STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES AND ENERGY
UTAH GEOLOGICAL AND MINERAL SURVEY

Base from U.S. Geological Survey
Provo and Vicinity, 1:100,000, 1978

SCALE 1:100,000

MILES

FEET

KILOMETERS

Contour interval 100 feet

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# MAP 55-A

# GEOLOGIC MAP OF THE SOUTHERN WASATCH FRONT, UTAH

April 1983

Compiled by Fitzhugh D. Davis

Klaus D. Gurgel, Cartographic Editor
B.R. Jones, S.R. Stewart and D.E. Powers, Cartographers

UTAH
INDEX MAP

Approximate mean declination, 1981

Published and sold by
UTAH GEOLOGICAL AND MINERAL SURVEY
Genevieve Atwood, Director
606 Black Hawk Way
Salt Lake City, Utah 84108

# GEOLOGIC MAP OF THE SOUTHERN WASATCH FRONT, UTAH

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## GEOLOGY OF THE SOUTHERN WASATCH FRONT

*Fitzhugh D. Davis*[1]

### INTRODUCTION

The accompanying map is one of a series to depict various aspects of the physical environment along the Wasatch Front between Tremonton and Logan on the north, and Santaquin on the south. The map includes a portion of the Middle Rocky Mountains physiographic province on the east side and the Basin and Range Province on the west. The Wasatch Front is being rapidly urbanized and the impact of human activity on the natural environment has been (and will continue to be) significant.

The geology of the southern Wasatch Front has rocks representing almost all geologic ages from Precambrian to Recent; only the Ordovician and Silurian periods are not represented. The descriptions and thicknesses of the strata are provided with the map explanation. Thirteen unconsolidated Quaternary units have been mapped and their delineation and composition should be of interest and help to planners, engineers, developers, and geologists.

The rock units are arrayed in complex anticlines and synclines and are involved with igneous intrusions, unconformities, normal faults, and thrust faults. Volcanic rocks are also present in the area. Most of the middle and upper Paleozoic rocks have been thrust eastward (or underthrust from the east) in large sheets. Some of the thrust planes probably do not reach the surface. Several windows are present in the uppermost thrust sheets, such as the one in Payson Canyon. Most thrusting took place in Late Cretaceous time. Autochthonous rocks may be present in the northeast part of the mapped area.

The geologic map area can be divided into seven geologic or geographic parts. These are: (1) Traverse Mountains, (2) Wasatch Mountains, (3) Utah and Goshen valleys, (4) northern Juab Valley, (5) West Mountain and Long Ridge, (6) Mosida and Fox hills, and (7) Lake Mountain. The geology of each is briefly discussed below.

### GEOLOGY

#### Traverse Mountains

The Traverse Mountains are a relatively low east-west range that separates Jordan Valley from Utah Valley. The range is divided into two parts at the Jordan Narrows water gap through which the Jordan River flows northward from Utah Lake to the Great Salt Lake. The Jordan Narrows water gap is the result of erosion and structural displacement along a north-south-trending graben. The range consists of smoothly rounded hills that rise 2,000 feet (610 meters) above the waters of Utah Lake (4,487 feet above sea level [1,368 meters]). The rocks exposed in the range are brecciated and faulted quartzite and limestone of the Pennsylvanian Oquirrh Formation and Tertiary latite and andesite flows and tuffaceous strata of the Salt Lake Group (Pitcher, 1957; Bullock, 1958). A pre-lake Bonneville fanglomerate covers much of the southern margin of the range and Lake Bonneville deposits overlap it on all sides. A well-developed spit of the Alpine and Bonneville formations is present just northeast of Jordan Narrows.

Oquirrh Formation strata in the west part of the Traverse Mountains dip 27° to 66° to the northwest. In the eastern part of the range, dips are quite steep and strike in several different directions. At least five northwest trending faults displace rocks on this side. Hunt (1953) mapped a fault, downdropped on the south side, along the southern flank of the east Traverse Mountains. The Traverse Mountains are considered to be an intermediate fault block, not elevated as high as the Wasatch and Oquirrh mountains to the east and west, but elevated above the downdropped valley blocks to the north and south. The Charleston zone of thrust faults is believed to underlie the entire range.

The Beverly Hills are a group of low, smoothly rounded hills adjoining the Traverse Mountains on the southwest side. The eastern parts of these hills expose Mississippian and Pennsylvanian rocks. The Paleozoic strata are overlain by latite flows and pyroclastics to the west (Bullock, 1951).

#### Wasatch Mountains

These rugged mountains, as viewed from the west, form a high, imposing escarpment. They are the westernmost range in the Middle Rocky Mountains physiographic province. In the southern Wasatch Front, the highest point is along the crest of Mount Timpanogos, 11,750 feet (3,581 meters) above sea level. Other summits are Provo Peak at 11,068 feet (3,374 meters), Spanish Fork Peak at 10,192 feet (3,107 meters), and Santaquin Peak at 10,685 feet (3,257 meters). The Wasatch Mountains present a relief of about 6,500 feet (1,981 meters) above the floor of Utah Valley. The chief perennial drainages are, from north to south, American Fork River, Provo River, Hobble Creek, and Spanish Fork River, all of which have carved spectacular, deeply dissected canyons.

