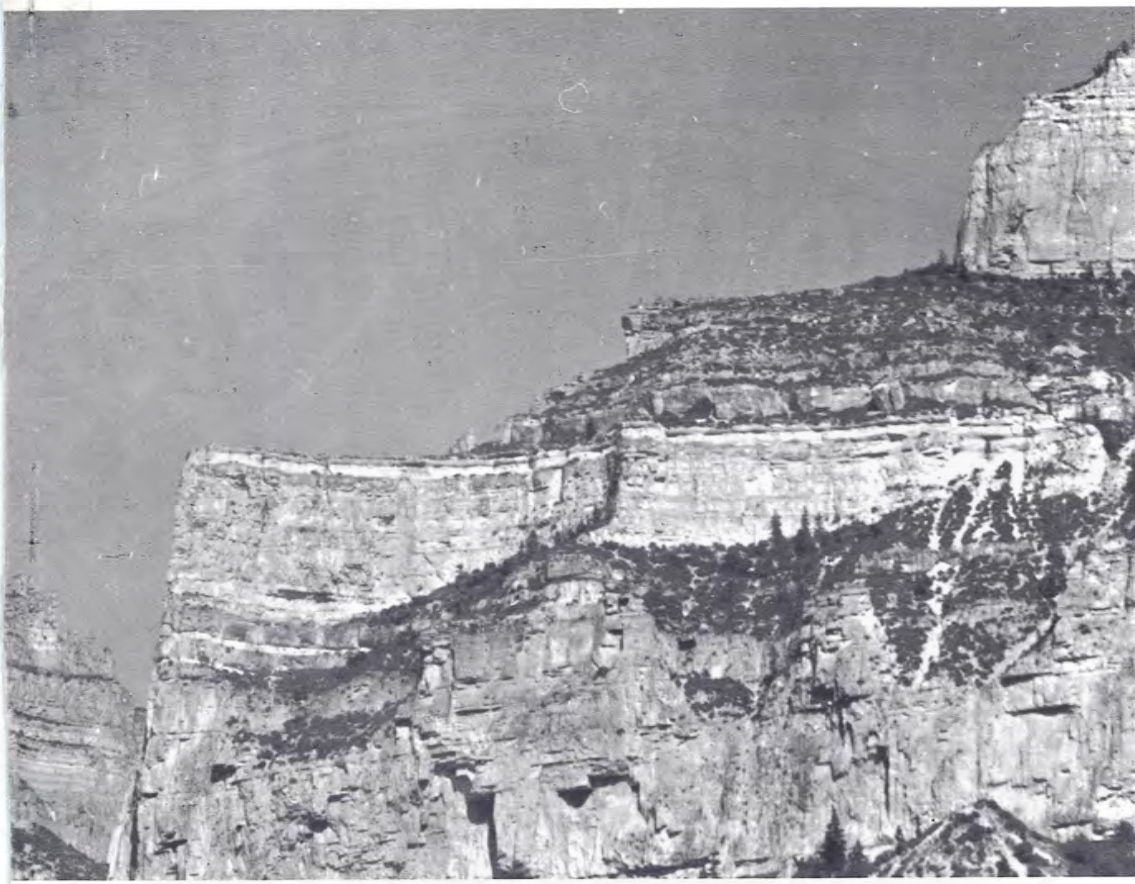
THE GEOLOGICAL SURVEY OF WYOMING

D. L. BLACKSTONE, JR., STATE GEOLOGIST



BULLETIN 52

MEASURED SECTIONS OF DEVONIAN ROCKS IN NORTHERN WYOMING

by

CHARLES A. SANDBERG

Cover. Profile formed by Madison Limestone (light cliff at top), Jefferson Formation (dark ledges in middle), and Bighorn Dolomite (light cliff at base). View looking eastward in Cottonwood Canyon, west side of Bighorn Mountains, Wyoming.

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LARAMIE, WYOMING

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CONTENTS

Page

Abstract 7

Introduction 7

Sources of data and acknowledgments 9

Methods of investigation 11

Section measurement and sample collection 11

Sample examination and description 12

Color 12

Composition 13

Crystallinity and granularity 15

Brecciation 16

Supplementary studies 18

Nomenclature 19

Regional correlation 23

Measured sections 29

Clarks Fork Canyon, Beartooth Mountains 29

Cottonwood Canyon, Bighorn Mountains 37

Ed Point area, Bighorn Mountains 44

Hunter Peak, Absaroka Range 47

Little Bighorn Canyon, Bighorn Mountains 52

Little Tongue Canyon, Bighorn Mountains 55

North Crazy Woman Canyon, Bighorn Mountains 61

Page

North Piney Canyon, Bighorn Mountains 63
Ragan Draw, Hartville Uplift 64
Shell Canyon, Bighorn Mountains 66
Shoshone Canyon, near Absaroka Range 69
Sisters Hill, Bighorn Mountains 77
South Fork Rock Creek, Bighorn Mountains 79

Core descriptions 83
Shell Oil 1 Clear Creek well, Powder River Basin 83
Shell Oil 1 Crow Tribal well, Powder River Basin, Montana 86

References cited 91

ILLUSTRATIONS

Figure 1. Distribution of continuous Devonian and lowermost Mississippian rocks and location of measured sections 8

2. Correlation chart of Devonian and adjacent rocks in northern and eastern Wyoming 20

3. Cross section of Devonian and adjacent rocks between Logan, Montana, and eastern flank of Bighorn Mountains, Wyoming 22

Errata: Captions for Figure 1 and Figure 2 are reversed.

Measured sections of Devonian rocks in northern Wyoming[1]

By CHARLES A. SANDBERG[2]

ABSTRACT

Thirteen measured surface sections and two well cores, which provided data for other reports on Devonian and lowermost Mississippian rocks, are described in detail. Twelve sections are in the Bighorn and Beartooth Mountains and Absaroka Range of northern Wyoming; the other is in the Hartville Uplift of east-central Wyoming. The Interlake Formation of Silurian and latest Ordovician age is recognized and described for the first time in northern Wyoming. It is present in the cores of two wells in the northern Powder River Basin, near the Wyoming-Montana State line.

INTRODUCTION

Devonian and adjacent rocks at 13 surface sections are described in detail on the basis of comprehensive measurement, sampling, and field notes combined with microscopic examination of all samples and supporting chemical analyses of selected samples. Two well cores of the same rocks are described in similar detail. Most of the measured sections were mentioned by name and were located or briefly described in previous reports (Sandberg, 1961a, b; 1963a, b; 1965) on the Devonian and lowermost Mississippian rocks of northern Wyoming, but the lithologic descriptions heretofore have not been published.

This report deals largely with northern Wyoming, where all but one of the measured sections are located (fig. 1). Nine of the measured sections are on the flanks of the Bighorn Mountains, two are in or near the Absaroka Range, and one is on the eastern flank of the Beartooth Mountains. The other measured section is at Ragan Draw in the Hartville Uplift of east-central Wyoming, south of the area shown on figure 1.

Both core descriptions are from wells in the northern Powder River Basin. One of the wells is in northern Wyoming; the other is in southern

[1] Manuscript received October 28, 1965. Publication authorized by the Director, U. S. Geological Survey. The dark shale unit of Devonian and Mississippian age, which is described herein, is now formally named the Cottonwood Canyon Member of the Madison Limestone (Sandberg and Klapper, in press). The measured section given here for the dark shale unit at Cottonwood Canyon is designated the type section and the one at Clarks Fork Canyon is designated a reference section of the Cottonwood Canyon Member.

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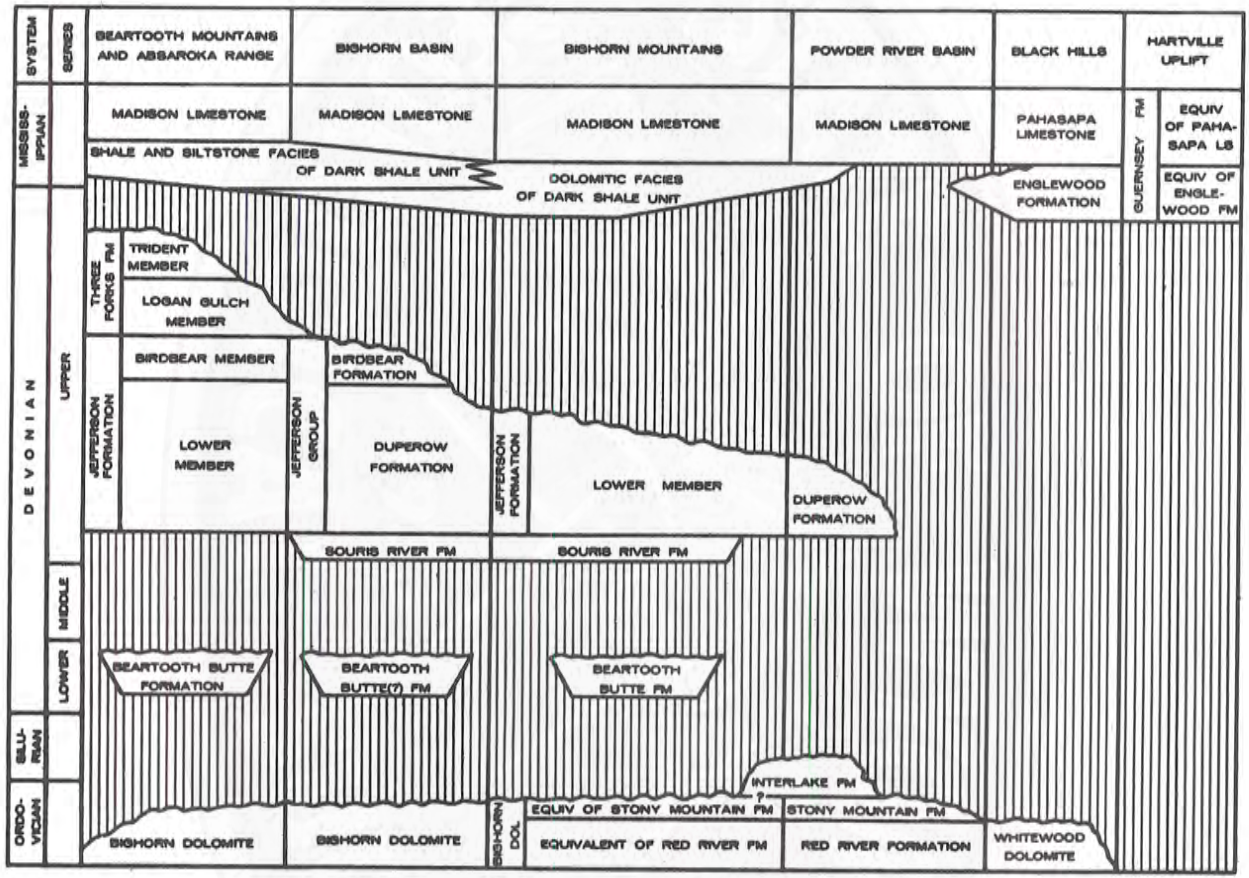

Figure 1.—Distribution of continuous Devonian and lowermost Mississippian rocks and location of measured sections. Devonian and lowermost Mississippian rocks absent except for small outliers in shaded area. Limits of formations shown by solid lines except limits of Souris River and Darby Formations shown by dashed lines. Formations present on side of limit lines with wording. Named sections (x) and wells (o) are described in text; those with underlined names are shown only on cross section (fig. 3).

Montana, less than a mile north of the Wyoming State line. The well in Montana is a dry hole at the north end of the Ash Creek oil field, most of which is in Wyoming. The cores of both wells are stored at Laramie, Wyo., by the Geological Survey of Wyoming.

Sources of data and acknowledgments

This report is part of a regional stratigraphic study of the lowermost Mississippian, Devonian, and older Paleozoic rocks of the Williston Basin and northern Rocky Mountain area. This investigation, which has been in progress since 1954, encompasses about 250,000 square miles in North Dakota, South Dakota, Montana east of the Continental Divide, and the northern two-thirds of Wyoming.

The measured sections and cores presented herein represent an aggregate thickness of about 3,000 feet. They are described on the basis of microscopic examination of more than 1,000 samples supplemented by about 225 calcium-magnesium analyses and 50 thin sections.

All sections, except those at Hunter Peak and Sisters Hill and a small part of the Clarks Fork section, were measured and sampled by the author. P. W. Richards helped measure seven sections and W. S. Alvarez, C. J. Galvin, R. F. Gantnier, A. E. Roberts, and E. V. Stephens each helped measure all or part of one or two sections. Their assistance is specifically credited in the heading of the appropriate measured sections. P. W. Richards measured and sampled the Hunter Peak section, assisted by W. G. Pierce, and the Sisters Hill section. J. I. Ziony measured and described the thicker part of the Beartooth Butte Formation at Clarks Fork Canyon. Determinations of fossils in various categories were provided as follows: algae by P. E. Cloud, Jr.; brachiopods by J. T. Dutro, Jr.; conodonts by W. H. Hass, J. W. Huddle, and T. J. M. Schopf; fish by F. C. Whitmore, Jr.; and spores and palynomorphs by R. A. Scott and R. H. Tschudy. All the calcium-magnesium analyses were made by J. A. Thomas. The author is solely responsible for descriptions based on samples and thin sections, and for interpretations of the calcium-magnesium analyses.

The contributions of all the above-mentioned U.S. Geological Survey colleagues are sincerely and gratefully acknowledged. Special thanks are expressed to P. W. Richards, who guided the early part of the study from 1954 to 1957 in coordination with his own investigation of the Bighorn Dolomite and equivalent Red River and Stony Mountain Formations, all of Ordovician age.

The assistance of several persons outside the U.S. Geological Survey is also gratefully acknowledged. Dr. D. H. Dunkle, U.S. National Museum, provided several helpful determinations of Early and Late Devonian fishes; and Dr. B. F. Glenister, State University of Iowa, made one age assignment based on conodonts. Dr. Gilbert Klapper, whose investigation of conodont zones (Klapper, 1966) involved many of the same

measured sections, provided several conodont determinations and age assignments and made many helpful suggestions on regional correlation. Dr. H. D. Thomas, State Geologist of Wyoming, kindly permitted examination and sampling of the two well cores and gave enthusiastic support to the preparation of this paper.

METHODS OF INVESTIGATION

Section measurement and sample collection

Sites for measured sections, spaced at optimum distances for regional correlation, were selected after several days' reconnaissance to determine local areas of most complete exposures. Canyons or buttes, where ledges and cliffs of gently dipping strata could be measured directly by steel tape, were preferred. The stratigraphic thickness of slopes between resistant beds and the total thickness of some sections, for checking against the sums of individually measured units, were calculated trigonometrically from measurements by tape and Brunton compass traverse. Composite sections were integrated by tracing or correlating marker beds between areas where only partial sections are exposed. Closely spaced determinations of strike and dip permitted accurate calculation of stratigraphic thickness and helped locate some faults. Familiarity with the normal succession of cyclically deposited Devonian sediments enable detection of some low-angle faults that are nearly parallel to bedding. Where repetition or omission of strata was suspected, units were traced for short distances. Notes on location by land grid, geographic features, and topographic quadrangle, and on attitude of beds and structural complications accompany each measured section. Locations and stratigraphic descriptions were field checked to ensure that they would permit the reader to relocate sections and identify units.

Field notes contain, in addition to thickness data and sample numbers, only brief preliminary lithologic descriptions. They emphasize sketches and descriptions of sedimentary, stratigraphic, and paleontologic features that could not be described later from hand specimens.

Determinations of carbonate content of rocks by conventional field methods—observations under a 10X hand lens and tests with 10 percent hydrochloric acid—were found to be fairly inaccurate on comparison with subsequent laboratory determinations. Uncontrollable factors that govern the rate of acid reaction and cause errors of judgment in the field are variations in temperature of air, rocks, and acid, and variations in porosity, permeability, and grain size. Because of combinations of these factors, dolomite commonly may effervesce moderately and be mistaken for limestone.

Thickness of bedding was described by use of the following classification, modified from that of McKee and Weir (1953):

Thickness	Description
>4 ft.	Massive
2-4 ft.	Thick-bedded
½-2 ft.	Medium-bedded
2-6 in.	Thin-bedded
½-2 in.	Platy
1/10-½ in.	Laminated
<1/10 in.	Thinly laminated

Relative resistance of units was arbitrarily characterized as resistant, moderately resistant, weakly resistant, or nonresistant.

Most sections and many interesting beds and features were photographed in three ways for different purposes. Polaroid photographs, which were incorporated in the field notes, were used for immediate notation of stratigraphic, sedimentary, or paleontologic features and for location of important rock or fossil collections. Color transparencies were used for subsequently verifying contacts, field units, and weathering colors. Conventional photographs, with features and beds inked after comparison with duplicating color transparencies and polaroid photographs, serve as a permanent record of the location and appearance of measured sections.

Numbered samples were collected from every field unit that was expressed topographically as a ledge, cliff, reentrant, or slope, and from each different rock within a unit. Combined representative samples were collected from covered or partly covered slopes, where several lithologically similar rocks were found in float or by trenching, and from thin units characterized by repetitive interbedding or interlamination. From massive units of apparently uniform lithologic character, representative samples were taken of the base, middle, and top or of every 5 feet of thickness. On the average, one fresh rock sample, weighing ¼ to 1 lb., was collected for every 3 feet of section measured. Larger rock samples, weighing about 1 to 4 lbs., were taken from beds in which conodonts or spores were observed or suspected.

Sample examination and description

Rock samples were examined under a binocular microscope illuminated by a 100-watt incandescent bulb filtered by blue and frosted glass. Early in the study, 15X oculars were used in combination with 1X, 2X, and 3X objectives. Later, 9X oculars were substituted because of the larger field of view and to attain a closer comparison with field observations made under a 10X hand lens. For uniformity, early descriptions were rechecked and adjusted to those made under 9X oculars.

Color

Colors of samples were described by comparison with the National Research Council Rock-Color Chart (Goddard and others, 1948). To approximate outdoor lighting, color descriptions were made by naked eye under fluorescent lighting provided by one 15-watt daylight bulb and one 15-watt white bulb. Necessary interpolations between color names given by Goddard and others (1948) were made by using an adjectival sequence of very light or very pale, light or pale, grayish or moderate or medium, dark, very dark, dusky, and very dusky. Number-letter-fraction designations of hue, value, and chroma were noted, but they were intentionally excluded from the stratigraphic sections as superfluous to color names. Series or ranges of colors for a single varicolored

rock unit are listed in order of decreasing abundance; in other words, the first color is predominant and would characterize the unit in a simplified description.

Composition

Carbonate composition was estimated by a rapid, easily performed test, which is most accurate for samples containing less than 15 percent insoluble residue. Carbonate rocks were classified as dolomite, calcitic dolomite, dolomitic limestone, or limestone; accessory carbonate content of clastic rocks was described as dolomitic or calcareous.

The test involves totally immersing a small chip of rock in 10 percent hydrochloric acid at room temperature in a beaker and interpreting the type of effervescence. Dolomite effervesces with a steady stream of minute bubbles that are readily observable under the binocular microscope but are almost undetectable to the naked eye. Calcitic dolomite effervesces with small to medium bubbles, in proportion to greater content of calcite, and at an accelerating rate. This acceleration probably reflects the gradual change from a dolomitic reaction to a combined dolomitic and calcitic reaction as the dolomite is slowly digested and increasing permeability allows the acid to encounter larger numbers of imbedded calcite crystals. Dolomitic limestone effervesces rapidly with medium to large bubbles but at a decreasing rate, because the dolomite reaction is masked until the calcite is nearly digested. Limestone effervesces vigorously with very large bubbles, which cause the chip to skip around the bottom of the beaker and commonly to rise to the frothy surface of the acid.

The carbonate content of calcareous or highly dolomitic clastic rocks can be estimated by the same technique. The presence of dolomite in moderately or slightly dolomitic clastic rocks, however, is difficult to detect solely by interpreting the reaction to cold acid.

Brief additional tests were made on samples that could not be accurately identified in cold acid and on at least one sample of each different rock in every measured section or core.

The additional tests involve boiling a rock chip in hydrochloric acid until it is completely disintegrated and only an insoluble residue remains or until effervescence ceases. If its shape is not visibly affected, the chip is crushed in place and reheated to detect latent effervescence. The composition, amount, and grain size of the insoluble residue and the successive changes in effervescence in cold and hot acid are then evaluated together with the microscopic observations to estimate the rock composition.

Tentative estimates of rock composition were compared to results of calcium-magnesium chemical analyses. The estimates as well as techniques used in deriving them were modified as necessary. The simple laboratory techniques were found to have an accuracy of 70 to

30 percent before correction. Estimates of composition that were nearly identical with those interpreted from chemical analyses were almost invariably obtained for samples having less than 15 percent insoluble residue. Estimates of dolomite content for clastic rocks containing less than 15 percent carbonate were found to be largely inaccurate, however, and such a small amount of dolomite was concluded to be virtually undetectable in weak acid. It is interesting to note that the author's proficiency in estimating carbonate content in the laboratory was found to be nearly twice his proficiency in the field.

Calcium-magnesium analyses were made of cuts of samples of all major rock types and of many component fossils, nodules, and concretions. Molal ratios and percentage of calcium carbonate were calculated by J. A. Thomas from chemical tests, which are accurate to about 3 percent. These figures were then interpreted in conjunction with the sample and insoluble residue descriptions to obtain the final rock identifications.

Carbonate rocks were classified by quantitative interpretation of calcium-magnesium molal ratios by using a modification of the scheme proposed by Guerrero and Kenner (1955). Magnesian limestone was eliminated from the classification by including it with limestone, as both limestone and magnesium limestone are relatively minor components of the predominantly dolomitic Devonian rocks of northern Wyoming.

Ca/Mg Molal ratio	Rock classification
1.00-1.20	Dolomite
1.20-2.85	Calcitic dolomite
2.85-17.67	Dolomitic limestone
17.67-100.00	Limestone

Clastic rocks, containing less than 50 percent carbonate, were classified either as dolomitic, where the molal ratio was less than 2.85, or as calcareous, where the molal ratio was greater than 2.85.

The terms for carbonate or clastic components of rocks are qualified where the total carbonate content is close to the minimum, medium, or maximum. The terms "slightly dolomitic" and "slightly calcareous" are applied to clastic rocks that contain 8 to 15 percent carbonate; rocks that contain less than 8 percent carbonate are arbitrarily considered noncalcareous or nondolomitic. The terms "very dolomitic" and "very calcareous" describe clastic rocks whose carbonate content is 40 to 50 percent. The terms "very argillaceous," "very silty," and "very sandy," depending on the character of the insoluble residue, describe carbonate rocks whose carbonate content is only 50 to 60 percent. The terms "slightly argillaceous," "slightly silty," and "slightly sandy" are applied to limestone or dolomite that contain 85 to 92 percent carbonate. Limestone and dolomite that contain more than 92 percent carbonate are arbitrarily considered pure, and their clastic component is not described.

Crystallinity and granularity

The grain sizes of carbonate rocks that are not obviously of clastic origin are described in terms of crystallinity rather than granularity. Crystalline carbonate rocks, which constitute the bulk of the samples, are classified by eight sizes ranging from very coarsely crystalline to dense, but most of the rocks studied are finer than medium crystalline.

Crystal sizes visible by naked eye are classified as very coarsely, coarsely, medium, finely, or very finely crystalline, using the same size ranges as in the sand classification by Wentworth (1922).

Crystal sizes below the lower limit of recognition by naked eye—usually about 1/16mm—are classified microscopically as microcrystalline, cryptocrystalline, or dense. Microcrystalline is applied to a size wherein individual crystals are distinguishable under 9X or 10X magnification. Coarsely microcrystalline designates a size that is almost distinguishable by naked eye, whereas finely microcrystalline designates a size that is barely distinguishable under 27X magnification. Cryptocrystalline describes a rock whose crystallinity can be recognized by light flashes from random crystal or cleavage faces but whose individual crystals are indistinguishable under 27X magnification. Dense is applied to a size so fine that crystallinity is undetectable by binocular microscope.

Two crystal sizes in a single rock description are listed in decreasing order of abundance. If the two sizes are given as finely crystalline and microcrystalline, for example, then the rock has discrete irregular patches of distinctly different crystal sizes. This texture is characteristic of pseudobrecciated dolomite, which will be discussed later. If the two sizes are given as microcrystalline to very finely crystalline, for example, they express a gradational range.

The term "rhombic" is applied to dolomite that contains discrete crystals or rhombs, shows little or no evidence of crystalline intergrowth, and commonly has intercrystalline porosity. Rhombic dolomite that appears to have a sugary texture because of myriad light reflections from clear crystal faces is further described as sucrosic or microsucrosic, depending on crystal size. Rock with a heterogeneous texture resulting from gradational patches of different crystal sizes is described as fragmental, or, if the patches are parts of fossils, as fossil-fragmental. Sizes are given by terms expressing range from very coarsely fragmental or fossil-fragmental to microfragmental or microfossil-fragmental.

The grain sizes of sandstones, siltstones, and clastic carbonate rocks are described in terms of granularity following the classification of Wentworth (1922). Where significant, coarse- and fine-grained siltstone are differentiated by the same criteria as coarsely and finely microcrystalline carbonate rocks.

Laboratory tests and calcium-magnesium analyses indicate that in many beds complete gradations exist between microcrystalline silty dolo-

mite and dolomitic siltstone. These two rocks are probably the most difficult to differentiate in the field.

Nonfissile, extremely fine siltstone, composed entirely of quartz grains in the clay size range (<1/256 mm), is included in the lithologic descriptions with normal, fissile quartzose shale, because no widely recognized name for a nonfissile silty rock comparable to claystone or mudstone is available. In an earlier core description of the Three Forks Formation, quartzose shale as used here was alternatively described as very fine grained siltstone (Sandberg and Hammond, 1958, p. 2324).

