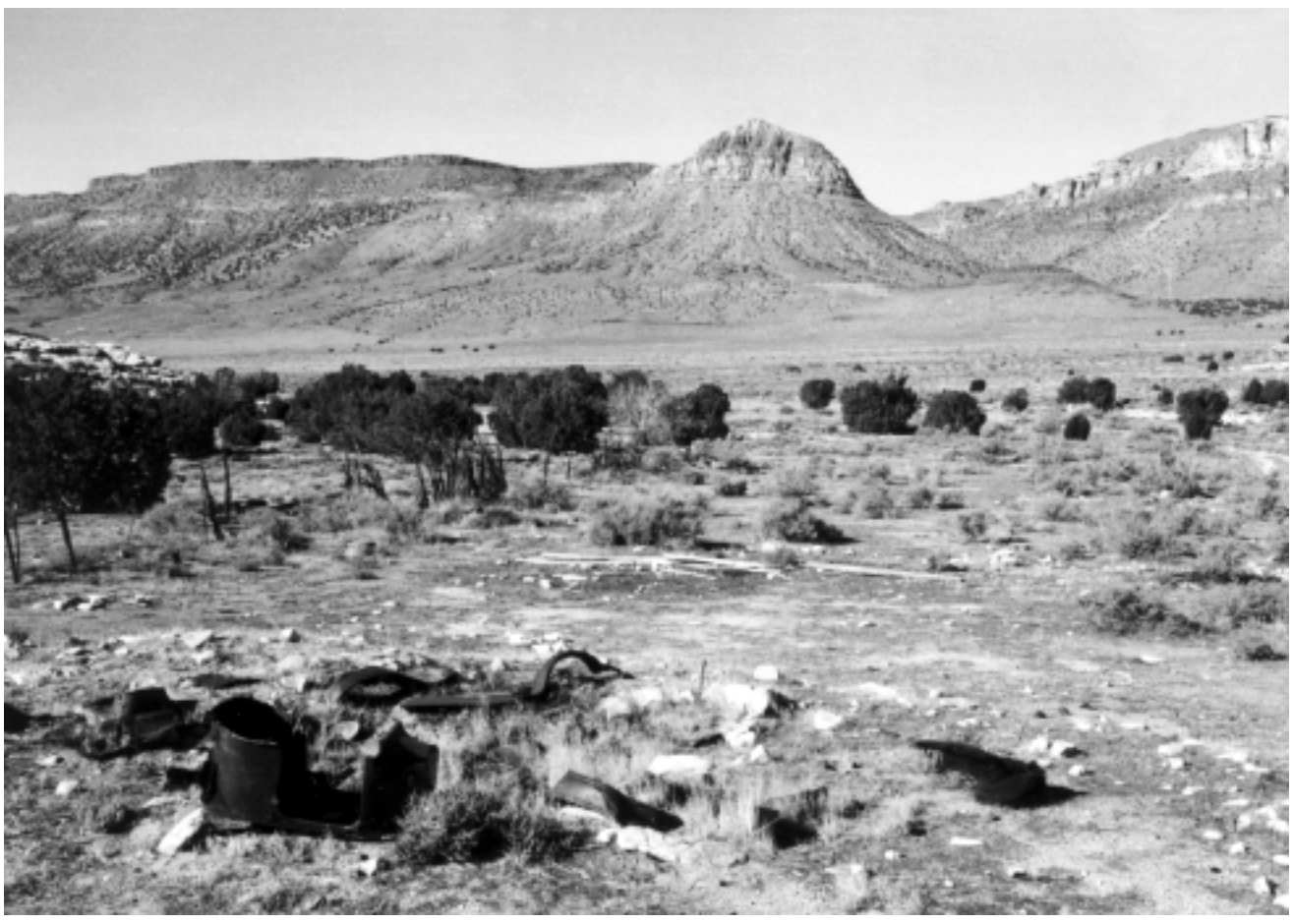
ISBN 1-55791-584-9

GEOLOGIC MAP OF THE WAH WAH MOUNTAINS NORTH 30′ x 60′ QUADRANGLE AND PART OF THE GARRISON 30′ x 60′ QUADRANGLE, SOUTHWEST MILLARD COUNTY AND PART OF BEAVER COUNTY, UTAH

by

Lehi F. Hintze and Fitzhugh D. Davis



MAP 182
UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources
2002

UTAH GEOLOGICAL SURVEY

Hintze, Davis
GEOLOGIC MAP OF THE WAH WAH MOUNTAINS NORTH QUADRANGLE, MILLARD AND BEAVER COUNTIES, UTAH
UGS Map 182

SCALE 1:100,000
Contour interval 40 meters
Supplementary contour interval 10 meters

2 1 0 2 4 6 8 10 Kilometers

2 1 0 2 4 Miles

Base from U.S.G.S. Wah Wah Mountains North and Garrison 30' x 60' quadrangles

2002 MAGNETIC DECLINATION AT CENTER OF SHEET

13°26'E
242 MILS

GEOLOGIC MAP OF THE WAH WAH MOUNTAINS NORTH 30' x 60' QUADRANGLE AND PART OF THE GARRISON 30' x 60' QUADRANGLE, SOUTHWEST MILLARD COUNTY AND PART OF BEAVER COUNTY, UTAH

by

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2002

UTAH

Plate 1 of 2
Map 182
Utah Geological Survey
a division of
Utah Department of Natural Resources
***in cooperation with* U.S. Geological Survey**
Statemap Agreement No. 99HQAG0138

Project Manager: Jon King
GIS compilation: Denise Y. M. Laes and Basia Matyjasik
Cartography: James W. Parker

PLATE 2 of 2

Map 182

Geologic Map of the Wah Wah Mountains North 30' x 60' Quadrangle and part of the Garrison 30' x 60' Quadrangle, Southwest Millard County and part of Beaver County, Utah

by
Lehi F. Hintze and Fitzhugh D. Davis
2002

UTAH GEOLOGICAL SURVEY
a division of
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in cooperation with
THE UNITED STATES GEOLOGICAL SURVEY
STATEMAP Agreement No. 99HQAG0138

MAP AND CROSS-SECTION SYMBOLS

CONTACT--Dashed where location inferred.

