Correlation of the West Canyon, Lake Point, and Bannock Peak Limestones (Upper Mississippian to Middle Pennsylvanian), Basal Formations of the Oquirrh Group, Northern Utah and Southeastern Idaho

U.S. GEOLOGICAL SURVEY BULLETIN 2088

Correlation of the West Canyon, Lake Point, and Bannock Peak Limestones (Upper Mississippian to Middle Pennsylvanian), Basal Formations of the Oquirrh Group, Northern Utah and Southeastern Idaho

By L.E. Davis, G.D. Webster, *and* T.S. Dyman

U.S. GEOLOGICAL SURVEY BULLETIN 2088

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1994

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For Sale by U.S. Geological Survey, Map Distribution
Box 25286, MS 306, Federal Center
Denver, CO 80225

Library of Congress Cataloging-in-Publication Data

Davis, L. E. (Larry E.)
Correlation of the West Canyon, Lake Point, and Bannock Peak Limestones (Upper Mississippian to Middle Pennsylvanian), basal formations of the Oquirrh Group, northern Utah and southeastern Idaho / by L.E. Davis, G.D. Webster, and T.S. Dyman.
p. cm.—(U.S. Geological Survey bulletin ; 2088)
Includes bibliographical references.
Supt. of Docs. no. : I 19.3:2088
1. Geology, Stratigraphic—Pennsylvanian. 2. Geology—Utah. 3. Geology—Idaho. 4. Stratigraphic correlation—Utah. 5. Stratigraphic correlation—Idaho. 6. West Canyon Limestone (Utah) 7. Lake Point Limestone (Utah) 8. Bannock Peak Limestone (Idaho) I. Webster, G. D. (Gary D.), 1934– . II. Dyman, T. S. III. Title. IV. Series.
QE75.B9 no. 2088
[QE673]
557.2 s—dc20
[551.7'52'09792] 94-4948
CIP

CONTENTS

PLATE

FIGURES

TABLES

Correlation of the West Canyon, Lake Point, and Bannock Peak Limestones (Upper Mississippian to Middle Pennsylvanian), Basal Formations of the Oquirrh Group, Northern Utah and Southeastern Idaho

By L.E. Davis,[1] G.D. Webster,[2] and T.S. Dyman[3]

ABSTRACT

At their type sections, the West Canyon Limestone in the southern Oquirrh Mountains of Utah, the Lake Point Limestone in the northern Oquirrh Mountains of Utah, and the Bannock Peak Limestone (named in this report) in the Deep Creek and Samaria Mountains of southeastern Idaho are each considered the basal formation of the Oquirrh Group within their respective areas of distribution. Lower Oquirrh strata were studied in detail by measuring four representative outcrop sections in northern Utah and southeastern Idaho. The Bannock Peak Limestone is here introduced for lower Oquirrh strata in southeastern Idaho because of distinct lithologic and facies differences with the northern Utah sections.

The Bannock Peak Limestone is from 432 to 446 m thick and is present in the Samaria, Deep Creek, and Black Pine Mountains and the Albion, Bannock, and Sublett Ranges in southeastern Idaho. The West Canyon Limestone is 307 m thick at its reference section in Soldier Canyon in the southern Oquirrh Mountains in northern Utah where it was measured for this study. It also is present in the Grassy, Cedar, Stansbury, Lake, and Timpanogos Mountains of northern Utah. The Lake Point Limestone, identified only in the Garfield quadrangle, is 466 m thick at its type section in the northern Oquirrh Mountains in northern Utah.

Seven major carbonate and clastic lithofacies are present within the three formations in the four sections measured; however, the relative abundance and stratigraphic position of each lithofacies vary. These lithofacies include bioclastic packstone to grainstone; whole-fossil wackestone to muddy packstone; bioturbated, arenaceous mudstone to wackestone; oncolite packstone to grainstone; coral and bryozoan framestone; quartzarenite to sublitharenite; and calcareous shale. Together, the lithofacies represent deposition on a carbonate platform within the Oquirrh basin during latest Chesterian through earliest Atokan time.

Nine conodont biozones are present in these lower strata of the Oquirrh Group (in ascending order): *Adetognathus unicornis, Rhachistognathus muricatus, R. primus-Declinognathodus noduliferus, R. minutus-Idiognathoides sinuatus, Neognathodus symmetricus, N. bassleri, Idiognathodus sinuosus, Idiognathodus parvus,* and *Diplognathodus coloradoensis-N. atokaensis.* Although *Neognathodus symmetricus* and *N. bassleri* Biozones are important in Morrowan biostratigraphy of the North American midcontinent, their utility for conodont biostratigraphy of the eastern Great Basin is limited. The *Idiognathodus parvus* Biozone is recognized as the uppermost Morrowan to lowermost Atokan conodont biozone in the eastern Great Basin.

Recognition of conodonts within these seven lithofacies is important in making paleoecologic interpretations. Species of *Adetognathus* predominate in mudstone, whole-fossil and bioturbated, arenaceous wackestone, and bioturbated, arenaceous, muddy packstone deposited in lagoons, bays, and behind barrier bars in areas of restricted circulation and (or) quiet waters and water depths of a few tens of meters. Species of *Declinognathodus, Idiognathoides,* and *Idiognathodus* are abundant in bioclastic and oncolite packstone and grainstone and coral-bryozoan framestone deposited in open-marine, open-circulation conditions and water depths of 10–200 m.

[1]Department of Geology, Washington State University, Pullman, Washington 99164, and U.S. Geological Survey, Denver, Colorado 80225.

[2]Department of Geology, Washington State University, Pullman, Washington 99164.

[3]U.S. Geological Survey, Denver, Colorado 80225.

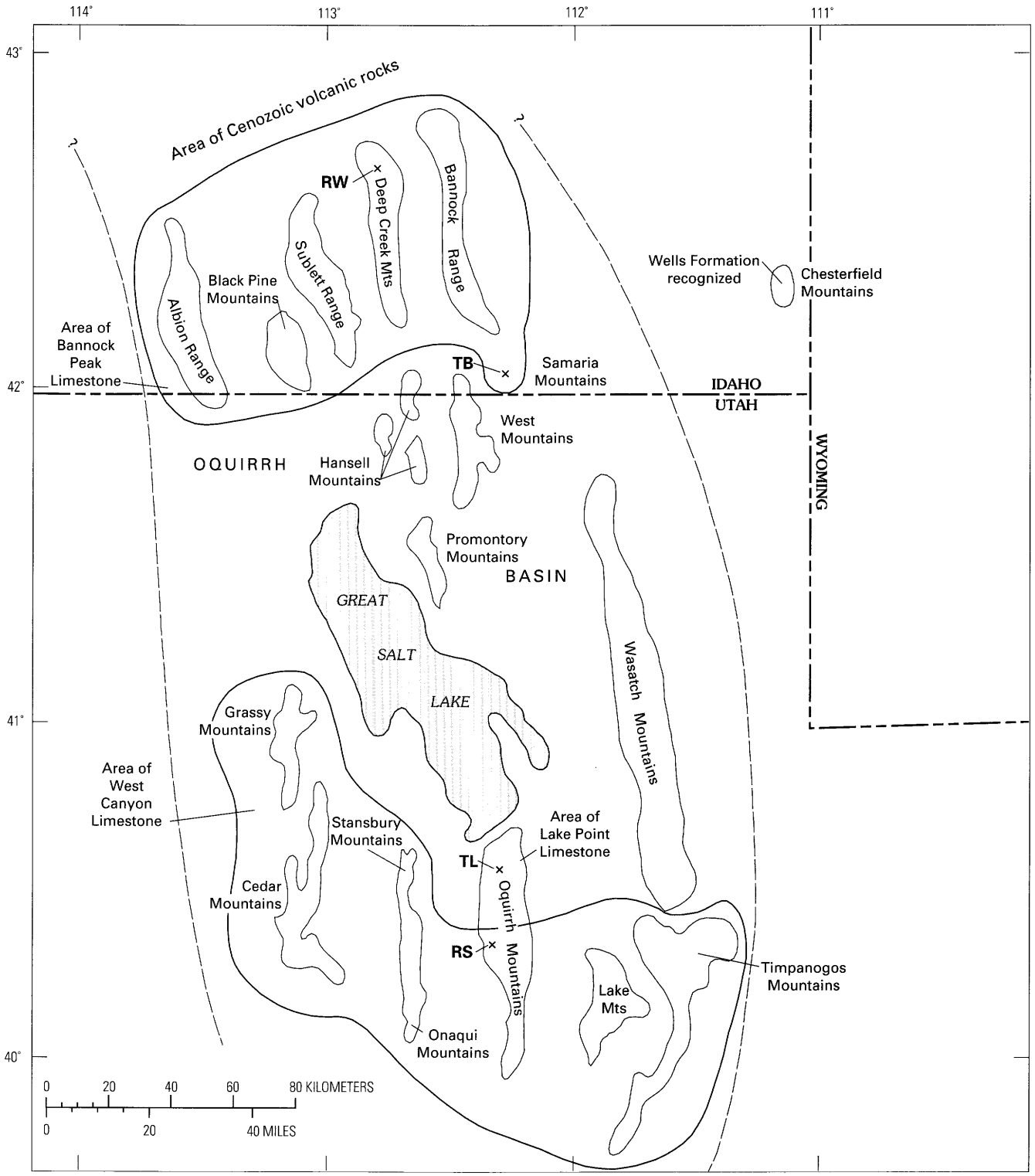

Figure 1. Limits of usage of formation names as used in this report and locations of measured sections, northern Utah and southeastern Idaho. Dashed lines indicate approximate eastern and western limits of early Oquirrh (Pennsylvanian) basin. Locations of measured sections in this report: RS, reference section, West Canyon Limestone, Soldier Canyon, southern Oquirrh Mountains; TL, type section, Lake Point Limestone, northern Oquirrh Mountains; TB, type section, Bannock Peak Limestone, Brush Canyon, Samaria Mountains; RW, reference section, Bannock Peak Limestone, Well Canyon, Deep Creek Mountains.

INTRODUCTION

Strata of the Late Mississippian through Early Permian Oquirrh Group are present within an area of 30,000 km^2 (fig. 1) and are as thick as 7.5 km (Jordan and Douglas, 1980). Numerous studies have subdivided the Oquirrh Group in northern Utah and southeastern Idaho, but few detailed measured sections and stratigraphic correlations have been published. Sequences of lithologies in the lower part of the Oquirrh in northern Utah and southeastern Idaho, which ranges in age from Chesterian to Atokan, are different from each other, and lithologic correlations between time-equivalent strata are difficult to establish. Biostratigraphic correlations must be used to establish time and facies relationships.

In this report we present new detailed lithologic and conodont biostratigraphic data from four measured sections in the lower part of the Oquirrh Group in the Oquirrh Mountains of Utah and the Deep Creek and Samaria Mountains of Idaho. Information regarding equivalent strata in adjacent ranges (see fig. 1) was derived from published reports. The use of stratigraphic terminology for equivalent strata in the area of the West, Hansell, and Promontory Mountains is not addressed in this report, and specific stratigraphic terminology in these ranges is queried in figure 1. Lithofacies and formation descriptions, conodont biozones, and contact relationships are presented for the four sections. The Bannock Peak Limestone is formally assigned, and its type section is described and compared to other time-equivalent sections in the lower Oquirrh Group.

THE OQUIRRH BASIN

The position and alignment of the Oquirrh basin have been debated in the past by Eardley (1947), Stokes and Heylmun (1958), Roberts and others (1965), and Bissell (1970, 1974). Bissell (1974) interpreted the Oquirrh basin to be a large north-trending element of the Cordilleran miogeosyncline (fig. 1). The tectonic development of the Cordilleran miogeosynclinal belt and the Oquirrh basin has been discussed by Armstrong (1968), Stewart and Poole (1974), Poole (1974), Bissell (1974), Skipp and Hall (1980), and Jordan and Douglas (1980). The paleogeographic relationship between the Oquirrh basin and adjacent depocenters and positive structural elements is presented in figure 2. The source of clastic sediments in the Oquirrh basin was originally believed to have been the Antler positive element to the west (Roberts and others, 1965), but recent interpretations indicate that clastic sediments were derived from cratonic highlands to the east and northeast (Konopka and Dott, 1982). Carbonate sediments formed on shallow, nearshore carbonate platforms and in deeper water (greater than 200 m) basinal depositional environments. Rapid lateral facies changes were recognized in Oquirrh carbonate and clastic rocks by Wright (1961) and Armstrong (1968).

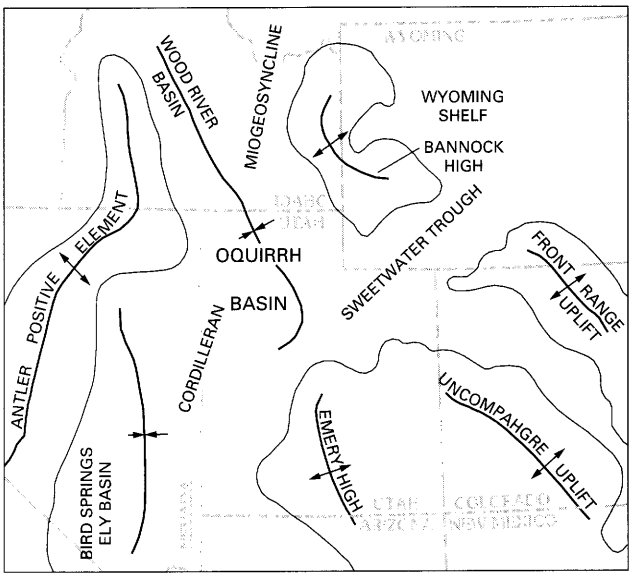

Figure 2. Paleogeography of Early Pennsylvanian depocenters and positive elements in the Great Basin and surrounding region. Modified from McKee and Crosby (1975, plate 15–A).

MEASURED SECTIONS

Four sections of lower Oquirrh strata were selected for stratigraphic, lithofacies, and conodont studies (table 1, fig. 1, plate 1): (1) the reference section of Tooker and Roberts (1970) of the West Canyon Limestone at Soldier Canyon on the west side of the southern Oquirrh Mountains in northern Utah (2) the type section of Tooker and Roberts (1970) of the Lake Point Limestone type section on the west side of the northern Oquirrh Mountains in northern Utah; (3) the type section of the Bannock Peak Limestone, formerly misidentified as the West Canyon Limestone Member of the Oquirrh Formation (Beus,1968), at Brush Canyon in the Samaria Mountains, southeastern Idaho; and (4) a reference section of the Bannock Peak Limestone, formerly part of unit A of the Oquirrh Formation of Trimble and Carr (1976).

In southeastern Idaho, rocks referred to herein as the Bannock Peak Limestone contain sandstone and sandy limestone in the lower part of the formation near its lower contact with the Manning Canyon Shale. The abundance of sandy limestone and sandstone decreases upward through the section, and the upper part of the formation is all limestone.

