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OREM QUADRANGLE, UTAH

by

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INTRODUCTION

The Orem quadrangle is on the west slope of the Wasatch Mountains extending northward from the city of Provo. A portion of the ridge of Mount Timpanogos, which here forms the crest of the range, crosses the extreme northeastern corner of the quadrangle. The west base of the range is at the east margin of the Basin and Range province and also formed the east shore of ancient Lake Bonneville. Approximately two-thirds of the area of the quadrangle is within the basin of Lake Bonneville and constitutes but a small part of the total area of 20,000 square miles covered by the lake. Provo River, the major stream in the quadrangle, drains a large area east of the Wasatch Mountains, flows southwestward in a deep canyon cut through the mountains, and empties into Utah Lake. The drainage basins of the other principal streams in the quadrangle including Grove Creek, Battle Creek, Dry Canyon, and Rock Canyon, are confined to the west slope of the range.

Geologic mapping was extended into the quadrangle as part of a regional mapping project in the central Wasatch Mountains. The large part of the quadrangle west of the mountain front was mapped by C. B. Hunt in part contemporaneously with the field work in the mountains. The results of his studies have been published (Hunt, 1953) and the details of the stratigraphy of the lake sediments recognized in his mapping are not repeated here.

STRATIGRAPHY

Precambrian rocks

Mineral Fork Tillite.-The Mineral Fork Tillite crops out at the mouth of Rock Canyon in the southeast corner of the quadrangle and is the oldest unit exposed. The matrix of the conglomeratic tillite is gray to brown fine- to coarse-grained micaceous siltstone that weathers dark brown to black. In contrast to the unsheared rock at its type locality in Big Cottonwood Canyon near Salt Lake City, the tillite at Rock Canyon is mildly sheared and the matrix is micaceous or locally even schistose. Boulders as much as 4 feet in diameter are scattered through the tillite. They are subrounded to rounded and consist of white to brown quartzite, light-gray-weathering dark-gray dolomite, and greenstone. Some of the dolomitic boulders contain calcareous oolites. In a specimen examined by Richard Rezak the ooids averaged 1.8 mm in diameter and examination in thin section did not disclose organic structures. The incomplete section of the tillite at the mouth of Rock Canyon is about 200 feet thick. As measured in Slate Canyon about 2½ miles south of Rock Canyon the tillite is 145 feet thick but north of the quadrange in Big Cottonwood Canyon its maximum thickness may be as much as 3,000 feet (Crittenden, Sharp and Calkins, 1952). The tillite at Rock Canyon and to the south is overlain by the Tintic Quartzite, the basal contact of which is generally marked by a conglomerate with boulders of quartz. At its type locality in Big Cottonwood Canyon, however, the Tillite rests upon the Big Cottonwood Formation and is overlain by the Mutual Formation both of which are Precambrian in age.

Cambrian System

Tintic Quartzite.-The Tintic Quartzite crops out in the Orem quadrangle only in the southeast corner, in the faulted area along the front of the range south of Little Rock Canyon and in prominent escarpments at the mouth of Rock Canyon. It consists of light-brown-weathering, white to tan, fine- to coarse-grained, thin- to thick-bedded quartzite. A few conglomeratic bands in the lower 200 feet contain quartz pebbles as much as 2 inches in diameter, and the base of the formation commonly contains boulders of quartz a foot or more in diameter. The quartzite at the top of the formation is greenish and has some interbedded green shale at the gradational contact with the overlying Ophir Formation. The thickness of the Tintic Quartzite is 1,080 feet as measured in Slate Canyon to the south of the quadrangle and about 1,300 feet in American Fork Canyon (Baker and Crittenden, 1961).

The Tintic quartzite is included in the Cambrian on the basis of its regional stratigraphic relationships which show it to be unconformable upon the underlying rocks of Precambrian age and to be gradational with the overlying Ophir Formation. Sparse collections of fossils from the overlying Ophir and Maxfield Formations in Rock Canyon and at nearby localities in the Central Wasatch Mountains are included in the Middle Cambrian by A. R. Palmer.