EROSIONAL SURFACE--Shown on cross sections; dashed where inferred.

map ... ? cross section

NORMAL FAULT--Dashed where location inferred; dotted where concealed, queried where speculative; bar and ball on downthrown side; arrow shows relative movement on cross section.

map ... cross section

NORMAL FAULT--Inferred and delineated from geophysical data; concealed; bar and ball on downthrown side; arrow shows relative movement on cross section.

map

TEAR FAULT--High-angle fault with strike-slip offset; dashed where location inferred; dotted where concealed; arrows show relative movement on map.

map

STEEPLY DIPPING FAULT--Sense of motion not known or complex; dashed where location inferred; dotted where concealed.

map ... cross section

THRUST FAULT--Dashed where location inferred; dotted where concealed; barbs on side of upper plate; arrow shows relative movement on cross section.

map ... cross section

ATTENUATION FAULT--Younger over older rocks with strata thinned or cut out between; present in Tunnel Spring Mountains and Mountain Home Range; dotted where concealed; arrow shows relative movement on cross section B-B'.

anticline   syncline

FOLD AXES--Arrow on axis shows plunge; dotted where concealed, location approximate.

10 inclined   vertical   80 overturned

STRIKE AND DIP OF BEDDING

45

STRIKE AND DIP OF PLANAR FEATURES IN VOLCANIC ROCK

DEEP EXPLORATION WELL--
Map symbol on left, cross section symbol on right.

SHORELINES--Dashed where location inferred; dotted where obscure.

G — Lake Gunnison shoreline

PV — Pine Valley Lake shoreline

P — Provo shoreline of Lake Bonneville

B — Bonneville shoreline of Lake Bonneville

Qpm/QTln

Thin cover of the first unit overlying the second unit.

DESCRIPTION OF GEOLOGIC UNITS

Q Quaternary surficial units, undivided--Cross section only; for included units see correlation chart and descriptions below.

Qlf Fine-grained lacustrine deposits--Grayish-tan, tan, and light-gray, calcareous silts that are the deep-water sediments of Lake Bonneville, Pine Valley Lake, Lake Gunnison (all late Pleistocene), and Sevier Lake (when it contained surface water in the Holocene); locally includes younger alluvium; about 10 feet (3 m) thick or less.

Qll Lacustrine lagoon deposits--Sand, silt, clay, and marl that accumulated in lagoons behind gravel barrier beaches of Lake Bonneville; locally includes younger alluvium; mostly less than 10 feet (3 m) thick.

Qlm Lacustrine marl--Fine-grained, thinly bedded to laminated, white to light-gray, offshore to deep-water marl deposited in Lake Bonneville; ostracodes abundant throughout marl and, locally, gastropods present at top and base of marl; 0 to 30 feet (0-9 m) thick.

Qls Lacustrine sand--Fine- to coarse-grained sand, marly sand, and pebbly sand deposited as a spit adjacent to playa mud (Qpm) of Sevier Lake and just below Lake Gunnison shoreline gravels (Qlg); Holocene (Sevier Lake) or late Pleistocene (Lake Gunnison) in age; 0 to 30 feet (0-9 m) thick.

Qlg Lacustrine gravel--Shore-zone gravel deposited by Lake Bonneville, Pine Valley Lake, Lake Gunnison, and Sevier Lake; chiefly silty, fine- to coarse-grained sand and gravel; gravel content is generally greater than 50 percent; 0 to 18 feet (0-5.5 m) thick; gravel of Lake Bonneville, Pine Valley Lake, and Lake Gunnison is late Pleistocene. Beach gravel of Sevier Lake is adjacent to playa mud (Qpm) and is Holocene.

Qla Lacustrine and alluvial deposits, undifferentiated--Mixed and reworked, gravelly lacustrine and alluvial deposits on piedmont slopes; grades from pebbly sand and silt to sandy pebble gravel; generally 0 to 12 feet (0-3.7 m) thick, but may be thicker locally.

Qal1 Alluvium, late Holocene--Youngest alluvium deposited in channels and adjacent floodplains of Lake Creek and Beaver River; consists of sand, silt, and clay with lenses of gravel; mostly 0 to 20 feet (0-6 m) thick, but may be thicker locally.

Qaf1 Younger alluvial-fan deposits--Poorly sorted silt, sand, and pebble, cobble, and boulder gravel deposited by streams, sheetwash, debris flows, and flash floods on alluvial fans, and in canyons and mountain valleys; post-Bonneville shoreline in age; 0 to 60 feet (0-18 m) thick.

Qaf2 Older alluvial-fan deposits--Poorly sorted silt, sand, and pebble, cobble and boulder gravel deposited by streams, debris flows, and flash floods on alluvial fans, and in canyons and mountain valleys above the Bonneville shoreline; includes colluvial deposits in canyons and mountain valleys; mostly Pleistocene and pre-Lake Bonneville in age, but locally includes younger material; up to 200 feet (60 m), or more, in thickness.

Qac Alluvium and colluvium, undifferentiated--Mixed alluvial and colluvial deposits that consist of fluvially reworked, coarse-grained colluvium and/or alluvium with a significant colluvial component; also includes talus; mapped chiefly in mountain headwater areas that are isolated from mountain-flanking alluvial fans; generally 0 to 50 feet (0-15 m) thick, but may be thicker locally.

Qpm Playa mud--Laminated, silty fine sand, silt, and clayey silt that are infused with various salts, chiefly gypsum and calcium carbonate; saline mud is as much as 900 feet (274 m) thick beneath the Sevier Lake playa but only the uppermost few feet are Quaternary; thickness of salty mud in other playas is probably 20 feet (6 m) or less.

Qes Eolian sand--Windblown sand in sheets, low irregular mounds, shrub-coppice dunes, and narrow northeast-trending ridges that are largely stabilized by vegetation; mostly silty, well-sorted, fine-grained quartz sand; 0 to 10 feet (0-3 m) thick.

Qed Eolian dunes--Chiefly barchan, parabolic, dome, and transverse sand dunes that are active and not stabilized by vegetation; mostly tan, well-sorted, fine-grained quartz sand; 3 to 35 feet (1-11 m) thick.

Qms Mass movements, slides and slumps--Primarily mapped in the south-western part of the Black Hills where Cambrian and Ordovician rocks have slumped or slid downslope; also bouldery debris of land-slide or mudflow in Wah Wah Mountains in Beaver County; small, isolated slides or slumps are present in many mountainous areas, but are too small to show at map scale; 0 to 200 feet (0-60 m) thick.

QTlf Fine-grained lacustrine deposits of Sevier Desert--Brown and light-olive-gray, calcareous, lacustrine silt and silty clay with minor sand; offshore to deep-water sediments that are Pliocene to middle Pleistocene in age; 0 to 872 or more feet (0-266+ m) thick.

