A STRUCTURAL HISTORY OF NORTHWESTERN COLORADO AND PARTS OF NORTHEASTERN UTAH

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FOREWORD

A resume of structural history such as follows, is more fitting for a lengthy dissertation of the professional paper type. In a discussion of this sort, necessarily limited in length, it is virtually impossible to cite all evidence at hand; consequently the discussion, without doubt, appears dogmatic. The conclusions drawn and presented herein are well supported by field evidence, and in many cases represent the results of more than ten years of continuing investigation of the region by the writer.

Briefly, the discussion is confined to regional movements and generalities. To specifically describe and discuss each fold and fault system would require enough space to completely fill this publication. Therefore, the writer, while apologizing for the rather high handed treatment of the subject matter, feels that the best possible method of attack has been chosen in view of the limitations. He regrets that this does not include a more specific discussion of local features such as Wilson Creek, Rangely, or the Douglas Creek Arch, but believes the major tectonic features are more important to the structural history of the region than are the subsidiary folds.

HISTORY

Paleozoic

The Paleozoic structural history of Northwestern Colorado is but little understood because of the depth of burial of this system of rocks in most places. This has precluded widespread drilling in most of the area and what we may infer is largely from outcrops of these beds which are at best only peripheral to the region and are probably not truly representative of those buried beneath thick Mesozoic and Tertiary sediments.

From outcroppings in the general region of Steamboat Springs we may infer that pre-Pennsylvanian uplift took place in this region. By studying the east side of the Rocky Mountains, in the general vicinity of Boulder, Colorado, and northward and southward from both Boulder and Steamboat Springs, we may further infer that the direction of the axis of this uplift was roughly east-west and that it was probably a western extension of ancient Siouxia. From studying this uplift in well borings in Eastern Colorado and Nebraska, we may still further infer that the folding was probably pre-Mississippian in age; for various members of the Mississippian on-lap this ancient uplift. Westward of the general area under discussion, we find our first real evidence of pre-Mississippian movement. In the Uinta Mountains, in the canyon of the Whiterocks River, Mississippian rocks of Burlington-Keokuk to Kinderhook age rest unconformably upon Cambrian shales. The unconformity is angular and the angle is approximately eleven degrees. Thus, from regional inference we can say that movement took place in the general area in post-Cambrian and pre-Mississippian time. Further than this we cannot go at present. Thus, we begin our structural history of Northwestern Colorado with an east-west trending arch through the vicinity of Steamboat Springs which had its probable beginnings in post-Cambrian - pre-Mississippian times, and persisted well into the Pennsylvanian, probably through rejuvenation. The arch was a broad feature and its effects were felt at least as far south as Township 1 North, while to the north it probably affected areas north of the Wyoming-Colorado line. For purposes of convenience, and for lack of a better name, it will be referred to as the "Steamboat Arch".

We have no evidence whatever for tectonic movements in Northwestern Colorado during Mississippian time. This period seems to have been a quiet one and it resulted in the deposition of marine limestones, except over previously uplifted areas.

The Pennsylvanian opened as a time of little movement and, during the Morrowan and part of the Atokan, black shales were widely deposited. Following the deposition of these shales widespread uplifting took place throughout the general Colorado Rocky Mountain chain. The Pennsylvanian movement, which seemingly began in early Des Moines time, had little effect upon the western portion of the region and, except for those parts of Northwestern Colorado adjacent to the present Rocky Mountain chain and the Uncompahgre Uplift, it might better be termed a period of subsidence and marine deposition. A large evaporite basin was developed in the southeastern part of the area under discussion, and seems to have centered geographically somewhere near the northwest edge of the present White River Plateau. The salt basin possibly formed in an embayment between the ancestral Uncompahgre Uplift to the south, and the Steamboat Arch to the north.

During Pennsylvanian time the western part of the area was receiving more or less continuous marine deposition, but the southern and eastern parts of Northwest Colorado were covered by conglomerates and arkoses derived from the newly formed uplifts.

These conditions seem to have persisted with but minor interruptions throughout nearly all of the early and middle Pennsylvanian.

Toward the close of the Pennsylvanian the seas began to recede and the typically marine limestone, shale, and evaporite deposits gave way to clastics. These clastics, predominantly arkoses adjacent to the uplifts, graded laterally into fine grained, cross-bedded sandstones to the west and northwest. These conditions gave origin to the typical Weber sandstone and seem to have persisted well into Wolfcamp time at the close of Weber deposition and the beginning of the marine encroachment responsible for the deposition of the Phosphoria formation in the northwestern part of the area.

Permian and Triassic

Save for some minor movements, and possible rejuvenation of parts of the Uncompahgre Uplift, the Permian seems to have represented a period of quiescence and stable, uniform conditions. The Triassic likewise appears to have been a period of little fluctuation although the seas appear to have advanced and receded several times during Moenkopi time without leaving much trace except for a few marine fossils and some evaporites. One period, and only one during the Triassic appears to record any sharp movement or uplift. This was during the deposition of the Shinarump conglomerate. This formation is so widespread and so relatively uniform in thickness that it must represent the widespread, spasmodic and contemporary rejuvenation of many uplifts that supplied the sediments. It appears to be a piedmont type of deposit formed by the coalescence and the reworking of alluvial fans. The angular character of its constituent grains belies the idea of any considerable amount of transportation.

