STRATIGRAPHY OF THE MOBIL OIL COMPANY PALEOZOIC TEST WELL, No. 22-19-G, TIP TOP UNIT, SUBLETTE COUNTY, WYOMING

by

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This report is preliminary and has not been edited or reviewed for conformity with USGS standards and nomenclature.

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INTRODUCTION

Location and Structural Setting

The Tip Top Unit is located in the west-central part of the Green River Basin adjacent to the Overthrust Belt of western Wyoming. The Tip Top Unit lies in T. 27, T. 28, and T. 29 N., R. 113 and R. 114 W., Sublette County, Wyoming (Michael, 1960). The field lies athwart the Dry Piney anticline with what has commonly been called the Darby thrust lying on its westward-dipping limb (Howe, 1955).[1] The anticline itself is contained almost entirely within one, and possibly more, intermediate thrust blocks between the "Darby" thrust and the autochtonous Green River Basin sediments.

The Mobil Oil Company Paleozoic test well, 22-19-G, is located in the NW 1/4 NW 1/4 sec. 19, T. 28 N., R. 113 W., Sublette County, Wyoming. The well thus lies on the westward-dipping limb of the Dry Piney anticline. The surface elevation at the well is 7,546 feet above sea level. No. 22-19-G was spudded April 13, 1961, and completed February 1, 1962, at a total depth of 15,435 feet.

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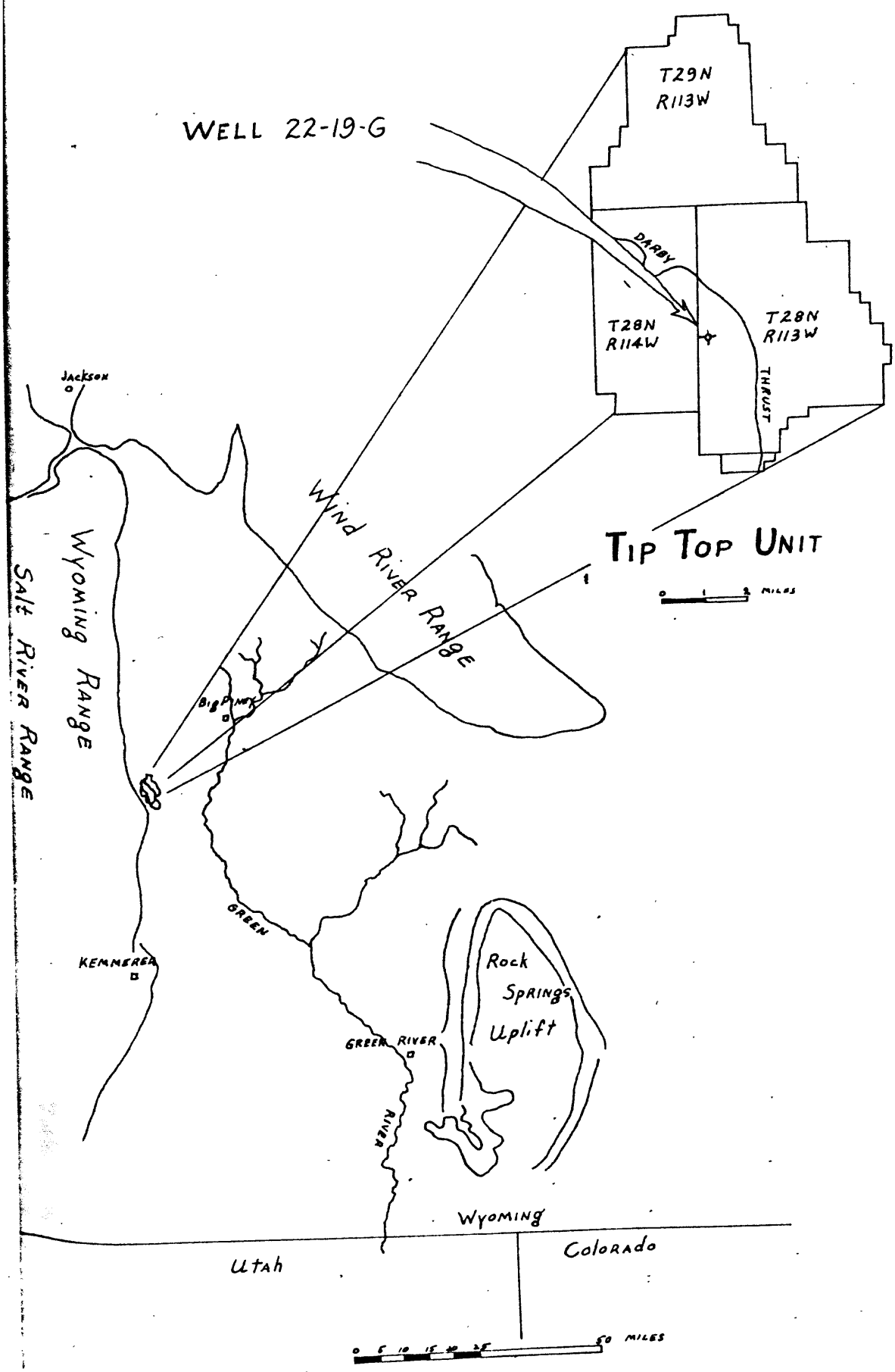
1 The designation as Darby for the thrust here considered has recently come under question and will be renamed by Steven S. Oriel in the near future. (W. W. Rubey, oral communication).



g. 1.--Index map showing location of Tip Top Unit and well 22-19-G

Stratigraphic Importance Well 22-19-G

A complete discussion of the great thickness of sediments contained in the Green River Basin cannot be undertaken here, but brief mention of the thickness of sediments and deepest stratigraphic penetration by deep wells at different localities in the basin bear on the importance of the Tip Top well 22-19-G. Seismic work indicates the deepest part of the Green River Basin to lie in the syncline west of the Pinedale anticline near the northern end of the basin (Krueger, 1960, p. 198). The sediments are at least 30,000 feet thick at Pacific Creek on the eastern side of the basin while at Church Buttes in the southeastern part of the basin a little more than half of this thickness, or approximately 17,000 feet, is present. In the northern end of the basin drilling has exceeded 13,500 feet without passing through the Mesaverde Formation.

Up to 1960, two of the five stratigraphically deepest wells in the Green River Basin had penetrated as deep as the Tensleep Sandstone (Pennsylvanian). One on the Clay Basin anticline at a depth of 9,025 feet, the other, the Lakeridge well 43-19-G at a depth of 14,485 feet. The other deep wells penetrate Nugget Sandstone in the Church Buttes gas field at a depth of 14,517 feet, Frontier Formation at Pacific Creek at a depth of 19,720 feet, and Baxter shale on the Daniel structure at a depth of 16,340 feet. Before 1960, five wells within the Tip Top Unit had penetrated the Nugget sandstone.

