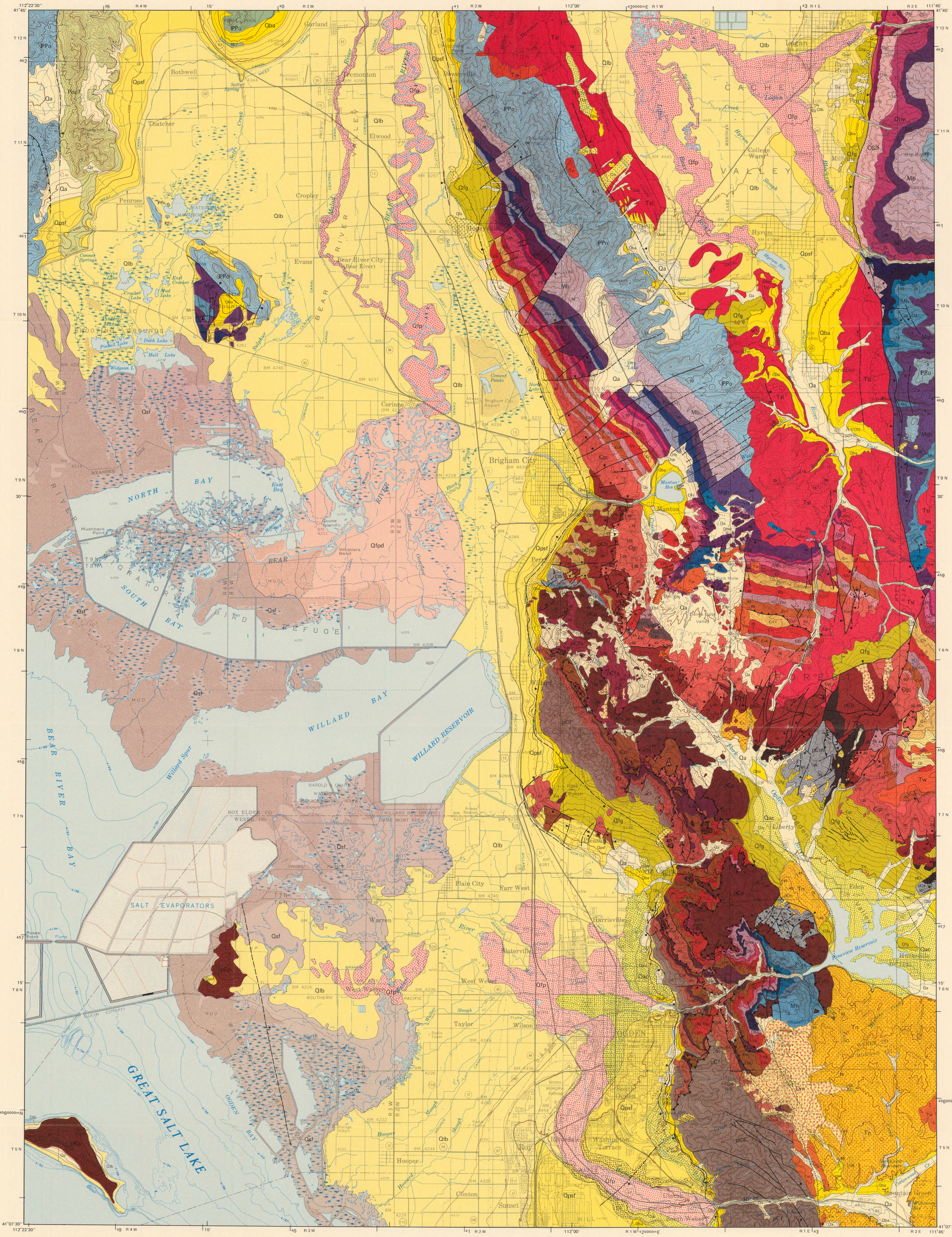
STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES AND ENERGY
UTAH GEOLOGICAL AND MINERAL SURVEY

MAP 53-A
Sheet 1 of 2
Geologic Map–Northern Wasatch Front



Base from U.S. Geological Survey
Great Salt Lake and Vicinity, 1:125,000, 1974

SCALE 1:100,000

MILES
FEET
KILOMETERS

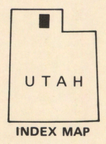
Contour interval 100 feet
Underwater contour interval 1-foot
Datum mean sea level

Appropriation No. 6120
Archives Approval No. P840153

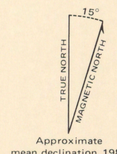
MAP 53-A
GEOLOGIC MAP OF THE NORTHERN WASATCH FRONT, UTAH
1985

Compiled by Fitzhugh D. Davis

Klaus D. Gurgel, Cartographic Editor
B.R. Jones, D.E. Powers, and K.D. Brown, Cartographers



