UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geologic map and structure sections of the Logan 30' X 60' quadrangle Utah and Wyoming

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This report and map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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DESCRIPTION OF MAP UNITS

a ARTIFICIAL FILL (HOLOCENE)--Includes unconsolidated materials used in highway and dam construction and waste rock produced by phosphate mining

Qu SURFICIAL DEPOSITS, UNDIVIDED (QUATERNARY)--Gravel, sand, silt, and possibly other unconsolidated materials; mapped only in Salt Lake Valley in southwest corner of map

Qa MAIN STREAM ALLUVIUM (HOLOCENE)--Unconsolidated, crudely stratified clay- to boulder-sized material deposited in channels and flood plains of major streams, including Bear, Little Bear, and Logan Rivers, and Blacksmith Fork; locally includes alluvial fan and terrace deposits, colluvium, talus, or lake deposits. Contacts with side stream alluvium gradational and arbitrarily drawn in places. Thickness generally a few meters or less

Qc COLLUVIUM (HOLOCENE)--Unconsolidated and largely unstratified, mostly angular, silt- to boulder-sized debris along valley sides; includes talus cones. Thickness a few meters or less

Qg GRAVEL (HOLOCENE)--Unconsolidated gravel veneer or pavement on erosional benches; derived as lag concentrate from erosion of nearby or underlying rocks. May locally include Bear River terrace gravel along west side of Bear River. Thickness 1-2 m

Qtg TERRACE GRAVEL (HOLOCENE)--Unconsolidated boulder-, cobble-, and pebble-rich gravel, and sand in bench about 2 m high; mapped only in northern part of Cache Valley

Qaf SIDE STREAM ALLUVIUM AND FAN DEPOSITS (HOLOCENE AND PLEISTOCENE)--Unconsolidated, crudely stratified clay- to boulder-sized material deposited in tributary stream channels and alluvial fans; commonly includes terrace deposits, colluvium, talus, or lake deposits. Gradational into mainstream alluvium and colluvium units. Thickness a few meters or less

Ql LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)--Consists of angular, poorly sorted soil or rock debris and(or) large slumped masses; materials locally derived. Many landslides labeled according to source rock unit and shown on map only by landslide scarp symbol

Qd DUNE DEPOSITS (HOLOCENE AND PLEISTOCENE)--Eolian sand and silt in dunes as high as 50 m; mapped only along southwest side of Crawford Mountains, in Woodruff Narrows quadrangle

Qm MORAINAL DEPOSITS (PLEISTOCENE)--Poorly sorted bouldery till of unknown age on east flank of northern Bear River Range; may include some outwash sand and gravel

Qp PROVO FORMATION (PLEISTOCENE)--Unconsolidated, generally well-stratified and well-sorted gravel, sand, silt, and clay deposited by lacustrine and alluvial processes during Provo stage of Lake Bonneville. Thickness of 15-23 m reported by Williams (1962)

Qab ALPINE AND BONNEVILLE FORMATIONS, UNDIVIDED (PLEISTOCENE)--Mainly unconsolidated, well-stratified, well-sorted lacustrine silt and clay, with alluvial sand and gravel, mainly near Bonneville shoreline. Deposited during Alpine and Bonneville stages of Lake Bonneville. Thickness of 15-30 m reported by Williams (1962)

QTdm DIAMICTITE (QUATERNARY AND(OR) UPPER TERTIARY)--Largely unconsolidated conglomerate consisting of locally derived cobbles, boulders and angular blocks as much as 1 m across in a poorly stratified and poorly sorted matrix of sand and gravel; thickness unknown. Mapped only in upper part of Logan Creek drainage

QTb BASALT (QUATERNARY OR UPPER TERTIARY)--Vesicular flow rocks containing olivine phenocrysts in a fine-grained matrix of plagioclase and pyroxene; mapped only east of Bear Lake near north-central edge of map

Tsl SALT LAKE FORMATION (UPPER? TERTIARY)--White to pale green or gray, poorly consolidated, tuffaceous to marly sand and silt, with subordinate thin interbeds of volcanic ash and gravel; locally contains intermixed red mud, sand, and gravel thought to be reworked from adjacent exposures of Wasatch Formation. Thickness of as much as "several thousand feet" reported by Williams (1964) may include some beds now mapped as Fowkes or Norwood Formations. Miocene to Pliocene age based on fossil plants (Brown, 1949), ostracods and molluscs (Yen, 1947; Adamson and others, 1955); K-Ar dates of 11.6±1.4 m.y. and 18.9±1.6 m.y. (Williams, 1964) and a fission-track age on zircon of 7.9±2.0 m.y. (at 2 sigma level, Izett, 1981, written commun.). Mapped only in Cache Valley and Bear Lake areas; appears to be patchy and to occupy erosional depressions on Wasatch Formation in Bear Lake area

Tsd Diamictite facies--Moderately well-consolidated diamictic conglomerate consisting mainly of locally derived, subangular quartzite, carbonate, and chert boulders and cobbles in a poorly stratified and poorly sorted matrix of tuffaceous to marly sand and gravel; thickness at least 315 m in Richmond quadrangle (Mendenhall, 1975). Mapped only along northeastern margin of Cache Valley

Tsf Fanglomerate facies--Unconsolidated deposit of cobbles, boulders, and angular blocks as much as 0.5 m across of Oquirrh(?) Formation in a matrix of grit and sand; may include pre-Bonneville Pleistocene fanglomerate. Thickness unknown. Mapped only near Wellsville Mountain along southwestern margin of Cache Valley

