BRIGHAM YOUNG UNIVERSITY

GEOLOGY STUDIES

Volume 17 Part 1 May 1970

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Brigham Young University Geology Studies

Volume 17, Part 1 — May 1970

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A publication of the
Department of Geology
Brigham Young University
Provo, Utah 84601

Editor

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Brigham Young University Geology Studies is published semi-annually by the department. *Geology Studies* consists of graduate student and staff research in the department and occasional papers from other contributors, and is the successor to *BYU Research Studies, Geology Series,* published in separate numbers from 1954 to 1960.

Distributed June 5, 1970

Price $3.00

Scanty Fossil Evidence Emphasizes Correlation Problems in Northeastern Utah and Southcentral Idaho

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ABSTRACT.—Dating of sedimentary formations in which fossils are rare or absent presents special difficulties. The history of ideas about the age and correlation of the Uinta Group —20,000 feet of sandstone, quartzite and shale—illustrates what may happen when fossils are not found as expected. On the basis of one fragmentary fossil, found loose in float, the series was dated as Carboniferous. Only with the finding of obscure Cambrian fossils was the problem solved.

A serious correlation problem has arisen in connection with the dating of a thick section of pre-Late Pennsylvanian sediments in northwestern Utah and southcentral Idaho. Echinoderm columns, probably crinoid, are the only fossils yet found. The best specimens occur low in the sequence and are no different from those found much higher. Structure is complex.

Previous to about 1960 workers placed the sequence in the Precambrian. Current workers, because of the fossils, have attempted to identify in it most or all pre-Pennsylvanian systems. It is proposed by this writer that the entire sequence may be mostly or entirely Carboniferous. The fossil evidence, though meager, is uniform and appropriate to Mississippian or Pennsylvanian. The thickness is not excessive when compared with such formations in the Oquirrh and Wood River mountains. The lithology is no more varied than Pennsylvanian sections elsewhere and the evidence of deformation and tectonism can be compared in part with the Ouachita-Wichita mountains. Northwestern Utah is on trend with the structural elements of this system and intervening features such as the ancient Uncompahgre uplift and the Paradox and Oquirrh basins.

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INTRODUCTION

Although many thousands of sedimentary formations have been placed in their proper positions in the geologic column on the basis of fossils, this procedure is not possible for rocks too old to contain recognizable remains or where metamorphic effects are relatively strong. Especially exasperating are borderline cases where metamorphic effects may or may not have been intensive enough to obliterate all organic traces, or where unmetamorphosed sediments that may have been laid down in fossil-bearing periods are apparently barren. A geologist might be excused for not spending days or weeks in what may be a hopeless

search of these rocks, but this does not save him from embarrassing consequences if he makes a guess that is later disproved by fossil evidence.

A number of thick, relatively unmetamorphosed sections of ancient sedimentary rocks have been preserved in the Rocky Mountains, Colorado Plateau, and Great Basin areas of the United States. Many of these sections, such as the Belt Series, Grand Canyon Series, and corresponding sediments in the southern Great Basin, are overlain by fossiliferous Cambrian formations which give a minimum age for the underlying rocks and a datum that assures a Precambrian age for at least some of them.

There are, however, a number of thick sections where the Cambrian is absent or unrecognizable and the first or oldest known datable fossils are much higher in the section. This gives the possibility that the underlying undated deposits may be Precambrian, Paleozoic, or both. More than usual interest attaches to these sections because of the divergent tectonic, stratigraphic, paleogeographical, and economic implications that may be drawn depending on how they are dated.

Two examples, the Uinta Mountains Group of northeastern Utah and the Dove Creek Group of northwestern Utah and southcentral Idaho will be discussed.

