CORRELATION OF DEVONIAN STRATA IN NORTHWESTERN WYOMING

by

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ABSTRACT

In Wyoming and Montana, the Devonian System is represented by formations of Lower and Upper Devonian age. The Lower Devonian Beartooth Butte Formation occurs only as channel-fill and sinkhole deposits on the underlying Bighorn Dolomite. Its appearance is sporadic and, when present, is unconformably overlain by Upper Devonian strata. No rocks of proved Middle Devonian age have been reported in Wyoming. Upper Devonian strata are represented by the Maywood (Souris River), Jefferson, and Valaite Lake Formations.

The Maywood is believed to be of early Upper Devonian age. Its only reported occurrence in Wyoming is in the Wind River Range. The Souris River Formation is the Williston Basin subsurface equivalent of the Maywood. The Souris River is exposed in Shoshone Canyon and in the northern Bighorn Mountains of Wyoming. The Maywood (Souris River) is considered to be a deposit laid down in the upper reaches of a long, narrow bay or estuary that extended southward from Montana. The contact between the Maywood (Souris River) and the underlying Bighorn Dolomite is unconformable. The overlying Jefferson Formation is conformable.

A five-fold division of the Jefferson Formation into lower carbonate, middle shale, and upper carbonate beds, the Brindle Creek beds, and the Birdbear Member is proposed.

The lower carbonate beds through the Brindle Creek beds are considered correlative with the Duperow Formation of the Jefferson Group in the Williston Basin. These beds are present throughout western and north-central Wyoming. The Birdbear Member, correlative with the Birdbear Formation of the Jefferson Group, is present in western Wyoming but absent in north-central Wyoming due to pre-Mississippian erosion. In western Wyoming, Devonian strata equivalent to the Jefferson Formation of Montana have been called Darby. In view of the lithologic similarity of the strata with the Jefferson, the author has chosen to abandon the term Darby.

The Valaite Lake Formation is proposed by the author for strata lying unconformably upon the Jefferson. This purple-red-brown-gray argillaceous siltstone unit contains conodonts which indicate an Upper Devonian-Lower Mississippian age. The unit is typically developed in western Wyoming but changes lithology in north-central Wyoming where it is predominantly a sandy dolomite. The formation is probably mostly Lower Mississippian in the latter area. The Valaite Lake has previously been miscorrelated with the Three Forks Formation of Montana on the basis of superficial lithologic similarity; also, it has more recently been identified as the "dark shale unit." Uncertainty exists as to whether or not an unconformity is present between the Valaite Lake and the overlying Madison Limestone.

The distribution and thickness of Devonian strata are related to tectonic activity in the Williston Basin, in the miogeosyncline of Idaho, and along the Transcontinental Arch. The so-called "Absaroka Arch", responsible for depositional thinning of the Jefferson Formation in west-central Wyoming, evidently remains an active tectonic element from the Upper Ordovician through Jefferson time. Devonian strata are missing south and east of a line connecting the southern Wind River Range, central Owl Creek Range, and Tensleep Canyon in the Bighorns. This absence of Devonian rock probably was caused in part by nondeposition and by pre-Mississippian erosion.

INTRODUCTION

Purpose and Scope

The purpose of this report is to establish a suitable nomenclature for the Devonian sequence in northwestern Wyoming and to demonstrate the correlation of the various units within this area. The project involves a regional reconnaissance study of the physical and paleontological aspects of the stratigraphy of strata included within the Devonian System.

Procedure

Field work was conducted during the summer of 1964 at which time lithologic and paleontologic samples were collected from measured surface sections throughout northwestern Wyoming. In the laboratory, limestones were treated with 10 percent acetic acid, and shales were heated, immersed in white gasoline, then in water in order to obtain residues. That material retained on the 40 mesh and 100 mesh screens was examined under a binocular microscope for microfossils and details of lithology.

Acknowledgments

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The author is grateful to Gilbert J. Klapper who provided valuable discussion concerning the Maywood and Three Forks Formations, and to Dr. Herbert E. Hendriks, Cornell College, for directing the author to the Devonian exposure in Warm Spring Canyon.

PREVIOUS INVESTIGATIONS

Strata of Devonian age in southwest Montana, near Logan, were first described by Peale in 1893. He subdivided the strata into an upper clastic Three Forks Formation and a lower carbonate Jefferson Formation. Blackwelder (1918) did not agree with the use of Three Forks and Jefferson for Devonian strata in western Wyoming and proposed the Darby Formation for rocks exposed on the west side of the Teton Mountains. The term "Darby" has been generally applied by subsequent workers for Upper Devonian exposures in western Wyoming, whereas equivalent strata in Montana and the Williston Basin have been referred to the Jefferson and Three Forks.

The type area of the Jefferson and Three Forks was restudied by Sloss and Laird (1947), and they divided the Jefferson into an upper Dolomite Member and a lower Limestone Member. Their work did not extend into northern Wyoming, but was restricted to western and central Montana. In their interpretation, the Three Forks thins eastward from the type area near Logan. Similar eastward thinning of the Dolomite Member of the Jefferson is compensated by increasing thickness of the underlying Limestone Member.

Andrichuk (1956) correlated the upper Darby in the Wind River Range with the Three Forks Shale and the lower Darby with the upper Dolomite Member of the Jefferson as defined by Sloss and Laird. He regarded the Jefferson or lower Darby lithology as a relatively pure carbonate and the Three Forks or upper Darby lithology as a mixture of clastics (shales and some sandstones) and carbonates. According to Andrichuk's interpretation, the Darby represents the maximum transgression of the Upper Devonian sea onto the Wyoming shelf from the geo-synclinal belt to the west.

McMannis (1962) noted that there is a general southeasterly thinning of the Jefferson from southwest Montana toward Yellowstone Park, along with an increase in the amount of argillaceous and sandy beds and a decrease in number and thickness of solution breccias. He indicated that the sections at Cinnabar Mountain, Crowfoot Ridge, Mill Creek, and near Cooke City exemplified these changes. Previous workers have tried to recognize the Three Forks in these and in other sections in the southern Beartooth region, and because of the increased amount of clastic debris in the rock have concluded that Three Forks "shale" is present. McMannis concluded that this latter interpretation is untrue and that the entire Devonian sequence in most of that area is a shaley Jefferson (Darby) except where the Beartooth Butte channels underlie it.

Sandberg (1965) subdivided the Jefferson Formation of southern Montana and northern Wyoming into a thick "lower member" and the Birdbear Member. The former is the equivalent of the subsurface Duperow Formation and the latter is correlated with the Birdbear Formation in the Williston Basin. The Three Forks Formation is divided by Sandberg into, in ascending order, Logan Gulch, Trident, and Sappington Members. He concluded that the two upper members of the Three Forks do not continue into Wyoming but that the Logan Gulch Member is present at least as far as the southwestern Absaroka Mountains.

Klapper (1958) studied a conodont fauna from the so-called "upper Darby" of the Wind River Range. These conodonts were secured from the "dark shale unit" of Sandberg (1965). Klapper tentatively correlated these strata with zone V (Clymenia - Stufe) of the Fammenian Stage in Germany.

Mills (1956) reported the penetration of Devonian rocks by wells in the Bighorn Basin. These beds were correlated with upper Jefferson of the Williston Basin.

Blackstone and McGrew (1954) reported the discovery of a Devonian section in the walls of Cottonwood Canyon on the west side of the Bighorns. On the basis of lithologic similarity, stratigraphic position, and contained vertebrate fossils, the lower part of the exposure was correlated with the channel deposits described at Beartooth Butte by Dorf (1934a). The remainder of the Devonian exposure was divided into a lower carbonate sequence overlain by a series of clastic beds. These strata were tentatively correlated with the Jefferson and Three Forks, respectively, on the basis of similar lithology. Ethington, *et al.* (1961) described a conodont fauna from the Upper Devonian rocks at Cottonwood Canyon and concluded that this fauna is almost identical to the Darby fauna described by Klapper (1958). They suggested possible correlation with the Saverton of Missouri. Richards (1955, p. 14-21) described two sections of Devonian strata in Bighorn County, Montana, just a few miles north of the Cottonwood Canyon locality. Here, measured intervals and wells show approximately 200 feet of carbonate with minor amounts of shale, siltstone, and sandstone. These Devonian rocks were classified as undifferentiated Jefferson and Three Forks.

Sandberg & Hammond (1958) considered the Jefferson of the Williston Basin to be a group consisting of the Duperow and Birdbear Formations. In the northern Bighorn Mountains, the Jefferson was believed to be represented only by the Duperow, the overlying Birdbear equivalent having been removed by pre-Mississippian erosion. The clastic deposits (sandstone, shale, siltstone) in the upper part of the Devonian section of north-central Wyoming was interpreted as the near-shore facies of the Duperow deposited at the time of maximum advance of the Jefferson sea. They concluded that the Three Forks is less widespread in occurrence than the Jefferson, due in part to retreat of the seas during Three Forks time and to extensive post-Devonian erosion.

Larimer (1959) identified about 50 feet of Devonian exposure on South Fork of Rock Creek on the east side of the Bighorns. Fish plates from the top of the Devonian at this locality are of a general type known elsewhere from the Jefferson. Koucky & Rhodes (1963) have since examined and described well exposed sections above Dayton along new road cuts of Highway 14 in Little Tongue River Canyon. They concluded that the section there is not lithologically similar to the type Three Forks or Darby. They have assigned the terms "yellow unit" and "purple unit" to these strata. They indicated that these terms are not meant as a substitute for formational names, but only as working names until the fauna and lateral distribution of the rock are better understood. The upper unit (purple unit) contains Upper Devonian conodonts, but the age assignments of the lower part of the purple unit and the underlying yellow unit are subject to revision.

Sandberg (1963a) located and described a Spirorbal limestone unit belonging to the Souris River (?) Formation of Upper Devonian age in Cottonwood Canyon. This deposit lies about 30 miles southeast of the main body of the Souris River and is interpreted to have been laid down in the upper reaches of an estuary. Its abundant and unusual biota includes *Spirorbis*, fish remains, carbonized wood, plant impressions, spores, and megaspores. The fish and spores indicate an early Upper Devonian age. Sandberg and McMannis (1964) reported that channel-fill deposits were observed recently at the base of the Darby Formation in the Wind River Range. They mentioned that these deposits are related to the Maywood Formation exposed near Logan, Montana. The Maywood Formation of the Logan area is the correlative of the subsurface marine Souris River Formation, which is of Upper Devonian age farther east in Montana (Sandberg & Hammond, 1958).

Devonian strata are generally poorly exposed throughout Wyoming and, as a consequence, have not been studied as much as other rocks of older or younger age.

STRATIGRAPHY

General Statement

Devonian strata in northwestern Wyoming constitute a sequence which may be divided into four distinct lithologic units. In ascending order, these units are the Beartooth Butte Formation of Lower Devonian age, the Maywood Formation and its subsurface Williston Basin equivalent, the Souris River Formation, of Upper Devonian (Frasnian) age, the Jefferson Formation of Upper Devonian (Frasnian) age, and the Valaite Lake Formation of Upper Devonian (Famennian) and Lower Mississippian (Kinderhookian) age. The last unit, the Valaite Lake Formation, is newly proposed by the author.

Channel-fill deposits and sinkhole fillings assigned to the Beartooth Butte Formation do not occur at any of the six localities visited during the course of this investigation. Consequently, any further discussion concerning the Beartooth Butte Formation will be confined to an occasional mention of its stratigraphic relationships. Detailed information concerning lithology and paleontology may be obtained by reference to Dorf (1934a,b), (who first described the unit at Beartooth Butte, Wyoming), and Sandberg, 1961a.