Tsc Collinston conglomerate facies--Moderately well-consolidated pebble- to boulder-conglomerate consisting of subrounded clasts of locally derived quartzite, limestone, chert, calcareous sandstone, conglomerate and oolitic marl in a gastropod-bearing matrix of oolitic limestone and marly sand and gravel; some boulders 1-2 m across. Thickness of 762 m near Collinston, 8 km west of map area (Williams, 1964). Only one small patch mapped at west-central edge of map

Tf FOWKES FORMATION (EOCENE)--Light-colored, moderately well-consolidated tuffaceous sandstone and siltstone; thickness ranges from 90-180 m (Oriel and Tracey, 1970). Mapped only in Bear River valley and Crawford Mountains areas in southeastern part of map

Tfb Bulldog Hollow Member (Eocene)--Pale greenish-gray to white, tuffaceous sandstone and siltstone with scattered biotite and hornblende grains; thickness of about 60 m and K-Ar age on hornblende of 47.7±1.5 m.y. reported by Oriel and Tracey (1970)

Tfs Sillem Member (Eocene)--Pale pink and buff, slightly tuffaceous claystone, mudstone, and sandstone, with lenses of conglomerate and ostracodal limestone and marl; basal contact with Wasatch Formation gradational. Thickness of 32-120 m reported by Oriel and Tracey (1970), but may be absent in places within quadrangle

Tgr GREEN RIVER FORMATION (EOCENE)--White to light-gray limestone and marly siltstone; forms discontinuous lenticular interbeds in Wasatch Formation. Thickness about 3 m or less, but mapped thickness locally exaggerated. Mapped mainly on west side of Bear River valley west of Randolph, Utah

Tw WASATCH FORMATION (EOCENE)--Red, pale-red, and reddish-buff, crudely stratified, poorly sorted grit, conglomerate, and siltstone; locally includes lacustrine pisolitic limestone and marl interbeds. Some conglomerate interbeds are gray and contain mainly well-rounded pebbles and cobbles of Paleozoic carbonate rocks. Characterized by abrupt facies changes and interfingering of lithic types. Maximum thickness of a few hundred meters in areas east of Bear Lake and west of Randolph, Utah

Twc Conglomerate--Consists of carbonate-cemented boulders of Paleozoic limestone as much as 0.7 m across; assignment to the Wasatch is tentative. Only one small area 6 km southwest of Randolph is mapped

Twl Limestone--Locally developed basal unit of pisolitic to oncolitic, gritty to pebbly limestone and marl; individual beds 1-3 m thick. Locally, unit as mapped is exaggerated in thickness or includes gray, limy conglomeratic facies of Wasatch. Mapped in only two localities, one 3 km east of Logan Peak and the other 2 km east of Bear Lake

EVANSTON FORMATION (PALEOCENE AND UPPER CRETACEOUS)

Te Main body (Paleocene)--Gray carbonaceous claystone and siltstone with tan sandstone interbeds; maximum thickness 200 m. Mapped only in southeastern corner of map

Ter Redbeds (Paleocene)--Red claystone, siltstone, and sandstone; locally forms mappable interbed within dominantly gray Evanston strata. Thickness 20 m or less. Only two small outcrops mapped near southeastern corner of map

Keh Hams Fork Conglomerate Member (Upper Cretaceous)--Poorly to moderately well-consolidated cobble- and boulder conglomerate with gritty sandstone and siltstone matrix; contains quartzite, chert, and carbonate clasts with maximum diameter of about 0.3 m. Poorly exposed. Estimated thickness 20-30 m. Mapped only in southwest corner of map

Mzr MESOZOIC ROCKS, UNDIVIDED (MESOZOIC?)--Red-brown to reddish, calcareous? sandstone and conglomerate; more tightly folded than overlying Wasatch strata. Thickness unknown. Only one small outcrop along Big Creek about 4 km southwest of Randolph, Utah, mapped

Ksj SAGE JUNCTION FORMATION (LOWER CRETACEOUS)--Interbedded light-gray to tan siliceous siltstone, mudstone and shale; tan sandstone, and variegated porcellanite; thickness at least several hundred meters. Mapped only along Dry Hollow in southeastern part of map

Kc COKEVILLE FORMATION (LOWER CRETACEOUS)--Interbedded dark-gray, carbonaceous, shaly mudstone and siltstone, tan-weathering sandstone, and gray to tan limestone and coquina containing gastropod (Pyrgulifera) and pelecypod fauna; thickness about 650 m. Mapped only along southeastern edge of map

Ktf THOMAS FORK FORMATION (LOWER CRETACEOUS)--Interbedded pale red mudstone and gray, tan, or buff sandstone, with poorly exposed zones mantled by gray or lavender limestone nodules; thickness of at least 100-200 m. Mapped only along southeastern edge of map

Ks SMITHS FORMATION (LOWER CRETACEOUS)--Mainly tan to olive-brown quartz sandstone or quartzite, locally with black carbonaceous shale at the base; thickness about 60 m. Mapped only along southeastern edge of map

Kg GANNETT GROUP (LOWER CRETACEOUS)--Mainly orange-brown siltstone, sandstone, grit, and pebble conglomerate, with two prominent interbeds of gray to lavender nodular limestone; thickness at least 200 m. Mapped only along southeastern edge of map

Kgl Limestone interbed--Mapped locally

Jsp STUMP SANDSTONE AND PREUSS REDBEDS, UNDIVIDED (UPPER AND MIDDLE JURASSIC)--Greenish-gray glauconitic siltstone, sandstone, and limestone, and reddish-brown evaporite-bearing siltstone and sandstone; thickness unknown. Mapped only along South Eden Canyon, east of Bear Lake, and along Birch Creek near south-central edge of map