THE UINTA GROUP - A LESSON FROM THE PAST

Three of the four great geological surveys of the West entered the Uinta Mountains in the period from 1868 to 1875. To all concerned the stratigraphy and age of the great quartzite series making up the core of the range presented a major problem. The stratigraphy of the interior of the range was generalized by King (1878, p. 140-141) as follows:

> 1. An immense body of quartzites and indurated sandstones intercalated with groups of sheets of argillaceous shale, the whole forming the lowest of the Uinta Paleozoic series, and referred by us (not, however, without some questioning) to the Weber quartzite or middle member of the Coal Measures. The general thickness is 12,000 feet.
>
> 2. Directly overlying this throughout the whole range is observed a series of sandstones and limestones, more or less variable, and having a thickness of 2,000 to 2,500 feet. From the base to the summit of this series, Coal Measures fossils are obtained.
>
> 3. Overlying the uppermost member of the Coal Measures limestones, but exposed at only a few localities, is a body of calcareous and argillaceous shales and mud rocks bearing typical Permo-Carboniferous fossils.

The evidence on which the lowermost 12,000 feet of quartzite was assigned to the Carboniferous is described as follows:

> Upon the slopes of Mount Agassiz, about 1,000 to 1,500 feet below the summit, in a piece of quartzitic debris which could not be distinguished from the rock *in situ* immediately above it, was obtained half a ribbed *brachiopod,* referred with some doubt by Hall and Whitfield to *Spirifer imbrex.* The material of the fossil itself is precisely that of the enclosing quartzite, and there is a strong probability that the fragment represents a horizon 700 feet down from the summit of Mount Agassiz, and the fossil, which is a Carboniferous one, offers very fair evidence of the age of the series. It is altogether impossible that a fragment of the limestones which once arched over this region could have withstood the long period of erosion which has degraded the range since the close of the Cretaceous age. I therefore conclude that this connot be a relic of the fossiliferous Upper Coal Measures which were once vertically above the spot. It seems equally improbable

that a traveler, Indian or otherwise, should have accidentally dropped on this debris pile a foreign fragment identical with the neighboring rock in place.

From another portion of the upper Bear River Valley, and in another debris pile, was also obtained a quartz pebble containing the impression of a crinoid column. While I admit the possibility of these being accidentally imported fragments, the presumtion is decidedly in favor of their belonging to the quartzites of the region; and until better evidence to the contrary is adduced, I consider that they must be held to have indicated a Coal Measures age for the series. (King, 1878, pp. 152-153) (See Text-fig. 1)

On the basis of their experiences in other ranges of the Rocky Mountains where the highly metamorphosed crystalline granitic or gneissic basement rocks are easily differentiated from the nonmetamorphosed and fossiliferous Paleozoic, King and his associates would naturally suspect any noncrystalline, weakly metamorphosed rocks as being Paleozoic. No doubt the geologists were conscientiously, even anxiously, looking for fossils wherever they traversed the quartzite terrain.

What diabolical agency deposited a genuine unmistakable fossil in plain view on a debris pile on Mount Agassiz may never be known. In any event the specimen was found, accepted by everyone as being genuine, identified by experts as one-half of an internal cast of half a spiriferoid brachiopod, and considered as sufficient evidence for placing 12,000 feet of sediment in the Carboniferous. King would have been dismayed to know that an additional 10,000 to 15,000 feet of quartzitic sediments lay below those which he could measure.

TEXT-FIGURE 1.—Cast of *Spirifer imbrex* found loose in a piece of quartzite debris on the slopes of Mount Aggasis, Uinta Mountains, Utah. See text for discussion.

King wasn't entirely satisfied with his assignment of the Uinta Group to the Carboniferous, but it was a relatively long time before any further positive evidence came to light. Although the evidence was paleontological it was again meager and fragmentary. Small phosphatic brachiopods of Cambrian age and trilobites of Middle or Late Cambrian age were eventually discovered below the Madison Limestone and above a major unconformity which locally cuts deeply into the Uinta Group. Presence of Cambrian followed by Mississippian strata has proved to be the rule over much of the Rocky Mountains and Colorado Plateau, and no one now doubts either the Precambrian age of the Uinta Group or the proper placement of the overlying Paleozoic formation. *Spirifer imbrex* remains unexplained.