Following the deposition of the Shinarump, conditions settled down to what must have been a rather constant rain of volcanic ash upon a low lying platform. This is evidenced by the highly bentonitic Chinle formation. No other evidence of local Triassic vulcanism is known within Northwest Colorado.

Jurassic and Cretaceous

The Jurassic came and went, with the area fluctuating between marine, and low lying non-marine conditions. Only during the deposition of the Curtis formation and, doubtfully, during Carmel time was the area submergent to any degree. For the most part the area received continental sediments, and doubtless, during part of the Jurassic, it contributed sediment to other areas as is attested by the absence of some members present elsewhere, and the relative thinness of those that are present. This is particularly true of the San Rafael Group.

The Cretaceous was by and large a period of submergence with non-marine conditions being fluctuatingly persistent through Dakota (?) and into Frontier time as evidenced by the coal in the latter formation in the Uinta Mountains. Following Frontier time the territory submerged to receive the thick Mancos marine shale deposits.

After receiving up to 5000 feet of Mancos shale in places, the area became again emergent to receive the non-marine Mesa Verde deposits, and about the middle of Mesa Verde time the northern portion of the area again submerged to receive the Lewis shale. After Lewis time the entire area emerged and has remained so to the present.

Tertiary

There is no evidence in Northwest Colorado of mountain making movements between the end of the Pennsylvanian and the close of the Cretaceous. However, sometime shortly after the close of the Cretaceous, the area began to feel the effects of the Laramide revolution and a tremendous epoch of mountain building began. Sometime during the Eocene the Uinta Mountains were first formed and the present Rocky Mountain chain was rejuvenated and modified.

Much faulting and fracturing took place. The southern fault system associated with the Uinta Mountains was then formed. Although it cannot be as accurately dated, the northern system of Uinta faults probably also had its origin at this time. There followed a period of quiescence during which the Uintas, and the Rockies, were peneplaned. The mountains were eroded to old topography and monadnocks were developed. These monadnocks form the topmost peaks of the Uintas at this time. It is probable that the Green River lakes were formed during this period of peneplanation.

This was followed, also in the Eocene, by a second period of elevation, and it is believed that the Uinta and Duchesne River beds were laid down subsequent to this deformation. Faulting does not seem to be a predominant feature of this period of uplifting although rejuvenation of older faults undoubtedly took place. Peneplanation again followed, and such beds as the Duchesne River lapped well up into what are now the mountains. This is well demonstrated at Little Mountain northwest of Vernal, Utah.

This second peneplanation was extremely extensive. Its traces can be found throughout the area under discussion. It extended over the entire Uinta Basin at least as far south as the present face of the Book Cliffs. It is undoubtedly responsible for the high level flatlands in the vicinity of Rabbit Ears Pass, the top of the Gore range, and in many other areas in the mountains of Colorado. It probably extended north to coincide and merge with the peneplain on the south end of the Wind River Mountains in Wyoming. Everywhere it truncates Eocene and older rocks. The Bishop conglomerate was laid down locally on this surface. Local vulcanism apparently took place about the time peneplanation was complete, for the lower part of the Browns Park formation in the Washakie Basin consists mainly of glass tuffs. This vulcanism was possibly the precursor of the next period of movement.

Following this peneplanation there occurred another great period of differential uplift accompanied by collapse. The Rocky Mountain system and the Uinta Mountains reached their present development at that time; subsequent erosion has only partially modified them from what they were at the close of this period of orogeny.

Collapse took place, both in the Uinta Basin and at the east end of the Uinta Mountains. The present day Uinta Basin appears to owe its form to collapse rather than actual differential uplifting of the Uinta Mountains. The visible portions of the second period peneplain on the Roan Plateau are remarkably coincident on sea level datum with the same peneplain on the fore-front of the Uinta Mountains. Moreover the peneplain can be traced very well from the edge of the Book Cliffs down into the Uinta Basin. It has a uniform approximately three degree tilt from south to north until the axis of the basin is reached. In places the peneplain can be observed to be bent to correspond to the degree of this last age of folding, and is a good guide to its intensity. This is most notable in the Vermilion Creek area in Colorado in section 36, T. 10 N., R. 101 W. There the peneplain can be seen tilted 13° S.W. and truncating northeast dipping Mesozoics and Paleozoics.

Among the best evidences of collapse in the Uinta Basin are the many tension cracks, some of which are now filled with gilsonite. The collapse began in the eastern Uintas during the deposition of the Browns Park formation and subsequent to the deposition of the Bishop conglomerate which, in places, is the equivalent of the basal Browns Park conglomerate. A local unconformity showing the beginnings of the collapse can be seen a few miles west of Ladore, Colorado. The collapse continued and much of it took place after the end of deposition of the Browns Park. This collapse involved the whole east end of the Uinta Range and considerable area in Colorado and Wyoming. A reasonable assumption is that the Uinta Basin collapse took place at the same time as did that on the east end of the Uintas. However, only the east Uinta collapse can be dated accurately.

There is no good evidense of collapse adjacent to the present Colorado Rocky Mountain uplift. It is thought that structural features here are due largely to uplift.

Following this last period of deformation there occurred another volcanic period which seems to have persisted well into the Quaternary. North and west of Steamboat Springs it evidenced itself in numerous intrusives, while to the south, flows are much more common. The lava caps of the White River Plateau are typical of the latter.

Abundant balanced rocks, and the lack of recorded earth tremors in general, now indicate that the area is at least temporarily quiescent, and has been for some time.

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