Although exposures of Paleozoic sedimentary rocks may be observed even within the Tip Top Unit--indeed the 22-19-G well is surrounded by Paleozoic outcrops--these rocks lie within a thrust sheet of the Overthrust Belt. The closest autochthonous surface exposures of the Paleozoic, with the exception of small discontinuous outcrops near Boulder (Love, 1950), lie at the northwest end and on the eastern flank of the Wind River Mountains approximately 65 and 100 miles away respectively. The Tip Top Unit well 22-19-G therefore provides not only a first look at the subsurface Paleozoic rocks of the Green River Basin, but also provides a basis for comparing autochthonous Paleozoic rocks of the basin with allochthonous strata of the Overthrust Belt.

Methods of Study

In addition to well cuttings taken at either five or ten feet intervals and well cores from Mesozoic and Paleozoic parts of the section, the writer was supplied with electric logs and radioactivity. The drill cuttings were examined under a binocular microscope with objectives magnifying 15, 45, and 90 diameters. Well cores were split with a diamond abrasive wheel in order to provide smooth, clean surfaces for study with binocular microscope. Thirty-three thin sections were cut from the cores and examined under the petrographic microscope.

The size of sand size grains was determined by comparison with sieved, spherical sands of minus one, zero, one, two, three, and four phi diameters. Roundness of grains was determined by visual comparison with a roundness chart (Pettijohn, 1957, p. 59). Grains larger than very coarse sand were measured directly under the binocular microscope with a metric rule.

Distinction between dolomite and calcite was made by testing with dilute hydrochloric acid solution. Questionable determinations were checked by examining euhedral rhombs of carbonate mineral under the petrographic microscope and comparing the refractive index of omega to an immersion oil with a refractive index between the omega indices for calcite and dolomite. To a lesser extent, determinations were checked by X-ray diffraction.

Samples known or suspected to contain fossils were taken from cores of (1) the Bighorn Dolomite and Tensleep Sandstone because of the paucity of fossils known from these two formations, and (2) from the upper Brazer-Madison Limestone and the Amsden Formation with the hope of substantiating the suspected ages of these formations. The Mississippian and Pennsylvanian samples were examined by William J. Sando, Betty Skipp, and Helen Duncan of the U.S. Geological Survey.

The megafossils, algae(?), echinoderms, brachiopods, ostracodes, bryozoa, and horn corals were so fragmentary that no significant taxonomic determinations could be made. Two samples, one from about 50 feet below the top of the Brazer-Madison Limestone and the other from 150 to 175 feet below the top of the Amsden Formation, contain foraminifera. These were examined by Betty Skipp. The Brazer-Madison samples contain Endothyra aff. E. baileyi. Only skew-coiled forms are present, but these alone are sufficient to suggest an early Meramec age. From the Amsden samples, Mrs. Skipp identified the following forms:

Paramillerella sp.
Millerella cf. M. marblensis Thompson 1942
Cribrostomum sp.
Climacammina sp. or Deckerella sp.
Endothyra kleina Woodland 1958
Tuberitina sp.
Glomospira sp.

She states that, "The extreme abundance of the advanced thinly discoidal millerellid forms in combination with Cribrostomum and ?Deckerella make an Early Pennsylvanian age for this fauna more likely than a Late Mississippian age."[1]

The Bighorn samples were examined by John Huddle. He reports that no recognizable invertebrate fossils are present, but short cylindrical bodies in the core may be of algal origin or may represent borings of some type.

Colors were ascribed by comparison of wetted surfaces with the Rock Color Chart of the National Research Council.

From well cuttings alone it is not always possible to pick the tops of units nor distinguish individual beds in interbedded sequences due to mixing of the samples by caving. This is particularly true in sandstone and shale sequences such as those of the Cretaceous part of the section. Therefore, rock types and their percentages have been described from each sample, and relationsbetween rock types have been inferred from the electric logs. Because previous wells have supplied information on the upper part of the section from cores as well as cuttings, this report emphasizes the lower part of the section from which cores were taken, the section below the Twin Creek Limestone.

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1 William J. Sando, Betty Skipp, and Helen Duncan, written communication.

Acknowledgments

This study was made possible by the enthusiastic support of the Mobil Oil Company, which not only made cores and cutting available for study, but provided much additional data. We are indebted to R. A. Howe, G. G. Cooper, and L. O. Gentry of Mobil for numerous courtesies shown.

The writer wishes to thank W. W. Rubey for many helpful suggestions in the preparation and stratigraphic designation of the samples and for reading the manuscript. The writer acknowledges the work of Steven S. Oriel of the U.S. Geological Survey, many of whose choices from electric logs of formational tops were incorporated in this report. The writer is also indebted to many members of the faculty and graduate student body of the Department of Geology of the University of California, Los Angeles, for encouragement and helpful suggestions.

STRATIGRAPHY

General Statement

No system of stratigraphic nomenclature is now universally accepted for the west-central Green River Basin. The various stratigraphic names in use are tentative and have been extended to this area from current usages in three widely separated areas: (1) the Overthrust Belt of western Wyoming and southeastern Idaho, (2) the northwest end of the Wind River Mountains, and (3) the Rock Springs Uplift.

After a brief review of the multiplicity of defensible names, the writer, for the sake of brevity and simplicity, arbitrarily adopted the nomenclature of the Overthrust Belt for almost all rock units recognized. Although this decision can be defended, no attempt has been made to do so. The terminology adhered to hereafter is taken from publications by Schultz (1914), Wanless et al. (1955), Rubey (1958), and Oriel (1963). Some lack of common agreement exists among the various workers. Where conflict arises, the present writer has been guided by recency of publication and geographic proximity.

Two exceptions have been made to the adherence to Overthrust Belt nomenclature. The first is the extension of Cambrian names, Open Door and Du Noir, from the Gros Ventre and Wind River Mountains; the second, use of the name Tensleep, extended from the Bighorn Mountains, for the Pennsylvanian sandstone observed in the well. These exceptions are discussed under their respective headings.

A critical review of the stratigraphic nomenclature and establishment of a standard reference section is definitely needed for the western Green River Basin. It is the hope of the writer to undertake, in the near future, such a review and to present a reference section based in part on the study of the Tip Top Unit well 22-19-G.