THE DOVE CREEK GROUP - A CURRENT PROBLEM

A problem having many parallels with that confronting early workers in the Uinta Mountains currently exists in connection with a thick section of pre-Late Pennsylvanian sediments in northwestern Utah and nearby Idaho. Here the problem is complicated by metamorphic and structural effects. On the basis of intense structural deformation, grade of metamorphism displayed, and lithologic contrasts with the overlying early-recognized, fossil-bearing, nonmetamorphosed Oquirrh Formation, most former workers have been inclined to classify these rocks as Precambrian. However, because of their lithologic diversity and a few fossils (to be discussed below), later workers favor a Paleozoic age. The section has been designated as Precambrian on the geologic map of Utah and named the Dove Creek Group by Stringham (1962).

Here is a situation in which fossil evidence is greatly to be desired and an intensive search has been made by many competent geologists. This search has been spurred by the fact that abundant diagnostic fossils occur in practically all Paleozoic formations of nearby ranges to the east and south. Many of the fossils are silicified and others are preserved as impressions in durable quartzite. It seems almost inconceivable that all traces of brachiopods, trilobites, corals, bryozoans, and fusulinids could be obliterated by the low degree of metamorphism that prevails in extensive masses of carbonate and clastic sediment in the Raft River, Goose Creek, and Albion Ranges. Almost as difficult to explain would be the initial absence of easily preservable marine organisms in this vicinity through the successive, early, and middle Paleozoic periods. Such an ecological oddity might have been brought about by unknown paleogeographic factors, but this seems highly improbable.

The foregoing paragraphs should not be taken to mean that the search for fossils has been entirely fruitless. Felix (1956, p. 83-84) recovered a few crinoid columnals from two of his three subdivisions of the Lower Paleozoic(?) of the Raft River Range. This writer has seen these specimens and agrees that they are genuine. Felix found no fossils in the underlying more strongly metamorphosed Harrison Series. He found ample fossils, including diagnostic fusulinids in the unmetamorphosed Oquirrh rocks which he considers to be everywhere in fault contact with the metasediments below.

Compton (1968) reports crinoid stem fragments from the Yost Quadrangle, Grouse Creek Range in rocks which Stringham had named the Dove Creek Group and which he considered to be Precambian (Stringham, 1962). The

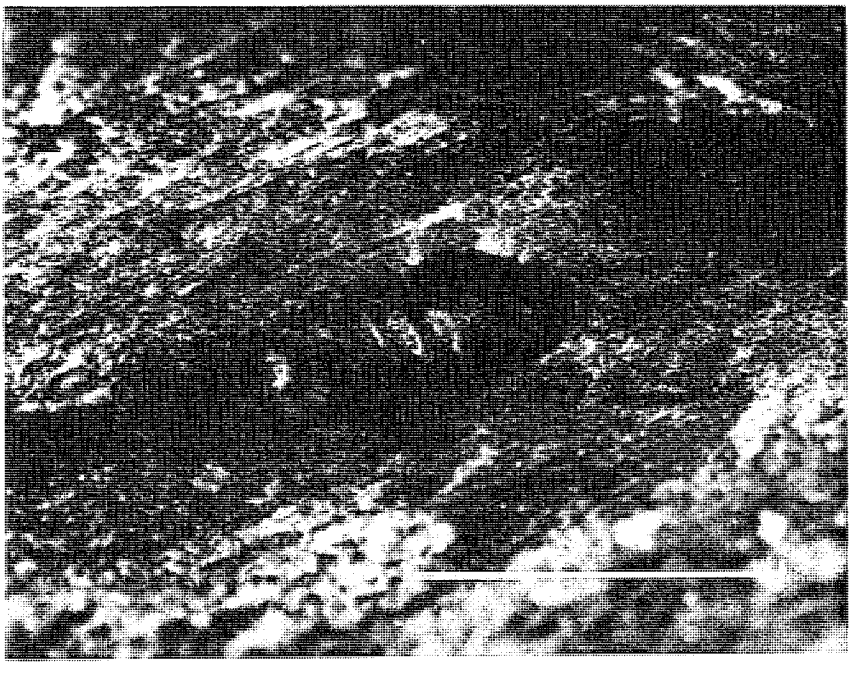
fossils come from a relatively high position in the section, but Compton considers the entire Dove Creek Group to be Paleozoic or questionably Paleozoic.