Jt TWIN CREEK LIMESTONE (MIDDLE JURASSIC)--Medium- to light-gray, thin- to medium-bedded limestone and agrillaceous limestone, with minor reddish-brown mudstone; thickness at least 800-1000 m east of Bear Lake

Jtg Gypsum Spring Member--Basal unit of red-weathering limestone breccia, buff sandstone, and red silty mudstone; thickness 20 m or less. Forms prominent red-weathering zone at base of Twin Creek Limestone on east side of Bear Lake

JTr n NUGGET SANDSTONE (LOWER JURASSIC? AND UPPER TRIASSIC?)--Grayish-orange, reddish-brown, tan, and white, typically manganese-stained, fine- to medium-grained, medium-bedded to massive, locally cross-bedded, well-sorted quartz sandstone with rounded to sub-rounded grains; forms prominent dark-brown blocky talus slopes. Thickness about 400 m on east side of Bear Lake

Tr a ANKAREH FORMATION (UPPER TRIASSIC)--Bright-red, orange-red, and maroon, partly calcareous mudstone, siltstone, and sandstone, with minor limestone interbeds; thickness 500-600 m

Ṯ t THAYNES LIMESTONE (LOWER TRIASSIC)--Greenish-gray calcareous siltstone and silty limestone in upper part, and grayish-brown silty limestone and calcareous shale in lower part; thickness about 600 m. Mapped in Laketown Canyon and Brazier Canyon areas and near Woodruff, Utah

Ṯ w WOODSIDE SHALE (LOWER TRIASSIC)--Reddish-orange to red-brown shale and siltstone, with minor sandstone and gray limestone interbeds; estimated thickness 300 m or less in Crawford Mountains

Ṯ d DINWOODY FORMATION (LOWER TRIASSIC)--Greenish-gray thin-bedded calcareous siltstone and silty limestone; thickness about 150 m in Crawford Mountains

Ṯ dw DINWOODY FORMATION AND WOODSIDE SHALE, UNDIVIDED (LOWER TRIASSIC)--Estimated thickness 200-300 m in Laketown Canyon, and 300-450 m in Crawford Mountains

Pzu PALEOZOIC ROCKS, UNDIVIDED--Mapped in north-central and southwestern parts of map; not examined in the field but near and on trend with known Paleozoic rocks

Pp PHOSPHORIA FORMATION (PERMIAN)--Gray, partly brownish-weathering, interbedded chert, cherty limestone and dolomite, phosphorite, and phosphatic siltstone and limestone; thickness 200-250 m. Mapped only in Laketown Canyon area and Crawford Mountains

Ppr Rex Chert Member--Upper part, consisting mainly of light-gray, thin-bedded chert, massive cherty limestone and dolomite, and minor phosphatic shale; thickness 50 m or less in Crawford Mountains

PPo OQUIRRH FORMATION (PERMIAN AND PENNSYLVANIAN)--Gray to tan, fine- to medium-grained, thin- to thick-bedded sandstone, calcareous sandstone, sandy limestone and cherty limestone; thickness at least several hundred meters in Wellsville Mountains area. Mapped only in mountains around south end of Cache Valley

PPw WELLS FORMATION (PERMIAN AND PENNSYLVANIAN)--Mainly white to buff, fine-grained, well-sorted quartzite and quartz sandstone, with interbedded siltstone, sandy limestone and dolomite; thickness 200-400 m. Mapped only in Laketown Canyon area and Crawford Mountains

Mu MISSISSIPPIAN ROCKS, UNDIVIDED--Includes rocks previously mapped as Brazer Limestone, and as Brazer Limestone and Lodgepole Limestone undifferentiated (Mullens and Izett, 1963); mapped only along west edge of Bear River Range east of Paradise, Utah

Mb BRAZER DOLOMITE (MISSISSIPPIAN)--Gray to grayish-brown, thin- to thick-bedded, fine-grained cherty dolomite; thickness of about 250 m reported by Sando and others (1959). Mapped only in Crawford Mountains

Mhdg HUMBUG FORMATION, AND DESERET AND GARDISON LIMESTONES, UNDIVIDED (MISSISSIPPIAN)--Tan, calcareous quartz sandstone, and blue-gray cherty limestone; thickness of about 600 m (Sorensen and Crittenden, 1976) near southwest corner of map, in Mantua quadrangle

Mmc MONROE CANYON LIMESTONE (UPPER MISSISSIPPIAN)--Mainly gray, fossiliferous limestone, with minor interbeds of calcareous quartz sandstone and siltstone; subdivided in Bear River Range into upper unit of cherty limestone, middle unit of medium-bedded limestone, and lower unit of massive limestone (after Dutro and Sando, 1963). Thickness 85 m in Laketown Canyon (Sando and others, 1976, p. 473; Sandberg and Gutschick, 1978, p. 31)

Mmcu Upper cherty limestone unit--Estimated thickness 60 m

Mmcm Middle medium-bedded limestone unit--Estimated thickness 90-120 m

Mmcl Lower massive limestone unit--Cliff-forming unit; estimated thickness 60-120 m

Mlf LITTLE FLAT FORMATION (UPPER AND LOWER MISSISSIPPIAN)--Interbedded gray, tan, and reddish-tan calcareous siltstone and sandstone, sandy limestone, and nodular cherty limestone, with a few thin phosphatic interbeds; forms receding slopes between prominent cliff-forming limestone units. Estimated thickness 200-300 m in Bear River Range; thickness 244 m in Old Laketown Canyon (Sando and others, 1976, p. 473; Sandberg and Gutschick, 1978, p. 31)

