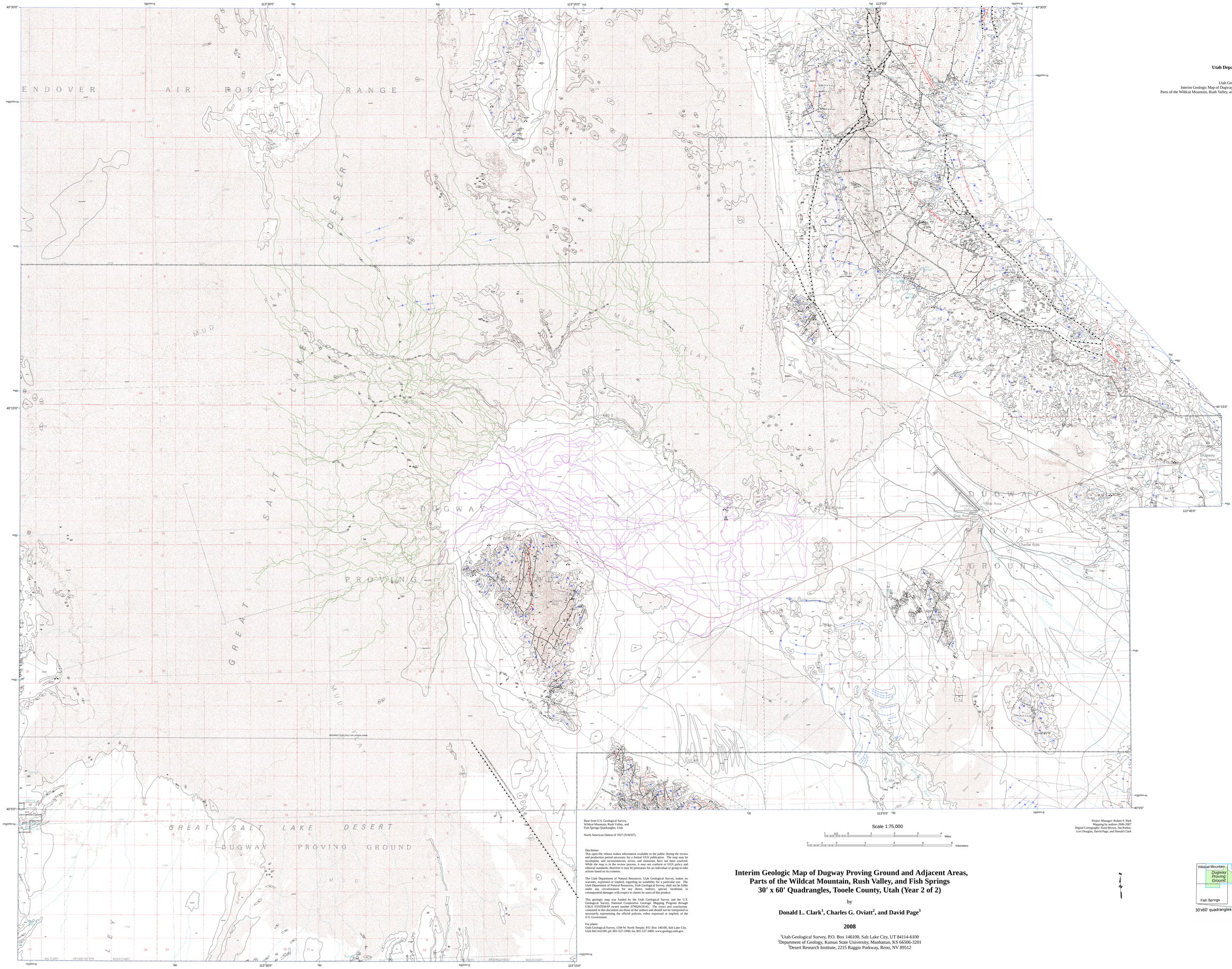

Base from U.S. Geological Survey,
Wildcat Mountain, Rush Valley, and
Fish Springs Quadrangles, Utah

North American Datum of 1927 (NAD27).

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Scale 1:75,000

Miles: 1 0.5 0 1 2 3 4

Kilometers: 2 1 0 2 4 6 8

Project Manager: Robert F. Biek
Mapping by authors 2006-2007
Digital Cartography: Kent Brown, Jim Parker, Lori Douglas, David Page, and Donald Clark

Interim Geologic Map of Dugway Proving Ground and Adjacent Areas, Parts of the Wildcat Mountain, Rush Valley, and Fish Springs 30' x 60' Quadrangles, Tooele County, Utah (Year 2 of 2)

by

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2008

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Utah Geological Survey
a division of
Utah Department of Natural Resources

Plate 1
Utah Geological Survey Open-File Report 532
Interim Geologic Map of Dugway Proving Ground and Adjacent Areas,
Parts of the Wildcat Mountain, Rush Valley, and Fish Springs 30' x 60' Quadrangles,
Tooele County, Utah (Year 2 of 2)

DPG_Combined_Year2_75K_080508.mxd

GEOLOGIC UNIT DESCRIPTIONS

Alluvial deposits

Qal **Alluvial deposits** (Holocene) – Primarily clay, silt, and sand with some gravel lenses, deposited by streams in channels and filling drainages; locally includes alluvial-fan, colluvial, and eolian deposits; thickness generally less than about 20 feet (6 m).