Table 1. Detailed locations of measured sections discussed in report.
[Locations of measured sections are shown in figure 1; measured sections are shown on plate 1]

West Canyon Limestone reference section
Ridge on north side of Soldier Canyon at first major sequence of limestone above black shale of the Manning Canyon Shale (approx. 6,800-foot (2,072 m) contour) trending northeast from NE¼SE¼NW¼ sec. 34, T. 4 S., R. 4 W. (lat 40°25'40" N., long 112°17'10" W.), continuing northeast along ridge to first major quartzarenite bed of the Butterfield Peaks Formation (approx. 7,200-foot (2,194 m) contour), SE¼NE¼NW¼ sec. 34, T. 4 S., R. 4 W. (lat 40°24'15" N., long 112°17'00" W.), Stockton quadrangle, Tooele County, Utah. Originally described by Tooker and Roberts (1970). Thickness of West Canyon Limestone is 307 m.
Lake Point Limestone type section
Northwest side of Oquirrh Mountains. Southwest ridge of hill where limestone above Green Ravine Formation begins (approx. 5,200-foot (1,584 m) contour) trending northward from NE¼ sec. 6, T. 2 S., R. 3 W. (lat 40°40' 30" N., long 112°14' 00" W.) to first major quartzarenite bed of the Erda Formation (approx. 6,160-foot(1,877 m) contour), SW¼ sec. 31, T. 1 S., R. 3 W. (lat 40°40'45" N., long 112°13'30" W.), Garfield quadrangle, Tooele County, Utah. Originally described by Tooker and Roberts (1970). Thickness of Lake Point Limestone is 466 m.
Bannock Peak Limestone type section
Base of ridge at the head of the left fork of Brush Canyon beginning at the base of the first significant limestone bed (minimum thickness 0.7 m) above the black shale of the Manning Canyon Formation (approx. 6,600-foot (2,011 m) contour), NW¼SW¼ sec. 14, T. 16 S., R. 4 W. (lat 42°01'10" N., long 112°19'45" W.), continuing northwestward along ridge to top of last major ridge-forming limestone (approx. 7,400-foot (2,255 m) contour), SE¼SW¼ sec. 10, T. 16 S., R. 4 W. (lat 42°02'30" N., long 112°21'00" W.), Samaria quadrangle, Oneida County, Idaho. Thickness of Bannock Peak Limestone is 432 m.
Bannock Peak Limestone reference section
Along north ridge of Well Canyon beginning at the first major limestone bed (minimum thickness 0.7 m) above black shale of the Manning Canyon Shale (approx. 6,000-foot (1,828 m) contour), SW¼SE¼NE¼ sec. 3, T. 9 S., R. 31 E. (lat 42°37'30" N., long 112°48'00" W.), continuing east-northeast to saddle (approx. 6,600-foot (2,011 m) contour), SE¼SW¼NW¼ sec. 24, T. 9 S., R. 31 E. (lat 42°37'45" N., long 112°47'00" W.), Rockland East and Indian Springs quadrangles, Power County, Idaho. Measured by Trimble and Carr (1974). Thickness of Bannock Peak Limestone is 446 m.

In Utah, rocks referred to as the West Canyon Limestone display an opposite trend; the abundance of sandy limestone and sandstone increases upward. The West Canyon Limestone grades upward into the dominantly sandstone facies of the Butterfield Peaks Formation of the Oquirrh Group. The Lake Point Limestone, as defined by Tooker and Roberts (1970), is lithologically more similar to the West Canyon Limestone than to the Bannock Peak Limestone.

The four sections were measured during summer and fall 1985 and summer 1986. Detailed lithologic descriptions, contact relationships, and paleontological data for the four measured sections are presented in Davis and others (1989). Unit numbers used in plate 1 accompanying this manuscript correspond to unit numbers in Davis and others (1989). Davis and others utilized the informal name "Bannock Peak unit" for the Bannock Peak Limestone of this report in southeastern Idaho.

The four measured sections and their biostratigraphic correlations are presented here (plate 1) using the Stratigraphic Report Graphic (SRG). The SRG is a stratigraphic applications computer program developed by the U.S. Geological Survey and Petroleum Information Corporation of Denver, Colorado. The SRG accepts sedimentologic, paleontologic, lithologic, paleoecologic, and nomenclatural data for outcrop sections and cores and displays these data in a scale variant format (Petroleum Information Corporation, 1984; Dyman and others, 1985). The SRG is proprietary to Petroleum Information Corporation but is available by contract to the U.S. Geological Survey for a variety of research applications. The sections illustrate conodont biozones and the Mississippian-Pennsylvanian boundary as placed by us. Lithologic symbols illustrated on plate 1 are explained on its legend and correspond to the more detailed descriptions presented in Davis and others (1989).

The term "lithofacies" as used in this report describes a set of specific sedimentary rock types and constituent fossil remains that grades laterally and vertically into other lithofacies. The carbonate rock classification of Dunham (1961) and sandstone classification of Folk (1968) were used to define rock names in this report. The term "framestone" as used in this report represents a limestone that is composed of a closely intergrown framework of reef-building fossils such as whole-body corals and bryozoans (Embry and Klovan, 1972).

STRATIGRAPHY

NORTHERN UTAH

Mid-Carboniferous rocks in the Oquirrh Mountains of northern Utah were first studied by Spurr (1895) (figs. 1, 3). The name Oquirrh was formally introduced by Gilluly (1932) for an incomplete section in the Oquirrh Mountains, Utah. Stratigraphic studies of Oquirrh rocks have been conducted in Utah by Nygreen (1958), Bissell (1959, 1960), Welsh and James (1961), Tooker and Roberts (1970), Morris

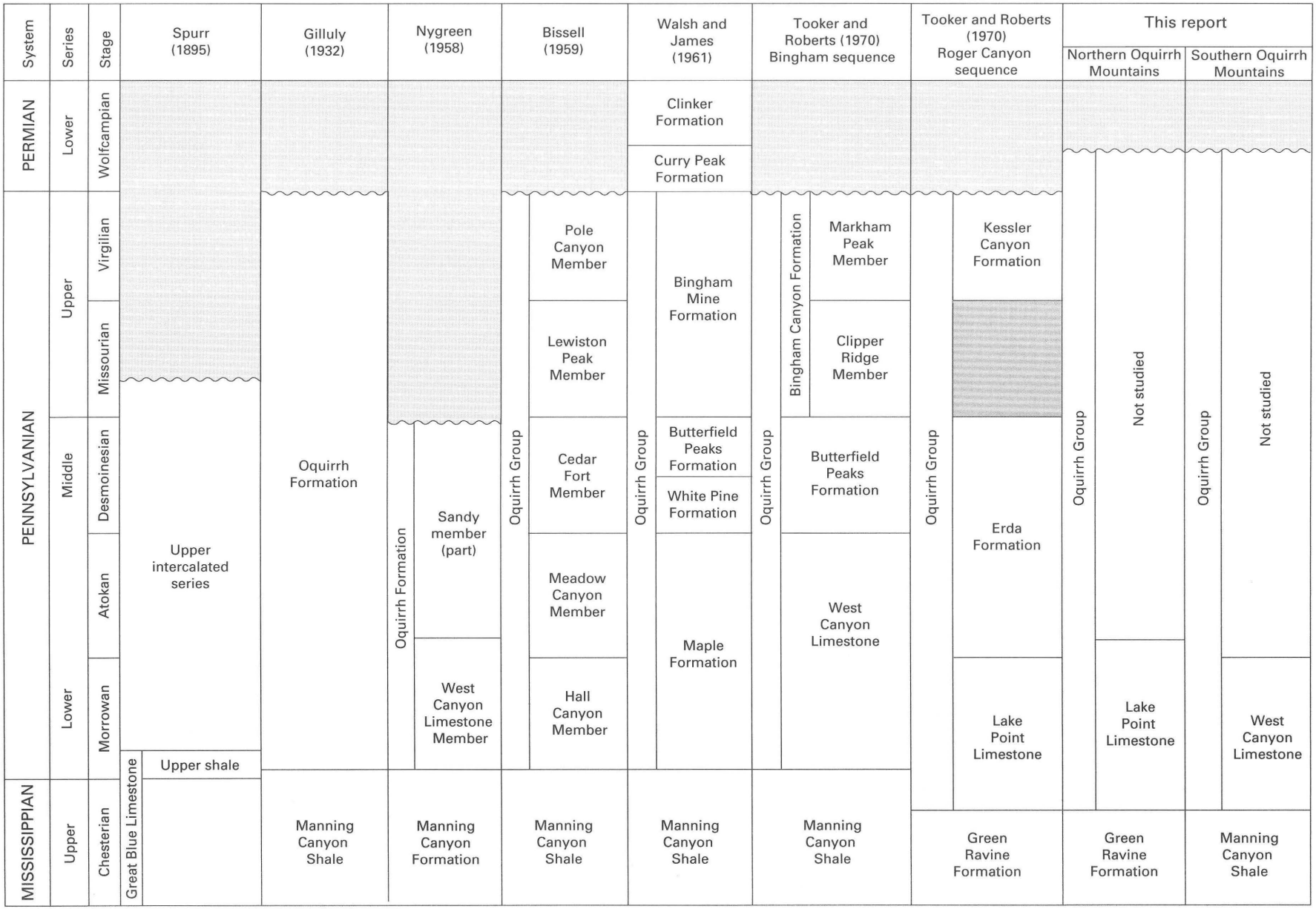

Figure 3. Middle Carboniferous stratigraphic terminology in northern Utah. In our northern Oquirrh Mountains section (loc. TL, fig. 1), we recognize the mappable upper contact of Tooker and Roberts (1970) of the Lake Point Limestone, but we identified Atokan conodonts within the upper 78 m of the Lake Point Limestone as defined by them (see Davis and Webster, 1991, and plate 1).

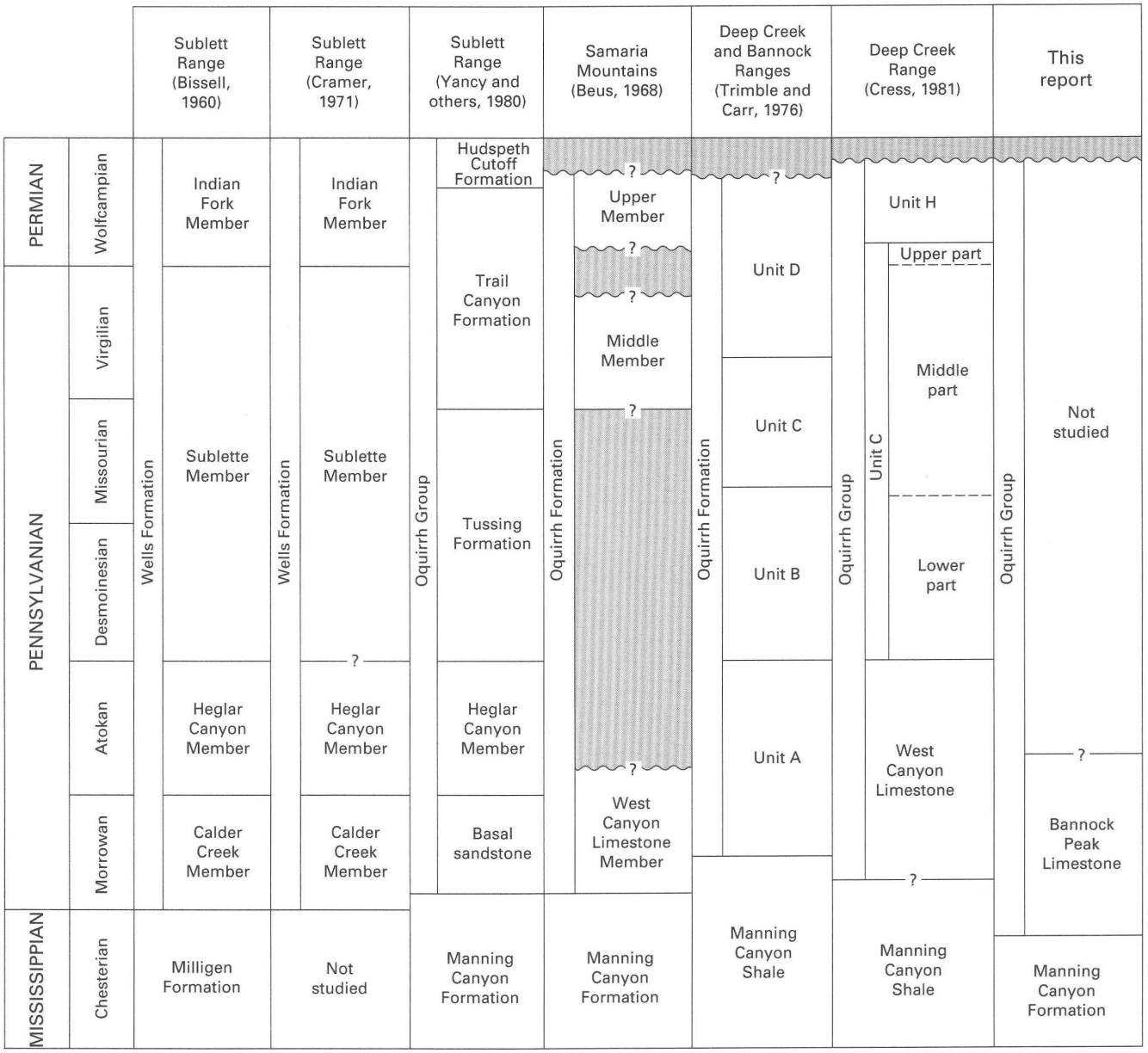

Figure 4. Middle Carboniferous stratigraphic terminology in southeastern Idaho. Beus (1968) assigned the West Canyon Limestone Member of the Oquirrh Formation to a Morrowan to Atokan age. The upper West Canyon Limestone boundary of Cress (1981) was placed at the Atokan-Desmoinesian boundary.

and others (1977), and Davis and Webster (1991). Welsh and James (1961) subdivided Gilluly's Oquirrh Formation into four formations that were assigned a Pennsylvanian age, and they raised the Oquirrh to group rank (fig. 3). Tooker and Roberts (1970) recognized two sequences, the Bingham and the Rogers Canyon, in the Oquirrh Group in the Oquirrh Mountains of northern Utah that range from latest Mississippian to Early Permian in age (fig. 3). The Bingham sequence consists of the West Canyon, Butterfield Peak, and Bingham Mine Formations in ascending order. The Rogers Canyon sequence consists of the Lake Point Limestone and Erda and Kessler Canyon Formations in ascending order.

In this report, stratigraphic terminology as defined by Tooker and Roberts (1970) is used for strata in northern Utah. Tooker and Roberts (1970) placed the age of the upper boundary of the Lake Point Limestone in the Early Pennsylvanian (Morrowan). Our conodont work indicates that the upper Lake Point Limestone boundary is within the lowermost Atokan or lowermost Middle Pennsylvanian (Davis and Webster, 1991). Most workers agree that the lower Oquirrh strata are conformably underlain by the Upper Mississippian Manning Canyon Shale (or Formation) (figs. 1, 3). Within the Rogers Canyon sequence of Tooker and Roberts (1970), lower Oquirrh strata are underlain by

the Upper Mississippian Green Ravine Formation. Based on previous studies, the Lake Point Limestone is present only in the northern part of the Oquirrh Mountains (Tooker and Roberts, 1970), whereas the West Canyon Limestone is present in the region of the Grassy, Cedar, Stansbury, Onaqui, Lake, Timpanogos, and southern part of the Oquirrh Mountains (fig. 1) (Nygreen, 1958; Stokes and Heylmun, 1958; Bissell, 1959, 1960; Welsh and James, 1961; Wright, 1961; Roberts and others, 1965; Tooker and Roberts, 1970; Morris and others, 1977; Alexander, 1978; Jordon, 1979; Larson, 1979; Konopka and Dott, 1982; Stevens and Armin, 1983; Webster, 1984). The application of stratigraphic terminology to equivalent strata in the area of the West, Hansell, and Promontory Mountains has not been addressed in this report, and specific stratigraphic terminology in these ranges is queried in figure 1.

SOUTHEASTERN IDAHO

In southeastern Idaho, the names Oquirrh Formation (or Group) and Wells Formation have been used by most workers for Pennsylvanian through Lower Permian strata (figs. 1, 4). In the Chesterfield and Sublett Ranges, Pennsylvanian and Lower Permian strata were assigned to the Wells Formation by Bissell (1960) and Cramer (1971). Richards and Mansfield (1912) named the Wells Formation for sandstone and sandy limestone of Pennsylvanian age exposed in Wells Canyon on the east side of the Preuss Range in southeastern Idaho. Bissell (1960, fig. 3) subdivided Pennsylvanian strata of the Wells Formation in the Sublett Range into (in ascending order) the Calder Creek, Heglar Canyon, Sublett, and Indian Fork Members but provided no basis for this subdivision. No type section was designated, and no reference was made as to the origin of these names. Therefore, these names are not considered valid. Furthermore, the Wells Formation is here considered to be restricted to the definition of Richards and Mansfield (1912) for the sandstone and sandy limestone of Pennsylvanian age exposed east of the Bannock Range (fig. 1).