More recently Armstrong has published photographs of unmistakable crinoid stems and a coral from the Albion Range, Idaho (Armstrong, 1968, plates 2 and 3; see Text-fig. 2, this paper). His older specimens come from the Conner Creek Formation which he considers to be the lowermost Paleozoic formation, Cambrian or Ordovician in age. (This is part of the Harrison Formation of previous workers.) The younger fossils, including genuine cup corals, are from the Oquirrh(?) Formation which is here metamorphosed in the same manner as the underlying units. Armstrong also found minor outcrops of unmetamorphosed limestone, cherty limestone, and calcareous sandstone several thousand feet thick which also appear to be Oquirrh Formation. No fossils are reported from these rocks.

From the above it is evident that crinoid columnals have apparently been found near the bottom and near the top of the metasedimentary section. This includes discoveries in what is almost certainly metamorphosed Oquirrh Formation as well as from older beds which have not been satisfactorily correlated with other formations.

WHAT THE FOSSIL EVIDENCE ALLOWS

It is possible that some or all of the fossils found in the Dove Creek Group are not indigenous to the general country rock in which they were found. For



TEXT-FIGURE 2.—Undeformed echinoderm columnal from Conner Creek Formation of Armstrong. Bar 1 cm long. Photograph courtesy Richard Lee Armstrong.

example, the echinoderm columns reportedly by Armstrong were found in a stretched pebble conglomerate very near a fault contact with undoubted Oquirrh Formation (see Armstrong, 1968, fig. 2). It is not uncommon for fragments to be detached and displaced in fault gouge and in rubble lying against or beneath fault planes. Perhaps this mode of origin is entirely out of the question with fossils from the Dove Creek Group but it must be considered.

Assuming that the fossils are truly indigenous to the rock in which they occur, what age assignments are possible? Echinoderm columns are distributed from the Cambrian to the present, but those under question cannot be younger than Late Pennsylvanian since rocks of that age were deposited in normal sequence above them. Stalked echinoderms are rare in the Cambrian and no one, to the writer's knowledge, has ever found Cambrian echinoderm columnals of any sort as large as those reported by Armstrong or those collected by Felix. Large columnals are very unusual until late in the Ordovician and then they are rare. If the Conner Creek Formation is placed in the Ordovician, the Cambrian would be reduced in thickness to a few hundred feet in a region where it should be thousands of feet thick. Large crinoid columnals are present in occasional lenses in the Silurian of the Great Basin but are rare in the Devonian. They are extremely common in the Mississippian where the name crinoidal limestone is appropriately applied to many large accumulations. But Mississippian limestones have not been positively identified in northwestern Utah. Permian rocks lie with depositional contact upon Devonian in the nearby Newfoundland Range and northern part of the Pilot Range.

Crinoid columnals are common also in the Pennsylvanian, particularly the lower, more limy portions. If the fossil evidence alone is considered and everything else frankly disregarded, it appears that the safest over-all assignment would be Mississippian or Pennsylvanian.