Ophir Formation.-Outcrops of the Ophir Formation in the Orem quadrangle are limited to several small areas in the fault zone along the mountain front in the vicinity of Little Rock Canyon. As measured in Slate Canyon about 2½ miles south of Rock Canyon, the Ophir Formation is 250 feet thick and consists of olive-green micaceous shale with some thin beds of greenish sandstone and a zone of shaly limestone in the upper part. The Ophir Formation as exposed in the central Wasatch Mountains to the north is composed typically of three units with a lower green shale 150 to 250 feet thick, a medial limestone 40 to 90 feet thick, and an upper green to brown shale and sandstone unit 170 feet or more thick (Crittenden, Sharp, and

Calkins, 1952, p. 7; Baker and Crittenden, 1961; and Baker, in press). The three typical units of the Ophir Formation have not been recognized in the vicinity of the Orem quadrangle. However, the zone of shaly limestone in the upper part of the upper part of the formation may be equivalent to the medial limestone, or the medial limestone and upper shale and sandstone units of other areas may be equivalent to part of the section here included in the overlying Maxfield Limestone.

Intertonguing of the Ophir Formation and the Maxfield Limestone has not been demonstrated but is considered to be probable. Sparse fossils collected from the overlying Maxfield Limestone in Rock Canyon are considered by A. R. Palmer to be of Middle Cambrian age.

Maxfield Limestone.-Exposures of the Maxfield Limestone in the Orem quadrangle are limited to a few small areas in the fault zone along the mountain front between Little Rock Canyon and Rock Canyon. About three fourths of a mile north of Rock Canyon the following section of the Maxfield Limestone was measured.

Section of Maxfield Limestone measured about 400 feet north of south ¼ cor. sec. 20, T. 6 S., R. 3 E.

	Feet
Fitchville Formation	
Limestone and dolomite, massive, medium- to light-gray	
Maxfield Limestone	
Limestone, thin-bedded, dark-gray, with yellow-brown mottling	15
Limy shale, fissile, dark-gray, light-brown weathering, grading upward into yellow-brown-mottled limestone	27
Limestone, massive to thin-bedded, light- to dark-gray, mottled yellow-brown to grayish-yellow and in part so heavily mottled that weathered surfaces of the limestone are yellow brown	148
Total	190
Ophir Formation	

In Rock Canyon the Maxfield Limestone is 597 feet thick, and the upper part of the formation is medium-gray to nearly white dolomite about 165 feet thick. The dolomite is underlain by light- to dark-gray, mainly thin bedded limestone with abundant mottling. The Maxfield Limestone is overlain by rocks of Mississippian age and its thickness shows considerable variations as a result of pre-Mississippian erosion. At places in the Wasatch Mountains all or most of the formation has been removed at the unconformity (Baker and Crittenden, 1961).

Trilobites collected from the Maxfield Limestone 100 to 160 feet above the base near the bottom of Rock Canyon included Kootenia sp., Dolichometopsis? sp., and Spencia? sp. as identified by A. R. Palmer and assigned by him to the Middle Cambrian.

CARBONIFEROUS SYSTEMS

Mississippian System

Fitchville Formation.-The Fitchville Formation is discontinuously exposed in the fault zone along the mountain front between Little Rock and Rock Canyons. The formation unconformably overlies rocks of Cambrian age; no rocks of Ordovician, Silurian, or Devonian age have been recognized in the vicinity of the Orem quadrangle. A bed of grit or coarse light-gray to tan quartz sandstone is generally present at the base of the Fitchville Formation and varies in thickness up to 20 feet. As measured in Rock Canyon the Fitchville Formation is 265 feet thick and consists mainly of medium- to light-gray, thin-bedded to massive dolomite that is free of chert and contains numerous small vugs. The upper 30 feet of the formation consists of interbedded limestone and dolomite. The formation generally forms a cliff or a series of prominent ledges.

The rocks included in the Fitchville Formation were formerly correlated with the Jefferson Dolomite and considered tentatively to be of Devonian age (Gilluly, 1932, p. 20-22). Additional collections of fossils have been made from the formation and a study of all available material has led Helen Duncan to the conclusion that all the faunal evidence is in favor of an Early Mississippian age. The name Fitchville used here has been applied to the unit in the East Tintic Mountains by Morris and Lovering (1961, p. 82).

Gardison Limestone.-The Gardison Limestone crops out in small areas in Little Rock Canyon and along the cliffs to the south. Because of faulting the entire formation is not exposed in the Orem quadrangle, but its full thickness is exposed in the Bridal Veil Falls and Springville quadrangles that adjoin the Orem quadrangle to the east and southeast. An unusually great thickness of 901 feet for the Gardison Limestone as measured in Rock Canyon may be due to thickening of the formation at the crest of the sharp fold exposed in Rock Canyon. In American Fork Canyon the Gardison is 617 feet thick near the mouth and 660 feet thick near the head (Baker, 1947).