Ordovician

Bighorn Dolomite

The Bighorn Dolomite is exposed at the surface in what has commonly been called the "Darby" thrust plate. The well passes through 70 feet of alluvial cover before penetrating 450 feet of light gray dolomite. Although the most characteristic feature of the Bighorn Dolomite is its uniformity, five units may be distinguished from the cuttings. The first is 40 feet of medium light gray (N6) to light olive gray (5Y 6/1) dolomite of medium silt-size grain containing calcite stringers, patches of dark red-orange (10R 5/6) organic residue, some pyrite, and having negligible porosity. The second unit, 140 feet of light olive-gray (5Y 6/1), medium silt-size grained dolomite, is composed of euhedral rhombs; the rock has very good intercrystalline porosity. Towards the bottom of the unit a few dolomite rhombs are of very coarse sand size. Calcite stringers are common near the top of the unit. Minor pyrite and organic residues are common throughout. No cuttings were recovered from two separate 10-foot intervals included in this unit. Below the second unit, the drill passed through 30 feet of yellowish-gray (5Y 7/1), very fine silt-size, sucrose dolomite. For the next 70 feet, no cuttings were recovered. At a depth of 350 feet, the drill reached the top of 110 feet of medium gray (N5) to very light gray (N8) dolomite comprising a mosaic of coarse silt-size to very fine sand-size euhedral and subhedral crystals having fair intercrystalline porosity. A 20-foot interval from which no cuttings were recovered is present near the top of the unit. The fifth unit in this sequence, 60 feet of medium gray to light gray calcitic dolomite, consists of coarse silt-size euhedral dolomite in a matrix of very fine silt-size anhedral calcite. The percent of calcite matrix increases downward. Iron oxide stains are present in small amounts along with minor amounts of pyrite and sulfur. The bottom of the Bighorn Dolomite lies at a depth of 520 feet.

Cambrian

Gallatin Group

Shaw (1954) proposed elevating the Gallatin Limestone to group status. Shaw and Deland (1955) have extended the formation names of the Gallatin Group, the Open Door Limestone and the underlying Du Noir Limestone, to the Overthrust Belt of western Wyoming. These authors have further recognized the Dry Creek Shale Member of the Open Door Limestone at its base. Recognition of these units from the well cuttings has led to their incorporation in this report.

Open Door Limestone

The Open Door Limestone may be stained pale grayish red (5R 5/2), but otherwise ranges from grayish black (N2) to dark gray (N3) and medium dark gray (N4) to very light gray (N3). The upper 70 feet of limestone, 20 feet of which was not recovered, is of medium to coarse silt-size subhedral and anhedral grain in finer calcite matrix. Calcite veinlets are common. The grain size increases to very fine sand-size crystals at the bottom of the unit. The more coarsely crystalline limestone is underlain by 30 feet of grayish black to very light gray, very fine silt-size, dense limestone. This is followed by 40 feet of very fine silt-size to aphanitic, oolitic or pisolitic limestone with minor glauconite and some iron oxide stains. A total of 140 feet of Open Door Limestone was penetrated before passing into Dry Creek Shale Member at a depth of 660 feet.

Dry Creek Shale Member of the Open Door Limestone--The Dry Creek Shale Member examined from cuttings consists of very uniform calcareous, dark greenish gray, fissile shale. A thin bed of pisolitic limestone is present near the top. One hundred and ten feet of Dry Creek Shale overlies the Du Noir Limestone.

Du Noir Limestone

The Du Noir Limestone as interpreted from cuttings may be divided into three units, an upper and lower limestone separated by a thin shale unit. The upper unit is 50 feet of very light gray (N3), microcrystalline to very fine silt-size grained limestone and interbedded dark greenish-gray shale. It is separated from the lower limestone unit by 30 feet of dark greenish-gray (5GY 4/1), fissile, calcareous shale. The lower limestone unit is medium light gray (N6). It is microcrystalline and contains pisolites of medium sand-size. This lower unit is 60 feet thick making a total thickness for the Du Noir Limestone of 140 feet.

Gros Ventre Formation

The Gros Ventre Formation was named by Blackwelder (1918) from exposures on Double Top Peak, Gros Ventre Range. Wanless et al.(1955, p. 11-13) recognize three members in the northern Wyoming Range. From top to bottom, these are (1) Park Shale Member, (2) Death Canyon Limestone Member, and (3) Wolsey Shale Member. Correlation of these units with the Park Shale, the Meagher Limestone, and Wolsey Shale of Montana has been substantiated by Lochman (1949, p. 42-47). The Death Canyon Limestone Member derives its name from Death Canyon in the Teton Range (Miller, 1936, p. 119). Shaw (1954) has proposed elevating the Gros Ventre Formation to group status wherever the Death Canyon Limestone separates the two shales. These three members are easily recognized from well cuttings and electric logs.

Park Shale Member--The Park Shale Member comprises two shale units separated by a thin limestone unit. Cuttings from the upper unit are dark greenish-gray, fissile, calcareous shale. The upper shale unit is 110 feet thick. Twenty feet of very light olive-gray aphanitic limestone intervenes between the upper and lower shale units. Fine glauconite-bearing quartz silt is present in small amounts. The limestone also contains thin interlaminations of dark greenish-gray shale. The lower shale unit, 80 feet thick, is dark greenish-gray (5GY 4/1) and contains intercalations of olive-gray (5Y 4/1) microcrystalline limestone. The limestone is stylolitic and calcite veinlets are common. Pyrite is less common and minor amounts of glauconite are present near the bottom of the unit. The total thickness of Park Shale here described is 210 feet.

Death Canyon Limestone Member--At a depth of 1,120 feet, olive-gray limestone cuttings belonging to the Death Canyon Limestone Member were recovered. The limestone is slightly vuggy with euhedral calcite crystals lining the vugs. Calcite veinlets are also common. Stylolites commonly carry hydrocarbon residue. Small amounts of pyrite occur sporadically. The Death Canyon Limestone is 290 feet thick, and is easily recognized on the electric logs.

Cretaceous

Adaville Formation

At a depth of 1,410 feet, the well intersects the "Darby" thrust fault. Directly below the fault surface the well cuttings reveal 100 feet of light gray (N6.5) sandstones not typical of the underlying Hilliard Shale. These sandstones are of very fine, subrounded to rounded quartz sand with carbonate cement. In places, they bear up to 35 percent dark minerals and 1 to 5 percent pyrite. They are most probably a basal unit of the Adaville Formation.

Hilliard Shale

The Hilliard Shale, examined from well cuttings, comprises 3,922 feet of interbedded sandstone, siltstone, and shale with siltstone and shale predominating. The formation is divided into eight units on the basis of composition of the sandstones and siltstones, color of the siltstones and shales, and relative proportions of the three lithologies. The top 462 feet consist of dark greenish-gray (5GY 4/1), calcareous shale containing minor pyrite and glauconite and a few thin beds of very fine, calcareous sandstone. Sand grains are subrounded to rounded. Iron oxide stains are present in the shale near the top of the unit.

The next 340 feet are predominantly siltstone with a few feet of interbedded shale near the top of the unit. The siltstone is light olive gray (5Y 6/1) with subangular to angular, coarse, quartz silt grains. Fifteen to twenty-five percent of the grains are dark minerals. Microcrystalline carbonate cements the grains. Thin laminations of very fine sandstone are common. Ten feet of light olive-gray, laminated sandstone lies at the base of the unit. The very fine sand contains 20 to 25 percent dark minerals in carbonate cement.