QTln Near-shore lacustrine limestone of Sevier Desert--Light-gray limestone and conglomeratic limestone that comprise the shoreline facies of QTlf; up to 90 feet (27 m) thick.

Tvs Tertiary volcanic and sedimentary units, undivided--Cross section only; for included units see correlation chart and descriptions.

Thb Basalt of High Rock--Brown-weathering, black, fine-grained flow rock containing small phenocrysts in a partly glassy matrix; Pliocene(?); maximum thickness 150 feet (50 m).

Ts Valley-fill sediments--Poorly consolidated tuffaceous sandstone exposed near Crystal Peak; gently dipping so may be younger than other Tertiary basin fill (Tcs, Tc); about 100 feet (30 m) exposed.

Tc Post-Needles Range conglomerate--Poorly consolidated conglomerate of subrounded cobbles and boulders in a limy and tuffaceous sand and silt matrix; exposed in and near the Burbank Hills; matrix contains doubly terminated quartz crystals from Tunnel Spring Tuff in Burbank Hills; up to 1,000 feet (300 m) thick.

Tcs Conglomerate and sandstone--Poorly cemented conglomerate with sandstone interbeds on west flank of Mountain Home Range; conglomerate and tuffaceous sandstone with some limestone on flank of Tunnel Spring Mountains; dips valleyward as much as 40 degrees; at least 2,000 feet (600 m) thick locally.

Tccb Condor Canyon Formation, Bauers Tuff Member--Firmly welded, pink to purple-gray, vitric ash-flow tuff; lower part includes light-colored pumice lapilli; age 22.7 Ma; only exposed in Halfway Hills in Beaver County where it is about 20 feet (6 m) thick.

Ti Isom Tuff--Multiple trachydacite ash-flow tuffs; exposed in Tunnel Spring Mountains, where it is about 20 feet (6 m) thick; also exposed near Brown Knoll and on the east flank of the San Francisco Mountains, where it is 33 to 50 feet (10-15 m) thick; K-Ar age 25.7 Ma.

Tig Granitic intrusions of Frisco--Pinkish- or lavender-gray granodioritic Cactus stock and associated dikes and minor plutons; contains medium-sized phenocrysts of perthitic orthoclase, oligoclase-andesine, quartz, hornblende, and biotite; better exposed to south; K-Ar biotite age 28.7 Ma.

Tigd Granodiorite of Beaver Lake Mountains--Light- to medium-gray, medium-grained, holocrystalline intrusive rocks; mostly granodiorite, but includes one small quartz-monzonite stock, granite border zones, dikelike bodies of quartz diorite and monzonite, and local aplite dikes; K-Ar ages 27.7 and 29.1 Ma.

Tm Marble--Contact metamorphosed Paleozoic carbonate rocks; light-gray to white, locally blotchy or streaked; locally brecciated; in Beaver Lake Mountains, parent carbonates were probably Devonian and Mississippian limestone; next to Diorite of Wah Wah Summit the parent strata were Cambrian limestone and dolomite.

Tj Jasperoid--Irregular masses of light- to dark-brown, fine-grained, silicified rock within marble bodies in Beaver Lake Mountains; produced by hydrothermal alteration and emanations from nearby igneous intrusions; largest mass about 100 feet (30 m) thick.

Tnu Upper Needles Range Group--Crystal-rich, dacitic ash-flow tuffs of the Lund Formation, Wah Wah Springs Tuff, and the Cottonwood Wash Tuff; Lund Formation only present in Halfway Hills; thickness up to 2,300 feet (700 m); ages about 28, 30.5, and 31 Ma, respectively.

Tnb Basalt of Brown Knoll--Dark-gray, mafic lava flow-rock that lies between the Cottonwood Wash and Wah Wah Springs Tuffs near Ibex in the southern Confusion Range and is exposed at Brown Knoll; as much as 250 feet (80 m) thick.

Tnc Conglomerates and landslide blocks--Conglomerates of pebbles, cobbles, and boulders of Paleozoic rocks in a tuffaceous matrix below and within the Needles Range Group; mostly rootless landslide blocks of Ordovician, Silurian, and Devonian strata near Crystal Peak; up to 500 feet (150 m) thick.

Tnl Lower Needles Range Group--Escalante Desert Formation consisting of crystal-poor, ash-flow tuff overlain by interbedded sandstone and andesitic conglomerate; up to 120 feet (37 m) thick in southwestern Millard County; age about 32 Ma.

Twb Windous Butte Tuff--Pink rhyolite ash-flow tuff; best exposed at the northeast end of the Burbank Hills where it is about 100 feet (30 m) thick; Ar/Ar age 31.4 ±0.5 Ma, but overlain by Needles Range Group tuffs north of map area at Toms Knoll in Conger Range.

Tsr Skull Rock Pass Conglomerate-- Unconsolidated, boulder and cobble conglomerate of Paleozoic clasts that lies above Tunnel Spring Tuff and beneath tuffs of the Needles Range Group; lies beneath the Windous Butte Tuff in the Burbank Hills; overlies Horn Silver Andesite in Iron Mine Pass quadrangle; sand and silt matrix is locally tuffaceous; contains rare igneous rock clasts; as much as 350 feet (107 m) thick.

Tsv Sedimentary and volcanic rocks--Conglomerate, tuffaceous sandstone, and andesitic and dacitic volcanic rocks not assignable to named regional formations; crops out locally in the Tunnel Spring quadrangle and Halfway Hills beneath lower Needles Range Group; may be time-equivalent of Sawtooth Peak Formation or igneous rocks near Wah Wah Summit; about 300 feet (90 m) thick.

Twp Rhyolite porphyry of Wah Wah Summit--Grayish brown, strongly welded rhyolite ash-flow tuff with small shattered quartz crystals in devitrified matrix; 0 to 100 feet (0-30 m) thick; age uncertain but thought to be younger than andesite of Kelleys Place.

Tdw Diorite of Wah Wah Summit--Gray to brownish-gray, non-resistant, medium-crystalline, porphyritic diorite and quartz diorite stocks; probably intrusive equivalent of andesite of Kelleys Place.

Tkp Andesite of Kelleys Place--Mostly pyroclastic, medium- to very coarse-grained (lapilli), bouldery, andesite agglomerate with gray to pink volcanic ash matrix; two, dark-brown, fine- to medium-crystalline, porphyritic, andesite lava flows are locally intercalated in the agglomerate; phenocrysts in the flows are andesine, biotite, and hornblende in a dense, felted groundmass; maximum thickness about 2,000 feet (600 m); K-Ar hornblende age on flow of 33.1 Ma.