INDEX MAP



Approximate
mean declination, 1981

Published and sold by
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GEOLOGIC MAP OF THE NORTHERN WASATCH FRONT, UTAH

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GEOLOGY OF THE NORTHERN WASATCH FRONT

Fitzhugh D. Davis[1]

INTRODUCTION

The accompanying map is one of a series that depict various aspects of the physical environment along the Wasatch Front between Tremonton and Logan on the north, and Santaquin on the south. The northern Wasatch Front sector covers the area from Logan and Tremonton southward to Weber Canyon and Sunset. This area is being rapidly urbanized and the impact of human activity on the natural environment is (and will be) significant. The quality of the environment and the application of earth science data to planning are of growning concern. Many geologic hazards are portrayed on the map and described in the text. The main perils depicted are (1) landslides and (2) faults - along which earth movements could take place. The northern Wasatch Front map covers the following 7.5 minute topographic quadrangles: Thatcher Mountain, Tremonton, Honeyville, Wellsville, Logan, Public Shooting Grounds, Bear River City, Brigham City, Mount Pisgah, Paradise, Mouth of Bear River, Whistler Canal, Willard, Mantua, James Peak, Willard Spur, Plain City SW, Plain City, North Ogden, Huntsville, Fremont Island, Ogden Bay, Roy, Ogden, and Snow Basin.

GEOLOGY

The northern Wasatch Front map covers parts of two major physiographic provinces. The Middle Rocky Mountains province extends eastward from the western base of the Wasatch Mountains. It consists of high rugged mountains among which are nestled three prominent valleys - Cache, Ogden, and the Weber River. The other major physiographic province is the Basin and Range that extends westward from the base of the Wasatch Mountains. This province is characterized by relatively narrow north-south trending mountain ranges that are separated by broad sediment-filled valleys.

The northern Wasatch Front is a segment of the old Wasatch line which was the hingeline of the Cordilleran geosyncline from at least early Precambrian Z times (800 million years b.p.) until the end of the Paleozoic Era (225 million years b.p.). West of the hingeline great thicknesses of marine basinal and shallow-water sediments accumulated during this time. Precambrian and Early Cambrian clastics, Cambrian and Mississippian carbonates, and Pennsylvanian clastic and carbonate deposition were especially thick. East of the hingeline a markedly thinner shelf sequence of sediments was deposited adjacent the craton. During Triassic and Jurassic time sedimentation diminished (or ceased) west of the hingeline and increased east of it.

From latest Jurassic time to Paleocene time the Sevier Orogenic belt formed in eastern Nevada and western Utah. East-west compressional forces produced large folds and thrust faults that transported thick sections of basinal strata eastward across the Wasatch line. Most of the eastern half of the map is covered by the Cache allochthon **(2)***. This allochthon is defined as the area covered by the upper plate of the Willard thrust. This thrust is part of the continent-long thrust and fold belt and it probably connects with the Crawford or another deep-seated eastern thrust fault beneath the Bear River Range.

The upper plate of the Willard thrust has, at the base, the Facer Formation of Precambrian X age (Crittenden, 1980) then a sequence of Precambrian Z rocks, totaling about 10,000 feet (3,048 meters) in thickness that are overlain by about 25,000 feet (7,620 meters) of Paleozoic strata. In the autochthon (lower plate) exposed in lower Ogden Canyon and southwards, there are no rocks of Precambrian Z age and relatively thin Cambrian Formations unconformably overlie the Farmington Canyon Complex of Precambrian X age. In lower Ogden Canyon and vicinity there are two local thrust faults, the Taylor and Ogden, that are below the Willard thrust and displace Cambrian units.

The Cache allochthon was fragmented by Cenozoic Basin and Range normal faulting that probably commenced in Oligocene or Miocene time. Differential uplift and subsidence occurred along large-scale, north trending faults that displaced prior thrust planes and produced horsts and grabens that outline the present mountains and valleys. In the Wellsville Mountain horst, north of Box Elder Creek (east of Brigham City), the Precambrian to Permian strata strike to the northwest and dip 35 to 50° to the northeast. The beds are offset by numerous northeast trending normal faults that form horsts and grabens of moderate displacement. South of Box Elder Creek, the Precambrian rocks are complexly folded and faulted and strikes vary from northwest to northeast. In the vicinity of Willard Canyon and Ben Lomond Peak, the Willard thrust plate overlies and strikes almost parallel with lower plate Cambrian strata.

On the east side of the northern Wasatch Mountains, the Cache Valley and Ogden Valley grabens were formed by slumping extensional fault wedges. The mountainous area between Cache and Ogden Valleys is a homocline with Precambrian strata at the base (south side) that are overlain successively to the north by Cambrian to Mississippian Formations. All of the beds strike east-west, more or less, and dip from 25 to 55° north. The structural mass is broken on the west side by a north-south fault on the east side of Devils Gate Valley and Sink Hole. The eastern boundary appears to be Davenport Creek and probably one or two north-south faults concealed in that area by Tertiary rocks of the Salt Lake Group. The Cambrian to Pennsylvanian Formations in the western part of the Bear River Range dip 8 to 30° eastward into the Logan Peak syncline **(12)**. On the northeast side of Ogden Valley is a mass of Precambrian and Cambrian strata that are involved in a large northeasterly plunging anticline that extends off the map (Crittenden and others, 1971, p. 588). The Middle Fork of the Ogden River follows the axis of this structure.