Ml LODGEPOLE LIMESTONE (LOWER MISSISSIPPIAN)--Gray cliff-forming, thin- to thick-bedded, partly cherty, fossiliferous limestone. Estimated thickness 200 m in Bear River Range; thickness 214 m in Old Laketown Canyon (Valenti, 1982)

MDl LEATHAM FORMATION (LOWER MISSISSIPPIAN? AND UPPER DEVONIAN)--Interbedded black sandstone, siltstone, mudstone, chert, and silty limestone; thickness of 0-25 m (Sandberg and Poole, 1977). Mapped only in Bear River Range

MDtf THREE FORKS FORMATION (LOWER MISSISSIPPIAN AND UPPER DEVONIAN)--Yellowish-gray, red-stained, fine-grained limestone and limestone-breccia, with poorly exposed interbeds of red to tan siltstone and sandstone; thickness about 87 m in Crawford Mountains (Ott, 1980)

Dj JEFFERSON DOLOMITE (DEVONIAN)--Dark gray, medium-bedded to massive, resistant dolomite; thickness about 110 m in southern Crawford Mountains (Chamberlain, (1980); estimated thickness 200-300 m in northeastern Crawford Mountains

Db BEIRDNEAU FORMATION (UPPER DEVONIAN)--Interbedded tan, reddish-tan, and grayish-yellow sandstone, siltstone, sandy limestone and dolomitic limestone; upper limestone beds equivalent to "Contact Ledge" of Williams (1948). Thickness 150-300 m

Dh HYRUM DOLOMITE (UPPER AND MIDDLE DEVONIAN)--Dark-gray, fine-grained, massive, cliff-forming dolomite, with minor gray limestone and olive-tan sandstone interbeds; thickness 200-300 m

Dwc WATER CANYON FORMATION (LOWER DEVONIAN)--Mainly gray, very light-gray-weathering, thin-bedded, laminated sandy dolomite, with interbeds of argillite, sandstone, and carbonate breccia mainly in upper part; thickness 76-185 m (Williams and Taylor, 1964)

Sl LAKETOWN DOLOMITE (SILURIAN)--Medium- to light-gray, thick-bedded to massive, cliff-forming, medium-grained, sugary dolomite; estimated thickness 350-600 m

Ofh FISH HAVEN DOLOMITE (UPPER ORDOVICIAN)--Dark-gray, medium-bedded, medium-grained, bioclastic dolomite; thickness 60-75 m

Ob BIGHORN DOLOMITE (UPPER ORDOVICIAN)--Light-gray, generally massive, sugary dolomite and dolomitic limestone; thickness 236 m of equivalent rocks in Crawford Mountains (Ott, 1980)

Osp SWAN PEAK QUARTZITE (MIDDLE ORDOVICIAN)--Mainly white to pale-reddish-tan, fine- to medium-grained, well-sorted, fucoidal quartzite or quartz sandstone with well-rounded grains; lower unit of black shale with thin quartzite and sandy limestone interbeds present locally. Thickness varies from 0-150 m (Oaks and others, 1977). Unit thins southeastward across Bear River Range and is generally absent in southeast half of map

Ogc GARDEN CITY FORMATION (MIDDLE AND LOWER ORDOVICIAN)--Mainly gray, thin-bedded, slabby limestone and argillaceous limestone, characterized by intraformational limestone conglomerate and breccia; upper 70 m typically dolomitic and cherty and delineated locally on map by dotted line. Thicknesses 370-520 m (Ross, 1951)

Ꞓg GALLATIN LIMESTONE (UPPER CAMBRIAN)--Gray and tan, mottled, thin- to medium-bedded limestone; estimated thickness 200 m or less. Mapped only in one small klippe at east-central edge of map

Ꞓsc ST. CHARLES LIMESTONE (UPPER CAMBRIAN)--Gray to dark-gray, mottled, thin-bedded to massive algal-mat dolomite, dolomitic limestone and limestone; basal Worm Creek Quartzite Member mapped separately in most places. Estimated thickness 300-400 m

Ꞓsw Worm Creek Quartzite Member--Gray to tan, medium-bedded, fine- to medium-grained quartzite and quartz sandstone; poorly exposed in most places. Thickness 2-125 m (Williams, 1948)

Ꞓn NOUNAN DOLOMITE (UPPER AND MIDDLE CAMBRIAN)--Gray, thin-bedded to massive, fine- to medium-grained dolomite, with subordinate limestone and white-weathering laminated fine-grained dolomite interbeds; estimated thickness 200-400 m

Ꞓns NOUNAN DOLOMITE AND ST. CHARLES LIMESTONE, UNDIVIDED (UPPER AND MIDDLE CAMBRIAN)--These formations grouped where not examined in the field or where Worm Creek Quartzite Member not identified

-€bo BLOOMINGTON FORMATION (MIDDLE CAMBRIAN)--Interbedded gray, thin-bedded limestone and olive-tan shale and siltstone; basal Hodges Shale Member locally separated from main body by dotted line on map. Minimum thickness 300 m; deformation and solution collapse complicate thickness estimates in places

-€bl BLACKSMITH DOLOMITE (MIDDLE CAMBRIAN)--Gray, cliff-forming, thick-bedded, fine-grained, locally oolitic dolomite, with subordinate silty dolomite, dolomitic limestone, and limestone; thickness 100-215 m (Williams, 1948)

-€u UTE FORMATION (MIDDLE CAMBRIAN)--Interbedded gray, thin-bedded, typically oolitic, silty limestone and limestone breccia, and citrine shale; thickness 200-300 m

