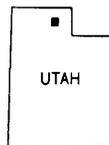


**GEOLOGIC MAP OF THE
HONEYVILLE QUADRANGLE,
BOX ELDER AND CACHE COUNTIES, UTAH**

By Charles G. Oviatt



UTAH GEOLOGICAL AND MINERAL SURVEY

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GEOLOGIC MAP OF THE HONEYVILLE QUADRANGLE, BOX ELDER AND CACHE COUNTIES, UTAH

By Charles G. Oviatt ¹

INTRODUCTION

The Honeyville quadrangle encompasses the northern Wellsville Mountains, which comprise the northern end of the Wasatch Range and include parts of western Cache Valley and eastern Bear River Valley. This area is near the eastern margin of the Basin and Range province in the foreland of the Sevier orogenic belt. Field studies began in September, 1983 as part of the UGMS mapping program and were completed in July, 1985. Field work consisted of mapping on aerial photographs, measuring stratigraphic sections, and collecting fossils and other geologic samples.

Previous mapping in the Honeyville area includes the work of Williams (1948, 1958), Beus (1958), Gelnett (1958), Sprinkel (1976), Doelling (1980), Miller (1980), Davis (1985), and Dover (1985). Of these, Beus's (1958) master's thesis map of the northern Wellsville Mountains has served as the primary basis for my work. Previous stratigraphic works in the area include those of Maxey (1958), Williams and Taylor (1964), and Lindsay (1977).

STRATIGRAPHY

Introduction

Over 14,000 feet (4260 m) of Paleozoic rocks ranging in age from Middle Cambrian to Pennsylvanian, and probably to Early Permian, are exposed in the Honeyville quadrangle. The stratigraphic section is dominated by carbonate rocks deposited in the eastern part of the Cordilleran miogeosyncline, but intervals of clastic sediment are also significant and serve as distinctive marker units. The stratigraphic nomenclature used here follows that of previous workers in this area and surrounding areas. Formation boundaries, as used in this report, differ in some cases from

previous interpretations, and some formations are broken into mappable subunits. Tertiary and Quaternary sediments unconformably overlie the Paleozoic rocks and are divided on the basis of lithology or genesis.

Cambrian System

The oldest rocks exposed in the Honeyville quadrangle are limestones of the Middle Cambrian Bloomington Formation. Following Maxey (1958), the Bloomington is divisible into three members — the lower Hodges Shale, a middle limestone member, and the upper Calls Fort Shale. Only the middle limestone (Cbm) and Calls Fort Shale members (Cbc), totalling over 957 feet (292 m) in thickness, are exposed in the Honeyville quadrangle. The Calls Fort Shale, which contains a large percentage of limestone, has yielded a trilobite fauna indicative of the Middle Cambrian *Bolaspidella* Zone (table 1, plate 2).

Overlying the thin-bedded silty limestones of the Calls Fort are medium- gray to dark-gray sugary dolomites of the lower Nounan Formation (Cnl). The lower Nounan contains abundant oncolites and forms cliffs and crags. The upper Nounan (Cnu) consists of sandy and silty dolomite, dolomitic sandstone, and thin fossiliferous limestone beds. It is a slope former and comprises the upper 545 feet (166 m) of the 1274 feet-thick (388 m) Nounan Formation. Two collections of Late Cambrian trilobites, stratigraphically separated about 280 feet (85 m) in the upper Nounan are representative of the *Crepicephalus* Zone and the ? *Dunderbergia* Zone of the Dresbachian Stage (M.E. Taylor, written communication, 1984). This stratigraphic separation sug-

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gests a possible disconformity in the upper Nounan or a compressed section relative to western Utah sections where the equivalent biostratigraphic interval is 3 to 4 times as thick (M. E. Taylor, written communication, 1984).

The St. Charles Formation is mapped as two units. The lower unit (Csl) includes the Worm Creek Quartzite, 77 feet (23 m) thick, and 100 feet (30 m) of overlying thin-bedded silty limestone. The Worm Creek consists of 3 to 5 feet (1-1.5 m) of white quartzite at the base overlain by about 70 feet (21 m) of sandy dolomite and limestone, and brown shale. Overlying the lower part of the St. Charles are 991 feet (302 m) of dolomite (Csu) ranging from light gray to medium dark gray. Pink chert is common throughout the upper St. Charles and the upper 270 feet (82 m) are relatively silty.

Trilobites in the Worm Creek are indicative of the Late Cambrian *Elvinia* Zone (table 1). Fossils in the upper St. Charles include oncolites and silicified conical plates of *Matthavia* sp. In the Bear River Range, the uppermost part of the St. Charles is Ordovician in age and the St. Charles and Garden City Formations are separated by a disconformity (Taylor and Landing, 1982). Although no direct evidence is available, similar relationships may be present in the Wellsville Mountains (Taylor and Repetski, 1985; Oviatt, 1985).

Ordovician System

A section of limestone, silty limestone, and intraformational limestone conglomerate 1334 feet (406 m) thick of the Garden City Formation (Ogc) overlies the St. Charles and forms cliffs and steep slopes in the southern part of the quadrangle. Limestone in the upper 230 feet (70 m) of the Garden City contains black chert that makes up as much as 50 percent of the volume of some beds (Beus, 1958).

Fossils in the Garden City include asaphid trilobites, brachiopods, graptolites, and gastropods. An orthocone cephalopod (*Buttsoceras williamsi*, table 1) from the upper cherty Garden City is indicative of Zone J or K of Ross (1951).

The Swan Peak Formation (Osp) overlies the Garden City and consists of three distinct lithologic units (Oaks et al., 1977). In the Honeyville quadrangle these are: a lower olive-gray shale member about 160 feet (40 m) thick, a middle member of purple quartzite 50 feet (15 m) thick with fucoidal markings, and an upper (Eureka) member of white quartzite 175 feet (53 m) thick. Fossils in the lower shale include trilobites, orthid brachiopods, orthocone cephalopods, graptolites, and ostracodes. The Swan Peak is Champlainian (Middle Ordovician) in age based on trilobite faunas (Oaks et al., 1977).

Unconformably overlying the Swan Peak are dark-gray dolomite beds of the Fish Haven Dolomite (Ofh), which is 197 feet (60 m) thick. The unconformity at the contact is marked by a few inches of relief on the uppermost quartzite beds of the Swan Peak and by 0.5 - 1 foot (0.15-0.3 m) of sandy bioturbated dolomite at the base of the Fish Haven. A low-angle regional unconformity at this level has been suggested by Oaks et al. (1977). The colonial corals *Haly-sites* sp. and *Favosites* sp., and small rugose corals are abun-

dant in the Fish Haven. The upper 137 feet (41 m) are characterized by light- and dark- gray dolomite beds. Bioturbated beds suggestive of the *Thalassinoides* interval of Sheehan and Schiefelbein (1984) mark the uppermost part of the Fish Haven.

Silurian System

The Silurian System is represented by the Laketown Dolomite, which consists of 1111 feet (338 m) of dark- to light-gray dolomite overlying the Fish Haven. In the Honeyville quadrangle the formation is divided into two mappable units. The lower unit (Sll), which comprises the Tony Grove Lake Member (Budge and Sheehan, 1980), consists of 561 feet (171 m) of medium-gray, finely crystalline dolomite. The upper 60 feet (18 m) of the lower unit contain nodular chert and irregular blobs and stringers of silica. The upper map unit (Slu) consists of 360 feet (109 m) of light-gray sugary dolomite and 190 feet (58 m) of medium- and light-gray crystalline dolomite at the top. The Laketown is characterized by colonial corals (*Halsites* sp.), rugose corals, and silicified brachiopods.

Devonian System

The Devonian System in the Honeyville quadrangle is represented by the Water Canyon, Hyrum, and Beirdneau Formations. The Water Canyon Formation is mapped as three units totalling 1285 feet (392 m) in thickness. The upper two units comprise the Grassy Flat Member, and the lower unit represents the Card Member of Williams and Taylor (1964). My interpretation of the measured section reported by Williams and Taylor (1964, p. 49-50) in the Honeyville quadrangle differs from theirs and thicknesses are revised in this report.

The Card Member (Dwl) consists of light-gray weathering, very fine-grained, laminated dolomite 428 feet (130 m) thick. It is overlain by 403 feet (123 m) of grayish orange-weathering, fine-grained sandstone and interbedded sandy dolomite (Dwm). Some of the sandstones contain fish-bone fragments and gray chert granules. A few thin beds of limestone contain small gastropods. The upper 454 feet (138 m) (Dwu) consist of light-gray to white weathering fine-grained dolomite. Well preserved fish-bone fragments in this unit include pteraspids, arthrodires, and lungfish (table 1).

Williams and Taylor (1964) and Johnson and Murphy (1984) suggested that unconformities occur at the base and the top of the Lower Devonian Water Canyon Formation. No biostratigraphic data were obtained in this study to evaluate this suggestion for Wellsville Mountain.