On the west side of the northern Wasatch Mountains the Willard thrust was truncated by the north-south trending Wasatch fault zone about 1.5 miles north of the town of Willard. The Blue Spring Hills, the West Hills, Fremont Island, and both places called Little Mountain are probably horsts and eroded remnants of the upper plate of the Willard thrust. The thrust plane(s) are probably at a considerable depth under these horsts and even deeper under the intervening grabens.

Basin and Range faulting is still proceeding, especially in regards to the seismically active Wasatch fault zone and east Cache fault zone (along the western base of the Bear River Range). The vertical displacement across the Wasatch fault zone is about 10,500 feet (3,200 meters). This figure is calculated from information given by the 1974 Geothermal Kinetics Utah Steam Venture No. 1 Davis well which was drilled two miles south of Honeyville. The vertical displacement across the east Cache fault zone is at least 8,600 feet (2,621 meters). This is based on data from the 1977 AMOCO No. 1 Lynn Reese well which was drilled two miles northwest of Logan.

During Pleistocene time, lakes inundated the Wasatch Front, Cache Valley, Ogden Valley, and the Weber River Valley. Lake currents and contemporaneous stream flows from the mountains combined to form spits, beaches, bars, and large deltas such as those surrounding the mouths of Weber Canyon, Ogden Canyon, Box Elder Creek (Brigham City), Logan Canyon, and the coalesced one of Blacksmith Fork and the Little Bear River. Pre-lacustrine alluvial fans (fanglomerate) underlie most of these deposits and project above them on the mountain flanks. The higher parts of the Wasatch and Bear River ranges were glaciated. Cirques, tarns, and moraines of all types are present in the higher altitudes.

During the last 10,000 years (Holocene), the Weber, Ogden, Bear, and Malad Rivers have dissected Pleistocene lacustrine sediments and have developed extensive floodplains in valley areas. Mountain streams have deposited alluvial fans at the mouths of many canyons and have transported large amounts of alluvium into the valleys. Many fault movements in the Wasatch fault zone have offset Quaternary deposits.

ROCK UNIT CHARACTERISTICS

Precambrian Rocks

Precambrian metamorphic and clastic rocks form the steep imposing western slopes of the Wasatch Mountains between Brigham City and Pleasant View. These spectacular slopes display craggy rocks with intermixed sublime hues of olive-green, tan, gray, blue-green, and purple. Another area of magnificent Precambrian scenery is the eastern and northern sides of Ogden Valley. The light-green, lavender, tan, white, and purple rocks in towering summits present a panorama of stark beauty. The deep precipitous gorge of Weber Canyon is lined on both sides by the white, gray, and dark-green banded gneisses and schists of the Farmington Canyon Complex. In places, pink and light-gray pegmatites contrast with the banded rocks.

In general, the Precambrian quartzites, gneisses, schists, argillites, and other lithologies are aquitards where they are saturated with ground water. However, in many places, they are fractured, highly jointed, and faulted which does provide an overall large volume of space for ground water. Uraninite has been found in pegmatites of the Farmington Canyon Complex in the Jim Dandy Mine in Holmes Canyon (NWNW sec. 31, T. 8 N., R. 1 W.).

Most of the Precambrian rock types are readily susceptible to weathering and in many places a fairly thick mantle has accumulated. When this material becomes wet enough it is subject to erosion and debris flows. A prime example is the debris flow from Rudd Creek, east of Farmington (south of the map area) on May 30, 1983. Three large landslides from the Farmington Canyon Complex are present just east and southeast of the Weber College campus. The Farmington Canyon Complex has been used as a source of field stone in the construction of numerous attractive homes.

Paleozoic Rocks

Cambrian

Tintic Quartzite—North and south of the mouth of Ogden Canyon the brilliant white Tintic Quartzite slants across the steep mountain front in repeated, thrust-faulted sections. These dazzling white bands can be seen for many miles. The alpine grandeur of Snow Basin is well-known to skiers and outdoors people. Upper Ogden Bowl, Mt. Ogden Bowl, and Middle Bowl are glacial cirques carved from the Tintic Quartzite near the crest of the Wasatch Range. The formation probably is an aquitard or an aquiclude in places where it is saturated. A large landslide, composed of Tintic Quartzite rubble, is adjacent to the mountain front in the vicinity of Rice Creek Spring northeast of North Ogden.