-€l LANGSTON DOLOMITE (MIDDLE CAMBRIAN)--Gray, medium- to thick-bedded dolomite with characteristic brown-weathering rind; gray, thin-bedded limestone in upper part. Thickness 120 m

BRIGHAM GROUP (MIDDLE AND LOWER CAMBRIAN AND PRECAMBRIAN)--Terminology after Crittenden and others (1971)

-€Zgc GEERTSEN CANYON QUARTZITE (MIDDLE? AND LOWER? CAMBRIAN AND PROTEROZOIC Z?)--Buff, white and pale-pink, thick- to massive-bedded, coarse-grained, locally cross-bedded quartzite, arkose, grit, and conglomerate with subrounded pebble- and cobble-sized clasts of quartz, quartzite and minor jasper; arkosic rocks in lower part contain broken crystals of pink and green microcline as long as to 1 cm. Estimated thickness at least 1400 m in western Bear River Range at north edge of map

-€gcu Upper member--Buff, white, and pink, thick- to massive-bedded, coarse-grained quartzite and pebble- to cobble-conglomerate; thickness in High Creek area of western Bear River Range about 950 m

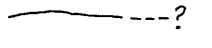
-€Zgcl Lower member--Buff, white, pink, and maroon, thick- to massive-bedded, coarse-grained quartzite and arkose with broken crystals of pink and green microcline as long as 1 cm, and conglomerate with subrounded granule- to pebble-sized clasts of white to reddish-purple quartzite and jasper; thickness in High Creek area of western Bear River Range about 450 m

Zb BROWNS HOLE FORMATION? (PROTEROZOIC Z)--Bright red-orange to maroon, hematitic to specularite-bearing siltstone and cross-bedded quartzite, with arkosic and gritty to pebbly interbeds; forms prominent red-weathering marker horizon about 50m thick that is questionably assigned to the Browns Hole Formation. Also tentatively assigned to the Browns Hole are two thin basalt flows and intervening quartzite beds mapped by Galloway (1970) in Dry,

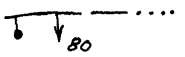
Birch, and Smithfield canyons, western Bear River Range; estimated thickness of the basalt-bearing section is 50 m

Zm MUTUAL FORMATION (PROTEROZOIC Z)--Pale-red to pinkish-buff, cross-bedded, coarse-grained to pebbly, locally feldspathic quartzite, with minor maroon argillite streaks and lenses. Estimated minimum thickness 400 m in High Creek area of western Bear River Range

EXPLANATION OF MAP SYMBOLS

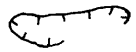


CONTACT--Dashed where approximately located; queried where location uncertain



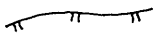
HIGH-ANGLE OR LISTRIC NORMAL FAULT--Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side. Arrow points down dip. Where listric, normal faults decrease in dip downward and merge with pre-existing thrust faults

THRUST FAULT--Dotted where concealed; sawteeth on upper plate. In cross-section, arrows show direction(s) of relative movements; opposing directions of movement are shown on thrust faults that later underwent listric normal fault movement

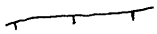


LANDSLIDE SCARP--Hachures point down dip

PLUVIAL LAKE BONNEVILLE SHORELINE--Mapped only in Cache Valley



Provo Level



Bonneville level

STRIKE AND DIP OF BEDDING

Inclined

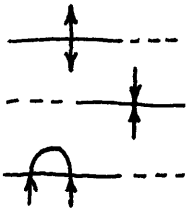
Vertical

Horizontal

Overturned

Estimated from aerial photographs or distant observation

FOLD AXIS



Anticline--dashed where covered

Syncline--dashed where covered

Overturned syncline--dashed where covered

DRILLHOLE

REFERENCES CITED

Adamson, R. D., Hardy, C. T., and Williams, J. S., 1955, Tertiary rocks of Cache Valley, Utah and Idaho: Utah Geological Society, Guidebook to the Geology of Utah, no. 10, p. 1-22.

Brown, R. W., 1949, Pliocene plants from Cache Valley, Utah: Washington Academy of Science Journal v. 39, p. 224-229.

Chamberlain, R. L., 1980, Structure and stratigraphy of the Rex Peak quadrangle, Rich County, Utah: Brigham Young University Geology Studies v. 27, pt. 3, p. 44-54.

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 America Bulletin v. 82, no. 3, p. 581-602.

Dutro, J. T., Jr., and Sando, W. J., 1963, New Mississippian Formations and faunal zones in Chesterfield Range, Portneuf quadrangle, southeast Idaho: American Association of Petroleum Geologists Bulletin v. 47, no. 11, p. 1963-1986.

Galloway, C. L., 1970, Structural geology of eastern part of the Smithfield quadrangle, Utah: Utah State University (Logan, Utah), Unpublished M.Sc. thesis, 115 p.

Mendenhall, A. J., 1975, Structural geology of eastern part of Richmond and western part of Naomi Peak quadrangle, Utah-Idaho: Utah State University (Logan, Utah), Unpublished M.Sc. thesis, 45 p.

Mullens, T. E., and Izett, G. A., 1963, Geology of the Paradise quadrangle, Utah: U.S. Geological Survey Map GQ-185 (scale 1:24,000).

Oaks, R. Q., Jr., James, W. C., Francis, G. G., and Schulingkamp, W. J., 1977, Summary of Middle Ordovician stratigraphy and tectonics, northern Utah, southern and central Idaho: Wyoming Geological Association, 29th Annual Field Conference Guidebook, p. 101-118.

Oriel, S. S., and Tracey, J. I., Jr., 1970, Uppermost Cretaceous and Tertiary Stratigraphy of Fossil Basin, southwestern Wyoming: U.S. Geological Survey Professional Paper 635, p. 33-38.