Qaf **Alluvial-fan deposits, undifferentiated** (Holocene to upper Pleistocene?) – Poorly sorted gravel with sand, silt, and clay deposited by streams, debris flows, and flash floods on alluvial fans and in canyon and mountain valleys above the Bonneville shoreline; includes alluvium and colluvium in canyon and mountain valleys; may include small areas of eolian deposits and lacustrine fine-grained deposits below the Bonneville shoreline; thickness variable, to 100 feet (30 m) or more.

Qafo **Older alluvial-fan deposits** (upper Pleistocene? to Pliocene?) – Deposits of higher-level, poorly sorted gravel with sand, silt, and clay that have been incised by younger alluvial deposits; present along the margin and interior valleys of the eastern Cedar Mountains; may locally include small areas of lacustrine or eolian deposits; thickness variable, to 100 feet (30 m) or more.

The Old River Bed is an abandoned river valley present on the southern part of Dugway Proving Ground (DPG) and southward to the Sevier River southwest of Delta. The Old River Bed formed during the most recent episode of overflow from the Sevier basin (Lake Gunnison) to the Great Salt Lake basin (Lake Bonneville) (Oviatt, 1987; Oviatt and others, 1994). Where the river entered Lake Bonneville, a delta formed with numerous distributary channels. Two types of channel systems were mapped- younger sand channels (Qas) and older gravel channels described below. We mapped only the main channels that were directly related to the Old River Bed delta. This channel mapping was simplified and modified somewhat from unpublished archeological survey reports prepared by the Desert Research Institute for the Directorate of Environmental Programs, U.S. Army DPG, and by Page (in preparation).

Qas **Alluvial sand deposits** (upper Pleistocene) – Sand and silt, locally with gravel, present in "exposed channels" (exposed due to deflation of mudflat surfaces) on mudflats north and west of Granite Peak, and in "buried channels" (buried by eolian sand and silt) extending between the Old River Bed and the mudflats of the southern Great Salt Lake Desert; associated with alluvial gravel deposits (Qag); probably related to continued Sevier-basin overflow and to groundwater discharge; ages of 8800 to 11,400 ^{14}C years B.P. (about 10,000 to 13,000 calendar years B.P.); thickness to about 3 feet (1 m) (Oviatt and others, 2003).

Qag **Alluvial gravel deposits** (upper Pleistocene) – Coarse sand and gravel, dominated by volcanic clasts, present in topographically inverted "gravel channels" on mudflats north of Granite Peak; these "gravel channels" have a distinct morphology–straight to curved, digitate, and with abrupt bulbous ends; associated with alluvial sand deposits (Qas); formed by a river delta that originated as overflow from the Sevier basin along the Old River Bed during the late regressive phases of Lake Bonneville, prior to 11,000 and after 12,500 ^{14}C yr B.P. (about 13,000 to 14,600 calendar years); thickness to about 12 feet (4 m) (Oviatt and others, 2003).

Spring deposits

Qsm **Spring and marsh deposits** (Holocene) – Clay, silt, and sand that is locally organic-rich, calcareous, or saline; present in saturated (marshy) areas near springs along margins of mudflats; thickness undetermined.

Qst **Spring tufa** (Holocene) – Tufa present in mounds around hot springs northwest of Fish Springs at south border of map; area referred to as Wilson Health Springs on Fish Springs NW 7.5' quadrangle map; thickness undetermined.

Eolian deposits

Qe **Eolian deposits** (Holocene) – Windblown sand and silt in sheet and dune forms; mapped along northern Snake Valley and east of Wildcat Mountain; not differentiated as Qes and Qed due to convergence of landforms and map scale; 0 to 10 feet (0-3 m) thick.

Qes **Eolian sheet-sand deposits** (Holocene) – Windblown sand and silt deposited as sheets rather than well-developed dunes; generally thin with no distinct bedding; mostly silty, well-sorted, fine-grained quartz sand; generally greater than 3 feet (1 m) and less than 10 feet (3 m) thick.

Qed **Eolian dune-sand deposits** (Holocene) – Windblown sand and silt in well-developed dunes and dune fields; mostly fine-grained quartz sand but also aggregates of clay, silt, and sand; present as parabolic, linear, dome, lunette, and shrub-coppice dunes (see Dean, 1978); larger dune fields may include a fringe of unmapped sheet sand; to 70 feet (20 m) thick.

Qei **Eolian silt** (Holocene) – Windblown silt mapped as stacked unit Qei/Qlf.

Qeg **Eolian gypsum deposits** (Holocene) – Windblown gypsum grains in dunes and local sheets on mudflats along western border of map area, not field checked; to 10 feet (3 m) thick.