The Gardison Limestone is dark gray, mostly thin bedded, and in part contains abundant light-brown to black chert in stringers and blebs. Some beds are highly fossiliferous. Its outcrop is characteristically cliff forming and is distinguished by thin bedding.

The Gardison Limestone is conformable with the underlying Fitchville Formation and the overlying Deseret Limestone. The base of the Deseret Limestone is placed at a thin bed of black phosphatic shale (Gilluly, 1932, p. 25; Morris and Lovering, 1961, p. 93) wherever this bed can be located; it was not observed in the section measured at Rock Canyon. The underlying Fitchville Formation is of Early Mississippian age and abundant fossils from the Gardison Limestone are also of Early Mississippian age. The rocks included in the Gardison were formerly designated the Madison Limestone.

Deseret Limestone.-The Deseret limestone conformably overlies the Gardison Limestone, and its outcrop in the Orem quadrangle also is confined to the cliffs along the mountain front in the vicinity of Little Rock Canyon. In the absence of the black phosphatic shale that is considered to mark the base of the Deseret Limestone, the contact of the Deseret with the Gardison Limestone is placed at the upper limit of the dom-

inantly thin bedded cliff-forming limestone and at the base of dominantly massive interbedded limestone and dolomite having distinctive light- and dark-gray banding. The upper limit of the formation is placed at the base of the lowest bed of sandstone, which by definition is included with the overlying Humbug Formation. Because both upper and lower contacts are somewhat indefinite, it is possible that the boundaries have been picked at different places in different parts of the region. Variations in thickness may be due in part to these conditions. In a section measured in Rock Canyon, 376 feet of strata was included in the Deseret Limestone. At neighboring localities the thickness of the formation is 420 feet in Boxelder Canyon (Baker and Crittenden, 1961), 585 feet near Cascade Springs in Provo Deer Creek (Baker, in press) and 650 feet in the Oquirrh Mountains (Gilluly, 1932, p. 25).

The Deseret Limestone consists of interbedded limestone and dolomite. The rocks are medium to dark gray and some beds weather light gray to nearly white. Some beds are sandy in part and the brown-weathering sand grains give the beds a brownish cast; the grains are etched in relief and are crossbedded. Black chert is present in most beds and is very abundant in some; it occurs in thin layers, blebs, and irregular masses. Crinoid stems up to 3-4 inch in diameter, large cup corals, and colonial corals are abundant locally.

The Deseret Limestone in the Orem quadrangle is correlated with the Deseret Limestone at its type locality in the Oquirrh Mountains. (Gilluly, 1932, p. 25-26) and with exposures in the East Tintic Mountains (Morris and Lovering, 1961, p. 93-99). At both localities the entire formation is assigned to the Upper Mississippian. No evidence was found in the vicinity of the Orem quadrangle to suggest that rocks containing fossils of Early Mississippian age are included in the Deseret Limestone, as they are in American Fork Canyon (Baker and Crittenden, 1961).

Humbug Formation.-The banded tan and gray rocks of the Humbug Formation crop out at the top of the cliffs and at the rim of the upland surface between Rock and Little Rock Canyons just east of the border of the Orem quadrangle. The Humbug Formation crops out in the limbs of a northward-plunging anticline, and its outcrop is terminated against a normal fault in the southwest part of sec. 17, T. 6 S., R. 3 E. For nearly a mile in the vicinity of the mouth of Little Rock Canyon, rocks of the Humbug Formation crop out on the west side of a normal fault, where they dip steeply westward and in the footwall rest on rocks as old as the Ophir Formation of Cambrian age.

The Humbug Formation consists of the interbedded gray-weathering limestone and light-brown-weathering sandstone that impart a characteristic gray and brown banded appearance to its outcrop. The limestone and the sandstone units both range in thickness from a foot or less to approximately 50 feet. The limestone is coarse to finely crystalline, dark to light gray, thin to thick bedded, and sparsely fossiliferous. The sandstone is fine to coarse grained, gray to buff, and limy to quartzitic.