Pennsylvanian strata in the Sublett and Bannock Ranges and in the Deep Creek, Black Pine, and Samaria Mountains were included in the Oquirrh Group (or Formation) by Beus (1968), Trimble and Carr (1976), Platt (1977), Yancey and others (1980), Smith (1983), Cress (1981), and Akers and Davis (1984). Cramer (1971) retained Bissell's (1960) stratigraphy in his description of Permian strata in the Sublett Range. Yancey and others (1980) recognized the incompleteness of Bissell's description of Oquirrh strata in the Sublett Range but retained his Heglar Canyon as a formational name. Yancey and others (1980) described and designated formational units for Desmoinesian through Wolfcampian strata and included all Morrowan through Wolfcampian strata within the Oquirrh Group. Most workers agree that the lower Oquirrh strata are conformably underlain by the Upper Mississippian Manning Canyon Shale.

BANNOCK PEAK LIMESTONE

In southeastern Idaho, strata herein designated the Bannock Peak Limestone of the Oquirrh Group consist of light- to medium-gray and light-brownish-gray limestone, arenaceous limestone, and calcareous sandstone of latest Mississippian to Middle Pennsylvanian age (plate 1). The calcareous sandstone and sandy limestone are in the lower part of the formation and grade upward into bioclastic limestone. Limestone in the Bannock Peak Limestone contains more fragmented fossils than time-equivalent units in the West Canyon and Lake Point Limestones in northern Utah; however, better preserved whole fossils, particularly brachiopods and corals, are present in the West Canyon and Lake Point Limestones.

In this report, the strata in northern Utah and southeastern Idaho are considered to have been deposited in the Oquirrh basin and all sections contain similar lithofacies, although the stratigraphic sequences of lithofacies are distinctly different. The Bannock Peak Limestone is herein designated for the latest Mississippian to Middle Pennsylvanian strata previously assigned to (1) the West Canyon Limestone Member of Beuss (1968) and Cress (1981) and the West Canyon Limestone of Akers and Davis (1984); (2) unit A of the Oquirrh Formation of Trimble and Carr (1974); (3) the basal Oquirrh sandstone and the Heglar Canyon Formation of the Oquirrh Group of Yancey and others (1980); and (4) the Calder Creek and Heglar Canyon Members of the Wells Formation of Bissell (1960) and Cramer (1971). Application of the name West Canyon from the southern Oquirrh Mountains of Utah to the limestone and sandstone of the lower Oquirrh Group in southeastern Idaho cannot be justified. The Bannock Peak Limestone is named for the 8,263-ft (2,542 m) peak in the northern part of the Deep Creek Mountains (SE¼SW¼ sec. 27, R. 32 E., T. 9 S., Bannock Peak 7.5-minute quadrangle, Power County, Idaho).

The measured section of rocks assigned to the West Canyon Limestone Member in the Samaria Mountains by Beus (1968) is designated by us as the type section of the Bannock Peak Limestone. The type section is established in the Samaria Mountains because of its accessibility and overall excellent exposures. The base of the type section begins at the first thick limestone bed overlying the Manning Canyon Shale at the base of a ridge (6,600 ft (2,011 m) contour) at the head of the left fork of Brush Canyon in NW¼SW¼ sec. 14, T. 16 S., R. 4 W., and continues northwestward along the same ridge to the top of the last major ridge-forming limestone (approximately 7,400 ft (2,255 m) contour) in SE¼SW¼ sec. 10, T. 16 S., R. 4 W., Samaria 7.5-minute quadrangle, Oneida County, Idaho (table 1, plate 1). The Bannock Peak Limestone is 432 m thick at its type section at Brush Canyon (appendix).

A reference section of the Bannock Peak Limestone is designated at Well Canyon in the northwestern Deep Creek Mountains. The stratigraphically lower end of the section is along the north ridge of Well Canyon, beginning at the first

major limestone, above shale and thin interbedded limestone and sandstone of the Manning Canyon Shale (approximately 6,000 ft (1,828 m) contour) in SW¼SE¼NE¼ sec. 3, T. 9 S., R. 31 E., Rockland East and Indian Springs 7.5-minute quadrangles, Power County, Idaho (table 1, plate 1). The Bannock Peak Limestone is 446 m thick at its reference section at Well Canyon (appendix).

Rock types present in the Bannock Peak Limestone include skeletal and oncolitic packstone and grainstone and lesser amounts of wackestone, mudstone, quartzarenite, and sedimentary litharenite. Mudstone is more prevalent in the upper part of the Well Canyon reference section. Limestone is generally medium bedded (20–30-centimeter-thick beds) and generally crops out as a series of gently dipping, resistant ridges and ledges. Brachiopods, crinoids, and ramose and fenestrate bryozoans dominate the skeletal grains; however, whole-fossil material is not common. Corals, trilobites, gastropods, and bivalves are less common constituents. Ostracodes, foraminifers, and conodonts are common microfaunas. Much of the skeletal material is silicified. Oncolites are abundant in the packstone and grainstone and commonly are present as thin (3–8 cm) beds or lenses. Some beds are strongly dolomitized, and bedded and nodular chert is abundant, especially in the lower part of the formation.

The lower third of the Bannock Peak Limestone contains medium-gray to light-brown, massive to thick-bedded, crossbedded quartzarenite and sedimentary litharenite. These rocks crop out as very resistant and prominent ridges. Bounding limestone units are crossbedded and commonly contain abundant (10–30 percent) sand and silt grains; limestone weathers as distinctive reddish-brown outcrops. Limestone may be mistaken for sandstone because of its silica-rich (3–4 cm thick) weathering rinds.

The Bannock Peak Limestone contains less interbedded sandstone, more oncolitic limestone, and more dolomitized rocks and generally is less fossiliferous than the Lake Point and West Canyon Limestones (plate 1). Because of its unique lithologic characteristics, the Bannock Peak Limestone is hereby designated to replace all previous formal and informal stratigraphic names for basal Oquirrh rocks that are of latest Mississippian to earliest Middle Pennsylvanian age in southeastern Idaho.

The lower boundary of the Bannock Peak Limestone is easily identified at the base of the first thick limestone with minor interbedded sandstone above the thick black shale and thin sandstone and fossiliferous limestone of the Manning Canyon Shale (plate 1). The upper boundary of the Bannock Peak is less distinct and is gradational. It is arbitrarily established at the base of the first major (minimum thickness approximately 3 m) sandy limestone and minor interbedded sandstone of the undivided Oquirrh Group above ledge-forming limestone of the Bannock Peak Limestone. Beuss (1968) indicated that the upper boundary of his West Canyon Limestone Member (equal to our Bannock Peak Limestone) in the Samaria Mountains represents an unconformity separating Lower Pennsylvanian strata from Upper Pennsylvanian and Lower Permian strata. Based on conodonts identified in this study, the age of the Bannock Peak Limestone is latest Chesterian to early Atokan. Formations of the Oquirrh Group proposed by Yancey and others (1980) for late Atokan through Wolfcampian strata in the Sublett Range were not studied by us nor were Oquirrh Group strata above the Bannock Peak Limestone in other southeastern Idaho mountain ranges.

LITHOFACIES

Seven lithofacies were observed in the sections measured (plate 1): bioclastic packstone to grainstone, whole-fossil wackestone to muddy packstone, bioturbated, arenaceous mudstone to wackestone, oncolite packstone to grainstone, coral and bryozoan framestone, quartzarenite to sublitharenite, and calcareous shale. The abundance of stratigraphically important conodonts recovered from each section and the representative lithofacies are presented in tables 2–5.

Bioclastic packstone to grainstone is volumetrically the most significant lithofacies and is present in all four measured sections. This lithofacies is characterized by well-sorted, commonly abraded skeletal grains deposited as structureless to horizontally and wavy stratified beds from 10 cm to 4 m in thickness. Common skeletal grains include brachiopods, crinoids, ramose and fenesrate bryozoans, echinoid plates and spines, corals, trilobites, pellets, red calcareous algae (*Komia* and *Archeolithophyllum*), and rare gastropods, foraminifers, and ostracodes. Arenaceous bioclastic packstone to grainstone is also common and contains 20–50 percent coarse silt- to very fine sand-sized, subangular to subrounded, and moderately well sorted quartz grains. Low-angle crossbedding is common with foreset dip angles of less than 8°.

Whole-fossil wackestone to muddy packstone is present in all four measured sections. This lithofacies is characterized by carbonate mud deposited as irregular, medium-bedded to massive units having wavy stratification. Whole-fossil skeletal material includes articulated spiriferid and productid brachiopods and minor fenestrate bryozoans. Other skeletal grains are generally fragmented and include ramose bryozoans, crinoid columnals and trilobites; echinoid plates and spines, foraminifers and solitary corals are less common. Strata within this lithofacies commonly contain 1–3 percent well-sorted, silt-sized quartz grains. A few lithic units may contain as much as 30 percent terrigenous clastic grains. Black chert nodules are common throughout the lithofacies.

Bioturbated, arenaceous mudstone to wackestone is present in all four measured sections; rocks of this lithofacies were deposited as thick to massive units. These strata are highly bioturbated with vertical burrows of the *Skolithos* ichnofacies. The terrigenous component may be as much as 40 percent and consists of silt- and fine sand-sized quartz that commonly defines low-angle, trough crossbeds. Skeletal debris is not common but is dominated by brachiopods,

crinoid columnals, trilobites and rare solitary corals, bryozoans, and gastropods. Pellets are common throughout the lithofacies. Black to brown chert nodules are rare.

Oncolite packstone to grainstone is common in the Bannock Peak Limestone at Brush Canyon but rare in the Well Canyon section. Rocks of this lithofacies were not observed in the West Canyon Limestone at Soldier Canyon in the southern Oquirrh Mountains or in the Lake Point Limestone in the northern Oquirrh Mountains. The limestone is medium to thick bedded and generally well exposed in outcrops 2.5–3 m thick. Oncolites are 0.01–0.05 mm in diameter and are moderately well sorted. Oncolites commonly develop around quartz and abraded skeletal grains, particularly crinoid ossicles, trilobite carapace fragments, and brachiopod shell fragments. Crinoid ossicles are the most common skeletal grains; other skeletal grains include gastropod fragments, calcareous algae, and rare ostracodes and foraminifers. Skeletal material is commonly micritized by boring algae. Ooids and well-rounded micritic lithoclasts, carbonate mud, and bedded and nodular chert are rare.

Coral and bryozoan framestone is present as small coralline (*Orygmophyllus* and *Lophophyllidium*) or bryozoan (*Fenestrellina* and *Rhombocladia*) bioherms in all four measured sections. Rocks of this lithofacies represent less than 5 percent of the total thickness in any one section. Other skeletal material includes crinoid ossicles, brachiopods, echinoid plates and spines, small rugose corals, and whole and fragmented trilobites. Conodonts are uncommon in this lithofacies.

Quartzarenite is abundant in the upper part of the West Canyon and Lake Point Limestones and in the lower part of the Bannock Peak Limestone. This lithofacies is characterized by medium-bedded to massive, well-exposed, and relatively thin (1–6 m) quartz-rich sandstone. Lithologically, the quartzarenite contains more than 95 percent fine sand-sized monocrystalline subangular to rounded quartz that has straight to slightly undulose extinction and is moderately to well sorted. Less than 1 percent of the grains is polycrystalline quartz or detrital chert. Highly abraded crinoid columnals and brachiopod fragments make up as much as 3 percent of the nonquartz fraction. Epidote, tourmaline, and magnetite are minor constituents. All units show small- to medium-scale, planar or trough crossbedding. Minor bioturbation consisting of narrow, vertical burrows of the *Skolithos* ichnofacies was observed in most strata of this lithofacies.

Sublitharenite (part of the quartzarenite lithofacies previously described) is very rare and is present only in the West Canyon Limestone at Soldier Canyon and the Bannock Peak Limestone at Well Canyon. The sublitharenite consists of more than 75 percent quartz sand having the same physical properties as the quartz in the quartzarenite. The nonquartz fraction consists of well-rounded limestone fragments, highly abraded crinoid columnals and brachiopod fragments, and rounded heavy minerals, primarily pyrite, magnetite, and limonite.

Calcareous shale was only observed in the Bannock Peak Limestone at Well Canyon and is rare (less than 3 percent of the total thickness of the section). Rocks of this lithofacies are very poorly exposed and comprise light-brown, very thin bedded (1–4 cm), bioturbated, silty, calcareous mud. Brachiopods are minor, and other macrofossils are very rare. Conodonts and foraminifers are absent; therefore, this lithofacies is not included in tables 2–5. Calcareous shale is generally underlain and overlain by brachiopod packstone.

Distribution of conodonts within lithofacies of the lower Oquirrh is consistent with the Late Mississippian to Early Pennsylvanian conodont biofacies of Davis and Webster (1985). Species of the genus *Adetognathus* predominate in mudstone, whole-fossil and bioturbated, arenaceous wackestone, and bioturbated, arenaceous, muddy packstone. These rocks are interpreted as having been deposited in lagoons and bays and behind barrier bars in areas of restricted circulation and (or) quiet waters and water depths of a few tens of meters. Species of the genera *Declinognathodus, Idiognathoides,* and *Idiognathodus* are abundant in bioclastic and oncolite packstone and grainstone and coral-bryozoan framestone and are interpreted as having been deposited in open-marine, open-circulation conditions in water depths of 10–200 m.

CONODONT ZONATION

Nine conodont biozones were recognized by us in these three formations of the Oquirrh Group and in ascending order are *Adetognathus unicornis, Rhachistognathus muricatus, R. primus-Declinognathodus noduliferus, R. minutus-Idiognathoides sinuatus, Neognathodus symmetricus, N. bassleri, Idiognathodus sinuosus, Idiognathodus parvus,* and *Diplognathodus coloradoensis-N. atokaensis* (fig. 5, plate 1). With the exception of the *Idiognathodus parvus* Biozone, these biozones are based on well-established conodont zonation for the Upper Mississippian through Middle Pennsylvanian (Lane and Baesemann, 1982; Manger and Sutherland, 1984; Baesemann and Lane, 1985). No one section contains a complete sequence of conodont biozones, but limited biostratigraphic correlation can be made based on these data. The most complete conodont zonation is in the Lake Point Limestone section in the northern Oquirrh Mountains.

Conodont biozones not recognized are assumed to be missing because of environmental conditions or because of their stratigraphic interval is so narrow that they were missed in sampling. The lower boundary of each biozone is based on the first stratigraphic appearance of the name bearer. The stratigraphic range of the name bearer is not restricted to its biozone but may extend upward through one or more overlying biozones. Consequently, the upper boundary of a biozone is defined as the first stratigraphic appearance of the name bearer of the next overlying biozone. The Mississippian-Pennsylvanian boundary is recognized in all four sections and is marked by the first occurrence of the *Declinognathodus noduliferus-Rhachistognathus primus* Biozone.

Table 2. Major conodont elements in the West Canyon Limestone at Soldier Canyon; their abundance in each numbered unit; and the associated lithofacies.