The remaining three formations are exposed at one or more of the six localities described in this report. The sequence, with the exception of the Maywood Formation, is best represented in the vicinity of Green River Lakes in the northern Wind River Range where it attains a thickness of approximately 300 feet. To the south and aoutheast there is a gradual thinning and eventual disappearance of Devonian strata, in part the result of pre-Mississippian erosion, and to non-deposition in nearer shore areas. Eastward from Green River Lakes the Devonian strata become generally thinner toward the southwest margin of the Williston Basin and thicker again in the basin proper of Montana and North Dakota. Westward from Green River Lakes the Devonian strata reveal increasing thickness toward the area of miogeosynclinal deposition in extreme western Wyoming and Idaho.

Locations of Described Sections

The distribution of described sections is depicted in text-figure 1; details and descriptions of locations are included in the Appendix. The following surface exposures were measured and described:

Locality No.

1. Little Tongue River Canyon, Bighorn Mountains, Sheridan Co., Wyoming - SE1/4 Sec. 21, SW1/4 Sec. 22, T. 56 N., R. 87 W.

2. Shell Canyon, Bighorn Mountains, Bighorn Co., Wyoming- 44° 36' 35" N, 107° 37' 10" W.

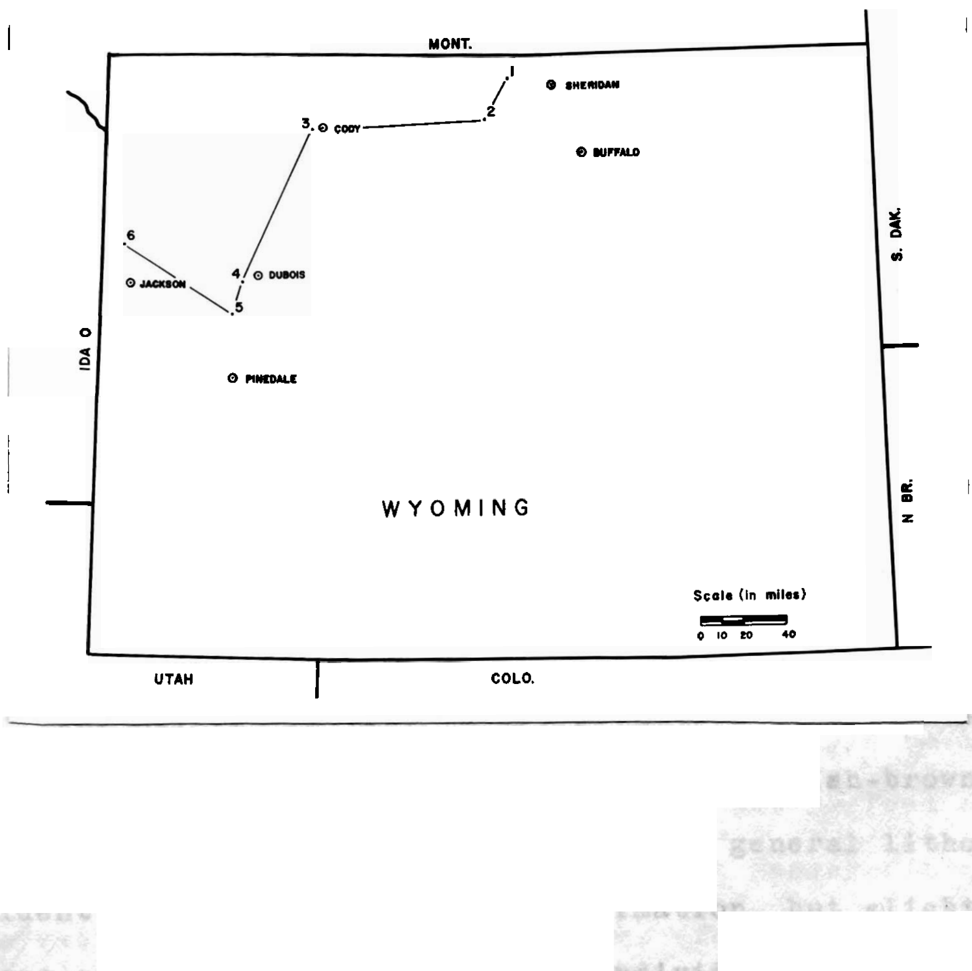
3. Shoshone Canyon, Park Co., Wyoming - NW 1/4 Sec. 5, T. 52 N., R. 102 W.

4. Warm Spring Canyon, Wind River Range, Fremont Co., Wyoming - NW 1/4 NE 1/4 Sec. 1, T. 41 N., R. 108 W.

5. Sheep Mountain, Wind River Range, Sublette Co., Wyoming - Sec. 6, T. 38 N., R. 108 W.

6. Teton Canyon, Teton Mountains, Teton Co., Wyoming - 43° 40' 20" N, 110° 50' 30" W.

Text-figure 1. Index map of localities.


MONT.
1
2
3
CODY
SHERIDAN
BUFFALO
6
4
DUBOIS
JACKSON
5
PINEDALE
IDA O
S. DAK.
N BR.
WYOMING
Scale (in miles)
0 10 20 40
UTAH
COLO.

UPPER DEVONIAN SERIES

Maywood (Souris River) Formation

Stratigraphic Nomenclature

Emmons and Calkins (1913) described and named the Maywood Formation for strata lying between the Red Lion Formation (Upper Cambrian) and the Jefferson Formation (Upper evonian) in western Montana. The formation is named for Maywood Ridge, west of Princeton, Montana. The Maywood Formation of southwestern Montana is the correlative of the subsurface marine Souris River Formation farther east in the Williston Basin (Sandberg & Hammond, 1958). The author's use f the term "Maywood" in western Wyoming for correlative trata called "Souris River" in the north-central part of he state is the result of the paleogeographic interpretation f these strata by Sandberg & McMannis (1964).

Lithology

The Maywood (Souris River) Formation consists typically f yellowish-gray, grayish-green, and yellowish-brown silty olomite and dolomitic siltstone. This general lithology is vident at all exposures of the formation, but slight differences are recognizable among the individual sections. In Little Tongue River Canyon, the Souris River consists of a hin basal black fissile shale with black pebbles overlain y thin gray-green silty dolomites with interbedded variegated shales (text-fig. 3). The Souris River Formation exposed in Shell Canyon consists of a basal argillaceous sandstone (containing abundant lithic fragments and fish plates) overlain by gray-green dolomite and dolomitic siltstone. In Shoshone Canyon, a sandstone containing glauconite, chert, and lithic fragments (but no fish remains) occurs at the base of a dark bituminous dolomite of the Jefferson Formation. The author, on the basis of lithology and stratigraphic position, tentatively refers this unit to the Souris River Formation.

The Maywood Formation in Warm Spring Canyon consists of, in ascending order, light gray-green dolomitic siltstone with abundant fish plates, becoming extremely glauconitic toward the top and brecciated throughout, gray-brown, mottled dolomite breccia, vuggy and containing abundant sand-sized glauconite grains, and green-gray thin-bedded shale.

Thickness, Distribution, Stratigraphic Relationships

In Montana, the Maywood is represented by a 56-foot-thick section near Logan, thinning to about 34 feet approximately 3/8 mile north of the Squaw Creek Ranger Station on the west side of the Gallatin Range. In southwestern Montana, the Maywood overlies rocks of Cambrian age, eventually overlapping younger rocks southward into Wyoming. In Wyoming it unconformably overlies the Upper Ordovician Bighorn Dolomite.

Exposures of the Maywood (Souris River) Formation in Wyoming have been restricted to isolated occurrences which probably represent deposits laid down in a long, narrow bay or estuary extending into an advancing shoreline (Sandberg & McMannis, 1964).

Sandberg (1963a) reported 13 feet of strata at Cottonwood Canyon on the west side of the Bighorn Mountains which he assigned to the Souris River (?) Formation. Approximately 30 miles south of Cottonwood Canyon, in Shell Canyon, the author found about 24 feet of the Souris River Formation. On the eastern side of the Bighorn Mountains, in Little Tongue River Canyon, the author assigned approximately 8 feet of strata to the Souris River Formation. Koucky (oral communication, 1964) considered most of the units assigned by the author to the Souris River at this latter locality to be of possible Silurian or Middle Devonian age. However, due to the general lithologic similarity with the Souris River on the western side of the Bighorns and the uncertainty of Silurian correlation in Wyoming, the author believes that beds S-5 through S-7 inclusively of Koucky and Rhodes (1963) represent strata which can be tentatively referred to the Souris River Formation.

The occurrence of about 2 feet of Souris River in Shoshone Canyon is interpreted by the author to represent the extreme western limit of deposition by the Souris River sea. The strata probably represent a very near-shore deposit.

Strata assigned to the Maywood Formation in Warm Spring Canyon attain a thickness of about 16 feet and probably represent a deposit laid down by the Maywood sea transgressing eastward and southward from the Cordilleran seaway (Sandberg & McMannis, 1964).

The Maywood (Souris River) Formation in Wyoming invariably lies with unconformity on the Bighorn Dolomite and is conformably overlain by the Jefferson Formation.

Age and Correlation

Strata assigned to the Maywood (Souris River) Formation in Montana and Wyoming include a fauna and flora of early Upper Devonian age. The Souris River (?) Formation at Cottonwood Canyon (Sandberg, 1963a) contains fish remains, impressions of large plant stems, rounded pebbles of carbonized wood, macerated plant remains, spores, and megaspores. Fish remains include palaeoniscoid teeth cf. *Rhadinichthys* sp., the antiarch *Bothriolepis* cf. *B. coloradensis* Eastman, coccosterid plates, and weathered heterostracan carapaces. According to Sandberg (1963a), the microflora consists almost entirely of a single spore species, *Punctatisporites* cf. *P. planus* Hacquebard. The fish and spores suggest an early Upper Devonian age.

The Souris River Formation has been traced from its type area in the Williston Basin into south-central Montana by Sandberg (1961b). Sandberg & Hammond (1958) have correlated the Maywood Formation exposed near Logan, Montana with the marine Souris River Formation which appears in the subsurface in the Williston Basin.

Jefferson Formation

General Statement

Devonian strata in Wyoming were first described by Blackwelder (1918) and named the Darby Formation from the canyon of Darby Creek on the west slope of the Teton Mountains (near author's locality 6). Blackwelder's description of the strata, however, was taken from an exposure at Green River Lakes (author's locality 5) in the northwestern part of the Wind River Range. Blackwelder (1918) gave no definition of the type Darby Formation in the Teton Mountains, only mentioning that the section at Green River Lakes is "a typical section of the Darby Formation" and that the formation is "well exposed" in the canyon of Darby Creek. The author, however, has visited the area in and around the canyon of Darby Creek and could find no section as well exposed as the Devonian section at Green River Lakes.