Lacustrine and Deltaic deposits

Qpm **Playa mud** (Holocene to upper Pleistocene) – Laminated clay and silt, with minor sand, typically calcareous or saline; locally present east of Granite Peak and on mudflats at areas of local groundwater discharge; probably less than 20 feet (6 m) thick.

Table 1 presents ages and elevations of Lake Bonneville shorelines in the map area. Crittenden (1963) and Currey (1982) provided regional data on shoreline elevations.

Qdg **Deltaic gravel** (upper Pleistocene) – Sand and gravel deposited near the mouth of the Sevier River in the Old River Bed area during the Bonneville lake cycle; well-sorted pebbly sand containing volcanic and sedimentary pebbles; cross-bedded to very thick bedded; regressive deposits were locally reworked by waves into a thin sheet with delta ridge crests; to 50 feet (15 m) thick.

Qlg **Lacustrine gravel** (upper Pleistocene) – Sandy gravel to boulders composed of locally derived rock fragments deposited in shore zones of Lake Bonneville; locally tufa-cemented and draped on bedrock; thickness variable, to 100 feet (30 m) or more.

Qls **Lacustrine sand** (upper Pleistocene) – Sand and silt deposited by regressional phase of Lake Bonneville; thickness to 100 feet (30 m) or more.

Qlf **Lacustrine fine-grained deposits** (upper Pleistocene) – Sand, silt, marl, and calcareous clay of Lake Bonneville; thinly to very thick bedded; locally includes the white marl of Gilbert (1890) and other fine-grained lacustrine deposits; thickness to 100 feet (30 m) or more.

Qll **Lacustrine lagoonal deposits** (upper Pleistocene) – Silt and clay deposited behind beaches of highest transgressional phase of Lake Bonneville at south and west margin of Cedar Mountains and on Wildcat Mountain; thickness to 40 feet (12 m).

Qlt **Lacustrine tufa** (upper Pleistocene) – Two areas of carbonate rock deposited on bedrock outliers west of Cedar Mountains; some unmapped Qlt present on Wildcat Mountain; thickness to 40 feet (12 m).

Colluvial deposits

Qc **Colluvial deposits** (Holocene to upper Pleistocene) – Fine- to coarse-grained detritus derived from local bedrock; commonly includes talus in upper parts of deposits; may locally include lacustrine, alluvial, or eolian deposits; more common on Granite Peak and northern Dugway Range than elsewhere; to 20 feet (6 m) or more thick.

Mass-movement deposits

Qmtc **Talus and colluvial deposits** (Holocene to upper Pleistocene) – Mixed talus and colluvium locally present on Tabbys Peak, on west side of Cedar Mountains, and on Camels Back Ridge; to 15 feet (5 m) or more thick.

Mixed-environment deposits

Qla **Lacustrine and alluvial deposits, undifferentiated** (Holocene to upper Pleistocene) – Mixed and reworked, gravelly lacustrine and alluvial deposits on piedmont slopes; includes pre-Bonneville alluvial fans etched by waves in Lake Bonneville, and thin alluvial-fan deposits overlying fine to coarse-grained lake sediments; grades from pebbly sand and silt to sandy pebble gravel; locally includes areas of thicker alluvial-fan deposits in western Skull Valley and west of Simpson Mountains; thickness locally exceeds 30 feet (10 m).

Qac **Alluvial and colluvial deposits, undifferentiated** (Holocene to upper Pleistocene) – Primarily gravel, with sand, silt, and clay; form aprons of small alluvial-fan and colluvial surfaces that spill out onto and grade into alluvial-fan deposits, and also present within upland valleys; thickness generally less than 20 feet (6 m).

Qlc **Lacustrine and colluvial deposits, undifferentiated** (Holocene to upper Pleistocene) – Primarily gravel and sand, but may include lacustrine fine-grained deposits; commonly includes talus in upper parts of deposits; mantles bedrock and fills washes, locally remobilized by slope-wash and rock-fall processes; locally marked by prominent secondary shorelines; mapped on northwest side of Granite Peak; thickness to 10 feet (3 m), or locally more.

Qea **Eolian and alluvial deposits** (Holocene) – Mixed eolian and alluvial deposits mapped as stacked units Qea/Qlf and Qed-Qea/Qlf.

Human-derived deposits

Qh **Human disturbance** (Historical) – Deposits from human development on Dugway Proving Ground that cover more extensive areas, consisting of wastewater treatment lagoons, sanitary landfill, and Michael Army Airfield; thickness less than about 20 feet (6 m).

Stacked-unit deposits

Qea/Qlf **Eolian and alluvial deposits over lacustrine fine-grained deposits** (Holocene/upper Pleistocene) – Windblown silt in sheet form adjacent to and locally covering alluvial sand and gravel in unmapped channels that collectively overlie lacustrine marl and fine-grained deposits; locally saline or gypsiferous; form extensive mudflats of southern Great Salt Lake Desert; may locally include small areas of thicker eolian deposits; cover unit thickness probably less than 15 feet (5 m) thick.