The rocks of these mountains range in age from Precambrian to Tertiary. The oldest formation is the Farmington Canyon Complex which forms a metamorphic terrane on the west side of Dry Mountain just southeast of Santaquin. The youngest formation is the Tibble Formation which crops out in American Fork Canyon and its tributaties. The rocks of the range, in this region, mostly consist of limestone, quartzite, dolomite, shale, and sandstone.

The Wasatch Mountains have undergone at least two episodes of mountain building. The first took place in Late Cretaceous time and resulted in uplift, folding of strata, and thrust faulting. Steep normal and reverse faults were undoubtedly associated with the thrust movements. The Charleston zone of thrust faults is believed to underlie most of the mountains. The second episode produced differential uplift along large-scale, north trending normal faults. The faulting displaced prior thrust planes and the overall uplift of horst and graben blocks is responsible for the present topography.

In Late Eocene time the quartz monzonite of the Little Cottonwood stock was intruded into Paleozoic rocks and uplifted them. In Corner and Dry Creek canyons this contact is mapped as a normal fault and reflects its most recent movement.

The Wasatch fault zone marks the western boundary of the Wasatch Mountains and is considered to be active today. The zone consists of many branching, braided, and *en echelon* faults that displace Paleozoic rocks as well as Quaternary deposits. Rocks that crop out high on the mountains are locally dropped to valley level, or lower, along faults dipping 30° to 50° west. Along the face of Buckley Mountain, limestones of Mississippian age are in fault contact with rocks of Precambrian age and the displacement is over 5,000 feet (1,524 meters) (Baker, 1973). Hintze (1972, p. F3) discusses three Wasatch fault zone scarps east of Provo that offset Quaternary deposits: (1) the Water Tank fault scarp displaces alluvial fan material about 15 feet (4.6 meters) in Rock Canyon where the road crosses the fault . . . but 0.2 mile south of this crossing the scarp is 35 feet (10.7 meters) high; (2) the fault scarp at the mouth of Slate Canyon, between the two water tanks, has a height of about 60 feet (18.3 meters); (3) the westernmost pair of fault scarps just west and south of the mouth of Rock Canyon dip towards each other and together form the flanks of a graben. These relatively fresh scarps give ample evidence that the Wasatch fault zone is seismically active.

During Pleistocene time, the higher reaches of the mountains were extensively glaciated. Great cirques that flank the summits of Box Elder Peak and Mount Timpanogos are impressive evidence of glaciers. American Fork Canyon must have been occupied by ice above Tibble Fork (Baker and Crittenden, 1961). Extensive moraines are present in and near the mouth of Dry Creek Canyon northeast of Alpine. Moraines are prominent on the north slopes of Mount Timpanogos and along the north Fork of Provo River. Another area of moraines extends down Provo Deer Creek beyond Cascade Springs. Moraines are present in all the larger tributaries of the South Fork of Provo River. Glaciers occupied cirques on the east side of Corral Mountain, a cirque on the east side of Spanish Fork Peak, and cirques on Loafer Mountain, especially the north slope.

#### Utah Valley and Goshen Valley

The valley topography was shaped by Pleistocene Lake Bonneville and by stream activity. Lake Bonneville occupied Jordan Valley, Utah Valley, and most other valleys in western Utah during Late Pleistocene time. The sediments deposited in this ancient lake have been divided into three formations: Alpine (oldest), Bonneville, and Provo (youngest). These sediments are unconsolidated, but locally are loosely cemented by calcium carbonate. Currents in Lake Bonneville and contemporaneous stream flows from the mountains combined to form spits, beaches, bars, and huge deltas such as those at and in between Dry Creek and American Fork canyons (Highland Bench), surrounding the mouth of Provo Canyon (Orem Bench), and surrounding the mouth of Spanish Fork Canyon. Pre-Lake Bonneville alluvial fans underlie most of these deposits and project above them on the mountain flanks. Lake bottom sediments form a nearly flat plain in the central parts of Utah and Goshen valleys.

The Jordan River flows northward from Utah Lake and has dissected Lake Bonneville deposits. Within its floodplain the river has deposited mostly fine-grained sediments. The perennial contributors of water to Utah Lake; Dry Creek, American Fork River, Provo River, Hobble Creek, and Spanish Fork River, have all laid down extensive floodplain deposits, channel alluvium, and combined delta-floodplain complexes. There are no perennial streams on the west side of Utah Valley and the intermittent drainages have deposited mostly channel alluvium. Widespread sheet flooding between drainages has left a thin veneer of alluvium over the Lake Bonneville sediments. The only perennial stream in Goshen Valley is Currant Creek which has deposited considerable alluvium.