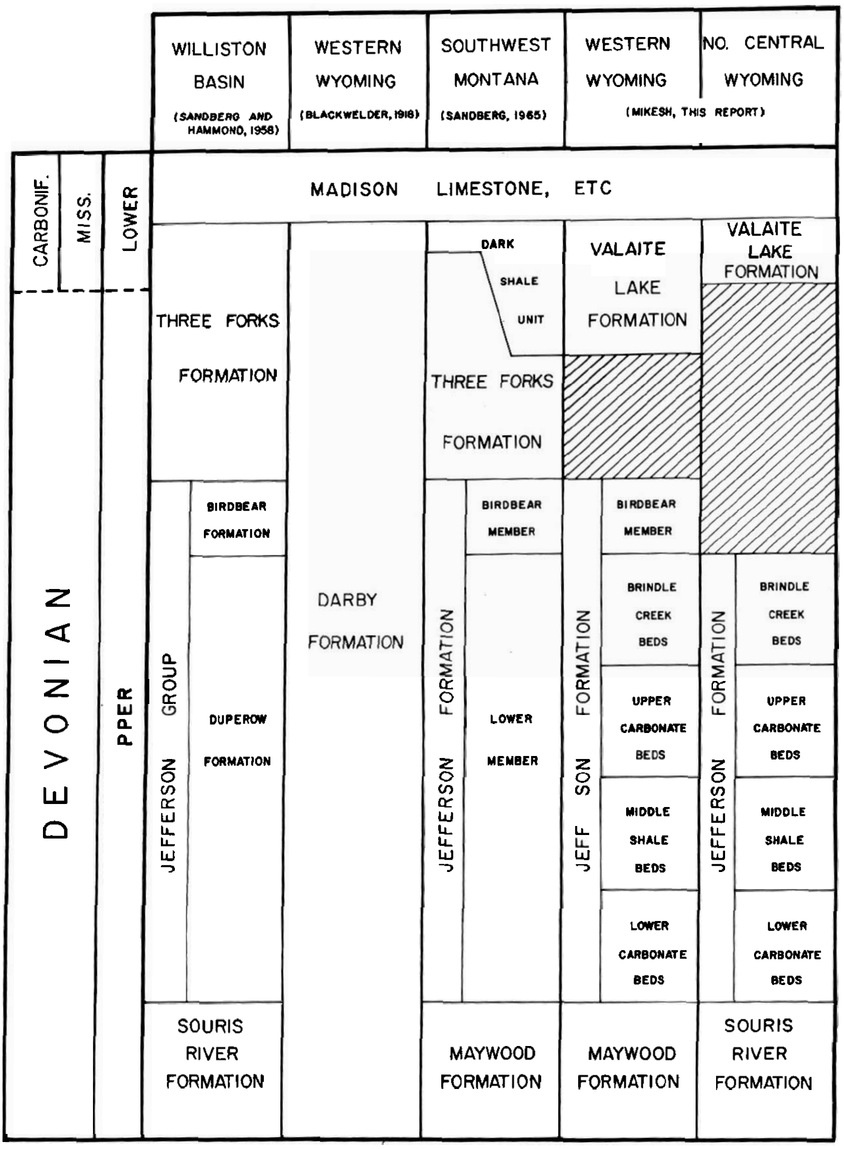
Strata which have been termed "Darby" in northwestern Wyoming (Wind River, Teton, Gros Ventre, and Owl Creek Mountains) are lithologically equivalent to the Jefferson Formation as recognized in southwestern Montana and defined by Peale in 1893. Blackwelder (1918) also indicated that the uppermost part of the Darby Formation is equivalent to Peale's Three Forks shale.

It is the author's contention that the use of the term "Darby" is unnecessary and should be eliminated altogether as a formation name. Blackwelder (1918) designated the type locality of the Darby Formation as the canyon of Darby Creek on the west slope of the Teton Mountains, yet inferred his type section to be on the east slope of Sheep Mountain near the head of the Green River at Green River Lakes. As mentioned previously, Blackwelder (1918) gave no description of the Darby Formation in the Teton Mountains. It is assumed by the author that the section at Green River Lakes is the type section of Blackwelder's Darby Formation, since the latter gave no other section description of Devonian strata in his publication of 1918 in which he proposed the term "Darby" as a formation name. Therefore, it becomes evident that Blackwelder's type locality and type section are not related geographically, being separated by a distance of approximately 60 miles. This is hardly in accordance with the Code of Stratigraphic Nomenclature (American Commission on Stratigraphic Nomenclature, 1961) or conventional and accepted stratigraphic practices employed in Blackwelder's time.

Equally significant is that most of the strata termed "Darby" in western Wyoming is lithologically equivalent to the Jefferson Formation of southwestern Montana, the uppermost part of the Darby being equivalent to the author's newly proposed Valaite Lake Formation. The use of state boundaries as a basis for nomenclatural boundaries has apparently been the situation just described. This type of nomenclature and correlation should be avoided when evidence indicates, as the author believes it does, equivalent lithology and sequence of Devonian strata among distant exposures occurring on both sides of state boundaries. Thus, the author has chosen to use the term "Jefferson Formation" for equivalent strata generally termed "Darby" in western Wyoming.

For the purpose of this report, the Jefferson Formation is divided into lower carbonate, middle shale, upper carbonate, and Brindle Creek beds (these strata are equivalent to the "lower member" of Sandberg, 1965), and the Birdbear Member. All five units are well exposed on the east slope of Sheep Mountain at Green River Lakes in the northwestern Wind River Range (locality 5).

Text-figure 2. Correlation chart.


WILLISTON BASIN
(SANDBERG AND HAMMOND, 1958)
WESTERN WYOMING
(BLACKWELDER, 1918)
SOUTHWEST MONTANA
(SANDBERG, 1965)
WESTERN WYOMING
NO. CENTRAL WYOMING
(MIKESH, THIS REPORT)
CARBONIF.
MISS.
LOWER
MADISON LIMESTONE, ETC
DEVONIAN
UPPER
THREE FORKS FORMATION
DARK SHALE UNIT
VALAITE LAKE FORMATION
VALAITE LAKE FORMATION
THREE FORKS FORMATION
JEFFERSON GROUP
BIRDBEAR FORMATION
DUPEROW FORMATION
DARBY FORMATION
JEFFERSON FORMATION
BIRDBEAR MEMBER
LOWER MEMBER
JEFFERSON FORMATION
BIRDBEAR MEMBER
BRINDLE CREEK BEDS
UPPER CARBONATE BEDS
MIDDLE SHALE BEDS
LOWER CARBONATE BEDS
JEFFERSON FORMATION
BRINDLE CREEK BEDS
UPPER CARBONATE BEDS
MIDDLE SHALE BEDS
LOWER CARBONATE BEDS
SOURIS RIVER FORMATION
MAYWOOD FORMATION
MAYWOOD FORMATION
SOURIS RIVER FORMATION

Lower carbonate, middle shale, upper carbonate beds

Stratigraphic Nomenclature

The lower carbonate, middle shale, and upper carbonate beds constitute general lithotypes which may be recognized regionally within the Jefferson Formation of Wyoming. The term "beds" is used informally and, therefore, is not capitalized. There is no designated type section for any of the units. The basis for recognition of the beds is the presence of a dominant lithology spaced vertically in the section. Thus, for example, the lower carbonate beds include strata which are dominantly limestones and dolomites with minor shales and siltstones; the upper boundary is placed at an arbitrary point where shales and siltstones predominate over carbonate beds. The use of the adjectives lower, middle, and upper merely indicates the relative position of these beds in a vertical sequence. All three units are well exposed at Green River Lakes (locality 5) and Shell Canyon (locality 2).

Lithology

In the Bighorn Mountains and Shoshone Canyon (localities 1 through 3), the lower carbonate beds consist of light to medium brown vuggy moderately argillaceous dolomite with minor interbedded shale and siltstone. In Little Tongue River Canyon (locality 1), vuggy dolomites contain interbedded variegated shale, and a 1.5-foot layer of yellowish-brown sublithographic limestone marks the top of the unit. In Shell and Shoshone Canyons (locality 2 and 3 respectively), the unit is composed of brown massive dolomite and no shales are present. Fish plates occur at the base of the yellow weathering dolomite at Shell Canyon, and small lenticular chert lenses appear in the Shoshone Canyon unit. At Warm Spring Canyon, Green River Lakes, and Teton Canyon (locality 4, 5, and 6 respectively), the lower carbonate beds consist of medium to dark brown fine-grained bituminous limestone and dolomite with occasional interbedded quartz sandstone layers. Generally, fossils are absent or rare in the lower carbonate beds.

The middle shale beds at all of the author's described localities consist of thin-bedded to fissile green to gray shale, massive greenish-gray siltstone, and minor interbedded thin carbonates. The unit is almost totally covered at Teton and Shoshone Canyons but is well exposed at the four remaining localities. The beds form distinctive slopes at all six localities. A brachiopod zone containing Atrypa reticularis occurs near the base of the first limestone bed approximately 10 feet above the base of the middle shale beds at Green River Lakes. Fossils are rare or absent at the remaining localities.

The upper carbonate beds consist of brown vuggy arenaceous and argillaceous dolomite with limestones occurring frequently toward the base. Interbedded dark shales and greenish-gray siltstone occur at Little Tongue River Canyon and Shell Canyon, but the remaining four exposures contain little, if any, shale or siltstone. The section at Green River Lakes displays a thick bed of white friable medium-grained quartz sandstone near the middle of the beds. The carbonate beds at Teton Canyon and Green River Lakes are highly bituminous and produce a fetid odor on fresh surfaces. A bituminous dolomite at the very top of the unit at Teton Canyon contains poorly preserved *Atrypa*, solitary corals, and stromatoporoids. No fossils were found at the other sections visited.

Thickness, Distribution, Stratigraphic Relationships

The lower carbonate beds exposed in Little Tongue River Canyon on the east flank of the Bighorns conformably overlie strata which are tentatively assigned, by the author, to the Souris River Formation. The thickness of the unit at this locality is about 11 feet. The lower contact of the beds is situated between a 5.5-foot layer of medium yellow vuggy dolomite with interbedded variegated shales and an underlying 1.3-foot layer of gray to gray-green thin-bedded to fissile silty shale of the Souris River. The author's lower carbonate beds include units S-8 through S-12 inclusively of Koucky & Rhodes (1963) which are assigned to, what they term, the "yellow unit." The lower carbonate beds at Shell Canyon reach a thickness of about 30 feet, and at Shoshone Canyon the thickness is reduced to only 10 feet. In both areas, the unit conformably overlies strata assigned to the Souris River Formation. The lower contact at Shell Canyon is situated between a massive 30-foot gray-brown argillaceous well indurated dolomite with fish plates occurring at the base and an underlying covered interval which, judging from the "float" present on the slope, contains interbedded carbonates and dark shales presumably belonging to the Souris River Formation. At Shoshone Canyon, the lower contact lies between a 10-foot layer of gray-brown slightly bituminous fine-grained cherty vuggy massive ledge-forming dolomite and an underlying light yellow-brown medium-grained quartz sandstone (containing chert and lithic fragments) assigned, by the author, to the Souris River Formation. The lower carbonate beds at Warm Spring Canyon conformably overlie strata assigned to the Maywood Formation and reach a thickness of 55 feet. The lower contact lies between an 18-foot layer of medium brown thick-bedded argillaceous vuggy dolomite with sporadic green glauconite bands and an underlying 1/2-foot irregular thin gray-green shale layer of the Maywood Formation. The unit at Green River Lakes and Teton Canyon attains a thickness of about 65 feet. The beds unconformably overlie the Bighorn Dolomite of Upper Ordovician age. At both localities, the lower contact lies between a massive strongly bituminous dolomite and an underlying light gray well indurated sharp-fracturing dolomite of the Bighorn (Text-fig. 7). At all six of the previous localities, the contact of the lower carbonate beds with the overlying middle shale beds is arbitrary; it is placed at the point where the strata change lithology upward from a dominantly carbonate sequence to a dominantly shale and siltstone sequence.

The middle shale beds are of fairly constant thickness at Teton Canyon, Green River Lakes, and Warm Spring Canyon, being approximately 25 feet at each locality. In Shoshone and Shell Canyons, the unit reaches a thickness of about 50 feet then thins eastward toward Little Tongue River Canyon where about 25 feet occur. The contact of the unit with the overlying upper carbonate beds is arbitrary at all six described sections and is placed at the point where the strata change lithology upward from a dominantly shale and siltstone sequence to a dominantly carbonate sequence.