Brecciation

Many of the carbonate rocks studied for this report, particularly the dolomite and calcitic dolomite, display some form of fragmentation or brecciation, which may be ascribed to a primary (depositional), diagenetic, or secondary origin. *Intraformational* breccia, which is readily distinguished from interformational breccia, is abundant and widespread in the Devonian rocks of northern Wyoming. *Interformational* breccia, which is present only in the Beartooth Butte Formation and very locally in the basal few inches of the Jefferson Formation, will be discussed later.

Intraformational breccia is divided for convenience into two genetic categories, *interstratal* and *intrastratal*. Each of these categories, although not mentioned specifically, is described by a different terminology in the lithologic descriptions.

Interstratal breccias are true breccias, or angular conglomerates, which may be either primary or secondary. They are derived from underlying or overlying strata within the same formation. Interstratal breccias contain angular rock fragments different in color, composition, and texture from the groundmass. In the lithologic descriptions, they are designated simply by the term *breccia*. Where an intraformational source is not readily apparent from the description of the fragments, the term "intraformational" is used as a modifier.

Intrastratal breccias were formed largely by dolomitization. They comprise angular fragments or pseudofragments that are derived virtually in place but some of which are slightly rotated. In the lithologic descriptions, the intrastratal breccias are designated by compositional rock name, such as dolomite or calcitic dolomite, which is modified by the terms *brecciated, highly brecciated,* or *pseudo-brecciated* in accordance with the following discussion.

The terms *brecciated* and *highly brecciated* are applied to carbonate rocks composed almost entirely of angular fragments, which are narrowly separated by veinlets and stringers, most commonly of calcitic dolomite, dolomitic limestone, limestone, or secondary calcite. In brecciated rocks, the original sedimentary layering is readily apparent and the fragments have not been rotated. In highly brecciated rocks, the frag-

ments are slightly rotated and disoriented, but sedimentary layering can still be matched among fragments.

Brecciated and highly brecciated dolomite or calcitic dolomite are of diagenetic and (or) secondary origin. They are attributed to shrinkage resulting from decrease of volume during dolomitization of originally more calcareous rocks. Highly brecciated dolomite is in some places difficult to distinguish from tectonic breccia, with which it may be gradational where dolomitization occurred during deformation. Brecciated and highly brecciated rocks are common in all Devonian formations described in this study.

The term *pseudobrecciated* is employed in virtually the same sense as the little-used term "pseudobreccia," which was mentioned by but did not originate with North (1930, p. 447). Pseudobrecciated is applied to dolomite or calcitic dolomite that has discrete but irregular, randomly oriented patches or pseudofragments different in color, porosity, and crystal size but not in composition or crystal orientation from the apparent groundmass. Pseudofragments differ from true fragments in that they are commonly interconnected in some direction, although this interconnection is not readily apparent on casual examination. Most pseudofragments are angular, but some may be rounded, lenticular, or sinuous. Pseudofragments in different parts of the same bed may be coarser or finer than the apparent groundmass. In outcrop, the brecciated appearance of pseudobrecciated rocks is greatly accentuated by characteristically rough, deeply pitted surfaces, caused by differential weathering.

Pseudobrecciation is undoubtedly of diagenetic or secondary origin. It probably resulted from differential dolomitization controlled by the initial porosity, permeability, and fossil content of originally more calcareous rocks. Significantly, crinoid columnals generally occur as calcite in pseudobrecciated rocks that are otherwise highly dolomitic. Crinoids, because their parts were initially formed by single large crystals, were apparently one of the last components to be dolomitized.

Pseudobrecciated dolomite is commonly associated with brecciated dolomite and both are greatly transected by veinlets of clear secondary calcite. Pseudobrecciated dolomite characterizes the massive Birdbear Member of the Jefferson Formation and Massive ledge- or cliff-forming beds of the Bighorn Dolomite of Ordovician age. These units resemble one another in their massive bedding, great resistance, light color of rock and weathered surfaces, highly dolomitic composition, and low percentage of insoluble residue. Some of the thicker ledges in the middle of the lower member of the Jefferson are partly pseudobrecciated.

Most *breccia* that is not further described in the stratigraphic sections is interstratal dolomite breccia of primary origin. It occupies parts of many reentrants in the lower member of the Jefferson Formation and was laid down during the early, transgressive phase of depositional cycles. The angular fragments generally are plates of partly consolidated rocks that were broken from underlying beds by desiccation and (or) by wave

or current action. Commonly the breccia fragments themselves are brecciated dolomite or dolomite breccia. Various interstratal breccias, whose fragments are traceable directly to source beds, are described in the stratigraphic section of the Jefferson Formation at Clarks Fork Canyon.

Another common type of interstratal dolomite breccia is *evaporite-solution breccia*, which is of secondary origin. The fragments in evaporite-solution breccia are derived in part from overlying strata, which collapsed into cavities formed in evaporitic beds as anhydrite and halite were dissolved.

Evaporite-solution breccia characterizes the Upper Devonian Logan Gulch Member of the Three Forks Formation (Sandberg, 1965, p. N11), which forms an eastward-thinning wedge along the west side of the report area (fig. 1). It is also common at the tops of ledges and bases of reentrants in the lower member of the Jefferson Formation, where it represents the closing, regressive phase of many depositional cycles. Several cycles are clearly demonstrated by the stratigraphic section of the Jefferson Formation at Shoshone Canyon.

Interformational dolomite breccia is most abundant in the Beartooth Butte Formation of Early Devonian age, particularly in sinkhole fillings and at the bottom and sides of channel-fill deposits. It generally consists of angular pebbles, cobbles, and boulders that are recognized to have been derived from certain beds of the Bighorn Dolomite. Commonly the breccia contains slabs of Bighorn Dolomite 10 feet long and rarely as much as 40 feet long. In the lithologic descriptions, interformational breccia is generally included with the more common, related dolomite conglomerate, which contains subangular to subrounded pebbles of Bighorn Dolomite.

Supplementary studies

In addition to the described comprehensive tests to which all samples were subjected, selected samples were studied in thin section, dissolved in acetic acid, or tested for phosphate.

Thin sections were studied for several purposes but only infrequently for lithologic description. They were used to verify the presence of conodonts, "calcispheres," *Spirorbis* sp. worm tubes, and other small fossils and microfossils that were barely discernible on broken rock surfaces. Thin sections were also useful in studies of fragmented rocks, conglomerates, and chert nodules.

Pilot samples of rocks submitted for conodont determination were dissolved in 10-percent acetic acid. After the residues were cleaned and separated, they were examined for conodonts and other microfossils to provide working field correlations. In addition, samples of carbonate rocks of possible clastic origin were dissolved in acetic acid to provide dolomite residues unobtainable in hydrochloric acid.

The phosphate content of pellets, granules, nodules, and coprolites in rocks that contained abundant conodonts and fish fragments was roughly determined by the simple method described by Shapiro (1952).

NOMENCLATURE

The nomenclature, shown on figure 2, for Upper Devonian and lowermost Mississippian rocks of various parts of the report area follows that used in several previous reports. The subsurface nomenclature proposed by Sandberg and Hammond (1958) for Upper Devonian rocks of the Williston Basin, Montana east of the 111th meridian, and northern Wyoming is used in the Bighorn and Powder River Basins. Members of the outcropping Jefferson and Three Forks Formations, which are of Late Devonian age in Wyoming, were named by Sandberg (1965), as were thin units below and above these formations (Sandberg, 1963a, b). Because of recent findings that support the southward extension of widespread but discontinuous basal Upper Devonian brackish-water channel-fill deposits (Sandberg and McMannis, 1964), the usage of Souris River Formation in northern Wyoming (Sandberg, 1963a) is no longer queried.

The discontinuous Beartooth Butte Formation of Early Devonian age, which unconformably underlies Upper Devonian rocks, was named for a locality in northwestern Wyoming by Dorf (1934). Its widespread distribution in northern Wyoming and southern Montana was described by Blackstone and McGrew (1954) and Sandberg (1961a).

A thin tongue of dolomitic rocks, which conformably overlies the Stony Mountain Formation of Late Ordovician age and extends from Montana southward into northern Wyoming within the Powder River Basin, is here referred to the Interlake Formation. The Interlake, as originally defined by Baillie (1951) from outcrops in the Interlake area of southwestern Manitoba, was of group rank and consisted of the thin Stonewall Formation at the base and four overlying informal units, which were designated by letters B, C, D, and E. It was anticipated by Baillie that the upper unnamed part of the group might later be divided into formations corresponding to the informal units. Subsurface studies of the Interlake in the United States part of the Williston Basin by Carlson and Eastwood (1962), Sandberg (1962a), and others, however, have not disclosed any mappable subdivisions. Following now widely accepted usage, the Interlake is here considered a formation in Montana, North Dakota, South Dakota, and Wyoming.

In its type area, the Interlake Group of Baillie (1951) is lithologically similar to but much thinner than the Interlake Formation in the southern Williston Basin. Baillie's Interlake is only about 350 feet thick and consists largely of yellowish-gray, grayish-yellow, and yellowish-orange fossiliferous dolomite that is sandy at the base and in the lower part. It overlies the Stony Mountain Formation with apparent conformity and is overlain by a basal Devonian regolithic deposit, the so-called Ashern Formation (Sandberg and Hammond, 1958, p. 2304-2305). In the southern Williston Basin, the Interlake Formation has a maximum thickness of more than 1,000 feet and consists largely of interbedded yellowish-gray, brownish-gray, and light-gray to white partly anhydritic dolomite and dolomite breccia.

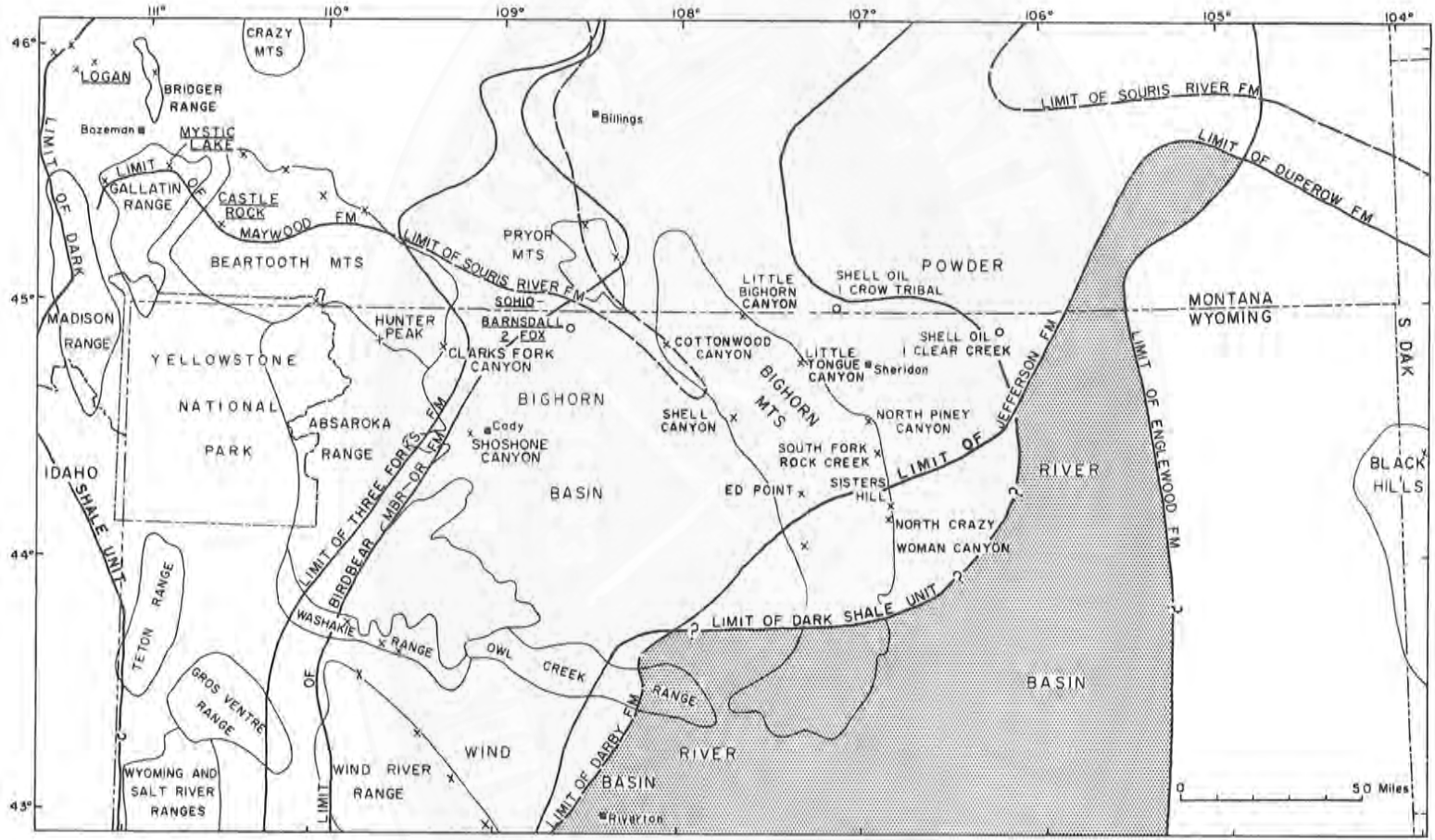

Figure 2.—Correlation chart of Devonian and adjacent rocks in northern and eastern Wyoming.

The age of the Interlake Formation is Silurian and latest Ordovician. The age was considered to be Silurian by Baillie (1951), but Ordovician fossils were later found in the lower part of his Interlake by Stearn (1956, p. 14-16) in Manitoba and by Ross (1957, pl. 44, col. 3, faunal zone H) in a well in southeastern Montana, just north of the report area (fig. 1).

The Interlake Formation, as defined in northern Wyoming, has the same lithologic character and stratigraphic relations as Baillie's Interlake. Baillie's Stonewall Formation cannot be differentiated from the Interlake Formation in the report area and adjacent parts of Montana and South Dakota.

Farther north, in areas where the Stonewall supposedly can be mapped, it has been excluded from the Interlake by some workers, including Stearn (1956) in Manitoba and Carlson and Eastwood (1962) in North Dakota. Other workers, including Andrichuk (1959), however, have retained the stonewall as a formation in the Interlake Group of Manitoba.

Figure 3.—Cross section of Devonian and adjacent rocks between Logan, Montana, and eastern flank of Bighorn Mountains, Wyoming.

REGIONAL CORRELATION

Many Devonian and adjacent formations were traced into northern Wyoming from outcrops in southwestern Montana or from the subsurface of the Williston Basin. The type localities of the Bighorn Dolomite, of Middle and Late Ordovician age, the Beartooth Butte Formation of Early Devonian age, and the Guernsey Formation of Devonian and Mississippian age, however, are in Wyoming in the Bighorn Mountains, Beartooth Mountains, and Hartville Uplift, respectively, and the reference section of the dark shale unit (Sandberg, 1963b) is also in Wyoming at Clarks Fork Canyon. The type localities of the Jefferson and Three Forks Formations (Sandberg, 1962b; 1965, figs. 2, 3) and Madison Limestone (Madison Group, where the formations are differentiated) are at Logan, Mont. The reference sections of the Souris River and Duperow Formations and the type section of the Birdbear Formation (Sandberg and Hammond, 1958), all of Late Devonian age in the report area, are in the Mobil Birdbear well in the North Dakota part of the Williston Basin. The southward extent of the Souris River and Duperow in southern Montana and northern Wyoming was shown by Sandberg (1961b, 1963a). The type localities of the Red River, Stony Mountain, and Interlake Formations are outcrops along the northeastern margin of the Williston Basin in southwestern Manitoba. The distribution and thickness of these formations from the southern Williston Basin into southeastern Montana were shown by Sandberg (1962a). The southern limits of the Stony Mountain and Red River in northern Wyoming and of the Interlake in southern Montana were illustrated by Richards and Nieschmidt (1961).

The regional correlation of the type Jefferson and Three Forks Formations into northern Wyoming, although briefly discussed in several previous reports (Sandberg and Hammond, 1958, p. 2315; Sandberg, 1963a, p. C14; 1963b, p. C18-C19; 1965), is here illustrated by a cross section from Logan, Mont., to the eastern flank of the Bighorn Mountains, Wyo. (fig. 3). The correlation of formations, members, and even individual beds is readily apparent on the cross section, but some of the important stratigraphic relations, facies changes, and differences in nomenclature need explanation.

The most prominent stratigraphic feature of the cross section (fig. 3) is the southeastward truncation of the Sappington, Trident, and Logan Gulch Members of the Three Forks Formation and the Birdbear Member of the Jefferson Formation, in descending order, by a regional unconformity beneath the dark shale unit of Devonian and Mississippian age in southern Montana and northwestern Wyoming. Farther southeastward, beyond the limit of the Birdbear, the lower member of the Jefferson Formation is greatly thinned beneath this same unconformity and then truncated north of North Crazy Woman Canyon (fig. 3, col. 9).

The Three Forks Formation in Wyoming is constituted almost entirely by its basal member, the Logan Gulch. The overlying Trident Member extends only several miles into the northwest corner of Wyoming

(Sandberg, 1965, fig. 1), and it is not described in any of the measured sections. The Sappington Member, whose uppermost unit (fig. 3, col. 1) comprises the only part of the Three Forks that is of Mississippian age, is truncated in the vicinity of the Gallatin Range, Mont. (fig. 1). No remnants of the Sappington have been recognized in Wyoming.

The Logan Gulch Member, which is largely evaporite-solution limestone breccia and shale breccia at Logan (fig. 3, col. 1) changes facies southeastward (col. 2-5) to dolomitic siltstone, dolomitic quartzose shale, and silty dolomite, containing interbeds of evaporite-solution dolomite breccia. In the report area, the Logan Gulch consists largely of silty dolomite and dolomitic siltstone that are lithologically similar to some beds in the dark shale unit and in the upper part of the lower member of the Jefferson Formation.

The Jefferson Formation, although widespread in Wyoming, has not been widely recognized because of facies changes between its type locality and northern Wyoming. During the past 70 years the Jefferson has been commonly misidentified as Three Forks Formation, Bighorn Dolomite, or Madison Limestone by many subsequent workers who followed the original miscorrelations in the Yellowstone National Park area of Hague, Iddings, Weed, and others (1899), who also misidentified the Bighorn Dolomite as Jefferson. Even though several later workers (Tomlinson, 1917; Blackwelder, 1918; Lovering, 1929) pointed out this latter error, it and many of the other miscorrelations persist in some recent investigations.

The recognition of widespread, continuous members and marker beds that are only slightly affected by facies changes now permits regional correlation of the Jefferson Formation, as demonstrated by figure 3.

The Birdbear Member has a remarkably uniform lithologic character. Its more massive bedding, pseudobrecciated texture, and greater resistance readily differentiate the Birdbear from the lower member. The widespread Birdbear forms the upper unit of the Jefferson throughout most of Montana, North Dakota, and South Dakota (Sandberg, 1961b). It also extends from Logan, Mont., southeastward (fig. 3, col. 1-5) to the western part of the Bighorn Basin, Wyo. (fig. 1), where it is truncated.

The lower member of the Jefferson is divisible in outcrop into a lower, resistant part characterized by alternating reentrants and thick ledges and an upper, weakly resistant part that is thin bedded and slope forming. The two parts are separated on figure 3 (col. 1-5) by the second correlation line below the top of the member. Because of facies changes farther east, the contact between the ledge-forming and slope-forming parts of the member at Shell Canyon (col. 7) in the Bighorn Mountains is the next lower correlation line. This contact at Shell Canyon can be correlated with the contact between similar ledge-forming and slope-forming units of the Darby Formation of Late Devonian age, which is in part correlative with the lower member of the Jefferson in west-central Wyoming.

The facies changes of the lower member of the Jefferson Formation (Sandberg, 1965, p. N5) are also shown on figure 3. The number and aggregate thickness of silty or argillaceous beds increase southeastward toward the shoreline with a corresponding increase in the content of glauconite. The aggregate thickness of calcareous beds decreases southeastward from one-fourth to one-twentieth of the total thickness of the member across the southern Beartooth Mountains (fig. 3, col. 3-5) and calcareous beds are almost entirely absent in the Bighorn Mountains (col. 7). Individual beds of the lower member thin depositionally southeastward from Logan, Mont., as indicated by the decreasing thickness of intervals between correlation lines. In the Bighorn Mountains most of the thinning is by erosion at the top of the lower member, but a minor part of the thinning results from southward disappearance of basal beds by transgressive onlap (fig. 3).

Because the lower member changes facies and thins depositionally in the same area and direction in which the overlying Devonian strata are successively truncated beneath a regional unconformity, many miscorrelations have resulted—far more than could be discussed in detail here. Only two papers, which describe sections at or close to the localities of the measured sections presented here, are cited. It should be emphasized that these are merely representative but not outstanding examples.

In the Bighorn Mountains, where the Birdbear Member is absent, all but the lower 37 feet of the lower member of the Jefferson Formation at Cottonwood Canyon, as described in the author's measured section, was miscorrelated with the Three Forks Formation by Blackstone and McGrew (1954, pl. 1). In suggesting this correlation, they were impressed by the lithologic similarity of this upper part of the lower member to the Three Forks of western Wyoming and were influenced by previously miscorrelated sections of several authors on the east and west. For a further discussion of the various correlations in the cottonwood Canyon area, the reader is referred to a stratigraphic summary by Ethington, Furnish, and Wingert (1961, p. 759-761).

In the Absaroka Range, even where the Birdbear Member is present, the striking change in lithologic character and resistance between the upper and lower parts of the lower member of the Jefferson Formation has caused the miscorrelation of the upper part with the Three Forks Formation. Although Lovering (1929, pl. 6 and p. 18) recognized earlier workers' misidentification of the Bighorn Dolomite, he apparently considered a sharp break between upper and lower parts of the lower member to be the Jefferson-Three Forks contact near Cooke City, Mont. Lovering's report area would be located on figure 3 at the Montana-Wyoming State line between columns 3 and 4. Although his measured thicknesses are slightly less than those measured by the author in the same area and at nearly Hunter Peak (fig. 3, col. 4), his photograph and description (Lovering, 1929, pl. 9A and p. 28) of a "massive light-brown sandy limestone 35 feet above the base of the Three Forks that stands out nearly everywhere as a low cliff 15 to 20 feet high" clearly match the Birdbear

of that area. Thus, he included all or part of the upper slope-forming unit of the lower member as well as the overlying Birdbear Member of the Jefferson in the Three Forks.

The Maywood Formation of Late Devonian age (fig. 3, col. 1-3) is the western equivalent of the Souris River Formation, which is described in the measured section at Cottonwood Canyon. Maywood is used for outcrops in the Beartooth Mountains and areas to the west of Montana, and Souris River is used for outcrops and in the subsurface in eastern Montana and northern Wyoming (fig. 1). The Maywood represents the basal deposit of a sea that transgressed eastward from the Cordilleran miogeosyncline; the Souris River represents the basal deposit of a sea that transgressed westward from the Williston intracratonic basin. These seas coalesced in central and north-central Montana, north of the report area (fig. 1), early in Late Devonian time and then spread southward into northern Wyoming.

The correlation of the Beartooth Butte Formation of Early Devonian age is queried at some localities where fossils were not found (fig. 3, col. 1 and 6), because the Beartooth Butte is not everywhere lithologically distinguishable from similar deposits of the Maywood and Souris River Formations (Sandberg and McMannis, 1964). Crevice fillings in the upper 10 feet of the Bighorn Dolomite of Ordovician age at North Crazy Woman Canyon (fig. 3, col. 9) are believed to be related to the Beartooth Butte, but this correlation also has not been proven.

The Interlake Formation, which in northern Wyoming consists largely of medium light-gray intraclastic, pelletal, and pseudobrecciated anhydritic dolomite, is recognized in cores of the Shell Oil 1 Crow Tribal well at the Ash Creek oil field in southernmost Montana and the Shell Oil 1 Clear Creek well in northern Wyoming (fig. 1). These wells are about 40 miles south of the previously mapped southern erosional limit of Silurian rocks (Richards and Nieschmidt, 1961; Sandberg, 1961a). The stratigraphic position and lithologic character of the Interlake in northern Wyoming are identical with those in southeastern Montana where the Interlake was previously recognized. In both areas the Interlake lies between Upper Devonian rocks and a bed of shale at the top of the Stony Mountain Formation. Intraclastic and pelletal anhydritic dolomite are characteristic of the Interlake in southeastern Montana and in the Williston Basin; these rock types have not been recognized in underlying or overlying formations.

In the Shell Oil 1 Crow Tribal well, the Interlake Formation was previously included in the Devonian between depths of 10,663 and 10,698 feet by Richards and Nieschmidt (1961, col. 7) in joint, though tentative, agreement with the author. The Interlake has been correlated by means of sample and radioactivity logs from the Crow Tribal well to three nearby wells, which were not cored, in the Ash Creek oil field. Two of these wells are in Wyoming.

A lenticular unit 3 to 10 feet thick directly above a bed of shale at the top of the Bighorn Dolomite at the Little Tongue Canyon section in the Bighorn Mountains is believed to be the thin wedge edge of the Interlake. Its lithologic character and stratigraphic position above a thick shale at the top of the Stony Mountain Formation equivalent are similar to those of the basal beds of the Interlake in the two cored wells.

Fossil evidence, presented in the appropriate measured sections and core descriptions, supports the regional correlation of many of the discussed units.