The top of the Water Canyon is overlain by the lowest dark-gray medium-crystalline dolomite of the Hyrum Formation (Dh). The total thickness of the Hyrum is 490 feet (149 m). Dark-gray dolomite speckled with white calcite-filled vugs, some of which contain quartz crystals, is typical of the Hyrum. A quartzite unit 12 feet (3.6 m) thick about 45 feet (13.7 m) above the base of the formation is cross-bedded and locally conglomeratic. It contains poorly preserved fish-bone fragments (table 1). An upper quartzite,

about 40 feet (12 m) below the top of the formation, is thinner and finer grained. Both quartzite units pinch out in the southern part of the quadrangle.

The Beirdneau Formation (Db) overlies the Hyrum and consists of medium- to light-gray dolomite, interbedded yellowish orange shale, and minor sandy dolomite or dolomitic sandstone. It is 346 feet (105 m) thick near its northern outcrop limit in the central part of the quadrangle but thins to nothing about 3 miles (4.8 km) to the south. The Beirdneau is not present south of Cottonwood Canyon.

Beus (1958) did not distinguish the Beirdneau from the Hyrum in the Wellsville Mountains and he mapped 165 feet (50 m) of dark cherty limestone — which I consider to be part of the Lodgepole Limestone — as the upper part of the Hyrum. Unconformities above and below the Leatham Formation, which occurs between the Beirdneau and the Lodgepole in the Bear River Range (Sandberg and Gutschick, 1979, p. 112), apparently merge into one major unconformity between the Beirdneau and Lodgepole in the Honeyville quadrangle since the Leatham Formation is not present in the Honeyville quadrangle.

Mississippian System

The Mississippian System is represented by the Lodgepole Limestone, Deseret Limestone, Humbug Formation, and Great Blue Formation totalling about 2900 feet (884 m) of rock. The Lodgepole Limestone (Ml) consists of 970 feet (295 m) of medium, dark-gray limestone; the lower and upper parts generally form high cliffs separated by a middle slope-forming part. Black chert is common in the cliff-forming parts. Fossils are abundant and well preserved in the Lodgepole and include well preserved crinoids and crinoid debris, corals, brachiopods, and gastropods (table 1). Conodonts and corals indicate a Kinderhookian to Osagian (Early Mississippian) age. Conodonts collected from 30 feet (9.1 m) above the top of the Beirdneau — from the limestone considered by Beus (1958) as upper Hyrum — are Kinderhookian in age (sample G.W. 84-2, table 1). In addition, this lower limestone is lithologically more similar to the Lodgepole than to the underlying Devonian rocks and is therefore considered part of the Lodgepole Limestone.

Conformably overlying the Lodgepole are 91 feet (28 m) of phosphatic limestone, gray shale, brown-weathering sandstone, and thin-bedded limestone containing abundant, black chert nodules, herein assigned to the Deseret Limestone (Md). The formation forms a slope above the cliffs of the Lodgepole and is mostly covered, but the cherty limestone locally forms ledges or low cliffs. Phosphate is unevenly distributed in the limestone in the lower part of the formation and consists of black coatings on fossil fragments and calcite grains. No pelletal phosphorite has been observed. This sequence is probably correlative with the phosphatic member of the Deseret Limestone or the phosphatic member of rocks equivalent to the Little Flat Formation in the Bear River Range (Sandberg and Gutschick, 1979). The Deseret is late Early to early Late Mis-

Mississippian (Osagian to Meramecian) in age (Sandberg and Gutschick, 1979).

The Humbug Formation (Mh) overlies the Deseret and forms part of a long, steep slope above the cliffs of the Lodgepole. It consists of 820 feet (250 m) of calcareous, dolomitic sandstone, sandy dolomite, and cherty limestone (Lindsay, 1977). In this report I use Lindsay's (1977) careful lithologic descriptions of the Upper Mississippian and lowermost Pennsylvanian rocks, but my interpretations of the section differ from his. The contact between the overlying Great Blue Formation and the Humbug Formation is drawn at the top of Lindsay's unit 14, which is at the top of the uppermost calcareous sandstone unit. Lindsay (1977) placed the contact lower in the section at the top of his unit 6. Corals collected about 56 feet (17 m) below this contact are typical Humbug forms (table 1) and the sandstones in this interval are lithologically similar to the sandstones in the lower Humbug. The Humbug Formation in the Wellsville Mountains is probably correlative to the upper part of the Little Flat equivalent rocks in the Bear River Range (Sandberg and Gutschick, 1979).

The Great Blue Formation is 1025 feet (312 m) thick and divided into two mappable units. The lower Great Blue (Mgl) is 550 feet (167 m) thick and consists of dark- to medium-gray, thin- to thick-bedded limestone. Some beds are oolitic, and fossils, particularly corals, are common throughout. It forms cliffs and ledges or steep slopes.

The upper Great Blue (Mgu) consists of 200 feet (61 m) of interbedded olive-gray shale and medium-gray limestone in the lower part, and about 275 feet (84 m) of cherty limestone in the upper part. The shale makes a convenient marker at the base of the upper member and is probably broadly equivalent to other medial shales in the Great Blue such as the Long Trail Shale in the Oquirrh Mountains (Lindsay, 1977).

Corals and conodonts indicate that the Great Blue is Meramecian to Chesterian (Late Mississippian) in age (table 1). The upper contact of the Great Blue Formation is drawn at the top of Lindsay's (1977) unit 88 below the first calcareous sandstone of the West Canyon Limestone.

Pennsylvanian and Permian (?) Systems

Overlying the Great Blue Formation is a sequence of interbedded cherty limestone, calcareous sandstone, and sandy or silty limestone about 395 feet (120 m) thick (PIPow). It forms ledges and small cliffs above the upper Great Blue cliffs and below the long slopes of the Oquirrh Formation. Lindsay (1977) considered this sequence to be part of the Great Blue Formation (his units 89-118), but it is lithologically distinct from the Great Blue and contains middle Morrowan (upper Lower Pennsylvanian) conodonts in its uppermost beds (table 1). This sequence is most likely equivalent to the West Canyon Limestone of Nygreen (1958). The Manning Canyon Shale, which is known to be present in the Dry Lake area only a few miles to the south (Sadlick, 1955; Sweide, 1977; Dutro, 1979), is missing in the Honeyville quadrangle. This unconformity was noted by Beus (1958, p. 37-38), but its regional significance is still poorly understood.

The Oquirrh Formation (PPo) conformably overlies the West Canyon and consists of interbedded sandstone, sandy limestone, and limestone. The sandstones generally weather yellowish brown or orange and the limestones are light gray. Much of the Oquirrh section is covered with thin colluvium, especially on the east side of the Wellsville Mountains, making it difficult to determine its lithologic character and true thickness.

Beus (1958) estimated a total of 6600 feet (2012 m) of Oquirrh, and Bissel (1962) reported 6100 feet (1859 m) of Oquirrh plus 160 feet (49 m) of Permian Kirkman Limestone above the Oquirrh Formation on the north end of the mountains. Previously unrecognized faults on the east side of the mountains, however, make these estimates probably too large. The Oquirrh Formation is 2588 feet (789 m) thick on the western slope and an estimated maximum additional 2000 feet (610 m) may be present on the eastern slope of the mountains.

The youngest fusulinids collected from Oquirrh Formation outcrops occur about 1800 feet (550 m) above the base of the formation and are Virgilian in age (sample F14700, table 1). Therefore, the estimated 2700 feet (823 m) of sandstone and interbedded limestone above these fossils is likely to be at least partly Permian in age. A sandstone pebble collected from upper Tertiary gravels on the north end of the Wellsville Mountains (sample F14693, table 1) contains Early Permian fusulinids. This pebble, and the associated clasts in the Tertiary gravel deposits, are probably locally derived but have not been traced to fossiliferous Oquirrh outcrops. The 2700 feet (823 m) of Wolfcampian-age Oquirrh and the Kirkman Limestone reported by Bissel (1962) have not been confirmed.

Tertiary System

Tertiary deposits in the Honeyville quadrangle are divided into two gravel units and one lacustrine unit. The Tertiary deposits are poorly exposed, are cut by many minor faults, and have undergone considerable mass-wasting deformation, making it difficult to define contacts between units and virtually impossible to measure sections in the deposits. Despite these uncertainties, broad outcrop patterns can be delineated and stratigraphic relationships can be inferred.

The oldest Tertiary unit (Tg_2) is a gravel composed of rounded to subangular pebbles, cobbles, and boulders of sandstone, limestone, and chert, all apparently locally derived from the Oquirrh Formation. In rare outcrops, Tg_2 has a calcite cement and locally is stained red with iron oxide. It is distinguished from the younger gravel unit (Tg_1) lithologically and texturally, although exposures are poor where they are in contact and they appear to be gradational. Tg_1 is generally coarser grained, its clasts are generally more rounded, and clasts having unknown source areas are common. The most distinctive exotic clasts are well-rounded, light-colored pebbles, cobbles, and boulders of porphyritic rhyolite or rhyodacite. Thin-section and hand-specimen descriptions of the rhyolite (M.A. Siders, UGMS, written communication, 1984) do not match those

from any known outcrops of volcanic rocks in this area (D.W. Fiesinger, USU Geology Dept., oral communication, 1984). Other exotic clasts include large, well-rounded boulders and cobbles of brown chert and tan sandstone.