[Location of collection site is described in table 1. Lithofacies: A, bioclastic packstone to grainstones; B, whole-fossil wackestone to muddy packstone; C, bioturbated, arenaceous mudstone to wackestone; D, oncolite packstone to grainstone; E, coral and bryozoan framestone; F, calcareous quartzarenite to sublitharenite]

Conodont/sample no.	2	3	11	18	21	23	25	28	35	37	42	47	49	50	53
Lithofacies	D	B	A	C	B	A	B	C	A	B	C	C	C	B	E
Adetognathus gigantus	1		2		2	4			1	1		1			
A. lautus	5	2	3			3			1	1	1				
A. spathus							1				1	1			
A. unicornis	1														
Declinognathodus ineaqualis						1									
D. noduliferus				1			7	3							
Gnathodus girtyi	2	3	1												
Idiognathodus sinuosis														4	3
Idiognathoides sinuatus						5		1							
I. sulcatus parvus							2								
Neognathodus symmetricus															1
Rhachistognathus minutus havlenai													1		

Conodont/sample no.	54	56	57	58	60	63	65	75	77	80	85	98	101	105
Lithofacies	A	C	C	B	B	A	B	E	C	B	B	A	B	C
Adetognathus gigantus	1				1							1		
A. lautus	1								2					
A. spathus	1								2	1			1	
A. unicornis														
Declinognathodus ineaqualis														
D. noduliferus											1			
Gnathodus girtyi														
Idiognathodus sinuosis	1	1	1	1		1	2	1	1			1		2
Idiognathoides sinuatus														
I. sulcatus parvus	1	1									1			
Neognathodus symmetricus	2	1	2					2	2					
Rhachistognathus minutus havlenai														

Table 3. Major conodont elements in the Lake Point Limestone; their abundance in each numbered unit; and the associated lithofacies.
[Location of collection site is described in table 1. Lithofacies: A, bioclastic packstone to grainstones; B, whole-fossil wackestone to muddy packstone; C, bioturbated, arenaceous mudstone to wackestone; D, oncolite packstone to grainstone; E, coral and bryozoan framestone; F, calcareous quartzarenite to sublitharenite]

Conodont/sample no.	1	2	3	4	6	7	9	19	20	24	27	29	30	31	32	33	35	37	39	40	44
Lithofacies	B	C	A	A	C	A	A	A	B	D	B	A	A	B	C	B	A	D	A	A	A
Adetognathus gigantus										3	1		3		1	1		1	8		2
A. lautus									1	3									6		1
A. spathus													1							1	1
A. unicornis			2	16	1	8	1														
Anchignathus minutus																					
Cavusgnathus convexus	1																				
C. naviculus						7															
C. regularis			1																		
C. unicornis				1		7	1														
Declinognathodus ineaqualis																		1			
D. japonicus																	1				
D. noduliferus																	2	2	2		
Diplognathodus coloradoensis																					
Gnathodus bilineatus							1														
G. commutatus commutatus				1																	
G. girtyi simplex			2																		
Idiognathodus sinuosis																					
Idiognathoides corrugatus																					
I. delicatus																					
I. marginodosus																					
I. sinuatus																					
I. sulcatus parvus																					
I. sulcatus sulcatus																					
Neognathodus atokaensis																					
N. symmetricus																					
Rhachistognathus minutus																					
R. minutus havlenai																					
R. minutus minutus																					
R. muricatus								1		3											
R. primus									9	10		4	2	1			3	3	3		
R. prolixus										8											
R. websteri										5		2	1								
Spathognathus minutus		1	7		1	1															
S. spiculus							2														

Table 3. Major conodont elements in the Lake Point Limestone; their abundance in each numbered unit; and the associated lithofacies—Continued.

[Location of collection site is described in table 1. Lithofacies: A, bioclastic packstone to grainstones; B, whole-fossil wackestone to muddy packstone; C, bioturbated, arenaceous mudstone to wackestone; D, oncolite packstone to grainstone; E, coral and bryozoan framestone; F, calcareous quartzarenite to sublitharenite]

Conodont/sample no.	45	46	48	49	52	53	57	59	61	62	64	66	67	70	71	73	74	75	76	77	79
Lithofacies	A	A	A	A	B	A	B	B	B	A	A	A	A	D	D	A	A	A	A	B	B
Adetognathus gigantus		1	4			1	1	1	6	1		3		1		4	5				
A. lautus		1	3			3			6	3	2	6	1			1	4	1			3
A. spathus	2	2	4	2	1				5	2	4	4	3		2		2	1	1	2	2
A. unicornis																					
Anchignathus minutus																	1				
Cavusgnathus convexus																					
C. naviculus																					
C. regularis																					
C. unicornis																					
Declinognathodus ineaqualis											1										
D. japonicus													2								
D. noduliferus													6						3	1	
Diplognathodus coloradoensis																					
Gnathodus bilineatus																					
G. commutatus commutatus																					
G. girtyi simplex																					
Idiognathodus sinuosis													4								
Idiognathoides corrugatus													14								
I. delicatus																					
I. marginodosus																					
I. sulcatus parvus													6						1		
I. sinuatus												1									
I. sulcatus sulcatus												1	1								
Neognathodus atokaensis																					
N. symmetricus									1			1							1		
Rhachistognathus minutus			1														1				
R. minutus havlenai																					
R. minutus minutus																					1
R. muricatus																					
R. primus																					
R. prolixus																					
R. websteri								1					1					1			
Spathognathus minutus																					
S. spiculus																					

Conodont/sample no.	80	86	87	88	89	92	94	95	97	99	100	102	106	107	108	109
Lithofacies	C	F	A	A	B	B	B	E	C	B	B	A	D	A	C	A
Adetognathus gigantus				8				4		3		3			1	
A. lautus	1			12	2			2	1	6		1				
A. spathus	2	1		17	1				1		3	2	1			
A. unicornis																
Anchignathus minutus		2														
Cavusgnathus convexus																
C. naviculus																
C. regularis																
C. unicornis																
Declinognathodus ineaqualis																
D. japonicus		1														
D. noduliferus			2					1								
Diplognathodus coloradoensis				1										1		
Gnathodus bilineatus																
G. commutatus commutatus																
G. girtyi simplex																
Idiognathodus sinuosis				3		1			1	5						1
Idiognathoides corrugatus																
I. delicatus				3						2			1			1
I. sinuatus													1			
I. marginodosus													1			
I. sulcatus parvus																
I. sulcatus sulcatus																
Neognathodus atokaensis														3		
N. symmetricus																
Rhachistognathus minutus																
R. minutus havlenai		1					1									
R. minutus minutus																
R. muricatus																
R. primus																
R. prolixus																
R. websteri																
Spathognathus minutus																
S. spiculus																

Table 4. Major conodont elements in the Bannock Peak Limestone at Brush Canyon; their abundance in each numbered unit; and the associated lithofacies.
[Location of collection site is described in table 1. Lithofacies: A, bioclastic packstone to grainstones; B, whole-fossil wackestone to muddy packstone; C, bioturbated, arenaceous mudstone to wackestone; D, oncolite packstone to grainstone; E, coral and bryozoan framestone; F, calcareous quartzarenite to sublitharenite]

Conodont/sample no.	1	7	13	14	15	19	22	23	25	28	29	31	32	33	39	41	42	44	45	46
Lithofacies	A	A	A	A	C	A	A	C	A	D	D	C	C	E	D	C	A	A	A	A
Adetognathus gigantus		5	10				4	1		2	3		2		5		2	2	1	
A. lautus		1	11				2	1	1	2	2			1	1			4		
A. spathus		2	8	2				2	3	5	1	1	1		13		2	10	1	2
Anchignathus minutus																				
Declinognathodus ineaqualis						10														
D. japonicus								1										2	1	1
D. noduliferus						20		2		1							3	20	8	1
Diplognathodus coloradoensis																				
Idiognathodus parvus																				
I. sinuosis															2	4	1	3	2	7
Idiognathoides delicatus																				
Id. marginodosus																				
Id. sulcatus parvus								1		1		2	3	1	4		3	2	2	
Neognathodus atokaensis																				
N. bassleri																				
Rhachistognathus minutus havlenai			2																	
R. minutus minutus			1	1																
R. muncatus	2	1		1	1															
R. primus		12	2		6															
R. prolixus				1	1															
R. websteri		3	3		3															
Conodont/sample no.	47	49	50	51	53	54	56	57	58	59	60	61	62	63	64	65	66	67	68	69
Lithofacies	D	D	A	D	D	A	D	D	D	A	D	D	B	A	D	A	A	D	D	C
Adetognathus gigantus	3	1				2	1		1		3	4			1		2	1		1
A. lautus		2		1	1		2	1			1				1		1	1	1	
A. spathus	2	3	1	3	6	3	2		4		1	1			1		1	5	1	
Anchignathus minutus						2														
Declinognathodus ineaqualis																				
D. japonicus			1																	
D. noduliferus	1	1	8																	
Diplognathodus coloradoensis																				
Idiognathodus parvus			4			1	1		2	4				5	1	4	8		1	1
I. sinuosis			7	3		11	11	7	3	2		1	5	2		26	18	10	2	3
Idiognathoides delicatus																			5	3
Id. marginodosus																				
Id. sulcatus parvus																				
Neognathodus atokaensis						7	2				1									
N. bassleri																				
Rhachistognathus minutus havlenai																				
R. minutus minutus																				
R. muncatus																				
R. primus																				
R. prolixus																				
R. websteri																				

Conodont/sample no.	70	71	72	73	76	77	79	81	82	84	86	88	93	95	101	110	111
Lithofacies	D	D	D	D	D	D	D	D	C	A	A	D	D	B	A	E	E
Adetognathus gigantus		1			1	1	1		1	1	1	2	3	3			
A. lautus		1				1				3		1	2	2		1	
A. spathus	1	4	1	2	2	3	2	1			1	3			1		
Anchignathus minutus										1							
Declinognathodus ineaqualis																	
D. japonicus																	
D. noduliferus																	
Diplognathodus coloradoensis													1				
Idiognathodus parvus					1		4		3		1						
I. sinuosis	1	1			4	6	15	5	4							1	2
Idiognathoides delicatus					17	5	6	1	14	5	16	2	2			4	
Id. marginodosus															1		
Id. sulcatus parvus		1															
Neognathodus atokaensis					5	3	7		5	13	3	3	1		13	1	
N. bassleri							12	1	1								
Rhachistognathus minutus havlenai																	
R. minutus minutus																	
R. muncatus																	
R. primus																	
R. prolixus																	
R. websteri																	

The late occurrence or absence of stratigraphically important conodonts in these sections, particularly *Neognathodus symmetricus* and *N. bassleri*, supports the concept of facies controls on Carboniferous conodonts (Davis and Webster, 1985). The *N. symmetricus* and *N. bassleri* Biozones are important in Morrowan biostratigraphy of the North American midcontinent; however, their utility for conodont biostratigraphy of the eastern Great Basin is limited.

Lane and Straka (1974) recognized two Morrowan conodont biozones above the *Idiognathodus sinuosis* Biozone in Arkansas and Oklahoma: in ascending order, the *I. klapperi* and *Idiognathoides convexus* Biozones. Grayson (1984) and Baesemann and Lane (1985) recognized the *Id. ouachitensis* Biozone as occurring above the *I. klapperi* and *Id. convexus* Biozones and the last conodont biozone in the Morrowan; however, *I. klapperi, Id. convexus,* and *Id. ouachitensis* were not recovered from samples of the West Canyon and Lake Point Limestones or the Bannock Peak Limestone and at this time are not recognized in the Oquirrh basin.

Dunn (1970, 1976) proposed the *Idiognathodus parvus (=Streptognathodus parvus*, Dunn, 1970)-*Adetognathus spathus* Biozone above the *I. sinuosis* Biozone as the highest conodont biozone in the Morrowan in the western United States. The lower limit of the zone was defined by the uppermost occurrence of *I. humerus* and *I. sinuosis* and the upper limit defined by the uppermost occurrence of *A. spathus*, which is approximately at the Morrowan-Atokan boundary as recognized by Dunn (1970, p. 2971–2972). However, *A. spathus* is found in strata considered to be Atokan by Webster (1969) and Davis and Webster (1991).

Koike (1967) reported *Idiognathodus parvus* from southwest Japan as being correlative with the uppermost Namurian of Europe and the upper Morrowan of North America. Dunn (1976, p. 645) defined the Morrowan-Atokan boundary as being between the uppermost limits of *Idiognathoides convexus* and (or) *Adetognathus spathus* and the initial appearance of *Spathognathodus coloradoensis (=Diplognathodus coloradoensis*). Manger and Sutherland (1984) reported that *I. parvus (=Streptognathodus parvus)* is present very close to the Morrowan-Atokan boundary in the eastern Llano uplift of central Texas and that an upper Morrowan *I. delicatus-I. parvus* assemblage is succeeded by Atokan elements. Grubbs (1984) indicated a late Morrowan age for *I. parvus* in the Wapanucka Formation in the central Arbuckle Mountains, Oklahoma. Following earlier workers (for example, Lane and others, 1972), Webster and others (1984) marked the base of the Atokan at the first appearance of the fusulinids *Pseudostaffella* or *Eoschubertella.* Webster and others (1984, p. 61) stated that until the Morrowan-Atokan boundary is established at a type section it will be impossible to determine its position in other areas. The appearance of the fusulinid *Eoschubertella* approximately coincides with the base of the *Idiognathodus n.* sp.-*Diplognathodus* spp. assemblage, which is slightly above the Morrowan-Atokan boundary in the Wapanucka Formation of southeastern Oklahoma as recognized by Groves and Grayson (1984, p. 83).

Table 5. Major conodont elements in the Bannock Peak Limestone at Well Canyon; their abundance in each numbered unit; and the associated lithofacies.
[Location of collection site is described in table 1. Lithofacies: A, bioclastic packstone to grainstones; B, whole-fossil wackestone to muddy packstone; C, bioturbated, arenaceous mudstone to wackestone; D, oncolite packstone to grainstone; E, coral and bryozoan framestone; F, calcareous quartzarenite to sublitharenite]

Conodont/sample no.	3	5	6	8	11	12	22	24	32	33	36	38	45	50	52	53	57	61	62	64
Lithofacies	A	A	A	A	B	A	A	A	C	B	C	F	B	C	D	C	C	B	B	B
Adetognathus gigantus		4		3			1		1						3	1				
A. lautus			1								3			1						
A. spathus	1	2		3			9	3	2	1	1	2	4							
Declinognathodus ineaqualis									2				1							2
D. japonicus												1								
D. noduliferus		6									3		2					1		1
Diplognathodus coloradoensis																				
Idiognathodus parvus																	16			8
I. sinuosis																	5		1	20
I. sp. A																				
Idiognathoides corrugatus							1	1												
Id. sulcatus sulcatus													2							
Neognathodus bassleri																				
N. symmetricus																	7			
Rhachistognathus minutus havlenai										1		1								
R. muricatus		6			1															
R. primus		78		34	1	1	21	10												
R. prolixus		5																		

Conodont/sample no.	70	72	74	76	78	79	84	89	90	91	93	98	102
Lithofacies	E	E	E	C	E	B	C	B	A	A	B	B	C
Adetognathus gigantus				6			1						
A. lautus				3									
A. spathus				1			1						
Declinognathodus ineaqualis													
D. japonicus													
D. noduliferus													
Diplognathodus coloradoensis											1		1
Idiognathoides corrugatus													
Id. sulcatus sulcatus													
Idiognathodus parvus	2				3	2	5	2	2	4	6		
I. sinuosis	11	6	10		4		11	6	4	6	17	2	3
I. sp. A										2			
Neognathodus bassleri							1						
N. symmetricus													
Rhachistognathus minutus havlenai													
R. muricatus													
R. primus													
R. prolixus													

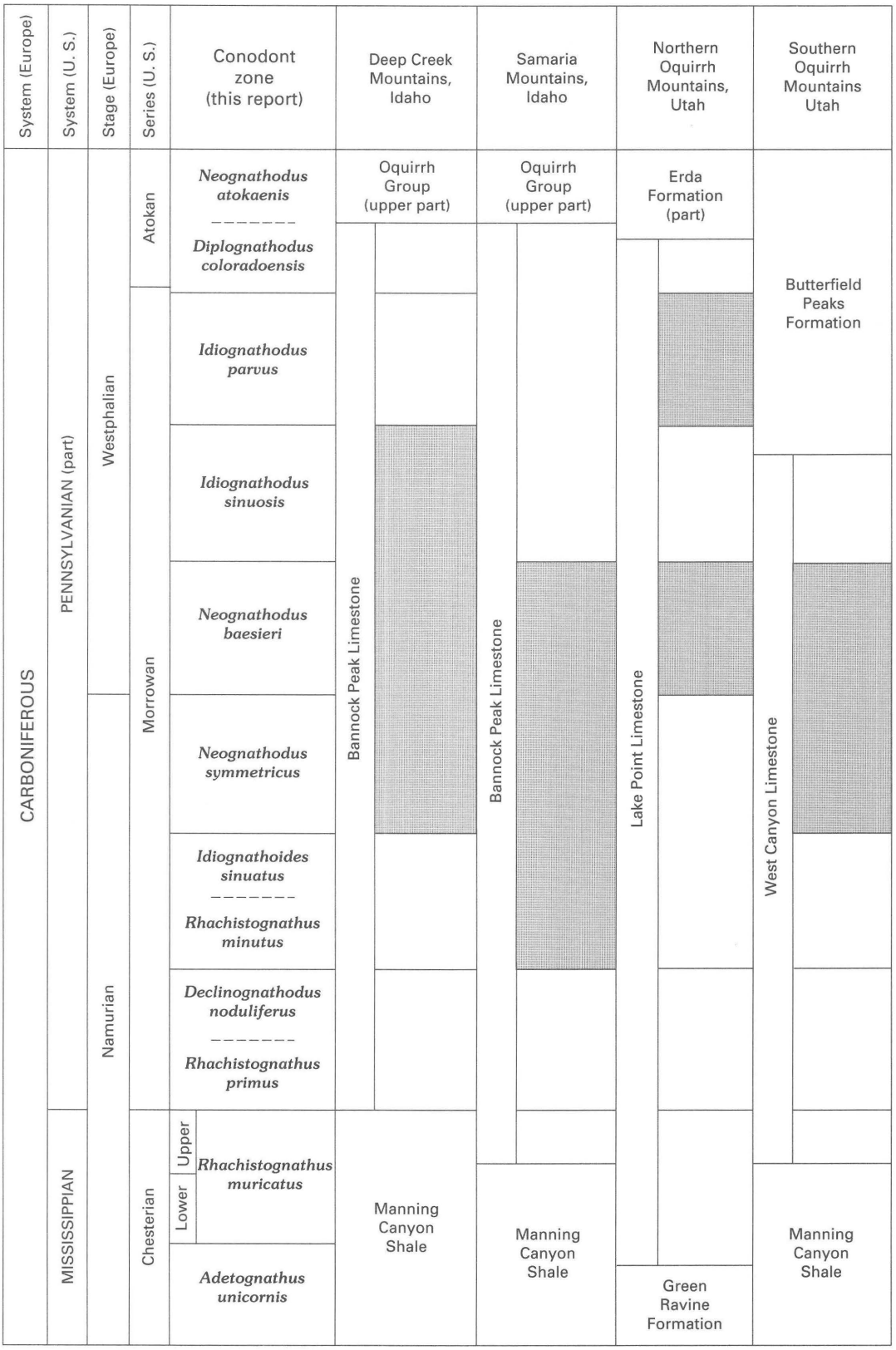

Figure 5. Conodont zonation for the Bannock Peak Limestone, Lake Point Limestone, and West Canyon Limestone in southeastern Idaho and northern Utah. Areas of diagonal lines indicate that zonal conodonts are absent; however, other, stratigraphically less important conodonts may be present in these areas.