STATE OF WYOMING
1933
GEOLOGICAL SURVEY

MEASURED SECTIONS

Composite stratigraphic section

Clarks Fork Canyon, Beartooth Mountains

At mouth of canyon north of Clarks Fork of Yellowstone River. In NE ¼ NE ¼ sec. 7, except thicker section of Beartooth Butte Formation measured in NW ¼ sec. 6, T. 56 N., R. 103 W., Park County, Wyo. (Deep Lake 15-minute quadrangle). Ledges and cliffs, which constitute almost entire section, measured directly by steel tape. All thicknesses rounded to nearest foot. Beds strike N. 20°-25° W. and dip 50°-55° NE.

[Measured by C. A. Sandberg, assisted by P. W. Richards in 1956 and A. E. Roberts in 1959; thicker section of Beartooth Butte Formation measured by J. I. Ziony in 1957. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN:	Thickness Ft.
MADISON LIMESTONE:	
Dolomite, pale-yellow to yellowish-gray and yellowish-orange, microcrystalline, slightly calcitic. Weathers to yellowish-gray and dark yellowish-orange smooth surface; massive; resistant; forms base of high cliff	10+
Total measured Madison Limestone	10+

Conformable contact.

MISSISSIPIAN AND DEVONIAN:	Thickness Ft.
SHALE AND SILTSTONE FACIES OF DARK SHALE UNIT:	
Siltstone, dolomitic, greenish-gray, light olive-gray, dark-gray, and dark yellowish-orange, fissile, partly carbonaceous, nodular, very fine grained; grades to dolomitic quartzose shale. Botryoidal nodules, about 1 in. in diameter, are white crystalline quartz geodes with vugs and cracks partly filled by white calcite and grayish-red hematite. Contains several conodont species that are characteristic of the Lower Carboniferous of Europe (B. F. Glenister, written commun., Mar. 2, 1961). Weathers very dusky red purple, olive gray, light brown, and yellowish brown. Inter-bedded with fissile siltstone are 2 thick-bedded lenses, 0 to 4 ft. thick, of slightly nodular, coarser grained, limonitic, dolomitic siltstone that is light olive-gray and moderate yellowish brown mottled with pale red purple, greenish gray, and pale reddish brown. Weakly resistant and slope forming, except for lenses, which form moderately resistant ledges about 4 ft. and 11 ft. below top	19
Siltstone, dolomitic, limonitic, hematitic; dark yellowish orange to moderate yellowish brown with grayish-red streaks and mottles in upper half; medium dark gray and olive gray with yellowish-brown and dark yellowish-orange laminae in lower half. Weathers	

moderate yellowish brown, dark yellowish orange, and light brown; upper half massive; lower half medium bedded; resistant; ledge forming 8

Siltstone, dolomitic, carbonaceous, medium dark-gray to dark-gray; grades to dolomitic quartzose shale. Weathers yellowish gray and dark yellowish orange; thick bedded to laminated; moderately resistant; ledge forming 8

Shale, quartzose, dolomitic, carbonaceous, dark-gray to grayish-black. Contains abundant palynomorphs, including hystricosphaeres, *Leiosphaeridia* sp. cysts, *Micrhystridium*, and *Tasmanites*, which are indicative of marine deposition USGS Paleobot. Loc. D1773; R. H. Tschudy, written commun., Feb. 14, 1962). Upper 8 ft. weathers dark gray to medium dark gray mottled locally with light olive gray; lower 5 ft. weathers light olive gray; weakly resistant; slope forming 13

Total shale and siltstone facies of dark shale unit 48

DOLOMITE FACIES OF DARK SHALE UNIT:

Dolomite, silty, microcrystalline; dark yellowish orange in upper part, medium gray mottled with dark yellowish orange and calcitic in lower part. Weathers to yellowish-orange smooth surface with 1- to 2-in. pits formed by weathering of calcite geodes; thick bedded; moderately resistant; ledge forming 5

Dolomite, silty, brownish-gray to medium dark-gray and yellowish-gray, microcrystalline. Lower half ft. is medium dark-gray very silty fissile dolomite. Medium dark-gray carbonaceous films on bedding planes resemble maserated plant or algal remains. Weathers yellowish gray and medium gray; platy; weakly resistant; forms reentrant 2

Total dolomitic facies of dark shale unit 7

Total dark shale unit 55

Disconformity.

DEVONIAN: **Thickness Ft.**

THREE FORKS FORMATION:

Logan Gulch Member:

Dolomite, silty, mottled yellowish-gray, light olive-gray, light-brown, and greenish-gray, microcrystalline. Grades to silty dolomite evaporite-solution breccia containing angular fragments and flakes of light greenish-gray dolomitic shale. Weathers to yellowish-gray and dark yellowish-orange rough surfaces; in ½- to 4-in.-thick beds; moderately resistant; ledge forming 11

Dolomite, calcitic, silty, yellowish-orange, yellowish-gray, and light-brown with grayish-red hematitic laminae, very finely crystalline,

fragmental, limonitic; in part nodular. Contains interbeds and scattered angular fragments of light greenish-gray dolomitic shale. Weathers yellowish gray and moderate yellowish brown; thin bedded to laminated; crossbedded; ripple marked; moderately resistant; ledge forming 4

Total Logan Gulch Member of Three Forks Formation 15

JEFFERSON FORMATION:

Birdbear Member:

Dolomite, calcitic, pseudobrecciated, yellowish-orange, yellowish-gray mottled with light-gray, light brownish-gray, and medium light-gray, very finely crystalline, rhombic, sucrosic, porous. Stained by limonite and hematite. Fractures and vugs filled by white calcite. Weathers to mottled moderate yellowish-brown and yellowish-gray rough, pitted surface; massive; resistant; cliff forming 27

Total Birdbear Member 27

Lower Member:

Shale, quartzose, dolomitic, light olive-gray, yellowish-gray, and dusky-yellow, glauconitic. Interlaminated with light-gray to greenish-gray clay shale. Bottom 4 ft. contains a few 1-ft.-thick interbeds of dark yellowish-orange silty dolomite. Weathers yellowish-gray and dusky-yellow; weakly resistant; slope forming 13

Dolomite, silty, banded dark yellowish-orange and yellowish-gray, microcrystalline, limonitic, glauconitic, slightly sandy. Stained grayish red and moderate reddish brown by hematite. Weathers yellowish gray and light brown; platy; forms weakly resistant ledge 6

Covered slope 6

Limestone, light brownish-gray and moderate yellowish-brown, finely microcrystalline, fragmental, slightly dolomitic. Fractures and vugs filled by white finely crystalline calcite. Weathers yellowish-gray; forms weakly resistant ledge 4

Limestone breccia, dolomitic, silty, light brownish-gray to light olive-gray, microcrystalline, glauconitic. Contains intraformational fragments, averaging 1 in. but as much as 10 in. in diameter, of grayish-yellow and yellowish-orange silty calcitic dolomite and smaller fragments and flakes of light greenish-gray dolomitic shale. Weathers pale yellowish orange and light olive gray; thin to medium bedded; forms moderately resistant ledge 8

Dolomite, medium light-gray and pale yellowish-brown to grayish-orange, very finely crystalline, rhombic, sucrosic, slightly calcitic, containing scattered ostracodes, about ¾ mm long. Bottom

2 ft. is microcrystalline silty dolomite. Weathers to yellowish-gray and grayish-orange smooth surface; medium bedded to platy; forms moderately resistant ledge 11

Dolomite, medium-gray, yellowish-orange, and yellowish-gray, very finely crystalline to microcrystalline, sucrosic; partly stained light olive gray and moderate yellowish-brown. Weathers yellowish gray and grayish orange; forms moderately resistant ledge 7

Dolomite, very sandy, yellowish-gray, microcrystalline. Sand is fine to medium, rounded, frosted grains of quartz. Top 3 ft. is yellowish-gray and light-gray sandy dolomite breccia. Weathers grayish orange and moderate reddish orange; partly stained moderate reddish brown, grayish red, and yellowish orange; thin, hackly bedding; weakly resistant; top 3 ft. ledge forming; lower 7 ft. slope forming 10

Dolomite, pale yellowish-brown mottled with yellowish-gray, very finely crystalline, sucrosic, brecciated; in part calcitic; in part stained grayish red. Weathers to mottled yellowish-gray and yellowish-orange rough surface; thick bedded to massive; forms 2 ledges in upper part of cliff 7

Limestone breccia, dolomitic, argillaceous, pale yellowish-brown, cryptocrystalline to very finely crystalline. Contains intraformational fragments, as much as ½ in. in diameter, of yellowish-gray and yellowish-orange silty dolomite and flakes of greenish-gray dolomitic shale. Fragments in lower half are almost in place. Weathers to mottled yellowish-gray and yellowish-orange rough surface; forms slight reentrant in cliff 6

Dolomite, calcitic, banded yellowish-gray and light-gray, very finely crystalline. Top 1 ft. is very pale yellowish-brown cryptocrystalline siliceous dolomite. Bottom few ft. is dusky-yellow microcrystalline silty dolomite. Weathers yellowish-gray and grayish-orange; thick bedded; resistant; forms lower part of cliff 13

Dolomite, silty, very sandy, light-gray, grayish-orange, and grayish-yellow, microcrystalline, brecciated; stained moderate reddish orange and moderate reddish brown by hematite. Interbedded with 2-in.-thick lenses of medium to very coarse grained dolomitic sandstone. Top 2 ft. is pale yellowish-brown very finely crystalline silty sandy dolomite breccia, containing fragments, as much as 4 in. in diameter, of yellowish-orange silty dolomite. Weathers to grayish-orange and light-brown rough surface; thin to medium bedded; moderately resistant; ledge forming 8

Dolomite, calcitic, pseudobrecciated, mottled light-gray and grayish-orange, very finely crystalline, sucrosic. Weathers yellowish gray and grayish orange; in part stained light brown and moderate reddish brown by hematite; medium bedded; resistant; forms two ledges 4

Dolomite, silty, very sandy, pale reddish-brown, grayish-orange, and grayish-red, finely microcrystalline, glauconitic. Sand is medium to coarse, well-rounded to subrounded grains of quartz. Lower 2 ft. is light-gray slightly silty dolomitic limestone that is stained yellowish orange in part and is sandy and glauconitic at base. Weathers mottled grayish orange, pale yellowish orange, and light brown; upper 6 ft. massive; lower 2 ft. medium bedded; moderately resistant; ledge forming 8

Dolomite, light-gray to pale yellowish-brown, finely crystalline, rhombic, sucrosic, porous. Top 1 ft. is medium light-gray to greenish-gray microcrystalline fragmental dolomitic limestone, partly stained light brown. Basal 1½ ft. is yellowish-gray microcrystalline slightly glauconitic silty dolomite. Weathers to light-gray, yellowish-gray, and grayish-orange smooth surfaces; thick bedded; resistant; cliff forming 16

Dolomite, very silty, mottled pale-olive and yellowish-gray, microcrystalline, glauconitic, containing *Atrypa* sp. brachiopods. Pale reddish-brown and grayish-red hematite staining increases towards base. Basal 1 ft. slightly sandy. Weathers yellowish-gray, light-brown, and dark yellowish-orange; thin bedded; moderately resistant; forms reentrant 6

Dolomite, calcitic, mottled yellowish-gray, light-gray, light olive-gray, and light brownish-gray, very finely crystalline to microcrystalline, sucrosic; partly pseudobrecciated. Basal 1 ft silty and thin bedded. Contains *Atrypa* sp. brachiopods. Weathers to yellowish-orange, grayish-orange, and yellowish-gray smooth or rough surfaces; medium bedded to massive; resistant; cliff forming 14

Dolomite, silty, mottled yellowish-gray and light-gray, microcrystalline, earthy. 3 ft. below top is 1½-ft.-thick ledge of very pale orange and pale yellowish-brown cryptocrystalline to very finely crystalline dolomite, weathering yellowish-gray. Weathers grayish-orange and yellowish-orange in lower part, light olive-gray in upper part; thin to thick bedded; moderately resistant; forms reentrant 8

Dolomite, pale yellowish-brown and yellowish-gray, very finely crystalline, sucrosic, cherty. Contains abundant round nodules, as much as 6 in. long, of white to medium-gray dense chert. Top 1 ft. is yellowish-gray to grayish-yellow dolomite breccia, containing fragments of light-gray dolomite. Weathers to yellowish-gray rough surface; massive; resistant; ledge forming 5

Dolomite, silty, very pale orange to very pale yellowish-brown, microcrystalline to cryptocrystalline, earthy; brecciated and recemented by yellowish-brown very finely crystalline calcite. Upper part grades to calcitic dolomite breccia. Weathers to mottled grayish-orange and medium light-gray rough surface; moderately resistant; forms reentrant 3

Dolomite, pale yellowish-brown mottled with yellowish-gray and medium light-gray, very finely to finely crystalline, rhombic, sucrosic; in part calcitic. Contains scattered ostracodes. Weathers yellowish gray to dark yellowish orange; massive; resistant; cliff forming 12

Dolomite breccia, calcitic, silty, yellowish-gray, very finely crystalline to microcrystalline, cherty. Contains rounded to angular fragments of light olive-gray chert, weathering white. Weathers to yellowish-gray rough surface; moderately resistant; forms reentrant .. 2

Dolomite, yellowish-gray mottled with medium light-gray and pale-olive, very finely crystalline to microcrystalline, glauconitic, slightly silty. Grades to yellowish-gray glauconitic silty dolomite breccia, containing angular to rounded fragments, as much as ¾ in. long, of light brownish-gray very finely crystalline dolomite and flakes of greenish-gray shale. Weathers to dark yellowish-gray or yellowish-orange smooth surface; massive; resistant; ledge forming 5

Dolomite breccia, calcitic, silty, sandy, yellowish-gray and light-gray, finely crystalline to microcrystalline. Contains subrounded to angular fragments, as much as 1 in. in diameter, of greenish-gray silty sandy dolomite and brownish-gray and pale yellowish-brown calcitic dolomite. Weathers to yellowish-gray or very pale orange rough surface; moderately resistant; forms reentrant 3

Dolomite, brownish-gray mottled with pale yellowish-orange, finely to very finely crystalline, rhombic, sucrosic, slightly calcitic. Weathers to yellowish-orange or grayish-orange rough surface; medium bedded; resistant; forms two ledges 2

Dolomite, very silty, sandy, greenish-gray to medium light-gray, very finely crystalline to microcrystalline, pyritic. Weathers to yellowish-gray or light olive-gray smooth surface; thin bedded; moderately resistant; forms reentrant 2

Dolomite, medium light-gray and light-gray mottled and streaked with pale yellowish-orange, finely to very finely crystalline, rhombic, sucrosic, porous; in part stained dusky yellow by limonite. Weathers to yellowish-gray or yellowish-orange rough surface; thick bedded to massive; resistant; cliff forming 18

Dolomite, silty, yellowish-gray to very pale orange, microcrystalline to cryptocrystalline, glauconitic. Bottom ½ ft. is light-gray to yellowish-gray silty dolomite weathering light olive gray. Weathers to pale yellowish-orange smooth surface; laminated to platy; weakly resistant; forms reentrant 3

Dolomite breccia, silty, yellowish-gray to pale yellowish-brown, very finely crystalline to microcrystalline. Contains angular to subrounded intraformational fragments of pinkish-gray, pale yel-

lowish-brown, and pale-red dolomite. Partly stained moderate orange pink and moderate reddish brown by hematite. Gradational to and intertonguing with underlying unit, which is source of many breccia fragments. Weathers dark yellowish orange and grayish orange; massive; forms weakly resistant ledge 5

Dolomite, light-gray and dark yellowish-gray, microcrystalline to very finely crystalline, slightly silty. Upper 2 ft. is brecciated and intertongues with overlying unit. Weathers to yellowish-orange or pale yellowish-gray smooth surface; platy to laminated; forms weakly resistant ledge 5

Dolomite, light-gray mottled, streaked, and banded with yellowish-gray, microcrystalline to very finely crystalline; upper 4 ft. pseudobrecciated. Basal 1 ft. is yellowish-gray glauconitic dolomitic siltstone that forms reentrant. Weathers to yellowish-gray surface that is rough and mottled with light gray in upper 4 ft.; thin to medium bedded; resistant; ledge forming 10

Dolomite, pseudobrecciated, yellowish-gray to yellowish-orange mottled, banded, and streaked with light-gray, very finely to finely crystalline, rhombic, sucrosic, porous, slightly calcitic. Middle 3 ft. is intraformational dolomite breccia, containing angular fragments, as much as 1 ft. in diameter, of light-gray and pale yellowish-brown microcrystalline dolomite. Weathers to yellowish-gray rough surface; massive; resistant; ledge forming 9

Dolomite, banded yellowish-gray and very light gray, microcrystalline to cryptocrystalline, slightly argillaceous; in part brecciated. Grades to intraformational dolomite breccia with broken very light gray beds forming fragments in yellowish-gray matrix. Weathers light olive gray; thin bedded to platy; weakly resistant; forms reentrant 1

Dolomite breccia, silty, pale yellowish-orange, microcrystalline, slightly calcitic. Contains fragments of light-gray dolomite that is derived laterally from 1- to 2-in.-thick interbeds. Weathers yellowish gray and light olive gray; medium bedded to platy; resistant; ledge forming 5

Dolomite breccia, argillaceous, yellowish-gray and yellowish-orange, microcrystalline. Contains rectangular fragments, 1- to 2-in. long, of yellowish-brown and yellowish-orange finely microcrystalline dolomite that is derived laterally from 1- to 2-in.-thick interbeds. Basal 1 ft. is yellowish-gray silty dolomite. Weathers to yellowish-gray and very light gray rough surface; wavy to contorted bedding; platy; moderately resistant; forms reentrant 5

Dolomite, calcitic, mottled and banded brownish-gray, yellowish-gray, and pale to dark yellowish-brown, finely crystalline, rhombic, sucrosic, fetid. Upper part contains stromatoporoids. 1-ft.-thick bed, 4 ft. below top, contains nodules of light olive-gray dense

chert, weathering white. Weathers to yellowish-gray and light olive-gray smooth or slightly rough surfaces; medium to thick bedded; resistant; ledge forming 17

Dolomite, calcitic, silty, sandy, mottled light-gray and yellowish-gray, microcrystalline to cryptocrystalline. Top ft. interbedded with lenses of light-gray very fine to medium-grained calcareous sandstone. Bottom ft. is light olive-gray to greenish-gray sandy dolomitic siltstone. Weathers light olive gray and grayish orange; platy; weakly resistant; forms reentrant 4

Dolomite, yellowish-gray and pale to dark yellowish-brown, very finely crystalline, rhombic, sucrosic, porous, fetid. Bottom 2 ft. is microcrystalline slightly silty dolomite, weathering light olive gray. Weathers to yellowish-gray or pale yellowish-brown smooth or slightly pitted surface; thick bedded; resistant; ledge forming .. 14

Total lower member 285

Total Jefferson Formation 312

Disconformity.

Thickness Ft.

BEARTOOTH BUTTE FORMATION:

Dolomite, very silty, yellowish-gray, grayish-yellow, and greenish-gray to light-gray, microcrystalline. Grades to dolomitic siltstone. In part sandy and conglomeratic, containing subrounded granules and small pebbles of grayish-red microcrystalline dolomite. Interbedded with lenses of dark yellowish-orange very finely crystalline silty dolomite and grayish-yellow fine- to medium-grained dolomitic sandstone. Weathers grayish yellow, yellowish gray, and pale yellowish orange; thin bedded to platy; moderately resistant; forms 1- to 2-ft.-thick ledges 8-18

Siltstone, dolomitic, grayish-red; and grayish-red silty microcrystalline dolomite. In part conglomeratic, containing pebbles of light-gray microcrystalline dolomite. Interbeds, ½ to 1 ft. thick, are yellowish-brown dense dolomitic limestone. Thin bedded to laminated; forms weakly resistant ledges or partly covered slope .. 0-35

Dolomite conglomerate. Light-gray, yellowish-gray, and pinkish-gray microcrystalline silty dolomite matrix contains subrounded to subangular granules, pebbles, and cobbles, and angular boulders, as much as 6 ft. long, of light-gray microcrystalline Bighorn Dolomite, partly stained grayish red and pale reddish brown. Interbedded with yellowish-gray microcrystalline to very finely crystalline silty dolomite. Intertongues with overlying unit. Unconformably overlies and fills irregular channels and crevices in underlying Bighorn Dolomite. Weathers to yellowish-gray and pinkish-gray very rough surface; moderately resistant; forms irregular ledges .. 3-24

Total Beartooth Butte Formation 11-77

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE.

Composite stratigraphic section

Cottonwood Canyon, Bighorn Mountains

On north wall of canyon, except Beartooth Buttte Formation and Bighorn Dolomite measured on south wall. In sec. 34, T. 57 N., R. 93 W., Big Horn County, Wyo. (Cody, Wyoming, 1:250,000 AMS sheet NL 12-12). Ledges and cliffs, which form most of section, measured directly by steel tape; a few slopes measured by tape and Brunton compass traverse. Beds strike N. 15° E. and dip 21° NW. on north wall; beds strike N. 10° E. and dip 6° NW. on south wall.

[Measured by C. A. Sandberg, assisted by P. W. Richards in 1956, A. E. Roberts in 1959, E. V. Stephens in 1960, and W. S. Alvarez in 1962. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN: **Thickness Ft.**

MADISON LIMESTONE:

Dolomite, calcitic, light-gray, yellowish-gray, and very pale yellowish-brown, microcrystalline, microsucrosic, finely to coarsely fossil-fragmental, crinoidal, slightly silty. Contains crinoid columnals and leached fossil molds, mostly of crinoids. Weathers to yellowish-gray rough, pitted surface; massive; resistant; cliff forming .... 21+

Limestone, dolomitic, medium light-gray, medium-gray, and light olive-gray, microcrystalline, finely to coarsely fossil-fragmental, crinoidal. Grades laterally to calcitic dolomite. Contains *Syringopora* sp. and *Vesiculophyllum* sp. corals in lower 3 ft. Weathers medium gray; medium to thick bedded; resistant; forms 3 slightly reentrant ledges 7

Dolomite, calcitic, medium-gray, medium light-gray, and light olive-gray, microcrystalline, very finely to finely fossil-fragmental, slightly silty. Bottom 2 in. is silty and slightly hematitic. Contains scattered crinoid columnals and small brachiopods. Weathers medium gray; thin to medium bedded; moderately resistant; forms 2 reentrant ledges 2

Total measured Madison Limestone ..... 30+

Gradational contact.

MISSISSIPPIAN AND DEVONIAN:

Dolomitic facies of dark shale unit:

Dolomite, calcitic, silty, yellowish-gray and light olive-gray mottled with yellowish-orange, microcrystalline, microsucrosic, slightly argillaceous, containing scattered limonite nodules and leached

fossil molds mostly of crinoids. Contains Lower Carboniferous (*cu*l) conodont fauna from ½ to 1½ ft. above base (Gilbert Klapper, written commun., Oct. 15, 1962). Weathers to yellowish-gray and pale yellowish-orange minutely pitted surface; thin to medium bedded; moderately resistant; forms reentrant ledge 3

Slight disconformity.

Dolomite, calcitic, grayish-orange to pale yellowish-brown and medium light-gray to light olive-gray, very finely crystalline, rhombic, sucrosic, vuggy, slightly sandy, slightly silty, slightly limonitic. Silt is subangular grains of quartz, slightly smaller than very fine grained sand. Sand is fine to medium rounded, frosted grains of quartz. Contains fish fragments and Upper Devonian (*to*V) conodont fauna in lower 1½ ft. (Gilbert Klapper, written commun., Oct. 15, 1962). Weathers to grayish-orange, yellowish-orange, and light yellowish-brown pitted surface; medium bedded; moderately resistant; forms reentrant ledge 2

Dolomite, calcitic, silty, grayish-orange, dark yellowish-orange, yellowish-orange, pale to moderate yellowish-brown and medium light-gray, very finely crystalline, rhombic, sucrosic, limonitic, slightly sandy, containing wisps and laminae of dark-gray to black carbonaceous dolomitic quartzose shale and nodules of limonite. Silt is subangular grains of quartz, slightly smaller than very fine grained sand. Sand is fine to coarse rounded, frosted grains of quartz. Fucoidal and *Taonurus* markings on bedding planes. In 3 ledges. 1-in.-thick reentrant at top and 2 2-in.-thick reentrants that separate ledges are black and mottled greenish-gray, yellowish-gray, and dark-gray carbonaceous dolomitic quartzose shale. Dolomite ledges contain abundant conodonts and fish fragments. Shale interbeds also contain conodonts, which were determined to be Upper Devonian (*to*V) by Ethington, Furnish, and Wingert (1961). Dolomite weathers to dark yellowish-orange smooth surfaces except upper 1-ft. ledge which weathers yellowish orange; shale weathers yellowish gray; thin to medium bedded; moderately resistant; ledge forming 7

Dolomite, calcitic, very silty, very sandy, conglomeratic, pale yellowish-brown, grayish-orange, medium-gray, and medium dark-gray, grading to subangular to subrounded very fine grained very dolomitic siltstone and sandstone. Contains laminae of black carbonaceous dolomitic quartzose shale, granules and rounded pebbles of yellowish-gray and greenish-gray microcrystalline silty dolomite, fine to coarse rounded frosted grains of quartz, and nodules of limonite and phosphate. Also contains very abundant conodonts and fish bones, plates, teeth, and scales. Conodonts determined to be Upper Devonian (*to*V) by Gilbert Klapper (written commun., Oct. 15, 1962). Weathers light brown and dark yellowish orange; medium bedded; moderately resistant; forms ledge at base of cliff 1

Total dolomitic facies of dark shale unit 13

Unconformity.