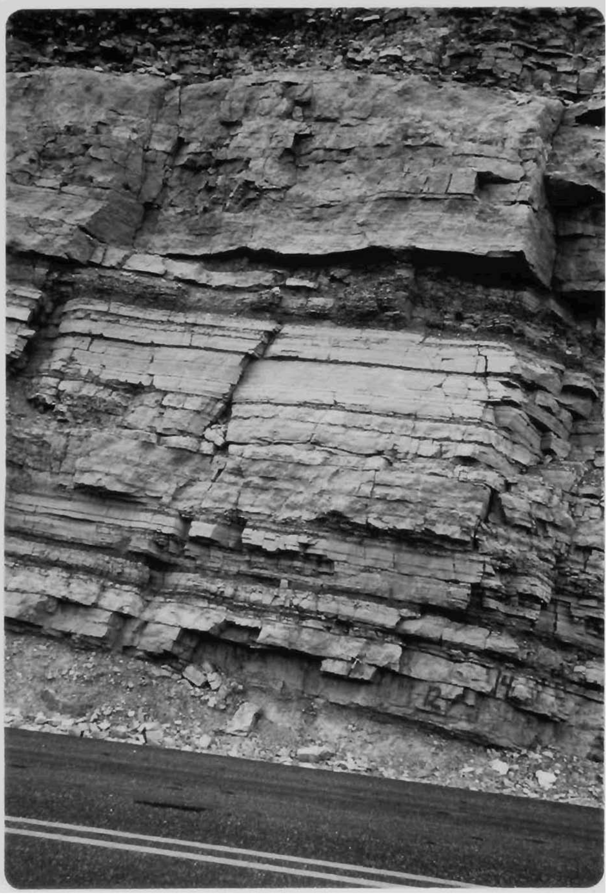
The upper carbonate beds constitute the thickest of the three units at all but the Warm Spring Canyon locality. At Teton Canyon and Green River Lakes, the beds reach a thickness of approximately 100 feet. At Warm Spring Canyon, the unit is only about 32 feet thick. At Shoshone, Shell, and

Little Tongue River Canyons, the beds attain a thickness of approximately 62 feet, 80 feet, and 43 feet respectively. At all six localities, the upper carbonate beds conformably underlie the Brindle Creek beds. The contact of the unit with the Brindle Creek beds is placed at the point where the lithology changes upward from a dominantly carbonate sequence to dominantly sandy siltstone and sandstone.

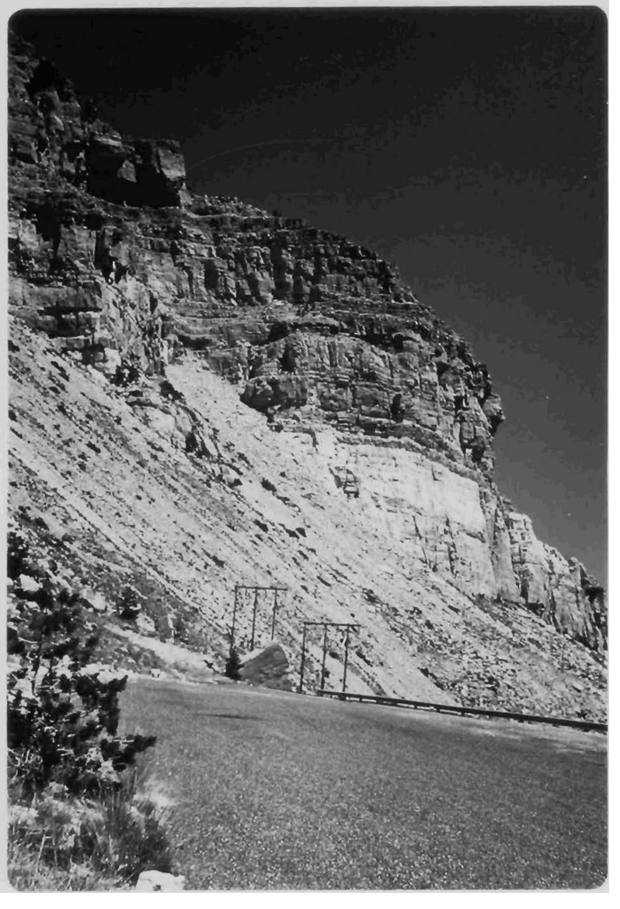
The lower carbonate, middle shale, and upper carbonate beds occur at all six of the author's described localities and, presumably, are continuous in the subsurface with surface exposures. The thicknesses represented by the three units are considered as depositional thicknesses because no major unconformities are known to be present. The previously described units, together with the overlying Brindle Creek beds, pinch out south and east of a line connecting Tensleep Canyon in the Central Bighorns, the central portion of the Owl Creek Range (Sandberg, 1965), and a short distance south of Middle Fork of Popo Agie River near the southeastern end of the Wind River Range (Branson, E. B. & Branson, C. C., 1941).

Text-figure 3. Base of the Devonian section at Little Tongue River Canyon along U. S. Highway 14, Bighorn Mountains (locality 1). The letter "B" near the left-center of the photograph is about 8 inches high and marks the contact of the Upper Devonian Souris River Formation with the underlying Ordovician Bighorn Dolomite.

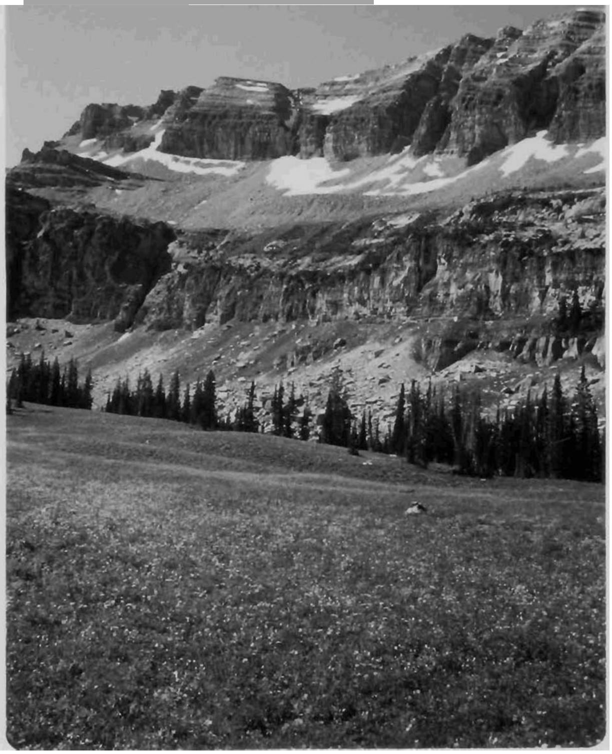
Text-figure 4. Exposure of bottom one-half of the middle shale beds (Jefferson Formation) in Little Tongue River Canyon along U. S. Highway 14, Bighorn Mountains (locality 1). Note the lensing-out of the argillaceous dolomite layer at the upper center of the photograph; this type of situation occurs frequently throughout the exposure at this locality.



Text-figure 5. Exposure of Jefferson Formation in Shoshone Canyon (locality 3). Good exposures of Brindle Creek, upper carbonate, and middle shale beds; lower carbonate beds and Souris River Formation are present but are too thin to be discerned in the photograph.



Text-figure 6. Exposure of Ordovician, Devonian, and Mississippian strata on west wall of upper Teton Canyon, Teton Mountains (locality 6). The Devonian section is situated between the upper cliff-forming Madison Limestone and the lower cliff-forming Bighorn dolomite. The resistant Birdbear Member of the Jefferson is located at the top of the middle ledge just above the extreme left center of the photograph.



Text-figure 7. Contact between dark brown bituminous dolomite of Jefferson Formation with light gray dolomite of the Bighorn. Location is on west wall of upper Teton Canyon, Teton Mountains (locality 6).

Brindle Creek beds

Stratigraphic Nomenclature

The Brindle Creek beds constitute a sequence of strata within the Jefferson Formation which is well exposed and best represented at Shell Canyon (locality 2, Text-fig. 8), but can be recognized in the other five described sections. This locality is just west of Brindle Creek in Shell Canyon, Bighorn Mountains, Bighorn County, Wyoming (44° 36' 35" N, 107° 37' 10" W).

Lithology

In general, the Brindle Creek beds consist of grayish green dolomitic arenaceous siltstone and shale at the top and bottom with a series of carbonate beds in the center of the unit. However, as will become evident with further discussion, this generality does not apply to the sections at Little Tongue River and Warm Spring Canyons.

The type section of the Brindle Creek beds at Shell Canyon consists of, in ascending order, grayish-green dolomitic highly arenaceous massive siltstone in which well rounded highly pitted quartz grains (averaging about 1 mm. in diameter) appear "floating" in the siltstone proper, brown vuggy argillaceous dolomite with a few associated thin limestone layers, and siltstone very similar to the lower siltstone but more arenaceous and displaying a thin one-foot argillaceous quartz sandstone at the very top. In the lower siltstone layer, the quartz grains occur with irregular frequency. Some zones contain between 30 and 40 percent "floating" grains, and other zones are almost entirely absent of the grains. A very thin black fissile shale layer occurs at the base of this unit. The Brindle Creek beds at Shoshone Canyon are very similar to those at Shell Canyon but display a dominance of limestone over dolomite in the center of the unit.

The exposure at Little Tongue River Canyon consists of light gray to brown argillaceous dolomite with beds of sandy dolomite. A very thin red and green irregular shale layer appears at the base of the unit. The section at this locality is atypical but is referred to the Brindle Creek beds on the basis of its conspicuous arenaceous and argillaceous character.

Strata referred to the Brindle Creek beds at Warm Spring Canyon are also atypical of the type section. In ascending order, the unit consists of purple-brown dolomitic siltstone with "floating" well rounded quartz grains, medium reddish-brown argillaceous medium- to coarse-grained quartz sandstone, and brownish-gray mottled arenaceous dolomite. These strata are included in the Brindle Creek beds on the basis of their arenaceous character and their abrupt lithologic dissimilarity with the underlying upper carbonate beds and the overlying Birdbear Member.

The beds at Green River Lakes and Teton Canyon consist of dark shales with interbedded dolomite and limestone with a medium- to coarse-grained argillaceous poorly sorted quartz sandstone forming the basal layer. Siltstones are absent entirely at Green River Lakes and probably are not present in the covered interval at Teton Canyon.

Thickness, Distribution, Stratigraphic Relationships

The Brindle Creek beds at Little Tongue River, Shell, and Shoshone Canyons attain thicknesses of approximately 10 feet, 45 feet, and 30 feet respectively and are overlain unconformably by the Madison Limestone of Lower Mississippian age.