The Lake Bonneville deposits which were mapped by Hunt (1953) and Bissell (1963) have been modified for the present map and are portrayed as follows: (1) Provo Formation and younger lake bottom sediments (Qlb), (2) offshore facies of the Alpine Formation (Qac), (3) shore facies of the Provo Formation (Qpsf), and (4) shore facies of the Alpine and Bonneville formations (Qba). Clay, silt, and fine sand are the main constituents of units one and two. Sand and gravel are the chief constituents of units three and four and many sand and gravel pits have been opened in unit three.

The structure of Utah and Goshen valleys may be visualized as several northwest-trending horsts and grabens which have all been downdropped relative to the mountains on each side. The Charleston zone of thrust faults presumably underlies the valleys at some depth and its thrust plane(s) have been offset by the normal faults. The thickness of the valley fill is indicated by the following from *Survey Notes*, Utah Geological and Mineral Survey, May 1979, p. 3:

> "On July 1, 1977, Gulf Oil Exploration and Production Company spudded the No. 1 Banks Well, NW SW section 13, T. 8 S., R. 2 E., Utah County, a few blocks west of the town of Spanish Fork and nearly in a central position within Utah Valley (the well was completed on 9-12-77).
>
> Total depth was to 13,000 feet in what palynologists later confirmed as Miocene sediments. Paleozoic formations were never reached. Formation dips in the bottom of the drill hole were considerably greater than expected and several faults and/or unconformities were crossed during the drilling.
>
> Unconsolidated gravels, conglomerates, clays, silts, and sands predominated in the first few thousand feet of the hole . . . Some sedimentary volcanics were drilled along with altered tuffs and pyroclastics . . . Thin beds of lacustrine limestones were common, and occasional thin coals were encountered in the lower part of the hole.
>
> . . . Thicknesses of Tertiary rocks, depth of burial, and geothermal temperatures proved sufficient for generation of gas and oil within the Tertiary section, and porous and permeable sandstones were found. Left unresolved were questions relating to the yet undrilled section."

The Quaternary and Tertiary sediments in Goshen Valley may be about the same thickness.

#### Northern Juab Valley

Large coalescing alluvial fans are present on both sides of this valley. Those on the east side are extremely large and extend almost to the center of the valley. Two landslides are present here; the northernmost, in the NE ¼ sec. 27, T. 10 S., R. 1 E., is about one-half mile wide at the toe and consists of jumbled debris of the North Horn Formation. Highway I-15 cuts through the toe of the landslide. About two miles south is a large hummocky debris slide at Mendenhall Canyon.

The lowest elevation in northern Juab Valley is 4,877 feet (1,487 meters) at Mona Reservoir. It is thought that the valley was occupied by only the highest stages of Lake Bonneville; the Alpine and Bonneville. Alpine sediments were mapped along the center of the valley but no shoreline deposits of either formation could be found.

The structure of northern Juab Valley is presumed to be a graben that consists of a downdropped east limb of an anticline. Foutz (1960, p. 29) states that on the west side of the valley, the Humbug Formation (Mississippian) dips to the east and that on the east side of the valley more Humbug outcrops have about the same attitude. The fault along the east side of the valley is quite obvious, but the only evidence for a fault on the west side is the vertical stratigraphic displacement. Foutz (1960, p. 29) mentions that at Mendenhall Canyon the northward-trending Wasatch fault is deflected to the northeast and crosses Santaquin Canyon about three miles southeast of the town of Santaquin.

#### West Mountain and Long Ridge

West Mountain and Long Ridge constitute one of the easternmost ranges in the Basin and Range province. West Mountain is the most prominent topographic feature in the south-central part of the map. It trends north-south for about eight miles and separates Goshen Valley on the west side from southern Utah Valley on the east side. Along the crest line, altitudes average about 6,730 feet (2,051 meters) and the mountain rises to 2,230 feet (680 meters) above the valleys. Southward, West Mountain gradually slopes downward into a series of low rounded hills; the White Lake Hills and Goshen Hill. These hills gradually rise in elevation to the northern part of Long Ridge which forms a low, narrow, arc-shaped ridge continuing to the southwest. Several distinct peaks along the crest of Long Ridge average about 5,830 feet (1,777 meters) in altitude. The west side of the ridge is a fairly steep escarpment and the east side is a gently inclined slope.

West Mountain, the intervening hills, and the northern part of Long Ridge are mainly composed of Paleozoic rocks, Cretaceous-Tertiary strata, and Tertiary rocks. The Paleozoic rocks predominantly consist of quartzite, limestone, shale, dolomite, and sandstone. Cretaceous-Tertiary rocks are represented by a reddish conglomerate, the North Horn Formation. A Tertiary fresh-water limestone, the Flagstaff Limestone, caps the top of West Mountain. Lake Bonneville shoreline deposits and Recent alluvial fans surround the base of West Mountain, almost inundate the low hills, and overlap the western base of Long Ridge.