Qed-Qea/Qlf **Eolian dune sand with eolian and alluvial deposits over lacustrine fine-grained deposits** (Holocene/upper Pleistocene) – Intermittent exposures of windblown dune sand and some silt interspersed with windblown silt in sheet form adjacent to and locally covering alluvial sand and gravel in unmapped channels that collectively overlie lacustrine marl and fine-grained deposits; locally saline or gypsiferous; mapped in three areas on mudflats where small dunes are difficult to map individually at this scale; cover unit thickness probably less than 18 feet (6 m) thick.

Qei/Qlf **Eolian silt over lacustrine fine-grained deposits** (Holocene/upper Pleistocene) – Windblown silt overlying lacustrine silt, clay, marl, and some sand over a large area east of Granite Peak; surface commonly contains distinctive vegetation stripes (characteristic landforms of sheetflow plains in arid to semiarid regions) (Oviatt and others, 2003); may locally include areas of thicker eolian deposits; cover unit thickness typically less than 3 feet (1 m).

Qes/Qlf **Eolian sheet-sand deposits over lacustrine fine-grained deposits** (Holocene/upper Pleistocene) – Windblown sand and some silt in sheets overlying lacustrine silt, clay, marl, and some sand northeast of Little Granite Mountain; may locally include areas of thicker eolian deposits; cover unit thickness probably less than 6 feet (2 m).

Qed/Qlf **Eolian dune-sand deposits over lacustrine fine-grained deposits** (Holocene/upper Pleistocene) – Windblown dune sand and some silt overlying lacustrine sand, silt, marl, and clay; cover unit thickness probably less than 20 feet (6 m).

Qes/Qla **Eolian sheet-sand deposits over lacustrine and alluvial deposits** (Holocene/Holocene to upper Pleistocene) – Windblown dune sand and silt overlying gravelly to fine-grained lacustrine and alluvial deposits; present at and northwest of Dugway and upland valley of White Rock-Post Hollow area; cover unit thickness probably less than 10 feet (3 m).

Qes/Qaf **Eolian sheet-sand deposits over alluvial-fan deposits** (Holocene/Holocene to upper Pleistocene?) – Windblown sheet sand and silt overlying younger gravelly to fine-grained alluvial-fan deposits near Wildcat Mountain; cover unit thickness probably less than 10 feet (3 m).

Qed/Qla **Eolian dune sand deposits over lacustrine and alluvial deposits** (Holocene/Holocene to upper Pleistocene) – Windblown sand and some silt that forms well-developed dunes overlying gravelly to fine-grained lacustrine and alluvial deposits; locally well exposed in large gravel pit on southern margin of Cedar Mountains and north of Michael Army Airfield (Prime Road gravel pit); cover unit thickness probably less than 20 feet (6 m).

Qal/Qlf **Alluvial deposits over lacustrine fine-grained deposits** (Holocene/upper Pleistocene) – Sand, silt, clay, and some gravel in alluvial channels and sheets overlying lacustrine silt, clay, marl, and some sand; present between Granite Peak and Old River Bed; cover unit thickness probably less than 6 feet (2 m).

Qaf/Qlf **Alluvial-fan deposits over lacustrine fine-grained deposits** (Holocene to upper Pleistocene?/upper Pleistocene) – Gravel, sand, and fine-grained alluvial-fan deposits overlying lacustrine sand, silt, marl, and clay; present along periphery of Granite Peak and in some upland valleys of eastern Cedar Mountains; cover unit thickness probably less than 10 feet (3 m).

Qed/Tac **Eolian dune-sand deposits over andesitic and dacitic rocks of southern Cedar Mountains** (Holocene/Oligocene? to Eocene?) – Windblown dune sand and silt overlying bedrock unit; locally includes small bedrock exposures; cover unit thickness probably less than 10 feet (3 m).

Qac/Tac **Alluvial and colluvial deposits over andesitic and dacitic rocks of southern Cedar Mountains** (Holocent/Oligocene? to Eocene?) – One area near Cochran Spring of fine-grained surficial deposits overlying bedrock unit; cover unit thickness probably less than 10 feet (3 m).

Qes/Tlw? **Eolian sheet-sand deposits over latitic rocks of Wildcat Mountain?** (Holocene/Oligovene? to Eocene?) – Two areas of western Wildcat Mountain of eolian deposits overlying bedrock unit; cover unit thickness probably less than 10 feet (3 m).

Qlg/Tlw **Lacustrine gravel over latitic rocks of Wildcat Mountain** (upper Pleistocene/Oligocene? to Eocene?) – Sandy and pebbly gravel overlying bedrock unit along western side of Wildcat Mountain; cover unit thickness probably less than 20 feet (6 m).

Qlg/₱obw **Lacustrine gravel over Oquirrh Group, Butterfield Peaks Formation and West Canyon Limestone, undivided** (upper Pleistocene/Middle to Lower Pennsylvanian) – Sandy and pebbly gravel overlying combined bedrock unit on Wildcat Mountain; gravel cover on east side of mountain is thinner to nonexistent compared to west side; cover unit thickness probably less than 20 feet (3 m).