The Humbug Formation is in the mid-part of a thick sequence of rocks that contain fossils of Late Mississippian age. The base of the formation is placed at the base of the lowest sandstone; because this basal bed probably occurs at slightly different horizons in different parts of the region, the base of the formation may be somewhat arbitrary and variable. The upper boundary of the formation is generally fairly sharply marked by the appearance of black shale with interbedded thin layers of brown-weathering fine-grained dark-gray quartzite, and by gray limestone in the base of the overlying Great Blue Limestone. Locally limestone beds are present in the base of the Great Blue Limestone that are similar to the limestone beds of the Humbug Formation. The thickness of the formation is 518 feet in a section measured in Rock Canyon. In the neighboring region the thickness of the formation is 595 feet in Snake Canyon northwest of Midway, 646 feet in the headwaters of American Fork (Baker, 1947), 800 feet in Boxelder Canyon (Baker and Crittenden, 1961), and 645 feet in the Oquirrh Mountains (Gilluly, 1932, p. 27-28).

Great Blue Limestone.-The Great Blue Limestone is extensively exposed in the Orem quadrangle. It forms the rim of a prominent bench that slopes southward from the summit of Mahogany Mountain in the Timpanogos Cave quadrangle to the north, to a low point near Provo River, then rises southward toward Rock Canyon in the Bridal Veil Falls quadrangle. Deep gorges below the rim of this bench expose great walls of the distinctive limestone of the Great Blue along Battle Creek, Dry Canyon, and Provo Canyon. The formation is cut by numerous normal faults and also is extensively folded in the Wasatch fault zone along the front of the range. South of Little Rock Canyon west-dipping Great Blue forms a facing on the lower cliffs, where it has been downfaulted against rocks in the footwall that range from Tintic Quartzite of Cambrian age to the Humbug Formation of Late Mississippian age.

The base of the Great Blue Limestone is conformable with the underlying Humbug Formation, and its upper boundary appears to be conformable with the overlying Manning Canyon Shale. The Great Blue consists of nearly homogeneous dark-gray to black limestone in very thin, regular beds. The limestone contains some thin beds and nodules of black chert which are most abundant in the upper part of the formation. Thin beds of black shale and of rusty-weathering fine-grained quartzite are interbedded with the limestones. The thin-bedded limestone weathers into rather characteristic pale-gray flakes and slabs that commonly have a pinkish tinge. The thickness of the Great Blue Limestone is 2,800 feet as measured on the north side of Rock Canyon about a mile and a half east of the Orem quadrangle. This thickness compares with 2,590 feet in Lake Mountain (Bullock, 1951, p. 17) and 3,355 in the Oquirrh Mountains (Gilluly, 1932, p. 29).

The Great Blue Limestone locally contains abundant fossils, and it is in the upper part of a thick section of rocks of established Late Mississippian age. Lists of fossils collected from the formation are given by Gilluly (1932, p. 30-31) and Bissell (1959, p. 57).

Mississippian and Pennsylvanian Systems

Manning Canyon Shale.-The Manning Canyon Shale is exposed at many places in the Orem quqdrangle but only relatively small segments of the formation can be examined at individual outcrops. The formation is com-

posed primarily of rocks that are not resistant to erosion and generally produces areas of low relief with few exposures. The shale of the Manning Canyon was the zone of weakness that facilitated movement of the mass of quartzite of the Oquirrh Formation extending from north of Big Baldy south across Provo River and west to the front of the range. The lower part of the formation crops out extensively around the margin of the transported mass of quartzite.

An overall thickness of the Manning Canyon Shale was measured by plane table across the valley north of the Rock Canyon picnic area, about 2 miles east of the Orem quadrangle. The total thickness obtained for the formation was 1,646 feet and the top of a medial gray limestone unit 90 feet thick was 830 feet above the base.

The Manning Canyon is composed principally of brown to black shale but contains some beds of gray to black, generally shaly limestone, numerous thin beds of light-gray, fine-grained, light-brown-weathering quartzite, and a few lenses of orange-brown-weathering sugary sandstone and grit. Some of the brown shale contains fossil plants, but marine fossils are abundant in other parts of the formation.

The Manning Canyon Shale has been known for many years to contain rocks of both Pennsylvanian and Mississippian ages (Gilluly, 1932, p. 32-33). About one mile east of the Orem quadrangle, on the divide between the Second Left Fork of Rock Canyon and Pole Canyon, the boundary between the two systems occurs about 50 feet below the medial limestone. In the saddle on the divide a shale unit beneath the medial limestone forms a slope west of the road. Fossils collected from this shale (U.S.G.S. collection 9570) were identified by Mackenzie Gordon, Jr. as Posidonia cf. P. wapanuckensis (Girty), Cravenoceras ? so, and Eumorphoceras cf. E. bisulcatum Girty s. l. of Mississippian age, and from black shale at the base of the Manning Canyon in the southwest corner of sec. 1, T. 6S., R. 2 E., fossils were collected (U. S. G. S. collection 16124) which were identified by Mackenzie Gordon as Rayonnoceras cf. R. solidiforme Croneis of Mississippian age. A fossil collection from the medial limestone immediately above collection 9570 was identified by Mackenzie Gordon as Pennsylvanian in age, as follows:

> USGS. collection 9569 on divide between Rock Canyon and Provo Canyon: Strophomenid brachiopod indet., Inflatia aff. I. inflata (McChesney), Dictyoclostus (Antiquatonia) cf. D. hermosanus (Girty), Flexaria n. sp., Schizophoria sp., Spirifer sp.

Pennsylvanian and Permian Systems

Oquirrh Formation.-The Oquirrh Formation includes the Bridal Veil Limestone Member at the base, and an overlying series of quartzitic sandstone with limestone interbeds that together have a thickness of about 25,000 feet east of the Orem quadrangle. No more than the lower 3,500 feet of the sandstone-limestone series above the Bridal Veil Limestone Member crops out in the ridge on which Mount Timpanogos is located.

The type locality of the Bridal Veil Limestone Member is at Bridal Veil Falls in Provo River Canyon, about one mile east of the Orem quadrangle, where it forms a prominent blue-gray sliff in the lower canyon walls. The limestone crops out in the cliff extending across the northeast corner of the Orem quadrangle along the side of the range but is partially obscured by the allochthonous mass of quartzite that extends from south of Provo River to the north edge of the quadrangle. The Bridal Veil Limestone Member is 1,245 feet thick as measured near Bridal Veil Falls in the cliffs east of Pole Canyon. It consists of medium- to dark-gray, thin- to thick-bedded limestone with nodules and thin nodular beds of black chert in the upper part and with some interbedded dark-gray to black shale and a few beds of quartzite. It contains abundant fossils including Millerella sp. as identified by L. G. Henbest and is of Early Pennsylvanian (Morrow) age. Nygreen (1958) applied the name West Canyon Limestone Member to rocks in the lower part of the Oquirrh Formation in the Oquirrh Mountains that are equivalent in part at least to the Bridal Veil Limestone Member, and Bissell (1959) applied the name Hall Canyon Member to the unit in the Oquirrh Mountains. The Bridal Veil Limestone Member appears to be equivalent at least in part to the Round Valley Limestone in the lower part of the Pennsylvanian section north of the Charleston zone of thrust faults.

The part of the Oquirrh Formation that overlies the Bridal Veil Limestone Member and is exposed in the upper slopes of the range in the northeast corner of the quadrangle consists of interbedded sandstone and limestone that impart a prominent tan and gray banding to the barren cliffs. As measured in the Bridal Veil Falls quadrangle to the east, this part of the Oquirrh Formation consists of gray to tan sandstone and quartzite units as much as 350 feet thick, with interbedded gray to black limestone in units as much as 200 feet thick. Some of the limestone beds contain abundant nodules of black chert. Fusulinids collected from the limestone beds are of Atoka to Des Moines age, as identified by L. G. Henbest.

A great allochthonous mass of the Oquirrh Formation crops out along the front of the range. It underlies Big Baldy and extends from the Timpanogos Cave quadrangle south to Provo River; a large remant is preserved south of Provo River. It is involved in the normal faulting along the front of the range and along much of the mountain front north of Provo River is dropped down on a series of normal faults to the level of the Lake Bonneville sediments. A collection of fusulinids from the rocks of this mass in NE¼ sec. 35, T. 5 S., R. 2 E. was assigned to the lower Atoka by L. G. Henbest, and of two collections from sec. 1, T. 6 S., R. 2 E., one was assigned by him to the upper Atoka and the other to the upper Des Moines or Missouri. These rocks are believed to be part of a mass that has been thrust from the west and has fortuitously come to rest against rocks of similar age in the main range. At the base of the Oquirrh mass the rocks are intensely brecciated, and sandy beds have been reduced nearly to a powder.

QUATERNARY SYSTEM AND RECENT DEPOSITS

Lake Bonneville sediments.-About two thirds of the area of the Orem quadrangle is within the basin of ancient Lake Bonneville, and the sediments deposited

in the lake cover most of the floor of the broad valley now occupied in part by the fresh-water Utah Lake. As described by Hunt (1953) most of the lake sediments in the Orem quadrangle were deposited at the Provo stage of the lake, and the broad bench at Orem is a notable feature formed at that stage. Silt, sand, and gravel of the Alpine and Bonneville stages have limited distribution along the east margin of the valley. The terrace formed at the high-level Bonneville stage of the lake is a conspicuous feature of the landscape.