Long Ridge and West Mountain are probably bounded by normal faults that continue northward under Utah Valley. In West Mountain, nearly vertical Oquirrh Formation and Kirkman Limestone are thrust over Cambrian to Mississippian strata at the south end (Hintze, 1962). In the vicinity of the Keigley quarries, other thrusts displace Paleozoic rocks. Brady (1965, p. 43-46) discusses these thrust faults in some detail. Horizontal displacements appear to vary from a few thousand feet to several miles.

Muessig (1951, p. 130-58) describes the structure of Long Ridge as an asymmetric anticline that plunges southward. The flatter and longer east limb of this anticline includes Warm Springs Mountain, the Little Valley area, Government Ridge, and northern Juab Valley. Long Ridge has been broken by numerous west and northwest trending normal faults as well as tear faults.

#### The Mosida and Fox hills

These low hills are on the west side of Utah Lake and south of Lake Mountain. The Mosida Hills, the southernmost group, consist of symmetrical north-south elongated hills with a general relief of about 600 feet (183 meters) above Utah Lake. The highest point is Cat Hill which has an elevation of 5,293 feet (1,613 meters). The Fox Hills gradually rise in elevation northward from 5,040 feet (1,536 meters) to 5,420 feet (1,652 meters) just south of Soldiers Pass. All but the highest peaks and ridges of these hills were covered by the higher levels of Lake Bonneville.

The central and northern Mosida Hills on the map consist of the Gardison Limestone, Deseret Limestone, and Humbug Formation; all of Mississippian age. The southern part of the hills are covered by volcanic rocks, chiefly basaltic flows. Hoffman (1951, p. 50) has mapped these hills and he states that the rocks have been folded into a series of north-south trending asymmetric synclines and anticlines, all of which have steep east dips. In the central part of the area, several west-trending tear faults are present.

In the Fox Hills, Davis (1981a) has mapped Tertiary volcanic rocks and sedimentary strata. The volcanic rocks were all mapped under the symbol Tv but they actually consist of three types: (1) pyroclastics, light gray (weathers tan to brown), mostly a latite breccia, (2) basalt, hard, dense, vesicular, dark brown, and (3) a latite flow, dark gray (weathers brown), very fine-grained, highly laminated (¼-inch to 1-inch laminae). The sedimentary rocks are alluvial and lacustrine deposits that were mapped as the Salt Lake Group. No structural trends or faults were observed mainly due to the covered nature of the terrain.

#### Lake Mountain

This range, on the west side of Utah Lake, is about 14 miles long in a north-south direction with a maximum width of 6 miles. The north one-half of the mountain is convex to the northeast. The summit area has two, almost parallel, north-trending crest lines of about the same elevations. A cluster of 7 peaks on both crest lines in Sections 22 and 27, T. 6 S., R. 1 W. have elevations ranging from 7,528 feet (2,295 meters) to 7,690 feet (2,344 meters). The mountain has a general relief of 3,100 feet (945 meters) above Utah Lake.

The rocks of Lake Mountain include Mississippian, lower Pennsylvanian, Tertiary and Quaternary strata. The Mississippian formations are the Gardison Limestone, Deseret Limestone, Humbug Formation, Great Blue Limestone, and the lower part of the Manning Canyon Shale. Lower Pennsylvanian strata includes the upper part of the Manning Canyon Shale and about 6,300 feet (1,920 meters) of the Oquirrh Formation. Tertiary rocks include volcanics and the Salt Lake Group on the southwest margin of the mountain. Quaternary deposits surround the lower slopes of the mountain and include a pre-Lake Bonneville fanglomerate, Lake Bonneville shoreline deposits, and Recent alluvium.

The Lake Mountain structure is a syncline whose axis is through the north-south middle of the mountain. The fold axis is just east of, and parallel to Mercer Canyon, passes northward between the dual crests of the range, then veers to the northwest. A tear fault through Long Canyon and striking northeast, offsets the syncline at the south end. Bullock (1951, p. 27-28) describes small thrust faults on the east and west margins of the mountain; some of the overthrust rocks have moved to the east at least two miles. Lake Mountain is thought to be part of a Late Cretaceous thrust sheet from the west, or southwest, that has been uplifted by Tertiary normal faulting on the east and west sides.

Cedar Valley lies west of Lake Mountain and was covered by Lake Bonneville waters during its higher stages. Offshore facies of the Alpine Formation are shown on the map for the eastern margin of this valley.

### GENERAL REFERENCES

The interested reader is referred to the following publications that deal with the general geology, the Wasatch fault zone, hydrology, and environmental problems along the southern Wasatch Front:

Armstrong, Robert M., 1975, Environmental geology of the Provo-Orem area: Brigham Young University Geology Studies, v. 22, part 1, p. 39.