Trw Rhyolite intrusive of Wah Wah Summit--Light-gray, finely crystalline rhyolite that forms a small intrusion; contains more than 50 percent phenocrysts of quartz and sanidine; located in the Wah Wah Summit eruptive center in Beaver County; age uncertain but thought to be about the same age as units Tdw and Tkp.

Tsp Sawtooth Peak Formation--Friable, porous, somewhat foliated, pale-greenish-gray, crystal-rich tuff with phenocryts of quartz, plagioclase, biotite, and minor sanidine and pyroxene comprising 30 to 50 percent of the rock; contains less than 10 to 20 percent white pumice lapilli and lithic fragments; maximum exposed thickness 200 feet (60 m); overlain by lower Needles Range Group (Tnl); K-Ar age about 33.5 Ma.

Twc Dacite of Wah Wah Cove--Upper four-fifths is medium- to dark-gray, dense, dacite porphyry flow with some flow breccia and vitrophyre near base; lower fifth is basal, white to reddish-gray, unbedded, lapilli-bearing, dacite tuff with local cavernous weathering; dacite flow locally more than 1,150 feet (350 m) thick; basal tuff as much as 330 feet (100 m) thick; K-Ar age about 34 Ma.

Ths Horn Silver Andesite--Heterogeneous unit of varicolored andesitic, dacitic, and latitic rocks in the northern San Francisco and Beaver Lake Mountains; rock types include: agglomerate, tuff, and volcanic conglomerate and sandstone, as well as dark-colored, medium- to fine-grained andesitic lava flows that increase in thickness and number to the south; total thickness up to about 2,000 feet (600 m); K-Ar ages about 31.6 and 35.0 Ma.

Thr Conglomerate of High Rock Pass--Unconsolidated, bouldery conglomerate with gray, tuffaceous matrix; restricted to the High Rock quadrangle in the San Francisco Mountains where it may be as much as 300 feet (90 m) thick; age uncertain, appears to underlie Horn Silver Andesite.

Tir Rhyolitic intrusions of Tunnel Spring Mountains--Pinkish- to light-gray rhyolite and quartz latite plugs and small domes that intrude the Tunnel Spring Tuff at the south end of the Tunnel Spring Mountains.

Tt Tunnel Spring Tuff--White, crystal-rich, poorly welded rhyolite ash-flow tuff that contains abundant xenoliths of Paleozoic rocks; characterized by well-formed, doubly terminated quartz crystals; probably erupted from caldera east of Crystal Peak; more than 1,000 feet (300 m) thick at Crystal Peak, but commonly only a few tens of feet thick in adjacent areas; K-Ar age about 35.4 Ma.

Tf Flagstaff Formation--White to very-light-gray, locally vuggy, thin- to thick-bedded limestone that locally contains small bivalves and high-spired gastropods; limestone is interbedded with pebble and cobble conglomerate with a red sandstone or mudstone matrix; mottled purple limestone and yellow limy mudstone present here are also found in Claron Formation of southern Utah and Flagstaff Formation in central Utah; up to 585 feet (180 m) thick.

TKbr Tectonic breccia--Includes: brecciated masses of Devonian, Silurian, and Upper Ordovician dolomite and Eureka Quartzite in the Halfway Hills and Tunnel Spring Mountains that are overlain by unbrecciated Oligocene volcanic rocks, likely Cretaceous or early Tertiary in age; brecciated masses of Devonian and Mississippian carbonate rocks on the west flank the Mountain Home Range that are overlain by poorly dated valley fill (Tcs), likely late Tertiary in age; and breccia in Precambrian rocks in the San Francisco Mountains, age uncertain; breccias are as much as 0.35 miles (0.56 km) wide and several miles long.

Jd Diabase plug in the Burbank Hills--Dark-greenish-gray, finely crystalline, dense diabase plug about 30 feet (9 m) in diameter; K-Ar age 141.4±3.1 Ma.

P Permian strata--Cross section only; may be entirely Arcturus Formation.

Pa Arcturus Formation--Yellowish-gray sandy dolomite, dolomitic sandstone, red sandstone, gray limestone, laminated dolomitic boundstone, and gypsum; thin- to medium-bedded, friable, forms mostly rounded ledges and rubble-covered hillslopes; no key beds; structure precludes measurement of complete section in this map area; thickness estimated to be 2,500 feet (760 m).

PIPMe Ely Limestone--Cyclic thin- to thick-bedded limestone that is commonly fossiliferous and cherty; characteristically forms stair-step, ledge-slope topography; upper 430 feet (130 m) is Permian as shown by large pseudoschwagerinid fusulinids; lowest 200 feet (60 m) is chertless and contains a Mississippian brachiopod fauna; total thickness about 2,740 feet (835 m).

M Mississippian, undivided--Cross section only; for included units see correlation chart and descriptions.

Mc Chainman Formation--Interbedded mudstone, clayey limestone, siltstone, black shale, sandstone, and gritstone; mostly thin-bedded but with some thick-bedded, resistant limestone units; basal beds are phosphatic siltstone; Hintze (1986) mapped 10 members of this formation in the Mountain Home Range; generally forms low topography with poor exposures; thickness about 2,150 to 2,700 feet (655-820 m), thinning northward.

Mj Joana Limestone--Medium-gray, thick-bedded to massive limestone; common fossils are corals, gastropods, crinoid stems, and brachiopods; cherty beds in lower third; average thickness about 520 feet (150 m).

Mr Redwall Limestone--Grand Canyon name used in eastern part of map area for the Joana of western Utah and Nevada; thickness and lithology are about the same as Joana.

D Devonian, undivided--Cross section only; for included units see correlation chart and descriptions.

MDp Pilot Shale--Dark-gray, thin-bedded, silty shale and fissile shale that weathers to yellowish-gray slopes; includes a few thin limestone and silty sandstone beds. Generally poorly exposed; average thickness about 480 feet (145 m).

Dg Guilmette Formation--Chertless, gray dolomite and limestone, undivided in some places on the map, but generally separated into three map units shown below; aggregate thickness is about 4,000 feet (1,220 m).

Dgw West Range Limestone Member--Medium-gray, thin- to medium-bedded, silty limestone that forms ledge-slope topography; fossil brachiopods common; thickness 260 to 860 feet (80-260 m).

Dgm Middle member--Mostly dark- to medium-gray, medium- to thick-bedded or massive dolomite and limestone; sandstone at top; stromatoporoids are common, gastropods and brachiopods are sparse; about 2,950 feet (900 m) thick.