DEVONIAN:

JEFFERSON FORMATION:

Lower member:

Siltstone, dolomitic, light greenish-gray, greenish-gray, and grayish-yellow-green, glauconitic, slightly pyritic; partly sandy. Grades in part to sandy silty dolomite. Sand is fine to coarse, rounded to well-rounded grains of quartz. Weathers yellowish gray; thin bedded to thinly laminated; nonresistant; forms partly covered slope with several weakly resistant, thin ledges near base and top .. 26

Dolomite, argillaceous, light-gray and yellowish-gray, microcrystalline to very finely crystalline, slightly silty; in part brecciated. Weathers yellowish gray and pale yellowish orange; thick bedded in upper 8 ft.; thin, hackly bedding in lower 8 ft.; forms moderately resistant ledges 16

Dolomite, grayish-orange, pale yellowish-orange, grayish-yellow, and white, cryptocrystalline to very finely crystalline, slightly argillaceous; in part slightly calcitic; in part slightly glauconitic. 1 ft. below top is 3-ft. bed of light greenish-gray mottled with pale yellowish-orange microcrystalline sandy very silty dolomite, containing stringers of greenish-gray and light olive-gray silty dolomitic shale. Weathers grayish orange, yellowish gray, and yellowish orange, medium bedded; forms moderately resistant ledges 8

Dolomite, silty, very sandy, dusky-yellow to pale-olive, glauconitic, argillaceous. Sand is largely very fine to coarse, subrounded to well-rounded grains of quartz but includes some coarse to very coarse, subangular to subrounded grains of white calcite. Weathers to yellowish-gray to grayish-orange smooth surface; thin bedded; forms moderately resistant ledge 5

Limestone, dolomitic, light-gray and light brownish-gray, very finely to finely crystalline, sucrosic, siliceous; grades in part to calcitic dolomite. Weathers to yellowish-gray to grayish-orange rough surface with large pits in part; massive; resistant; cliff forming 8

Dolomite, very silty, argillaceous, greenish-gray and pale-olive, microcrystalline, slightly sandy, glauconitic; grades to and interbedded with dolomitic siltstone. Basal 1 ft. is white finely microcrystalline dolomite that weathers to very pale orange smooth, powdery surface. Weathers to yellowish-gray to light olive-gray smooth surface; platy to laminated; weakly resistant; forms reentrant 6

Dolomite, pale yellowish-brown, yellowish-gray, and pinkish-gray, very finely crystalline, rhombic, sucrosic, porous; upper 2 ft. calcitic. Basal ½ ft. is light greenish-gray microcrystalline, slightly

glauconitic, silty, sandy, argillaceous dolomite that forms slight reentrant. Weathers to yellowish-gray to grayish-orange granular surface; medium bedded; resistant; ledge forming 11

Limestone, dolomitic, white mottled with pale-yellow, finely microcrystalline, coarsely fragmental, containing grains of clear calcite; and pale yellowish-orange to grayish-orange microcrystalline dolomite. Weathers very pale orange and dark yellowish orange; medium bedded; resistant; ledge forming 7

Dolomite, very silty, yellowish-gray and pale-olive, microcrystalline, earthy, glauconitic. Weathers to yellowish-gray smooth, powdery surface; laminated; weakly resistant; forms reentrant 3

Dolomite, medium-gray and yellowish-brown, finely crystalline, rhombic, sucrosic, porous. Top 2 ft. is white finely microcrystalline dolomite, in part brecciated and recemented by light-gray finely crystalline calcite. Weathers yellowish gray; thick bedded; resistant; ledge forming 14

Siltstone, dolomitic, greenish-gray and yellowish-gray, glauconitic, argillaceous. Top 1 ft. is yellowish-gray silty dolomite containing stromatoporoids. Weathers light greenish gray and yellowish gray; platy to thinly laminated; weakly resistant; forms reentrant .. 4

Dolomite, yellowish-gray and pale yellowish-brown, very finely to finely crystalline, rhombic, sucrosic; in part calcitic. Top 1½ ft. is white finely microcrystalline earthy dolomite. Weathers yellowish gray to yellowish orange; medium bedded; resistant; ledge forming 7

Dolomite, silty, sandy, yellowish-gray, light greenish-gray, white, and pale to moderate yellowish-brown, microcrystalline, earthy. Bottom 2 ft. is very sandy; sand is very fine to coarse, subrounded to rounded grains of quartz, some of which are replaced peripherally by dolomite. Thin bedded to laminated; moderately resistant; forms reentrant 6

Dolomite, light greenish-gray and yellowish-gray, very finely crystalline, sucrosic, slightly silty. In 1- to 2-ft.-thick beds separated by stringers of yellowish-gray and greenish-gray laminated dolomitic siltstone. Lower part contains round, flat algal(?) nodules, as much as 40 mm in diameter and 4 mm thick, composed of microcrystalline dolomitic limestone that weathers light brownish gray. Weathers yellowish gray or grayish orange; resistant; ledge forming 11

Dolomite, argillaceous, yellowish-gray, yellowish-orange, very pale orange, and dusky-yellow, microcrystalline to cryptocrystalline; in part very silty, containing stringers of greenish-gray dolomitic siltstone. 7 ft. below top is 2-ft. weakly resistant ledge of dusky-yellow and yellowish-orange porous microcrystalline dolomite. Weathers yellowish gray; platy to laminated; nonresistant; forms partly covered slope 22

Dolomite, light-gray mottled with yellowish-gray and dark yellowish-orange, very finely crystalline, sucrosic. In two beds separated by a few inches of very pale orange finely microcrystalline dolomite. Weathers yellowish gray; medium bedded; weakly resistant; ledge forming 4

Dolomite, argillaceous, pale yellowish-orange to very pale orange, microcrystalline to cryptocrystalline, cherty. Contains two ⅜-in.-thick stringers of medium dark-gray to brownish-gray dense primary chert; stringers partly broken into rectangular blocks, some of which are rotated perpendicular to bedding. Weathers pale to dark yellowish orange; thin bedded; weakly resistant; slope forming 7

Dolomite, moderate to dark yellowish-brown and brownish-gray, finely crystalline, sucrosic. Weathers to dark yellowish-orange or moderate yellowish-brown smooth surface; in 6- to 12-in.-thick beds; forms moderately resistant ledges 12

Dolomite, medium light-gray to light olive-gray and light-gray to pale yellowish-brown, finely crystalline, rhombic, sucrosic. Weathers yellowish gray; massive; resistant; cliff forming 25

Total lower member of Jefferson Formation 202

SOURIS RIVER FORMATION:

Dolomite, calcitic, carbonaceous, pale yellowish-brown, pale-brown, and light brownish-gray, microcrystalline, slightly silty. Contains *Bothriolepis* sp. fish plates and abundant spores, megaspores, carbonized plant fragments, and large flattened plant stems. The well-preserved sport flora (USGS Paleobot. Loc. D1532-1-4) consists almost entirely of a single species, *Punctatisporites* cf. P. *planus* Hacquebard (R. H. Tschudy, written commun., Feb. 14, 1962), but it also contains a few individuals of other genera including *Acanthotriletes* sp., *Ancyrospora* sp., *Cristatisporites* sp., and *Spinozonotriletes* sp. (R. A. Scott, written commun., Mar. 5, 1965). Grades eastward to medium-bedded brown- to yellowish-gray or grayish-orange smooth, powdery surface; thin ish-gray to brownish-black carbonaceous dolomitic limestone, containing marcasite or pyrite concretions and scattered white coiled worm tubes, about 1 mm in diameter, of *Spirorbis* sp. Weathers to yellowish-gray or grayish-orange smooth, powdery surface; thin bedded to platy but thinly laminated and fissile at base; forms reentrant 1½

Limestone, spirorbal, medium dark-gray, medium to coarsely fragmental, slightly silty, slightly dolomitic, pyritic (Sandberg, 1963a, fig. 63.2). Composed largely of *Spirorbis* tubes, ½ to 1 mm in diameter. Interbedded with thin lenses of fissile moderate yellowish-brown and grayish-brown microcrystalline silty calcitic dolomite, containing scattered *Spirorbis* tubes. Biota includes spores,

carbonized macerated plant remains and large flattened stems as much as 2 in. wide, fish plates and teeth, and rounded pebbles of carbonized wood as much as 1 in. in diameter (USGS Paleobot. Loc. D1532-1-4 and D1551). Fish remains include plates of *Bothriolepis* cf. *B. coloradoensis* Eastman, and palaeoniscoid teeth cf. *Rhadinisthys* sp. (F. C. Whitmore, Jr., written commun., July 14, 1961) and scales of *Holoptychius* cf. *H. giganteus* Eastman (D. H. Dunkle, written commun., Feb. 5, 1963). The spores and fish indicate an early Late Devonian age. Pyrite coats many *Spirorbis* tubes and partly replaces some carbonized wood pebbles. Weathers pale brown and yellowish gray; thin bedded to thinly laminated; forms weakly resistant ledges 2½

Limestone, carbonaceous, argillaceous, dark-gray and brownish-gray, microcrystalline to cryptocrystalline. Contains scattered white *Spirorbis* tubes and spores, megaspores, and carbonized macerated plant remains (USGS Paleobot. Loc. D1532-5; written communs., R. H. Tschudy, Feb. 14, 1962; R. A. Scott, Mar. 5, 1965). Weathers to very light gray or yellowish-gray smooth, rounded surface; medium bedded; forms weakly resistant ledge 1

Dolomite, calcitic, carbonaceous, silty, dark yellowish-brown, pale-brown, and grayish-brown microcrystalline, earthy, porous, friable. Contains fish plates and teeth and scattered *Spirorbis* tubes, and spores, megaspores and carbonized plant remains (USGS Paleobot. Loc. D3037-B; R. H. Tschudy, written commun., June 27, 1963). Weathers yellowish gray; thin bedded to laminated; nonresistant; forms partly covered slope with 1½-ft.-thick ledge near middle 9

Dolomite, silty, pale to dark yellowish-brown and yellowish-gray mottled with pale yellowish-brown; in part carbonaceous. Dark yellowish-orange porous finely to very finely crystalline rhombic sandy dolomite at base. Contains fish plates, scales, and teeth, and spores, megaspores, and carbonized plant stems (USGS Paleobot. Loc. D3037-A; R. H. Tschudy, written commun., Jun. 27, 1963). Weathers to yellowish-gray or yellowish-orange smooth surface; thin bedded; forms weakly resistant ledge that directly overlies moderately resistant ledge of very light gray to light-gray microcrystalline microsucrosic Bighorn Dolomite 2

Total Souris River Formation 16

BEARTOOTH BUTTE FORMATION:

Covered slope beneath basal cliff of Jefferson Formation; top part of interval may include Souris River Formation, as exposed on south wall of canyon 39

Dolomite, silty, yellowish-gray, greenish-gray, light-gray to medium light-gray, and light olive-gray, microcrystalline to very finely crystalline. In part sandy; sand is fine to very fine, subangular to subrounded grains of quartz. Contains eurypterids, plant stems, and

abundant fish remains, among which D. H. Dunkle (written commun., Oct. 14, 1959) recognized plates of *Protaspis* sp., *Cryptaspis* sp., and ?*Eurypaspis* sp. of Bryant, which indicate an Early Devonian age. Interbedded with ¼- to 2-in.-thick lenses of yellowish-orange and grayish-orange-pink fine-grained partly conglomeratic dolomitic sandstone, containing subangular to surbrounded grains of quartz and scattered fish fragments. Weathers yellowish gray, grayish orange, yellowish orange, and light brown; in 1- to 12-in.-thick beds; forms moderately resistant ledges and low cliffs 33

Dolomite, silty, sandy, greenish-gray to medium-gray, microcrystalline. Interlaminated with pale to moderate reddish-brown very fine grained dolomitic sandstone. Contains fish fragments. Lower half is grayish-red and pale-red slightly sandy very silty dolomite. Laminated to thinly laminated; weakly resistant; forms reentrant .. 1

Dolomite, silty, mottled and banded grayish-red, pale-red, and pale and moderate reddish-brown, very finely crystalline to microcrystalline. Contains scattered fish fragments. Upper 13 ft. is very sandy and conglomeratic, and contains fine to very fine grains of quartz and rounded granules and small pebbles of light-gray and very light gray cryptocrystalline Bighorn Dolomite. Middle 10 ft. contains lenses of light greenish-gray and dark yellowish-orange silty dolomite. Lower 10 ft. is slightly crossbedded and contains lenses of pale-red-purple and light greenish-gray silty dolomite. Weathers largely moderate to dark reddish brown but partly pale red, moderate reddish orange, or pale reddish brown; thin to thick bedded except top 5 ft. which is massive; resistant; cliff forming .. 33

Dolomite, pale-red mottled and banded with grayish-red, very finely crystalline, sucrosic, slightly silty; conglomeratic at base. Top 1½ ft. is very light gray, very finely crystalline partly brecciated sucrosic dolomite, weathering yellowish gray. Middle is partly brecciated and vuggy and contains lenses of intraformational silty dolomite breccia. Weathers to light-brown or moderate reddish-orange smooth, powdery surface; wavy irrigular bedding; resistant; forms lenticular ledge at base of cliff 7

Shale, dolomitic, silty, sandy, largely moderate reddish-brown and grayish-red with some pale-red and greenish-gray. Contains thin interbeds of light-brown to pale reddish-brown very finely crystalline very silty dolomite. Weathers light brown, moderate reddish orange, and grayish red; lenticular and as thin as 2 ft. in places; weakly resistant; forms partly covered slope 5

Sandstone, dolomitic, pale reddish-brown with grayish-orange-pink mottles, fine- to medium-grained, subangular to subrounded. Top 3 ft. is white and friable. Two-ft.-thick bed, 9 ft. below top, is very pale orange to moderate-orange-pink crossbedded, slightly glauconitic, dolomitic sandstone, containing granules and small pebbles of very light gray cryptocrystalline Bighorn Dolomite. Weathers pale

to dark reddish brown and moderate reddish orange, except light-colored beds at top and 9 ft. below top, which weather grayish orange; platy to medium bedded except light-colored beds which are massive; moderately resistant; forms 4 ledges 17

Dolomite conglomerate, sandy, very light gray, pinkish-gray, and grayish-orange-pink with grayish-red hematitic mottles; grades to and interbedded with irregular lenses of very fine to medium-grained conglomeratic dolomitic sandstone. Sandstone and conglomerate contain subrounded to rounded granules, pebbles, and cobbles, as much as 8 in. in diameter, of white to very light gray microcrystalline to cryptocrystalline Bighorn Dolomite, stained yellowish gray. Contains abundant fish plates, among which D. H. Dunkle (written commun., Oct. 14, 1959) recognized *Protaspis* sp., *Cryptaspis* sp., and ?*Euryaspis* sp. of Bryant, which indicate an Early Devonian age. Weathers yellowish gray; massive; moderately resistant; ledge forming 5

Total Beartooth Butte Formation 140

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, very light gray and white, cryptocrystalline to microcrystalline. Weathers light gray but partly stained reddish orange by weathering of overlying beds; massive, resistant; ledge forming .... 8+

Total measured Bighorn Dolomite ..... 8+

Composite stratigraphic section

Ed Point area, Bighorn Mountains

On Ed Point ridge and unnamed ridge to north. In NW ¼ sec. 27 and SE ¼ sec. 20, T. 50 N., R. 87 W. (unsurveyed), Big Horn County, Wyo. (Lake Solitude 7½-minute quadrangle). Slopes measured by tape and Brunton compass traverse; ledges measured directly by steel tape. All thicknesses rounded to nearest foot. Beds strike N. 15° W. and dip 4° SW. on ridge north of Ed Point.

[Measured by C. A. Sandberg and C. J. Galvin in 1958. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN:

MADISON LIMESTONE:

Dolomite, light-gray, yellowish-gray, and grayish-orange-pink, very finely crystalline to microcrystalline, microsucrosic, porous. Vuggy porosity results from leached molds of fossils, largely crinoids. Weathers to pale yellowish-brown or pinkish-gray smooth surface. Massive; resistant; cliff forming ..... 10+

Total measured Madison Limestone ..... 10+

Concealed contact.

MISSISSIPPIAN AND DEVONIAN:

DOLOMITIC FACIES OF DARK SHALE UNIT:

Dolomite, silty, yellowish-gray, grayish-yellow, yellowish-orange, and dusky-yellow, microcrystalline, siliceous. Upper half is sandy dolomite containing scattered subrounded to rounded fine to coarse grains of quartz and pods and ripples of dolomitic sandstone grading to orthoquartzite. Weathers to grayish-yellow or pale yellowish-brown smooth, powdery surfaces; thin bedded; nonresistant; upper half largely covered; lower half forms partly covered slope .. 8

Limestone, dolomitic, light olive-gray, light brownish-gray, and dark greenish-gray mottled and streaked with pale-red-purple and grayish-red-purple, cryptocrystalline to very finely crystalline, fragmental, slightly hematitic. Upper 6 in. contains abundant round algal balls, 1 to 2 in. in diameter, which resemble *Solenopora* sp. (P. E. Cloud, Jr., written commun., Feb. 5, 1959) and encrust brachiopods. Less abundant larger algae (or stromatoporoids) are fan shaped, yellowish gray, and as much as 8 in. in length. Associated with algae are a conodont fauna, dominated by *?Scaphignathus velifera*, and an assemblage of large rhynchonellid and small spiriferid brachiopods. Weathers to dark yellowish-gray granular surface except algae which weather to pale-red-purple, grayish-red-purple, and yellowish-gray smooth surfaces; medium bedded; resistant; ledge forming 3

Total dolomitic facies of dark shale unit 11

Concealed contact.

DEVONIAN:

JEFFERSON FORMATION:

Lower member:

Covered slope 4

Dolomite, sandy, yellowish-gray to light olive-gray, mottled and streaked with pale-red-purple, microcrystalline to very finely crystalline, microsucrosic, slightly hematitic, porous. Pinpoint vuggy porosity results from leaching of fossils. Sand is very fine to coarse, subrounded to rounded, frosted grains of quartz. Weathers yellowish-gray; moderately resistant; ledge forming 1

Dolomite, moderate yellowish-brown, finely to medium-crystalline, rhombic, sucrosic, slightly calcitic, porous. Weathers to pale yellowish-brown surface with large pits parallel to bedding; medium bedded; resistant; ledge forming 2

Dolomite, silty, calcitic, banded grayish-orange-pink and light greenish-gray, microcrystalline, earthy. Contains lenses of moder-

ate-red very fine grained hematitic dolomitic sandstone, composed largely of quartz with scattered phosphate pellets and glauconite grains. Weathers to yellowish-gray and pinkish-gray banded surface with sandstone lenses in relief; platy to laminated; moderately resistant; forms reentrant ledge 1

Partly covered slope; probably pinkish-gray silty dolomite 2

Dolomite, yellowish-brown to light olive-gray, finely to very finely crystalline, sucrosic, slightly calcitic, porous; in part fragmental. Weathers yellowish brown to yellowish gray; thin bedded in 3- to 6-in. beds; resistant; ledge forming 3

Covered slope 1

Total lower member of Jefferson Formation 14

Unconformity.

BEARTOOTH BUTTE FORMATION:

Dolomite conglomerate, sandy, calcitic, yellowish-gray streaked with grayish-red, hematitic, containing subrounded to subangular granules and pebbles, as much as ½ in. in diameter, of light-gray to light olive-gray Bighorn Dolomite. Grades to conglomeratic dolomitic sandstone, composed of very fine subangular to well-rounded grains of quartz, abundant grains of hematite, subrounded granules of light-gray Bighorn Dolomite, and scattered black phosphate pellets. Moderately resistant; ledge forming; 2 ft. thick. Unit thickens abruptly along outcrop and fills channel cut deeply into underlying Bighorn Dolomite. Channel fill is largely weakly resistant grayish-red hematitic siltstone, shale, and silty dolomite, which form moderate reddish-brown to moderate reddish-orange partly covered slope, but it includes interbeds of calcitic dolomite conglomerate. The dolomite conglomerate, which resembles the thin, ledge-forming facies, is mottled yellowish gray, pinkish gray, and very light gray and contains subrounded pebbles, as much as ½ in. in length, of light brownish-gray cryptocrystalline Bighorn Dolomite. Cobbles and boulders of light-gray Bighorn Dolomite and large boulders of calcitic dolomite conglomerate, as much as 7 ft. long, litter partly covered slope. Maximum thickness of channel fill 70

Total Beartooth Butte Formation 70

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, very light gray mottled with pale-yellow, and pale yellowish-brown motled with dark yellowish-brown, micro-crystalline to cryptocrystalline, microfragmental, containing white chert and

favositid corals; in part microsucrosic. Stained pinkish gray, yellowish orange, and grayish orange pink. Massive; resistant; forms ledge that weathers to large rounded light-gray blocks about 10 to 20 ft. long 10

Dolomite, very light gray to pale greenish-yellow and pale yellowish-gray, microcrystalline, microsucrosic. Moderately resistant; slope forming 24

Dolomite, light-gray, very finely crystalline, sucrosic, containing leached molds of fossils including brachipods. Channel filled by Beartooth Butte Formation cut to within about 10 ft. of approximate base of this unit. Weathers light gray to very light gray; thick bedded to massive; resistant; cliff forming ..... 41+

Total measured Bighorn Dolomite ..... 75+

Stratigraphic section

Hunter Peak, Absaroka Range

On north side of Hunter Peak, below west (8,949-foot) summit, about ¾ mile south of Squaw Creek and 2 miles south of Sunlight Basin Road. At lat 44°52′30″ N., long 109°41′ W. in T. 57 N., R. 106 W. (unsurveyed), Park County, Wyo. (Beartooth Butte 15-minute quadrangle). Slopes measured by tape and Brunton compass traverse and intervals checked approximately by hand leveling; ledges and cliffs measured directly by steel tape. All thicknesses rounded to nearest foot. Beds strike N. 65° E. and dip about 2° SE.

[Measured by P. W. Richards and W. G. Pierce in 1956. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN: **Thickness Ft.**

MADISON LIMESTONE:

Dolomite, light olive-gray to medium light-gray, very finely crystalline, microsucrosic, mottled and stained pale red and light brown by hematite. Weathers light brown and moderate brown; massive; resistant; cliff forming ..... 20+

Dolomite, light olive-gray, yellowish-gray, grayish-orange, and pale to moderate yellowish-brown, microcrystalline; silty dolomite at base. Medium bedded to massive; resistant; forms several ledges.. 30

Total measured Madison Limestone ..... 50+

MISSISSIPPIAN AND DEVONIAN:

SHALE AND SILTSTONE FACIES OF DARK SHALE UNIT:

Siltstone, carbonaceous, medium dark-gray banded and streaked with yellowish-gray, slightly dolomitic. Silt is subangular to subrounded very coarse grains of quartz, which approach very fine

sand grains in size. Weathers medium gray mottled with pale yellowish brown; platy to laminated; weakly resistant; forms reentrant 5

Siltstone, carbonaceous, light olive-gray to moderate yellowish-brown with medium dark-gray streaks and laminae, coarse-grained, slightly dolomitic. Lower 6 ft. is medium-gray to medium dark-gray sandy quartzitic siltstone. Weathers pale to moderate yellowish brown; platy at base and thin bedded at top; moderately resistant; forms thin ledges 14

Siltstone, carbonaceous, medium dark-gray with moderate yellowish-brown lenses and pods, slightly dolomitic. Contains conodonts. Weathers medium gray and pale yellowish brown; laminated to thinly laminated; weakly resistant; slope forming 9

Siltstone, carbonaceous, quartzitic, medium dark-gray mottled with light olive-gray to medium yellowish-brown. Weathers yellowish brown; moderately resistant; ledge forming 3

Shale, quartzose, carbonaceous, medium dark-gray mottled with yellowish-gray, slightly dolomitic, containing conodonts. Oil yield on pyrolysis by Ruska Still method is 10.3 gal. per ton (R. F. Gantnier, written commun., July 27, 1959). Weathers yellowish brown; laminated; weakly resistant; slope forming 14

Total shale and siltstone facies of dark shale unit 45

Unconformity.