Beginning with 181 feet of shale and interbedded siltstone and sandstone, the next unit is subdivided into five sub-units. Below the shale lies 156 feet of siltstone followed by 50 feet of shale capped by 10 feet of sandstone. Another 72 feet of siltstone completes the 469 feet thick unit. The shales are dark greenish-gray, calcareous, and fissile and include minor amounts of pyrite. Siltstones are light olive gray to medium gray (N5) with subangular to angular, coarse silt and 15 to 25 percent dark minerals in carbonate cement. They are commonly micaceous. Sandstones are light olive gray, laminated and contain very fine, subangular, quartz sand with 20 to 25 percent dark minerals. A few sandstone beds are micaceous. This 469 feet thick unit is repeated by a reverse fault at a depth of 2,782 feet.

The fifth unit, 550 feet thick, also is predominantly siltstone with thinner sub-units of sandstone and shale. The sandstones are typically thicker than those in the preceding unit. Shales are dark greenish-gray, calcareous and fissile. Sandstones, light olive gray, are composed of very fine, subangular sand and commonly are micaceous. The siltstones are medium gray with fine, subangular silt containing 15 to 20 percent dark minerals in carbonate cement. They are laminated and micaceous.

The next 612 feet contain approximately equal thicknesses of siltstone and shale in subunits ranging from 40 to 100 feet thick. The sandstones, fewer in number, attain a maximum thickness of 25 feet. In the upper and lower portions of the 612 feet, the shales are dark greenish-gray as preceding, but in the middle of the unit they are olive black (5Y 2/1) to black (N1) and silty. The siltstones comprise fine, subangular to angular silt and minor laminations of very fine sandstone. They are olive black throughout. The sandstones are much as preceding, but contain a few Inoceramus prisms.

The underlying 334 feet is predominantly shale with several beds of sandstone, and only a few feet of siltstone. The thickest sandstone is approximately 32 feet thick. The shales are dark greenish-gray and calcareous with the exception of a few feet of dark gray, micaceous, silty shale near the middle of the unit. The very fine sandstone varies from light olive gray to dark gray (N3) and contains laminae of olive black silt. The remaining 686 feet contain approximately equal proportions of sandstone, siltstone, and shale in units ranging from 3 to 50 feet thick. Sandstones are olive gray (5Y 4/1) and contain very fine, subangular to angular sand with 15 to 25 percent dark minerals. Shales are olive black, silty and have poor fissility. Toward the bottom, dark greenish-gray shales contain limestone stringers bearing pisolites and glauconite. The siltstones, composed of fine angular silt, vary from dark gray to brownish black (5YR 2/1) and olive black. Inoceramus prisms are common throughout this lower unit.

Frontier Formation

The Frontier Formation is 1,608 feet of interbedded sandstone, siltstone, and silty shale, and thin discontinuous limestone lenses. Approximately 662 feet of the Frontier Formation have been repeated by the Tip Top thrust at a depth of 6,014 feet. The repetition of strata is readily identified on the electric logs.

Sandstone and siltstone predominate in the formation, with sandstone increasing toward the bottom of the section. The sandstones are most commonly medium olive gray (5Y 5/1) and light olive gray (5Y 6/1) to medium light gray. The sands are very fine to fine, subangular to subrounded and comprise 70 to 80 percent heavy minerals, and commonly 5 to 10 percent glauconite in calcite cement. The sandstones take on a salt and pepper appearance towards the bottom.

The siltstones and shales are dusky brown (5YR 2/2) and olive black (5Y 2/1). The siltstones are of fine to very fine quartz silt and commonly are platy. They commonly contain thin laminations of coarser silt or very fine sand. Both siltstones and shales are calcareous.

Some coal was encountered between depths of 6,150 feet and 6,190 feet. Thin, white bentonite beds are common in the repeated part of the section. Inoceramus prisms are abundant in the siltstones and shales. Hydrocarbon residues are present in a few sands.

Aspen Shale

Lithologies typical of the Aspen Shale were encountered in cuttings from depths of 7,040 feet to 7,822 feet. The top 55 feet consists of greenish-black (5GY 2/1) fissile, noncalcareous, dense shale. Two thin beds of very fine salt and pepper, quartzitic sandstone are also present.

The next 366 feet is predominantly siltstone with several quartzitic sandstone beds. Four white bentonite beds are also included. The very fine siltstone varies from grayish black (N2) to olive black (5Y 2/1) and is characteristically blocky and interlaminated with grayish-black, silty shale. Inoceramus prisms are common.

The remaining 361 feet are predominantly sandstone with interbedded siltstone and a few thin shales. The sandstones tend to be quartzitic. They vary from light olive gray (5Y 6/1) to medium dark gray (N4) and commonly have a salt-and-pepper appearance. The very fine sand grains are subangular to subrounded. Toward the bottom of the formation the sandstones are tuffaceous. The siltstones are medium dark gray to grayish black and contain coarse, quartz silt in silica cement. The shales are siliceous, medium dark gray and sometimes spotted.

Bear River Formation

The Bear River Formation, examined in cuttings recovered between depths of 7,822 feet and 8,270 feet, is composed of splintery, dense, black (N1) shale, and interbedded olive-gray (5Y 4/1), very fine, glauconitic sandstone. The middle 187 feet of the formation is siltstone interbedded with medium light gray (N6) glauconitic sandstone. The lower black shale contains beds of subrounded to rounded, olive-gray (5Y 4/1), calcareous sandstone with 5 percent dark minerals and minor glauconite. Minor amounts of greenish-black (5GY 2/1), silica cemented, very fine sandstone are present at the base of the formation.

Gannett Group Undifferentiated

To the west of the well site in the Overthrust Belt, the Gannett Group is divided into the Draney Limestone, the Bechler Redbeds, the Peterson Limestone, and the Ephraim Conglomerate. In the well, the conglomeratic facies is missing, the clastic facies being represented by fine sandstone, siltstone and shale. Furthermore, the limestone present comprises six separate units totaling only 57 feet in a sequence of 254 feet of siltstone and shale.

Above the limestones, at the top of the Gannett Group lies 111 feet of soft, medium gray (N5) claystone with a purplish cast followed by 58 feet of very dusky red-purple shale and interbedded medium gray sandstone. The limestones themselves are light olive-gray (5Y 6/1), aphanitic and dense. They are interbedded in a sequence of shales which are very dusky red purple (5RP 2/2) at the top and are variegated very dusky red purple, grayish red (10R 4/2) and medium gray toward the bottom.

Below the limestone-bearing sequence lies 357 feet of interbedded shale and sandstone and a few feet of dark reddish-brown (10R 3/4) siltstone. The shales are variegated very dusky red (10R 2/2), very dusky red purple, and grayish red purple (5RP 4/2). The colors are more vivid than those of the shales preceeding. The interbedded sandstones are light gray (N6) and contain very fine sand with 5 percent dark minerals. The total thickness of the Gannett Group is 780 feet.