Brady, Michael J., 1965, Thrusting in the southern Wasatch Mountains, Utah: Brigham Young University Geology Studies, v. 12, p. 3.

Dustin, J. D. and Merritt, L. B., 1980, Hydrogeology of Utah Lake with emphasis on Goshen Bay: Utah Geological and Mineral Survey Water Resources Bulletin 23, 50 p.

Hintze, L. F., 1972, Wasatch fault zone east of Provo, Utah: *in* Environmental geology of the Wasatch Front, 1971: Utah Geological Association Publication 1, p. F1-F10.

Hintze, L. F., 1973, Geologic history of Utah: Brigham Young University Geology Studies, v. 20, part 3, 181 p.

Hintze, L. F., 1980, Geologic map of Utah (1:500,000): Utah Geological and Mineral Survey, 2 sheets.

Marsell, R. E. (ed), 1964, The Wasatch fault zone in north central Utah: Guidebook to the geology of Utah, no. 18, Utah Geological Society, 60 p.

[1] Geologist, Utah Geological and Mineral Survey.

*Refers to Index of Map Sources numbers.

## EXPLANATION

### QUATERNARY

**Recent**

**UNCONSOLIDATED DEPOSITS**

**Qa** — Alluvial Deposits
*Stream alluvium, alluvial fans, and locally, mudflows and colluvium.*

**Qfp** — Floodplains
*Floodplains adjacent to existing streams; mostly silt and sand deposits.*

**Qfpd** — Floodplain and Delta Complex
*Chiefly fine-grained and poorly drained sediments.*

**Qaf** — Abandoned Floodplains and Stream Channels
*Chiefly deposits of silt, sand and gravel.*

**Pleistocene and Recent**

**Qmf** — Mudflow
*Mudflow, dominantly volcanic material in Provo Deer Creek Canyon.*

**Qt** — Terrace Deposits
*Stream terraces consisting of silt, sand, and gravel.*

**Qls** — Landslides
*Masses of rock and soil moved downslope by the force of gravity; generally unstable slopes.*

**Pleistocene**

**Qlb** — Provo Formation and Younger Lake Bottom Sediments
*Clays, silts, sands, and locally, offshore sand bars.*

**Qpsf** — Provo Formation and Younger Shore Facies
*Chiefly sand and gravel in beach deposits, bars, spits, and deltas.*

**Qba** — Bonneville and Alpine Formations**
*Mainly shore facies of sand and gravel; includes beach deposits, bars, spits, and deltas.*

**Qac** — Alpine Formation
*Chiefly offshore facies of clay, silt, and fine sand in thin beds.*

**Qm** — Moraines
*Glacial moraines, till, and outwash that consist of unsorted mixtures of clay, silt, sand, gravel, and boulders.*

**Qfg** — Fanglomerate
*Unconsolidated and poorly sorted boulders, gravel, sand, silt, and clay deposited in pre-Lake Bonneville alluvial fans. In the mountains some of these deposits may be Late Tertiary.*

*UNCONFORMITY*

### TERTIARY

**SEDIMENTARY ROCKS**

**Lower Oligocene to Upper Pliocene**

**Tsl** — Salt Lake Group
*Contains one to several diverse units or formations in different localities; in the Jordan Narrows there is a lower water-laid unit of white marlstone, cherty limestone, sandstone, and rhyolitic tuff (300 ft.); a middle unit of tan mudstone, siltstone, and a basal conglomerate (100 ft.); and an upper white or pale cream travertine unit (0-20 ft.). In the Fox Hills there is white, light-gray, tan, and orange-brown thin-bedded limestone; yellow, vermilion, orange, gray, and lavender thin-bedded fluvial siltstone and very fine-grained sandstone in different exposures totalling about 30 ft.*

**Upper Eocene and Lower Oligocene**

**Tt** — Tibble Formation
*This unit includes pebble to boulder conglomerate, sandy to shaly greenish-gray to reddish-brown tuffaceous sediments, and thin lenticular beds of white fresh-water limestone. The larger boulders are gray to red andesite or latite; the unit is about 2,500 ft. thick in American Fork Canyon.*

**Eocene**

**Tgr** — Green River Formation
*Gray to greenish-gray shale interbedded with gray sandstone and sandy limestone; about 360 ft. thick in Thistle Creek area.*

**Tc** — Colton Formation
*Chiefly red sandstone, siltstone, and shale; locally conglomeratic; approximately 310-550 ft. in thickness.*

**Paleocene**

**Tf** — Flagstaff Limestone
*Tan and brown to white limestone with some light pink streaks; abundant algal concretions. Rawson (1957, p. 6) reports a thickness of 600 ft.*