Alluvium, alluvial cones, and outwash.-The alluvial fill in the bottom of the canyon of Provo River extends along the course of the river across the lake sediments. Well-developed alluvial cones extend valleyward from the mouths of the larger canyons draining the west face of the range and are especially notable at the canyon mouths of Grove Creek, Battle Creek, Dry Canyon, and Rock Canyon.

Landslides.-Landslides of substantial size are present in the canyon of Provo River and south of Rock Canyon near the southeast corner of the quadrangle. On the south side of Provo River about a half mile from the mouth of the canyon a large mass of material has moved on the underlying Manning Canyon Shale. The largest slide covers almost a square mile on the north side of Provo River opposite the mouth of Pole Canyon. The Manning Canyon Shale at this locality also underlies the mass of material from the Bridal Veil Limestone Member and the sandy part of the Oquirrh formation that has moved down the hillside. A basin whose former outlet east of the Orem quadrangle was closed by a bar of river gravel has been formed on this slide.

Terrace gravel.-Sand and terrace gravel are present on both sides of Provo River at altitudes that are in part above the highest stage of Lake Bonneville. Some uplift of these deposits relative to the shoreline of Lake Bonneville may have resulted from the normal faulting in the Wasatch zone of faulting, but some of the deposits almost certainly antedated Lake Bonneville. A substantial part of the sand and gravel undoubtedly accumulated in the canyon of Provo River while it contained an arm of Lake Bonneville at the Bonneville stage.

STRUCTURE

A series of normal faults and faulted flexures that together constitute the Wasatch fault zone defines the front of the range within the Orem quadrangle. North of the Provo River the mountain front is slightly oblique to the trend of these faults, and as a result, successively more easterly faults reach the front and disappear beneath the sediments of Lake Bonneville. In this vicinity the faults appear to be nearly vertical. South of the Provo River, however, the faults dip westward at angles as low as 40°. Near Rock Canyon, Mississippian limestones in the hanging walls of such faults form a series of steeply dipping flatirons along the foot of the range and rest on rocks of Cambrian age in the footwalls. These Cambrian rocks are part of a northward-plunging faulted anticline that has Mineral Fork Tillite in its core. The cumulative effect of the succession of small normal faults and of the flexures associated with them is a displacement of at least 2,000 feet at the north edge of the quadrangle and 3,000 feet or more in the vicinity of Rock Canyon.

The dominant structural feature in the northern part of the quadrangle is the large displaced mass of the Oquirrh Formation that extends from south of the Provo River, beneath Big Baldy, and continues north beyond the border of the quadrangle. This mass consists entirely of the sandy part of the Oquirrh, with intercalated limestones in which fusilinids as youngas middle or late Des Moines age have been found. The basal Bridal Veil Limestone Member is significantly absent. Although this mass lies on a bench on the west slope of the range in a position suggestive of landsliding from the east, it is believed that the concept of thrust faulting accords more closely with all the known facts, and the mass is therefore considered to have been thrust from the west along a gently dipping surface designated the Big Baldy thrust. The plane of this fault is well exposed along the canyon of Provo River where flexed and faulted rocks of Mississippian age are overlain on a nearly flat surface by 200 to 300 feet of intensely crushed limestone and quartzite. The fault plane is offset by numerous normal faults of the Wasatch zone, showing that the thrust antidates the period of normal faulting.

Downfaulted segments of this overriding mass of Oquirrh rocks crop out along the edge of the range as far north as Battle Creek, and it is entirely possible that the Oquirrh rocks of the Traverse Range, a few miles to the north, may represent a further extension of this series of downfaulted blocks. In fact, the demonstrated thrust relation between the Oquirrh rocks of the Traverse Range and the rocks of the adjoining Wasatch Mountains is one of the strongest supports for interpretation of the displacement beneath Big Baldy as the result of movement along a thrust fault. This fault is believed to be the highest of a series of imbricate slices related to an underlying sole thrust, the Charleston Thrust (Baker, in press). Present evidence suggests that before erosion and normal faulting, the Big Baldy thrust curved upward along the front of Mount Timpanogos (See sec. A-A') and that the straight western face of this peak is the little-modified footwall of the Big Baldy thrust.

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