Jurassic

Stump Sandstone

The poor quality of the samples and a stratigraphic thickness of only 35 feet make a detailed description of the Stump Sandstone difficult. The formation consists of very fine, light olive gray (5Y 6/1), rounded sandstone with minor amounts of glauconite. The upper and lower limits of the Stump Sandstone at 9,050 feet and 9,085 feet respectively are easily recognized on the electric logs.

Preuss Redbeds

The Preuss Redbeds comprise 175 feet of variegated shale and light olive-gray (5Y 6/1) sandstone with a few thin beds of dark reddish-brown (10R 3/4) siltstone near the base of the formation. The upper 48 feet are variegated dusky grayish-red, grayish-red, and dusky red-purple shale and two thin beds of light olive-gray sandstone. Similar sandstone with rounded very fine quartz sand and some glauconite make up the next 47 feet. The remaining 80 feet are interbedded variegated shale, olive-gray sandstone and siltstone.

Twin Creek Limestone

From examination of well cuttings, 742 feet of Twin Creek may be divided into four units not including the Gypsum Spring Member at the base. The upper 52 feet is predominantly light olive-gray (5Y 6/1) sandstone composed of very fine, rounded grains. Interbedded at the base of the sandstone is grayish-black (N2) siltstone.

A sequence, 393 feet thick, of interbedded limestones and shales with a few thin beds of dark gray (N3) calcareous, glauconitic sandstone and dark gray, very fine siltstone underlie the uppermost 52 feet. The total thickness of limestone present is 178 feet. The limestones are dusky yellowish-brown (10YR 2/2) and contain coarse silt-size to fine sand-size oolites in a microcrystalline matrix. A few beds of dense, aphanitic limestone are also present. The shales are very dusky red purple (5RP 2/2) and grayish red (10R 4/2), and are in part calcareous. A similar limestone and shale sequence 125 feet thick underlies the preceeding. However, the limestones are dense, aphanitic and non-oolitic. Below the aphanitic limestone, the shales are greenish gray (5GY 6/1) and dark reddish brown (10R 3/4). The sandstones are medium gray (N5), very fine, and contain subrounded grains. They are interbedded with dark gray (N3), fine, laminated siltstone. Near the base of this sandstone and shale sequence lies 27 feet of dusky yellowish-brown, oolitic limestone. From the base of the aphanitic limestone to the base of the formation the thickness is 172 feet.

Gypsum Spring Member of the Twin Creek Limestone--The upper 48 feet of the Gypsum Spring Member examined from well cuttings includes olive-gray (5Y 4/1) dolomite and grayish-red (10R 4/2) shale. Core chips recovered between 10,050 feet and the base of the formation at a depth of 10,081 feet reveal a sequence of interbedded argillaceous dolomite and anhydrite. The anhydrite in places is irregularly banded white and brownish-black (5YR 2/1), or pale brown (5YR 5/2). Elsewhere it is present in solid colors of medium to light olive gray (5Y 5/1 to 5Y 6/1) or dusky yellowish brown (10YR 2/2). Crystal size ranges from medium silt to medium sand-size. The argillaceous dolomite varies from dark greenish gray (5GY 4/1) to shades of brownish gray (5YR 4/1) and dark olive-gray (4Y 3/1) with occasional stringers of grayish orange-pink (5YR 7/2) anhydrite. The dolomite is microcrystalline and contains from 5 to 40 percent very fine, quartz silt. The uppermost dolomite contains from 1 to 4 mm. diameter pyrite nodules. A single very fine, dolomitic siltstone is present at 10,073 feet.

Nugget Sandstone

The Nugget Sandstone is predominantly pale yellowish-brown (10YR 6/2) to light olive-gray (5Y 6/1) sandstone with a few thin greenish-black (5GY 2/1) and dark greenish-gray (5G 4/1) to medium dark gray (N4) beds. The light colored sandstone is commonly cross-stratified. A total of 41.5 feet of core was recovered from three cores taken from the Nugget Sandstone.

The sandstone is composed of very fine to fine, subrounded to well rounded, quartz sand. The quartz grains are commonly pitted or frosted. Plane contacts between grains are the rule with little or no interpenetration of grains. Heavy minerals comprise from 2 to 5 percent of the clastic grains. Feldspar is a minor constituent. Relative to those in the top-set laminae, the grains are better rounded and more spherical in the fore-set strata. The latter often display alternating laminae of fine and very fine sand. Besides containing more angular sand, the top-set strata contain more heavy minerals.

The darker green and gray beds are irregularly stratified, with a wavy, undulatory appearance. These beds are stylolitic. Individual laminae are composed of angular quartz grains with preferred horizontal orientation of long axes.

Four thin red units interrupt the otherwise very uniform sequence of light-gray sandstone. The first of these, near the middle of the formation, is 6 feet of grayish-red (10R 4/2) shale accompanied by dull, white, earthy anhydrite. The other three red units, lying near the bottom of the formation and averaging 11 feet thick, are dark reddish-brown (10R 3/4) fine quartz siltstones. At the top of the formation several grayish-red (10R 4/2) beds of sandstone, only inches thick, are present. Associated with these are thin partings of grayish-green (5G 5/2) shale. Light greenish-gray (5GY 6/1) subcircular blotches suggestive of burrowing activity also occur in this part of the section.

Triassic

Ankareh Redbeds

The Ankareh Redbeds, underlying the Nugget Sandstone, is composed of dark reddish-brown (10R 3/4) and grayish-red siltstones and a few shales of the same colors. The siltstones characteristically display shaly partings. The formation is 800 feet thick. Forty-one feet of core were recovered between 11,057 feet and 11,098 feet depths.

The siltstones consist of moderately sorted medium to coarse quartz silt and very fine sand. The quartz grains are subangular. Five to ten percent heavy minerals are present accompanied by approximately 5 percent feldspar. The matrix is composed of finely divided iron oxide disseminated in microcrystalline carbonate. Gypsum sand crystals (Pettijohn, 1957, p. 202), stringers, and vug fillings are common. Micaceous minerals lie parallel to stratification. Heavy minerals are concentrated along cross-strata.

Evidence for deposition by water currents is abundant. Stratification has been disrupted by currents prior to consolidation forming pre-consolidation clasts of microcrystalline sediment. Small-scale scour-and-fill structures, microcross-stratification, and graded laminae are common. Swirls of disturbed bedding are also present. A few gray to dark gray and grayish-green zones contain abundant gypsum stringers and minor amounts of dark organic matter and horizontal streaks of pyrite.

Thaynes Limestone

The Thaynes Limestone is a sequence, 489 feet thick, of interbedded medium to light olive-gray (5Y 5/1 to 5Y 6/1) limestone and siltstone, and grayish-red (10R 4/2) and dark reddish-brown (10R 4/4) siltstone and shale. The red units are tongues of the Chugwater Formation interfingering westward with the marine Thaynes Limestone.