DEVONIAN:

THREE FORKS FORMATION:

Logan Gulch Member:

Dolomite, silty, shaly, yellowish-gray and pale to dark yellowish-orange streaked with greenish-gray microcrystalline, containing partings and laminae of dolomitic shale. Interbedded with dark yellowish-orange dolomitic siltstone and yellowish-gray dolomitic shale. Weathers yellowish gray; upper 14 ft. forms weakly resistant ledges; lower 42 ft. forms partly covered slope 56

Total Logan Gulch Member of Three Forks Formation 56

JEFFERSON FORMATION:

Birdbear Member:

Dolomite, calcitic, pseudobrecciated, mottled pale yellowish-orange, yellowish-gray, and pale yellowish-brown, microcrystalline to very finely crystalline, porous. Weathers to yellowish-gray and grayish-orange rough, hackly surface; massive; resistant; cliff forming 27

Dolomite, dark yellowish-orange to moderate yellowish-brown, microcrystalline to very finely crystalline, slightly argillaceous. Weathers to moderate or dark yellowish-brown smooth surface; moderately resistant; forms reentrant ledge	3
Total Birdbear Member	30

Lower member:

Siltstone, shaly, dolomitic, yellowish-gray to light-olive gray, slightly glauconitic, containing pods and lenses of dark yellowish-orange siltstone and partings of greenish-gray shale. Weathers yellowish gray; laminated; weakly resistant; slope forming	14
Siltstone, dolomitic, argillaceous, sandy, yellowish-gray mottled with light-gray, glauconitic. Sand is very fine to medium, rounded, frosted grains of quartz. Weathers yellowish gray; moderately resistant; ledge forming	3
Dolomite, yellowish-gray to pale yellowish-orange, microcrystalline to very finely crystalline, slightly calcitic. Weathers yellowish gray; moderately resistant; forms thin ledges	6
Limestone breccia, yellowish-brown and yellowish-gray, microcrystalline to finely crystalline, glauconitic; upper 2 ft. is dolomitic; lower 2 ft. is argillaceous. Contains fragments of light greenish-gray silty shale. Weathers yellowish gray to light olive gray; resistant; ledge forming	4
Partly covered slope; 2-ft-thick ledge near middle is light-gray mottled with yellowish-gray very finely crystalline partly fragmental dolomitic limestone, which weathers to yellowish-gray laminated surface	7
Dolomite, yellowish-gray mottled with light-gray, microcrystalline to very finely crystalline. Weathers yellowish gray; thin bedded; moderately resistant; forms thin ledges	6
Covered slope	4
Dolomite, medium light-gray, dense; brecciated and recemented by very finely crystalline yellowish-gray dolomite. Weathers to yellowish-gray rough surface; thin to medium bedded; weakly resistant; forms thin, poorly exposed ledges	11
Dolomite, calcitic, yellowish-gray, finely crystalline, fossiliferous, containing brachiopod fragments. Top 3 ft. is brownish-gray dense siliceous limestone. Weathers yellowish gray to light olive gray; massive; resistant; forms 3 ledges	29
Limestone, dolomitic, dark yellowish-brown, dense, microfragmental. Weathers yellowish gray mottled with light brownish gray; and light gray; resistant; ledge forming	2

Dolomite, calcitic, grayish-yellow and yellowish-gray, microcrystalline, earthy; and light-gray to pale yellowish-brown dolomitic limestone. Contains brachiopod fragments. Weathers to yellowish-gray rough surface; resistant; ledge forming 8

Siltstone, dolomitic, sandy, argillaceous, motled grayish-yellow-green and yellowish-gray, glauconitic. Sand is very fine to coarse, subangular to rounded grains of quartz. Weakly resistant; forms reentrant 5

Limestone, dark yellowish-brown, dense, slightly dolomitic. Contains "calcispheres." Weathers yellowish brown; resistant; forms upper part of 13-ft. cliff 5

Limestone, dolomitic, moderate yellowish-brown, very finely crystalline to microcrystalline, microfragmental, containing scattered brachiopod fragments. Weathers to grayish-yellow rough surface; resistant; forms middle of 13-ft. cliff 4

Dolomite, siliceous, silty, light-gray mottled with yellowish-gray, microcrystalline, microsucrosic, slightly calcitic. Weathers yellowish brown; resistant; forms lower part of 13-ft. cliff 4

Dolomite, silty, sandy, grayish-yellow-green mottled with yellowish-orange, glauconitic; grades to dolomitic siltstone. Thin bedded; weakly resistant; forms partly covered reentrant 3

Limestone, dolomitic, very pale yellow to yellowish-gray, microcrystalline, earthy, silty, siliceous, weathering yellowish gray. Grades to medium light-gray to brownish-gray microcrystalline to very finely crystalline dolomitic limestone breccia, weathering yellowish orange and yellowish brown. Contains a few brachiopod fragments. Thin bedded; moderately resistant; ledge forming.... 4

Dolomite breccia, calcitic, yellowish-gray to greenish-gray, microcrystalline, silty, glauconitic. Contains angular to subrounded fragments of yellowish-brown dense limestone and yellowish-gray to pale-yellow microcrystalline dolomite. Weathers yellowish gray; resistant; forms lenticular ledge 7

Dolomite, light-gray, very finely crystalline, slightly calcitic, brecciated, weathering yellowish gray. Top 1½ ft. is pale yellowish-brown dense dolomitic limestone. Massive except thin bedded in top 1½ ft.; resistant; ledge forming 9

Dolomite breccia, shaly, yellowish-gray, slightly silty, microcrystalline, containing flakes and angular fragments of light greenish-gray shale. Weakly resistant; forms poorly exposed reentrant 2

Limestone, dolomitic, light-gray, very finely crystalline. Weathers yellowish gray to light olive gray; medium bedded; resistant; ledge forming 4

Limestone, dolomitic, siliceous, light-gray, very finely to finely crystalline. Contains ostracodes, about 1¼ mm in length. Weathers yellowish gray to light olive gray; platy; moderately resistant; forms reentrant 2

Dolomite, light-gray to yellowish-gray, finely to very finely crystalline, rhombic, sucrosic, slightly calcitic, porous. Resistant; ledge forming 2

Siltstone, dolomitic, sandy, yellowish-gray to light greenish-gray, slightly calcitic, glauconitic. Sand is fine to medium, rounded, frosted grains of quartz. Weakly resistant; forms partly covered slope 4

Limestone, light brownish-gray, light-gray, and pale yellowish-brown, dense, fossiliferous. Weathers yellowish gray; upper 9 ft. is thin bedded; basal 10 ft. is massive; resistant; cliff forming 19

Partly covered slope; 1-ft. bed near middle is yellowish-gray microcrystalline slightly glauconitic, argillaceous calcite dolomite 9

Dolomite, siliceous, mottled light-gray and light olive-gray to yellowish-gray, microcrystalline, microsucrosic, porous. Intraformational dolomite conglomerate, 1 ft. thick, present locally at base. Weathers yellowish gray to light olive gray; medium to thick bedded; resistant; ledge forming 12

Dolomite, light-gray to yellowish-gray, microcrystalline, microsucrosic, slightly argillaceous. Weathers yellowish gray; medium to thick bedded; resistant; ledge forming 15

Limestone, yellowish-brown to light brownish-gray, micro-crystalline to cryptocrystalline. Weathers to light olive-gray and medium-gray smooth surface; resistant; ledge forming 3

Dolomite, dark yellowish-gray, microcrystalline, earthy, slightly calcitic, slightly argillaceous. Weathers to light olive-gray or yellowish-gray smooth surface; forms weakly resistant ledge 3

Limestone, light-gray to yellowish-gray, dense; and yellowish-gray very finely crystalline cherty limestone containing subangular to angular reworked pebbles of light-gray chert. Weathers yellowish gray; lenticular; forms weakly resistant ledge 4

Dolomite, very light gray to yellowish-gray, microcrystalline, earthy, slightly calcitic; stained grayish orange in part. Weathers yellowish brown; platy to thin bedded; weakly resistant; forms reentrant 3

Limestone, dolomitic, yellowish-gray to yellowish-brown, very finely crystalline, sucrosic. Weathers yellowish gray to grayish yellow; thin bedded; moderately resistant; forms three 4-ft.-thick ledges 12

Dolomite, yellowish-gray to light olive-gray, microcrystalline. Upper 2 ft. is silty glauconite dolomite that grades to dolomitic sandy siltstone. Thin bedded; weakly resistant; slope forming	5
Dolomite, light olive-gray, brownish-gray and pale yellowish-brown, finely crystalline, rhombic, sucrosic, porous. Contains *Amphipora* and nodules and thin lenses of light-gray to light olive-gray chert. Weathers yellowish gray to light olive gray; resistant; upper 14 ft. is cliff forming; lower 2 ft. forms reentrant	16
Dolomite, silty, reddish-brown mottled with light olive-gray, slightly glauconitic. Weathers yellowish gray; moderately resistant; forms reentrant ledge	6
Total lower member	256
Total Jefferson Formation	286

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, very light gray with medium-gray mottles, microcrystalline, microsucrosic. Vuggy porosity results from leached fossil fragments. Massive; resistant; cliff forming	30+
Total measured Bighorn Dolomite	30+

Stratigraphic section

Little Bighorn Canyon, Bighorn Mountains

On west side of canyon below Fisher Mountain in SW ¼ sec. 19, T. 58 N., R. 89 W., Sheridan County, Wyo. (Sheridan, Wyoming-Montana, 1:250,000 AMS sheet NL 13-10). Slopes measured by tape and Brunton compass traverse; ledges and cliffs measured directly by steel tape. All thicknesses rounded to nearest foot. Beds strike N. 50° W. and dip 14° NE.

[Measured by C. A. Sandberg and P. W. Richards in 1957. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN:	Thickness Ft.
MADISON LIMESTONE:	
Dolomite, calcitic, yellowish-gray, very finely crystalline, slightly porous. Weathers medium light gray and moderate yellowish brown; massive; resistant; cliff forming	21+
Dolomite, calcitic, pale yellowish-brown to yellowish-gray, very finely crystalline, porous. Weathers pale yellowish brown; medium bedded; moderately resistant; forms reentrant	8

Dolomite, calcitic, very light gray to yellowish-gray and light olive-gray, microcrystalline and very finely crystalline, fossiliferous. Weathers yellowish gray and light gray; upper 5 ft. is medium bedded and forms moderately resistant ledges; lower 26 ft. is massive, resistant, and cliff forming	31
Total measured Madison Limestone	60+

DEVONIAN:

JEFFERSON FORMATION:

Lower member:

Siltstone, sandy, light greenish-gray, yellowish-gray, and very light gray, dolomitic, glauconitic. Contains 2-in.-thick interbeds of yellowish-gray and light-gray fine- to coarse-grained quartzitic sandstone 2 in. below top and at base. May be in part dolomitic facies of dark shale unit. Weathers yellowish gray; moderately resistant; forms ledge in lower part of cliff	1
Dolomite, very pale yellow, microcrystalline, earthy, powdery. Lower half is mottled light-gray and yellowish-orange very finely crystalline dolomite. Weathers to yellowish-orange and yellowish-gray smooth surfaces; medium bedded; moderately resistant; forms base of cliff	3
Covered slope	6
Dolomite, calcitic, yellowish-gray and light-gray, very finely crystalline, medium-bedded, weathering grayish orange. Bottom 4 ft. is massive bed of very light gray to yellowish-gray microcrystalline slightly calcitic dolomite, weathering light gray. Resistant; ledge forming	10
Dolomite, light-gray, yellowish-gray, and very pale yellow, microcrystalline, earthy, slightly calcitic. Interbedded with light greenish-gray sandy argillaceous dolomite and very light gray dolomitic siltstone, which contain glauconite and scattered, subangular to well-rounded, fine to medium grains of quartz. Weathers yellowish gray; thin bedded to platy; weakly resistant; forms partly covered slope	10
Limestone, pale yellowish-brown and medium light-gray, cryptostalline to microcrystalline, fragmental, slightly dolomitic. Contains brachiopods. Weathers to yellowish- gray rough surface; massive; resistant; ledge forming	6
Partly covered slope; basal 1 ft. is very light gray to yellowish-gray microcrystalline, earthy, slightly argillaceous calcitic dolomite, weathering light gray	9
Dolomite and dolomite breccia, medium-gray to light-gray, light olive-gray, yellowish-brown, and yellowish-gray, very finely crystal-	

line to microcrystalline. In 1- to 3-ft.-thick beds, which weather to yellowish-gray and yellowish-orange alternately smooth or pitted surfaces, resistant; ledge forming 14

Covered slope 3

Dolomite, yellowish-gray and light-gray, very finely crystalline, rhombic, sucrosic. Upper 4 ft. porous and thin bedded to platy; lower 5 ft. nonporous and massive. Weathers yellowish gray to light gray; resistant; ledge forming 9

Covered slope 5

Dolomite, yellowish-gray to light olive-gray, micro-crystalline to very finely crystalline, slightly calcitic; basal 4 ft. partly brecciated. 6-ft. bed, 6 ft. below top is light-gray to light brownish-gray microcrystalline to dense siliceous limestone, containing "calcispheres," including foraminifer *Umbellina* sp. Upper 12 ft. thin to medium bedded; lower 4 ft. massive; resistant; ledge forming 16

Covered slope; probably argillaceous and silty dolomite; bottom 1 ft. is platy yellowish-gray microcrystalline silty dolomite, weathering yellowish gray and grayish orange 33

Dolomite, light olive-gray, light brownish-gray, and yellowish-gray, very finely crystalline, weathering light gray. Interbedded in 1- to 2-ft.-thick beds with platy light olive-gray and light-gray microcrystalline silty dolomite, weathering yellowish orange. Resistant; ledge forming 9

Dolomite, grayish-orange, microcrystalline, slightly argillaceous, porous, vuggy; and yellowish-gray slightly glauconitic very fine grained sandstone. Weathers to yellowish-gray smooth, rounded surface; thick bedded; resistant; ledge forming 3

Total lower member of Jefferson Formation 137

Disconformity.

Beartooth Butte Formation:

Dolomite conglomerate, silty, sandy, argillaceous, yellowish-gray, very finely crystalline, slightly calcitic, containing subangular to rounded pebbles, cobbles, and boulders of light-gray cryptocrystalline to microcrystalline Bighorn Dolomite. Bottom 2 in. is yellowish-gray and light greenish-gray shale and rock flour containing granules and small pebbles of Bighorn Dolomite. Weathers yellowish gray and light gray; moderately resistant; forms reentrant 8

Total Beartooth Butte Formation 8

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, very light gray, cryptocrystalline to microcrystalline; partly stained pinkish gray and yellowish gray, weathers light gray; resistant; ledge forming	2
Total measured Bighorn Dolomite	2

Stratigraphic section

Little Tongue Canyon, Bighorn Mountains

Along road cuts on north side of U.S. Highway 14, and north of Little Tongue River. On line between secs. 27 and 22, T. 56 N., R. 87 W., Sheridan County, Wyo. Completely exposed; measured directly by steel tape. All thicknesses rounded to nearest foot. Regional strike N. 45°-60° W. and dip 21°-23° NE. Lowermost Mississippian rocks and upper part of Devonian rocks measured about half a mile east of lower part of Devonian rocks. Gentle syncline interrupts regional dip, and measured strata plunge below road level between these two partial sections, which were correlated by means of conspicuous yellowish-orange-weathering marker ledge. Present road cuts now permit entire section to be measured on east flank of syncline.

[Measured by C. A. Sandberg, assisted by P. W. Richards in 1956 and W. S. Alvarez in 1961. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN:	Thickness Ft.
MADISON LIMESTONE:	
Dolomite, calcitic, yellowish-gray and light olive-gray, microcrystalline, microsucrosic, fragmental. Interbedded with very pale orange, white, very light gray, and grayish-yellow microcrystalline to cryptocrystalline, fragmental, powdery, slightly cherty dolomitic limestone. Weathers yellowish gray; massive; resistant; ledge forming	20+
Dolomite, light-gray and light olive-gray, coarsely microcrystalline to very finely crystalline, sucrosic, slightly fragmental. Contains *Syringopora* sp. corals. Weathers yellowish gray to yellowish orange; massive; resistant; ledge forming	6
Total measured Madison Limestone	26+

Gradational contact.

DOLOMITIC FACIES OF DARK SHALE UNIT:

Dolomite, silty, pale yellowish-brown, light olive-gray, and yellowish-gray mottled with medium light-gray and pale-red-purple,

microcrystalline, microsucrosic, hematitic, slightly sandy; in part fragmental. Contains streaks and small pods of hematite, scattered round grains of quartz, conodonts, and fish teeth and bones. Conodonts determined to be of Kinderhook age by Gilbert Klapper (written commun., Aug. 10, 1965). At base is reentrant formed by 1½-in.-thick bed of greenish-gray to light greenish-gray mottled with yellowish-gray, pale-red, and light-brown hematitic sandy, silty, dolomitic quartzose shale, containing very coarse grains of quartz, conodonts, and fish bones. Weathers yellowish gray to grayish orange; massive; moderately resistant; ledge forming 4

Total dolomitic facies of dark shale unit 4

Unconformity.

DEVONIAN:

JEFFERSON FORMATION:

Lower member:

Dolomite, banded yellowish-gray, light greenish-gray, and very light brownish-gray, finely microcrystalline to cryptocrystalline, slightly silty. Interbedded in ¼- to ½-in.-thick beds with mottled pinkish-gray, pale-red, and grayish-red microcrystalline hematitic silty very sandy dolomite. Sand is largely fine to coarse grains of quartz with some very fine and very coarse grains. Weathers to light-brown or grayish-orange smooth surface; wavy, contorted bedding; moderately resistant; forms upper part of 8-ft.-thick ledge 2

Dolomite, very silty, sandy, pale-red, pale-olive, and yellowish-gray, finely microcrystalline, slightly hematitic. Contains ½-ft.-thick interbeds of mottled pale-red and grayish-orange-pink conglomeratic dolomitic siltstone and sandstone, containing rounded intraformational pebbles of yellowish-gray silty sandy dolomite. Weathers to grayish-orange or light-brown smooth surface; moderately resistant; forms lower part of 8-ft.-thick ledge 6

Dolomite, very pale orange and very light greenish-gray, finely microcrystalline to cryptocrystalline, in part brecciated and recemented by light-gray calcite. At base is 3-in.-thick bed of medium-gray, pale-brown to grayish-red, light olive-gray, and pale-olive shale, which forms reentrant. Weathers to light grayish-orange smooth surface; moderately resistant; ledge forming 1

Dolomite, medium brownish-gray, light olive-gray, and pale yellowish-brown, partly streaked with grayish-red, very finely crystalline to microcrystalline, sucrosic, slightly hematitic, slightly vuggy. Weathers to pale yellowish-brown smooth surface; massive; resistant; forms upper part of 13-ft.-thick ledge 9

Dolomite, dark yellowish-orange, pale yellowish-brown mottled with yellowish-orange, and medium brownish-gray mottled with

grayish-orange, very finely to finely crystalline, rhombic, sucrosic, fragmental, porous. Contains scattered crystals of secondary calcite, ¼ to ½ in. in diameter. Top 2 to 6 in. is lenticular bed of dolomite containing large calcite-filled vugs. Weathers pale yellowish brown and light brown; massive; resistant; forms lower part of 13-ft.-thick ledge 4

Siltstone, mottled and banded light olive-gray, pale-olive, pale greenish-yellow, yellowish-gray, very pale red-purple, and grayish-red-purple, slightly dolomitic, slightly sandy, hematitic, friable. Top 8 in. is finely microcrystalline silty hematitic dolomite. Bottom 0-6 in. is lenticular bed of yellowish-gray to dusky-yellow intraformational silty dolomite breccia, which contains angular fragments of grayish-yellow-green shale and very pale orange cryptocrystalline dolomite and channels underlying bed. Thin bedded to laminated; weakly resistant; forms reentrant 3

Dolomite, brownish-gray and mottled pale yellowish-brown, pale-brown, grayish-orange, and dark yellowish-orange, very finely and finely crystalline, rhombic, sucrosic; in part fragmental; in part highly porous. Contains scattered crystals of white calcite, as much as ½ in. in diameter. Massive; resistant; forms upper part of 9-ft.-thick ledge 5

Dolomite, moderate-red mottled with light yellowish-brown, pale-brown streaked with grayish-yellow, and light yellowish-brown mottled with pale-brown, very finely and finely crystalline, rhombic, sucrosic, porous; lower half pseudobrecciated and vuggy. Massive; resistant; forms lower part of 9-ft.-thick ledge 4

Dolomite, silty, light greenish-gray and light-gray to yellowish-gray, finely microcrystalline, hematitic, containing laminae of light-gray, grayish-red, and grayish-red-purple dolomitic siltstone. Top 8 in. is pale-brown to moderate-red microcrystalline to very finely crystalline sucrosic dolomite, gradational to overlying unit. Wavy, contorted bedding; laminated; weakly resistant; forms upper part of 4-ft. reentrant 2

Siltstone, very dolomitic, light olive-gray, grayish-orange-pink, dusky-yellow, and light greenish-gray, slightly sandy; gradational to very silty dolomite. Contains laminae and pods of light-gray, pale-red, and grayish-red glauconitic hematitic calcareous sandstone. Basal 3 in. is greenish-gray and light olive-gray slightly dolomitic quartzose shale and shaly siltstone. Weathers to light olive-gray smooth surface; wavy, contorted bedding in upper ½ ft.; weakly resistant; forms lower part of 4-ft. reentrant 2

Dolomite, calcitic, pale yellowish-brown mottled with yellowish-gray and grayish-orange, very finely and finely crystalline, rhombic, sucrosic, fragmental, porous. Top 2½ ft. is moderate-orange-pink, very pale orange, and yellowish-gray, finely microcrystalline dolomite. Basal 8 in. is light greenish-gray and yellowish-gray

finely microcrystalline slightly sandy silty dolomite. Thick bedded; resistant; forms 3 beds in upper part of 13-ft.-thick ledge 7

Dolomite, medium brownish-gray, microcrystalline to very finely crystalline, microsucrosic. Thick bedded; resistant; forms middle of 13-ft. thick ledge 3

Dolomite, very silty, banded light greenish-gray and grayish-orange-pink, and mottled light-red, moderate-red, and greenish-gray, microcrystalline, slightly sandy. Contains interbeds, laminae, and pods of pale-red, grayish-red, and yellowish-gray calcitic dolomite, dolomitic limestone, and calcareous sandstone. Wavy, contorted bedding; resistant; forms 2 beds in lower part of 13-ft.-thick ledge 3

Siltstone, greenish-gray, very pale olive, and light greenish-gray slightly dolomitic. Interbedded with grayish-red very fine grained calcareous sandstone and greenish-gray to light olive-gray finely microcrystalline very silty dolomite. Top ½ ft. is medium dark-gray, pale-olive, and greenish-gray dolomitic quartzose shale. Thin bedded to thinly laminated; forms weakly resistant ledge 3

Dolomite, argillaceous, silty, very pale olive to very light olive-gray and pale-olive, cryptocrystalline to finely microcrystalline. Contains interbeds ¼ to 1 in. thick, laminae, pods, and very thin crossbeds of grayish-orange very silty calcitic dolomite, grayish-red hematitic calcareous sandstone, and dark greenish-gray dolomitic quartzose shale. Thin bedded to thinly laminated; forms weakly resistant ledge 4

Dolomite, silty, banded and mottled yellowish-gray, light olive-gray, very pale orange, grayish-orange-pink, pale-red-purple, grayish-red-purple, and moderate reddish-orange, microcrystalline, fragmental, hematitic. Contains laminae of pale-olive and mottled yellowish-gray and pale-red-purple dolomitic quartzose shale and angular medium to coarse grains, granules, and small pebbles of pale-olive dolomitic shale and siltstone. Upper and lower parts separated by 2-in.-thick bed of pale-red-purple and grayish-red-purple hematitic slightly dolomitic shale and pale greenish-yellow dolomitic shale. Contains plates of ptyctodont fish, possibly *Ptyctodus* sp. (D. H. Dunkle, written commun., Dec. 13, 1956). Weathers to pale-red or light-brown smooth surface; medium bedded; forms weakly resistant ledge 6

Dolomite, argillaceous, banded very pale yellowish-brown, light-brown, very pale orange, and grayish-orange-pink, finely microcrystalline and cryptocrystalline; in part brecciated and recemented by clear calcite. Contains laminae of pale-red-purple microcrystalline slightly dolomitic limestone and blackish-red fine- to medium-grained hematitic sandstone. In beds 8 to 12 in. thick, separated by 2- to 3-in. reentrants of pale-red, pale-olive, grayish-orange-pink, and yellowish-gray very shaly dolomite. Basal ½ in. is

blackish-red sandy slightly dolomitic hematite. Channels about 5 in. into underlying bed. Weathers yellowish gray, pale red, and grayish red; forms weakly resistant ledges 5

Dolomite, calcitic, argillaceous, yellowish-orange to dusky-yellow, finely microcrystalline, powdery. In 3 lenticular beds, 6 to 9 in. thick, separated by lenses of very pale olive dolomitic shale, grading to very shaly dolomite. Weathers to yellowish-orange smooth surface, partly stained pale reddish brown from weathering of overlying bed of hematite; moderately resistant; forms conspicuous marker ledge that was used to join 2 partial sections 2

Dolomite, calcitic, yellowish-gray, grayish-yellow, very pale orange, and very light olive-gray, microcrystalline to finely microcrystalline, powdery, containing a few 1-in.-thick interbeds of greenish-gray shale. Upper 3½ ft. slightly fragmental; lower 5½ ft. partly brecciated. Basal 6 ft. is slightly argillaceous to slightly silty. Weathers to yellowish-gray, grayish-orange, and light olive-gray smooth surfaces; thinly laminated to medium bedded; forms 8 weakly resistant ledges 9

Dolomite, very shaly, light olive-gray and medium greenish-gray, grading downward to medium dark-gray and olive-gray dolomitic shale. Contains lenses of banded light olive-gray and yellowish-orange laminated silty argillaceous microcrystalline dolomite. Weathers light olive gray; weakly resistant; forms upper part of reentrant 2

Dolomite, argillaceous, mottled yellowish-gray, light olive-gray, yellowish-orange, and light greenish-gray, microcrystalline and cryptocrystalline, limonitic, powdery. Weathers yellowish gray; thin bedded, weakly resistant; forms lower part of reentrant 2

Dolomite, argillaceous, silty, light greenish-gray mottled with yellowish-gray, yellowish-orange, dark yellowish-orange and greenish-gray, microcrystalline to cryptocrystalline, containing scattered pebbles of medium dark-gray dolomite in lower 2 in. Locally underlain by regolithic deposit, as much as 1 ft. thick, composed of medium dark-gray to medium light-gray slightly sandy very shaly conglomeratic dolomite, containing well-rounded resistant pebbles as much as 7 in. long of medium-gray to medium dark-gray cryptocrystalline silty dolomite. Locally channels 2 ft. into each of 4 underlying units and truncates upper 3 of these westward. Weathers to yellowish-gray smooth surface; moderately resistant; ledge forming except for regolithic deposit, which forms reentrant at base 5

Total lower member of Jefferson Formation 89

Unconformity.