Tg_2 overlies the Oquirrh Formation, in places occurring as isolated patches of gravel on ridge crests. Tg_1 overlies both the Oquirrh Formation and Tg_2 , and it also overlies and intertongues with lacustrine limestone, marl, claystone, and volcanic ash mapped collectively as Tl. Tl overlies the older gravel unit (Tg_2) and apparently also interfingers with it. All three of these units are regarded as late Tertiary in age on the basis of the following arguments.

Previous workers (Williams, 1948; Adamson, 1955; Adamson, Hardy, and Williams, 1955; Beus, 1958; and Sprinkel, 1976) also have mapped two Tertiary gravel units in the Wellsville Mountains; however, the units were defined differently. Some of the red iron-stained gravels were previously mapped as part of the Wasatch Formation and all other gravels were regarded as the Collinston conglomerate of the Salt Lake Group (Adamson, Hardy, and Williams, 1955). These usages are abandoned in this report for the following reasons: (1) The "Wasatch" gravels in the past were distinguished on the basis of their redness, yet, when examined carefully, the red gravels are lithologically indistinguishable from gravels previously mapped as "Collinston" but which are not red. In addition, some of the gravels previously mapped as "Collinston" are red. Thus, the redness has been inconsistently applied as a mapping criterion. (2) There is no evidence that any of the gravel deposits in the Wellsville Mountains are Eocene in age, as is the Wasatch. Because the gravel deposits previously mapped as Wasatch are lithologically similar to gravels that interfinger with lacustrine deposits (Tl) known to be late Tertiary in age in the Cutler Dam quadrangle to the north, it is more reasonable to regard all of the gravel deposits as late Tertiary in age. (3) The Honeyville quadrangle includes much of the type area of the Collinston conglomerate, which has been regarded as the basal gravel of the Salt Lake Group (Adamson, Hardy, and Williams, 1955). However, gravels previously mapped as Collinston (Tg_1) both *overlie* and *interfinge* with late Tertiary lacustrine deposits (Tl) that were previously mapped as the Cache Valley Formation of the Salt Lake Group (Adamson, Hardy, and Williams, 1955). Tg_1 gravels can be seen overlying Tl deposits in many localities, including the E 1/2 sec. 35, T. 12 N., R. 2 W., where Tl beds exposed along ridge crests dip beneath Tg_1 gravels exposed higher on the slope.

Therefore, the stratigraphic terms Wasatch, Collinston, Cache Valley, and Salt Lake are avoided in this report, and descriptive or genetic map units are used for the Tertiary deposits. Tg_2 includes deposits previously mapped as Wasatch, and part of what has been previously mapped as Collinston. Tg_1 includes part of what has been previously mapped as Collinston. Tl is essentially equivalent to the Cache Valley Formation, although my interpretation of its stratigraphic relationships with the gravel units differs from previous interpretations.

Two small disjunct outcrops of locally derived Tertiary

fan gravels (Tgf) occur on the west side of the Wellsville Mountains, one near Chocolate Peak, and one about 2 miles east of Crystal Springs. Blocks of Oquirrh Formation (PPos) and Lodgepole Limestone (Mls) mapped west of the mountain front near Crystal Springs, and a mass of brecciated Oquirrh Formation (PPob) south of Big Canyon, are parts of a massive rock slide of Tertiary age (see further discussion below).

Quaternary System

Quaternary surficial deposits in the Honeyville quadrangle are of alluvial, lacustrine, mass-wasting, and glacial origin. In most cases, the deposits can be assigned ages relative to Lake Bonneville history. The oldest are pre-Bonneville and at least middle Pleistocene in age, and consist of alluvial-fan gravels (Qaf₂) that form dissected benches on the foot-wall side of the Wasatch fault northeast of Honeyville. Qaf₂ also occurs as faulted alluvial fans and gravel deposits overlying Tertiary deposits east of the mountains. Younger alluvial fans (Qaf₁) were deposited in post-Bonneville time and are active today at the mouths of major canyons. Alluvial channel gravels (Qag) of the Bear River were deposited during the regressive phase of Lake Bonneville.

A large area east of Crystal Springs is mapped as undifferentiated pre-Bonneville alluvium, Bonneville lacustrine gravel, and post-Bonneville alluvium (Qla). Thick lacustrine gravel deposits (Qlg) are mapped along the mountain front and probably were deposited mostly during the Bonneville lacustrine cycle (25,000 - 12,000 yr B.P.). Thin lacustrine deposits (Qlu) reworked from the underlying Tertiary rocks east of the mountains are undifferentiated in terms of texture and age. The youngest deposits in the quadrangle consist of Holocene alluvium (Qal) and ox-bow lake deposits (Qab) along the Bear River and smaller streams.

Fine-grained deposits of two major late Pleistocene lacustrine cycles are exposed along the Bear River and are mapped together as Qls₂. The older deposits are referred to as the "alloformation of Cutler Dam" and consist of organic-rich muds and interbedded sand that bear a moderately to strongly developed buried soil (the "geosol of Fielding"). They are overlain by fine-grained sediments of the Bonneville Alloformation (Correlation chart, plate 2). A radiocarbon date of 28,180 ± 1120 yr B.P. (Beta-9483) on the organic fraction of mud from the "alloformation of Cutler Dam" is considered unreliable for two reasons: (1) Lake Bonneville was at a very low stage 28,000 yr B.P. (Currey and Oviatt, 1985); and (2) a radiocarbon date on wood from the "alloformation of Cutler Dam" in the Cutler Dam quadrangle is greater than 36,000 yr B.P. (Beta-9845). The organic-rich mud sample (Beta-9483) must have been contaminated with young organic carbon. Based on data collected primarily in the Cutler dam quadrangle (amino-acid analyses, buried-soil development, and radiocarbon date Beta-9845), the "alloformation of Cutler Dam" was deposited in early to middle Wisconsin time in a lake that rose no higher than 4400 feet in altitude (Oviatt et al., 1985).

A relatively complete stratigraphic record of Lake Bonneville (approximately 25,000 to 12,000 yr B.P.) is exposed in section A. A radiocarbon date on wood from this section of 19,580 ± 290 yr B.P. (Beta-8093), and ostracode correlations with Great Salt Lake sediment cores (R. M. Forester, written communication, 1984), show that the upper part of Qls₂ was deposited during the Bonneville cycle. The flat floor of the Bear River Valley is the result of bottom sedimentation in Lake Bonneville, and the Bear River was rapidly entrenched below this surface as the lake dropped to a low level approximately 12,000 yr B.P. (Currey and Oviatt, 1985).

Remnants of a low terrace along the Bear River (Qls₁) bear a surficial soil comparable in degree of development to the soil developed on the Bonneville Alloformation. The sediments underlying the terrace remnants consist of a basal gravel overlain by a variable thickness of well sorted to silty sand, and the surface altitude of the terrace remnants is consistently 4245 to 4250 feet (1294-1295 m). The sediments underlying this terrace were probably deposited during the Gilbert stage of Lake Bonneville (about 11,000 to 10,000 yr B.P., Currey and Oviatt, 1985), when a narrow estuary of the Gilbert lake extended up the entrenched Bear River at an altitude of 4250 feet (1295 m). A radiocarbon date of 7460 ± 250 yr B.P. (Beta-13153) on gastropods collected from ox-bow lake deposits that interfinger with the Gilbert-terrace sands in the Cutler Dam quadrangle is interpreted as a minimum-limiting date on the Gilbert stage (Oviatt, 1986).

Pleistocene glaciers occupied shallow cirques in the Wellsville Mountains at the heads of Jim May, Shumway, Brushy, and Pine Canyons and extended a short distance down these valleys. However, end moraines are not preserved and down-valley limits must be inferred from the patchy distribution of till (Qgt) and from the morphology of the valleys. Colluvium and avalanche-debris deposits (Qcu) in many canyons were apparently interpreted as till by Church (1943), who also suggested that the Pine Canyon glacier, and possibly the Shumway Canyon Glacier, reached as low as the Bonneville shoreline. However, glaciers probably did not reach altitudes below about 6000 feet (1830 m) on the east side of the mountains.

Nivation deposits (Qmn) occur in a hollow west of Wellsville Cone and indicate perennial snow, probably in the late Pleistocene. Avalanching was probably a significant geomorphic process during Pleistocene glaciations and is an important depositional process in the mountain valleys today.