**Upper Cretaceous and Lower Paleocene**

**KTn** — North Horn Formation
*Mostly red conglomerate with subordinate pale red shale and siltstone; clasts in conglomerate are pebble-to cobble-size and mainly limestone and quartzite. Rawson (1957, p. 16) estimates a thickness of 400-500 ft.*

*UNCONFORMITY*

### JURASSIC

**Middle and Upper Jurassic**

**Jtc** — Twin Creek Formation
*Gray thin-bedded limestone and shale with some interbedded green shale in upper part; about 1,100 ft. thick in Spanish Fork Canyon.*

### TRIASSIC

**Upper Triassic and Lower Jurassic**

**JTRn** — Nugget Sandstone
*Tan, gray, and pale orange crossbedded sandstone; 1,500 ft. thick.*

**Upper Triassic**

**TRau**, **TRam**, **TRal** — Ankareh Formation
TRau, *red and variegated shale interbedded with gray to red sandstone; 450 ft. thick.*
TRam, *coarse gray to red conglomeratic sandstone; 35 ft. thick.*
TRal, *red to brown thin-bedded sandy shale and sandstone; 1,000 ft. thick.*

**Lower Triassic**

**TRt** — Thaynes Limestone
*Brown-weathering gray limestone with interbedded gray sandstone and some red shale; 950 ft. thick.*

**TRw** — Woodside Shale
*Red to brown thin-bedded shale, siltstone, and sandstone; 315 ft. thick.*

*UNCONFORMITY*

### PERMIAN

**OQUIRRH BASIN FACIES**

**Lower Permian**

**Pp** — Phosphoria Formation (or Group)
*Light gray massive cherty limestone with some interbedded dolomite; phosphatic and siliceous shale in middle part; 1,655 ft. thick in upper Hobble Creek Canyon.*

**Pdc** — Diamond Creek Sandstone
*Tan, gray, and red crossbedded sandstone with some interbedded dark to light gray limestone; 1,000 ft. thick.*

**Pk** — Kirkman Limestone
*Gray to black limestone, partly laminated; partly cemented breccia; 75-200 ft. thick.*

**SHELF FACIES**

**Ppc** — Park City Formation
*Gray to tan limestone with interbedded gray to tan limy sandstone and a medial unit of black shale and thin phosphatic shale; thickness 870 ft. in the northeast corner of the map.*

*UNCONFORMITY*

### PENNSYLVANIAN

**Pennsylvanian Lower**

**IPPo** — Oquirrh Formation
*This formation (or group) is a thick allochthonous unit that has moved eastwards along with other strata in great imbricate thrust slices. In general the lower 1100-1300 ft. consists of dark gray to black, thin- to thick-bedded cherty limestone with a few quartzite beds. Above this basal unit the remainder of the formation is composed of gray to tan limy or quartzitic sandstone, tan quartzite, and gray to black limestone and cherty limestone; 17,050 ft. thick in Provo Canyon area, 6,300 ft thick in Lake Mountain.*

**Middle Upper**

**IPMmc** — Manning Canyon Shale
*Black and brown shale with interbedded thin gray limestone and shaly sandstone; 1,650 ft. thick north of Springville, 1,121 to 1,419 ft. thick in Lake Mountain.*

**IPw** — Weber Quartzite
*Gray to tan quartzitic sandstone with beds of gray cherty limestone; 8,000 ft. thick along the ridge north of Bear Canyon on the northeast part of the map.*

**IPrv** — Round Valley Limestone
*Light gray crystalline limestone with white and orange-red chert; 225-400 ft. thick.*

### MISSISSIPPIAN

**Upper Mississippian**

**Mgb** — Great Blue Limestone
*Dark gray to black, thin, regularly bedded limestone and shaly limestone with some interbedded brown and black shale; 2,800 ft. thick in the Rock Canyon area (east of Provo) and about 2,500 ft. thick in the Lake Mountain.*

**Mdo** — Doughnut Formation
*Black shale and dark to light gray limestone, in part shaly; 1,300 ft. thick.*

**Mun** — Mississippian Rocks Undivided
*Includes, in ascending order, the Fitchville Formation, Gardison Limestone, Deseret Limestone, and Humbug Formation.*

**Mh** — Humbug Formation
*Medium-to fine-grained gray to tan sandstone interbedded with light to dark gray cherty limestone and dolomite; 520 ft. thick in Rock Canyon east of Provo.*

**Md** — Deseret Limestone
*Interbedded dark- to light-gray limestone and dolomite in thick beds with distinctive black chert in thin layers, blebs, and irregular masses; about 575 ft. thick in Springville quadrangle.*

**Lower Mississippian**

**Mg** — Gardison Limestone
*Dark gray thick- to thin-bedded limestone with abundant light-brown to black chert; thickness about 900 ft. in Springville quadrangle.*

**Mf** — Fitchville Formation
*Medium- to light-gray thick-bedded vuggy dolomite; some interbedded limestone in upper part; thickness ranges from 100 to 265 ft. in Springville quadrangle; unconformable on Cambrian strata; conformable on Pinyon Peak Limestone.*