Qlg/R **Lacustrine gravel over undifferentiated bedrock** (upper Pleistocene/Miocene? to Cambrian) – Sandy and pebbly gravel overlying various bedrock units along western and southern margin of Cedar Mountains, southwest of Dugway, and on Camels Back Ridge; locally includes small bedrock exposures of map units Ts, Tac, Pp, Oquirrh Group formations, and Cambrian units; cover unit thickness probably less than 10 feet (3 m).

Geochemical and age data for Tertiary and Jurassic rocks presented in tables 2 and 3, figures 2 through 4, Clark (2008), Christiansen and Vervoort (in preparation), and UGS & NMGRL (2007, 2008, in preparation). Rock names from total alkali-silica classification diagram of LeBas and others (1986).

Trd **Rhyolite dikes of Granite Peak** (Miocene) – Grayish-orange, weathering to dark-yellowish-brown porphyritic rhyolite with phenocrysts of feldspar and biotite; cross-cuts granite (Jg), granodiorite (Jgd) and pegmatite dikes; prior K-Ar age of about 13 Ma (Moore and McKee, 1983), new ^{40}Ar/^{39}Ar age of 7.78 ± 0.05 Ma on sanidine (UGS & NMGRL, 2007); dikes probably related to rhyolite of Sapphire Mountain; width to 30 feet (10 m).

Trs **Rhyolite of Sapphire Mountain** (Miocene) – Pale-red, weathering to dark-yellowish-brown and moderate-red, porphyritic rhyolite lava flow; containing about 10% phenocrysts of quartz, sanidine, and minor biotite in an aphanitic groundmass; locally includes flow breccia; forms cliffy exposures on Sapphire Mountain; ^{40}Ar/^{39}Ar age of 8.20 ± 0.05 Ma on sanidine (UGS & NMGRL, 2007); exposed thickness is 450 feet (140 m).

Trr **Rhyolite of Rydalch Canyon area** (Miocene?) – Light-gray and very pale orange rhyolite ash-flow tuff exposed south and east of Rydalch Canyon in southern Cedar Mountains; contains about 25 % phenocrysts of feldspar, quartz, hornblende, and biotite; unreliable age obtained (see table 4); exposed thickness to 650 feet (200 m).

Ts **Tertiary strata** (Oligocene? to Eocene?) – One area southwest of Dugway (English Village) of grayish-orange, very pale orange, and moderate-orange-pink lacustrine limestone that is locally oncolitic, moderately crystalline, and indistinctly to thin bedded; underlain by small exposure of moderate-reddish-orange tuffaceous sandstone; exposed thickness is 12 feet (4 m).

Tdd **Dacite dikes of Granite Peak** (Oligocene? - Eocene?) – Medium-gray to medium-dark-gray porphyritic dacite dikes on northwest side of mountain; only one such dike is mapped, and uncommon, unmapped latite dikes are also present; cross-cuts granite (Jg), granodiorite (Jgd) and pegmatite dikes; not dated; width to 30 feet (10 m).

Tdi **Dacitic intrusions of Little Granite Mountain and White Rock** (Eocene) – Light-gray weathering to white and yellowish-gray porphyritic dacite; contains about 25% phenocrysts of plagioclase, quartz, biotite, and amphibole (0.5-2 mm long average), and groundmass is intergrowth of plagioclase, potassium feldspar, and quartz (Maurer, 1970; Moore and Sorensen, 1977); ^{40}Ar/^{39}Ar ages of 39.56 ± 0.10 Ma (biotite) and 40.95 ± 0.32 Ma (hornblende) for Little Granite Mountain and 38.69 ± .010 Ma (sanidine) for White Rock (UGS & NMGRL, in preparation); exposures to 9500 feet (2900 m) across.

Tac **Andesitic and dacitic rocks of southern Cedar Mountains** (Eocene) – Dark- to light-gray and pale-red lava flows interlayered with lahars and less common tuffs; lava flows are porphyritic to aphanitic, and phenocrysts include feldspar, quartz, and biotite; lahars contain clasts of intermediate volcanic rocks to 4 feet (1 m) across; variously welded ash-flow tuffs contain phenocrysts of feldspar, hornblende, and biotite; calc-alkaline affinities are similar to those of Oligocene-Eocene rocks in the region; local vents mapped as unit Taci, described below; ^{40}Ar/^{39}Ar ages of 38.17 ± 0.47 and 40.66 ± 0.45 (groundmass) and 41.73 ± 0.24 Ma (hornblende) (UGS & NMGRL, in preparation); exposed thickness to 1200 feet (370 m).

Taci **Andesitic intrusions of southern Cedar Mountains (Devils Postpile, Six Horse Pass, Tabbys Peak)** (Eocene) – Dark-gray porphyritic to aphanitic andesitic intrusions associated with local vents for extrusive suite of calc-alkaline volcanic rocks (Tac); where porphyritic, contains phenocrysts of feldspar, hornblende, and lesser biotite; columnar jointing of exposures common; Devils Postpile previously called Moronis Postpile (Maurer, 1970); ^{40}Ar/^{39}Ar ages of 39.55 ± 0.22 Ma (groundmass) from Devils Postpile and 40.61 ± 0.78 Ma (groundmass) from Tabbys Peak (UGS & NMGRL, in preparation); exposures to 1600 feet (490 m) across.