Other surficial deposits in the quadrangle include lateral spreads in lacustrine gravels (Qml), landslides in the Tertiary deposits (Qms), and talus accumulations below cliffs (Qmt).

STRUCTURE

The Honeyville quadrangle is located within the foreland of the Sevier orogenic belt and in the eastern Basin and Range Province, and it contains structures typical of both tectonic belts/provinces. Tertiary extensional faults cross-cut and displace the older thrust-related structures.

The Paleozoic rocks generally dip 25-60° northeast in the Wellsville Mountain homocline, which is the northern extension of the eastern limb of the Absaroka ramp-anticline (Smith and Bruhn, 1984; Oviatt, 1985). This homocline is cut by a series of northeast-trending strike-slip faults of small separation, which are interpreted as tear faults associated with Mesozoic thrusting (Williams, 1948; Beus, 1958; Oviatt, 1985). The tear faults dip to the south at high angles and die out upsection.

An inferred thrust fault, herein referred to as the Wellsville thrust fault, places rocks of the Oquirrh Formation over limestone of the Great Blue and West Canyon Formations in the Chocolate Peak area (Oviatt, 1985). This interpretation of the structural geology of the Chocolate Peak area differs from the interpretations of Sprinkel (1979), who called for thrusting of what he regarded as Lodgepole Limestone over the Oquirrh, then reversed movement along the thrust fault in the Wasatch fault zone. However, the limestone in question contains corals typical of the Great Blue (locality 25, table 1) rather than Lodgepole. In addition, the dips of the carboniferous rocks swing from the northeast (the Wellsville Mountain homocline) to the northwest in the area southeast of Deweyville around a steeply north-plunging anticline that may be a lateral ramp-anticline associated with the Wellsville thrust (Oviatt, 1985).

Extensional faults include both low- to moderate-angle normal faults within the Wellsville Mountains structural block and the Wasatch and west Cache fault zones, which bound the mountains on the west and east, respectively. A major west-dipping normal fault has displacement parallel to its dip, as shown by striae on the fault plane, of almost 2000 feet (610 m) and shows 300 to 400 feet (91-122 m) of topographic relief along the crest of the mountains directly west of Mendon Peak. This fault is referred to herein as the Big Canyon fault. Northeast of Honeyville another west-dipping normal fault, which may be trough-shaped, is referred to as the Two Jump Canyon fault. Other low-angle faults create a complex pattern of fault traces east and south of Box Elder Peak and Wellsville Cone. The dips on all these normal faults range from about 50° for the Big Canyon and Two Jump Canyon faults to 35° or less for the faults near Box Elder Peak and Wellsville Cone.

A major reentrant in the Wellsville Mountains, herein referred to as the Coldwater Canyon reentrant, lies directly east of a rounded sloping bench (the Madsen spur) that extends westward from the mountain front to Crystal Springs. The Madsen spur is underlain over most of its area by Quaternary alluvial and lacustrine deposits, but near Crystal Springs small outcrops of limestone and sandstone of the Oquirrh Formation (PPos) are exposed. A few small outcrops of Lodgepole Limestone (Mls) protrude through the alluvial cover closer to the mountains.

I interpret the Madsen spur as the smoothed topographic expression of an enormous rockslide that slid off the west face of the Wellsville Mountains and thus formed the Coldwater Canyon reentrant. In this interpretation, the Big Canyon and Two Jump Canyon faults are parts of a single fault zone (section B-B') which formed the glide plane for the rockslide. The rockslide is part of the hanging wall of the Big Canyon - Two Jump Canyon fault which broke

loose from the mountains between weak zones along two tear faults and slid westward into the Bear River Valley. The tear faults were weak zones in the hanging wall and served as glide surfaces during the slide.

A complexly faulted and brecciated mass of Oquirrh Formation and associated Mississippian and Devonian rocks between Big Canyon and Limekiln Canyon (PPob) is interpreted as a remnant of the rockslide preserved in the reentrant. The remnant is capped by locally derived fanglomerate (Tgf) of probable late Tertiary age.

The Wasatch fault curves eastward north of Honeyville following the Coldwater Canyon reentrant, and this change in direction of the fault trend is considered by Personius (1986) to mark the northern end of the Brigham City segment of the Wasatch fault. Middle to late Quaternary surface rupture on the Wasatch fault in this area (Personius, 1985) has occurred close to the presumed subsurface trace of the Two Jump Canyon - Big Canyon fault zone. Therefore, the Wasatch fault has stepped to the east to this parallel fault zone along the zones of weakness parallel to the two tear faults, which also formed the lateral boundaries of the rockslide.

The west Cache and Wasatch fault zones are the youngest structural features in the quadrangle. The north-striking Collinston segment of the Wasatch fault (Schwartz and Coppersmith, 1984) cuts all older fault systems including the low- to moderate-angle west-dipping normal faults within the mountain block. Dips on fault planes in the Wasatch fault zone are between 25 and 50° west and striae indicate movement roughly parallel to the dip direction. The Wasatch fault offsets middle to late Pleistocene alluvial deposits (Qat₂); the youngest scarp in this area is in Provo or post-Provo alluvium east of Honeyville where total offset is 13 feet (4 m; Personius, 1985). A northwest-trending fault in the valley fill northwest of Honeyville is inferred from gravity data (Peterson, 1974) and is presumed to be normal.

The west Cache fault has a well defined, sinuous north-trending trace on the east side of the mountains where it marks the sharp boundary between the Oquirrh Formation dip slopes and the Tertiary and Quaternary deposits. The fault dips to the east and is roughly parallel to the strike of the bedding in the Oquirrh Formation. It crosses the bedding, however, in the reentrant between Bird Canyon and Coldwater Lake. Middle to late Pleistocene alluvial-fan deposits (Qat₂) at the mouth of Deep Canyon are offset approximately 50 feet (15 m) by the west Cache fault where it diverges from the mountain front. North of Deep Canyon the fault cannot be mapped as a single fault trace but merges with a wide zone of landslide scarps and short fault traces in the Tertiary deposits.

The area directly east of Coldwater Lake is a graben, however, the main antithetic fault on the east side of the graben is east of the Honeyville quadrangle boundary. Many short discontinuous faults having small displacements cut the Quaternary alluvial deposits east of the mountains and are considered part of the west Cache fault zone. Similar small faults are inferred in the Tertiary deposits in the northern part of the quadrangle but are too numerous and poorly exposed to show on the geologic map.

ECONOMIC GEOLOGY

Sand and gravel are probably the most significant economic deposits in the Honeyville quadrangle. Gravel pits in Quaternary lacustrine gravel deposits (Qlg) at Honeyville and north of Deweyville are the largest operations in the quadrangle although there are many smaller pits scattered about, mostly in the lacustrine deposits. Any of the deposits of Qlg in the map area, and some alluvial-fan deposits, are potential future sand and gravel sources.

Limestone from the lower Great Blue Formation, where it intersects the mountain front south of Deweyville, has been quarried for use in the sugar-beet industry (Doelling, 1980, p. 230). There are huge reserves of Great Blue limestone at this locality that are a potential resource. Several small quarries in the lower Great Blue crop out northeast of Deweyville and supplied limestone to a small limekiln that is now abandoned. The limestone reserves at this locality are difficult to estimate because exposures are poor and the geology is complicated by the Wellsville thrust fault. Limestone was supplied to another abandoned limekiln south of Honeyville from pits in adjacent Quaternary gravel deposits (Qlg and Qaf₁) that contain predominantly carbonate clasts.

Other than calcite veins and local minor oxidation, no mineralization has been observed in the Honeyville quadrangle. A single prospect pit on Chocolate Peak exposes oxidized breccia of Oquirrh Formation.

No petroleum wells have been drilled in the Honeyville quadrangle and a geothermal well to TD 11,000 feet (3352 m) drilled 1.5 miles (2.4 km) directly south of the quadrangle by Geothermal Kinetics in 1974 was unsuccessful.

Crystal Springs is operated as a recreational facility and consists of hot (54°C) and cool (20°C) springs, the waters of which are mixed before being pumped into the pools (Murphy and Gwynn, 1979). Felmler and Cadigan (1978) estimate from the concentrations of radium and uranium in the thermal water at Crystal Springs that at least 5200 metric tons of uranium, possibly in economic concentrations, is present somewhere along the flow path of the thermal water.

GEOLOGIC HAZARDS

Geologic hazards in the Honeyville quadrangle consist of various kinds of mass movements and of potential seismic hazards. The Tertiary deposits in the northern part of the area (Tg₁, Tg₂, Tl) have undergone extensive mass-wasting deformation, possibly during Pleistocene glacial episodes, and are presently subject to slumping and sliding on a small scale. Small slumps and mud flows occur along the bluffs of the Bear River where perched ground water discharges along sand beds and where the Bear River has undercut the steep slopes. The slumps along the Bear River were especially active during the wet years of 1983 and 1984.