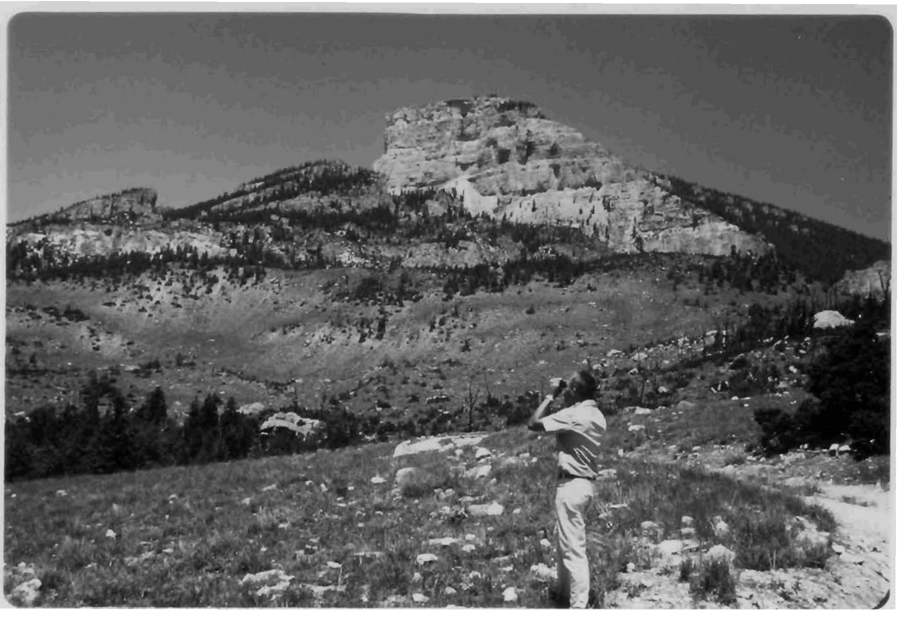
At Little Tongue River Canyon, the Brindle Creek beds are overlain locally by a thin 1/2-inch red sandy clay seam containing small black pebbles and fish remains. This red clay unit and an overlying 8-foot dolomite layer which Koucky, *et al.* (1961) assigned to the Madison Limestone is regarded by Klapper (1962) to represent the Clarks Fork Formation (Valaite Lake Formation of the author) and to contain Lower Carboniferous (*cuI*) conodonts.

Strata referred to the Brindle Creek beds at Warm Spring Canyon, Green River Lakes, and Teton Canyon attain thicknesses of approximately 5 feet, 60 feet, and 55 feet respectively and are conformably overlain by the Birdbear Member.

The thickening of the beds in the area of miogeogynclinal deposition at Green River Lakes and Teton Canyon is expected, but the unusually thin occurrence of the unit at Warm Spring Canyon is anomalous. This depositional thinning was probably caused by the presence of the so-called "Absaroka Arch" (Goodwin, 1964). The Absaroka Arch was, evidently, an active tectonic element from the Upper Ordovician through Brindle Creek time and probably was present during deposition of the Birdbear.

In general, the distribution of the Brindle Creek beds follows that of the lower units described previously.

Text-figure 8. Author's locality 2 at Shell Canyon, Bighorn Mountains (type locality of the Brindle Creek beds). The Jefferson Formation lies between the upper cliff-forming Madison Limestone and the lower cliff-forming Bighorn Dolomite. The exposure is situated on the north side of the canyon and is about 1 mile distant with reference to the photograph.



Birdbear Member

Stratigraphic Nomenclature

McMannis (1962) used the term "Birdbear equivalent" to designate the distinctive massive dolomite unit in the uppermost part of the Jefferson Formation at Mission Creek, southeast of Livingston, Montana. However, the word "equivalent" is not a recognized rock-stratigraphic term; its only meaning in this case indicating a correspondence in geologic age or stratigraphic position with the Birdbear Formation of the Williston Basin. Because this light-coloured dolomite has been correlated with the Birdbear Formation by Sandberg & Hammond (1958) and is a distinctive unit, the author believes there is good reason to assign it a formal rock-stratigraphic name in western Wyoming. Therefore, the author has chosen to employ Sandberg's (1965) nomenclature by using the term "Birdbear Member" for this upper dolomite of the Jefferson. Sandberg (1965) originally designated the term "Birdbear Member" to represent the upper 70 feet of the type Jefferson Formation at Logan, Montana (see Sandberg, 1962, p. 48).

Lithology

Unlike the lower units of the Jefferson Formation, the Birdbear Member has remarkably uniform lithologic character. At the three localities where it is present (Teton Canyon, Green River Lakes, Warm Spring Canyon), it consists of light gray to brownish-gray mottled finely crystalline pseudo-brecciated dolomite. Such features as massive bedding, lighter color, pseudo-brecciated texture, deeply pitted weathering surfaces, and greater resistance readily distinguish the Birdbear from the lower units.

Thickness, Distribution, Stratigraphic Relationships

The Birdbear Member ranges in thickness from 60 feet at Teton Canyon to only 8 feet at Warm Spring Canyon. The unit does not occur at Shoshone, Shell, or Little Tongue River Canyons due to pre-Mississippian erosion. As far as could be determined, the Birdbear undergoes rapid thinning in the Wind River Mountains and does not occur eastward from this area. The Birdbear Member ranges in thickness from about 50 to 80 feet in southwestern Montana, except near its erosional limit. The unit thickens westward to about 200 feet in the Sawtooth Range but is commonly so thin as to be unmappable (Sandberg, 1965).

At the three described localities in Wyoming where the Birdbear is present, it is invariably overlain unconformably by a distinctive sequence of variegated siltstones and sandstones of the author's newly designated Valaite Lake Formation. The contact between these two units is sharp and well defined.

AGE AND CORRELATION OF THE JEFFERSON FORMATION

The age and correlation of the Jefferson Formation have been a subject of considerable discussion since Peale's work near the turn of the century. In Wyoming, age determinations are made very difficult by the absence of diagnostic fossils. Correlation by physical stratigraphic procedures is not easily accomplished due to abrupt facies changes (both vertically and laterally) within the Jefferson. Although physical and paleontological correlations have been demonstrated with some degree of success, the exact age of the Jefferson and its equivalents has remained a topic of dispute. Recent work by Sandberg (1962) and Sandberg & McMannis (1964) has resulted in a better understanding of these relationships. To date, the problem has not been completely resolved.

Age of the Jefferson Formation

The Jefferson Formation in southwestern Montana is regarded by Cooper (in Cooper, *et al.*, 1942) as Frasnian in age. He correlated the contained brachiopod and coral fauna with the *Spirifer argentarius* and *Pachyphyllum* zones of the Devil's Gate Limestone in Nevada. Sandberg (1936b) also restricts the Jefferson to the Frasnian Stage of the Upper Devonian. Age assignments for Devonian strata in Wyoming are made exceedingly difficult by the almost complete lack of fossils. The author found no diagnostic fossils (megascopic or microscopic) in the field or in rock samples examined in the laboratory. Thus, an exact age determination was impossible. The assignment of the Jefferson to the Frasnian Stage is probably correct, however, due to the stratigraphic relationships with the underlying Maywood Formation and the overlying Three Forks Formation in Montana, both of which have more definite age assignments (Sandberg, 1963b, and Sandberg & McMannis, 1964).

Correlation of the Jefferson Formation

The Jefferson Formation is widespread in western and central Montana with a thickness ranging from about 200 feet at the north end of the Bighorn Mountains to a maximum of 775 feet in north-central Montana. In southwestern Montana and western Wyoming, the Jefferson contains beds equivalent to both the Duperow and Birdbear Formations of the Jefferson Group in the Williston Basin (Sandberg, 1962). The lower carbonate through Brindle Creek beds (equivalent to the Duperow) range in thickness from approximately 200 feet at the north end of the Bighorns to 225 feet in extreme western Wyoming. A thickness of 665 feet of Duperow strata is attained in the southern Elkhorn Mountains of Montana. These units have the same distribution as the Jefferson Formation. Wilson (1956) reported the branchiopod crustacean, Rhabdostichus, from the Jefferson Group (Duperow Formation) of the

Williston Basin and found the same fossil near the base of the Jefferson Formation at Logan, Montana. He regarded Rhabsdostichus as a widespread Duperow fossil.

The relatively thinner Birdbear Member (equivalent to the Birdbear Formation) has essentially the same distribution as the lower units. It is absent, however, from Shoshone Canyon and the Bighorn Mountains in Wyoming and the Big Snowy and Judith Mountains, Montana, due to pre-Mississippian erosion. The brachiopod genus, Atrypa, is the predominant fauna of the Birdbear (deWit, R. & McLaren, D. J., 1950). According to Wilson (1955), the Birdbear marks the last occurrence of the atrypids.

Valaite Lake Formation

Stratigraphic Nomenclature

Strata lying above the Logan Gulch Member of the Three Forks Formation (Upper Devonian) and below the Lodgepole Formation (Lower Mississippian) at Clarks Fork Canyon in north-central Wyoming were named the Clarks Form Formation by Sandberg (ms., fide Klapper, 1962). However, Sandberg's proposed "Clarks Fork" was refused recognition as a valid formation name by the Geological Survey Committee on Stratigraphic Nomenclature, because the term had already been applied to Eocene beds in north-central Wyoming (Furnish, oral communication, 1965). Sandberg (1965), and others following his example, subsequently referred to these strata as the "dark shale unit" and no formal rock-stratigraphic term has been applied. The author considers a formal name is appropriate for these strata and proposes the term "Valaite Lake Formation." The type section of the Valaite Lake Formation is located on the east slope of Sheep Mountain, west of the lower lake at Green River Lakes, northwestern Wind River Range, Wyoming (Text-fig. 9). The unit directly overlies the Birdbear Member and is overlain by the Madison Limestone. The name is derived from a small lake (Valaite Lake) which is located about one mile to the south of the exposure.

Lithology

At the type section at Green River Lakes, the Valaite Lake Formation consists of 30 feet of thin-bedded red-brown-purple-green and gray argillaceous dolomitic coarse siltstone and beds of brown argillaceous fine-grained quartz sandstone. Iron oxide (probably hematite) is responsible for the bright purple-brown color which characterizes the formation. The strata weather in plate-like slabs which are quite well indurated. Quartz grains compose the bulk of the silt- and sand-sized particles. The grains are tightly cemented by silica and calcium carbonate along with argillaceous material. The siltstone contains zones of abundant fish remains and conodonts which are visible on bedding surfaces to the unaided eye. Conodonts and fish remains become more common toward the top of the formation but still remain concentrated in selected layers. Impressions of *Taonurus caudagalli* appear quite regularly on bedding surfaces and aid in distinguishing the unit (Text-fig. 10). The formation at Teton and Warm Spring Canyons consists of strata of similar lithology to the type section.

Thickness, Distribution, Stratigraphic Relationships

The Valaite Lake Formation ranges in thickness from about 60 feet in Teton Canyon to about 8 feet in Little Tongue River Canyon. The formation, by its purple-brown color, slabby bedding, Taonurus impressions, and characteristic lithology, is readily differentiated from the underlying Jefferson Formation and the overlying Madison carbonates at Teton and Warm Spring Canyons and at Green River Lakes. (Text-fig. 11). The author did not recognize the presence of typical Valaite Lake lithology at the remaining three localities, but Klapper (1962) and Sandberg (1963b) described strata equivalent to the Valaite Lake in the Bighorn Mountains. The strata evidently change from siltstone to predominantly dolomite eastward and northward from the Wind River Range. The unit overlaps progressively older beds eastward from Teton Canyon. Uncertainty exists as to whether or not an unconformity is present between the Valaite Lake and the overlying Madison Limestone.