The upper, predominantly gray, 115 feet of the Thaynes comprises light olive-gray (5Y 6/1) siltstones and thin, light olive-gray limestones interbedded with dark reddish-brown (10R 4/4) siltstones and grayish-red (10R 4/2) shales. The gray siltstones are composed of medium, angular, quartz silt with 5 to 10 percent carbonate cement; the red siltstones, fine subangular to angular silt. The gray siltstone coarsens and becomes better rounded and more calcareous toward the bottom. The limestones are marly to silty with a few percent of fine, angular, quartz silt.

Below the lowest limestone lies 151 feet of interbedded grayish-red (10R 4/2) and dark reddish-brown (10R 3/4) siltstone and dark reddish-brown shale. Thirty-eight feet of core recovered in this interval is composed of medium to coarse, quartz silt in a microcrystalline matrix.

In the reddish-brown beds the matrix is carbonate containing finely divided iron oxide while in the grayish-red beds the matrix contains little carbonate. Here the micro-crystalline material is gypsum or anhydrite. Heavy minerals are most abundant in the upper and lower part of the core where they comprise 10 to 15 percent of the clastic grains. Feldspar is an additional constituent which ranges up to 5 percent. Gypsum forms veinlets, stringers, and vug fillings, particularly in the lower 18 feet of the core. Occasional streaks and patches of pale blue green (5BG 7/2) silt are also common in this lower part of the core. The reddish-brown shale has a hackly surface and is interstratified with very fine quartz siltstone.

Below the middle red unit, lies 90 feet of medium olive-gray (5Y 5/1), microcrystalline, dense dolomite. It is commonly pisolitic and in places, silty.

Medium gray, calcareous and pyritic siltstone is interstratified with the dolomite. Toward the bottom of the dolomite unit lies 13 feet of grayish-red (10R 4/2) shale. The remaining 133 feet are interbedded olive-gray (5Y 4/1) siltstone and grayish-ged shale.

Woodside Redbeds

The Woodside Redbeds, although predominantly red, include olive-gray limestones and siltstones totalling a little greater than one-third of the thickness of the entire formation. From an examination of well cuttings alone it is difficult to distinguish the interbedded red and gray beds of the Thaynes from those of the Woodside. However, a distinct change in the character of the resistivity log serves to place the top of the Woodside Redbeds at 11,869 feet deep.

The top 42 feet of the Woodside are dark reddish-brown (10R 3/4) siltstone containing fine quartz silt and shaly partings. The next 210 feet, from 40 feet of which no cuttings were recovered, are light olive-gray (5Y 6/1) siltstones and limestones and a few feet of grayish-red shale. The linestones are microcrystalline, silty and dense. The siltstones are calcareous and are composed of fine quartz silt. They become dolomitic toward the bottom of the unit. The remaining 377 feet are dark reddish-brown and grayish-red siltstone and grayish-red, fissile shale. The siltstones are composed of very fine to fine, subangular, quartz silt. The individual grains are coated with iron oxide. The carbonate cement, which in places ranges up to 40 percent of the rock, contains finely disseminated iron oxide. Shaly partings and stringers of anhydrite are common. A few thin beds of light olive-gray (5Y 6/1) limestone and one thin bed of very light gray (N7) anhydrite are also present.

Dinwoody Formation

The Dinwoody Formation as interpreted from well cuttings here has a total thickness of 104 feet. The upper 52 feet is medium olive-gray (5Y 5/1), microcrystalline, silty limestone with interstratified light olive-gray (5Y 6/1) siltstone. Below the limestone, lies 45 feet of dark reddish-brown (10R 3/4), fine siltstone composed of subangular quartz grains. There is an increasing amount of dark gray (N3) siltstone toward the bottom of the unit. The basal 7 feet of the Dinwoody Formation are dark olive gray (5Y 3/1) limestone. The very fine silt-size, anhedral limestone is pyritic.

Permian

Phosphoria Formation

Dark, organic-rich carbonates and siliceous rocks typical of the Phosphoria Formation were penetrated between depths of 12,602 feet and 12,877 feet. Of the total thickness of 275 feet, 137.5 feet were recovered by coring. There was no recovery of core or cuttings from 12,801.5 feet to 12,855 feet.

McKelvey et al. (1956) in establishing the intertonguing relationships of the Phosphoria Formation, Park City Formation, and Shedhorn Sandstone in eastern Idaho, northern Utah, and central and western Wyoming have proposed six, three, and two members respectively for each of these formations. At least one of the members of the Park City Formation was recognized by these authors (p. 2844) in General Petroleum's Lakeridge No. 1 well (Sec. 19, T. 29 N., R. 114 W., Sublette County, Wyoming). From figure 2 and 3 of McKelvey et al., one could expect to find the following members, from top to bottom, in well 22-19-G: Ervay Member of the Park City Formation, Tosi Chert and Retort Phosphatic Shale Members of the Phosphoria Formation, Franson Member of the Park City Formation, Meade Peak Phosphatic Shale and Lower Chert Members of the Phosphoria Formation, and the Lower Member of the Park City Formation. However, no attempt has been made to distinguish these members in the present study.

The upper 36 feet of the Phosphoria Formation, 29 feet of which was cored, is predominantly dark gray (N3) to medium dark gray (N4) and brownish-black (5YR 2/1) carbonate with minor amounts of sandstone. The middle 139 feet is composed of brownish-black (5YR 2/1) to olive-gray (5Y 4/5) and black (N1) to medium dark gray (N4), phosphatic chert and silty dolomite. The next 24.5 feet is olive-black (5Y 2/1) and light olive-gray (5Y 6/1) chert and dark gray (N3) and medium dark gray (N4) sandstone and siltstone. At this point a gap of 63.5 feet exists due to a lack of recovery of cuttings or cores. The lowest 12 feet is black (N1) to dark gray (N3) sandstone and mottled dark gray (N3.5) and medium light gray (N6) dolomite.

The upper carbonate unit consists predominantly of fine grained, sandy and cherty dolomite with 13 feet of fossiliferous limestone at the bottom. A thin calcareous sandstone is also present. The dolomite comprises very fine silt-size euhedral rhombs to rhombs of coarse silt-size. Fine stratification apparently has been disrupted by burrowing organisms. Micro-cross-stratification is also present. Toward the top, very fine quartz sand increases from 0 to 40 percent. Discontinuous, patchy laminae of chert are interstratified with the dolomite. Bodies of tabular chert, containing minute calcite veinlets, are present toward the bottom. The limestone contains detrital fossil fragments, and limestone and oolitic limestone fragments. Brachiopod fragments are especially abundant. Vugs have been filled with calcite. Chert and pyrite are present in the limestone in minor amounts.

The chert and dolomite of the middle unit are mottled except toward the bottom where extremely high organic content masks this pattern. The fibrous and globular chert encloses rounded carbonate rock fragments, euhedral rhombs of dolomite, and coarse quartz silt. Large irregular patches of white, crystalline calcite are common.