Dgb Breccia member--Medium-gray, massive limestone breccia that weathers to rounded, lumpy ledges and cliffs; breccia is probably a solution-cavern collapse feature formed in Devonian time; average thickness about 500 feet (150 m).

Ds Simonson Dolomite--Interbedded dark-brownish-gray sugary dolomite and light-gray laminated dolomite; poorly preserved stromatoporoids abundant in some beds; as much as 700 feet (213 m) thick.

Dsy Sevy Dolomite--Light- to medium-gray, medium-bedded, locally laminated, unfossiliferous dolomite; upper third contains frosted quartz sand grains; about 1,300 feet (400 m) thick.

SO Silurian-Upper Ordovician, undivided--Cross section only; for included units see correlation chart and descriptions.

Sl Laketown Dolomite--Banded dark- and light-brownish-gray, cherty, cliff-forming dolomite; locally tectonically brecciated in map area; silicified corals and brachiopods common in upper part; average apparent thickness about 1,300 feet (400 m).

Oes Ely Springs Dolomite--Dark-brownish-gray, cherty, unfossiliferous, ledge- and cliff-forming dolomite; commonly tectonically brecciated; average thickness about 500 feet (150 m).

O Middle and Lower Ordovician, undivided--Cross section only; for included units see correlation chart and descriptions.

Oew Eureka-Crystal Peak-Watson Ranch Formations, undivided--These formations are too thin to show individually at 1:100,000 scale; listed from the top downwards. Eureka Quartzite is light-gray, medium- to fine-grained quartzite that weathers reddish-brown; characteristically pitted with pock-marks about 0.5 inch (1 cm) across; forms orange cliffs conspicuous among the gray carbonate rocks; thickness as much as 600 feet (180 m). Crystal Peak Dolomite is interbedded, thin-bedded, light-olive-gray dolomite and bluish-gray, silty limestone; *Eofletcheria* coral fossils are common; thickness 90-164 feet (27-50 m). Watson Ranch Quartzite is interbedded orangish-brown, fucoidal quartzite and bluish-gray, silty limestone and dolomite; thickness 190 feet (60 m).

Opu Upper Pogonip Group, undivided--Consists of four formations too thin to show individually at 1:100,000 scale; listed from the top downwards. Lehman Formation--Interbedded, bluish-gray, silty limestone and shale; abundant ostracodes, brachiopods, trilobites, and other fossils; thickness up to 277 feet (85 m). Kanosh Shale--Light-olive-gray, fissile shale with interbeds of thin-bedded, bioclastic limestone made up of brachiopod, ostracode, trilobite, and echinoderm fragments; up to 560 feet (170 m) thick. Juab Limestone--Medium-gray, medium- to thick-bedded, silty, ledge-forming limestone; contains orthid brachiopods; about 155 feet (47 m) thick. Wah Wah Limestone--Medium-gray, medium- to thick-bedded, silty limestone interbedded with olive shale; fragmented trilobites common in some beds; about 245 feet (75 m) thick.

Of Fillmore Formation--Medium-gray, thin- to medium-bedded limestone and intraformational, flat-pebble limestone conglomerate interbedded with light-olive and yellowish-gray shale; up to 1,800 feet (550 m) thick.

Oh House Limestone--Medium-bluish-gray, thick-bedded to massive, cherty limestone; thickness 460 feet (140 m).

Ꞓu Upper Cambrian, undivided--Cross section only; for included units see correlation chart and descriptions.

OꞒn Notch Peak Formation--Dark-brownish-gray dolomite and gray limestone that commonly contain stromatolites; some beds cherty; forms massive cliffs; about 1,700 feet (520 m) thick.

Ꞓou Orr Formation, upper members, undivided--Two members, youngest listed first. Sneakover Limestone Member--Medium-gray limestone characterized by weathering into large box-shaped blocks; average thickness 160 feet (50 m). Steamboat Pass Shale Member--Fissile, olive shale interbedded with thin-bedded, nodular, trilobite-bearing limestone in upper half; thin-bedded, silty, nodular limestone in lower half; thickness 175 to 265 feet (53-80 m).

Ꞓob Orr Formation, Big Horse Limestone Member--Medium- to dark-gray, mottled limestone; oolitic and bioclastic in upper half, which bears *Crepicephalus* sp. trilobites, barren in lower half; forms ledges and cliffs; about 690 feet (210 m) thick.

Ꞓm Middle Cambrian, undivided--Cross section only; for included units see correlation chart and descriptions.

Ꞓwt Wah Wah Summit Formation and Trippe Limestone, undivided--Upper fifth of Wah Wah Summit Formation is white, laminated, dolomitic limestone; remainder is medium- to light-gray, medium- to coarsely crystalline, barren limestone and dolomite; total thickness is 870 feet (265 m). Underlying Trippe Limestone includes 115 feet (35 m) of thin-bedded, *Eldoradia*-bearing limestone overlying 506 feet (154 m) of interbedded, light-gray, laminated dolomite and dark-gray, mottled, dolomitic limestone.

Ꞓmp Pierson Cove Formation--The Pierson Cove Formation in the Wah Wah Mountains is the time-equivalent of the Marjum Formation in the House Range with which it shares the symbol Ꞓmp; mostly dark-gray, mottled, massive, dolomitic limestone, interbedded with light-gray, thin-bedded, slope-forming dolomite; 1,441 feet (439 m) thick at Pierson Cove type section in the Wah Wah Mountains.

Ꞓcm Limestone of Cricket Mountains--Dark-gray, silty limestone mottled with brownish-gray, dolomitic limestone; upper two-thirds includes interbeds of light-gray, laminated, dolomitic boundstone; see correlation chart for equivalent units; about 1,970 feet (600 m) thick.

Ꞓew Eye of Needle-Swasey-Whirlwind Formations, undivided--Partially exposed west of the Wah Wah Mountains and at Fifteenmile Point; in Beaver County, from the top downward, the Eye of Needle Limestone is 240 feet (73 m) thick, the Swasey Limestone is 440 feet (134 m) thick, and the Whirlwind Formation is 40 feet (12 m) thick.

Ꞓw Whirlwind Formation--Mostly light-olive-gray, slope-forming shale interbedded with thin-bedded, conglomeratic limestone that contains *Ehmaniella* trilobites; thickness 100 to 265 feet (30-80 m).