Age and Correlation

The Valaite Lake Formation is a time-transgressive unit of widespread regional extent. In western Wyoming (Teton and Wind River Mountains), Upper Devonian (toV) conodonts occur in the unit. Klapper (1962) reported Lower Carboniferous (cuI) conodonts in a dark shale layer about 10 feet below the top of the formation at Teton Canyon. At Bull Lake Creek in the Wind River Range, beds 3 and 5 of Klapper (1958) contain Devonian (toV) conodonts. In Little Tongue River Canyon in the Bighorns, a 1-inch basal sandy shale of the Valaite

Lake contains a very late Devonian conodont fauna as well as conodonts of earliest Mississippian age (Sandberg, 1963b). The remainder of the formation at this latter locality, however, is considered Lower Mississippian in age; the Devonian-Mississippian boundary falls somewhere in this one-inch sandy shale. Ethington, Furnish, & Wingert (1961) reported an Upper Devonian (toV) conodont fauna from the author's Valaite Lake Formation in Cottonwood Canyon, Bighorn Mountains, Wyoming. The age of the unit appears to be consistently Upper Devonian-Lower Mississippian in western Wyoming. The formation becomes predominantly Lower Mississippian eastward into north-central Wyoming, except for isolated occurrences where it again may contain strata of notable thickness which are Upper Devonian in age.

The Valaite Lake has previously been miscorrelated with the Three Forks Formation of Montana on the basis of superficial lithologic similarity. McMannis (1962) concluded that the entire Devonian sequence in western Wyoming is a shaley Jefferson (Darby) except where the Beartooth Butte channels underlie it. He indicated that previous workers thought Three Forks strata was present in this area due to the increased amount of clastic debris in the upper part of the Devonian section. Sandberg (1965) concluded that the Logan Gulch Member of the Three Forks is present in the southern Beartooth region and in the Wind River Range. The Logan

Gulch Member is correlated with the evaporitic member (Sandberg, 1962) of the Three Forks in southwestern Montana (Sandberg, 1965). As indicated previously, strata directly above the Birdbear Member in western Wyoming (Valaite Lake Formation)contain conodonts which suggest correlation with zone V (*Clymenia*-Stufe) of the Fammenian Stage in Germany. The evaporitic member (Logan Gulch Member) is referred to zone II (*Cheiloceras*-Stufe) of the Fammenian Stage. It is the author's contention, therefore, that no strata occur between the Birdbear Member (Upper Frasnian) and the Valaite Lake Formation (Upper Fammenian) in Wyoming which can be correlated with the Three Forks.

The Devonian-Mississippian Valaite Lake Formation is the homotaxial equivalent of the Englewood Formation of extreme northeastern Wyoming and the Black Hills of South Dakota (Sandberg, 1963b). The Englewood, like the Valaite Lake, overlaps progressively older beds southward and contains conodont faunas assigned to both the Upper Devonian (*to*V) and the lower Carboniferous (*cu*I) (Klapper & Furnish, 1962).

Text-figure 9. Exposure of the Devonian section on Sheep Mountain, west of Green River Lakes, Wind River Range (locality 5). The bottom of the section is toward the lower left. The strata are dipping about 35°; this narrow ridge intersects the dip of the strata thus exposing the entire Devonian sequence. This is the location of the type section of the newly proposed Valaite Lake Formation. The formation is about 30 feet thick and is situated just below the massive cliff-forming Madison Group exposed just right of center of the photograph.

Text-figure 10. Impressions of *Taonurus caudagalli* on bedding surface of Valaite Lake Formation. Location is on Sheep Mountain, west of Green River Lakes, Wind River Range (locality 5).

Text-figure 11. Contact between Valaite Lake Formation and overlying Lodgepole Formation (Mississippian) on west wall of Teton Canyon, Teton Mountains (locality 6). Hammer rests on top surface of the Valaite Lake.

SEDIMENTARY HISTORY

In Early Devonian time, shales, siltstones, sandstones, conglomerates, and carbonates of the Beartooth Butte Formation were being deposited in stream channels and sinkholes developed on the topographic surface of the Bighorn Dolomite in parts of the Beartooth, Bighorn, and Pryor Mountains of southern Montana and northern Wyoming. Contemporaneously, marine carbonate sedimentation was in progress in the Idaho miogeosynclinal belt to the west. The Wyoming Shelf and adjacent areas of southwestern Montana and Idaho were situated above the profile of depositional equilibrium and, thus, were probably subject to some erosion during Lower, Middle, and the early part of Upper Devonian time (Andrichuk, 1956).

Beginning in early Upper Devonian time, the Souris River sea advanced to the south and west from Canada into the Williston Basin, central Montana, and the north-central part of Wyoming. The Maywood sea, meanwhile, was moving eastward and southward across the Wyoming Shelf into southwestern Montana and western Wyoming. The two advancing seas coalesced in central Montana sometime in early Upper Devonian time. Deposits of the Souris River and Maywood Formations were laid down on an irregular erosional surface of post-Upper Cambrian and pre-Upper Devonian age. Sedimentation was continuous on the shelf as the now-merged Maywood and

Souris River seas advanced south into Wyoming.

As Maywood (Souris River) time passed, a slow eastward transgression of the marine sea from Idaho and Montana eventually reached and engulfed the present Bighorn Basin and northern Wind River Mountains by late Jefferson (Brindle Creek or Birdbear) time. The initial carbonate deposits of the Wyoming Shelf generally consist of limestones in the area of the extreme western shelf and dolomites in the more positive areas in the east. Maximum transgression of the Jefferson sea over the Wyoming Shelf probably occurred during Brindle Creek time. The present eastern limit of Devonian rocks in the Bighorn and southern Wind River Range represents the approximate southeastern shoreline of the Jefferson sea (Andrichuk, 1956).

Goodwin (1964) indicated that the Upper Ordovician Bighorn Dolomite in Wyoming generally thickens toward the Williston Basin and the miogeosyncline. He proposed the name "Absaroka Arch" for this area of depositional thinning of the Bighorn Dolomite in west-central Wyoming. The Jefferson Formation also thickens toward the Williston Basin and the miogeosyncline from west-central Wyoming. This area of depositional thinning of the Jefferson closely parallels that of the underlying Bighorn Dolomite. It is the author's opinion that the Absaroka Arch was probably still an active tectonic element through Brindle Creek time and possibly into

Birdbear time. The existence of the arch beyond Birdbear time is not precisely known at present.

Near the end of Birdbear time, the sea began to retreat northward and westward from Wyoming, leaving the Wyoming Shelf emergent as the sea regressed. The sea probably retreated northward past the Sweetgrass Arch area of Montana. During this time, erosion on the shelf destroyed any traces of Birdbear strata in north-central Wyoming and reduced the thickness of the unit in western Wyoming.

Following maximum regression of the Birdbear sea into central Montana, the sea began advancing again southward, depositing the widespread Three Forks strata in Montana. The shelf was probably alternately emergent and submergent during much of Three Forks deposition and was probably mostly emergent during late Three Forks time. In latest Upper Devonian time and continuing into Kinderhookian time, the Valaite Lake deposits were laid down as the sea transgressed into southern Montana and western and north-central Wyoming. This widespread marine transgression, emanating from the Williston Basin and central Montana trough areas on the north and from the Idaho miogeosynclinal belt to the west, completely covered the peneplained surface of northwestern Wyoming. Massive carbonate deposits were formed over the expanded Wyoming depositional shelf area and thus preserved the depositional edge of the Jefferson strata.

The distribution and thickness of Devonian rocks in Wyoming are related to tectonic activity in the Williston Basin, in the miogeosyncline of Idaho, and along the Transcontinental Arch. Generally, the strata thicken westward toward the area of miogeosynclinal deposition.

APPENDIX

LOCALITY 1

Location: Little Tongue River Canyon, Bighorn Mountains, along U. S. Highway 14 west of Dayton, Wyoming (SE 1/4 Sec. 21, SW 1/4 Sec. 22, T. 56 N., R. 87 W.). Measurements and descriptions are based partly on those of Koucky, F. L. and Rhodes, F. H. T., 1963.

UPPER DEVONIAN SERIES

	Thickness (ft.)
Jefferson Formation	
Brindle Creek beds	
Dolomite: brown and gray beds with purple streaks, argillaceous, with beds of sandy dolomite, top is red sandy dolomite, unconformably overlain by irregular, thin 2-inch layer of red sandy clay containing small black pebbles and abundant small fragmented fish teeth and plates--this red clay unit is assigned to the Lower Mississippian on the basis of contained conodonts.	7.5
Dolomite: very light gray, somewhat wavy-bedded, highly irregular upper and lower contact, contains occasional calcite cavities.	.6
Shale: 1/2-inch red shale overlain by 3-inch green shale, very irregular top contact.	.3
Total thickness of beds 8.4	
Upper carbonate beds	
Limestone: light brown, sublithographic, with small hematite patches occurring occasionally.	.2

	Thickness (ft.)
Dolomite: brown, massive, fine-grained, calcite cavities, grades up into the overlying limestone.	6.0
Dolomite: dark gray, very fine-grained, calcite cavities, well indurated, dense, massive conchoidal fracture.	3.7
Dolomite: light gray, abundant calcite cavities, well indurated.	.4
Dolomite: medium brown, arenaceous, well indurated.	1.0
Dolomite: dark gray, very fine-grained, calcite cavities.	1.4
Dolomite: medium brown, massive, argillaceous, calcite cavities.	2.7
Dolomite: greenish-gray, argillaceous, arenaceous at base, top 3 inches is green, arenaceous shale.	1.4
Light gray mottled breccia unit: calcite along base, primarily dolomite.	.2
Dolomite: banded gray-black, fine-grained dense.	2.3
Dolomite: gray-brown, very vuggy.	.8
Dolomite: dark gray, very fine-grained, well indurated.	.6
Dolomite: reddish-gray, fine-grained, numerous calcite cavities.	5.8
Dolomite: light green with red streaks, argillaceous, contorted bedding.	1.7
Dolomite: green-gray with red streaks, argillaceous, massive conchoidal fracture.	2.3
Shale: purple, gray, green, fissile, slightly arenaceous.	.2

	Thickness (ft.)
Dolomite: purple to gray, argillaceous, no calcite vugs.	1.9
Dolomite: medium dark brown, fine-grained, calcite cavities, becomes lighter and more slabby at top.	3.7
Dolomite: very light gray, very fine-grained, rounded quartz grains appearing throughout--especially abundant at very top.	.8
Dolomite: gray-brown, fine-grained, well indurated, calcite cavities.	3.0
Dolomite: red-brown, arenaceous, calcite cavities, hematite patches conspicuous on weathered surface.	.6
Dolomite: red-brown, contorted bedding, numerous calcite cavities.	.9
Dolomite: medium brown, massive, well indurated, wavy-bedded pattern conspicuous near top.	1.3
Total thickness of beds	42.9

Middle shale beds

Shale: green, arenaceous, lower 1 inch is purple.	.5
Shaley unit: several red-black streaks, multicolored red, purple, and green silty shales, moderately indurated, thin bedded.	6.2
Dolomite: light gray, argillaceous, with thin purple shale units above and below.	.6
Dolomite: purple-gray, massive, well indurated.	2.0

		Thickness (ft.)
Shales: variegated, silty, with interbedded argillaceous dolomites, streaked predominently red and purple, some layers with calcite cavities.		8.0
Dolomite: purple and gray, some calcite cavities.		1.2
Shale: dark red top 1/2 inch, green in 1/2 inch, fissile.		.1
Dolomite: bright yellow, very argillaceous, abundant calcite cavities, thickness varies and unit may pinch out within the exposure.		2.0
Shale: yellow-green, silty, fissile.		1.0
Total thickness of beds	21.6	

Lower carbonate beds

Limestone: medium yellow, sublithographic, homegeneous, bedding irregular and slabby near top.		1.4
Limestone: yellow-gray, slightly argillaceous, may be termed a fine calcilutite.		1.2
Dolomite: gray-brown, calcite cavities, no sharp contact with the overlying limestone.		2.0
Dolomite: yellow-gray, argillaceous, wavy-bedded, very irregular upper contact, lower 1/2 inch is green shale, no calcite cavities present.		1.0
Dolomite: medium yellow, numerous calcite cavities, interbedded thin variegated shales.		5.6
Total thickness of beds	11.2	

Total thickness of Jefferson Formation	84.1

	Thickness (ft.)
Souris River Formation	
Shale: gray, gray-green, lower 1 inch is black, silty.	1.3
Dolomite: green-gray, argillaceous, calcite cavities occur at random.	1.5
Siltstone: gray-green, slabby, irregular top contact, shaley throughout.	.6
Dolomite: green-gray, argillaceous, occasional calcite cavities, interbedded thin shales.	4.4
Shale: black, fissile, very irregular unit, with conspicuous black phosphatic pebbles averaging about 1/2 inch in diameter, unconformably overlies 2 feet of bright yellow dolomite (Bighorn Dolomite).	.3
Total thickness of Souris River Formation	8.1
Total thickness of the Devonian section	

LOCALITY 2

Location: North wall of Shell Canyon, Bighorn Mountains, Wyoming. The exposure is almost directly north of Shell Falls Observation Point at a distance of approximately 1.6 miles (44° 36' 35" N, 107° 37' 10" W).