But negative evidence cannot be disregarded. No trilobites, graptolites, brachiopods, or molluscs of any kind have been reported from the metamorphosed section. In the mind of this writer this negative evidence is enough to create very serious doubts as to the presence of any lower or middle Paleozoic rocks, except perhaps Late Cambrian, where fossils of all kinds are generally rare. This particular line of argument leads the writer to consider the possibility that the Dove Creek Group might be Early and Middle Pennsylvanian. This, if true, would mean that the lower part of the Pennsylvanian has been rendered unrecognizable while the upper part has not. That this may, in fact, be entirely possible is argued in the concluding section of this paper.

ARGUMENTS FOR A PENNSYLVANIAN AGE

Thickness of the Pennsylvanian System

The thickness of the pre-Late Pennsylvanian metasediments of the Dove Creek Group Series is given as from 2,000 to 8,000 feet by Compton, 22,000 feet by Armstrong, and about 6,000 feet by Felix. Each author reports unmetamorphosed Oquirrh Formation several thousand feet thick overlying the metasediments. By ordinary standards these are relatively thick sections for any one system, but they are not excessive for the Pennsylvanian along the belt in which they occur. The Pennsylvanian part of the Oquirrh Formation is about 20,000 feet in the nearby Oquirrh Basin. The pre-Virgilian portion is 17,000 feet thick and the Des Moinesian Series alone reaches 11,900 feet in the Provo Area. In

eastern Oklahoma and west-central Arkansas the pre-Virgilian Pennsylvanian rocks reach 26,000 feet and the Des Moinesian is 18,000 feet thick.

Other substantial accumulations of Pennsylvanian strata occur in the Paradox Basin, Utah and Colorado; the Sangre de Cristo Range, Colorado; and the Wood River region, Idaho. The point is that the total thickness of combined metasediments and Oquirrh Formation reported in northwestern Utah and south-central Idaho is not unique for the period of time represented.

Rock types

The metasediments reported by Stringham, Felix, Compton, and Armstrong are easily identified as having been sandstone, limestone, dolomite, and claystone. The thickest lithologically uniform unit is apparently the Dayley Creek Quartzite of the Albion Range, about 7,000 feet thick (Armstrong, 1968, p. 1302).

The varied nature of the original unmetamorphosed section is not uncompatible with sedimentation in the Pennsylvanian Period. The term Intercalated Series, an early name of the Oquirrh, calls attention to the heterogeneous nature of this interval. Twenty-five mappable units have been recognized in the Pennsylvanian rocks of the Oquirrh Range. The "Bingham Quartzites" of the Bingham Mines area are up to 6,500 feet thick.

Pennsylvanian sediments are notably diverse throughout the western United States. Sandstone, quartzite, limestone, siltstone, and dolomite make up most of the Oquirrh Formation; salt (halite, gypsum, and silvite) together with black shale and arkose characterize the Paradox Basin, and arkose, conglomerate, and sandstone predominate in the Sange de Cristo Range and central Colorado Basin. The much-studied Pennsylvanian rocks of Oklahoma and Arkansas are notoriously varied with rapid lateral facies changes.

Tectonic Environment

The tectonic evolution of the western United States provides several possible explanations for what is observed in and near the Raft River Range. This region lies on trend with numerous structural elements which originated in the interval from the Late Mississippian to the Late Pennsylvanian. Varied phases of this important mountain-building episode have been termed the Wichita Orogeny, the Arbuckle Orogeny, the Ouachita Orogeny, and the Ancestral Rockies Orogeny. Deep basins and corresponding uplifts extend in an essentially unbroken chain from central Arkansas to northwestern Utah. Details are complex and need not be discussed in this paper.

Outstanding characteristics of Carboniferous tectonic activity in the southwestern and western United States include: (1) rapid uplift of elongate blocks, many of which were eroded to expose Precambrian cores; (2) rapid downsinking of elongate geosynclinal belts which were filled by detritus from the neighboring uplifts; (3) great contrasts in quantity of sediment produced from place to place and time to time so that any given basin may display thousands of feet of sediment of certain epochs and little or none of other epochs.