### DEVONIAN

**Upper Devonian**

**Dpp** — Pinyon Peak Limestone
*Light- to dark-gray argillaceous and silty limestone and dolomite; 120 ft. thick in West Mountain.*

**Dv** — Victoria Formation
*Chiefly yellow-brown limonite stained quartzite that is 80 ft. thick in the Little Valley area of Long Ridge.*

*UNCONFORMITY*

### CAMBRIAN

**Upper Cambrian**

**€u** — Upper Cambrian Rocks Undivided
*Includes the Opex Formation and the Ajax Dolomite; the Opex is mostly light-gray thin- to thick-bedded dolomite and on Dry Mountain and West Mountain the symbol includes only this formation which is 206-472 ft. thick. The Ajax is dark to light gray dolomite with limestone in the upper part; 310-523 ft. thick in Long Ridge.*

**Middle Cambrian**

**€mu** — Middle Cambrian Rocks Undivided
*North of Spanish Fork Canyon the symbol includes the Ophir Formation and the Maxfield Limestone. Southwest of Spanish Fork Canyon the symbol includes the following carbonate units with representative thicknesses (in ascending order): Teutonic Limestone, 360 ft.; Dagmar Dolomite, 30-60 ft.; Herkimer Limestone, 340 ft.; Bluebird Dolomite, 200-300 ft.; Cole Canyon Dolomite, 460 ft.*

**€m** — Maxfield Limestone
*Dark- to light-gray thin- to thick-bedded limestone generally with gray to brown mottling; some interbedded gray to white dolomite especially near top; 595 ft. thick in Bridal Veil Falls quadrangle.*

**€o** — Ophir Formation
*Olive-green micaceous shale with some interbedded gray shaly limestone and thin beds of rusty quartzite near the base; 307 ft. thick in West Mountain.*

**€t** — Tintic Quartzite
*Tan-weathering pink and white coarse- to fine-grained quartzite with pebble conglomerate at base; thickness 1,170 ft. in Slate Canyon and 959 ft. in Dry Mountain.*

*UNCONFORMITY*

**€p€tb** — Tintic Quartzite and Big Cottonwood Formation
*These units are mixed, shattered, and contorted in the Charleston thrust zone just west of Deer Creek Reservoir.*

### PRECAMBRIAN

**Upper Precambrian**

**p€m** — Mutual Formation
*Gray, tan, and greenish-gray coarse sandstone; grayish-red shale and fine-grained sandstone; conglomerate with pebbles and boulders of schist, gneiss, limestone, and tillite; ranges from 100-1,300 ft. thick in the Timpanogos Cave quadrangle.*

*UNCONFORMITY*

**p€mf** — Mineral Fork Tillite
*Dark brown to black micaceous siltstone with boulders of quartzite, dolomite, gneiss, and greenstone; 250-300 ft. thick in American Fork Canyon.*

*UNCONFORMITY*

**p€bc** — Big Cottonwood Formation
*Tan, maroon, and pinkish-gray coarse-grained to conglomeratic quartzite with interbedded gray, green, and purple micaceous quartzite and phyllite; also purple, red, and maroon slate; thickness 1,347 ft. in Slate Canyon and 1,236 ft. at south end of Dry Mountain.*

*UNCONFORMITY*

**Middle Precambrian**

**p€f** — Farmington Canyon Complex
*About 900 ft. of these metamorphic rocks are exposed on the west side of Dry Mountain in the south-central part of the map. The complex consists of green to greenish-black quartz-hornblende-biotite schist and pink and dark green granitic gneiss. The schist and gneiss are intruded by numerous microcline-quartz rich pegmatites and pink granite dikes and sills.*

### Tertiary Igneous Rocks

**Upper Eocene and Oligocene**

**Tv** — Volcanic Rocks
*Volcanic flows, tuffs, welded tuffs, breccias, and stream deposited pyroclastics; lithologies are latite, andesite, and rhyolite; includes the Moroni Formation on the southeastern part of the map and the Laguna Springs Latite on Long Ridge; thicknesses range from a few ft. to hundreds of ft.*

**Tqm** — Quartz Monzonite
*Light gray porphyritic quartz monzonite of the Little Cottonwood stock.*

Contact
*Dashed where approximately located; dotted where concealed.*

Fault
*Dashed where approximately located; dotted where concealed; bar and ball on downthrown side.*

Thrust Fault
*Dashed where approximately located; dotted where concealed; sawteeth on upper plate.*

24
*Strike and dip of beds*

** **Alpine Formation:** Early mappers subdivided Lake Bonneville sediments into divisions which corresponded to deposits associated with the various shorelines. One of these was the "Alpine Formation" which is not accepted by more recent workers and which they include with the uppermost shoreline. Since this map is a compilation of previous works the "Alpine Formation" has been maintained in the map and represents transgressive shoreline deposits.