UPPER DEVONIAN SERIES

	Thickness (ft.)
Jefferson Formation	
Brindle Creek beds	
Siltstone: drab green, dolomitic, moderately indurated; unconformably overlain by Lower Mississippian series--contact sharp.	.2
Siltstone: drab green, dolomitic; with sporadic, well indurated black quartzose pebbles; contains abundant rounded, "frosted" quartz grains; thin 1/4 inch coarse sandstone layer in middle of unit.	.1
Sandstone: medium brown, quartzose, argillaceous, well indurated, dense, coarse-grained, grains subangular to subround; hard, black quartzose pebbles throughout; slightly dolomitic, some glauconite grains.	.7
Siltstone: light green, dolomitic, arenaceous, calcite cavities, sporadic brown argillaceous bands, quartz grains poorly sorted and sporadic--may occur in bands parallel to bedding.	10.0
Shale: dark green, fissile; pale yellow, round argillaceous pebbles at base.	.1

	Thickness (ft.)
Dolomite: gray-brown, mottled, argillaceous, well indurated, somewhat wavy-bedded in middle.	.5
Dolomite: medium brown, massive, moderately dense.	.4
Dolomitic limestone: light brown, calcite cavities, contorted bedding more dolomitic toward base.	1.3
Dolomite: dark brown, "sugary", massive, well indurated, calcite cavities.	3.5
Dolomite: gray-green, argillaceous, massive, no calcite cavities present.	1.5
Shale: dark green, fissile.	.1
Dolomite: gray-green, argillaceous, calcite cavities.	5.5
Limestone: light brown, "sugary", well indurated, sporadic calcite cavities, wavy-bedded in places.	1.2
Siltstone: green, very arenaceous, dolomitic; rounded, "floating" quartz grains numerous and randomly situated.	1.0
Dolomitic limestone: yellow-brown, argillaceous, many small calcite cavities, high permeability.	1.3
Siltstone: grayish-green, dolomitic, arenaceous--some very arenaceous bands parallel to bedding; round, "floating" quartz grains; dense, well indurated.	15.0
Shale: black, fissile, slightly silty.	.1
Total thickness of beds 42.5	

Upper carbonate beds	Thickness (ft.)
Dolomite: dark gray, massive, well indurated, pitted weathered surface, forms resistant ledge.	10.5
Calcarenite: dark brown, very fine-grained.	1.0
Dolomite: light gray-brown, massive, well indurated, thin 1/2 inch green shale 2 feet from top.	5.0
Siltstone: green, dolomitic, arenaceous; round, "floating" quartz grains; underlain by 1 inch green shale, bottom 1/2 inch of which is red shale.	2.4
Siltstone: black, dolomitic, fissile.	.5
Dolomite: dark gray, massive, well indurated, calcite cavities, forms resistant ledge.	9.0
Dolomitic limestone: light yellow-brown, argillaceous, calcite cavities, dense.	.8
Siltstone: light green, dolomitic, massive, dense; underlain by 2 inches green, fissile shale.	5.0
Dolomite: medium gray, massive, dense, well indurated.	9.0
Shale: light green, thin-bedded, silty, calcite cavities, brown argillaceous streaks parallel to bedding.	8.0
Shale: dark brown-gray, silty, thin-bedded to fissile.	1.0
Dolomite: medium gray, slabby, dense, brown streaks parallel to bedding.	2.5

		Thickness (ft.)
Dolomitic limestone: gray-brown, massive to slabby; interbedded thin, green shale beds.		25.0
Total thickness of beds	79.7	
Middle shale beds		
Covered interval: probably interbedded shale, siltstone, sandstone, with minor carbonate.		20.0
Siltstone: dark brown, thin bedded to fissile, most in slope.		20.0
Total thickness of beds	40.0	
Lower carbonate beds		
Dolomite: gray-brown, massive, very well indurated, silty; top 5 feet dolomite breccia; abundant fish remains present in bottom 8 feet.		30.0
Total thickness of beds	30.0	
Total thickness of Jefferson Formation	192.2	
Souris River Formation		
Covered interval: probably shale and siltstones with interbedded thin carbonate units.		10.0
Shale: green-gray, silty, thin-bedded to fissile.		2.0
Dolomite: light gray, massive, well indurated, dense.		8.0

	Thickness (ft.)
Dolomite: light brown, very arenaceous (quartz grains coarse and rounded), breccia-like (angular fragments of light gray dolomite in arenaceous dolomite matrix); fish remains of <u>Bothriolepis</u> sp. present throughout; unconformably underlain by Bighorn Dolomite.	4.0
Total thickness of Souris River Formation	24.0
Total thickness of Devonian section	216.2

LOCALITY 3

Location: North wall of Shoshone Canyon, 4 miles west of Cody, Wyoming (NW 1/4 Sec. 5, T. 52 N., R. 102 W.). All units are well exposed except for 45 feet of section situated about 12 feet above contact with Bighorn Dolomite.

UPPER DEVONIAN SERIES

	Thickness (ft.)
Jefferson Formation	
Brindle Creek beds	
Siltstone: gray-green, dolomitic, moderately well indurated, rounded quartz grains appear at very top, contact with overlying Mississippian Series sharp and unconformable.	3.5
Limestone: gray-brown, very fine-grained, wavy-bedded, calcite cavities--some with large "dog teeth", thickness may vary slightly.	1.2
Siltstone: gray-green, dolomitic, slabby, moderately well indurated, "floating" quartz grains in bottom 2 inches.	3.0
Limestone: gray-brown, fine-grained, medium-bedded, slabby in top 2 feet, some calcite cavities.	12.0
Siltstone: green-gray, dolomitic arenaceous--"floating" quartz grains, top 4 inches is an arenaceous limestone--here the quartz grains appear in bands parallel to bedding, smooth weathering.	2.5
Limestone: reddish-yellow, massive, argillaceous, wavy throughout, irregular top contact.	1.2

	Thickness (ft.)
Dolomite: gray, gray-brown, homogeneous, calcite cavities, irregular top contact.	1.3
Siltstone: yellow-brown, dolomitic, irregular bedded, some rounded quartz grains at very top, well indurated.	1.1
Sandstone: medium brown, coarse-grained, very well indurated, argillaceous, quartz grains well sorted and rounded, bottom 2 feet slightly dolomitic.	4.0
Limestone: yellow-brown, fine-grained, slabby.	1.3
Sandstone: yellow-brown, medium- to coarse-grained, argillaceous, rounded quartz grains, well indurated, dense.	.4
Calcarenite: pale yellow, friable, forms only small local pockets in underlying limestone.	--
Total thickness of beds	31.5

Upper carbonate beds

Limestone: very light gray, "sugary", homogeneous, calcite cavities, pitted weathered surface.	3.5
Dolomite: gray to gray-brown, massive, well indurated, fine-grained, numerous calcite cavities, resistant ledge-former, pitted weathered surface.	9.5
Siltstone: green-gray, dolomitic, dense, slabby.	6.0
Dolomite: gray-brown, massive, fine-grained, well indurated, large calcite cavities, pitted weathered surface.	14.0
Dolomite: medium brown, argillaceous, well indurated.	

	Thickness (ft.)
Dolomite: very dark gray-brown, massive, well indurated, fine-grained, dense, pitted weathered surface, forms resistant ledge.	13.5
Dolomite: dark gray-brown, well indurated, very large calcite cavities, massive, dense, resistant.	2.0
Limestone: light gray-brown, "sugary", fine-grained, well indurated, dense, calcite cavities.	1.3
Siltstone: grayish-green, dolomitic, dense, "floating" rounded quartz grains occur throughout.	.5
Dolomite: gray-brown, massive to thick-bedded, well indurated, fine-grained, dense, occasional calcite cavities, forms resistant ledge.	10.5
Total thickness of beds 61.5	

Middle shale beds

Covered interval: probably siltstones and shales with interbedded carbonates (judging from "float").	35.0
Dolomite: dark gray, well indurated, very fine-grained, calcite vugs.	1.5
Siltstone: light gray-green, well indurated, dense, dolomitic, faintly banded.	1.5
Siltstone: most is in slope, probably with interbedded carbonate (some very argillaceous, platelike slabs of limestone crop out in places).	10.0
Total thickness of beds 48.0	

	Thickness (ft.)	
Lower carbonate beds		
Dolomite: gray-brown, fine-grained, massive, moderately indurated, many calcite vugs, occasional chert lenses, slightly fetid odor, pitted weathered surface, forms resistant ledge.		10.5
Total thickness of beds	10.5	
Total thickness of Jefferson Formation	151.5	
Souris River Formation		
Sandstone: light yellow-brown, medium- to fine-grained, subangular to rounded quartz grains, other grains visible include chert, lithic fragments, and some few glauconite (?) grains, slightly dolomitic, resistant unit, very irregular lower contact.		1.0
Siltstone: greenish-gray, dolomitic.		.5
Dolomite: mottled, argillaceous, highly irregular unit, many calcite cavities, underlain by 1/2 inch yellow and red sandy shale, contact with underlying Bighorn Dolomite sharp and undulating.		.3
Total thickness of Souris River Formation	1.8	
Total thickness of Devonian section	153.3	

LOCALITY 4

Location: North wall of Warm Spring Canyon, Wind River Range, Wyoming, about 7 miles west of Dubois, Wyoming (NW 1/4 NE 1/4 Sec. 1, T. 41 N., R. 108 W.).

UPPER DEVONIAN SERIES

	Thickness (ft.)
Valaite Lake Formation (Devonian-Mississippian)	
Siltstone: red, purple, green, gray, argillaceous, coarse-grained, thin-bedded, abundant calcite cavities; overlain by irregular 3-inch red-brown "fish tooth" conglomerate considered Mississippian in age on the basis of conodonts.	6.0
Siltstone: yellow-brown, argillaceous, coarse-grained, dolomitic, medium-bedded, calcite cavities, *Taonurus* impressions appear on bedding surfaces throughout unit.	6.5
Shale: dark gray to black, silty, thin-bedded.	6.5
Siltstone: red, brown, mottled, argillaceous, dolomitic, slabby, coarse-grained, interbedded gray shales, *Taonurus* impressions present on bedding surfaces.	25.0
Sandstone: yellowish-brown, quartzose, argillaceous, medium-grained, unconformably overlies Birdbear Member of Jefferson Formation--contact sharp.	1.0
Total thickness of Valaite Lake Formation	45.0

Thickness (ft.)