Ꞓdh Dome-Chisholm-Howell Formations, undivided--Listed from the top downward. Dome Limestone is medium-gray, banded, finely crystalline, massive limestone averaging 300 feet (90 m) thick. Chisholm Formation is dark-gray, pisolitic limestone interbedded with *Glossopleura* trilobite-bearing, olive shale; thickness about 260 feet (80 m). Howell Limestone is massive, micritic limestone, light-gray in the upper half and dark-gray below; about 360 feet (110 m) thick. In Wah Wah Mountains in Beaver County, the Peasley Limestone, a carbonate equivalent of the upper part of the Chisholm Formation, is included within this map unit. Structurally thinned in Beaver Lake Mountains.

Ꞓl Lower Cambrian, undivided--Cross section only; for included units see correlation chart and descriptions.

Ꞓp Pioche Formation--Dark-green, micaceous argillite interbedded with light-brown to greenish-black quartzite; trace-fossil tubular trails and vertical *Skolithus* tubes are common; orange-weathering dolomite beds common in uppermost Pioche; average thickness about 800 feet (245 m).

Ꞓpm Prospect Mountain Quartzite--Pinkish-gray, medium- to coarse-grained quartzite; small-scale cross-bedding and thin beds of grit and pebble conglomerate are common; includes a thin (16 to 50 feet [5-15 m]) basalt flow about 1,600 feet (500 m) above the base in the San Francisco Mountains; estimated total thickness more than 4,000 feet (1,200 m).

pꞒ Precambrian, undivided--Cross section only; for included units see correlation chart and descriptions.

pꞒm Mutual Formation--Reddish-purple quartzite and metaconglomerate with some interbeds of red and green phyllitic slate; about 2,100 feet (635 m) thick in the San Francisco Mountains.

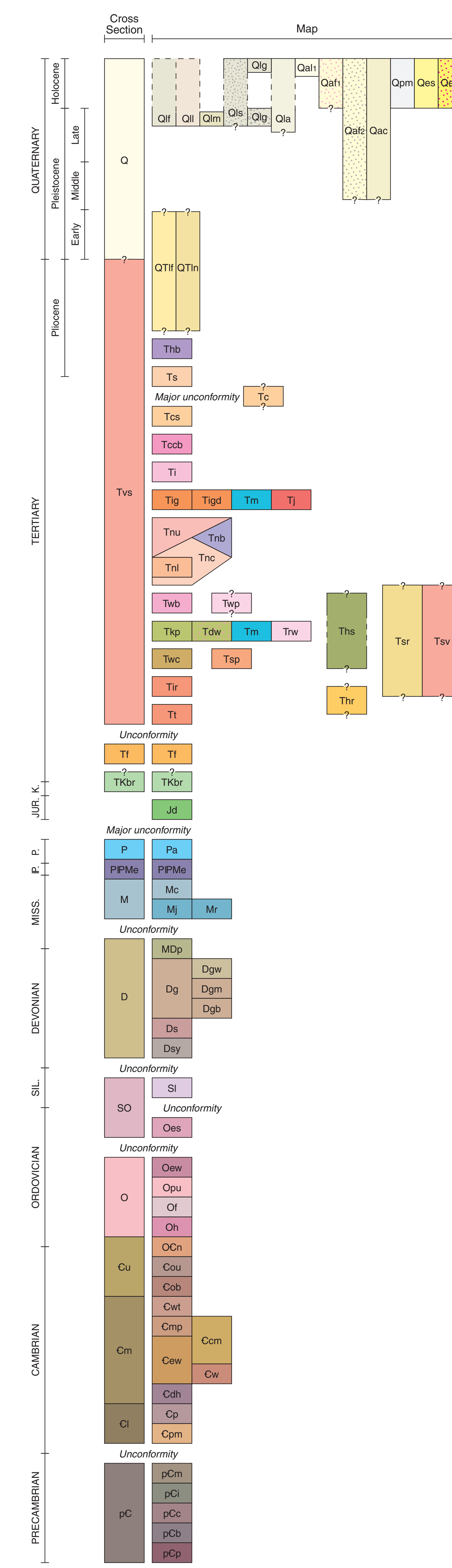
pꞒi Inkom Formation--Olive-gray, green, and reddish-brown, phyllitic slate that forms recessive topography and is commonly covered; lacks quartzite beds; about 500 feet (150 m) thick in the San Francisco Mountains.

pꞒc Caddy Canyon Quartzite--Light-pinkish or yellowish-gray quartzite with interbeds of conglomerate, siltstone, and argillite in the upper part; about 300 feet (90 m) thick in the San Francisco Mountains, probably thicker elsewhere.

pꞒb Blackrock Canyon Limestone--Chiefly interbedded argillite and quartzite with about 10 percent interbeds of limestone and dolomite that are commonly silty or sandy; contains the only carbonate rock in the Precambrian of western Utah; maximum thickness about 600 to 990 feet (180-300 m) in the San Francisco Mountains.

pꞒp Pocatello Formation--Light-gray, thick-bedded, medium- to coarse-grained quartzite with a few red slate beds near the top; exposed thickness 970 feet (300 m).