Landslides in lacustrine gravels along the western mountain front are interpreted as lateral spreads. The lateral spread at Honeyville has faint shorelines developed on it below about 4440 feet (1353 m) (Qlu/Qml) but not above this level (Qml), suggesting that the material spread out into Lake Bonneville during the regressive phase of the

lake. The lateral spreads near Crystal Springs and north of Deweyville had a similar history. They all may have formed in response to ground shaking during an earthquake that would have occurred between 13,000 and 12,000 yr B.P., but because they are old features and are composed of gravel they are not geologic hazards at present.

Snow avalanches that carry rock and vegetal debris are common in steep canyons during the winter and early spring. The hazard zone for avalanches extends beyond the mouths of canyons, especially on the east side of the Wellsville Mountains where debris cones covered with flattened trees, tree trunks, and rock debris provide evidence of frequent, destructive avalanches.

Alluvial fan deposits on the west side of the Wellsville Mountains, especially at the mouths of major canyons, contain a large debris-flow component. Most of these debris flows probably occur during heavy thunderstorms and are potential hazards near the mouths of canyons.

A major, potential geologic hazard that affects the entire Honeyville quadrangle area is the earthquake hazard associated with the Wasatch and west Cache fault zones. The Wasatch fault has been active in the quadrangle in post-Provo time as shown by the 13-foot (4-m) scarp in alluvium east of Honeyville (Personius, 1985). The west Cache fault zone has had surface rupture in post-Provo time in the Cutler Dam quadrangle (Oviatt, 1986). Liquefaction in alluvium (Qal) along the Bear River, and possibly in Qls₁ and Qls₂, is a potential hazard during earthquakes. Rock fall from cliffs along the mountain front would also be a hazard during earthquakes.

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TABLE 1

PALEONTOLOGICAL DATA FOR THE HONEYVILLE QUADRANGLE								
Map Location	Field Number	USGS Collection Number	Stratigraphic Unit	Fossil Age	Date of Report	Paleontologist	Faunal Description	Latitude Longitude
1	H217	F14695	pebble from Tertiary gravels (T ₂)	Early Permian	4/29/85	R. C. Douglass, USGS	This sample contains some silicified fusulinids that represent <u>Schwagerina</u> sp. of Early Permian age.	41° 43.02' 112° 2.66'
2	H99	F14693	cobble from Tertiary gravels (T ₂)	Late Pennsylvanian (Virgilian)	4/29/85	R. C. Douglass, USGS	This sample contains the small forams <u>Tetrataxis</u> sp., <u>Bradyina</u> sp., and <u>Climacammina</u> sp. and the fusulinid <u>Triticites</u> sp. aff. <u>T. cullomensis</u> . A Late Pennsylvanian (Virgilian) age is suggested.	41° 40.28' 112° 0.06'
3	Po 22.9.0	F14700	Oquirrh Formation	Late Pennsylvanian (Virgilian)	4/29/85	R. C. Douglass, USGS	This sample contains silicified fusulinids and abundant other fossil debris including the smaller forams <u>Tetrataxis</u> sp., <u>Bradyina</u> sp., and <u>Climacammina</u> sp. <u>Triticites</u> sp. aff. <u>T. cullomensis</u> is tentatively identified and suggests a Virgilian (Late Pennsylvanian) age.	41° 41.64' 112° 3.11'
4	Fu5	F14689	Oquirrh Formation	Late Pennsylvanian (Missourian or Virgilian)	4/29/85	R. C. Douglass, USGS	This sample contains the smaller forams <u>Tetrataxis</u> sp. and <u>Bradyina</u> sp. and fusulinids that probably represent <u>Pseudofusulinella</u> sp. The form present is transitional between <u>Eowaeringella</u> and <u>Pseudofusulinella</u> but is probably evolved enough to be called <u>Pseudofusulinella</u> . The age is Late Pennsylvanian but I'm not sure whether it is Missourian or Virgilian.	41° 39.80' 112° 0.20'
5	Po 15.23.0 Po 15.25.0	F14698A F14698B	Oquirrh Formation	late Pennsylvanian (early Missourian)	4/29/85	R. C. Douglass, USGS	These samples contain abundant fusulinids of the genus <u>Eowaeringella</u> that resemble those I illustrated from the Bingham Mine Formation of Jericho Pidge in the East Tintic Mountains. These forms are characteristic of early Missourian (Late Pennsylvanian) age.	41° 41.60' 112° 3.23'
6	Po 19.21.0	F14699	Oquirrh Formation	Late Pennsylvanian (Missourian)	4/29/85	R. C. Douglass, USGS	This sample contains a small <u>Triticites</u> sp. similar to those I illustrated from the Bingham Mine Formation. They suggest a Missourian age.	41° 41.62' 112° 3.17'
7	Fu0	F14684	Oquirrh Formation	Late Pennsylvanian (early Missourian)	4/29/85	R. C. Douglass, USGS	This sample contains <u>Eowaeringella</u> sp. and is of approximately the same age as samples F14698A & B.	41° 38.65' 112° 0.77'
8	Fu1	F14685	Oquirrh Formation	Missourian (Late Pennsylvanian)	4/29/84	R. C. Douglass, USGS	This sample contains the smaller forams <u>Tetrataxis</u> and <u>Climacammina</u> and the fusulinid <u>Eowaeringella</u> sp. and again suggests a Missourian age.	41° 39.82' 112° 0.11'
9	Fu2	F14686	Oquirrh Formation	Missourian (Late Pennsylvanian)	4/29/85	R. C. Douglass, USGS	This sample contains the small foram <u>Bradyina</u> sp. and the fusulinid <u>Eowaeringella</u> sp. and suggests a Missourian age.	41° 39.82' 112° 1.11'
10	Fu3	F14687	Oquirrh Formation	Missourian (Late Pennsylvanian)	4/29/85	R. C. Douglass, USGS	The preservation in this sample makes positive identification difficult but the fusulinids seem to represent <u>Eowaeringella</u> sp. of Missourian age.	41° 40.01' 112° 1.30'
11	Fu4	F14688	Oquirrh Formation	Missourian (Late Pennsylvanian)	4/29/85	R. C. Douglass, USGS	This sample contains well preserved specimens of <u>Eowaeringella</u> sp. of Missourian age.	41° 39.92' 112° 1.22'
12	Fu8	F14692	Oquirrh Formation	Missourian (Late Pennsylvanian)	4/29/85	R. C. Douglass, USGS	The sample contains specimens resembling <u>Eowaeringella powowensis</u> Stewart from the Missourian of western Texas.	41° 40.94' 112° 2.08'
13	H235	F14696	Oquirrh Formation	Missourian (Late Pennsylvanian)	4/29/85	R. C. Douglass, USGS	This sample contains <u>Triticites</u> sp. of Missourian age.	41° 41.16' 112° 2.54'
14	H192	F14694	brecciated Oquirrh Formation	Missourian (Late Pennsylvanian)	4/29/85	R. C. Douglass, USGS	This sample contains specimens of <u>Triticites</u> sp. of Missourian age.	41° 40.21' 112° 3.04'
15	PO 1.50.0	F14097	Oquirrh Formation	Middle Pennsylvanian (Desmoinesian)	4/29/85	R. C. Douglass, USGS	The form present is probably <u>Wedekindellina</u> sp. suggesting a Middle Pennsylvanian (Desmoinesian) age.	41° 41.55' 112° 3.42'
16	H253	29545-PC	Oquirrh Formation	post-Atokan, probably Virgilian (Late Pennsylvanian)	2/19/85	W. J. Sando, USGS	Corals: <u>Heintzella?</u> sp. (1) <u>Neosyringopora</u> morphogroup A (1) fusulinids, undet.	41° 41.25' 112° 39.14'
17	Po 11.65.0	29546-PC	Oquirrh Formation	post-Morrowan (Pennsylvanian)	2/19/85	W. J. Sando, USGS	Corals: <u>Multithecopora</u> morphogroup C (1) <u>Pseudozaphrentooides</u> sp. (8) Comment on H253 and Po 11.65.0: Both collections contain genera that are common in Pennsylvanian rocks and range into the Permian. The low diversity of the assemblages and the lack of genera having a narrow stratigraphic range make exact age diagnosis difficult.	41° 41.59' 112° 3.26'

