STRUCTURAL HISTORY OF WESTERN MONTANA

The western part of Montana is not a depositional basin in the sense of this symposium, but its depositional and structural history are related to events of nearby areas. The decipherable part of this history begins with Late Precambrian (Belt) sedimentation during which the fundamental structural framework of western Montana evolved. Thick Belt strata are present in the western extremities of the state and in an eastward-projecting embayment. Subsequent depositional patterns and present structural configuration are intimately related to distribution of that thick sedimentary wedge. Course arkose conglomerates were deposited along the southern fault-controlled margin of the Belt embayment. Cambrian through Mississippian formations and parts of the Cretaceous section are typically thicker in east-west zones essentially coincident with the old Belt embayment than they are to the north or south of the embayment.

A positive arch existed along the southwestern Montana and Idaho border against which Cambrian through Devonian formations thin and/or disappear. This positive element became strongly negative during Mississippian and later depositional intervals as geosynclinal subsidence encroached on the cratonic margin.

Abrupt changes in stratigraphic units across the northeast trending Greenhorn fault in the Greenhorn-Snowcrest Range suggest faulting or strong flexure along this zone during post-Ordovician to pre-Late Devonian and during Mississippian time. Pennsylvanian, Permian, and Triassic thicknesses also seem to be mildly influenced by relatively negative movements in this area.

Other northeast thickness trends in several stratigraphic units are apparent in the Sweetgrass arch area, where they seem to coincide with known present-day subsurface faults. Northeast structural trends apparently also control the thickness of Upper Cretaceous and Paleocene strata in the Crazy Mountains basin.

In general, successively older (Triassic, Permian, Pennsylvanian, Mississippian) formations underlie Jurassic beds from south to north, a relationship that has been explained as a result of southward tilt and beveling by pre-Jurassic erosion. Irregularities in the truncational pattern and general thinning of each formation beneath the next younger unit indicate that much of the northward pinchout is related to depositional thinning on which southward tilt was superimposed. During deposition of the marine Jurassic several large "islands" remained above the sea for part of all of that interval.

Late in Jurassic time the western seaway along which earlier seas had transgressed the region was destroyed by increasing tectonism in the area west of Montana, and a flood of debris was carried eastward to form the nonmarine Morrison Formation. The basal conglomerate of the Kootenai Formation (Lower Cretaceous) marks a particularly strong uplift in areas that could not have been far west of Montana. When the seas returned to this region, they came from the northeast and east.

In the eastern part of the area, Cretaceous, and Paleocene rocks are generally separable into rock and time-rock units; however, to the west the corresponding sequence is almost entirely nonmarine, sparsely fossiliferous, exceedingly diverse in lithologic character, and subdivision is very difficult.

Four major westward advances of the sea punctuate Cretaceous deposition in an increasingly unstable tectonic setting. Locally, volcanic debris is very abundant in the Colorado Group and rapid increase in thickness westward attests to further encroachment of geosynclinal downwarping onto the cratonic margin.

Laramide orogeny began in the Montana area coincident with deposition of the Eagle-Claggett and correlative units. Local areas of strong uplift, erosion, and volcanism, and the strong influx of andesitic volcanic debris in these stratigraphic units is evidence of the initial stages of orogeny. Accumulation of very thick volcanic sequences in at least two separate fields during Judith River time attests to increasing intensity of orogenic processes. Strong deformation and erosion followed by deposition of coarse erosional products and volcanism in the southwestern and central parts of the area, intrusion of granitic plutons in the west central part of the area, and thick accumulation of coarse gravels in the Crazy Mountains basin, all during Lancian and Paleocene time, coincide with the culmi-