Ott, V., 1980, Geology of the Woodruff Narrows quadrangle, Utah-Wyoming: Brigham Young University Geology Studies v. 27, pt. 2, p. 67-84.

Ross, R. J., Jr., 1951, Stratigraphy of the Garden City Formation: Peabody Museum of Natural History, Yale University (New Haven, Connecticut), Bulletin 6, 161 p.

Sandberg, C. A, and Gutschick, R. C., 1978, Biostratigraphic guide to Upper Devonian and Mississippian rocks along the Wasatch front and Cordilleran hingeline, Utah: U.S. Geological Survey Open-File Report 78-351, 52 p.

Sandberg, C. A., and Poole, F. G., 1977, Conodont biostratigraphy and depositional complexes of Upper Devonian cratonic-platform and continental-shelf rocks in the western United States, in Murphy, M. A., Berry, W. B. N., and Sandberg, C. A., eds., Western North America--Devonian: University of California (Riverside, California), Campus Museum Contribution 4, p. 144-182.

Sando, W. J., Dutro, J. T., Jr., and Gere, W. C., 1959, Brazer Dolomite (Mississippian), Randolph quadrangle, northeast Utah: American Association of Petroleum Geologists Bulletin v. 43, no. 12, p. 2741-2769.

Sando, W. J., Dutro, J. T., Jr., Sandberg, C. A., and Mamet, B. L., 1976, Revision of Mississippian stratigraphy, eastern Idaho and northeastern Utah: U.S. Geological Survey Journal of Research v. 4, no. 4, p. 467-479.

Sorensen, M. L., and Crittenden, M. D., Jr., 1976, Preliminary geologic map of the Mantua quadrangle and part of the Willard quadrangle, Box Elder, Weber, and Cache Counties, Utah: U.S. Geological Survey Map MF-720 (scale 1:24,000).

Valenti, G. L., 1982, Preliminary geologic map of the Laketown quadrangle, Rich County, Utah: Utal Geological and Mineral Survey Map 58, 9 p., (scale 1:24,000).

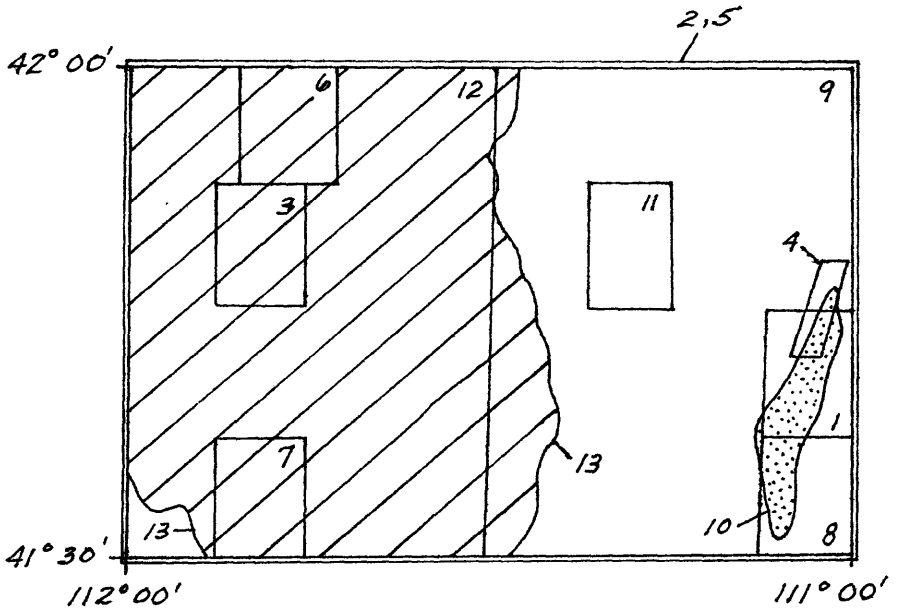
Williams, J. S., 1948, Geology of the Paleozoic rocks, Logan quadrangle, Utah: Geological Society of America Bulletin, v. 59, p. 1121-1164.

_____, 1962, Lake Bonneville--Geology of southern Cache Valley, Utah: U.S. Geological Survey Professional Paper 257-C, p. 131-151.

_____, 1964, The age of the Salt Lake Group in Cache Valley, Utah-Idaho: Utah Academy of Sciences, Arts and Letters Proceedings v. 41, pt. 2, p. 269-277.

Williams, J. S., and Taylor, M. E., 1964, The Lower Devonian Water Canyon Formation of northern Utah: University of Wyoming (Laramie, Wyoming) Contributions to Geology v. 3, no. 2, p. 38-53.

Yen, T., 1947, Pliocene fresh-water mollusks from northern Utah: Journal of Paleontology v. 21, no. 3, p. 268-277.



INDEX TO SOURCES OF GEOLOGIC MAPPING

SOURCES OF GEOLOGIC MAPPING

1. Chamberlain, R. L., 1980, Structure and stratigraphy of the Rex Peak quadrangle, Rich County, Utah: Brigham Young University Geologic Studies v. 27, pt. 3, p. 44-54, scale 1:24,000.

2. Dover, J. H., 1977-1980, Unpublished reconnaissance geologic mapping, scale 1:24,000.

3. Galloway, C. L., 1970, Structural geology of eastern part of the Smithfield quadrangle, Utah: Utah State University (Logan, Utah), Unpublished M.Sc. thesis, 115 p., scale 1:12,000.

4. Gere, W. C., 1955, Phosphate deposits, northern part Crawford Mountains, Rich County, Utah, and Lincoln County, Wyoming: U.S. Geological Survey, Conservation Division Preliminary Map #2, scale 1:12,000.