Phosphatic pellets are contained in fine to medium silt-size euhedral dolomites. The dolomite also contains abundant finely divided pyrite and minor amounts of quartz grains. The organic content of the dolomite is very high causing ready parting along fine laminations. The dolomite also contains rounded rock fragments. Medium, angular to subangular quartz silt increases to 30 or 40 percent at the bottom.

The light olive gray chert is silicified fossil hash containing abundant echinoid spines. The silicified fossil hash overlies interbedded siltstone, silty dolomite, and dolomitic sandstone. The medium silt contains 60 to 70 percent subangular quartz and lesser amounts of rock fragments. In some places the rock fragments enclose euhedral authigenic quartz. The silty dolomite includes interbedded discontinuous chert bands. The lowest sandstone and dolomite consist of very fine to fine subangular quartz sand and very fine to microcrystalline dolomite respectively.

Pennsylvanian

Tensleep Sandstone

The Tensleep Sandstone was named by Darton (1904, p. 397) from extensive exposures in Tensleep Canyon in the Bighorn Mountains. Richmond (1945) applied the name Tensleep to 330 feet of "clean, coarse-grained, crossbedded sandstone" exposed in the northwest Wind River Mountains. Wanless et al (1955, p. 34-36) designated as Tensleep the sequence of alternating dolomite and sandstone lying between the Amsden and Phosphoria Formations in the northern Hoback and Snake River Ranges. The alternations of dolomite and sandstone appear very similar to those examined in the well cores. Ross and St. John (1960, p. 48) have extended the name Tensleep slightly further to the south in the northern Wyoming Range.

The Tensleep Sandstone is a sequence of interbedded sandstone and dolomite with sandstone predominating. The sandstone and dolomite units thin toward the bottom. Of the 463 feet of Tensleep Sandstone, 280 feet were recovered by coring. No core or cuttings were recovered between depths of 13,196 feet and 13,255 feet.

The sandstone ranges in color from dark gray (N3) to medium gray (N5) and brownish black (5YR 2/1) to black (N1) to light olive gray (5Y 6/1) and brownish gray (5YR 4/1). The darker sandstone commonly is streaked with light olive gray or contains small, subcircular blotches of very light gray (N8). The sandstone contains 70 to 90 percent, very fine to fine, sugangular to subrounded sand. Some well rounded, medium to coarse sand is present along with 5 to 20 percent feldspar and 0 to 10 percent calcite cement. Where organic matter is abundant, cross-stratification is faint. Other uniformly dark horizons lack apparent stratification, but contain very light gray blotches of calcite cement. Occasional zones of quartz overgrowths are present and pyrite is locally abundant. The porosity of the overgrowth zones is negligible, but elsewhere ranges from poor to good. A few stylolites are present. The thickest sandstone unit is 148.5 feet thick; the thinnest, 5.5 feet.

The dolomite beds range in color from dark gray (N3) to medium gray (N5) and medium olive gray (5Y 5/1) to olive gray (5Y 4/1). Some of the dolomite is mottled or streaked with light olive gray (5Y 6/1) or light gray (N7). There is a great deal of variability in crystal development and crystal size. The dolomite ranges from microcrystalline to very fine sand size crystals, and is composed of either anhedral crystals or euhedral rhombs. Very commonly the dolomite is sandy or silty containing anywhere from 5 to 40 percent quartz grains. Chert is present also, but is less common. Organic matter is commonly disseminated throughout the rock and hydrocarbon residues are included between stylolitic surfaces. Calcite veinlets are common and calcite commonly has invaded the dolomite porosity. The dolomite is locally vuggy and intercrystalline porosity ranges from poor to very good. The thickest dolomite unit is 16 feet thick; the thinnest, 1.5 feet.

In the lower Tensleep Sandstone, subangular to angular quartz grains which have a highly preferred orientation of long axis of grains in the horizontal direction occur in zones 1 to 6 inches thick. The quartz grains lie in a microcrystalline matrix of carbonate and clay. The matrix is irregularly laminated, forming thin, wavy, undulatory streaks which commonly have a "frothy" appearance. These zones commonly contain abundant pyrite. The zones are here interpreted as of cataclastic origin.

Mississippian and Pennsylvanian

Amsden Formation

The top of the Amsden Formation, marked by 5 feet of white anhydrite, was penetrated at a depth of 13,342 feet. Two hundred and fifty feet of the total thickness of 383 feet were recovered by coring. The Amsden Formation is a variable sequence of sandstones, siltstones, limestones, and dolomites, with occasional thin beds of anhydrite in the upper 140 feet. The differing lithologic units range in thickness from 1 to 20 feet, the average being approximately 5.3 feet. The Amsden beds are predominantly drab grays and olive grays; however, 4 feet of mottled red siltstone lies directly below the anhydrite at the top of the formation. The shades of red vary from pale red (5R 6/2) and grayish red (5R 4/2) to dark reddish-brown (10R 3/4) and moderate reddish-brown (10R 4/6). The red siltstone is composed of fine to medium, angular to subangular quartz silt in 30 to 40 percent matrix. The matrix comprises dolomite, anhydrite sand crystals, and finely divided iron oxide.

The drab siltstones vary in color from black (N1) to medium light gray (N6) and olive black (5Y 2/1) to light olive gray (5Y 6/1). The siltstone comprises subrounded to well rounded, coarse, quartz silt to very fine, quartz sand. Blotches of calcite cement are common, as are calcite veinlets. Organic matter, with residues coating grains, and pyrite are abundant. Structures include cross-stratification and stylolites. Plane contacts between grains are present to the exclusion of interpenetration. Quartz overgrowths occur throughout the section. The porosity is poor to fair.

Although sandstones are less common in the sequence than are the siltstones and carbonates, they make up the thickest lithologic units. Some of the sandstones consist of alternating laminae of light olive gray (5Y 6/1) and grayish black (N2) and some patches of very light gray (N8) and olive gray (5Y 4/1) in a background of dark gray (N3). The light patches are cemented with carbonate while the dark background contains silica cement. Cross-stratification is common. There are plane contacts between the very fine to fine, rounded to well rounded quartz grains. Organic matter is commonly present. Calcite veinlets and stylolites are also present. The intergranular porosity is poor.

The carbonates appear as thin beds between siltstone or sandstone and siltstone and are themselves commonly sandy or silty. They vary in color from medium gray (N5) to dark gray (N3) and olive gray (5Y 4/1) to olive black (5Y 2/1). The crystal size of the carbonates falls for the most part within the silt range, but some are microcrystalline. The crystals are euhedral rhombs or fine anhedral crystals forming a sucratic carbonate. Fossil ghosts appear in some dolomites. Elsewhere, silicified zones preserve the original spergenite texture (Pettijohn, 1957, p. 405). Hydrocarbon residues are included between stylolitic surfaces. The dolomite is present throughout the formation; limestone is absent in the upper 150 feet. The limestone is commonly microcrystalline and spergenitic with various microfossils and echinoid spines common. Pyrite and organic matter are common throughout the carbonate section. The porosity is poor to fair.