Ophir Formation—This unit is fairly soft and easily eroded, but there are good exposures in North Ogden Canyon and the lower part of Ogden Canyon. Galena, sphalerite, and cerussite have been found as bedded replacement lodes in this formation about a mile west of Willard Peak in the SESW sec. 32, T. 8 N., R. 1 W. The Eldorado (or Alvarado) Mine opened in 1898 and was worked intermittently until 1973 **(6, p. 177)**.

A large abandoned nondescript pit in brownish-gray shales of the Ophir Formation is located on the Pleasant View salient in the NE sec. 13, T. 7 N., R. 2 W. The shale has been used to manufacture bricks and possibly other clay products in the Harrisville brick plant.

Langston Formation—Just north of Brigham City this formation is well exposed in the lower slopes of Wellsville Mountain. The formation is probably an aquifer. A middle shale unit, the Spence Shale Member, is very fossiliferous. Abundant, well preserved Cambrian trilobites have been found in it near the mouth of Cataract Canyon about 2.2 miles north of North Lake.

Blacksmith Limestone—This massive cliff-forming limestone and dolomite unit is conspicuous in Wellsville Mountain north of Brigham City. It is probably an aquifer where ground water is available. The formation would probably make good concrete aggregate after quarrying and crushing.

Bloomington Formation—Stibnite was mined from this formation in the old Dry Lake Antimony Mine (Copper Blossom Mine) near the mouth of Antimony Canyon in the NENE sec. 36, T. 10 N., R. 2 W. Galena, sphalerite, and smithsonite were mined from replacement deposits in the unit in the old Baker Mine in the SWNW sec. 30, T. 10 N., R. 1 W. The Bloomington Formation has upper and lower shale members and, as a whole, it quite possibly has the essential ingredients for Portland cement. The formation is an aquifer and, in places, has produced karst topography.

Nounan Dolomite—This formation and the overlying St. Charles Formation are both cliff-forming units especially on the west face of Wellsville Mountain. Both are probably aquifers where ground water is available. Also, both would probably make good concrete aggregate.

Ordovician

Garden City Limestone—The majestic western escarpment of the Bear River Range consists of this unit upwards through Mississippian strata. It is also well exposed along the west side of Wellsville Mountain where numerous fossils, namely trilobites, brachiopods, cephalopods, and graptolites can be found, especially in Cottonwood Canyon. The Garden City Limestone is an aquifer and it and the underlying formations have been partially dissolved to form Devils Gate Valley in the NE part of T. 8 N., R. 1 W. The Garden City Limestone was quarried and used in the L.D.S. temple and tabernacle in Logan **(12, p. 21)**.

Swan Peak Quartzite—This formation is the most easily identified in the region and greatly aids in the interpretation of structurally complex areas. It is well exposed in the western slopes of Wellsville Mountain and the Bear River Range. Fossils, especially trilobites, graptolites, brachiopods, and fucoids can be found in it.

Silurian

Laketown Dolomite—This thick, massive dolomite is the only Silurian formation in northern Utah. It's description is the same almost everywhere and it is well exposed on the west side of Wellsville Mountain and in the lower part of Logan Canyon where it forms scenic cliffs. The formation is probably an aquifer where ground water is available. Corals, both solitary and colonial, can be found in it as well as *Halysites*, a chain coral.

Devonian

Water Canyon Formation—This unit is prominent in Wellsville Mountain from east of Honeyville southward into the Pisgah Hills. It is well-known for its fossil fish fauna; armored fish have been found in Coldwater Canyon northeast of Honeyville. The formation is probably an aquifer where ground water is available.

"Jefferson" Formation (Hyrum Dolomite and Beirdneau Sandstone)—In the Bear River Range the Hyrum Dolomite originally was the lower member of the "Jefferson" Formation and the Beirdneau Sandstone was the upper member. Sorensen and Crittenden **(9 and 10)** in their mapping of the Wasatch Range near North Ogden, and the Mantua and Willard quadrangles, discarded the name Jefferson and mapped the Hyrum Dolomite and Beirdneau Sandstone as distinctive formations. The name Jefferson has been retained for other areas on the map. The Hyrum Dolomite and Beirdneau Sandstone are probably aquifers where ground water is available.

Mississippian

Gardison Limestone (Lodgepole Limestone)—The central Utah Mississippian nomenclature is gradually replacing the older, largely Montanan, nomenclature in northern Utah. In Wellsville Mountain and north of Blacksmith Canyon in the Bear River Range the name Lodgepole has been retained. The formation, by whatever name, is cliff-forming, and in the Bear River Range it is locally called the "Chinese Wall". The unit is undoubtedly an aquifer where ground water is available. The unit is very fossiliferous almost everywhere. On the west side of Wellsville Mountain, especially in Hank Bell Canyon, brachiopods, crinoids, bryozoa, gastropods, echinoderms (starfish), and corals have been found.