TABLE 1 continued

Map Location	Field Number	USGS Collection Number	Stratigraphic Unit	Fossil Age	Date of Report	Paleontologist	Faunal Description	Latitude Longitude
18	H233	29386-PC	top of West Canyon Limestone	late Early Pennsylvanian	12/8/84	A. G. Harris, USGS	Conodonts: <u>Idiognathodus sinuosis</u> Ellison & Graves 5 Pa elements <u>Neognathodus bassleri</u> (Harris & Hollingsworth) 5 Pa elements 7 indet. bar, blade, and platform fragments 6 ichthyoliths The co-occurrence of these two species restricts the age of this collection to the <u>Idiognathodus sinuosis</u> Zone (middle Morrowan; late Early Pennsylvanian)	41° 41.53' 112° 3.47'
19	H232	29385-PC	top of upper Great Blue Formation	Late Mississippian	12/8/84	A. G. Harris, USGS	Conodonts: <u>Cavusognathus altus</u> Harris & Hollingsworth 6 Pa, 3 PB, 3 M, 1 Sb, and 2 Sc elements <u>Hindeodus</u> cf. <u>H. cristulus</u> (Miller & Youngquist) 2 Pa, 2 M, 1 Sb, and 1 Sc elements 21 indet. bar, blade, and platform fragments 18 ichthyoliths This is a very shallow water species association that indicates a middle Meramec to late (but not latest) Chester age.	41° 41.32' 112° 3.39'
20	T82-48b (collected by T. E. Jordan)	28684-PC	upper Great Blue Formation	Late Mississippian (Coral Zone IV; Chesterian)	10/25/82	W. J. Sando, USGS	Corals: <u>Siphonophyllia</u> cf. <u>S. nevadensis</u> (Meek) The coral genus represented here is the principle index to the K Zone in the coral zonation of Sando, Mamet, and Dutro (1969). This is Zone IV of the new coral zonation for the Western Interior Province (Sando and Ramber, 1979). These corals are common in the upper part of the Great Blue Limestone. They do not occur in the Manning Canyon Shale.	41° 40.95' 112° 3.00'
21	H213	----	upper Great Blue Formation	Chesterian	6/3/85	R. Lund, Adelphi Univ.	Fish teeth: 1. cochliodont: <u>Deltodus rhomboideus</u> 2. cochliodont: <u>Antilodus arcuatus</u> 3. cochliodont: <u>Antilodus arcuatus</u> 4. cochliodont: <u>Antilodus arcuatus</u> 5. <u>Venustodus argutus</u> 6. cochliodont: cf. <u>Vaticinodus</u> 7. cochliodont: cf. <u>Vaticinodus</u> 6. and 7. are probably upper plates of <u>D. rhomboideus</u> 8. <u>Tanaodus</u> sp. cf. <u>T. sculptui</u> 9. [<u>Helodus</u>] <u>Psephodus rugosus</u> 10. <u>Venustodus</u> cf. <u>V. argutus</u> 11. indetem. frag., cochliodont 12. Petalodont frag. <u>Antilodus arcuatus</u> 13. ? Cladodont, cusp of tooth 14. <u>Chomatodus linearis</u>	41° 38.74' 112° 0.95'
22	H195-H199	----	upper Great Blue Formation	Mississippian	7/20/84	R. Lund, Adelphi Univ.	Fish teeth: Cochliodont tooth plate, Bradyodont (Holocephali, Cochliodontiformes) <u>Cladodus robustus</u> , teeth (?Elasmobranchii, Cladodontiformes) lovely tooth whorl, probably the left anterior of a Cochliodont <u>Chomatodus linearis</u> , tooth (Holocephali, cf. Helodontiformes)	41° 39.58' 112° 1.55'
23	H208	----	upper Great Blue Formation	Mississippian	7/20/84	R. Lund, Adelphi Univ.	Fish tooth: <u>Psephodus</u> SP., tooth (Holocephali, presumed Helodont)	41° 41.30' 112° 3.43'
24	H231	29384-PC	top of lower Great Blue Formation	Late Mississippian	12/8/84	A. G. Harris, USGS	Conodonts: <u>Cavusognathus altus</u> Harris & Hollingsworth 1 Pa, 1 Sa, and 2 Sc elements <u>Hindeodus</u> sp. indet. 1 Pa fragment and 3 S elements 1 Sc element 25 indet. bar, blade, and platform fragments 40 ichthyoliths This is a very shallow water species association that indicates a middle Meramec to late (but not latest) Chester age.	41° 41.29' 112° 3.53'
25	H193	29358-PC	lower Great Blue Formation	Late Mississippian (Coral Zone IV; late Meramecian)	10/30/84	W. J. Sando, USGS	Corals: <u>Faberophyllum</u> sp. (11) <u>Pleuroisiphonella morphogroup B</u> (1) <u>Pseudodorlodotia</u> sp. (3 fragments) Confirms Great Blue identification.	41° 43.53' 112° 4.93'

TABLE 1 continued

Map Location	Field Number	USGS Collection Number	Stratigraphic Unit	Fossil Age	Date of Report	Paleontologist	Faunal Description	Latitude Longitude
26	H220	29359-PC	lower Great Blue Formation	Late Mississippian (Coral Zone IV; late Meramecian)	10/30/84	W. J. Sando, USGS	Corals: <i>Faberophyllum</i> sp. (11) Confirms Great Blue identification	41° 38.62' 112° 1.10'
27	H250	29363-PC	lower Great Blue Formation	Late Mississippian	10/30/84	W. J. Sando, USGS	Corals: <i>Siphonodendron</i> cf. <i>S. whitneyi</i> Meek coral Zone IIID (middle Meramecian), or IV (upper Meramecian), probably the latter. Confirms Great Blue identification.	41° 41.25' 112° 3.61'
28	H251	29364-PC	lower Great Blue Formation	Late Mississippian	10/30/84	W. J. Sando, USGS	Corals: <i>Faberophyllum</i> sp. <i>Pleurosiphonella</i> morphogroup B coral Zone IV (upper Meramecian). Confirms Great Blue identification	41° 41.27' 112° 3.58'
29	H249	29362-PC	Humbug Formation	Late Mississippian	10/30/84	W. J. Sando, USGS	Corals: <i>Ekvasophyllum</i> lg. sp. <i>Canadiphyllum</i> sp. Probably coral Zone IIID (middle Meramecian). Confirms Humbug identification	41° 41.24' 112° 3.67'
30	M1 1.56.0 M1 2.98.0	29349-PC 29350-PC	Lodgepole Limestone	Early Mississippian (Kinderhookian or Osagean)	1/30/84	W. J. Sando, USGS	Corals: <i>Vesiculophyllum</i> sp. <i>Lophophyllum?</i> sp. 1 Coral Zone IB or C or II	41° 40.05' 112° 2.55'
30	many #s	29351-PC through 29361-PC	Lodgepole Limestone	Early Mississippian (Osagean)	1/30/84	W. J. Sando, USGS	Corals: <i>Syringopora</i> morphogroup E <i>Vesiculophyllum</i> sp. <i>Syringopora</i> morphogroup B <i>Lophophyllum?</i> sp. 2 <i>Stelechophyllum</i> cf. <i>S. microstylum</i> (White) <i>Stelechophyllum</i> small sp. <i>Sychnoelasma</i> sp.	41° 40.05' 112° 2.55'
30	G.W. 84-3 through G.W. 84-14 and H74, H75, H240, & H241	----	Lodgepole Limestone	Early Mississippian (Kinderhookian and Osagean)	2/8/85	G. D. Webster, Washington State Univ.	Crinoids: <i>Aphelocrinus</i> n. sp. (most similar to <i>A. sacculatus</i>) <i>Dichocrinus</i> n. sp. <i>Ramulocrinus</i> n. sp. (most similar to <i>R.</i> <i>livingstonensis</i> Laudon and Severson, 1953) <i>Dichocrinus</i> cf. <i>D. bozemanensis</i> Miller and Gurley <i>Cribanocrinus wortheni</i> <i>Bridgerocrinus fairyensis</i> Laudon and Severson, 1953 <i>Rhodocrinites</i> sp. Tegmen nodes similar to <i>R. macrotumidus</i> <i>Rhodocrinites</i> sp. cf. <i>R. brewsteri</i> Laudon, Parks, and Spreng, 1952 Indeterminate camerate, possibly <i>Cactocrinus</i> sp. Inadunate, cf. <i>Ramacrinus</i> sp. Indeterminate inadunate, possibly a <i>Ramulocrinus</i> or <i>Hypselocrinus</i> <i>Platycrinites bozemanensis</i> (Miller and Gurley, 1897) <i>Ramulocrinus?</i> n. sp. Indeterminate inadunates starfish crushed echinoid corona	41° 40.05' 112° 2.55'
31	H161	----	Lodgepole Limestone	Osagian Early Mississippian	2/23/84	G. D. Webster, Washington State Univ.	Crinoid: <i>Histocrinus?</i> n. sp.	41° 40.56' 112° 3.25'
32	H74, H75	----	Lodgepole Limestone	late Kinderhookian to early Osagian Early Mississippian	2/23/84	G. D. Webster, Washington State Univ.	Crinoids: <i>Platycrinites bozemanensis</i> (Miller and Gurley, 1897)	41° 40.71' 112° 3.43'
33	G.W. 84-2	----	lowermost Lodgepole Formation	Kinderhookian Early Mississippian	11/84	G. D. Webster, Washington State Univ.	Conodonts: <i>Polygnathus inornatus</i> <i>Polygnathus communis communis</i> Lower <i>Siphonodella crenulata</i> Zone or <i>S.</i> <i>isostichia</i> -upper <i>S. crenulata</i> Zone. Lacks name bearers for the zone.	41° 40.01' 112° 6.40'
34	H1-14-1 to H1-14-6	----	Hyrum Formation	Middle Devonian	2/14/84	H. P. Schultze, Univ. Kansas	Fish bones: Arthrodire indet.	41° 40.57' 112° 3.74'