Tlw **Latitic rocks of Wildcat Mountain** (Oligocene? to Eocene?) – Dark- to moderate-gray and pale-red latite lava flows and dark-gray trachydacite intrusions associated with local vents; exposed on west side of Wildcat Mountain; rocks are porphyritic to aphanitic and locally vesicular; not dated; previously mapped as Tertiary basalt and basaltic andesite (?) (Moore and Sorensen, 1979); mostly mapped as stacked units Qlg/Tlw and Qlg/Tlw?, and also as Tlw?; exposed thickness to 120 feet (40 m).

Tti **Trachytic intrusions of northern Dugway Range** (Eocene?) – Gray to reddish-brown aphanitic to porphyritic trachyte and tephriphonolite (previously called rhyodacite by Staatz, 1972); locally with phenocrysts of quartz, plagioclase, biotite, and amphibole; locally vesicular, highly oxidized and devitrified; occurs as plugs along Buckhorn fault; also includes small areas of flow breccia and associated tuffs (see Staatz and Carr, 1964; Staatz, 1972; Kelley and others, 1987; Kelley and Yambrick, 1988); age estimate of 36? Ma (Lindsey, 1979; Hintze, 1988), unreliable age obtained (see table 4); exposures to 1400 feet (430 m) across.

Tb **Breccia** (Tertiary?) – One northern Dugway Range exposure of heterogeneous jumbled bedrock blocks and fragments in a reddish, clayey, calcareous matrix (possible breccia pipe); blocks are chiefly limestone and siltstone of the Woodman Formation, but in places include fragments of limestone from the Ochre Mountain Limestone and Joana Limestone (Staatz, 1972); age unknown, assumed Tertiary; Staatz (1972) mapped as intrusive breccia; circular exposure is about 500 feet (150 m) in diameter.

Jgu **Foliated granodiorite and granite of Granite Peak, undivided** (Late Jurassic) – Foliated granodiorite (Jgd) with sills and dikes of granite (Jg) exposed in the central and western part of mountain; exposed thickness is 400 feet (120 m).

Jgd **Foliated granodiorite of Granite Peak** (Late Jurassic) − Medium-light-gray to medium-gray granodiorite with variable chemical composition (decreasing silica) to quartz monzonite, monzonite, diorite, and monzodiorite; primary minerals include plagioclase > quartz > alkali-feldspar >biotite > amphibole > muscovite (Fowkes, 1964; Christiansen and others, 2007; Jensen and others, 2007); rock is weakly to strongly foliated, contains uncommon dark xenoliths and local large feldspar crystals; cut by numerous unmapped, white, beryl-bearing pegmatite dikes in various forms (Fowkes, 1964; Clark and others, in press) as much as 100 feet (30 m) thick; also cut by minor aplite dikes, quartz veins, and younger dikes (Trd, Tdd); granodiorite is believed to be altered upper part of granite intrusion (Jg) (Clark and Christiansen, 2006; Christiansen and others, 2007; Jensen and others, 2007); some fault and fracture zones in granodiorite and associated granite (Jg) are mineralized with hematite and lesser amounts of base metal-bearing minerals; Jensen and others (2007) and Clark and others (in press) provide isotopic data on granodiorite; U-Pb zircon age determination of 149.8 ± 1.3 Ma (intrusion age) (Clark and Christiansen, 2006; Christiansen and others, 2007; Jensen and others, 2007; Christiansen and Vervoort, in preparation); ^{40}Ar/^{39}Ar ages of 15.97 ± 0.04 Ma on biotite and 27.13 ± 0.05 Ma on K-feldspar (cooling and possibly unroofing ages) (UGS & NMGRL, 2008; Clark and others, in press); exposed thickness is about 2000 feet (600 m).

Jg **Granite of Granite Peak** (Late Jurassic) − White (leucocratic) granite weathers to pale-orange and moderate-yellowish-brown; primary minerals include quartz > plagioclase > alkali-feldspar > muscovite > biotite (Fowkes, 1964; Christiansen and others, 2007; Jensen and others, 2007); locally includes dark schistose inclusions and large potassium feldspar crystals; generally weakly foliated, except in northeastern exposures where strong flow foliation exists in upper part near contact with foliated granodiorite; cut by a few pegmatite and aplite dikes, quartz veins, and younger dikes (Trd, Tdd); Jensen and others (2007) and Clark and others (in press) provide isotopic data on granite; U-Pb zircon age determination of 148.8 ± 1.3 Ma (intrusion age) (Clark and Christiansen, 2006; Christiansen and others, 2007; Jensen and others, 2007; Christiansen and Vervoort, in preparation); ^{40}Ar/^{39}Ar ages of 13.69 ± 0.12 Ma on muscovite and 19.14 ± 0.08 Ma on K-feldspar (cooling and possibly unroofing ages) (UGS & NMGRL, 2008; Clark and others, in press); exposed thickness is 1400 feet (425 m).