Eoschubertella (identified by J.R. Groves, written communication, 1986) appears in the same sample as the first appearance of *I. parvus* in the Bannock Peak Limestone and therefore approximates the Morrowan-Atokan boundary. In the Bannock Peak Limestone, conodonts of Atokan age (as defined by Grayson, 1984; Groves and Grayson, 1984; Grubbs, 1984; and Manger and Sutherland, 1984) are not present until 26 m above the first occurrence of *I. parvus*. The first occurrence of *I. parvus* in the Bannock Peak Limestone at Brush Canyon is considered to be at or near the Morrowan-Atokan boundary. It is likely that time-equivalent strata of the *I. parvus* Biozone are present below the first occurrence of *I. parvus* at Brush Canyon, but *I. parvus* was not observed probably because of environmental controls. *Idiognathodus parvus* also is present below conodonts of Atokan age in the Lake Point Limestone. We therefore propose that the *I. parvus* Biozone be utilized as the uppermost Morrowan and lowermost Atokan conodont biozone in the eastern Great Basin.

The base of the *Idiognathodus parvus* Biozone is placed by us at the first occurrence of *I. parvus*. The upper limit of this biozone is the first occurrence of *Diplognathodus coloradoensis* or *Neognathodus atokaensis*. Other platform elements of this biozone observed in the Bannock Peak Limestone and Lake Point Limestone are *Adetognathus lautus, A. spathus, Declinognathodus noduliferus, D. japonicus,* and *I. sinuosis*.

SUMMARY

The West Canyon and Lake Point Limestones in northern Utah and the Bannock Peak Limestone in southeastern Idaho are each considered the basal formation of the Oquirrh Group. The Bannock Peak Limestone is introduced by us for lower Oquirrh strata in southeastern Idaho because of distinct lithologic and facies differences between it and the West Canyon and Lake Point Limestones in northern Utah. In southeastern Idaho, the sequence of rocks referred to herein as the Bannock Peak Limestone contains more sandstone and sandy limestone in its lower part, near the lower contact with the Manning Canyon Shale. The abundance of sandy limestone and sandstone decreases upward through the section, and only limestone is present in the upper part. In Utah, rocks referred to as the West Canyon Limestone display an opposite trend, in that sandy limestone and sandstone increase in abundance in the upper part of the section. The West Canyon Limestone grades upward into the dominantly sandstone facies of the Butterfield Peaks Formation. The Lake Point Limestone, as defined by Tooker and Roberts (1970), is lithologically more similar to the West Canyon Limestone than to the Bannock Peak Limestone.

Seven major lithofacies were observed in the sections measured, and recognition of these will aid in future conodont paleoecologic studies. These lithofacies include bioclastic packstone to grainstone; whole-fossil wackestone to muddy packstone; bioturbated, arenaceous mudstone to wackestone; oncolite packstones to grainstone; coral and bryozoan framestone; quartzarenite to sublitharenite; and calcareous shale. Together, these lithofacies represent deposition on a carbonate platform within the Oquirrh basin during latest Chesterian through earliest Atokan time.

Nine conodont biozones were recognized in these lower strata of the Oquirrh Group and in ascending order are *Adetognathus unicornis, Rhachistognathus muricatus, R. primus-Declinognathodus noduliferus, R. minutus-Idiognathoides sinuatus, Neognathodus symmetricus, N. bassleri, Idiognathodus sinuosus, Idiognathodus parvus,* and *Diplognathodus coloradoensis-N. atokaensis.* The *Neognathodus symmetricus* and *N. bassleri* Biozones are important in Morrowan biostratigraphy of the North American midcontinent; however, their utility for conodont biostratigraphy of the eastern Great Basin is probably limited. The *Idiognathodus parvus* Biozone is recognized as the uppermost Morrowan to lowermost Atokan conodont biozone in the eastern Great Basin.

REFERENCES CITED

Akers, R.H., and Davis, L.E., 1984, Conodont biostratigraphy of the lower Oquirrh Group, Samaria Mountain, southeastern Idaho: The Compass, v. 62, no. 1, p. 45–52.

Alexander, D.W., 1978, Petrology and petrography of the Bridal Veil Member of the Oquirrh Formation at Cascade Mountain, Utah: Brigham Young University Geologic Studies, v. 25, p. 11–25.

Armstrong, R.L., 1968, The Cordilleran miogeosyncline in Nevada and Utah: Utah Geological and Mineralogical Survey Bulletin 78, 58 p.

Baesemann, J.F., and Lane, H.R., 1985, Taxonomy and evolution of the genus *Rhachistognathus* Dunn (Conodonta; late Mississippian to Early middle Pennsylvanian): Cour. Forsch Inst. Senckenberg, v. 25, p. 93–136.

Beus, S.S., 1968, Paleozoic stratigraphy of Samaria Mountain, Idaho-Utah: American Association of Petroleum Geologists Bulletin, v. 52, no. 5, p. 782–808.

Bissell, H.J., 1959, Stratigraphy of the southern Oquirrh Mountains—Pennsylvanian System, *in* Bissell, H.J., ed., Geology of the southern Oquirrh Mountains and Fivemile Pass—Northern Boulter Mountain area, Tooele and Utah Counties, Utah: Utah Geological Society Guidebook 14, p. 93–127.

———1960, Eastern Great Basin Permo-Pennsylvanian strata—Preliminary statement: American Association of Petroleum Geologists Bulletin, v. 44, no. 8, p. 1424–1435.

———1970, Realms of Permian tectonism and sedimentation in western Utah and eastern Nevada: American Association of Petroleum Geologists Bulletin, v. 54, p. 285–312.

———1974, Tectonic control of late Paleozoic and early Mesozoic sedimentation near the hinge line of the Cordilleran miogeosynclinal belt, *in* Dickinson, W.R., ed., Tectonics and sedimentation: Society of Economic Paleontologists and Mineralogists Special Publication 22, p. 83–97.

Cramer, H.R., 1971, Permian rocks of the Sublett Range, southern Idaho: American Association of Petroleum Geologists Bulletin, v. 55, no. 10, p. 1787–1801.

Cress, L.D., 1981, Stratigraphy and structure of the south half of the Deep Creek Mountains, Oneida and Power Counties, Idaho: Golden, Colorado School of Mines, PhD. dissertation, 251 p.

Davis, L.E., Dyman, T.S., Webster, G.D., and Schwarz, D., 1989, Measured stratigraphic sections of West Canyon Limestone and equivalent strata (Upper Mississippian–Middle Pennsylvanian), lower Oquirrh Group, northern Utah and southeastern Idaho: U.S. Geological Survey Open-File Report 89–292, 47 p.

Davis, L.E., and Webster, G.D., 1985, Late Mississippian to Early Pennsylvanian conodont biofacies in central Montana: Lethaia, v. 18, no. 1, p. 67–72.

———1991, The Lake Point Limestone: an alternate mid-Carboniferous boundary stratotype in western North America: International Carboniferous Conference, 11th, Beijing, China, Guidebook.

Dunham, R.J., 1961, Classification of carbonate rocks according to depositional texture, *in* Ham, W.E., ed., Classification of carbonate rocks: American Association of Petroleum Geologists Memoir 1, p. 108–121.

Dunn, D.L., 1970, Conodont zonation near the Mississippian-Pennsylvanian boundary in western United States: Geological Society of America Bulletin, v. 81, p. 2959–2974.

———1976, Biostratigraphic problems of Morrowan and Derryan (Atokan) strata in the Pennsylvanian System of western United States: Geological Society of America Bulletin, v. 86, p. 641–645.

Dyman, T.S., Materna, W.L., and Wilcox, L.A., 1985, Stratigraphic applications of the Geologic Analysis System [abs]: American Association of Petroleum Geologists Bulletin, v. 69, p. 251.

Eardley, A.J., 1947, Paleozoic Cordilleran geosyncline and related orogeny: Journal of Geology, v. 55, p. 309–342.

Embry, A. F., and Klovan, E.J., 1972, Absolute water-depth limits of Late Devonian paleoecological zones: Geologische Rundschau., v. 61, no. 2.

Folk, R.L., 1968, Petrology of sedimentary rocks: Austin, Texas, Hemphills, 170 p.

Gilluly, J., 1932, Geology and ore deposits of the Stockton and Fairfield quadrangles, Utah: U.S. Geological Survey Professional Paper 173, 171 p.

Grayson, R.C., 1984, Morrowan and Atokan (Pennsylvanian) conodonts from the northeastern margin of the Arbuckle Mountains, southern Oklahoma, *in* Sutherland, P.K., and Manger, W.L., eds., The Atokan Series (Pennsylvanian) and its boundaries—A symposium: Oklahoma Geological Survey Bulletin 136, p. 41–64.

Groves, J.R., and Grayson, R.C., Jr., 1984, Calcareous foraminifers and conodonts from the Wapanucka Formation (Lower-Middle Pennsylvanian), Frontal Ouachita Mountains, southeastern Oklahoma, *in* Sutherland, P.K. and Manger, W.L, eds., The Atokan Series (Pennsylvanian) and its boundaries—A symposium: Oklahoma Geological Survey Bulletin 136, p. 81–90.

Grubbs, R.K., 1984, Conodont platform elements from the Wapanucka and Atoka Formations (Morrowan-Atokan) of the Mill Creek syncline, central Arbuckle Mountains, Oklahoma, *in* Sutherland, P.K., and Manger, W.L., eds., The Atokan Series (Pennsylvanian) and its boundaries—A symposium: Oklahoma Geological Survey Bulletin 136, p. 65–80.

Jordon, T.E., 1979, Lithofacies of the Upper Pennsylvanian and Lower Permian western Oquirrh Group, northwest Utah: Utah Geologist, v. 6, p. 41–56.

Jordon, T.E., and Douglas, R.C., 1980, Paleogeography and structural development of the Late Pennsylvanian to Early Permian Oquirrh basin, northwestern Utah, *in* Fouch, T.D., and Magathan, E.R., eds., Paleozoic paleogeography of west-central United States: Society of Economic Paleontologists and Mineralogists, p. 217–238.

Koike, T., 1967, A Carboniferous succession of conodont faunas from the Atetsu Limestone in southwest Japan: Science Report Tokyo Kyoikum Daigahu, v. 9, no. 32, p. 279–318.

Konopka, E.H., and Dott, R.H., Jr., 1982, Stratigraphy and sedimentology, lower part of the Butterfield Peaks Formation (Middle Pennsylvanian), Oquirrh Group, Mt. Timpanogos, Utah: Utah Geological Association Publication 10, p. 215–234.

Lane, H.R., and Baesemann, J.F., 1982, A Mid-Carboniferous boundary based on conodonts and revised intercontinental correlations, *in* Ramsbottom, W.H.C., Saunders, W.B., and Owens, B., eds, Biostratigraphic data for a Mid-Carboniferous boundary: Subcommission on Carboniferous Stratigraphy, p. 6–12.

Lane, H.R., Sanderson, G.A., and Verville, G.J., 1972, Uppermost Mississippian-basal Middle Pennsylvanian conodonts and fusulinids from several exposures in the south-central and southwestern United States: International Geological Congress, 24th, Proceedings, sec. 7, p. 546–555.

Lane, H.R., and Straka, J.J., 1974, Late Mississippian and Early Pennsylvanian conodonts, Arkansas and Oklahoma: Geological Society of America Special Paper 152, 144 p.

Larson, J.A., 1979, Redeposited carbonates of the Upper Oquirrh Formation, Utah: Brigham Young University Geologic Studies, v. 26, no. 1, p. 65–84.

Manger, W.L., and Sutherland, P.K., 1984, Preliminary conodont biostratigraphy of the Morrowan-Atokan boundary (Pennsylvanian), eastern Llano uplift, central Texas, *in* Sutherland, P.K., and Manger, W.L., eds., The Atokan Series (Pennsylvanian) and its boundaries—A symposium: Oklahoma Geological Survey Bulletin 136, p. 115–122.

McKee, E.D., and Crosby, E.J., eds., Paleotectonic investigations of the Pennsylvanian System in the United States: U.S. Geological Survey Professional Paper 853, 349 p.

Morris, H.T., Douglas, R.C., and Kopf, R.W., 1977, Stratigraphy and microfaunas of the Oquirrh Group in the southern Tintic Mountains, Utah: U.S. Geological Survey Professional Paper 1025, 23 p.

Nygreen, P.W., 1958, The Oquirrh Formation—Stratigraphy of the lower portion in the type area and near Logan, Utah: Utah Geological and Mineralogical Survey Bulletin 61, 67 p.

Petroleum Information Corporation, 1984, Geologic Analysis System (GAS) technical services training manual: Denver, Petroleum Information Corporation, 195 p.

Platt, L.B., 1977, Geologic map of the Ireland Springs-Samaria area, southeastern Idaho and northern Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF–890.

Poole, F.G., 1974, Flysch deposits of the Antler foreland basin, western United States, *in* Dickinson, W.R., ed., Tectonics and sedimentation: Society of Economic Paleontologists and Mineralogists Special Publication 22, p. 58–82.

Richards, R.W., and Mansfield, G.R., 1912, The Bannock overthrust, a major fault in southeastern Idaho and northeastern Utah: Journal of Geology, v. 20, p. 681–709.

Roberts, R.J., Crittenden, M.D., Jr., Tooker, E.W., Morris, H.T., Hose, P.K., and Cheney, T.M., 1965, Pennsylvanian and Permian basins in northwestern Utah, northeastern Nevada, and south-central Idaho: American Association of Petroleum Geologists Bulletin, v. 49, p. 1926–1956.

Skipp, B., and Hall, W.E., 1980, Upper Paleozoic paleotectonics and paleogeography of Idaho, *in* Fouch, T.D., and Magathan, E.R., eds., Paleozoic paleogeography of west-central United States: Society of Economic Paleontologists and Mineralogists, p. 387–422.

Smith, J.F., Jr., 1983, Paleozoic rocks in the Black Pine Mountains, Cassia County, Idaho: U.S. Geological Survey Bulletin 1536, 36 p.