SILURIAN AND ORDOVICIAN:

EQUIVALENT (?) OF INTERLAKE FORMATION:

Dolomite, light olive-gray to pale yellowish-brown, finely microcrystalline to cryptocrystalline, partly pseudobrecciated. Locally brecciated; fractures that extend upward to pre-Devonian unconformity are filled partly by calcite and partly by yellowish-orange silty argillaceous dolomite that resemble basal bed of Jefferson Formation. Weathers yellowish gray; moderately resistant; ledge forming. Truncated westward beneath pre-Devonian unconformity; maxium observed thickness 3

Shale, dolomitic, light-gray, slightly calcareous. Weathers very light and light gray; weakly resistant; forms reentrant. Truncated westward beneath pre-Devonian unconformity; maximum thickness 2

Dolomite, light-gray, finely microcrystalline to cryptocrystalline; pseudobrecciated in lower 1 ft. Weathers yellowish gray; moderately resistant; ledge forming. Truncated westward beneath pre-Devonian unconformity; maximum thickness 2

Dolomite, argillaceous, yellowish-gray and yellowish-orange, finely microcrystalline to cryptocrystalline, slightly silty. Contains a medial 2-in.-thick interbed of light olive-gray and light-gray dolomitic shale. Bottom 1 ft. is nodular and shaly, containing wisps and laminae of pale-olive to greenish-gray dolomitic shale and granules as much as ¼ in. long of dark yellowish-orange microcrystalline silty dolomite. Single specimen of Ordovican conodont *Drepanodus homocurvatus* noted. Unconformably overlain by Jefferson Formation in western partial measured section, where overlying 7 ft. of Silurian and Ordovician rocks is absent. Weathers to mottled dark yellowish-orange and very light gray rough surface; thin irregular bedding; moderately to weakly resistant; ledge forming 3

Total equivalent (?) of Interlake Formation 10

Conformable contact.

ORDOVICIAN:

BIGHORN DOLOMITE:

Upper part (equivalent of Stony Mountain Formation):

Shale, dolomitic; moderate yellowish brown in upper half, grading downward to pale olive and light olive gray with some medium light gray and greenish gray in lower half. Interbedded with fissile shale dolomite. Top 1½ ft. is grayish-red-purple dolomitic mudstone. Basal 4 ft. contains interbeds and laminae of pale-olive mot-

tled with dark yellowish-orange finely microcrystalline, vuggy, slightly argillaceous crinoidal dolomite. Contains laminae of yellowish-gray and dark yellowish-orange shale throughout and granules, lenses, and pods of dark yellowish-orange microcrystalline silty dolomite increasing in abundance downward. Nonresistant; slope forming except for weakly resistant ledges in basal 4 ft... 11

Dolomite, pseudobrecciated, yellowish-gray, grayish-yellow, and pale yellowish-orange with light-gray and pale yellowish-brown mottles, slightly argillaceous; in part vuggy. Groundmass is very finely crystalline to microcrystalline; pseudofragments are cryptocrystalline. Finely fossil fragmental; contains crinoid columnals and favositid corals. Top 1 ft. is limonitic and part of groundmass is light brown. Weathers to mottled yellowish-gray and light-gray rough, pitted surface; resistant; ledge forming 14

Dolomite, calcitic, shaly, light olive-gray and yellowish-gray, cryptocrystalline; fissile. Weathers light brownish gray; weakly resistant; forms reentrant 3

Dolomite, very pale orange and grayish-yellow to very pale orange, cryptocrystalline to very finely microcrystalline, sublithographic. Weathers to mottled grayish-yellow and pale yellowish-orange smooth surface; medium bedded; resistant; ledge forming 21

Total measured upper part of Bighorn Dolomite 49

Stratigraphic section

North Crazy Woman Canyon, Bighorn Mountains

Along north side of trail and north of creek in center NW ¼ SE ¼ sec. 28, T. 49 N., R. 83 W., Johnson County, Wyo. Measured directly by steel tape. All thicknesses rounded to nearest foot. Beds strike N. 10°-15° E. and dip 15° SE. Land-grid location based on geologic map with planimetric base (Hose, 1955, pl. 6).

[Measured by C. A. Sandberg, assisted by R. F. Gantnier in 1954 and P. W. Richards in 1957. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN: **Thickness Ft.**

MADISON LIMESTONE:

Dolomite, yellowish-gray, microcrystalline to finely crystalline, containing *Syringopora* sp. corals and numerous leached fossil molds. Weathers to yellowish-gray deeply pitted surface; massive; resistant; cliff forming ..... 17+

Dolomite, yellowish-gray to pale yellowish-brown, microcrystalline, slightly silty. Contains *Syringopora* sp. corals, spiriferid brachiopods, crinoid columnals, and leached fossil molds. Weathers yellowish gray; medium bedded; moderately resistant; forms reentrant 3

Dolomite, very light gray to yellowish-gray, microcrystalline, slightly silty. Contains leached fossil molds largely of crinoid columnals, spiriferid brachiopods, and *Syringopora* sp. corals. Weathers yellowish gray; thin to medium bedded; forms moderately resistant ledges 5

Total measured Madison Limestone ..... 25+

Gradational contact.

MISSISSIPPIAN AND DEVONIAN:

DOLOMITIC FACIES OF DARK SHALE UNIT:

Dolomite, silty, light greenish-gray, yellowish-gray, pinkish-gray, and very light gray, microcrystalline, earthy, slightly argillaceous. Stained pale red purple by hematite, which occurs in fine grains disseminated throughout matrix, in lineations parallel to bedding, and in vertical bands. Contains *Syringopora* sp. corals, 1.3 ft. below top and leached fossil molds, largely of crinoids, throughout. Bottom 1 ft. is sandy dolomite, containing abundant phosphatic nodules as much as 1 in. in diameter, fish bones, plates, and teeth, and conodonts. Conodonts determined to be Lower Carboniferous (*cul*) by Gilbert Klapper (written commun., Aug. 10, 1965). Weathers yellowish gray and pinkish gray; thin bedded; forms moderately resistant ledges 6

Disconformity.

Dolomite, silty, yellowish-gray, light greenish-gray, light olive-gray, pinkish-gray, and light-gray, finely crystalline to microcrystalline, hematitic, slightly calcitic. Fine hematite grains disseminated throughout matrix and concentrated in vertical and horizontal bands in upper part. Contains conodont fauna of probably latest Devonian age, dominated by *?Scaphignathus velifera*. Thin to medium bedded; forms weakly resistant ledges 13

Dolomite, sandy, yellowish-gray, very light gray, and light olive-gray, finely crystalline, grading to dolomitic sandstone at base. Upper 1 ft. is silty dolomite with 3-in.-thick bed of yellowish-gray silty dolomitic shale at top. Sand is largely rounded, frosted very fine grains of quartz with scattered medium grains. Medium bedded; moderately resistant; ledge forming 3

Total dolomitic facies of dark shale unit 22

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, mottled pinkish-gray and light olive-gray, very finely crystalline, sucrosic, slightly vuggy, porous. Contains *Rhynchotrema* sp. brachiopods. Dikes, stringers, and lenses of moderate

reddish-orange sandy dolomite are fracture fillings probably related to eroded Beartooth Butte Formation of Early Devonian age. Massive, resistant; ledge forming 10

Total measured Bighorn Dolomite 10

Stratigraphic section

North Piney Canyon, Bighorn Mountains

Along creek bed in NE ¼ NW ¼ sec. 11, T. 53 N., R. 84 W., Sheridan County, Wyo. Vertical beds measured directly by steel tape. Land-grid location based on geologic map with planimetric base (Mapel, 1959, pl. 1).

[Measured by C. A. Sandberg and P. W. Richards in 1957. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN: **Thickness Ft.**

MADISON LIMESTONE:

Dolomite, very light gray to yellowish-gray, microcrystalline, fragmental, slightly calcitic. Resistant; ledge forming ..... 5+

Total measured Madison Limestone ..... 5+

DEVONIAN:

JEFFERSON FORMATION:

Lower member:

Dolomite, argillaceous, yellowish-gray to yellowish-orange, microcrystalline, earthy, slightly calcitic. Upper few feet may include thin dolomitic facies of dark shale unit. Lower 7 ft. is yellowish-gray sandy dolomite, grading to dolomitic sandstone composed of very fine, angular to coarse, rounded, frosted grains of quartz. Weathers yellowish gray, grayish orange, and yellowish orange; thin to medium bedded; resistant; ledge forming 12

Covered slope 4

Limestone, dolomitic, light olive-gray, finely crystalline, fragmental. Top is yellowish-gray to light olive-gray glauconitic slightly sandy dolomitic siltstone. Resistant; ledge forming 15

Partly covered slope; outcropping ledges are light-gray, greenish-gray, yellowish-gray, pinkish-gray, and pale yellowish-orange thinly laminated to platy microcrystalline silty argillaceous dolomite; in part slightly calcitic 31

Total lower member of Jefferson Formation 62

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, very light gray and medium-gray, dense to microcrystalline, fragmental. Thick bedded; resistant; ledge forming	3+
Total measured Bighorn Dolomite	3+

Stratigraphic section

Ragan Draw, Hartville Uplift

On north side of south fork of unnamed tributary, half a mile south of Ragan Draw. In SW ¼ SE¼ NW ¼ sec. 4, T. 28 N., R. 67 W., Platte County, Wyo. (Cassa 7½-minute quadrangle). Ledges measured directly by steel tape on steep wall of canyon. All thicknesses rounded to nearest foot. Mississippian and Devonian rocks strike N. 5° W. and dip 15° NE.; foliation of unconformably underlying Precambrian rocks strikes N. 10° E. and dips 55° NW. Columnar section at or near same locality was shown under heading of Sand Canyon by Love, Henbest, and Denson (1953, col. 4).

[Measured by C. A. Sandberg and W. S. Alvarez in 1961. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN AND DEVONIAN:	Thickness Ft.
GUERNSEY FORMATION:	
Upper part (equivalent of Pahasapa Limestone):	
Dolomite, grayish-pink and pinkish-gray, very finely crystalline, fragmental, porous; in part slightly calcitic. Contains silicified horn corals and brachiopods. Weathers to light brownish-gray pitted surface; strongly crossbedded; massive; resistant; ledge forming	7
Total measured upper part of Guernsey Formation	7
Lower part (equivalent of Englewood Formation):	
Dolomite, silty, yellowish-gray, light olive-gray, and pale yellowish-brown, finely microcrystalline to dense, containing bands of grayish-red-purple hematitic dolomite and thin seams of blackish-red hematite. Bottom 4 ft. is grayish-purple to medium dark-gray slightly sandy very silty dolomite. Weathers to yellowish-gray, grayish-yellow, or mottled medium light-gray and light-gray smooth surfaces; medium bedded to platy; weakly resistant; upper half forms reentrant, lower half forms partly covered slope; lenticular; thickness decreases eastward to 12 ft. along outcrop	18
Limestone, yellowish-gray to pale yellowish-brown, finely microcrystalline to cryptocrystalline, cherty. Mottled light-gray, very light gray, and yellowish-gray dense chert in nodules 2 to 3 in. in	

diameter and in wavy laminae. Weathers to medium-gray rough, minutely pitted surface; forms moderately resistant ledge; lenticular; irregular step-like basal contact; thickness decreases to as little as 4 ft. along outcrop 6

Dolomite, yellowish-gray, pale yellowish-brown, pinkish-gray, and grayish-pink, finely microcrystalline, slightly silty. Upper part very cherty; chert content decreases downward. Light-gray, very light gray, and light bluish-gray hematite-stained dense chert forms round nodules 2 to 3 in. in diameter and stringers several ft. long and ¼ to 1 in. thick, and contains *Camarotoechia* sp. brachiopods and abundant ghosts of microfissil debris. Stringers of grayish-red shale that apparently separate some beds may have leaked into section from overlying formations. Weathers to light-gray, pale yellowish-orange, and light grayish-orange smooth surfaces; medium bedded; weakly resistant; forms reentrant ledges; lenticular 14

Sandstone, dolomitic, pinkish-gray, very light gray, pale greenish-yellow, and pale-red-purple, speckled with grayish-red and very dusky red, hematitic, fine to very coarse grained, subangular to subrounded. Upper part contains scattered subangular granules and small pebbles of white quartz and grayish-orange-pink feldspar; lower part is conglomeratic. Interbedded with pinkish-gray microcrystalline very sandy dolomite. Top 6 in. is mottled medium light-gray, grayish-red, greenish-gray, and pale greenish-yellow slightly dolomitic sandy shale. A few interbeds near top are yellowish-gray to light olive-gray microcrystalline silty dolomite, containing vertical tubes of pale-olive mottled with grayish-red very sandy dolomite. Contains impressions of brachiopods, leached molds of crinoids, conodonts, and minute fragments of fish plates. Late Devonian brachiopod fauna and gastropods are reported from this unit (Love, Henbest, and Denson, 1953). Weathers pale red, yellowish gray, and grayish orange pink; thin bedded; forms moderately resistant ledge 3

Conglomerate, sandy, very light gray, light-gray, and pale greenish-yellow, faintly mottled with grayish-red, composed largely of subangular to rounded pebbles of white quartz, as much as 3 in. in diameter, apparently derived from veins in underlying Precambrian rocks. Upper contact is gradational. Forms moderately resistant ledge 1

Total lower part of Guernsey Formation 42

Unconformity.

PRECAMBRIAN:

UNDIVIDED METAMORPHIC AND IGNEOUS ROCKS:

Schist and gneissic granite; highly weathered and altered to grayish-red hematitic clay at top; cut by veins of white quartz; weakly resistant ..... 5+

Stratigraphic section

Shell Canyon, Bighorn Mountains

On north side of canyon, on opposite side of Shell Creek from U.S. Highway 14. In SE ¼ SW ¼ sec. 9 (unsurveyed), T. 53 N., R. 90 W., Big Horn County, Wyo. (Black Mountain 7½-minute quadrangle). Ledges measured directly by steel tape; slopes measured by tape and Brunton compass traverse. All thicknesses rounded to nearest foot. Beds strike N. 10° W. and dip 20° SW.

[Measured by C. A. Sandberg in 1957. Lithologic descriptions by C. A. Sandberg.]

	Thickness Ft.
MISSISSIPPIAN:	
MADISON LIMESTONE:	
Dolomite, light-gray, light olive-gray, and light brownish-gray, microcrystalline, slightly silty, containing leached fossil molds. Contains *Syringopora* sp. corals 6-8 ft. above base. Weathers light gray; medium to thick bedded; resistant; cliff forming	15
Total measured Madison Limestone	15
Gradational contact.	
DOLOMITIC FACIES OF DARK SHALE UNIT:	
Dolomite, pale yellowish-brown streaked with medium light-gray, microcrystalline, slightly silty, containing scattered rounded grains of quartz. Top ¼ in. is yellowish-brown shaly dolomite. Lower 4 in. is sandy dolomite; bottom 2 in. is slightly glauconitic sandy conglomeratic dolomite containing phosphate pellets, fish and brachiopod fragments, and Lower Carboniferous (upper *cu*l) conodont fauna. Weathers yellowish gray; moderately resistant; forms basal ledge of cliff	1
Total dolomitic facies of dark shale unit	1
Unconformity.	
DEVONIAN:	
JEFFERSON FORMATION:	
Lower member:	
Dolomite, pale yellowish-brown, medium light-gray, and yellowish-gray, very finely crystalline, sucrosic. Top bedding plane is pale red and mudcracked. Upper 1 in. is light olive-gray cryptocrystalline brecciated dolomite, impregnated and stained yellowish brown to dusky brown by asphaltic residue. Vugs parallel bedding in lower 1-½ ft. Weathers to grayish-orange smooth surface; medium bedded; moderately resistant; forms 2 ledges	4

Dolomite, silty, mottled light-gray and medium light-gray, microcrystalline to cryptocrystalline. Interbedded with medium light-gray and yellowish-gray dolomitic shale and shaly dolomite. Weathers yellowish orange; weakly resistant; forms reentrant 4

Dolomite, silty, light brownish-gray, microcrystalline. Thin bedded; weakly resistant; forms ledge at base of reentrant 1

Dolomite, grayish-orange mottled with light-gray, finely crystalline, sucrosic, slightly porous. Weathers yellowish orange; moderately resistant; ledge forming 1

Dolomite, very silty, sandy, light greenish-gray, microcrystalline. Weakly resistant; forms reentrant 2

Dolomite, very pale orange to pinkish-gray, microcrystalline. Weathers grayish orange to yellowish gray; strongly laminated; moderately resistant; ledge forming 2

Dolomite, silty, banded grayish-orange-pink and light greenish-gray, microcrystalline, glauconitic, slightly sandy. Truncated along strike by overlying bed. Laminated; weakly resistant; forms reentrant ledge 1

Dolomite, very silty, sandy, light greenish-gray, microcrystalline, glauconitic. Weathers yellowish gray; weakly resistant; forms reentrant 4

Dolomite, light-gray to light brownish-gray, microcrystalline. Weathers pale yellowish orange to grayish orange; moderately resistant; ledge forming 1

Siltstone, dolomitic, sandy, very light gray to light greenish-gray, glauconitic. Interbedded with yellowish-gray microcrystalline sandy very silty dolomite. Thin bedded to laminated; nonresistant; forms partly covered slope 9

Dolomite, yellowish-brown to pale yellowish-brown, finely crystalline, rhombic, sucrosic, fetid, slightly glauconitic. Weathers yellowish brown and grayish orange; thick bedded; resistant; ledge forming 7

Dolomite, very silty, sandy, very light gray to light greenish-gray, microcrystalline, glauconitic. Lower ½ ft. is light-gray microcrystalline to cryptocrystalline fragmental partly brecciated dolomite. Weathers yellowish gray; thin bedded; weakly resistant; forms reentrant 1

Dolomite, yellowish-brown, finely crystalline, rhombic, sucrosic, fetid. Weathers to yellowish-brown and light-brown smooth surface; moderately resistant; ledge forming 1

Dolomite, yellowish-gray and light olive-gray, very finely crystalline to cryptocrystalline, fragmental, partly brecciated. Lower ½

ft. is yellowish-gray cryptocrystalline dolomite. Weathers yellowish gray; thin bedded; weakly resistant; forms 2 reentrant ledges 1

Dolomite, pale yellowish-brown mottled with yellowish-brown, very finely crystalline, rhombic, sucrosic. Weathers light gray and yellowish gray; medium bedded; moderately resistant; ledge forming 2

Dolomite, very silty, greenish-gray, glauconitic. Lower ½ ft. is a light olive-gray to yellowish-gray cryptocrystalline dolomite that is oolitic and contains angular pebbles of light olive-gray dolomite in bottom 2½ in. Thin bedded; weakly resistant; slope forming .. 4

Dolomite, mottled medium brownish-gray, yellowish-brown, medium dark-gray, and dusky-yellow, finely crystalline, rhombic, sucrosic, fetid; vuggy, porous. Weathers to yellowish-brown surface, which is pitted in lower 6 ft.; massive; resistant; ledge forming 11

Siltstone, dolomitic, grayish-yellow-green to yellowish-gray, glauconitic, grading to silty shale. Thin bedded; weakly resistant; forms reentrant 5

Dolomite, mottled yellowish-gray, dusky-yellow, grayish-orange, dark yellowish-orange, and yellowish-brown, microcrystalline to finely crystalline, vuggy, porous. Upper 4 ft. is pseudobrecciated and slightly fetid. Middle 1 ft. is greenish-gray and grayish-orange glauconitic sandy dolomitic siltstone, containing lenses of light brownish-gray cryptocrystalline limestone and weathering grayish yellow. Bottom 3 ft. is nonbrecciated. Weathers dark yellowish orange; forms resistant ledge with 1-ft. reentrant in middle 8

Shale, dolomitic, sandy, greenish-gray, glauconitic. Interbedded and interlaminated with grayish-yellow glauconitic dolomitic siltstone. Nonresistant; slope forming 9

Siltstone, dolomitic, yellowish-gray. Interbedded with mottled grayish-yellow and medium light-gray microcrystalline argillaceous dolomite. Weathers pale to dark yellowish orange; thin bedded; forms weakly resistant ledge 4

Shale, dolomitic, light olive-gray. Nonresistant; forms partly covered slope 6

Dolomite, silty, yellowish-gray, microcrystalline, earthy. Top 1 ft. is mottled light-gray and grayish-yellow finely crystalline dolomite, weathering yellowish orange. Weathers light gray; medium bedded; forms weakly resistant ledge 5

Dolomite, light-gray mottled with dark yellowish-orange, finely crystalline, porous. Weathers pale yellowish orange; forms weakly resistant ledge 2

Dolomite, calcitic, argillaceous, yellowish-gray to grayish-yellow, microcrystalline, earthy, powdery. Interbedded with yellowish-gray shale. Nonresistant; forms partly covered slope 4

Dolomite, mottled yellowish-gray and medium light-gray, finely crystalline to cryptocrystalline; and medium-gray microcrystalline vuggy, partly brecciated calcitic dolomite. Bottom 1 ft. sandy. Massive; resistant; forms 3 beds in upper part of cliff	15
Dolomite, sandy, very light gray, microcrystalline, earthy, containing scattered pebbles. Bottom ½ ft. is yellowish-gray fine- to medium-grained dolomitic conglomeratic sandstone containing subangular to subrounded pebbles, as much as ½ in. in diameter, of medium-gray dense argillaceous dolomite. Moderately resistant; forms reentrant	2
Dolomite, yellowish-gray, microcrystalline, vuggy; partly brecciated. Massive; resistant; forms middle of cliff	5
Dolomite, shaly, yellowish-gray mottled with pale yellowish-orange, microcrystalline, earthy. Moderately resistant; forms reentrant	2
Dolomite, calcitic, silty, light olive-gray, cryptocrystalline to dense. Bottom ½ ft. is yellowish-gray microcrystalline sandy dolomite conglomerate containing subangular to subrounded pebbles, as much as 1 in. in diameter, of very light gray finely microcrystalline Bighorn Dolomite. Sand is very fine grained quartz. Massive; resistant; forms lower part of cliff	7
Total lower member of Jefferson Formation	130

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, very light gray, finely microcrystalline. Weathers to yellowish-gray smooth surface; thin, wavy, irregular bedding; forms weakly resistant ledge	4+
Total measured Bighorn Dolomite	4+

Stratigraphic section

Shoshone Canyon, near Absaroka Range

On prominent ridge on north side of canyon at south end of Rattlesnake Mountain. In W ½ SE ¼ NW ¼ sec. 5, T. 52 N., R. 102 W., Park County, Wyo. (Cody 15-minute quadrangle). Completely exposed; ledges measured directly by steel tape. All thicknesses rounded to nearest foot. Beds dip gently northeastward.

[Measured by C. A. Sandberg and P. W. Richards in 1954 and 1956. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN:	Thickness Ft.
MADISON LIMESTONE:	
Dolomite, pale yellowish-brown and yellowish-gray, microcrystalline, microsucrosic, slightly silty. Contains leached molds of fossils, including many crinoid columnals. Weathers yellowish gray; massive; highly resistant; forms base of cliff	6+
Dolomite, cherty, pale yellowish-brown, finely microcrystalline, microsucrosic, slightly silty. Contains leached molds of crinoid columnals and round nodules of yellowish-gray highly fossiliferous dense chert, weathering white and grayish yellow. Weathers to yellowish-gray smooth surface; medium bedded; resistant; forms highest reentrant ledge beneath cliff	2
Dolomite yellowish-gray and yellowish-brown, microcrystalline, slightly silty; in part microsucrosic. Weathers yellowish gray to grayish orange; medium bedded; forms 2 reentrant ledges	11
Dolomite, silty, light olive-gray and pale yellowish-brown, microcrystalline, crinoidal. Silt content increases downward; basal 1 in. is yellowish-gray very silty dolomite. Weathers to dark yellowish-orange or yellowish-orange smooth surfaces with calcite-lined pits, 3 to 4 in. in diameter; medium bedded; forms 4 reentrant ledges	6
Total measured Madison Limestone	25+
Conformable contact.	
SHALE AND SILTSTONE FACIES OF DARK SHALE UNIT:	
Shale, quartzose, greenish-gray, slightly dolomitic. Contains Lower Carboniferous (*cu*l) conodont fauna (Gilbert Klapper, oral commun., July 26, 1965). Top 1 ft. is mottled medium dark-gray, light olive-gray, and greenish-gray dolomitic quartzose shale, containing round nodules about 1 in. in diameter, composed of quartz, calcite, and pyrite. Nonresistant; forms deep reentrant	6
Siltstone, dolomitic, light olive-gray and medium light-gray, glauconitic. Interbedded with very silty dolomite. *Taonurus* markings on bedding planes. Lower part contains phosphatic pellets and nodules, fish bones, plates, and teeth, and conodonts. Conodonts determined to be Lower Carboniferous (*cu*l) by Gilbert Klapper (oral commun., July 26, 1965). Weathers dark yellowish orange and grayish orange; forms weakly resistant ledge	2
Total shale and siltstone facies of dark shale unit	8
MISSISSIPPIAN AND DEVONIAN:	
DOLOMITIC FACIES OF DARK SHALE UNIT:	
Dolomite, silty, yellowish-gray, pale yellowish-brown, and light olive-gray, microcrystalline. *Taonurus* markings on bedding planes.	

Weathers to dark yellowish-orange, grayish-orange, yellowish-gray, and light-brown smooth surfaces; platy to thin bedded; forms slope composed of weakly resistant ledges 13

Dolomite, calcitic, mottled pale yellowish-brown and dark yellowish-orange, very finely to finely crystalline, crinoidal, medium-fragmental, highly glauconitic, slightly silty. Contains very fine to medium grains of glauconite, fragmentary fish remains, and conodonts. Top 2 in. is slightly silty crinoidal dolomitic limestone. Bottom 2 in. is light olive-gray, grayish-orange, and pale yellowish-brown very sandy very silty calcitic dolomite that contains cono donts and fish plates, scales, and bones. Conodonts were determined to be Upper Devonian (*to*V) by Gilbert Klapper (written commun., Oct. 20, 1965). Basal 2-in. bed channels into underlying unit. Weathers dark yellowish orange and grayish orange; thick bedded; moderately resistant; ledge forming 2

Total dolomitic facies of dark shale unit 15

Total dark shale unit 23

Unconformity.