In general, Carboniferous disturbances reached a high point in the Des Moinesian and Missourian epochs. Virgilian time (latest Pennsylvanian) was marked by erosion of previous uplifts and spread of shallow seas across wide intervening areas.

In the Great Basin generally a pronounced hiatus represents the Late Pennsylvanian so that Permian rests on Middle Pennsylvanian. This disconformity is slight or missing in the Oquirrh Basin and in the Wood River Formation of central Idaho. Rocks of Virgilian age are several thousand feet thick in the Oquirrh Basin. Until the facts are known, it is unsafe to say how much of Pennsylvanian time is represented in the Raft River region and how thick the corresponding sediments may be.

Additional Observations

The pioneer work of Felix (1956) in the Raft River Range was the first to specifically depict the peculiar features of the metamorphic section. That he had doubts about its proper classification is shown by the following statement:

> The recrystallized nature of these Lower (?) Paleozoics suggests that they are much older than the Pennsylvanian limestones above. However, porphyroblasts have been found in a recrystallized schistose crinoidal limestone at the base of the unit mapped as Oquirrh formation.
>
> The Lower (?) Paleozoics were closer to the regional source of heat and had a greater overburden than the younger rocks. They may also have a greater metamorphic susceptibility than the younger rocks. . . . There is the possibility that the Lower (?) Paleozoics of the Raft River Range are metamorphosed Carboniferous strata. (Felix 1956, p. 84-85).

Felix also states that crinoid columnals are numerous in the purer limestone of the Oquirrh Formation.

C. P. Ross (1966) has contributed a paper titled "Diverse interfingering Carboniferous strata in the McKay Quadrangle, Idaho." In this paper the Milligan Formation (Mississippian) is described as 7,000 feet thick with "hardly any diagnostic fossils." The Wood River Formation of Pennsylvanian age is described as lithologically diverse with abundant sandy beds. The so-called Brazer Formation has both Mississippian and Pennsylvanian sediments. Most significant is a unit said by Ross to contain equivalents of the Milligan, Brazer, and Wood River. This unit is evidently very difficult to subdivide.

What is observed in the McKay Quarrangle is significant in understanding the Raft River, Goose Creek, and Albion Ranges. These areas appear to be at or near the edge of the continent during the Carboniferous and should have much in common.

This writer has suggested in a previous abbreviated note (Stokes, 1952) that the Raft River Range and vicinity was a positive area during much of the Paleozoic, with only a thin representation of pre-Pennsylvanian rocks. For this postulated uplift the name Raft River High was proposed. In spite of categorical assertions that such a positive area did not exist (Hazzard and Turner, 1957), the evidence still appears valid and the case is by no means closed.

CONCLUSIONS

The history of stratigraphy records many instances of the importance of rare or imperfect fossils in correlating generally barren rocks. In most cases fossils have been found only after periods of speculation and miscorrelation. Accidental fossil finds have proven about as important as those deliberately sought after. Dating of the thick and regionally important Dove Creek Group is uncertain not only because of the scarcity of remains but also because of their nondiagnostic character.

As matters stand the section may include representation of much or little of pre-Late Pennsylvanian time. All pre-Pennsylvanian systems have been tentatively identified by some workers. This paper presents evidence that those portions of the sequence which have yielded echinoderm stems may be Carboniferous in age. Evidence includes: (1) nature of the fossils and the similarity of those so far discovered; (2) comparisons of total thickness with other Carboniferous accumulations; (3) comparisons of lithologic types with other Mississippian and Pennsylvanian formations; (4) comparison of tectonic history with that displayed along the Hercynian (Ouachita-Wichita, etc.) orogenic belt, of which the Raft River region could well be a hitherto unrecognized extension.

Inasmuch as fossil evidence will be a deciding factor in correlating and subdividing the Dove Creek Group, a careful search should be continued. This author hopes to bow gracefully to the evidence once it is found.

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