Spurr, J.E., 1895, Economic geology of the Mercur Mining District, Utah: U.S. Geological Survey, 16th Annual Report, p. 374–376.

Stevens, C.H., and Armin, R.A., 1983, Microfacies of the Middle Pennsylvanian part of the Oquirrh Group, central Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., eds., Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 83–100.

Stewart, J.H., and Poole, F.G., 1974, Lower Paleozoic and uppermost Precambrian Cordilleran miogeocline, Great Basin, western United States, *in* Dickinson, W.R., ed., Tectonics and sedimentation: Society of Economic Paleontologists and Mineralogists Special Publication 22, p. 28–57.

Stokes, W.L., and Heylmun, E.B., 1958, Outline of the geologic history and stratigraphy of Utah: Utah Geological and Mineralogical Survey, 37 p.

Tooker, E.W., and Roberts, R.J., 1970, Upper Paleozoic rocks in the Oquirrh Mountains and Bingham mining districts, Utah: U.S. Geological Survey Professional Paper 629–A, 76 p.

Trimble, D.E., and Carr, W.J., 1976, Geology of the Rockland and Arbon Quadrangles, Power County, Idaho: U.S. Geological Survey Bulletin 1399, 115 p.

Webster, G.D., 1969, Chester through Derry conodonts and stratigraphy of northern Clark and southern Lincoln Counties, Nevada: University of California Publication Geological Sciences 79, 105 p.

———1984, Conodont zonations near the Mississippian-Pennsylvanian boundary in the eastern Great Basin, *in* Lintz, J., eds., Western geological excursions: Geological Society America Annual Meeting, 1984, v. 1, p. 78–82.

Webster, G.D., Brenckle, P., Gordon, M., Jr., Lane, H.R., Langenheim, R.L., Jr., Sanderson, G.A., and Tidwell, W.D., 1984, The Mississippian-Pennsylvanian boundary in the eastern Great Basin, *in* Sutherland, P.K., and Manger, W.L., eds., Neuvieme Congres International de Stratigraphie et de Geologie du Carbonifere, Comptes Rendu, v. 2, Biostratigraphy: Southern Illinois University Press, p. 406–418.

Welsh, J.E., and James, A.H., 1961, Pennsylvanian and Permian stratigraphy of the central Oquirrh Mountains, Utah, *in* Cook, D.R., ed., Geology of the Bingham mining district and northern Oquirrh Mountains: Utah Geological Society, Guidebook to the Geology of Utah 14, p. 1–16.

Wright, R.E., 1961, Stratigraphic and tectonic interpretation of Oquirrh Formation, Stansbury Mountains, Utah: Brigham Young University Geological Studies, v. 8, p. 147–166.

Yancey, T.E., Ishibashi, G.D., and Bingmam, P.T., 1980, Carboniferous and Permian stratigraphy of the Sublett Range, south-central Idaho, *in* Fouch, T.D., and Magathan, E.R., eds., Paleozoic paleogeography of west-central United States: Society of Economic Paleontologists and Mineralogists, p. 259–269.

Published in the Central Region, Denver, Colorado
Manuscript approved for publication February 11, 1994
Graphics prepared by Wayne Hawkins
Photocomposition by Carol Quesenberry
Edited by Judith Stoeser

APPENDIX

APPENDIX—REFERENCE AND TYPE SECTIONS FOR BANNOCK PEAK LIMESTONE

In the northern half of the Deep Creek Range of southeastern Idaho, Trimble and Carr (1976) referred to the basal limestone of the Oquirrh Group as unit A, Oquirrh Formation. In the southern half of the Deep Creek Mountains, Cress (1981) referred to the lower Oquirrh Group as the West Canyon Limestone. In this report, these units are referred to the Bannock Peak Limestone of the Oquirrh Group. The Bannock Peak Limestone crops out as an almost continuous band along the western flanks of the Deep Creek Mountains. Exposures in the southern half of the range are complexly faulted, and exposures are poor. The base of the unit is recognized as the first major limestone above the slope-forming, poorly exposed black shale, thin gray limestone, and gray quartzarenite of the Manning Canyon Shale. The upper limit is difficult to delineate but is placed at the base of the silty to sandy, gray to tan-gray limestone containing abundant, large solitary corals (*Caninia*?).

BANNOCK PEAK LIMESTONE, OQUIRRH GROUP

Reference section. Along north ridge of Well Canyon beginning at approximately 6,000 ft (1,828 m) contour, SW¼SE¼NE¼ sec. 3, T. 9 S., R. 31 E., continuing east-northeast along ridge to saddle (approximately 6,600 ft, 2,011 m, contour), SE¼SW¼NW¼ sec. 24, T. 9 S., R. 31 E., Power County, Idaho; Rockland East and Indian Springs 7.5-minute quadrangles. Measured by L.E. Davis, D. Schwarz, and T. Christensen.

	Thickness (meters)	*Cumulative thickness (meters)*
Conformable contact		
Oquirrh Group (unit B of Trimble and Carr, 1976)		
Bannock Peak Limestone of the Oquirrh Group		
106. Mudstone, medium-gray; poor exposure, mostly covered, forms saddle in ridge; medium bedded (20–30 cm)	7.4	446.4
105. Mudstone, light-brownish-gray; poor exposure, mostly covered, forms saddle in ridge; medium bedded (20–30 cm)	5.3	439.0
104. Wackestone, medium-gray; good exposure, small dip slope at top of unit; medium bedded (20–30 cm); bioturbated; brachiopods; minor 6–8-cm-diameter brownish-gray chert nodules	4.3	433.7
103. Mudstone, dark-gray; good exposure; medium bedded (20–30 cm); minor 8–16-cm-thick zone of brownish-black chert nodules	1.5	429.4
102. Mudstone, dark-gray; poor exposure; thin bedded (2–6 cm); bioturbated	4.3	427.9
101. Mudstone, medium-dark-gray; poor exposure; thin bedded (2–4 cm); bioturbated	3.0	423.6
100. Mudstone, medium-dark-gray; good exposure, small dip slope at top; medium bedded (30–40 cm)	8.8	420.6
99. Covered interval; dark-gray limestone float	3.4	411.8
98. Brachiopod wackestone, dark-gray; poor exposure; medium bedded (25–35 cm); corals, crinoids, and brachiopods	2.2	408.4
97. Brachiopod wackestone, medium-dark-gray; poor exposure; massive; bioturbated; brachiopods	2.0	406.2
96. Mudstone, dark-gray; good exposure, resistant ridge former; massive	2.8	404.2
95. Crinoid wackestone, light-gray; poor exposure; medium bedded (30–40 cm); crinoids	6.0	401.4
Bannock Peak Limestone, Reference section—Continued		
Bannock Peak Limestone of the Oquirrh Group—Continued		
94. Shale, light-brown; poor exposure; very thin bedded (3–4 cm)	3.3	395.4
93. Brachiopod packstone, dark-gray; excellent exposure, resistant ridge former; medium bedded (25–35 cm); bioturbated; corals and brachiopods	5.3	392.1
92. Covered interval; dark-gray limestone float	2.7	386.8
91. Brachiopod packstone, dark-gray; poor exposure; medium bedded; bioturbated; corals, trilobites, brachiopods, and foraminifers	2.5	384.1
90. Arenaceous brachiopod packstone, light-gray; poor exposure; massive; 20–25 percent quartz sand; bioturbated; crinoids, trilobites, oncolites	3.0	381.6
89. Brachiopod wackestone to brachiopod packstone, light-gray; very poor exposure, mostly covered; massive; brachiopods and bryozoans; extensive silicification	8.0	378.6
88. Brachiopod packstone to brachiopod grainstone, dark-gray; excellent exposure, resistant ridge former; thick bedded (40–60 cm); bioturbated; echinoids, trilobites, and brachiopods; abundant 8–12-cm-diameter black chert nodules	7.5	370.6
87. Arenaceous skeletal wackestone to arenaceous skeletal packstone, light-gray; fair exposure; massive; 25–30 percent quartz sand; bioturbated; crinoids, brachiopods, foraminifers, and bryozoans	12.3	361.1
86. Brachiopod packstone, light-gray; good exposure, resistant ridge former; massive; echinoids, trilobites, brachiopods, and bryozoans; minor 4–8-cm-diameter black chert nodules	4.7	350.8
85. Brachiopod packstone, light-gray; poor exposure; massive; corals, crinoids, and brachiopods; extensive silicification; minor 8–15-cm- diameter black chert nodules	7.4	346.1
84. Pelletal wackestone, light-gray; fair exposure; massive; bioturbated; crinoids, brachiopods, and pellets; minor 4–8-cm-diameter bedded black chert	3.5	338.7
83. Brachiopod packstone to brachiopod grainstone, dark-gray; good exposure; massive; trilobites, brachiopods, foraminifers, bryozoans, and pellets	5.2	335.2
82. Covered interval; dark-gray limestone float	1.53	30.0
81. Pelletal wackestone, medium-dark-gray; poor exposure; massive; bioturbated; pellets; abundant 10–18-cm-diameter black chert nodules	2.4	328.5
80. Pelletal wackestone, medium-dark-gray; poor exposure; massive; bioturbated; bivalves, crinoids, trilobites, and pellets	3.1	326.1

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Reference section—Continued		
Bannock Peak Limestone of the Oquirrh Group—Continued		
79. Brachiopod wackestone, dark-gray; good exposure, resistant ridge; medium bedded (20–30 cm); corals, brachiopods, and bryozoans; extensive silicification; abundant 10–18-cm-diameter black chert nodules	2.8	323.0
78. Coral-brachiopod wackestone to coral-brachiopod packstone, medium-dark-gray; poor exposure; massive; brecciated zone, possible small fault; corals, brachiopods, and foraminifers	6.8	320.2
77. Covered interval; dark-gray limestone float	2.8	313.4
76. Skeletal dolomitic wackestone, light-gray; poor exposure; thin bedded (8–10 cm); 5 percent silt-sized quartz; echinoderms and brachiopods; extensive dolomitization	6.3	310.6
75. Covered interval; gray limestone float	3.8	304.3
74. Crinoid wackestone to crinoid packstone, light gray; fair exposure; massive; bioturbated; solitary corals, crinoids, brachiopods, and bryozoans	5.7	300.5
73. Dolomitic mudstone, medium-dark-gray; poor exposure; medium bedded (25–35 cm); echinoids, crinoids, and brachiopods; extensive silicification and dolomitization	2.3	294.8
72. Bryozoan wackestone to bryozoan packstone, medium-gray; fair exposure; massive; foraminifers and bryozoans	2.2	292.5
71. Shale, light-brown; poor exposure, mostly covered; very thin bedded (2–4 cm)	1.8	290.3
70. Brachiopod-bryozoan wackestone to brachiopod bryozoan packstone, light-gray; excellent exposure, resistant ridge former; massive; solitary corals, trilobites, brachiopods, and fenestrate bryozoans; minor 10–15-cm-diameter black chert nodules	6.0	288.5
69. Covered interval; light-gray limestone float	9.0	282.5
68. Dolomitic mudstone, light-brownish-gray; poor exposure; massive; brachiopods; abundant 8–15-cm-diameter black chert nodules	5.5	273.5
67. Covered interval; light-brownish-gray limestone float	2.8	268.0
66. Dolomitic mudstone, medium-dark-gray; good exposure; massive; 4–8-cm-diameter interbedded black chert nodules	6.3	265.2
65. Covered interval; dark-gray limestone float	2.3	258.9
64. Brachiopod wackestone, light-gray; poor exposure; medium bedded (20–30 cm); 5 percent silt-sized quartz; corals and brachiopods; minor silicification	3.7	256.6
63. Covered interval; light-gray limestone float	1.6	252.9
62. Brachiopod wackestone, medium-dark-gray; poor exposure; medium bedded (15–25 cm); bioturbated; brachiopods; minor silicification	4.9	251.3
61. Skeletal wackestone, medium-gray; poor exposure, dip slope at top; massive; crinoids, brachiopods, and bryozoans; minor 6–8-cm-diameter black chert nodules	3.2	246.4
60. Skeletal wackestone, medium-dark-gray; excellent exposure, very resistant ridge former; massive; bioturbated; crinoids, brachiopods, and bryozoans; minor 6–8-cm-diameter interbedded black chert nodules	3.3	243.2
59. Bryozoan-brachiopod packstone, grayish-black; excellent exposure, very resistant ridge former; massive; crinoids, trilobites, brachiopods, foraminifers, and fenestrate and ramose bryozoans; abundant 8–12-cm-diameter black chert nodules	5.5	239.9
58. Pelletal dolomitic packstone, medium-dark-gray; very poor exposure; thick bedded (40–60 cm); pellets	3.4	234.4
57. Dolomitic mudstone, dark-gray; fair exposure; medium bedded (25–35 cm); bioturbated; crinoids; minor 8–12-cm-diameter black chert nodules	3.3	231.0
56. Skeletal wackestone, medium-gray; good exposure, resistant ridge former; massive; arenaceous toward top; bioturbated; crinoids, echinoids, and brachiopods; minor 8–10-cm-diameter black chert nodules	7.2	227.7
55. Covered interval; gray limestone float	1.5	220.5
54. Coraline packstone, medium-dark-gray; excellent exposure, resistant ridge former; massive; bioturbated; solitary corals, trilobites, brachiopods, and pellets; minor 6–8-cm-diameter black chert nodules	2.4	219.0
53. Mudstone, medium-gray; fair exposure; massive; bioturbated; abundant 8–10-cm-diameter black chert nodules	1.2	216.6
52. Oncolite packstone, medium-light-gray; poor exposure; medium bedded (25–35 cm); crinoids, echinoids, bryozoans, and oncolites	6.1	215.4
51. Dolomitic wackestone, medium-gray; poor exposure; thin bedded (4–10 cm), argillaceous; bioturbated; 10 percent quartz sand; brachiopods; abundant 6-12-cm-diameter black chert nodules	6.0	209.3
50. Dolomitic mudstone to dolomitic wackestone, medium-gray; good exposure, ridge former; massive; 10 percent quartz sand; brachiopods and bryozoans	5.8	203.3
49. Dolomitic mudstone, medium-light-gray; fair exposure; massive; 10 percent quartz sand	7.5	197.5
48. Skeletal wackestone to skeletal packstone, medium-gray; good exposure, resistant ridge former; massive; 3 percent quartz sand; bioturbated; solitary corals, crinoids, echinoids, brachiopods, fenestrate bryozoans, oncolites, and pelloids	4.8	190.0
47. Quartzarenite, brownish-gray; poor exposure; massive; well sorted; subangular to subrounded grains; silica cemented; 2 percent crinoid fragments	1.3	185.2