DEVONIAN:

JEFFERSON FORMATION:

Lower member:

Dolomite, calcitic, very pale orange and grayish-orange, finely microcrystalline to cryptocrystalline; in part fragmental, containing very fine to fine grains of dark yellowish-orange calcite. Represents top of minor depositional cycle. Locally truncated beneath unconformity. Weathers to yellowish-gray or grayish-yellow smooth surface; weakly resistant; ledge forming 1

Dolomite, calcitic, dark yellowish-orange to grayish-orange, very finely to finely crystalline, rhombic, sucrosic, porous. Lower half is mottled medium light-gray and light olive-gray silty dolomite. Represents middle and lower parts of minor depositional cycle. Locally truncated beneath unconformity. Weathers dark yellowish orange and light brown; thin bedded; moderately resistant; ledge forming 1

Dolomite, silty, light olive-gray and yellowish-gray, microcrystalline, glauconitic. Contains thin interbeds of light yellowish-brown microcrystalline dolomite, weathering dark yellowish orange. Weathers to yellowish-gray or pale grayish-orange smooth, powdery surfaces; laminated; wavy bedded; nonresistant; forms reentrant .. 4

Dolomite, yellowish-gray and pale-yellow, microcrystalline, slightly argillaceous. 2 ft. below top is 4-in.-thick bed of mottled yellowish-gray and yellowish-brown cryptocrystalline to very finely crystalline pseudobrecciated dolomite. Weathers to yellowish-gray or

dusky-yellow smooth surfaces; thinbedded; forms weakly resistant 1- to 2-ft.-thick ledges .....

Dolomite, argillaceous, pale-orange, cryptocrystalline to microcrystalline, highly brecciated. Recemented by pale yellowish-brown very finely crystalline calcite. Thinbedded; forms weakly resistant ledge .....

Dolomite, silty, dusky-yellow and yellowish-gray mottled with grayish-yellow, microcrystalline; in part calcitic. Contains thin lenses of medium brownish-gray fine-grained dolomitic sandstone. Weathers to yellowish-gray smooth surface; moderately resistant; ledge forming .....

Dolomite, silty, dusky-yellow and pale-olive, microcrystalline, glauconitic, slightly argillaceous, in part sandy; in part brecciated. Weathers yellowish gray; thinbedded; nonresistant; forms reentrant .....

Dolomite breccia, calcitic, yellowish-orange, finely microcrystalline, containing fragments of yellowish-gray dense dolomite and pale-green shale. Interbedded with thin beds of yellowish-brown mottled with dark yellowish-orange cryptocrystalline to dense siliceous dolomite. Weathers yellowish gray to yellowish orange; thick-bedded; moderately resistant; ledge forming .....

Siltstone, very dolomitic, sandy, dusky-yellow, pale-olive, greenish-gray, and light olive-gray, glauconitic; gradational to silty dolomite. Contains lenses of fine- to coarse-grained dolomitic sandstone. Grades laterally to pale reddish-brown microcrystalline fragmental hematitic silty calcitic dolomite. Thinbedded; nonresistant; forms reentrant at base of thin-bedded, slope-forming upper part of lower member .....

Dolomite, very pale orange, finely microcrystalline, microsucrosic. Contains lenses of pinkish-gray and light yellowish-brown fine- to medium-grained dolomitic sandstone. Represents top of major depositional cycle. Platy; forms weakly resistant ledge .....

Dolomite, very pale orange and pale yellowish-brown, very finely to finely crystalline, sucrosic, containing stromatoporoids and brachiopods. Upper 3 ft. is microcrystalline, very finely fragmental dolomite, weathering to smooth surface. Weathers to grayish-orange rough, deeply pitted surface; massive; lower 6 ft. forms resistant ledge; upper 3 ft. forms moderately resistant ledge .....

Dolomite, yellowish-orange and light yellowish-brown, microcrystalline to very finely crystalline, sucrosic, slightly calcitic; in part finely fragmental; in part pseudobrecciated. Weathers to dark yellowish-orange and grayish-yellow smooth surface; moderately resistant; forms reentrant ledge .....

Siltstone, very dolomitic, pale-olive, yellowish-orange, dusky-yellow, and light olive-gray, glauconitic, slightly argillaceous, slightly

sandy at top grading to very sandy at base. Sand is very fine to coarse rounded grains of quartz. Top ½ ft. grades to very silty microcrystalline dolomite with skeletal crystals of dolomite pseudomorphous after halite on bedding planes. Weathers pale olive, light olive gray, and yellowish gray; thinbedded to laminated; forms slope composed of weakly resistant ledges 6

Dolomite, mottled yellowish-brown, pale yellowish-brown, and pale to dark yellowish-orange, microcrystalline to finely crystalline, rhombic, sucrosic; lower 4 ft. pseudobrecciated. Unit represents single incomplete depositional cycle. Upper 2 ft. weathers to light yellowish-brown smooth surface; lower 9 feet weathers to yellowish-gray and grayish-orange rough, deeply pitted surface; massive; resistant; cliff forming 11

Dolomite, calcitic, yellowish-gray, microcrystalline; in part brecciated, vuggy, and porous. Represents top of incomplete depositional cycle. Weathers to yellowish-gray smooth surface; thinbedded; weakly resistant; forms reentrant 2

Dolomite, grayish-orange to yellowish-orange mottled with pale yellowish-brown, microcrystalline to very finely crystalline, sucrosic, slightly calcitic. Thin bed of very pale orange finely microcrystalline dolomite near base. Upper half contains *Amphipora*, chertified stromatoporoids, and nodules of yellowish-brown dense chert. Weathers to yellowish-orange and yellowish-gray smooth surface; medium bedded; resistant; forms upper part of ledge 3

Dolomite, pale yellowish-brown to medium light-gray, mottled with grayish-orange in upper part, microcrystalline to very finely crystalline, sucrosic. Contains stromatoporoids and crinoid columnals. Weathers grayish orange to dark yellowish orange; thick bedded; resistant; forms lower part of ledge 4

Dolomite, silty, dusky-yellow and light olive-gray, microcrystalline, slightly glauconitic; ½ ft. thick; represents base of depositional cycle. Lower 2½ ft., which represents top of underlying cycle, is yellowish-gray dense lithographic dolomite interbedded with ¼-in.-thick beds of pale yellowish-orange cryptocrystalline silty dolomite. Thin bedded; weakly resistant; forms reentrant 3

Dolomite, very pale orange to grayish-yellow, finely microcrystalline, earthy; in part brecciated. Weathers grayish yellow; forms moderately resistant ledge 2

Dolomite, yellowish-brown mottled with medium brownish-gray and dark yellowish-orange, finely crystalline, rhombic, sucrosic, porous. Weathers to yellowish-brown or dark yellowish-orange rough, pitted surface; massive; resistant; forms 2 ledges 9

Dolomite, silty, light greenish-gray to pale olive and dusky-yellow, microcrystalline, slightly glauconitic, weathering dark yellowish orange; 1½ ft. thick; represents base of depositional cycle. Lower

1½ ft., which represents top of underlying cycle, is very pale orange to pale yellowish-orange finely microcrystalline dolomite, in part brecciated and recemented by yellowish-brown calcite. Thin bedded; weakly resistant; forms reentrant 3

Dolomite, yellowish-brown and pale yellowish-brown, very finely to finely crystalline, sucrosic, porous. Upper 3 ft. weathers to pale yellowish-brown pitted surface; lower 3 ft. weathers to mottled yellowish-gray and light-gray smooth surface; massive; resistant; ledge forming 6

Dolomite, silty, sandy, dusky-yellow, cryptocrystalline, slightly glauconitic; ½ ft. thick; represents base of depositional cycle. Lower 1½ ft., which represents top of underlying cycle, is very pale orange and pale-orange finely microcrystalline dolomite, weathering grayish orange. Platy; weakly resistant; forms reentrant 2

Dolomite, irregularly mottled yellowish-brown, grayish-orange, and yellowish-orange, very finely crystalline, fragmental, vuggy, porous. Weathers to yellowish-gray rough, pitted surface; forms moderately resistant ledge 1

Dolomite, sandy, pale-olive to yellowish-gray, microcrystalline; ½ ft. thick; represents base of minor depositional cycle. Lower ½ ft., which represents top of underlying cycle, is very pale orange very finely crystalline sucrosic calcitic dolomite. Weathers yellowish orange to moderate yellowish brown; weakly resistant; forms reentrant 1

Dolomite, pale yellowish-brown streaked with yellowish-orange, very finely crystalline, sucrosic. Weathers to yellowish-gray rough, pitted surface; medium bedded; resistant; ledge forming 2

Dolomite, medium brownish-gray and yellowish-brown, microcrystalline to very finely crystalline, sucrosic. Weathers to grayish-orange smooth surface; thin bedded; resistant; ledge forming 5

Dolomite, yellowish-gray and medium light-gray, very finely and finely crystalline, sucrosic, vuggy, porous. Weathers to yellowish-gray and grayish-orange rough, pitted surface; resistant; ledge forming 3

Dolomite, argillaceous, yellowish-orange, finely microcrystalline; interbedded with thin lenses of yellowish-gray to light olive-gray microcrystalline silty dolomite. Lower half is interbedded greenish-gray shale and light olive-gray dolomitic shale. Weakly resistant; slope forming 5

Dolomite, calcitic, yellowish-orange to grayish-orange, microcrystalline, fragmental; in part brecciated and vuggy. Top 1 ft., which represents top of depositional cycle, is pale yellowish-orange cryptocrystalline partly brecciated dolomite. Brecciated dolomite is recemented by pale yellowish-brown finely crystalline calcite. Weathers yellowish orange and grayish orange; medium bedded; forms moderately resistant ledge with slight reentrant in middle 5

Dolomite, silty, dusky-yellow and dark yellowish-orange, microcrystalline, slightly glauconitic, containing lenses of yellowish-brown calcareous siltstone. Laminated; weakly resistant; forms reentrant 4

Dolomite, calcitic, grayish-orange and yellowish-orange, finely microcrystalline, hematitic; in part fragmental. Represents top of depositional cycle. Weathers to pale yellowish-orange rough surface; wavy, contorted bedding; laminated; resistant; forms top of 8-ft.-thick ledge 2

Dolomite, calcitic, cherty, mottled and banded pale yellowish-brown, yellowish-orange, grayish-orange, and very pale orange, finely microcrystalline to very finely crystalline, fragmental; in part brecciated. Contains large nodules of light-gray and medium light-gray chert, weathering white. Weathers grayish orange and dark yellowish orange; thick bedded; resistant; forms middle of 8-ft.-thick ledge 4

Dolomite, calcitic, grayish-orange and pale yellowish-brown, microcrystalline to very finely crystalline, fragmental. Weathers grayish orange and yellowish orange; medium bedded; resistant; forms base of 8-ft.-thick ledge 2

Dolomite, argillaceous, yellowish-gray, cryptocrystalline. Weathers to yellowish-gray or yellowish-orange smooth surfaces; laminated; weakly resistant; slope forming 4

Dolomite, calcitic, cherty, yellowish-orange, finely microcrystalline, fragmental. Contains laminae of light-gray very finely crystalline limestone and round nodules, 1 to 2 in. in diameter, of medium dark-gray cryptocrystalline chert. Represents top of minor depositional cycle. Weathers to pale yellowish-orange or yellowish-gray rough surface; laminated; resistant; ledge forming 2

Dolomite, cherty, pale yellowish-brown and dark yellowish-orange, mottled with grayish-orange, very finely crystalline to microcrystalline, sucrosic. Contains nodules of pale yellowish-brown dense chert, showing ghosts of brachiopods and microfossils. Weathers to light yellowish-brown rough, pitted surface; medium bedded; resistant; forms 2 ledges 2

Dolomite, silty, yellowish-gray to light olive-gray, cryptocrystalline, laminated to platy, weathering yellowish gray; 1½ ft. thick; represents base of minor depositional cycle. Lower 1½ ft., which represents top of underlying cycle, is pale yellowish-orange finely microcrystalline fragmental calcitic dolomite, grading to yellowish-brown and pale yellowish-orange dolomitic limestone breccia; weathers dark yellowish orange. Weakly resistant; forms reentrant 3

Dolomite, cherty, pale yellowish-brown and yellowish-gray, cryptocrystalline. Contains thin lenses of light-brown microcrystalline

silty dolomite and banded dark yellowish-brown chert. Weathers to very pale orange or pale yellowish-orange smooth surface; thin bedded; resistant; ledge forming 4

Dolomite, very pale orange to pale yellowish-orange, finely microcrystalline. Interbedded with 2- to 4-in.-thick beds of moderate yellowish-brown microcrystalline argillaceous dolomitic limestone breccia, containing fragments of pale yellowish-orange, very pale orange, and grayish-orange finely microcrystalline dolomite. Represents top of depositional cycle. Weathers to pale yellowish-orange laminated surface; thin bedded; weakly resistant; forms reentrant ledge and slope 3

Dolomite, pale to light yellowish-brown, very finely crystalline, sucrosic. Weathers to yellowish-gray and dark yellowish-orange smooth surface; thin bedded; moderately resistant; ledge forming 2

Dolomite, very cherty, medium brownish-gray and yellowish-brown mottled and streaked with yellowish-gray and grayish-orange, very finely to medium-crystalline, rhombic, sucrosic, vuggy. Contains stringers and nodules of yellowish-brown dense primary chert, weathering very pale orange, and nodules, as much as 6 in. in diameter, of pale to light yellowish-brown microcrystalline to cryptocrystalline vuggy fossiliferous secondary chert, containing stromatoporoids and spiriferid brachiopods. Weathers to yellowish-orange or grayish-orange laminated, deeply pitted surface; massive; resistant; ledge forming 7

Dolomite, pale yellowish-brown, very finely crystalline, sucrosic, vuggy. Weathers to yellowish-gray rough surface; moderately resistant; forms reentrant ledge 2

Dolomite, yellowish-gray, microcrystalline to cryptocrystalline; in part brecciated and recemented by clear calcite. Interbedded with 3/8-in.-thick beds of yellowish-gray microcrystalline to cryptocrystalline silty dolomite. Represents top of depositional cycle. Weathers pale yellowish orange; thin bedded; weakly resistant; slope forming 3

Dolomite, yellowish-gray to very light gray, microcrystalline, microsucrosic, containing a few scattered very fine grains of quartz. Weathers to yellowish-gray or grayish-orange slightly pitted surface; medium bedded; resistant; forms 2 ledges 3

Dolomite, conglomeratic, yellowish-gray and light olive-gray, microcrystalline, slightly silty, slightly calcitic, limonitic, vuggy. Contains rounded to subrounded grains. granules, and small pebbles, most of medium light-gray and a few of very light gray and medium-gray cryptocrystalline Bighorn Dolomite. Weathers to yellowish-gray and grayish-orange rough surface; medium bedded; resistant; forms upper part of 6-ft.-thick ledge 2

Dolomite, mottled yellowish-gray, light olive-gray, and medium light-gray, microcrystalline, microsucrosic, slightly limonitic; in part pseudobrecciated and vuggy. Represents top of minor depositional cycle. Weathers to yellowish-gray and grayish-orange granular surface; thin to medium bedded; resistant; forms middle of 6-ft.-thick ledge	3
Dolomite, pale yellowish-brown to light olive-gray, microcrystalline, fragmental, limonitic. Contains scattered granules and fine to medium grains of medium light-gray cryptocrystalline Bighorn Dolomite. Weathers grayish orange and dark yellowish orange; thin bedded; resistant; forms lower part of 6-ft. thick ledge	1
Total lower member of Jefferson Formation	164

Disconformity.

BEARTOOTH BUTTE FORMATION:

Dolomite conglomerate, silty, argillaceous, pale yellowish-orange, grayish-yellow, yellowish-gray, and grayish-orange, microcrystalline. Contains rounded to subangular granules, pebbles, cobbles, and boulders of light-gray, light brownish-gray, and medium brownish-gray to medium olive-gray microcrystalline microsucrosic Bighorn Dolomite. Fills channel cut at least 4 ft. into underlying Bighorn Dolomite. Weathers grayish orange to dark yellowish orange; forms moderately resistant ledge; lenticular; thickness as little as 1½ ft.; maximum thickness	6
Total Beartooth Butte Formation	6

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, medium light-gray, medium brownish-gray to medium olive-gray, and very light gray, finely to coarsely microcrystalline, microsucrosic, porous. Contains fragmentary crinoid columnals and conodonts. Weathers to yellowish-gray or grayish-orange smooth, granular surface; thick bedded; resistant; ledge forming; locally truncated by overlying Devonian beds; maximum thickness	5
Total measured Bighorn Dolomite	5

Stratigraphic section

Sisters Hill, Bighorn Mountains

On northeast slope of Sisters Hill, south of old logging trail. In SE ¼ SE ¼ sec. 3, T. 49 N., R. 83 W., Johnson County, Wyo. Measured directly by steel tape. All thicknesses rounded to nearest foot. Beds strike about

N. 5° E. and are vertical or slightly overturned to west. Land-grid location based on geologic map with planimetric base (Hose, 1955, pl. 6).

[Measured by P. W. Richards in 1957. Lithologic descriptions by C. A. Sandberg.]

	Thickness Ft.
MISSISSIPPIAN:	
MADISON LIMESTONE:	
Dolomite, light olive-gray to greenish-gray motled with very pale orange, microcrystalline and cryptocrystalline, brecciated, porous. Weathers to mottled light-gray, light olive-gray, and yellowish-gray rough surface; massive, resistant; cliff forming except basal 1 ft., which forms reentrant	5+
Total measured Madison Limestone	5+
MISSISSIPPIAN AND DEVONIAN:	
DOLOMITIC FACIES OF DARK SHALE UNIT:	
Dolomite, calcitic, light yellowish-brown and pale yellowish-brown to light olive-gray, very finely crystalline, rhombic, sucrosic, slightly argillaceous; in part stained grayish-red-purple by hematite. Contains fragmentary crinoid columnals. Weathers pale yellowish brown to light olive gray; moderately resistant; ledge forming	4
Dolomite, calcitic, grayish-orange mottled with light yellowish-brown and pale yellowish-brown mottled with yellowish-gray to grayish-orange, very finely crystalline, rhombic, sucrosic, friable. Weathers to yellowish-gray or pale yellowish-brown smooth surface; medium bedded; moderately resistant; ledge forming	6
Dolomite, yellowish-brown, microcrystalline to very finely crystalline, microsucrosic. Weathers to yellowish-gray smooth surface; thin bedded; moderately resistant; ledge forming	1
Limestone, dolomitic, yellowish-gray, microcrystalline, microsucrosic, fragmental, slightly silty. Weathers yellowish gray; moderately resistant; ledge forming	2
Dolomite, sandy, pale yellowish-brown mottled with grayish-orange, microcrystalline to very finely crystalline, microsucrosic, slightly silty, slightly argillaceous. Sand is fine to coarse subrounded to rounded grains of quartz. Weathers to grayish-orange and yellowish-gray smooth surface; weakly resistant; forms reentrant	1
Total dolomitic facies of dark shale unit	14
Unconformity.	
ORDOVICIAN:	
BIGHORN DOLOMITE:	
Dolomite, very pale orange to pale yellowish-brown, very finely	

crystalline to microcrystalline, microsucrosic, slightly vuggy. Top 2 ft. is stained moderate orange pink and pale reddish brown. Weathers yellowish gray; massive; resistant; ledge forming ..... 5+

Total measured Bighorn Dolomite ..... 5+

Stratigraphic section

South Fork Rock Creek, Bighorn Mountains

At top of ridge north of creek in SW ¼ NW ¼ SW ¼ sec. 25, T. 52 N., R. 84 W., Johnson County, Wyo. Measured directly by steel tape. All thicknesses rounded to nearest foot. Beds strike N. 15° W. and dip 45° NE. Land-grid location based on geologic map with planimetric base (Mapel, 1959, pl. 1).

[Measured by C. A. Sandberg and P. W. Richards in 1954 and 1957. Lithologic descriptions by C. A. Sandberg.]

MISSISSIPPIAN: **Thickness Ft.**

MADISON LIMESTONE:

Dolomite, very light gray to yellowish-gray, finely crystalline, containing *Syringopora* sp. corals and fossil molds, chiefly of crinoid columnals. Resistant; cliff forming ..... 5+

Total measured Madison Limestone ..... 5+

Gradational contact.

DOLOMITIC FACIES OF DARK SHALE UNIT:

Dolomite, silty, mottled very light gray and yellowish-gray, very finely crystalline, containing streaks of hematite grains parallel to bedding. Basal 3 in. is pinkish-gray hematitic very sandy calcitic dolomite, grading to dolomitic sandstone and locally stained moderate reddish orange and grayish red. Basal bed contains well-rounded coarse to very coarse grains of quartz, round black phosphatic granules, and fish bones, teeth, and plates. Dental plates of conchliodont fishes, *Psephodus* sp., *Helodus* sp., and *Sandalodus* sp., and teeth of hybodont shark *Ordus* sp. were identified by D. H. Dunkle (written commun., Nov. 19, 1957). Numerous conodonts, mostly siphonodellids of Kinderhook age but including a few reworked Upper Devonian specimens, were identified by W. H. Hass (written commun., Nov. 1, 1957). Resistant; forms slight reentrant in cliff 2

Total dolomitic facies of dark shale unit 2

Unconformity.

DEVONIAN:

JEFFERSON FORMATION:

Lower member:

Siltstone, dolomitic, yellowish-gray and pinkish-gray, grading to

finely crystalline silty dolomite. Contains stromatoporoids. Medium bedded; resistant; forms 3 ledges in cliff	5
Dolomite, calcitic, silty, mottled light-gray and yellowish-gray, very finely crystalline. Resistant; forms 2 ledges in cliff	5
Sandstone, dolomitic, light-gray to yellowish-gray, coarse-grained; and medium light-gray microcrystalline dolomite. Resistant; forms ledge in cliff	2
Dolomite, calcitic, medium-gray to medium brownish-gray, microcrystalline. Sand grains and grayish-red hematite staining in upper few inches. Near center is thin lens of greenish-gray shale, which forms reentrant. Weathers yellowish gray; resistant; forms 2 ledges in cliff	2
Dolomite, silty, yellowish-gray, finely crystalline to microcrystalline, porous. Resistant; forms ledge in cliff	3
Sandstone, dolomitic, yellowish-gray to light greenish-gray, composed mostly of very fine grains of quartz with a few scattered coarse grains; and microcrystalline to dense light brownish-gray dolomite. Resistant; forms basal ledge of cliff	3
Shale, pale-red and light greenish-gray. Nonresistant; forms reentrant	1
Dolomite, sandy, yellowish-gray to light greenish-gray, finely crystalline, brecciated in upper ½ ft. Sand is mostly very fine grained quartz. Mud cracks on upper bedding plane. Moderately resistant; ledge forming	1
Dolomite, sandy, silty, light greenish-gray and grayish-orange-pink. Platy; weakly resistant; forms partly covered slope	5
Dolomite, calcitic, light-gray to yellowish-gray, finely crystalline. Contains calcite-lined vugs. Resistant; ledge forming	4
Dolomite, sandy, light-gray to light greenish-gray, very finely crystalline. Sand is very fine grained quartz. Resistant; ledge forming	4
Covered slope; probably shale	3
Dolomite, calcitic, yellowish-gray to light brownish-gray, finely crystalline to microcrystalline, slightly porous. Thin to medium bedded; moderately resistant; ledge forming	5
Covered slope; probably shale	4
Dolomite, calcitic, yellowish-gray, very finely crystalline, rhombic. 2 ft. above base is 1-ft.-thick bed of very fine to coarse-grained dolomitic sandstone, grading to sandy dolomite. Medium bedded; resistant; forms 3 ledges	6
Covered slope; probably shale	2

Dolomite, very light gray, finely crystalline, rhombic, sucrosic, friable, slightly calcitic. Stained pale red and grayish red; resistant; ledge forming	4
Total lower member of Jefferson Formation	59

BEARTOOTH BUTTE FORMATION:

Covered slope; soil contains flakes of shale, mostly grayish-red with some greenish-gray near top. Interbedded with underlying unit	10
Limestone conglomerate, yellowish-gray, hematitic; stained moderate reddish orange and moderate orange pink. Contains fragmentary fish plates and subangular to rounded pebbles of light-gray dense calcitic Bighorn Dolomite, as much as ½ in. long. Conglomerate interbedded with grayish-red shale in lower 4 ft. Ledge forming except lower 4 ft. partly covered	12
Total Beartooth Butte Formation	22

Unconformity.

ORDOVICIAN:

BIGHORN DOLOMITE:

Dolomite, calcitic, mottled light greenish-gray and pale-red, microcrystalline to cryptocrystalline; upper part brecciated. Resistant; ledge forming	6+
Total measured Bighorn Dolomite	6+

STATE OF WYOMING
1933
GEOLOGICAL SURVEY

CORE DESCRIPTIONS

Shell Oil 1 Clear Creek well, Powder River Basin

In center NW ¼ SE ¼ sec. 11, T. 57 N., R. 78 W., Sheridan County, Wyo. Continuous cores between depths of 11,310 and 11,508 feet described by C. A. Sandberg. Cores stored by the Geological Survey of Wyoming at Laramie, Wyo.