TABLE 1 continued

Map Location	Field Number	USGS Collection Number	Stratigraphic Unit	Fossil Age	Date of Report	Paleontologist	Faunal Description	Latitude Longitude
35	H1-4-1, H1-4-2, H1-4-3, H1-6-1, H1-6-2, H1-6-3	----	upper Water Canyon Formation (upper Grassy Flat Member)	Early Devonian	2/14/84	H.-P. Schultze, Univ. Kansas	Fish bones: Pteraspids: <i>Protaspis brevispina</i> (H1-4-2), <i>Protopteraspis</i> sp. (H1-4-1, H1-6-3), <i>pteraspid</i> indet. (H1-6-1) Arthrodire: <i>Bryantolepis</i> sp. (H1-4-3) Lungfish: <i>Uranolophus wyomingensis</i> (H1-6-2)	41° 40.57' 112° 3.74'
36	H107	----	upper Water Canyon Formation (upper Grassy Flat Member)	Early Devonian	2/14/84	H.-P. Schultze, Univ. Kansas	Fish bones: Lungfish: <i>Uranolophus wyomingensis</i>	41° 38.74' 112° 2.50'
37	H124	----	upper (cherty) member of Garden City Formation	Early Ordovician (Canadian)	1/31/84	R. H. Flower, New Mexico Bur. Mines	Orthocone cephalopod: The sample is unquestionably <i>Buttsoceras</i> , and almost certainly <i>Buttsoceras williamsi</i> Flower. It is certainly from the highest Canadian, Zone J or K of Ross (1951).	41° 38.28' 112° 3.15'
38	MT84-8-30D	D3428-CO	Worm Creek Formation	Elvinia Zone, Franconian Stage, Late Cambrian	12-19-84	M. E. Taylor, USGS	Trilobites: <i>Elvinia</i> n. sp. <i>elvininid</i> , gen. and sp. undet. cf. <i>Elburgia</i> sp. <i>Parahousia</i> sp. <i>Pterocephalia</i> sp. inarticulate brachiopods, gen. and sp. indet., rare	41° 37.65' 112° 2.78'
39	MT84-8-30C	D3427-CO	upper Nounan Formation	? <i>Dunderbergia</i> Zone, upper Dresbachian Stage, Late Cambrian	12-19-84	M. E. Taylor, USGS	Trilobites: cf. <i>Dytremacephalus</i> n. sp. cf. <i>Dunderbergia</i> n. sp., aff. <i>D.</i> (?) <i>anya</i> (Hall & Whitfield) other trilobites, gen. and sp. undet. echinoderm plates, gen. and sp. indet. inarticulate brachiopods, gen. and sp. indet., rare	41° 37.63' 112° 2.80'
40	MT84-8-30B	D3430-CO	upper Nounan Formation	<i>Crepicephalus</i> Zone, Dresbachian Stage, Late Cambrian	12-19-84	M. E. Taylor, USGS	Trilobites: blountid pygidium, gen. and sp. undet. cf. <i>Cedaria</i> sp. <i>Coosella</i> sp. <i>Crepicephalus</i> sp. inarticulate brachiopods, gen. and sp. indet., rare	41° 37.60' 112° 2.85'
41	MT84-8-30A	D3429-CO	upper Calls Fort Member	<i>Bolaspidea</i> Zone, (undifferentiated), latest Middle Cambrian	12-19-84	M. E. Taylor, USGS	Trilobites: <i>Baltagnostus</i> sp. <i>Bolaspidea</i> sp. cf. <i>Elrathia</i> sp. cf. <i>Modocia</i> sp. inarticulate brachiopods, gen. and sp. indet., rare hyoliths, gen. and sp. indet.	41° 37.50' 112° 3.10'

UTAH GEOLOGICAL AND MINERAL SURVEY

*606 Black Hawk Way
Salt Lake City, Utah 84108-1280*

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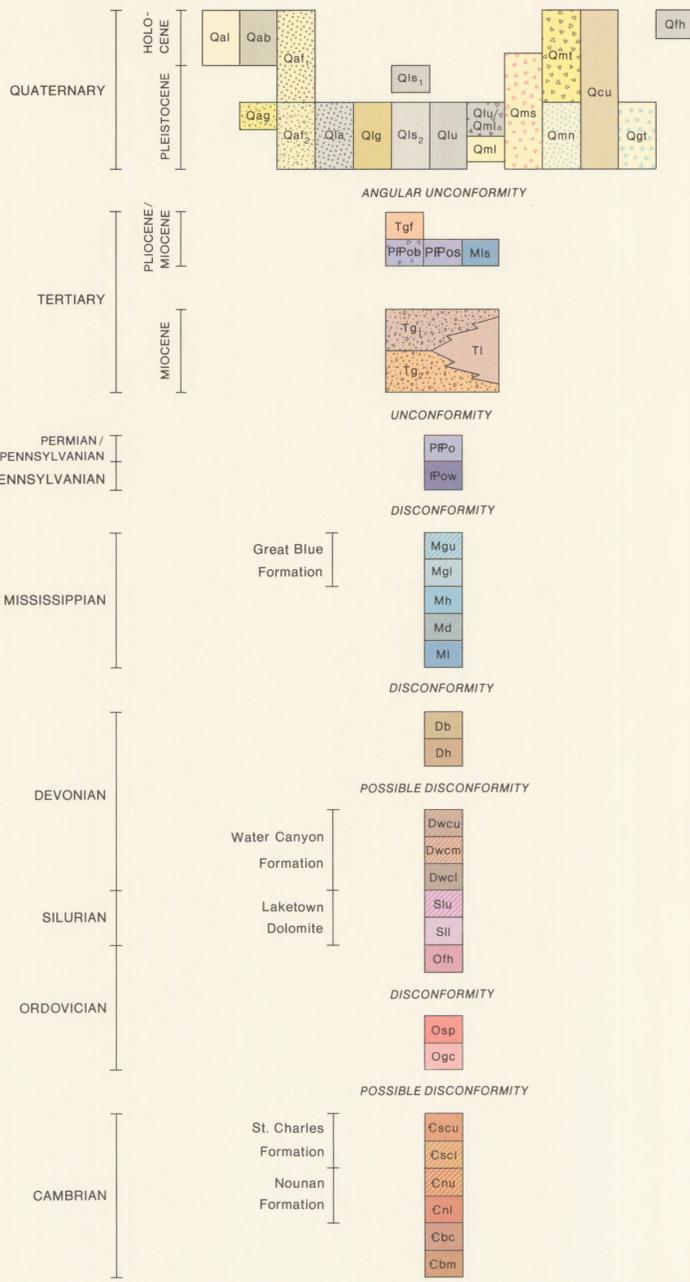
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SYSTEM	SERIES	FORMATION	SYMBOL	LITHOLOGY	THICKNESS (feet)
PERMIAN	Lower	Oquirrh Formation	PPo		4500(?)
	Upper				
PENNSYLVANIAN	Lower	West Canyon Limestone	IPow		395
	Upper	Great Blue Formation	Upper	Mgu	475
	Lower		Mgl	1025	
MISSISSIPPIAN	Meramecian	Humbug Formation	Upper	Mh	820
			Lower	Md	91
	Osagean	Deseret Limestone	Upper	Ml	970
			Lower	MI	970
DEVONIAN	Upper	Beirdneau Formation	Upper	Db	0-346
			Lower	Dh	490
	Middle	Hyrum Formation	Upper	Dwcu	454
			Lower	Dwcm	403
Lower	Water Canyon Formation	Upper	Dwcl	428	
		Lower	Dwcl	428	
SILURIAN	Lower	Laketown Dolomite	Upper	Slu	550
			Lower	Sil	561
ORDOVICIAN	Champlainian	Garden City Formation	Upper	Ogc	1334
			Lower	Ogc	1334
	Cincinnati	Swan Peak Formation	Upper	Osp	379
			Lower	Osp	379
Canadian	Fish Haven Dolomite	Upper	Ofh	197	
		Lower	Ofh	197	
CAMBRIAN	Upper	St. Charles Formation	Upper	Cscu	991
			Lower	Cscl	178
	Lower	Nounan Formation	Upper	Cnu	545
			Lower	Cnl	729
Lower	Bloomington Formation	Upper	Cbc	306	
		Lower	Cbm	651 + 957 +	