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Reference section—Continued		
Bannock Peak Limestone of the Oquirrh Group—Continued		
46. Crinoid dolomitic wackestone to crinoid dolomitic packstone, brownish-gray; excellent exposure, resistant ridge former; thick bedded (40–60 cm); crinoids and brachiopods; extensive dolomitization and silicification; abundant 8–15-cm-diameter black chert nodules	4.5	183.9
45. Skeletal wackestone to skeletal packstone, light-gray; fair exposure; medium bedded (15–25 cm); low-angle sandy crossbeds; corals, crinoids, echinoids, brachiopods, and fenestrate bryozoans	7.8	179.4
44. Shale, light-brown; poor exposure, mostly covered; thin laminations (1–4 cm)	3.3	171.6
43. Brachiopod packstone, medium-light-gray; excellent exposure, resistant ridge former, dip slope at top of unit; massive; crinoids, echinoids, trilobites, brachiopods, foraminifers, and bryozoans	7.8	168.3
42. Skeletal dolomitic wackestone, light-gray; excellent exposure, resistant ridge former; medium to thick bedded (20–50 cm); bioturbated; corals, echinoids, brachiopods, bryozoans, and sponge spicules; minor dolomitization; abundant 6–12-cm-diameter black chert nodules	7.2	160.5
41. Spiculitic dolomitic mudstone, medium-dark-gray to light-brownish-gray; good exposure, resistant ridge former; medium bedded (15–30 cm); bioturbated; sponge spicules; extensive dolomitization; minor 8–10-cm-diameter black chert nodules	8.1	153.3
40. Skeletal mudstone to skeletal wackestone, dark-gray; poor exposure; thin to medium bedded (2–20 cm); crinoids; extensive silicification	6.2	145.2
39. Shale, light-brownish-gray; poor exposure, mostly covered; thin laminations (1–6 cm)	5.8	139.0
38. Sedimentary sublitharenite, light-brownish-gray; excellent exposure, resistant ridge former, dip slope at top of unit; massive; low-angle crossbedding; moderately well sorted; subangular to subrounded grains; calcite cement; crinoids and echinoids	3.2	133.2
37. Covered interval; light-brownish-gray sandstone and limestone float	2.0	130.0
36. Arenaceous dolomitic mudstone, light-brownish-gray; poor exposure; thin bedded (4–10 cm); 5–10 percent quartz sand; crinoids and brachiopods	9.4	128.0
35. Arenaceous dolomitic mudstone, medium-gray; poor exposure; thin bedded (8–10 cm); 5–15 percent quartz sand	3.4	118.6
34. Covered interval; medium-gray to light-brownish-gray limestone float	2.6	115.2
33. Skeletal wackestone, medium-dark-gray; excellent exposure, resistant ridge former; medium bedded (15–30 cm); corals, echinoids, crinoids, brachiopods, and ramose bryozoans; abundant 8–10-cm-diameter black chert nodules	4.0	112.6
Bannock Peak Limestone, Reference section—Continued		
Bannock Peak Limestone of the Oquirrh Group—Continued		
32. Mudstone, medium-light-gray; excellent exposure, resistant ridge former; massive; brachiopods; 8–10-cm-diameter black chert nodules in lower 3.0 m	5.3	108.6
31. Skeletal dolomitic wackestone to skeletal dolomitic packstone, medium-dark-gray; fair exposure; thin to medium bedded (8–25 cm); bioturbated; corals, crinoids, brachiopods, bryozoans, and pellets; extensive dolomitization and silicification; minor 10–15-cm-diameter black chert nodules	11.8	103.3
30. Covered interval; dark-gray limestone float	5.6	91.5
29. Brachiopod packstone to brachiopod grainstone, medium-light-gray; poor exposure; medium bedded (20–30 cm); bioturbated; gastropods, corals, crinoids, echinoids, brachiopods, foraminifers, bryozoans, and pellets	2.8	85.9
28. Sedimentary sublitharenite, light-brownish-gray; excellent exposure, resistant ridge former, dip slope at top of unit; massive; low-angle crossbedding; well sorted; subangular to well-rounded grains; calcite cement; crinoids	4.3	83.1
27. Covered interval; light-brownish-gray sandstone and limestone float	1.5	78.8
26. Brachiopod packstone to brachiopod grainstone, medium-gray; poor exposure; massive; gastropods, echinoids, crinoids, brachiopods, foraminifers, pellets, and pelletal mudstone lithoclasts; minor 4–8-cm-diameter black chert nodules	0.8	77.3
25. Arenaceous mudstone, light-brownish-gray; excellent exposure, resistant ridge former; thick bedded (30–50 cm); low-angle crossbedding; 15–20 percent silt-sized quartz; crinoids	10.4	76.5
24. Skeletal grainstone, medium-gray; good exposure; massive; 3–5 percent quartz sand; bioturbated gastropods, crinoids, echinoids, brachiopods, foraminifers, and bryozoans; interbedded black chert	1.3	66.1
23. Sedimentary sublitharenite, medium-light-gray; excellent exposure, resistant ridge former; massive; low-angle crossbedding; moderately well sorted; subangular to subrounded grains; calcite cement; carbonate lithoclasts	2.7	64.8
22. Crinoid-brachiopod grainstone, light-gray; good exposure; massive; low-angle crossbedding; 3 percent quartz sand; bioturbated; gastropods, crinoids, echinoids, brachiopods, fenestrate and ramose bryozoans, and pelloids	1.4	62.1
21. Sedimentary sublitharenite, medium-light-gray; excellent exposure, resistant ridge former; massive; wavy laminations; well sorted; subangular to well-rounded grains, calcite cement; carbonate lithoclasts	1.5	60.7

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Reference section—Continued		
Bannock Peak Limestone of the Oquirrh Group—Continued		
20. Arenaceous dolomitic mudstone, light-gray; poor exposure; thin bedded (5–20 cm); 15–20 percent quartz sand	2.3	59.2
19. Dolomitic mudstone, medium-gray; poor exposure; laminated to thin bedded (2–6 cm); sponge spicules (?); extensive dolomitization	1.9	56.9
18. Chert, black	0.2	55.0
17. Dolomitic mudstone, medium-gray; poor exposure; laminated to thin bedded (2–6 cm); sponge spicules (?); extensive dolomitization	2.8	54.8
16. Dolomitic mudstone, medium-gray; poor exposure; laminated to thin bedded (1–6 cm); sponge spicules (?); extensive dolomitization; 2–5-cm-diameter interbedded black chert nodules	2.8	54.8
15. Spiculitic mudstone, medium-gray; poor exposure; laminated to thin bedded (1–6 cm); minor silt-sized quartz; sponge spicules; minor 2–5-cm-diameter interbedded black chert nodules	6.0	46.0
14. Sedimentary sublitharenite, medium-light-gray; poor exposure; thin bedded (4–6 cm); low-angle crossbedding; moderately well sorted; subangular to subrounded grains; carbonate lithoclasts and crinoids	3.3	40.0
13. Sedimentary sublitharenite, light-brownish-gray; poor exposure; thin to medium bedded (4–20 cm); low-angle crossbedding; moderately well sorted; subangular to subrounded grains; carbonate lithoclasts and crinoids	3.6	36.7
12. Arenaceous crinoid packstone to arenaceous crinoid grainstone, medium-gray; good exposure; massive; 15–20 percent quartz sand; crinoids, brachiopods, and bryozoans	4.8	33.1
11. Arenaceous skeletal wackestone, medium-gray; good exposure; massive; low-angle crossbedding; 10–15 percent quartz sand; crinoids and brachiopods; minor 10–12-cm-diameter black chert nodules	1.3	28.3
10. Arenaceous crinoid packstone, light-brownish-gray; poor exposure; thin bedded (8–10 cm); 40–50 percent quartz sand; crinoids and brachiopods	1.3	28.3
9. Calcareous quartzarenite, light-brown; poor exposure; medium bedded (10–15 cm); well sorted; subangular to well-rounded grains; calcite cement	0.5	23.0
8. Arenaceous crinoid packstone, medium-gray; fair exposure; laminated to thin bedded (0.5–6 cm); low-angle crossbedding; 20–30 percent quartz sand; crinoids and echinoids	2.6	22.5
7. Calcareous quartzarenite, light-brownish-gray; fair exposure; thin to medium bedded (4–15 cm); well sorted; subangular to well-rounded grains; calcite cement	1.5	19.9
6. Arenaceous crinoid packstone, medium-gray; excellent exposure, resistant ridge former; 20–30 percent quartz sand; crinoids and brachiopods; abundant 5–8-cm-diameter black chert nodules	3.5	18.4
5. Brachiopod-crinoid grainstone, medium-gray; good exposure; medium bedded (20–30 cm); crinoids, brachiopods, and foraminifers; minor 10–12-cm-diameter black chert nodules	1.6	14.9
4. Calcareous quartzarenite, light-brownish-gray; good exposure, resistant ridge former; low-angle crossbedding; well sorted; subangular to subrounded grains; calcite cement	5.3	13.3
3. Crinoid packstone, medium-gray; poor exposure; thin bedded (3–6 cm); 5–10 percent quartz sand; bioturbated; corals and crinoids	2.0	8.0
2. Dolomitic mudstone, medium-gray; poor exposure; thin bedded (3–6 cm); extensive dolomitization obliterating allochemical constitutents	3.0	6.0
1. Arenaceous dolomitic mudstone, dark-gray; poor exposure; laminated to thin bedded (1–5 cm); 10–15 percent quartz sand; extensive dolomitization obliterating allochemical constituents	3.0	3.0
Conformable contact		
Manning Canyon Formation		

BANNOCK PEAK LIMESTONE, OQUIRRH GROUP

Type section. Base of ridge (6,600 ft, 2,011 m, contour) at the head of the left fork of Brush Canyon, NW¼SW¼ sec. 14, T. 16 S., R. 4 W., continuing northwestward along ridge to top of last major ridge-forming limestone (approximately 7,400 ft, 2,255 m, contour), SE¼SW¼ sec. 10, T. 16 S., R. 4 W., Oneida County, Idaho: Samaria 7.5-minute quadrangle, Idaho-Utah. Measured by L.E. Davis and D. Schwarz.

	Thickness (meters)	Cumulative thickness (meters)
Oquirrh Group		
Sandy member, Oquirrh Formation (Platt, 1977)		
Upper member, Oquirrh Formation (Bues, 1968)		
Conformable contact		
Bannock Peak unit, Oquirrh Group		
111. Coral framestone to pelloid grainstone, medium-gray; good exposure, ridge former; medium thick bedded (20–40 cm); 10–15 percent quartz sand; brownish-gray interbedded chert; corals including *Lophophyllidium* sp. ?, crinoids, foraminifers, fenestrate bryozoans, and pelloids	3.5	431.5
110. Skeletal wackestone to skeletal packstone, medium-dark-gray; poor exposure; thin to medium bedded (10–25 cm); minor quartz; minor, brownish-black interbedded chert; bioturbated; gastropods, rugose corals (in upper part), echinoids, and crinoids	2.0	428.0

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
109. Arenaceous mudstone, brownish-gray; poor exposure; thin bedded (8–12 cm); 20–30 percent quartz sand; abundant brownish-gray 4–16-cm-diameter chert nodules; brachiopods	3.9	426.0
108. Calcareous quartzarenite, medium-light-gray; poor exposure; thick bedded (40–50 cm); well sorted; subangular to subrounded grains; calcite cement	3.4	422.1
107. Arenaceous dolomitic mudstone, medium-dark-gray; poor exposure; thin bedded (8–12 cm); 20–30 percent quartz sand; interbedded moderate-red siltstone; bioturbated	4.5	418.7
106. Covered interval; medium-dark-gray limestone and moderate-red siltstone float	46.0	414.2
105. Arenaceous mudstone, medium-gray; very poor exposure, upper 2.0 m covered; medium bedded (25–30 cm); 20–30 percent quartz sand; minor brownish black 5–8-cm-diameter chert nodules; bioturbated	3.0	368.2
104. Covered interval; medium-gray limestone float	4.5	365.2
103. Arenaceous skeletal wackestone, medium-dark-gray; fair exposure; thick bedded (40–60 cm); 10–15 percent quartz sand; bioturbated; crinoids, trilobites, and brachiopods	3.4	360.7
102. Arenaceous dolomitic mudstone to arenaceous dolomitic wackestone, medium-dark-gray; excellent exposure, top of last good cliff; medium bedded (20–30 cm); 10 percent quartz sand; stylolites; interbedded 10–15-cm-thick brownish-black chert beds and 6–8-cm-diameter chert nodules; bioturbated	3.5	357.3
101. Arenaceous crinoid packstone, medium-gray; excellent exposure; massive; 20–25 percent quartz sand; 6–8-cm-diameter brownish-black chert nodules; bioturbated; echinoids, crinoids, trilobites, brachiopods, and foraminifers	1.4	353.8
100. Arenaceous dolomitic mudstone, medium-light-gray; excellent exposure, base of last major cliff near top of ridge; thin bedded (argillaceous, 4–8 cm); 20–30 percent quartz sand; interbedded 4–6-cm-thick black chert; extensive dolomitization and silicification; bioturbated; crinoids	3.1	352.4
99. Covered interval; medium-light-gray limestone float	8.0	349.3
98. Arenaceous dolomitic mudstone, medium-gray; poor exposure; medium bedded (20–30 cm); 25–30 percent quartz sand; 6–8-cm-thick bedded brownish black chert; bioturbated	3.0	341.3
97. Arenaceous mudstone, dark-gray; poor exposure, mostly covered; thick bedded (30–40 cm); 20 percent quartz sand	5.7	338.3
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
96. Covered interval; moderate-red siltstone float	18.0	332.6
95. Skeletal wackestone, medium-dark-gray; poor exposure; medium bedded (20–30 cm); bioturbated; crinoids, trilobites, brachiopods, and foraminifers	1.5	314.6
94. Skeletal wackestone, medium-gray; poor exposure; thin bedded (argillaceous, 5–15 cm); bioturbated; corals, brachiopods, foraminifers, oncolites, and pellets	2.6	313.1
93. Ooid grainstone, medium-gray; good exposure; resistant ledge; low-angle crossbeds; stylolites; ooids	2.5	310.5
92. Covered interval; medium-gray limestone float	3.4	308.0
91. Oncolite packstone to oncolite grainstone, medium-gray; poor exposure; medium bedded (20–25 cm); bioturbated; crinoids, trilobites, brachiopods, and oncolites	1.7	304.6
90. Covered interval; medium-gray limestone float	6.0	302.9
89. Arenaceous mudstone, medium-gray to brownish-gray; good exposure, resistant ledge; thick bedded (40–50 cm), argillaceous in lower 0.5 m; 30 percent quartz sand; crinoids and trilobites	1.5	296.9
88. Oncolite packstone; dark-gray; fair exposure; thick bedded (50–60 cm); stylolites; crinoids, echinoids, trilobites, brachiopods, foraminifers, bryozoans, oncolites, and pellets	3.1	295.4
87. Covered interval; dark-gray limestone	4.3	292.3
86. Brachiopod packstone, medium-dark-gray; good exposure, resistant ledge; massive; stylolites; minor quartz sand; crinoids, echinoderms, trilobites, brachiopods, foraminifers, bryozoans, and pellets	1.7	288.0
85. Covered interval; medium-gray limestone float	6.4	286.3
84. Brachiopod packstone; medium-dark-gray; good exposure; massive; 40-cm-diameter brownish-black chert nodules; bioturbated; crinoids, echinoids, trilobites, brachiopods, foraminifers, ostracodes, and pellets	0.7	279.9
83. Covered interval; silty, sandy soil	2.8	279.2
82. Arenaceous dolomitic mudstone, light-gray; poor exposure, mostly covered; medium bedded (20–30 cm); 5 percent silt-sized quartz; bioturbated	3.0	276.4
81. Oncolite grainstone, brownish-gray; poor exposure, mostly covered; medium bedded (20–30 cm); stylolites; bioturbated; crinoids, echinoids, trilobites, and oncolites	3.0	273.4
80. Covered interval; silty, sandy soil	4.2	270.4
79. Oncolite grainstone, dark-gray; poor exposure; medium bedded (20–30 cm); minor silt; cherty near top; bioturbated; crinoids and oncolites	4.8	266.2