Deseret Limestone, Humbug Formation, and Great Blue Limestone—These formations are gradually being mapped and replacing the "Brazer" Formation which is now restricted to the Crawford Mountains (east of the map). The Deseret Limestone is 200-250 feet (61-76 meters) thick in Ogden Canyon, but it thins northward and is about 90 feet (27.4 meters) thick in the area east of Honeyville (C.G. Oviatt, Nov. 1984, verbal comm.). The Humbug and Great Blue are present everywhere and are not too difficult to trace. Sphalerite, smithsonite, and hematite were mined from a shear zone of the Great Blue Limestone in the Moon Mine (SESE sec. 11, T. 10 N., R. 1 E.). These deposits were discovered about 1915 **(8, p. 24)**. In Providence Canyon of the Bear River Range the Great Blue Limestone was quarried for use in sugar refining plants in Utah and Idaho **(12, p. 82)**. The limestone was very pure - about 94% calcium carbonate. All of these Mississippian formations are probably aquifers where ground water is available. The Great Blue is quite fossiliferous and it contains abundant gastropods and corals, both solitary and colonial.

Pennsylvanian and Permian

Oquirrh Formation—Quite commonly this formation forms the top of ridges and peaks. The highest peaks of the frontal ridge of the Bear River Range consist of this unit; also the crest of the northern part of Wellsville Mountain where the formation is about 5,600 feet (1,707 meters) thick. It has undergone considerable erosion and the part that is preserved is mostly Pennsylvanian strata. Doelling **(6, p. 52)** reports that the West Hills probably consists of the Permian Oquirrh Formation and 1,600 feet (488 meters) of strata were measured. Most of the Oquirrh Formation is probably an aquifer where ground water is available. In Hank Bell Canyon, 2.5 miles north of Honeyville, corals, bryozoans, crinoids, and fusulinids have been found in the formation.

Cenozoic Rocks

Paleocene and Eocene

Wasatch Formation—This coarse clastic unit unconformably overlies all older formations in areas where it is found. It seems to be only preserved in protected places or on high ridges. It is undoubtedly an orogenic unit shed from an uplift or an encroaching thrust plate. Precise dating of erosional debris is difficult and it may well be that, at least in places, the Wasatch is Late Cretaceous in age.

Oligocene, Miocene, and Pliocene

Norwood Tuff and the Salt Lake Group—On the map the Norwood Tuff is found south of the divide between Cache and Ogden Valleys. The Salt Lake Group is mapped north of the divide. The middle and lower parts of the Salt Lake Group in Cache Valley consists of tuff and tuffaceous sediments and they probably correlate, at least in part, with the Norwood Tuff. The differences in thickness and the variation of lithologies are probably due to different depositional basins. The Norwood Tuff and the Salt Lake Group are probably mixtures of aquifers and aquitards. The greatest part of the strata of both units are soft and relatively easily eroded. Both units have achieved slope stability as they presently stand. Any significant cut into either unit would produce an unstable slope.

Pleistocene

Unconsolidated Pleistocene deposits consist of fanglomerate, glacial moraines, and lacustrine sediments. The deltaic lacustrine deposits are notorious for landslides and many have been mapped. In T. 5 N., R. 1 W., along the north and south sides of the Weber River bluffs, a series of complex slump-earthflows are present in zones at least 3 miles long. These landslides are in thin-bedded deltaic sands, silts, and clays and are very active, especially when they have a high moisture content. In the bluffs south of Ogden River and adjacent to Valley Drive (northern part of sec. 27, T. 6 N., R. 1 W.) are two large landslides. These rotational slumps are in very thin-bedded, fine-grained sands and silts of the Ogden River delta.

Shore and nearshore lake deposits in beaches, bars, spits, and deltas provide abundant sand and gravel for the forseeable future in the northern Wasatch Front. In 1913 the Ogden Portland Cement Company had a plant at Bakers Spur, 5.5 miles northeast of Brigham City (just north of the present city airport). The plant was designed to use nearby lacustrine marl and clay beds for the production of cement. The marl is gray, homogeneous, soft, and unstratified and the underlying clay is light-gray through yellow to bluish in color. The marl is 4 to 10 feet (1.5 to 3.0 meters) deep and the clay has been tested to a depth of 18 feet (5.5 meters). Analyses of the marl and clay are given in Doelling **(6, p. 231)**.

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 northern Wasatch Front:

Crittenden, M. D., Jr., Schaeffer, F. E., Trimble, D. E., and Woodward, L. A., 1971, Nomenclature and correlation of some upper Precambrian and basal Cambrian sequences in western Utah and southeastern Idaho: Geological Society of American Bull., v. 82, p. 581-601.

Crittenden, M. D., Jr., 1980, The Facer Formation, a new Early Proterozoic unit in northern Utah: U.S. Geological Survey Bull. 1482-F, 28 p.

Gwynn, J. Wallace (ed.), 1980, Great Salt Lake: Utah Geological and Mineral Survey Bulletin 116, 400 p.