fault

PzZm **Metasedimentary rocks of Granite Peak** (Paleozoic? or Upper Proterozoic?) − Metasedimentary rocks composed of schist with minor quartzite, and marble with lesser schist intruded by granodiorite (Jgd) and leucogranite (Jg) sills and dikes at the south end of the mountain; approximately 60% metasedimentary rocks and 40% intrusions; metasedimentary rocks may correspond to part of the Proterozoic McCoy Creek Group or Trout Creek Sequence of the southern Deep Creek Range (see Rodgers, 1989) or, less likely, to Neoproterozoic units of the Sheeprock Mountain (Christie-Blick, 1982); locally cut by pegmatite and aplite dikes and quartz veins; in fault contact with granodiorite (Jgd) unit; exposed thickness is 2300 feet (700 m).

MISSISSIPPIAN TO CAMBRIAN STRATA OF NORTHERN DUGWAY RANGE

Mississippian and Devonian stratigraphy for the northern Dugway Range modified from Staatz (1972) after Hintze (1988; unpublished notes on Staatz and Carr, 1964). Exposures near Buckhorn fault are bleached, dolomitized, or silicified (Staatz and Carr, 1964; Staatz, 1972; Kelley and others, 1987; Kelley and Yambrick, 1988).

Mo **Ochre Mountain Limestone** (Upper Mississippian) – Medium-gray limestone and a few interbeds of dark-gray dolomite; thin to thick bedded and locally cherty; horn corals locally common; forms ledgey exposures; top eroded; 700+ feet (200+ m) thick.

Mw **Woodman Formation** (Upper to Lower Mississippian) – Upper part thin-bedded, light-gray silty limestone with a 20-foot-thick (6 m), brown-weathering quartzite near base, and lower part of thin-bedded, reddish-brown, calcareous siltstone; forms slopes with some ledges; 785 feet (240 m) thick.

Mj **Joana Limestone** (Lower Mississippian) – Fine-grained, medium-gray limestone with some chert in upper part; thin to very thick bedded and forms ledges; Staatz (1972) mapped as Madison Limestone equivalent; 315 feet (95 m) thick.

unconformity

Dg **Guilmette Formation** (Upper to Middle Devonian) – Light- to dark-gray, commonly sandy-textured dolomite; upper part contains interbedded light-gray limestone and brown-weathering gray to white dolomitic quartzite, middle part is thick to very thick bedded and contains some medium-bedded gray limestone, and lower part contains interbedded brown-weathering dolomitic and calcareous quartzite; *Amphipora* (stromatoporoid) common in some dolomite beds of middle part; forms cliffy and ledgey outcrops; Staatz (1972) mapped as Hanauer Formation, Gilson Dolomite, and Goshoot Formation; 2180+ feet (660+ m) thick.

Ds **Simonson Dolomite** (Middle Devonian) – Very thick bedded, crystalline, sandy-textured, gray to black dolomite; forms less resistant ledges than overlying Guilmette; Staatz (1972) mapped as Englemann Formation; only upper part exposed, 1080+ feet (330+ m) thick.

Buckhorn fault

Ꞓpm **Prospect Mountain Quartzite** (Lower Cambrian) – White to tan, resistant, thick-bedded quartzite with local thin beds of olive-green, micaceous shale and lenses of quartz-pebble conglomerate (Staatz, 1972); ledge- to cliff-forming unit; partly exposed, 450+ feet (140+ m) thick.

MISSISSIPPIAN TO CAMBRIAN STRATA OF WIG MOUNTAIN

Mississippian to Cambrian stratigraphy modified from Moore and Sorensen (1977, 1979), using regional stratigraphic names of Hintze (1980, 1988), rather than local names of Dugway Range (Staatz and Carr, 1964; Staatz, 1972).

Wig Mountain thrust fault

Mo **Ochre Mountain Limestone** (Upper Mississippian) – Medium- to dark-gray limestone and fossiliferous limestone with uncommon black nodular chert; medium- to thick-bedded, forming rugged ledges and cliffs; isolated exposure north of Wig Mountain contains brachiopods and numerous large crinoid columnals; top not exposed, exposed thickness is 600+ feet (180+ m).

Mw **Woodman Formation** (Upper to Lower Mississippian) – Very pale orange calcareous sandstone and siltstone, medium-gray cherty limestone, fossiliferous limestone, and sandy limestone; black chert in nodules and beds; very thin to thin-bedded; 1000 feet (300 m) thick.

Mj **Joana Limestone** (Lower Mississippian) – Moderate-gray, thin-bedded, fossiliferous limestone with uncommon black chert nodules; limited exposures between north and south parts of Wig Mountain; 300 feet (90 m) thick.

Unconformity

Devonian strata apparently depositionally thinned near Stansbury uplift (Rigby, 1959)

Dg **Guilmette Formation** (Upper to Middle Devonian) – Moderate-gray to moderate-brown, thick- to very thick bedded dolomite; local laminated surface appearance; includes ~40-foot-thick (~12 m), dark-reddish-brown quartzite at top of formation; thickness is 400 to 800 feet (120-250 m).