MISSISSIPPIAN: **Thickness Ft.**

MADISON LIMESTONE:

11,310-37 Dolomite, pale yellowish-brown, yellowish-brown, and brownish-gray, very finely crystalline to microcrystalline, sucrosic, slightly vuggy. Contains leached fossil molds and inclusions of white very coarsly crystalline anhydrite 27

11,337-44 Dolomite, medium brownish-gray, light olive-gray, and yellowish-brown, finely microcrystalline, sucrosic, slightly silty, containing fish fragments. May be gradational to dolomitic facies of dark shale unit. Very dusky red-purple hematitic patches in bottom 2 ft. 7

Total described Madison Limestone 34

DEVONIAN:

DUPEROW FORMATION:

11,344-53 Siltstone, dolomitic, sandy, light-gray to medium greenish-gray, glauconitic, containing lenses of light greenish-gray, yellowish-gray, and pinkish-gray medium- to coarse-grained silty dolomitic sandstone. Interbedded with light-gray and yellowish-gray finely microcrystalline silty sandy dolomite, containing pale-red-purple and grayish-red hematitic patches 9

11,353-59 Dolomite, moderate brownish-gray and yellowish-brown, very finely crystalline and microcrystalline, sucrosic, fragmental, slightly anhydritic 6

11,359-64 Siltstone, dolomitic, pale-olive, medium light-gray, and greenish-gray mottled with grayish-purple, pale-red-purple, and grayish-red-purple, slightly glauconitic, slightly hematitic, slightly sandy 5

11,364-69 Dolomite, dark yellowish-brown to olive-gray and dark olive-gray to dark brownish-gray, finely and very finely crystalline, rhombic, sucrosic, slightly anhydritic, fetid. Contains marine cysts, probably *Leiosphaeridia* sp. (R. H. Tschudy, written commun., Aug. 7, 1963) 5

11,369-72 Dolomite, very silty, carbonaceous, dark brownish-gray, dark olive-gray, and olive-gray, grading in part to dolomitic silt-

stone and to medium light-gray very fine grained sandstone. Contains abundant *Leiosphaeridia* sp. 3

11,372-74 Siltstone, dolomitic, sandy, greenish-gray and medium-gray mottled with pale-red and grayish-red-purple, slightly glauconitic, slightly hematitic 2

11,374-75 Dolomite, anhydritic, pale to dark yellowish-brown mottled with yellowish-gray and very light gray, microcrystalline, fragmental; in part brecciated and recemented by clear anhydrite .. 1

11,375-80 Dolomite, grayish-red to brownish-gray and pale-brown to light grayish-red, very finely to finely crystalline, rhombic, sucrosic, slightly anhydritic, slightly vuggy. Upper 2 ft. contains ¼-in. interbeds of yellowish-gray and grayish-red-purple to pale-red-purple silty dolomite 5

11,380-82 Dolomite, dark yellowish-brown, cryptocrystalline to microcrystalline, slightly anhydritic, slightly sandy, slightly vuggy. Contains inclusions of white medium to coarsely crystalline anhydrite and scattered very fine grains of quartz 2

11,392-91 Dolomite, silty, olive-gray, medium brownish-gray, mottled yellowish-brown and grayish-purple, and mottled pale-red-purple and greenish-gray, finely microcrystalline, microsucrosic. Contains fish plates and ¼-in. interbeds of mottled grayish-red-purple and dark greenish-gray slightly dolomitic shale 9

11,391-96 Dolomite, mottled medium light-gray, pale yellowish-brown, and light brownish-gray to pale-red, finely microcrystalline, microsucrosic, slightly silty 5

Total Duperow Formation 52

SILURIAN AND ORDOVICIAN:

INTERLAKE FORMATION:

11,396-99 Dolomite, light olive-gray, dense, stylolitic; and pale yellowish-brown cryptocrystalline and very light gray finely microcrystalline microfragmental slightly anhydritic dolomite 3

11,399-401 Siltstone, very dolomitic, grayish-purple to medium dark-gray, containing laminae and interbeds of dark grayish-red slightly sandy shale 2

11,401-04 Dolomite, banded light and moderate brownish-gray and grayish-red, finely microcrystalline, microsucrosic 3

Total Interlake Formation 8

ORDOVICIAN:

STONY MOUNTAIN FORMATION:

11,404-11 Shale, dolomitic, grayish-red to brownish-gray and mottled medium-gray, greenish-gray, and grayish-red, slightly dolo-

mitic, containing interbeds of pale to dark grayish-red-purple silty dolomite 7

11,411-16 Dolomite, mottled brownish-gray to light brownish-gray to medium light-gray, and light olive-gray, finely microcrystalline, microsucrosic, containing stylolites of greenish-gray shale. Contains Ordovician conodont fauna that includes *Drepanodus* spp., *Panderodus* spp., *Oistodus* sp., *Ozarkodina* cf. *O.? equilatera*, *Prioniodina* sp., and a few specimens of 5 other genera (J. W. Huddle and T. J. M. Schopf, written commun., Oct. 7, 1963) 5

11,416-53 Dolomite, mostly light olive-gray with some pale yellowish-brown and medium olive-gray, very finely microcrystalline to cryptocrystalline, containing stylolites of greenish-gray shale. Vertical joints lined by grayish-red hematite and hematitic staining of dolomite adjacent to joints in upper half; a little hematitic staining but no joints in lower half. Contains conodonts and fragmentary brachiopods 37

11,453-69 Dolomite, argillaceous, shaly, greenish-gray and light olive-gray mottled with pale-red to grayish-red and some grayish-red-purple, and medium brownish-gray mottled with medium light-gray, cryptocrystalline to finely microcrystalline, hematitic, stylolitic, containing laminae of light greenish-gray and pale-red slightly dolomitic shale. Contains impressions of brachiopods 16

11,469-72 Dolomite, medium light-gray mottled with very light gray and pale yellowish-brown, microcrystalline and cryptocrystalline, pseudobrecciated. Contains impressions of brachiopods and gastropods 3

11,472-93 Shale, very dolomitic, greenish-gray, medium greenish-gray, and pale yellowish-brown with grayish-red to dusky-red and grayish-red-purple to dusky-red-purple mottles, hematitic, grades to very shaly dolomite. 3-ft. interbed of silty dolomite, 15 ft. below top, is medium olive gray mottled with dusky red purple and contains crinoid fragments and conodonts. Shale contains conodonts and fragmentary fish plates throughout and in lower 3 ft. lenses and pods of siltstone containing crinoid fragments and conodonts 21

11,493-500 Dolomite, silty, anhydritic, mottled medium brownish-gray, medium olive-gray, and medium-gray to grayish-red, microcrystalline to very finely crystalline, sucrosic, vuggy, containing laminae and pebbles of yellowish-gray dolomitic siltstone; in part stylolitic. Contains crinoid fragments and gastropod molds 7

Total Stony Mountain Formation 96

RED RIVER FORMATION:

11,500-508 Dolomite, light olive-gray and medium light-gray, mottled with yellowish-gray, yellowish-brown, and medium brown-

ish-gray, very finely crystalline, rhombic, sucrosic, fragmental, vuggy. Fossiliferous; contains abundant crinoid fragments and molds of gastropods, cephalopods, and brachiopods 8

Total described Red River Formation 8

Shell Oil 1 Crow Tribal well, Powder River Basin, Montana

At north end of Ash Creek oil field, less than a mile north of Wyoming State line. In NE ¼ NE ¼ NE¼ sec. 36, T. 9 S., R. 37 E., Big Horn County, Mont. Continuous cores between depths of 10,544 and 10,722 feet described by C. A. Sandberg. Cores stored by the Geological Survey of Wyoming at Laramie, Wyo.

MISSISSIPPIAN: **Thickness Ft.**

MADISON LIMESTONE:

10,544-48 Dolomite, calcitic, medium light-gray to light olive-gray, finely microcrystalline, microsucrosic; in part slightly glauconitic 4

Total described Madison Limestone 4

Gradational contact.

DOLOMITIC FACIES OF DARK SHALE UNIT:

10,548-51 Dolomite, silty, medium light-gray to light olive-gray, microcrystalline, slightly anhydritic; in part stained pale reddish brown and grayish red 3

10,551-52 Sandstone, dolomitic, silty, light-gray, medium light-gray, and greenish-gray, rounded, very fine to very coarse grained, poorly sorted, glauconitic. Contains fish teeth and bones, conodonts, phosphatic pellets, and coprolites 1

Total dolomitic facies of dark shale unit 4

Unconformity.

DEVONIAN:

DUPEROW FORMATION:

10,552-53 Siltstone, very dolomitic, grayish-red and pale-red. Interbedded with pinkish-gray and pale-red cryptocrystalline dolomite. Contains laminae of dark greenish-gray and grayish-red slightly dolomitic shale 1

10,553-54 Dolomite, anhydritic, dark brownish-gray mottled with yellowish-brown, finely crystalline, rhombic, sucrosic. Contains disseminated grains and radiating lathes of anhydrite 1

10,554-60 Dolomite, medium brownish-gray and medium olive-gray, microcrystalline, microsucrosic; in part stylolitic 6

10,560-67 Dolomite, anhydritic, brownish-gray and medium olive-gray, finely microcrystalline, microsucrosic, containing radiating

lathes and large pods of anhydrite. Contains interbeds of light brownish-gray and pale yellowish-brown cryptocrystalline dolomite and a few laminae of banded greenish-gray and grayish-red slightly dolomitic shale 7

10,567-82 Dolomite, silty, sandy, pale-red to grayish-red, greenish-gray to olive-gray, mottled greenish-gray and grayish-red, and mottled light-gray and pinkish-gray, finely microcrystalline and cryptocrystalline; in part hematitic; in part slightly glauconitic. Sand is very fine to coarse, subrounded to rounded grains of quartz. Contains a few thin lenses of dolomitic sandstone and 9 ft. below top of 2-ft. interbed of medium light-gray cryptocrystalline dolomite 15

10,582-93 Dolomite, dark to dusky yellowish-brown, very finely to finely crystalline, rhombic, sucrosic, slightly anhydritic. Contains two 1-ft. interbeds of light-gray and light olive-gray finely microcrystalline to cryptocrystalline argillaceous dolomite and a few laminae of dark greenish-gray shale 11

10,593-99 Dolomite, silty, medium brownish-gray, greenish-gray to light olive-gray, and yellowish-brown, finely microcrystalline, microsucrosic, containing small ostracodes. Interbedded, with 4- to 12-in. beds of dark greenish-gray glauconitic siltstone containing laminae of dark greenish-gray shale. 3 ft. below top is 1-ft. interbed of dark to dusky yellowish-brown very finely crystalline rhombic sucrosic dolomite 6

10,599-606 Dolomite, anhydritic, brownish-black and dark yellowish-brown, medium and finely crystalline, rhombic, sucrosic, porous, vuggy; in part pseudobrecciated. Contains disseminated grains and large pods of anhydrite 7

10,606-07 Siltstone, very dolomitic, carbonaceous, medium- to dark-gray, fine-grained, very slightly glauconitic 1

10,607-18 Dolomite, anhydritic, brownish-black and dark yellowish-brown, finely and very finely crystalline, rhombic, sucrosic. Contains disseminated grains and large pods of anhydrite. No core 10,608-11, but missing interval presumed to contain anhydritic dolomite 11

10,618-19 Siltstone, dolomitic, sandy, dusky greenish-gray. Sand is very fine to medium rounded grains of quartz 1

10,619-25 Dolomite, anhydritic, dark yellowish-brown and medium dark-gray, microcrystalline to very finely crystalline, sucrosic; in part stylolitic. Contains veins, pods, and radiating lathes of anhydrite 6

10,625-39 Dolomite, silty, olive-gray, dark-gray, and medium brownish-gray, very finely crystalline, spore-bearing; in part anhydritic; in part gradational to dolomitic siltstone. Contains thin

interbeds and laminae of medium light-gray coarse-grained glauconitic siltstone, dark-gray, grayish-black, and dusky greenish-gray glauconitic shale, and white and medium light-gray anhydrite 14

10,639-42 Dolomite, very silty, anhydritic, grayish-black, greenish-black, and mottled olive-gray and medium dark-gray, dense, slightly argillaceous. Contains interbeds and laminae of mottled medium light-gray, medium-gray, and light olive-gray anhydrite and fewer laminae of medium light-gray siltstone 3

10,642-43 Dolomite, silty, carbonaceous, brownish-gray to olive-gray, cryptocrystalline to finely microcrystalline, finely fossil-fragmental. Contains corroded spores and megaspores and possibly dolomitized "calcispheres" 1

10,643-46 Siltstone, dolomitic, anhydritic, medium dark-gray and dark brownish-gray to brownish-black, fine-grained. Interlaminated with brownish-gray anhydrite. Wavy bedded 3

10,646-50 Anhydrite, mottled medium-gray, grayish-black, light olive-gray, and light to very light gray. Lower part interbedded with dark brownish-gray microcrystalline anhydritic dolomite 4

10,650-56 Dolomite, dark brownish-gray to medium dark-gray, finely microcrystalline, microsucrosic, slightly silty. Upper 2 ft. contains laminae of grayish-black shale 6

10,656-60 Anhydrite, mottled medium dark-gray, olive-gray, and light olive-gray. Interbedded with brownish-black to dark brownish-gray dense to cryptocrystalline argillaceous dolomite, containing corroded spores 4

10,660-63 Dolomite, silty, dark brownish-gray to medium dark-gray, finely microcrystalline, microsucrosic, slightly anhydritic. Interbedded with black shale and dusky yellowish-brown very finely crystalline argillaceous carbonaceous dolomite. Contains Late Devonian nonmarine assemblage of spores, including *Convolutispora* sp., *Cristatisporites* sp., *Densosporites* sp., *Leiotriletes* sp., and *Punctatisporites* sp., and megaspores (USGS Paleobot. Loc. D3483; R. A. Scott, written commun., Mar. 5, 1965) 3

Total Duperow Formation 111

SILURIAN AND ORDOVICIAN:

INTERLAKE FORMATION:

10,663-70 Dolomite, anhydritic, medium-gray to medium light-gray, very finely crystalline to microcrystalline; in part sucrosic; in part very finely fragmental 7

10,670-76 Dolomite, pseudobrecciated, anhydritic, medium-gray and medium olive-gray, microcrystalline to very finely crystalline, sucrosic; in part intraclastic. Contains large rounded irregular

pseudofragments of light-gray and light olive-gray cryptocrystalline to dense dolomite 6

10,676-82 Dolomite, intraclastic, anhydritic, medium light-gray, light-gray and light olive-gray, mottled with very light gray and medium dark-gray, cryptocrystalline; in part pelletal. Composed largely of rounded intraclasts, as much as ½ in. in diameter; most intraclasts are medium light-gray to very light gray dense or cryptocrystalline dolomite, but some are medium dark gray. Contains abundant pellets of dense dolomite and fewer oolites and pseudo-oolites, ¼ to 1 mm in diameter, and widely disseminated very fine to medium rounded grains of quartz. Inclusions within intraclasts and centers of some pseudo-oolites resemble "calcispheres" or charophytes in thin section. Rock is cemented partly by lathes of clear anhydrite and partly by rhombic dolomite 6

10,682-86 Dolomite, anhydritic, light to medium-gray and light to very light olive-gray, dense, microfragmental; in part slightly calcitic. Contains lenses, pods, and veins of anhydrite 4

10,686-88 Dolomite, argillaceous, medium-gray, cryptocrystalline, stylolitic 2

10,688-92 Dolomite, anhydritic, medium light to very light gray, cryptocrystalline, stylolitic. Contains a few medium dark-gray intraclasts and large pods of anhydrite 4

10,692-94 Siltstone, very dolomitic, olive-gray to medium light-gray, fine-grained, slightly sandy. Contains scattered very fine to medium subrounded grains of quartz 2

10,694-98 Dolomite, medium-gray, cryptocrystalline, slightly fragmental, slightly anhydritic, slightly silty, stylolitic 4

Total Interlake Formation 35

ORDOVICIAN:

STONY MOUNTAIN FORMATION:

10,698-704 Shale, very dolomitic, sandy, silty, medium-gray to dark greenish-gray. Contains scattered grains and granules of light-gray dolomite. Interbedded with light olive-gray and medium-gray sandy dolomitic siltstone, light-gray to yellowish-gray dense dolomite, and light brownish-gray microcrystalline silty dolomite .. 6

10,704-06 No core 2

10,706-08 Dolomite, very light gray to yellowish-gray, cryptocrystalline, slightly calcitic 2

10,708-10 No core	2
10,710-22 Dolomite, yellowish-gray, light to very light gray, and light olive-gray, finely microcrystalline, microsucrosic; in part anhydritic	12
Total described Stony Mountain Formation	24

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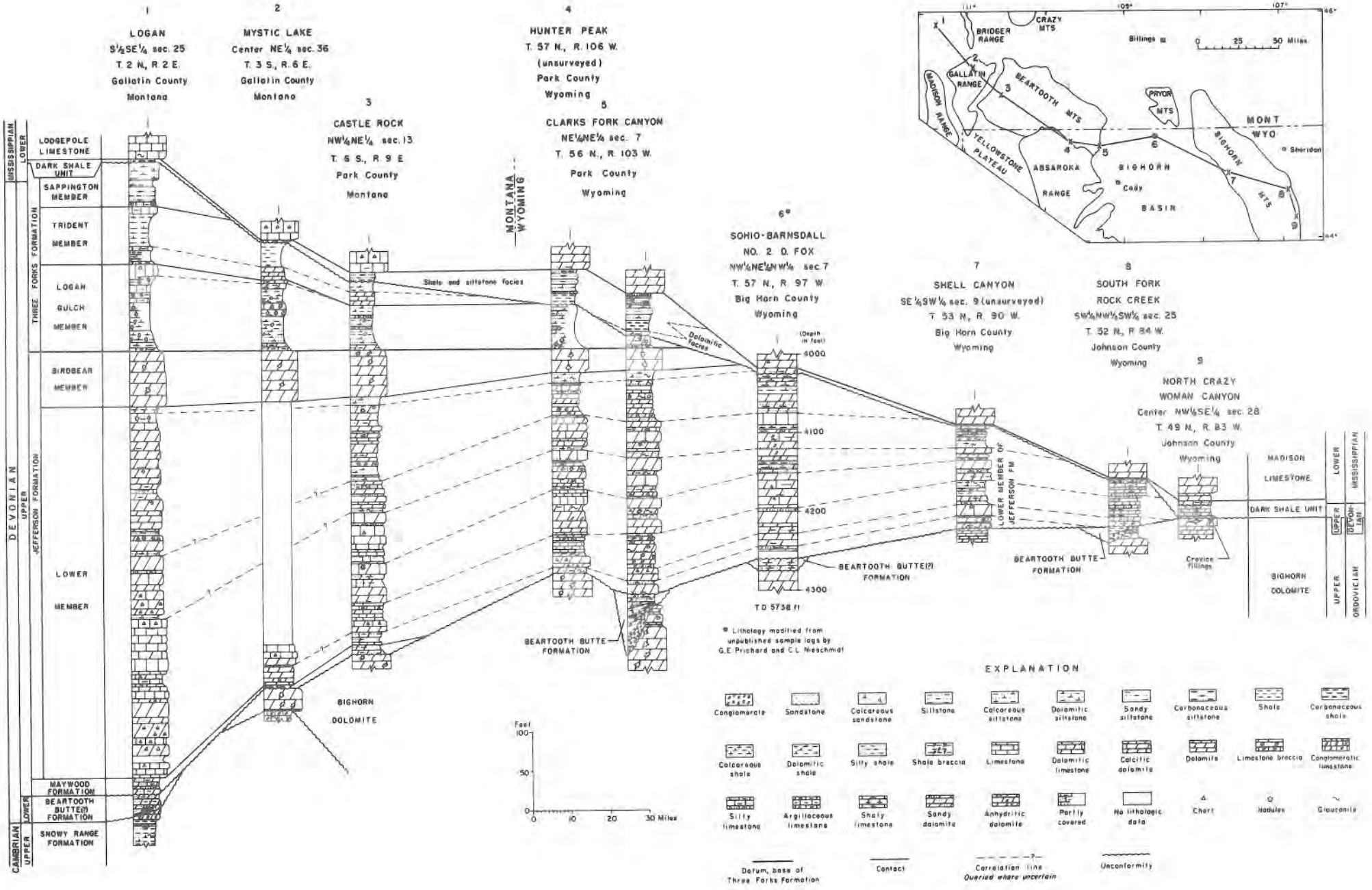
The Geological Survey of Wyoming Bulletin 52

"Measured sections of Devonian rocks in northern Wyoming"
by Charles A. Sandberg

ERRATA

p. 25, line 4 from bottom	For "nearly" read "nearby"
p. 25, line 2 from bottom	For "that" read "(that)"
p. 26, line 7	For "of Montana" read "in Montana"
p. 30, line 26	For "maserated" read "macerated"
p. 41, line 26	For "sport" read "spore"
p. 41, line 13 from bottom	Delete entire line
p. 42, line 6	For "Rhadinisthys" read "Rhadinichthys"
p. 42, line from bottom	For "south" read "north"
p. 43, line 3	For "?Eurypaspis" read "?Euryaspis"
p. 43, line 14 from bottom	For "irrigular" read "irregular"
p. 46, line 2 from bottom))	For "motled" read "mottled"
p. 50, line 5)	
p. 51, line 16	For "calcite" read "calcitic"
p. 53, line 14 from bottom	Insert "sandy" between "gray" and "dolomitic"
p. 60, line 2 from bottom	For "shale" read "shaly"
p. 65, line 11	For "microfissil" read "microfossil"
p. 66, line 2 from bottom	For "1-$\frac{1}{2}$" read "1$\frac{1}{2}$
***p. 72, lines 2, 6, 11, 15, 21, 28, 32, 38, 43	In the lines listed, insert at the right margin of the page, the following omitted thickness: line 2, "8 ft"; line 6, "2 ft"; line 11, "1 ft"; line 15, "3 ft"; line 21, "2 ft"; line 28, "3 ft"; line 32, "2 ft"; line 38, "9 ft"; line 43, "2 ft"
p. 79, line 12 from bottom	For "Ordus" read "Orodus"
p. 84, line 18	For "11, 392-91" read "11, 382-91"
p. 85, line 4	Insert ", medium-gray" before "to medium light-gray"
p. 87, line 11	For "of 2-ft" read ", a 2-ft"
p. 87, line 20	Insert "three" after "with"


1
LOGAN
S½SE¼ sec. 25
T. 2 N., R. 2 E.
Gallatin County
Montana
2
MYSTIC LAKE
Center NE¼ sec. 36
T. 3 S., R. 6 E.
Gallatin County
Montana
3
CASTLE ROCK
NW¼NE¼ sec. 13
T. 6 S., R. 9 E.
Park County
Montana
4
HUNTER PEAK
T. 57 N., R. 106 W.
(unsurveyed)
Park County
Wyoming
5
CLARKS FORK CANYON
NE¼NE¼ sec. 7
T. 56 N., R. 103 W.
Park County
Wyoming
MONTANA - WYOMING
6*
SOHIO-BARNSDALL
NO. 2 O. FOX
NW¼NE¼NW¼ sec. 7
T. 57 N., R. 97 W.
Big Horn County
Wyoming
7
SHELL CANYON
SE¼SW¼ sec. 9 (unsurveyed)
T. 53 N., R. 90 W.
Big Horn County
Wyoming
8
SOUTH FORK
ROCK CREEK
SW¼NW¼SW¼ sec. 25
T. 52 N., R. 84 W.
Johnson County
Wyoming
9
NORTH CRAZY
WOMAN CANYON
Center NW¼SE¼ sec. 28
T. 49 N., R. 83 W.
Johnson County
Wyoming
DEVONIAN
MISSISSIPPIAN
LOWER
UPPER
CAMBRIAN
LODGEPOLE LIMESTONE
DARK SHALE UNIT
SAPPINGTON MEMBER
TRIDENT MEMBER
LOGAN GULCH MEMBER
BIRDBEAR MEMBER
LOWER MEMBER
THREE FORKS FORMATION
JEFFERSON FORMATION
MAYWOOD FORMATION
BEARTOOTH BUTTE(?) FORMATION
SNOWY RANGE FORMATION
Shale and siltstone facies
Dolomitic facies
(Depth in feet)
4000
4100
4200
4300
TD 5738 ft
BEARTOOTH BUTTE FORMATION
BEARTOOTH BUTTE(?) FORMATION
BIGHORN DOLOMITE
LOWER MEMBER OF JEFFERSON FM
Crevice Fillings
MADISON LIMESTONE
DARK SHALE UNIT
BIGHORN DOLOMITE
DEVONIAN
ORDOVICIAN
* Lithology modified from unpublished sample logs by G.E. Prichard and C.L. Nieschmidt
Feet
100
50
0
0 10 20 30 Miles
BRIDGER RANGE
CRAZY MTS
Billings
0 25 50 Miles
GALLATIN RANGE
BEARTOOTH MTS
MADISON RANGE
YELLOWSTONE PLATEAU
PRYOR MTS
ABSAROKA RANGE
BIGHORN MTS
BIGHORN BASIN
Cody
Sheridan
MONT
WYO
EXPLANATION
Conglomerate
Sandstone
Calcareous sandstone
Siltstone
Calcareous siltstone
Dolomitic siltstone
Sandy siltstone
Carbonaceous siltstone
Shale
Carbonaceous shale
Calcareous shale
Dolomitic shale
Silty shale
Shale breccia
Limestone
Dolomitic limestone
Calcitic dolomite
Dolomite
Limestone breccia
Conglomeratic limestone
Silty limestone
Argillaceous limestone
Shaly limestone
Sandy dolomite
Anhydritic dolomite
Partly covered
No lithologic data
Chert
Nodules
Glauconite
Datum, base of Three Forks Formation
Contact
Correlation line
Queried where uncertain
Unconformity