5. Hintze, L. F., 1980, Geologic map of Utah: Utah Geological and Mineral Survey Map, scale 1:500,000.

6. Mendenhall, A. J., 1975, Structural geology of eastern part of Richmond and western part of Naomi Peak quadrangles, Utah-Idaho: Utah State University (Logan, Utah), Unpublished M.Sc. thesis, 45 p., scale 1:12,000.

7. Mullens, T. E., and Izett, G. A., 1963, Geology of the Paradise quadrangle, Utah: U.S. Geological survey Map GQ-185, scale 1:24,000.

8. Ott, V., 1980, Geology of the woodruff Narrows quadrangle, Utah-Wyoming: Brigham Young University Geologic Studies, v. 27, pt. 2, p. 67-84, scale 1:24,000.

9. Richardson, G. B., 1941, Geology and mineral resources of the Randolph quadrangle, Utah-Wyoming: U.S. Geological Survey Bulletin 923, 54 p., scale 1:125,000.

10. Sando, W. J., Dutro, J. T., Jr., and Gere, W. C., 1959, Brazer Dolomite (Mississippian), Randolph quadrangle, northeast Utah: American Association of Petroleum Geologists Bulletin v. 43, no. 12, p. 2741-2769, scale 1:45,260.

11. Valenti, G. L., 1982, Preliminary geologic map of the Laketown quadrangle, Rich County, Utah: Utah Geological and Mineral Survey Map 58, scale 1:24,000.

12. Williams, J. S., 1948, Geology of the Paleozoic rocks, Logan quadrangle, Utah: Geological Society of America Bulletin v. 59, p. 1121-1164, scale 1:125,000.

13. _____, 1958, Geologic atlas of Utah--Cache County: Utah Geological and Mineralogical Survey Bulletin 64, 104 p., scale 1:126,720.

DRILLHOLES FOR WHICH SUBSURFACE GEOLOGIC

INFORMATION IS AVALIABLE [1/]

Map #	Section, Township Range	Company	Name	Total Depth (in feet)
1	27,T14N,R1W	Drilco Investment	1-Lower	1,677
2	19,T14N,R1E	Delta Petroleum	1-Steven Szot	8,930
3	10,T13N,R1W	Karmis Oil & Gas	1-C. A. Brown	5,210
4	14,T13N,R1W	Lynn Erickson	2 Fee	200
5	14,T13N,R1W	Lynn Erickson	5 Fee	136
6	19,T13N,R1W	Utah-Idaho Exploration	1 Ed Gossner	5,500
7	17,T12N,R1E	Amoco	1 Lynn Reese	8,159
8	2,T14N,R6E	American Quasar	2-41 Eden State	15,710+
9	12,T14N,R6E	American Quasar	12-1 Eden	10,218
10	14,T14N,R7E	American Quasar	14-44 Nebeker	12,164
11	14,T14N,R7E	American Quasar	14-44 South Rabbit Creek Nebeker	11,725+
12	3,T22N,R120W	Houston Oil & Minerals	14-3 Federal	9,000
13	15,T13N,R6E	Marathon Oil	1-15 South Eden Canyon	18,000
14	17,T13N,R7E	American Quasar	17-1 Hogback Ridge	10,732
15	20,T13N,R7E	American Quasar	20-1 Hogback Ridge	10,910
16	28,T13N,R7E	American Quasar	28-1 Hogback Ridge	12,200
17	21,T12N,R6E	Marathon Oil	1-21 Otter Creek	12,299
18[2/]	28,T12N,R6E	Marathon Oil	1-28 Otter Creek	12,500
19	31,T11N,R7E	American Quasar	1 Hoffman	15,400
20	10,T10N,R6E	Marathon Oil	1-10 Hawk Springs	16,909
21	8,T10N,R8E	Marathon Oil	1-8 Mud Springs	9,026
22	20,T10N,R8E	Christmann & Associates	1-20 LL&E-Federal	18,054

23	29,T19N,R120W	Getty Oil	29-15 Narrows South	9,216
24	35,T10N,R7E	Marthon Oil	1-35 South Crawford Mountain	3,269
25	10,T9N,R5E	Marathon Oil	1-10 Thousand Dollar	11,981
26	18,T9N,R6E	American Quasar	18-1 Federal	10,948
27	19,T9N,R6E	American Quasar	19-1 Chournos	9,214
28	23,T9N,R6E	American Quasar	23-1 Putnam	14,183

1/ Data compiled through 1982 from Petroleum Information Corporation index cards
2/ From Valenti, G. L. (1982)