Hilpert, Lowell S., (ed.), 1972, Environmental geology of the Wasatch Front, 1971: Utah Geological Association Publication 1.

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.

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.

[1] Geologist, Utah Geological and Mineral Survey.
* Refers to Index of Map Sources numbers.

EXPLANATION

- **QUATERNARY**
  - *Pleistocene and Recent*
    - Qa — Alluvial Deposits — *Stream alluvium, alluvial fans, and locally, mud flows and colluvium.*
    - Qsf — Salt Flat — *Soils, poorly drained, with high silt, clay, and salt content.*
    - Qfp — Floodplains — *Floodplains adjacent to existing streams; mostly silt and sand deposits.*
    - Qfpd — Flooplain and Delta Complex — *Chiefly fine-grained and poorly drained sediments.*
    - Qt — Talus — *Rock piles and colluvium on steep slopes or at the base of slopes or cliffs.*
    - Qls — Landslides — *Masses of rock and soil moved downslope by the force of gravity; generally unstable slopes.*
  - *Pleistocene*
    - *Lake Bonneville Group*
      - Qlb — Provo Formation and Younger Lake Bottom Sediments — *Clays, silts, sands, and locally, offshore sandbars.*
      - 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 — *Mainly 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 in age.*

UNCONFORMITY

- **TERTIARY**
  - *Pliocene and Pleistocene*
    - Tsl — Salt Lake Group — *A composite section around the margin of Cache Valley, in descending order, is as follows: (1) light-gray to pale-orange conglomerate of Paleozoic cobbles and pebbles, locally interbedded with white tuff; 3,400 ft. thick, (2) interbedded, light-colored tuffs, tuffaceous sandstones, tuffaceous limestones, pebble conglomerates, and dark limestone; 2,000 ft. thick in southern Cache Valley, and (3) light-gray conglomerate of Paleozoic clasts cemented by calcite, tuff, and red silt; 1,500 ft. thick.*
  - *Upper Eocene and Lower Oligocene*
    - Tn — Norwood Tuff — *White- to tan-weathering tuff and sandy tuff, probably waterlain; about 1,150 ft. thick on the west side of Ogden Valley.*

UNCONFORMITY

- *Paleocene and Eocene*
  - Tw — Wasatch Formation — *Light-reddish brown pebble, cobble, and boulder conglomerate; abundant clasts of tan, gray, and purple quartzite; locally red sandstone; up to 490 ft. thick in the Huntsville quadrangle area.*

- **PENNSYLVANIAN AND PERMIAN**
  - *Pennsylvanian and Permian*
    - Pdc? — Diamond Creek Sandstone? — *Tan to yellow-weathering cross-bedded sandstone and quartzite with some minor sandy limestone or dolomite (Leonard?); about 950 ft. exposed on the east side of the Blue Spring Hills.*
    - IPPu — Pennsylvanian — Permian Undivided — *Gray, thin-bedded, shaly limestones, orthoquartzites, and cherty and sandy limestones in the West Hills (NW of Tremonton); 1,600 ft. have been measured.*
    - IPPo — Oquirrh Formation — *Gray sandy ledge-forming limestone, brown to tan calcareous siltstone, sandstone and quartzite, and minor black shale; at least 6,600 ft. thick east of Deweyville and has undergone considerable erosion in most places.*

UNCONFORMITY

- **MISSISSIPPIAN**
  - *Upper Mississippian*
    - Mgb — Great Blue Limestone — *Chiefly dark gray, thick-bedded to massive, cherty limestone; also minor black shale, nonresistant calcareous sandstone and bioclastic limestone; varies from 725 to 1,300 ft. thick in the Paradise quadrangle.*
    - Mh — Humbug Formation — *Tan and gray siltstone and fine-grained sandstone with interbedded dark to medium gray limestone and dolomite; varies from 800 to 1,100 ft. thick in the Paradise quadrangle.*
    - Md — Deseret Limestone — *Dark- to light-gray limestone and dolomite with thin beds and lenses of dark-gray to black chert; 200 to 250 ft. thick near Pineview dam.*
    - Mb — "Brazer" Formation — *Depicted on older maps; these areas have not been mapped as Deseret Limestone, Humbug Formation, and Great Blue Limestone as yet.*
  - *Mississippian*
    - Mhdg — Humbug Formation and Deseret and Gardison Limestones Undivided
    - Mg — Gardison Limestone — *Medium- to dark-gray, thick-bedded to massive dolomite in upper part; lower part is dark-gray to black, thin- to medium-bedded dolomite; 295 to 850 ft. thick in Ogden Canyon.*
    - Ml — Lodgepole Limestone — *Dark-gray thin-bedded limestone and dolomite characterized by thin wavy chert layers along bedding planes; 500 to 850 ft. thick in the Bear River Range.*