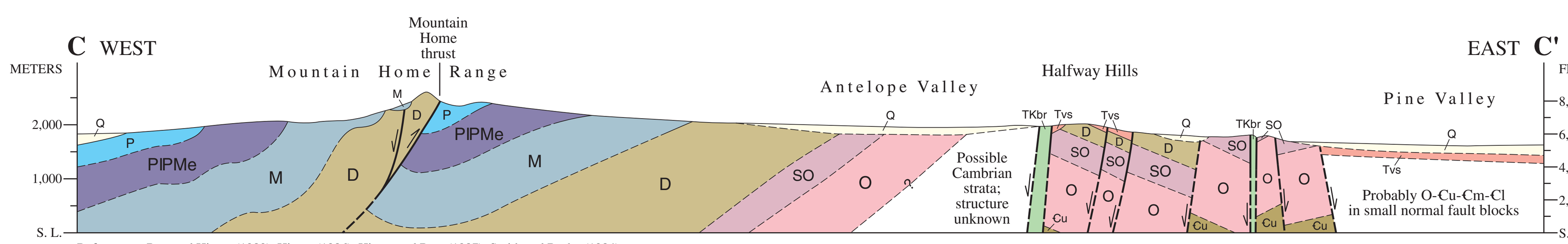
CORRELATION OF GEOLOGIC UNITS



LITHOLOGIC COLUMN

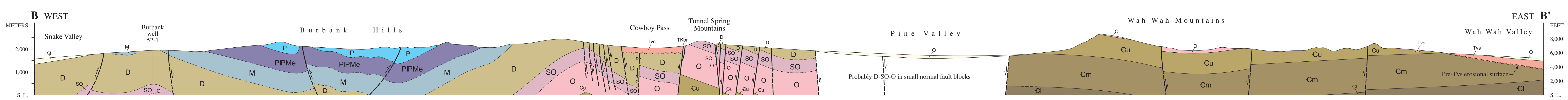
AGE	MAP SYMBOL	MAP UNIT	THICKNESS FEET	THICKNESS METERS	SCHEMATIC COLUMN	OTHER INFORMATION
Q. P.-H.	Q-various	Alluvial, lacustrine, eolian, and playa deposits	0-200	0-60		
Q. PL.	QTlf,QTln	Fine lake sediments (lf); shoreline deposits (ln)	0-870+	0-265+		Pliocene to mid-Pleistocene
PL.	Ts,Thb	Valley fill sediments (s); Basalt of High Rock (hb)	0-150	0-50		
MIO.	Tc,Tcs	Post-Needles Range congl. (c); congl. & ss. (cs)	0-2,000	0-600		Age unknown
MIO.	Tccb**	Condor Canyon Formation, Bauers Tuff Mbr	0-20	0-6		22.7 Ma
TERTIARY OLIGOCENE	Ti	Isom Tuff	0-50	0-15		25.7 Ma
	Tm**,Tj**	Marble (m); jasperoid (j)	--	--		Alteration
	Tig**,Tigd**	Granitic intrusions, San Francisco & Beaver Lake Mts.	--	--		28-29 Ma
	Tnu / Tnb / Tnc (Needles Range Group)	u=Wah Wah Springs-Cottonwood Wash Tuff; b=Basalt of Brown Knoll; c=Conglomerate and large slide blocks	0-2,300; 0-250; 0-500	0-700; 0-80; 0-150		28, 30.5 & 31 Ma crystal-rich tuffs
	Tnl (Needles Range Group)	l=Escalante Desert Formation	0-120	0-37		32(?) Ma crystal-poor tuff
	Twb	Windous Butte Tuff	0-100	0-30		31.4 Ma Ar-Ar
	Tsr,Tsv	Skull Rock Pass Cg; sedimentary & volcanic rocks	0-350	0-107		K-Ar ages not exact, and units not in contact, so stacking order is tentative.
	Twp**	Rhyolite porphyry of Wah Wah Summit	0-100	0-30		Age?
	Tkp**	Andesite of Kelleys Place	2,000	600		~33 Ma
	Tdw**/Trw**	Intrusions of Wah Wah Summit	--	--		
	Tsp**	Sawtooth Peak Formation	200	60		33.5 Ma
	Twc	Dacite of Wah Wah Cove	1,500+	460+		34 Ma
	Ths	Horn Silver Andesite	0-2,000	0-600		31-35 Ma
	Thr	Conglomerate of High Rock Pass	0-300	0-90		
	Tir	Rhyolitic intrusions of Tunnel Spring Mts.	--	--		
	Tt	Tunnel Spring Tuff	0-1,000	0-330		35.4 Ma quartz-rich; HIATUS
PAL.	Tf	Flagstaff Formation	0-585	0-180		HIATUS
K.	TKbr	Tectonic breccia	<0.35 mi (0.5 km)			Age in question; HIATUS
J.	Jd	Diabase plug in the Burbank Hills	30 ft (9 m) diam.			141 Ma; MAJOR UNCONFORMITY
PERMIAN	Pa	Arcturus Formation	2,500±	760±		Gypsum
PENN.	PIPMe	Ely Limestone	2,740±	835±		Large fusulinids at top; Cyclic cherty limestone; Brachiopods and corals
MISSISSIPPIAN	Mc	Chainman Formation	2,150-2,700	655-820		Fossiliferous near top; Phosphatic beds near base
	Mj, Mr	Joana Limestone (west); Redwall Limestone (east)	460-560	140-170		
	MDp	Pilot Shale	480*	145*		
DEVONIAN	Dg / Dgw	Guilmette Formation: West Range Limestone Mbr	260-860	80-260		Brachiopods common
	Dg / Dgm	Guilmette Formation: Middle member	2,950*	900*		Stromatoporoids; Chertless limestone and dolomite
	Dg / Dgb	Guilmette Formation: Breccia member	500*	150*		Massive limestone breccia
	Ds	Simonson Dolomite	540-700	165-213		Dark-gray sugary dolomite
	Dsy	Sevy Dolomite	1,300±	400±		Light-gray dolomite
SIL.	Sl	Laketown Dolomite	1,000-1,560	300-474		Cherty dolomite
ORDOVICIAN	Oes	Ely Springs Dolomite	345-630	105-192		
	Oew	Eureka - Crystal Peak - Watson Ranch Fms, undivided	733-865	223-264		
	Opu	Pogonip Group: Lehman - Kanosh - Juab - Wah Wah Fms, undivided	1,120*	340*		
	Of	Pogonip Group: Fillmore Formation	1,800	550		Thin-bedded limestone; Intraformational conglomerate and light-olive shale
	Oh	Pogonip Group: House Limestone	460*	140*		*Symphysurina*
CAMBRIAN	OꞒn	Notch Peak Formation	1,700*	520*		
	Ꞓou	Orr Formation, upper members, undivided	400*	120*		*Dunderbergia*
	Ꞓob	Orr Formation, Big Horse Limestone Member	690*	210*		*Crepicephalus*; Bioclastic limestone
	Ꞓwt	Wah Wah Summit - Trippe Formations, undivided	1,490*	455*		Gray dolomitic limestone, white laminated dolomite
	Ꞓmp / Ꞓcm / Ꞓew	Marjum / Pierson Cove Formations; Limestone of Cricket Mountains (Ꞓcm); Eye of Needle - Swasey - Whirlwind Fms, undivided	2,200*	670*		Mostly dark-gray limestone
	Ꞓw	Whirlwind Formation	100-265	30-81		*Ehmaniella*
	Ꞓdh	Dome - Chisholm - Howell Fms, undivided	920*	280*		Includes Peasley Ls in Beaver Co.
	Ꞓp	Pioche Formation	800*	245*		Argillite, burrows and tracks; *Olenellus* trilobites
	Ꞓpm	Prospect Mountain Quartzite	4,000+	1,200+		Pinkish-gray vitreous quartzite; Basalt flow 15-50 ft thick, 1,650 ft above base
PRECAMBRIAN	pꞒm	Mutual Formation	2,100	635		Purple conglomerate quartzite; Maroon slate; Reddish-brown pebbly quartzite
	pꞒi	Inkom Formation	500*	150*		Green phyllitic slate
	pꞒc	Caddy Canyon Quartzite	300*	90*		Pinkish or yellowish-gray
	pꞒb	Blackrock Canyon Limestone	600-990	180-300		Argillite and quartzite with silty limestone and dolomite interbeds
	pꞒp	Pocatello Formation	970+	300+		Light-gray quartzite

Diagram is schematic-- no fixed thickness scale. *Thickness figures are averages. **Unit only in Beaver County.