The cataclastic zones described from the lower Tensleep Sandstone are present throughout the Amsden. In addition, many of the dolomites are highly fractured and interlaced with calcite veinlets. These two features appear to the writer to indicate tectonic movements, probably within the Amsden Formation.

Mississippian

Brazer and Madison Limestones Undifferentiated

Eight cores, totaling 144 feet, were recovered between depths of 13,766 feet and 14,077 feet. The Brazer and Madison Limestones are 806 feet thick. Of the 806 feet of carbonates, 510 feet is dolomite opposed to 274 feet of limestone. For 22 feet there was no recovery.

The dolomite is light olive gray (5Y 6/1) to olive black (5Y 2/1), brownish gray (5YR 4/1), and dark gray (N3) to medium dark gray (N4). The crystal size falls within the silt range. Euhedral to subhedral rhombs are common. Highly fractured zones, stylolites, horizontal parting, and vertical calcite veins are common features. The dolomite is locally vuggy and intercrystalline porosity varies from poor to good. Fossil and oolite ghosts commonly appear in beds adjacent to limestones. Small-scale load casts and graded bedding occur in some layers. Some of the dolomites give off a fetid odor on breaking.

The limestones are olive gray (5Y 4/1), and dusky yellowish brown (10YR 2/2) to dark yellowish brown (10YR 3/2). The textures are microcrystalline to silt-size crystals. The limestones are commonly fossiliferous, even spargenitic, or oolitic. The oolites locally may comprise 95 percent of the rock. In cross-section the oolites are elongate parallel to the horizontal axis. All phases of dolomitization can be traced as the oolitic limestone grades upward into euhedral dolomite. Bryozoa, brachiopods, corals, crinoids, echinoids, and fusilinds are abundant in the limestones. The limestones are locally cherty. Stylolites are accentuated by hydrocarbon residues. The intercrystalline porosity is fair to good. There is a single one foot siltstone bed at 13,949 feet.

Devonian

Darby Formation

Three hundred and eighty-nine feet of sandstone and dolomite representing the Darby Formation lie between depths of 14,531 feet and 14,920 feet. No cores were taken in this interval. The upper 179 feet of the formation are grayish-black (N2) to dusky-brown (5YR 2/2) and medium gray (N5) to olive-gray (5Y 4/1), dense, pyritic, microcrystalline dolomite. Underlying this dolomite is a sequence of interbedded dolomite and sandstone. The medium gray, microcrystalline to aphanitic dolomite contains 10 to 25 percent frosted, well-rounded, fine quartz silt to coarse quartz sand and pyrite. The percentage of quartz grains increases downward. The dolomitic, medium light gray (N6) sandstone is composed of rounded, fine, quartz silt to fine, quartz sand in which sand crystals are common. The dolomite and sandstone unit has a total thickness of 137 feet.

Below the dolomite and sandstone lies 73 feet of interbedded siltstone, shale, and dolomite. Approximately the upper half of the 73 feet is interbedded greenish-gray (5GY 4/1) shale and fine, argillaceous, olive-black (5Y 2/1) siltstone. This is underlain by 20 feet of brownish-black (5YR 2/1), microcrystalline dolomite followed by 20 feet of greenish-gray (5GY 4/1) and dark reddish-brown (10R 3/4) shale.

Ordovician

Bighorn Dolomite

Four hundred and forty-eight feet of Bighorn Dolomite were penetrated between depths of 14,920 feet and 15,368 feet. Two cores were taken, the first between 15,060 feet and 15,100 feet; the second, between 15,216 feet and 15,242.5 feet. The Bighorn Dolomite is notably uniform in texture, structure, and color. The color varies from light olive gray (5Y 6/1) to olive black (5Y 2/1) and is typically mottled. Both the light and dark mottles are dolomite. The dark mottles are composed of interlocking anhedral crystals while the light areas comprise loose euhedral rhombs with good to excellent intercrystalline porosity. The crystal size ranges from aphanitic to microcrystalline, but most commonly it is coarse silt to very fine sand-size. The dolomite, in addition to the very good intercrystalline porosity, is commonly vuggy or in places fractured. The fractures, however, are commonly filled with calcite. Stylolites contain hydrocarbon residues. Disseminated organic matter, pyrite, and a little sulfur are also present. White cylindrical structures which occur in distinctly mottled horizons are probably the result of burrowing organisms, as indeed a good deal of the mottling itself also may be.

Cambrian

Gallatin Group

Open Door Limestone

The Tip Top Well 22-19-G bottomed in dolomite tentatively ascribed to the Open Door Limestone at a total depth of 15,435 feet. The dolomite penetrated here is olive gray (5Y 4/1) to black (N1), dense, and is composed of very fine silt-size anhedral crystals.

Table 1.--Depths to formation tops as presented by (1) this report, (2) American Stratigraphic Company, (3) Steven S. Oriel, (4) Petroleum Information Company. Depth to top of formation is given in feet.

Name of Formation	This Report	American Stratigraphic Co.	Steven S. Oriel	Petroleum Information Co.
Bighorn Dolomite	70	70	----	----
Gallatin Group	520	410	----	----
Open Door Limestone	520	----	----	----
Dry Creek Shale Member	660	----	----	----
Du Noir Limestone	770	----	----	----
Gros Ventre Formation	910	649	650	----
Park Shale Member	910	----	650	----
Death Canyon Limestone Member	1120	----	1110	----
Adaville Formation	1410	1386	1400	Darby Thrust 1405
Hilliard Shale	1510	1600	1598	1596
Frontier Formation	5432	5433	5432	5353
Aspen Shale	7040	7036	Cret. Unit 5 7140	7040
			" " 4 7484	
Bear River Formation	7822	7388	" " 3 7820	7820
			" " 2 7915	
			" " 1 8183	
Gannett Group	8270	8260	8246	Beckwith 8270

Table 1--(Continued)

Name of Formation	This Report	American Stratigraphic Co.	Steven S. Oriel	Petroleum Information Co.
Stump Sandstone	9050	9048	9050	----
Preuss Redbeds	9085	9080	9085	9082
Twin Creek Limestone	9260	9271	9260	9314
Gypsum Spring Member	10002	10004	9988	10004
Nugget Sandstone	10081	10081	10081	10081
Ankareh Redbeds	10580	10650	10560	10608
Thaynes Limestone	11380	11366	10860	11394
Woodside Redbeds	11869	11852	11855	11784
Dinwoody Formation	12498	12401	12402	----
Phosphoria Formation	12602	12596	12602	12595
Tensleep Sandstone	12877	Weber 12880	Wells 12880	12874
Amsden Formation	13342	----	13340	13336
Madison Formation	13725	13726	13762	13727
Darby Formation	14531	Devonian 14530	14530	Devonian 14531
Bighorn Dolomite	14920	14920	14920	14920
Gallatin Group	15368	15348	15370	Cambrian 15368

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