UNCONFORMITY

- **DEVONIAN**
  - *Upper Devonian*
    - Db — Beirdneau Sandstone — *Tan, orange, and brown-weathering fine- to medium-grained sandstone, dolomitic sandstone, and dolomite; 250 to 300 ft. thick in Ogden Canyon.*
    - Dh — Hyrum Dolomite — *Dark-gray to black fine-grained dolomite with many lenses of intraformational dolomite breccia, 960 ft. thick in lower Blacksmith Fork Canyon.*
    - Dj — "Jefferson" Formation — *Depicted on older maps; these areas have not been mapped as Hyrum Dolomite and Beirdneau Sandstone as yet.*
  - *Lower Devonian*
    - Dhw — Hyrum Dolomite and Water Canyon Formation Undivided
    - Dw — Water Canyon Formation — *Medium- to dark-gray dolomite in upper part (265 ft. thick); medium-gray dolomitic sandstone in lower part (290 ft. thick) east of Honeyville.*
    - Djw — "Jefferson" Formation and Water Canyon Formation Undivided in Bear River Range

- **SILURIAN**
  - *Silurian*
    - Sl — Laketown Dolomite — *Medium-gray massive dolomite in the upper part and alternating light and dark-gray dolomite in the lower part; 1,600 ft. thick east of Honeyville.*
    - OSlf — Laketown Dolomite and Fish Haven Dolomite Undivided in Bear River Range

UNCONFORMITY

- **ORDOVICIAN**
  - *Upper Ordovician*
    - Ofh — Fish Haven Dolomite — *Dark gray, coarsely crystalline, massive dolomite; 140 ft. thick in Wellsville Mountain.*
    - Ofs — Fish Haven Dolomite and Swan Peak Quartzite Undifferentiated
  - *Middle Ordovician*
    - Osp — Swan Peak Quartzite — *Orange-pink massive quartzite in upper part, brown to grayish-green quartzite in middle part, and black shale and quartzitic sandstone in lower part; 430 ft. thick in Wellsville Mountain.*
  - *Lower Ordovician*
    - Ofg — Fish Haven Dolomite and Garden City Limestone Undifferentiated
    - Ogc — Garden City Limestone — *Light-gray, medium- to thick-bedded limestone and dolomitic limestone with interbedded intraformational conglomerate; 1,700 ft. thick in Wellsville Mountain and 1,400 ft. thick east of Logan.*

Cambrian and Precambrian Rocks above the Willard Thrust

- **CAMBRIAN**
  - *Upper Cambrian*
    - €s — St. Charles Formation — *Dark-gray, white-weathering, cliff-forming dolomite with a basal gray, brown-weathering quartzite; 1,100 ft. thick in Wellsville Mountain.*
    - €sn — St. Charles Formation and Nounan Dolomite Undivided
    - €n — Nounan Dolomite — *Light gray, finely crystalline, cliff-forming dolomite with interbedded gray limestone in the upper part; 825 ft. thick in Wellsville Mountain.*
  - *Middle Cambrian*
    - €b — Bloomington Formation — *Tan to olive-drab shale with interbedded gray and orange-brown limestone (Calls Fort Shale) in the upper part, 165 ft. thick; light- to dark-gray limestone in the medial part, 500 ft. thick; tan and olive shale with some inter-bedded gray limestone (Hodges Shale) in the lower part, 300 ft. thick.*
    - €bl — Blacksmith Limestone — *Gray to blue-gray, thin- to medium-bedded limestone and dolomite; 800 ft. thick in Wellsville Mountain.*
    - €ut — Ute Limestone — *Light- to dark-gray limestone with inter-bedded gray sandstone, and greenish shale; 645 ft. thick in Wellsville Mountain.*
    - €ul — Ute Limestone and Langston Formation Undivided
    - €l — Langston Formation — *Gray limestone inter-bedded with gray shale and tan to brown dolomite; 310 ft. thick in Wellsville Mountain.*
  - *Lower Cambrian*
    - €gc — Geertsen Canyon Quartzite — *White, gray, pink, and light-green, medium- to coarse-grained quartzite in upper part; tan, white, maroon, and green quartzite in lower part; 4,000 to 4,400 ft. thick in the Huntsville quadrangle area.*
    - €t — Tintic Quartzite — *White, pink, buff, and tan medium- to coarse-grained, medium- to thick-bedded quartzite; layers and zones of quartz-pebble conglomerate increase in abundance downwards; 1,100 to 1,400 ft. thick in North Ogden Quadrangle.*