Jefferson Formation

Birdbear Member

Limestone: light grayish-brown, thick-bedded to massive, well indurated, finely granular, occasional hematitic stains, forms resistant ledge. — 8.0

Total thickness of member — 8.0

Brindle Creek beds

Dolomite: brownish-gray, mottled, arenaceous, well indurated, dense. — 1.0

Sandstone: medium reddish-brown, argillaceous, quartzose, hematitic cement, medium- to coarse-grained, calcite cavities. — 1.2

Siltstone: purple-brown, dolomitic, with round "floating" quartz grains scattered throughout. — 3.0

Total thickness of beds — 5.2

Upper carbonate beds

Limestone: light to medium brown, argillaceous, massive, abundant calcite cavities, well indurated, forms resistant ledge. — 32.0

Total thickness of beds — 32.0

Middle shale beds

Sandstone: medium brown, very argillaceous, quartzose, medium-grained, poorly sorted. — .5

Dolomite: dark brown to gray, mottled, argillaceous, massive, well indurated, fine-grained, forms resistant ledge. — 3.5

	Thickness (ft.)
Siltstone: purple, gray, green highly argillaceous, occasional well-rounded "floating" quartz grains, thin-bedded.	3.0
Covered interval: probably interbedded shales and siltstones.	5.0
Dolomite: reddish-brown, fine grained, well indurated, slabby.	3.3
Dolomitic limestone: dark brown, fine-grained, argillaceous, homogeneous, forms small resistant ledge.	3.0
Siltstone: green-gray, argillaceous fine-grained, thin-bedded.	3.0
Total thickness of beds 21.3	

Lower carbonate beds

Limestone: gray, finely crystalline, well indurated, slabby.	3.0
Dolomite: light gray, slabby, splintery fracture, well indurated, very fine-grained.	3.7
Limestone: brown, slabby, argillaceous.	1.0
Limestone: dark brown, finely crystalline, massive, bituminous, forms small resistant ledge.	2.5
Dolomite: light gray-brown, argillaceous, medium-bedded, homogeneous.	2.0
Limestone: medium brown, slabby, finely crystalline, forms slope.	8.0
Dolomite: dark brown, fine-grained, bituminous, well indurated, thick-bedded to massive.	13.0
Sandstone: grayish-white, argillaceous, quartzose, medium-grained, permeability good, moderately friable.	2.0

	Thickness (ft.)
Siltstone: light gray, dolomitic, with well-rounded "floating" quartz grains occurring at random.	.7
Dolomite: medium brown, argillaceous, thick-bedded, calcite cavities, sporadic green glauconite bands, contact with underlying Maywood Formation sharp but conformable.	18.0
Total thickness of beds 53.9	
Total thickness of Jefferson Formation 120.4	

Maywood Formation

	Thickness (ft.)
Shale: green-gray, thin-bedded, irregular top surface.	.5
Dolomite breccia unit: gray-brown, mottled, massive, some calcite cavities, bottom 3 inches is shaley and glauconitic; many poorly sorted fragments of dark gray dolomite in matrix of argillaceous dolomite, these resistant fragments stand out in relief on weathered surface.	4.5
Siltstone: light gray-green to dark gray, dolomitic, massive; dark gray, angular dolomite fragments occur scattered at random throughout the unit; fish plates abundant (Bothriolepis sp. ?); extremely glauconitic in top 6 feet; contact with underlying Bighorn Dolomite sharp, undulating, and unconformable.	10.5
Total thickness of Maywood Formation 15.5	
Total thickness of Devonian section 180.9	

LOCALITY 5

Location: Sheep Mountain above west side of lower Green River Lake, northwestern Wind River Range, Sublette County, Wyoming. Near head of major creek which enters lake at middle of west shore (Sec. 6, T. 38 N., R. 108 W.).

UPPER DEVONIAN SERIES

	Thickness (ft.)
Valaite Lake Formation (Devonian-Mississippian)	
Siltstone: red, purple, green, thin-bedded, argillaceous, coarse-grained, abundant calcite cavities; conodonts and fish remains visible on some bedding surfaces; contact with overlying Lodgepole Formation sharp.	12.0
Sandstone: purple-brown, fine-grained, very argillaceous, well indurated, slabby, occasional small hematite concentrations, black pebbles in lower 2 inches, *Taonurus* impressions present on bedding surfaces throughout the unit, forms small resistant ledges.	4.8
Shale: variegated, silty, thin-bedded, conspicuous purple layer in center.	6.2
Sandstone: light brown, argillaceous, very fine-grained, well indurated, medium-bedded to slabby, *Taonurus* impressions present on bedding surfaces.	3.0
Shale: black, silty, thin-bedded, underlain by 1 inch purple sandy shale.	.7
Sandstone: brown, argillaceous, fine-grained, thin-bedded, *Taonurus* impressions present on bedding surfaces.	1.5

	Thickness (ft.)
Shale: black, silty, thin-bedded, occasional fish teeth in upper 3 inches.	2.5

Total thickness of Valaite Lake Formation 30.7

Jefferson Formation

Birdbear Member

Dolomite: dark gray-brown, argillaceous, massive, well indurated, fine-grained, occasional small hematite concentrations, surface stained red by iron oxide, pitted weathered surface, forms resistant ledge, contact with overlying Valaite Lake Formation sharp and unconformable.	15.0

Total thickness of member 15.0

Brindle Creek beds

Shale: green-gray, silty, thin bedded to fissile.	14.0
Dolomitic limestone: dark gray-brown, argillaceous, medium-bedded, well indurated, resistant.	4.5
Shale: dark gray, silty, thin-bedded, slightly dolomitic, ripple marks in lower 5 feet.	35.0
Sandstone: light gray-brown, quartzose, highly argillaceous, medium- to coarse-grained, poorly sorted, bottom 2 feet light green-gray; resistant.	3.0

Total thickness of beds 56.5

Upper carbonate beds

Dolomite: light gray, well indurated, finely crystalline, interbedded siltstone.	22.0
Limestone: light brown, fine-grained, thick-bedded.	8.0

	Thickness (ft.)
Sandstone: very light gray-brown, medium-grained, quartzose, friable, poorly sorted, calcareous cement, argillaceous toward top.	20.0
Dolomite: dark brown, massive, fine-grained, well indurated, bituminous.	10.0
Limestone: light gray, well indurated, finely crystalline, massive.	5.0
Dolomite: light gray, fine-grained, well indurated, thick-bedded.	5.0
Dolomite: dark brown, fine-grained, well indurated, homogeneous, bituminous.	2.0
Dolomite: brown to green, argillaceous, well indurated.	5.0
Dolomite: dark brown, massive, fine-grained; 5-foot layer of light brown, argillaceous dolomite about 10 feet from top; thin 3 inch sandy dolomite at base.	20.0
Limestone: dark gray-brown, fine-grained, moderately permeable, well indurated, massive, bituminous, some fish remains.	2.0
Total thickness of beds 99.0	

<u>Middle shale beds</u>

Shale: green, thin-bedded, silty; interbedded slabby, well indurated dolomite; top 2 feet is sandy and contains calcite and gilsonite cavities.	15.0
Limestone: dark brown, thin-bedded, fine-grained, bituminous, <u>Atrypa reticularis</u> occurs just above vuggy bed at bottom 6 inches.	3.5
Dolomite: medium brown, argillaceous, well indurated.	

	Thickness (ft.)
Shale: dark gray, thin-bedded, silty, becoming sandy toward top, top 6 inches contains abundant calcite and gilsonite cavities.	6.0
Total thickness of beds 26.5	

Lower carbonate beds

Limestone: dark gray, slabby, well indurated, most in slope.	10.0
Dolomite: light brown, argillaceous, very well indurated, massive conchoidal fracture, massive bedded, interbedded variegated shales and siltstones.	22.0
Dolomite: dark gray-brown, fine-grained, bituminous, massive, pitted weathered surface.	12.0
Sandstone: light gray to brown, very argillaceous, quartzose, medium-grained, poorly sorted, massive.	8.0
Limestone: light gray, coarsely crystalline, thin-bedded, well indurated.	2.0
Dolomite: dark brown, fine-grained, strongly bituminous, massive, vuggy, forms resistant ledge; contact with underlying Bighorn Dolomite sharp and unconformable.	8.0
Total thickness of beds 62.0	

Total thickness of Jefferson Formation 259.0

Total thickness of Devonian section 289.7

LOCALITY 6

Location: West wall of Teton Canyon, west slope of Teton Mountains, Wyoming (43° 40' 20" N, 110° 50' 30" W).

UPPER DEVONIAN SERIES

Thickness (ft.)

Valaite Lake Formation (Devonian-Mississippian)

Sandstone: gray, reddish-brown, yellow-brown, quartzose, very fine-grained, very argillaceous; may be termed a coarse siltstone, medium-bedded to slabby, *Taonurus* impressions visible on bedding surfaces throughout the unit, the lower 54 feet is mostly in slope with only occasional exposures.	60.0

Total thickness of Valaite Lake Formation 60.0

Jefferson Formation

Birdbear Member

Dolomite: medium gray, mottled, finely crystalline, well indurated, massive, calcite cavities, resistant, major ledge former, pitted weathered surface contact with overlying Valaite Lake Formation sharp and unconformable.	60.0

Total thickness of member 60.0

Brindle Creek beds

Siltstone: grayish-green, argillaceous, interbedded dark brown bituminous dolomite with calcite cavities and some sandstone units, less shaley and more dolomitic and slabby in bottom 10 feet, most is in slope and poorly exposed.	30.0

	Thickness (ft.)	
Dolomite: dark gray-brown, medium- to thick-bedded, well indurated, very fine-grained, bituminous, forms resistant ledge.		10.0
Sandstone: medium to light brown, quartzose, argillaceous, medium- to coarse-grained, poorly sorted, massive, extremely dark 1-foot bituminous dolomite unit about 3 feet from base.		15.0
Total thickness of beds	55.0	

Upper carbonate beds

Dolomite: dark brownish-gray, fine-grained, massive, bituminous, contains *Atrypa*, some solitary corals and stromatoporoids--all poorly preserved.		13.0
Dolomite: light gray, argillaceous, well indurated, most is in slope, probably some interbedded shales.		13.0
Dolomite: dark gray-brown, bituminous. fine-grained, well indurated, thick-bedded to massive, forms resistant ledge.		10.0
Dolomite: light gray, well indurated, thick-bedded to slabby, more calcareous toward top.		8.0
Dolomite: dark gray-brown, fine grained, bituminous, massive, well indurated, resistant ledge former.		25.0
Limestone: light gray, medium-bedded to slabby, finely crystalline, resistant.		30.0
Total thickness of beds	99.0	

	Thickness (ft.)	
Middle shale beds		
Interbedded shale, sandstone, and dolomite, most is covered; light brown, very well indurated, splintery fracturing, argillaceous dolomite crops out at top 5 feet.		25.0
Total thickness of beds	25.0	
Lower carbonate beds		
Limestone: dark gray, well indurated, fine-grained, bituminous, thick-bedded to massive.		30.0
Dolomite: dark brownish-gray, thick-bedded, becoming more slabby at base, slightly bituminous, forms resistant ledge.		12.0
Dolomite: medium brown, silty, rounded "frosted" quartz grains appear sporadically, weathers bright yellow.		10.0
Limestone: dark brown, very fine-grained, bituminous.		8.0
Dolomite: dark brown, thick-bedded, arenaceous, well indurated, slightly bituminous, contact with underlying Bighorn Dolomite sharp and unconformable.		5.0
Total thickness of beds	65.0	
Total thickness of Jefferson Formation	304.0	
Total thickness of Devonian section	364.0	

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