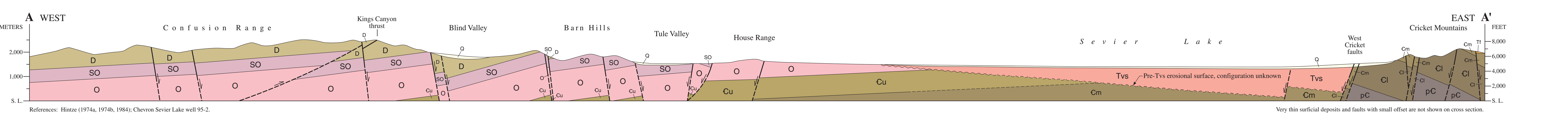
References: Best and Hintze (1980), Hintze (1986), Hintze and Best (1987), Smith and Bruhn (1984).

Very thin surficial deposits and faults with small offset are not shown on cross section.



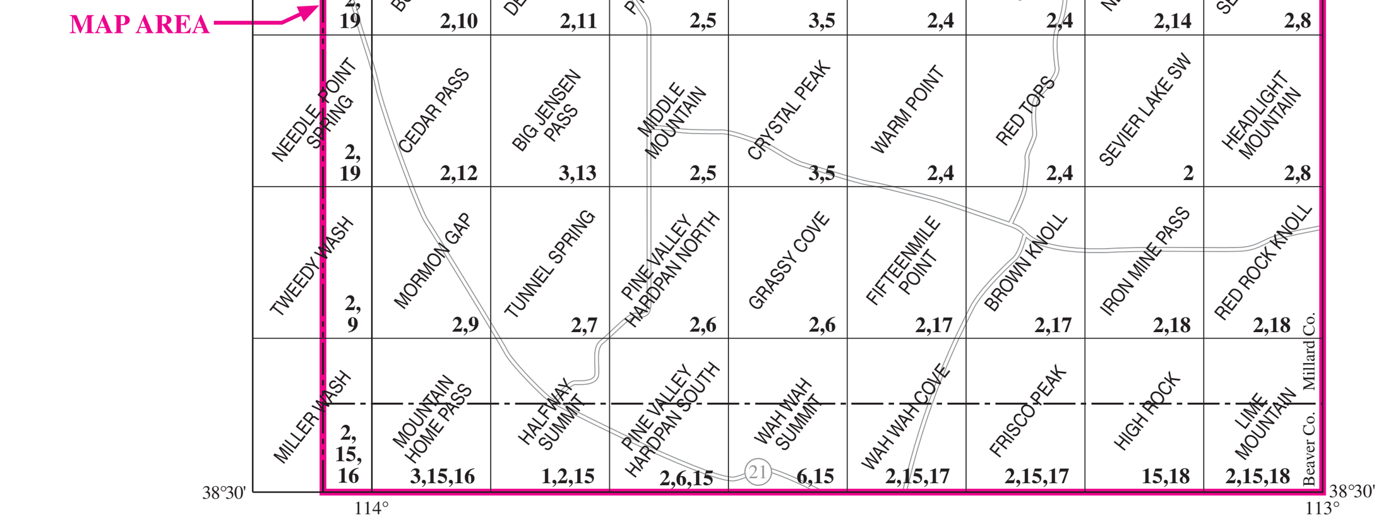
References: Hintze (1974b, 1974c), Hintze and others (1984), Hintze (1997a, 1997d).

Very thin surficial deposits and faults with small offset are not shown on cross section.



References: Hintze (1974a, 1974b, 1984); Chevron Sevier Lake well 95-2.

Very thin surficial deposits and faults with small offset are not shown on cross section.



SOURCE LIST FOR GEOLOGIC MAPPING

(Index map, *above*, shows sources of geologic mapping and 7.5-minute quadrangles. Numbers, *below,* correspond to those on index map).

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2. Davis, F.D., 1992-1996, unpublished mapping of surficial geology of valley areas in Millard County for this publication, scale 1:24,000.
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5. Hintze, L.F., 1974b, Preliminary geologic map of the Crystal Peak [15'] quadrangle, Millard County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-635, scale 1:48,000; mapping of Tertiary units locally modified by L.F. Hintze for this publication.
6. Hintze, L.F., 1974c, Preliminary geologic map of the Wah Wah Summit [15'] quadrangle, Millard and Beaver Counties, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-637, scale 1:48,000.
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8. Hintze, L.F., 1984, Geology of the Cricket Mountains, Millard County, Utah: U.S. Geological Survey Open-File Report 84-683, 14 p., plates 3 and 6, map scale 1:24,000.
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12. Hintze, L.F., 1997c, Interim geologic map of the Cedar Pass quadrangle, Millard County, Utah: Utah Geological Survey Open-File Report 354, scale 1:24,000.
13. Hintze, L.F., 1997d, Interim geologic map of the Big Jensen Pass quadrangle, Millard County, Utah: Utah Geological Survey Open-File Report 357, scale 1:24,000.
14. Hintze, L.F., 1985, unpublished mapping from field check of Coyote Knolls for this publication, scale 1:24,000.
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16. Hintze, L.F., and Best, M.G., 1987, Geologic map of the Mountain Home Pass and Miller Wash quadrangles, Millard and Beaver Counties, Utah, and Lincoln County, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-1950, scale 1:24,000.
17. Hintze, L.F., Lemmon, D.M., and Morris, H.T., 1984, Geologic map of the Frisco Peak [15'] quadrangle, Millard and Beaver Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1573, scale 1:48,000.
18. Lemmon, D.M., and Morris, H.T., 1984, Geologic map of the Beaver Lake Mountains [15'] quadrangle, Beaver and Millard Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1572, scale 1:48,000; mapping of Tertiary rocks locally modified by L.F. Hintze for this publication.
19. Whitebread, D.H., 1969, Geologic map of the Wheeler Peak and Garrison [15'] quadrangles, Nevada and Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-578, scale, scale 1:48,000; and L.F. Hintze, 1997, unpublished mapping for this publication, scales 1:24,000 and ~1:50,000.

Subsurface Data (Only used on cross section)
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