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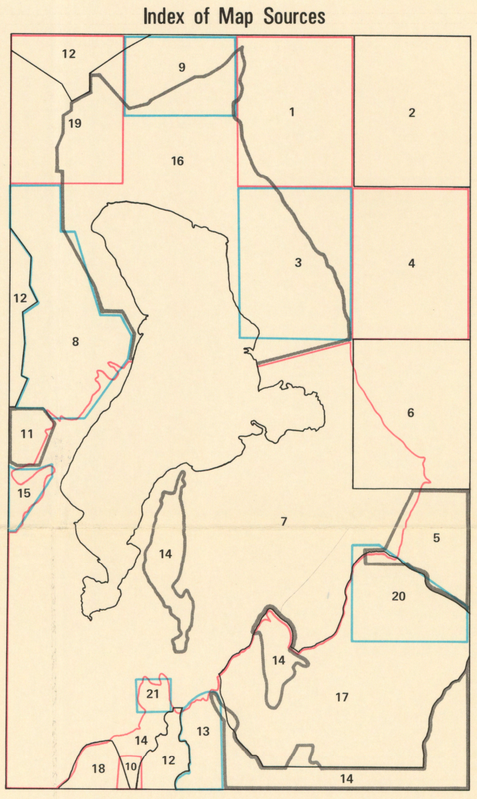
### Index of Map Sources




1. **Baker, A. A. and Crittenden, M. D., Jr.,** 1961, Geology of the Timpanogos Cave quadrangle, Utah: U. S. Geological Survey Map GQ-132.
2. **Baker, A. A.,** 1964a, Geology of the Aspen Grove quadrangle, Utah: U. S. Geological Survey Map GQ-239.
3. **Baker, A. A.,** 1964b, Geology of the Orem quadrangle, Utah: U. S. Geological Survey Map GQ-241.
4. **Baker, A. A.,** 1972a, Geologic map of the Bridal Veil Falls quadrangle, Utah: U. S. Geological Survey Map GQ-998.
5. **Baker, A. A.,** 1972b, Geologic map of N.E. part of Spanish Fork Peak quadrangle, Utah: U. S. Geological Survey Open-File Map.
6. **Baker, A. A.,** 1973, Geologic map of the Springville quadrangle, Utah: U. S. Geological Survey Map GQ-1103.
7. **Bissell, H. J.,** 1963, Lake Bonneville: Geology of southern Utah Valley, Utah: U. S. Geological Survey Professional Paper 257-B.
8. **Bullock, Kenneth C.,** 1951, Geology of Lake Mountain, Utah: Utah Geological and Mineralogical Survey Bulletin 41, 46 p.
9. **Bullock, R. L.,** 1958, Geology of the Lehi quadrangle, Utah: Unpublished Brigham Young University M.S. thesis.
10. **Clark, R. S.,** 1953, Structure and stratigraphy of Government Ridge, Utah: Unpublished Brigham Young University M.S. thesis.
11. **Davis, F. D.,** 1981a, Tertiary rocks in the Fox Hills, Utah: Unpublished Utah Geological and Mineral Survey map.
12. **Davis, F. D.,** 1981b, Quaternary mapping at the south end of Jordan Valley, the eastern margin of Cedar Valley, and northern Juab Valley, Utah: Unpublished Utah Geological and Mineral Survey map.
13. **Foutz, D. R.,** 1960 Geology of the Wash Canyon area, southern Wasatch Mountains, Utah: Brigham Young University Research Studies, Geology Series v. 7, no. 2.
14. **Hintze, L. F.,** 1962, Geology of the southern Wasatch Mountain and vicinity, Utah: Brigham Young University Geology Studies, v. 9, part 1.
15. **Hoffman, F. H.,** 1951, Geology of the Mosida Hills area, Utah: Unpublished Brigham Young University M.S. thesis.
16. **Hunt, C. B.,** 1953, Lake Bonneville: Geology of northern Utah Valley, Utah: U. S. Geological Survey Professional Paper 257-A.
17. **Metter, R. E.,** 1955, Geology of the northern part of the southern Wasatch Mountains, Utah: Unpublished Ohio State University Ph D. dissertation.
18. **Muessig, S. J.,** 1951, Geology of a part of Long Ridge, Utah: Unpublished Ohio State University Ph. D. dissertation.
19. **Pitcher, G. G.,** 1957, Geology of the Jordan Narrows quadrangle, Utah: Brigham Young University Geology Series, v. 4, no. 4.
20. **Rawson, R. R.,** 1957, Geology of the southern part of the Spanish Fork Peak quadrangle, Utah: Brigham Young University Research Studies, Geology Series, v. 4, no. 2.
21. **Sirrine, G. K.,** 1953, Geology of Warm Springs Mountain, Utah: Unpublished Brigham Young University M.S. thesis.