LIST OF STRATIGRAPHIC UNITS USED ON STRUCTURE SECTIONS

Qp	PROVO FORMATION (PLEISTOCENE)--Thickness 15-23 m; exaggerated on sections
Qab	ALPINE AND BONNEVILLE FORMATIONS, UNDIVIDED (PLEISTOCENE)--Thickness 15-30 m; exaggerated on sections
QTdm	DIAMICTITE (QUATERNARY AND (OR) TERTIARY)--Thickness unknown
Tsl	SALT LAKE FORMATION (UPPER? TERTIARY)--Thickness unknown
Tsd	Diamictite facies--Thickness 0-800 m
Tf	FOWKES FORMATION (EOCENE)--Thickness 90-180 m
Tfb	Bulldog Hollow Member--Thickness 60 m
Tgr	GREEN RIVER FORMATION (EOCENE)--Thickness 3 m or less; exaggerated on sections
Tw	WASATCH FORMATION (EOCENE)--Thickness 0-400 m
Mzr	MESOZOIC ROCKS, UNDIVIDED--Thickness unknown
Ksj	SAGE JUNCTION FORMATION (LOWER CRETACEOUS)--Thickness unknown
Jsp	STUMP SANDSTONE AND PREUSS REDBEDS, UNDIVIDED (UPPER AND MIDDLE JURASSIC)--Thickness unknown
Jt	TWIN CREEK LIMESTONE (MIDDLE JURASSIC)--Thickness 800-1000 m
Jtg	Gypsum Spring Member--Thickness 20 m; exaggerated on sections
JTr n	NUGGET SANDSTONE (LOWER JURASSIC? AND UPPER TRIASSIC?)--Thickness 400 m
Tr a	ANKAREH FORMATION (UPPER TRIASSIC)--Thickness 500-600 m
Tr t	THAYNES LIMESTONE (LOWER TRIASSIC)--Thickness 600 m
Tr w	WOODSIDE SHALE (LOWER TRIASSIC)--Thickness 150-300 m
Tr d	DINWOODY FORMATION (LOWER TRIASSIC)--Thickness 150 m

Tr dw	DINWOODY FORMATION AND WOODSIDE SHALE, UNDIVIDED (LOWER TRIASSIC)--Thickness 200-450 m
Pzu	PALEOZOIC ROCKS, UNDIVIDED
Pp	PHOSPHORIA FORMATION (PERMIAN)--Thickness 200-250 m
Ppr	Rex Chert Member--Thickness 50 m
PPo	OQUIRRH FORMATION (PERMIAN AND PENNSYLVANIAN)--Thickness unknown
PPw	WELLS FORMATION (PERMIAN AND PENSYLVANIAN)--Thickness 200-400 m
Mb	BRAZER DOLOMITE (MISSISSIPPIAN)--Thickness 250 m
MDSOr	MISSISSIPPIAN, DEVONIAN, SILURIAN, AND ORDOVICIAN ROCKS, UNDIVIDED
Mmc	MONROE CANYON FORMATION (UPPER MISSISSIPPIAN)
Mmcu	Upper unit--Thickness 60 m
Mmcm	Middle Unit--Thickness 90-120 m
Mmcl	Lower unit--Thickness 60-120 m
Mlf	LITTLE FLAT FORMATION (UPPER AND LOWER MISSISSIPPIAN)--Thickness 200-300 m
Ml	LODGEPOLE LIMESTONE (LOWER MISSISSIPPIAN)--Thickness 200 m
MDl	LEATHAM FORMATION (LOWER MISSISSIPPIAN? AND UPPER DEVONIAN)--Thickness 0-25 m; exaggerated on sections
MDtf	THREE FORKS FORMATION (LOWER MISSISSIPPIAN AND UPPER DEVONIAN)--Thickness 87 m
Dj	JEFFERSON DOLOMITE (DEVONIAN)--Thickness 110 m
Db	BEIRDNEAU FORMATION (UPPER DEVONIAN)--Thickness 150-300 m
Dh	HYRUM DOLOMITE (UPPER AND MIDDLE DEVONIAN)--Thickness 200-300 m
Dwc	WATER CANYON FORMATION (LOWER DEVONIAN)--Thickness 100 m
Sl	LAKETOWN DOLOMITE (SILURIAN)--Thickness 350-600 m
Ofh	FISH HAVEN DOLOMITE (UPPER ORDOVICIAN)--thickness 60-75 m
Ob	BIGHORN DOLOMITE (UPPER ORDOVICIAN)--Thickness 250 m
Osp	SWAN PEAK QUARTZITE (MIDDLE ORDOVICIAN)--Thickness 0-150 m
Ogc	GARDEN CITY FORMATION (MIDDLE AND LOWER ORDOVICIAN)--Thickness 400 m
Cr	CAMBRIAN ROCKS, UNDIVIDED

-Cg GALLATIN LIMESTONE (UPPER CAMBRIAN)--thickness 200 m

-Csc ST. CHARLES LIMESTONE (UPPER CAMBRIAN)--Thickness 300-400 m

-Csw Worm Creek Quartzite Member--Thickness 50 m

-Cn NOUNAN DOLOMITE (UPPER AND MIDDLE CAMBRIAN)--Thickness 200-400 m

-Cns NOUNAN DOLOMITE AND ST. CHARLES LIMESTONE, UNDIVIDED (UPPER AND MIDDLE CAMBRIAN)--Thickness 550-800 m

-Cbo BLOOMINGTON FORMATION (MIDDLE CAMBRIAN)--Thickness 300 m

-Cbl BLACKSMITH DOLOMITE (MIDDLE CAMBRIAN)--Thickness 100-200 m

-Cu UTE FORMATION (MIDDLE CAMBRIAN)--Thickness 200-300 m

-Cl LANGSTON DOLOITE (MIDDLE CAMBRIAN)--Thickness 120 m

-CZgc GEERSTEN CANYON QUARTZITE (MIDDLE? AND LOWER? CAMBRIAN AND PROTEROZOIC Z?)--Thickness 1400 m

-Cgcu Upper Member (Middle? and Lower? Cambrian)--Thickness 950 m

-CZgcl Lower Member (Lower? Cambrian and Proterozoic Z)--Thickness 450 m

Zb BROWNS HOLE FORMATION (PROTEROZOIC Z)--Thickness 100 m

Zm MUTUAL FORMATION (PROTEROZOIC Z)--Thickness unknown

Zr PROTEROZOIC ROCKS, UNDIVIDED (PROTEROZOIC Z)--Thickness unknown

(17) DRILLHOLE--See explanation to geologic map