CORRELATION OF MAP UNITS

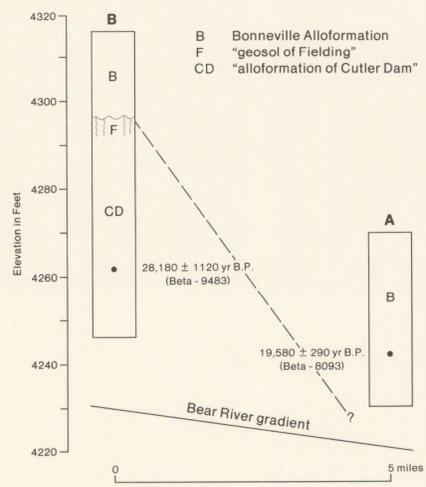


DESCRIPTION OF MAP UNITS

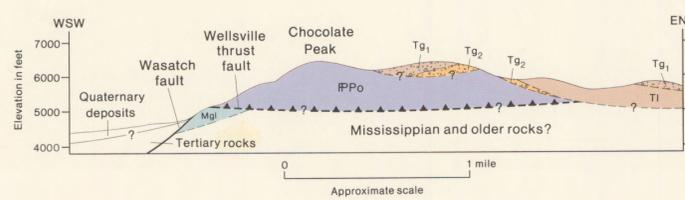
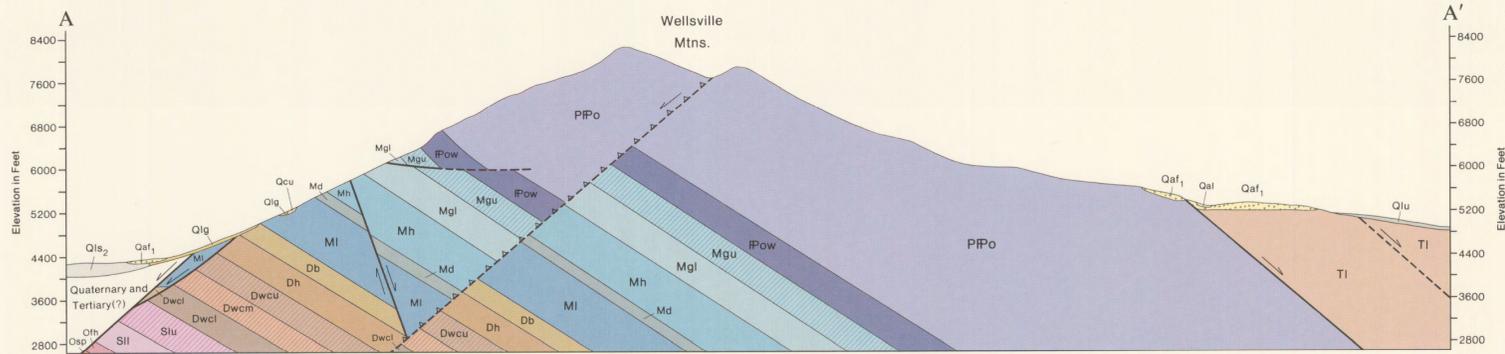
- Qal** Alluvium—fine-grained to gravelly; deposits in flood plains and channels.
- Qab** Ox-bow lake deposits—fine-grained, organic-rich.
- Qaf** Alluvial fan deposits—poorly sorted boulders, cobbles, pebbles, and fines; post-Lake Bonneville in age.
- Qaf₁** Alluvial fan deposits—poorly sorted boulders, cobbles, pebbles, and fines; pre-Lake Bonneville in age.
- Qag** Alluvial gravel of late Pleistocene Bear River—fills paleochannels in lacustrine deposits (Qls₂).
- Qla** Lacustrine and alluvial gravel deposits undifferentiated.
- Qlg** Lacustrine gravel and sand—shore-zone deposits of Lake Bonneville and possibly of pre-Bonneville lakes.
- Qls₁** Lacustrine sand, silt, and clay—deposited during Gilbert stage of Lake Bonneville.
- Qls₂** Lacustrine sand, silt, and clay—Bonneville and pre-Bonneville in age.
- Qlu** Undifferentiated lacustrine deposits
- Qlu/Qml** Thin lacustrine deposits overlying lateral-spread deposits
- Qml** Lateral-spread mass movement deposits—composed of Qlg, stabilized and not active.
- Qms** Landslide deposits—derived from Qlg or from Tertiary gravel or lacustrine deposits.
- Qmt** Talus—thick rock-fall accumulations below cliffs.
- Qmn** Nivation deposits—poorly-sorted rock debris in a nivation hollow on Wellsville Cone.
- Qcu** Colluvial deposits, undifferentiated—locally includes talus, alluvium, debris-flow, and avalanche-debris deposits.
- Qgt** Glacial till—forms moraines in Jim May, Shumway, Brushy, and Pine Canyons.
- Qfh** Highway fill
- Tgf** Fonglomerate—angular to subrounded locally derived alluvium.
- Tg₁** Gravel deposits—includes both locally derived clasts of Paleozoic rocks and exotic clasts of silicic volcanic rocks.
- Tg₂** Gravel deposits—clasts locally derived and generally finer-grained and more angular than Tg₁.
- TI** Lacustrine deposits—marl, oolitic limestone, and including thick layers of volcanic ash.
- PPob** Oquirrh Formation—brecciated and highly deformed above low-angle fault south of Big Canyon.
- PPos** Oquirrh Formation—in gravity slide mass east of Crystal Springs.
- Mis** Lodgepole Limestone—in gravity slide mass east of Crystal Springs.
- IPow** West Canyon Limestone—medium-gray cherty limestone, sandy limestone, and minor shale.
- Mgu** Upper Great Blue Formation—interbedded olive-gray shale and limestone in lower part, cherty gray limestone in upper part, fossiliferous.
- Mgl** Lower Great Blue Formation—medium- to dark-gray limestone, fossiliferous.
- Mh** Humbug Formation—brown sandstone with interbedded sandy limestone or limestone.
- Md** Deseret Limestone—cherty limestone and minor sandstone, thin phosphatic shale and black chert in lower part.
- Ml** Lodgepole Limestone—medium- to dark-gray limestone, fossiliferous.
- Db** Beirdneau Formation—medium- to light-gray dolomite, and orange dolomitic sandstone and siltstone.
- Dh** Hyrum Formation—dark- to medium-gray dolomite, includes two or three thin local quartzite beds.
- Dwcu** Upper Water Canyon Formation—light-gray to white dolomite, contains fish-bone fragments.
- Dwcm** Middle Water Canyon Formation—grayish orange dolomitic sandstone and sandy dolomite, some thin limestone beds near middle of unit.
- Dwcl** Lower Water Canyon Formation—light-gray laminated dolomite, nonfossiliferous.
- Slu** Upper Laketown Dolomite—light- to medium-gray, coarsely crystalline dolomite, contains colonial corals.
- Sil** Lower Laketown Dolomite—medium- to dark-gray dolomite, contains colonial corals.
- Ofh** Fish Haven Dolomite—dark-gray to medium-gray dolomite, fossiliferous.
- Osp** Swan Peak Formation—dark olive-gray shale in lower part and white to purple quartzite in upper part; shale is fossiliferous.
- Ogc** Garden City Formation—limestone, silty limestone, intraformational limestone conglomerate; chert is common in upper part, fossiliferous.
- Cscu** Upper St. Charles Formation—dark- to light-gray dolomite, some silty dolomite in upper part.
- Cscl** Lower St. Charles Formation—thin interbedded quartzite, limestone, and shale in lower part, silty limestone in upper part; fossiliferous.
- Cnu** Upper Nounan Formation—interbedded dolomite, sandy dolomite, dolomitic sandstone, and thin limestone; limestone is fossiliferous.
- Cnl** Lower Nounan Formation—medium- to dark-gray dolomite.
- Cbc** Calls Fort Member of Bloomington Formation—olive-gray shale, medium- to light-gray silty limestone, intraformational limestone conglomerate; fossiliferous.
- Cbm** Middle limestone member of Bloomington Formation—medium-gray limestone.

MAP SYMBOLS

- CONTACT**
Dashed where approximately located
- FAULTS**
Dashed where approximately located; dotted where concealed
- High- to moderate-angle fault, primarily dip slip; bar and ball on downthrown side; dip indicated
- Low- to moderate-angle normal fault; teeth on hanging wall
- Buried trace of thrust fault; teeth on upper plate
- Strike-slip fault; arrows indicate relative offset
- SCARPS**
Teeth on downdropped side
- Scarp having the morphology of a fault scarp but which probably resulted from slumping associated with lateral-spread mass movement
- STRIKE AND DIP OF BEDS**
35
- BONNEVILLE SHORELINE**
Dashed where approximately located
- PROVO SHORELINE**
Dashed where approximately located
- Location of paleontological sample (see Table 1)
- Estimated altitude of beach-ridge crest of Bonneville or Provo Shoreline
- 4786 ± 10
- X**
Prospect



Correlation of Quaternary deposits in sections A and B along the Bear River, Honeyville quadrangle.



Schematic cross section through the Wellsville Mountains near Chocolate Peak showing the inferred configuration of the Wellsville thrust fault.