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
78. Oncolite grainstone, medium-dark-gray; poor exposure, mostly covered; thin bedded (10–15 cm); oncolites	3.0	261.4
77. Oncolite grainstone, brownish-gray; good exposure, resistant ridge former; thick bedded (40–60 cm); bioturbated; gastropods, crinoids, trilobites, brachiopods, and oncolites	2.5	258.4
76. Oncolite grainstone, light-gray; good exposure; thick bedded (45–60 cm); crinoids, echinoids, trilobites, brachiopods, bryozoans, and oncolites	1.9	255.9
75. Covered interval; light-gray limestone float	5.0	254.0
74. Crinoid-oncolite grainstone, light-gray; fair exposure; medium bedded (20–30 cm); minor quartz sand; crinoids, echinoids; trilobites, foraminifers, bryozoans, and oncolites	1.8	249.0
73. Oncolite packstone to oncolite grainstone, light-gray; fair exposure; medium bedded (20–30 cm); minor silt-sized quartz; bioturbated; trilobites, brachiopods, and oncolites	2.0	247.2
72. Oncolite packstone to oncolite grainstone, medium-light-gray; good exposure; medium to thick bedded (25–50 cm); 15–20-cm-diameter brownish-black chert nodules; trilobites, oncolites, and pellets	4.0	245.2
71. Oncolite packstone to oncolite grainstone, light-gray; good exposure; thick bedded (35–50 cm); bioturbated; echinoids, trilobites, brachiopods, pellets, and oncolites	2.4	241.2
70. Trilobite-oncolite packstone, light-gray; poor exposure; thin bedded (argillaceous, 10–15 cm); stylolites; 10–15-cm-diameter brownish-black chert nodules; crinoids, echinoids, trilobites, and oncolites	1.5	238.8
69. Dolomitic wackestone, light-gray; excellent exposure, ridge former; thin to thick bedded (10–40 cm); 5–10 percent quartz sand; trilobites, bryozoans, and oncolites	2.2	237.3
68. Oncolite packstone to oncolite grainstone, light-brownish-gray; poor exposure; medium bedded (20–30 cm); 5–10 percent silt-sized quartz; bioturbated; crinoids, trilobites, brachiopods, ostracodes, oncolites, and pellets	1.6	235.1
67. Oncolite grainstone, brownish-gray; excellent exposure; massive; stylolites; brownish-black bedded chert; bioturbated; gastropods, crinoids, echinoids, trilobites, and oncolites	2.2	233.5
66. Brachiopod-trilobite packstone, medium-light-gray; excellent exposure, resistant ridge former; massive; stylolites; minor silt-sized quartz; pinch-and-swell brownish-black bedded chert; bioturbated; crinoids, echinoids, trilobites, brachiopods, foraminifers, bryozoans, and oncolites	1.8	231.3
65. Crinoid-brachiopod dolomitic packstone, light-gray; poor exposure; medium bedded (20–30 cm); minor silt-sized quartz; brownish-gray chert ribbons and nodules; bioturbated; crinoids, trilobites, brachiopods, oncolites, and lithoclasts	5.5	229.5
64. Oncolite grainstone, medium-light-gray; poor exposure; medium bedded (20–30 cm); cherty toward top; bioturbated; gastropods, crinoids, and oncolites	4.5	224.0
63. Brachiopod wackestone to brachiopod packstone, medium-dark-gray; good exposure, ridge former; thick bedded (40–50 cm); abundant bedded and nodular brownish-gray chert; crinoids, trilobites, brachiopods, and bryozoans	2.2	219.5
62. Brachiopod wackestone to brachiopod packstone, medium-light-gray; good exposure; medium bedded (20–30 cm); 6-cm-thick chert bed in center; corals, brachiopods, and foraminifers	1.3	217.3
61. Arenaceous oncolite packstone, medium-light-gray; excellent exposure, cliff former; thick bedded (40–60 cm); 10 percent quartz sand; brownish-gray bedded and nodular chert in upper 1.0 m; bioturbated; crinoids, brachiopods, oncolites, and pellets	2.8	216.0
60. Oncolite packstone to oncolite grainstone, light-gray; fair exposure, cliff former; medium bedded (25–35 cm); minor silt-sized quartz; crinoids, echinoids, trilobites, brachiopods, oncolites, and pellets	1.7	213.2
59. Skeletal packstone, medium-grey; fair exposure; medium bedded (25–30 cm); abundant bedded chert; rugose corals, crinoids, echinoids, trilobites, brachiopods, foraminifers, and bryozoans	2.5	211.5
58. Oncolite grainstone, medium-light-gray; fair exposure; thick bedded (40–50 cm); crinoids, echinoids, oncolites, and pellets	3.7	209.0
57. Oncolite-bryozoan packstone to oncolite bryozoan grainstone, medium-gray; good exposure; medium to thick bedded (25–50 cm); 6–8-cm-diameter black chert nodules; crinoids, echinoids, bryozoans, oncolites, and pellets	4.5	205.3
56. Oncolite grainstone, medium-light-gray; good exposure; medium to thick bedded (25–50 cm); 6–8-cm-diameter black chert nodules; echinoids, trilobites, and oncolites	4.1	200.8
55. Arenaceous mudstone, medium-gray; poor exposure, mostly covered; thin to medium bedded (5–20 cm, argillaceous in lower 1.0 m); 10–15 percent quartz sand; bioturbated; crinoids and brachiopods	4.3	196.7
54. Brachiopod-bryozoan packstone, light-gray; fair exposure; medium to thick bedded (30–50 cm); 6–10-cm-diameter black chert nodules; crinoids, echinoids, trilobites, brachiopods, and fenestrate bryozoans	3.3	192.4

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
53. Arenaceous oncolite-skeletal packstone, medium-light-gray; fair exposure; thick bedded (40–60 cm); 20–30 percent quartz sand; 4–10-cm-diameter black chert nodules; bioturbated; gastropods, crinoids, trilobites, brachiopods, and oncolites	5.3	189.1
52. Covered interval; medium-gray limestone float	19.2	183.8
51. Oncolite grainstone, light-gray; poor exposure; massive; crinoids, echinoids, trilobites, oncolites, and pellets	1.2	164.3
50. Skeletal packstone to skeletal grainstone, medium-dark-gray; poor exposure, mostly covered; thick bedded (40–50 cm); minor silt-sized quartz; crinoids, echinoids, trilobites, brachiopods, foraminifers, bryozoans, oncolites, and pellets	5.5	163.1
49. Oncolite grainstone, very light gray; fair exposure; thick bedded (50–60 cm); brownish-gray chert nodules near top; crinoids and oncolites	4.5	157.6
48. Covered interval; light-gray limestone float	3.0	153.1
47. Oncolite packstone, very light gray; poor exposure; thick bedded (50–60 cm); 5 percent silt-sized quartz; crinoids, echinoids, trilobites, oncolites, and pelloids	3.0	150.1
46. Skeletal dolomitic packstone, light-gray; fair exposure; thick bedded (50–60 cm); abundant 10–15-cm-diameter brownish-gray chert nodules; extensive silicification and dolomitization; crinoids, foraminifers, bryozoans, and oncolites	5.5	147.1
45. Crinoid grainstone, light-gray; very poor exposure; thick bedded (50–70 cm); minor quartz sand; crinoids, echinoids, trilobites, fenestrate and ramose bryozoans, oncolites, and pellets	4.5	141.6
44. Crinoid grainstone, medium-light-gray; poor exposure; medium to thick bedded (20–50 cm); minor quartz sand; crinoids, echinoids, trilobites, brachiopods, foraminifers, bryozoans, oncolites, and pelloids	3.0	137.1
43. Arenaceous mudstone, medium-light-gray; poor exposure; thin to medium bedded (8–20 cm); 10–15 percent silt-sized quartz; 5–10-cm-diameter brownish-black chert nodules, bioturbated; echinoderms	3.0	134.1
42. Skeletal grainstone, medium-light-gray; poor exposure; medium bedded (10–15 cm); stylolites; bioturbated; gastropods, crinoids, echinoids, trilobites, brachiopods, foraminifers, fenestrate and ramose bryozoans, oncolites, and pelloids	1.8	131.1
41. Arenaceous skeletal wackestone, medium-light-gray to light-brown-gray; good exposure; argillaceous; thin bedded; 10–15 percent silt-sized quartz; 4–8-cm-diameter brownish-black interbedded chert nodules; crinoids, trilobites, brachiopods, and ramose bryozoans	3.5	129.3
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
40. Covered interval; brownish-gray limestone float	3.4	125.8
39. Oncolite grainstone, light-gray; fair exposure; medium bedded (25–30 cm); crinoids, trilobites, fenestrate and ramose bryozoans, oncolites, and pelloids	1.7	122.4
38. Dolomitic mudstone, medium-light-gray; excellent exposure, cliff former; medium bedded (20–30 cm); penecontemporaneous deformation of beds; abundant brownish-black, bedded chert	3.5	120.7
37. Dolomitic mudstone, medium-dark-gray; excellent, cliff former; argillaceous to thin bedded (1–5 cm); thin, interbedded black chert; echinoderms	2.8	117.2
36. Dolomitic brachiopod packstone, grayish-black; poor exposure; massive; extensive dolomitization and silicification; corals, crinoids, and brachiopods	0.4	114.4
35. Skeletal wackestone, medium-gray; fair exposure; medium to thick bedded (25–30 cm); minor silt-sized quartz; abundant brownish-black chert nodules; bioturbated; echinoderms and brachiopods	1.9	114.0
34. Brachiopod-bryozoan wackestone to brachiopod-bryozoan packstone, medium-light-gray to light-brownish gray; poor exposure; medium bedded (10–15 cm); abundant 10–15-cm-diameter brownish-gray chert nodules; crinoids, brachiopods, and fenestrate and ramose bryozoans	2.7	112.1
33. Brachiopod-bryozoan wackestone to brachiopod-bryozoan packstone, medium-dark-gray; poor exposure; medium bedded (10–15 cm); abundant 10–15-cm-diameter brownish-gray chert nodules; brachiopods and fenestrate bryozoans	4.5	109.4
32. Skeletal wackestone, medium-light-gray; poor exposure, mostly covered; thick bedded (40–50 cm); minor silt-sized quartz; abundant 10–15-cm-diameter brownish-gray chert nodules; bioturbated; crinoids, trilobites, brachiopods, foraminifers, bryozoans, oncolites, and pelloids	4.5	104.9
31. Skeletal wackestone, medium-light-gray; excellent exposure, cliff former; thin to medium bedded (5–20 cm); minor silt-sized quartz; brownish-black interbedded chert; penecontemporaneous deformation of beds; bioturbated; corals, crinoids, trilobites, brachiopods, foraminifers, bryozoans, and oncolites	3.2	100.4
30. Covered interval; medium-light-gray limestone float	3.0	97.2
29. Oncolite packstone, light-gray; fair exposure; medium to thick bedded (20–50 cm); 5–10 percent quartz sand; minor black chert nodules; bioturbated; gastropods, crinoids, trilobites, brachiopods, fenestrate bryozoans, oncolites, and pelloids	2.3	94.2

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
28. Arenaceous oncolite packstone, medium-light-gray; fair exposure; massive; 20–25 percent quartz sand; minor 1–5 cm-diameter brownish-black chert nodules in upper 0.5 m; crinoids, trilobites, ramose bryozoans, and oncolites	1.5	91.9
27. Brachiopod-bryozoan wackestone to brachiopod-bryozoan packstone, medium-gray; good exposure, ridge former; massive; 15–20-cm-diameter brownish-black chert nodules; bioturbated; brachiopods, foraminifers, fenestrate bryozoans, and oncolites	1.9	90.4
26. Crinoid-brachiopod packstone, medium-gray; good exposure, ridge former; medium bedded (25–30 cm); 8–10-cm-diameter brownish-black bedded chert and 10–15-cm-diameter black chert nodules; crinoids, trilobites, brachiopods, and bryozoans	3.3	88.5
25. Crinoid packstone, brownish-gray; poor exposure; massive; 10 percent quartz sand; sandy in lower 1.0 m; crinoids, trilobites, and bryozoans	4.0	85.2
24. Spiculitic mudstone, medium-dark-gray; fair exposure; thin to thick bedded (4–15 cm); 5–10 percent silt-sized quartz; minor 6-cm-diameter brownish-black bedded chert and locally abundant 5–8-cm-diameter black chert nodules; bioturbated; sponge spicules	0.5	81.2
23. Arenaceous skeletal wackestone, light-brownish-gray; very poor exposure; medium bedded (25–30 cm); 30 percent quartz sand; 10–15-cm-diameter brownish-gray chert nodules; bioturbated; crinoids and brachiopods	7.5	80.7
22. Arenaceous crinoid packstone, medium-light-gray to light-brownish-gray; fair exposure; massive; 15–20 percent quartz sand; bioturbated; gastropods, crinoids, trilobites, brachiopods, foraminifers, bryozoans, and oncolites	1.5	73.2
21. Calcareous quartzarenite, light-brownish-gray; very poor exposure; medium bedded (20–25 cm); subangular to subrounded grains; well sorted; calcite cement	2.8	71.7
20. Dolomitic crinoid packstone to dolomitic crinoid grainstone, medium-gray; poor exposure; medium bedded (15–20 cm); 10–15-cm-diameter brownish-gray chert nodules; minor silification and dolomitization; crinoids, brachiopods, and fenestrate bryozoans	2.5	68.9
19. Dolomitic crinoid packstone to dolomitic crinoid grainstone, medium-gray to medium-dark-gray; poor exposure; thin bedded (5–15 cm); argillaceous in upper 0.5 m; crinoids, brachiopods, and fenestrate bryozoans	1.5	66.4
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
18. Crinoid packstone to crinoid grainstone, light-gray to light-brownish-gray; very poor exposure; medium bedded (20–30 cm); minor silt-sized quartz; very sandy in upper 1.5 m; 10–15-cm-diameter brown chert nodules; bioturbated; gastropods, coral, crinoids, echinoids, trilobites, brachiopods, and ramose and fenestrate bryozoans	4.5	64.9
17. Quartzarenite, light-brownish-gray; good exposure, resistant ridge former; medium bedded (20–40 cm); subangular to subrounded grains; well sorted; silica cemented	4.2	60.4
16. Covered interval; light-brownish-gray sandstone float	7.5	56.2
15. Arenaceous skeletal wackestone, light-gray; good exposure, resistant ridge former; massive; 40 percent quartz sand; brownish-gray interbedded chert; corals, crinoids, brachiopods, and bryozoans	4.5	48.7
14. Dolomitic crinoid packstone to dolomitic crinoid grainstone, medium-light-gray; poor exposure; medium bedded (15–25 cm); extensive dolomitization; abundant 8–10-cm-diameter brown cherty nodules; numerous tan sandy layers; crinoids	4.0	44.2
13. Crinoid grainstone, medium-light-gray; very poor exposure; thin bedded (5–8 cm); minor silt-sized quartz; bioturbated; gastropods, crinoids, brachiopods, and bryozoans	6.0	40.2
12. Quartzarenite, yellowish-gray; good exposure, resistant ridge former; thick bedded (50–60 cm); subrounded; well sorted; silica cemented	2.1	34.2
11. Skeletal wackestone, medium-light-gray; good exposure, resistant ridge former; medium bedded (25–40 cm); 5-cm-thick brownish-black pinch-and-swell zone; interbedded chert; bioturbated	3.9	32.1
10. Dolomitic crinoid grainstone, light-gray; fair exposure; massive; 5–10 percent quartz sand, minor brown sandy layers; abundant 8–12-cm-diameter brownish-black chert nodules; crinoids and brachiopods	2.2	28.2
9. Covered interval; light-gray limestone float	4.0	26.0
8. Skeletal wackestone, medium-light-gray; poor exposure; medium to thick bedded (20–50 cm); minor silt-sized quartz; 5–10-cm-diameter brownish-black chert nodules; extensive silification; bioturbated; crinoids and the brachiopod *Linoproductus*	2.0	22.0
7. Crinoid grainstone, medium-light-gray; poor exposure; massive; crinoids, trilobites, and brachiopods	1.3	20.0
6. Quartzarenite, light-brownish-gray; very poor exposure; thick bedded (40–60 cm); low-angle crossbedding; subrounded; well sorted; silica cemented	6.5	18.7
5. Covered interval; light-brownish-gray sandstone float	4.5	12.2

	Thickness (meters)	Cumulative thickness (meters)
Bannock Peak Limestone, Type section—Continued		
Bannock Peak unit, Oquirrh Group—Continued		
4. Arenaceous dolomitic skeletal wackestone, light-gray to medium-gray; poor exposure; thick bedded (40–60 cm); 20–30 percent quartz sand; extensive dolomitization and silicification; bioturbated; crinoids, brachiopods, and bryozoans	2.3	7.7
3. Arenaceous crinoid wackestone to arenaceous crinoid packstone, medium-light-gray; poor exposure; thick bedded (40–60 cm); minor 4–8-cm-diameter brownish-black chert nodules; minor tan sandy layers and lenses, 10–15 percent quartz sand; bioturbated; crinoids, trilobites, brachiopods, and fenestrate bryozoans	1.9	5.4
2. Covered interval; medium-light-gray limestone float	1.0	3.5
1. Arenaceous crinoid packstone to arenaceous crinoid wackestone, medium-gray; poor exposure; thick bedded (40–60 cm); 10–15 percent quartz sand; crinoids, trilobites, the brachiopod *Dictyoclostus*, and fenestrate bryozoans	2.5	2.5
Conformable contact		
Manning Canyon Formation		

☆ U.S. GOVERNMENT PRINTING OFFICE: 1994-673-046/86049