Cambrian and Precambrian Rocks below the Willard Thrust

- **CAMBRIAN**
  - *Middle Cambrian*
    - €m — Maxfield Limestone — *Medium- to dark-gray thin-bedded dolomite, light and dark gray thin-bedded limestone with olive-drab to greenish-brown micaceous shale inter-bedded with gray limestone in the medial part; 850 ft. thick in the North Ogden Quadrangle.*
    - €o — Ophir Formation — *Light blue-gray limestone and shaly limestone with some olive-drab shale in the upper part, middle part is blue-gray limestone and tan to orange-brown limestone, lower part is light-brown to olive-drab micaceous shale and brown-weathering sandstone and dolomite; 450 to 600 ft. thick in North Ogden quadrangle area.*
- **PRECAMBRIAN**
  - *Precambrian Z*
    - *Brigham Group*
      - p€b — The remaining formations in the Brigham Group are undifferentiated and include the following:
      - Browns Hole Formation — *White to terra cotta quartzite, 100 to 150 ft. thick, and a lower volcanic conglomerate member 180 to 460 ft. thick with K/Ar age of 570 ± 7 m.y. on hornblende.*
      - Mutual Formation — *Grayish-red, pink, maroon, and pale purplish medium- to coarse-grained quartzite; 1,200 to 2,600 ft. thick.*
      - Inkom Formation — *Purple, olive-drab, and green siltstone, sandstone, argillite, and quartzite with gray-weathering tuff at the base; 20 to 390 ft. thick.*
      - Caddy Canyon Quartzite — *White, tan, gray, green, and purple medium-grained quartzite; 1,500 to 1,970 ft. thick.*
    - p€pc — Papoose Creek Formation — *Dark gray to olive-drab siltstone with interbedded light-gray to greenish-gray quartzitic sandstone; 750 to 1,500 ft. thick.*
    - p€k — Kelley Canyon Formation — *Dark-gray to black argillite; locally, pinkish-gray limestone in the medial part and gray-weathering dolomite at base; 600 to 2,000 ft. thick.*
    - p€m — Maple Canyon Formation — *Light-green to greenish-gray arkosic quartzite and sandstone; in most places the upper part has conglomerate and olive-drab argillite; locally, a gray limestone near base; 1,000 to 2,000 ft. thick.*
    - p€p — Perry Canyon Formation — *Dark-gray graywacke, brown and gray to dark-green micaceous siltstone, brown quartzitic sandstone, and gray to dark-green argillite; 1,500 ft. thick; lower part of unit is gray to black diamictite (tillite?); 0 to 390 ft. thick; minor pillow lava and limestone near base.*

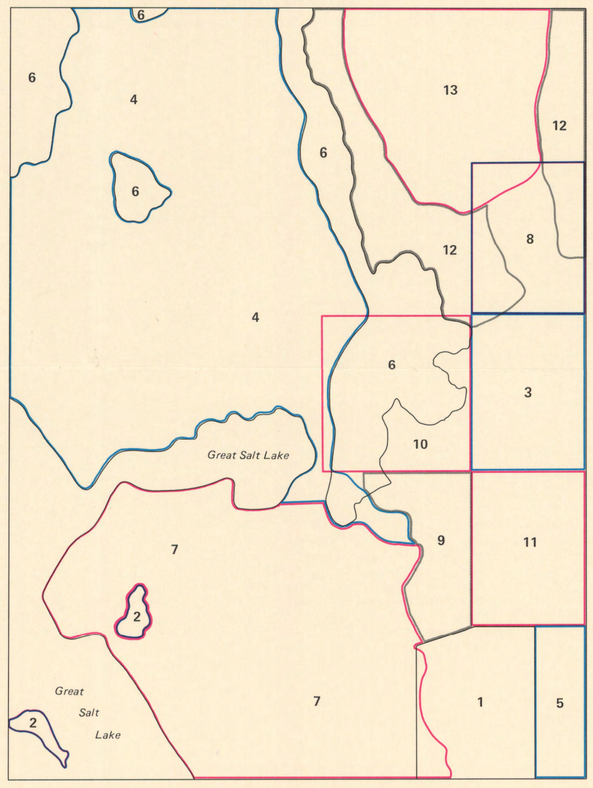
UNCONFORMITY

- *Precambrian X*
  - p€fa — Facer Formation — *White to light-gray quartzite, pale greenish-gray or grayish-purple schist, lustrous quartz muscovite schist, dark-green to greenish-black amphibolite (in sills), creamy-white gneiss, and light-gray quartzose conglomerate; locally gray limestone and dolomite; partial sections aggregating about 2,450 ft. have been measured; the unit has Rb/Sr ages of 1.6 to 1.7 b. y. and a K/Ar date of 1.68 b. y.; the base of the unit is everywhere a thrust plane.*

UNCONFORMITY

- p€f — Farmington Canyon Complex — *Light gray, pinkish-gray, and yellowish-gray quart monzonite gneiss with lenses of greenish-black amphibolite; medium-gray mica schist; light gray, pinkish-gray, and pale orange pegmatite; also white to pale yellowish-green coarse-grained quartzite; about 4,000 ft. exposed in North Ogden Quadrangle; the unit has Rb/Sr and K/Ar ages of 1.6 to 1.7 b. y. and may be as old as 2.6 b. y.*

Index of Map Sources



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