Dss **Simonson and Sevy Dolomites** (Middle to Lower Devonian) – Moderate gray, thin- to medium-bedded dolomite; weathers to very light and light gray with laminated surface appearance; lighter colored, more distinctly bedded, and less resistant than adjacent formations; thickness is 100 feet (30 m).

Sl **Laketown Dolomite** (Silurian) – Light- to dark-gray, weathers to light- and moderate-brown, very thick bedded dolomite commonly with small open vugs, local black chert, laminated appearance, and case hardening; thinner bedded interval (roughly 50 feet [15 m] thick) with dark-brown and light-gray dolomite is about 500 feet (150 m) above base; formation generally cliffy and indistinctly bedded; thickness is 1800 feet (550 m).

Oes **Ely Springs Dolomite** (Upper Ordovician) – Moderate-gray, thin- to medium-bedded dolomite that weathers to moderate brown and light gray; forms more distinct and less resistant beds between enclosing formations; thickness is 300 feet (90 m).

Unconformity

Tooele arch (Hintze, 1959) - Eureka Quartzite and Pognip Group not present

OꞒn **Notch Peak Formation** (Lower Ordovician to Upper Cambrian) – Present on south side of Wig Mountain; exposures are moderate-gray dolomite that weathers to light and moderate brown and gray brown, locally with a mottled appearance; locally sandy, with dark brown laminae, and twiggy bodies; thin to very thick bedded; base not exposed; exposed thickness 1000 feet (300 m).

DEVONIAN TO CAMBRIAN STRATA OF CAMELS BACK RIDGE, SIMPSON BUTTES, AND TWO OUTLIERS
Regional stratigraphic names of Hintze (1980, 1988) applied to Devonian through Cambrian strata of Camels Back Ridge rather than local names of Dugway Range (Staatz and Carr, 1964; Staatz, 1972).

DꞒd **Devonian-Cambrian dolomite** (Upper Devonian? to Upper or Middle Cambrian?) – Includes small exposure on mud flat between the Old River Bed and northern Dugway Range of moderate-gray to moderate-brown dolomite that weathers to light brown, dark brown and pale red with common near-vertical fractures; exposed thickness 25 feet (8 m); also mapped as single outcrop on Goodyear Road near western DPG border (Baker Strong Point or Black Point area) that was not field checked; about 50 feet (15 m) thick.

Dg? **Guilmette Formation?** (Upper and Middle Devonian) – Moderate- to dark-gray, finely to moderately crystalline dolomite that locally weathers brownish gray; thin to thick bedded, forming ledges; exposed thickness about 500 feet (150 m).

Fault

Ds **Simonson Dolomite** (Middle Devonian) – Light- to dark-gray, finely to moderately crystalline dolomite that locally weathers brownish gray; local zones of chert; thin to very thick bedded, forming cliffs and ledges; exposed thickness about 500 feet (150 m).

Dsy **Sevy Dolomite** (Lower Devonian) – Moderate-gray, finely crystalline dolomite weathers light gray with laminated surface appearance; thin to medium bedded; thickness is about 250 feet (75 m).

Fault

Sl **Laketown Dolomite, undivided** (Silurian) – Moderate- to dark-gray, finely to moderately crystalline dolomite that locally weathers to light and moderate brown and light gray, with some intervals of light gray dolomite; with gray and red chert in beds, masses and nodules, and rust-colored case hardening; mostly very thick bedded, forming cliffs and ledges; to south separated into several members (Hintze, 1980) corresponding to formations of Staatz and Carr (1964); exposed thickness is about 500 feet (150 m).

Oes **Ely Springs Dolomite** (Upper Ordovician) – Includes upper part (Floride Member) and lower part (lower member) not mapped separately; upper part is very light gray, finely crystalline dolomite with indistinct to medium bedding; lower part with cherty, resistant, moderate-gray dolomite at top underlain by brown-weathering, less resistant, thin-bedded dolomite; thin to thick bedded, forming ledges, cliffs and slopes; thickness is 250 feet (75 m).

Unconformity

Tooele Arch (Hintze, 1959) - Eureka Quartzite and uppermost part of Pogonip Group likely missing

Op **Pogonip Group, undivided** (Middle to Lower Ordovician) – Exposed in low hills west of Camels Back Ridge; may include part of Kanosh Shale and underlying formations; upper part of dark-gray and moderate-gray, finely to moderately crystalline dolomite, underlying moderate-gray intraformational conglomerate with siltstone and limestone; thin to medium bedded, forming ledges and slopes; Hintze (1980) described the various formations; exposed thickness to 150 feet (45 m).

Fault – separating Camels Back Ridge from low hills to west

OꞒn **Notch Peak Formation** (Lower Ordovician and Upper Cambrian) – Moderate-and light-gray finely to moderately crystalline dolomite and limey dolomite, with intervals several feet thick that weather to tan and light pink; cliff- and ledge-forming unit, medium- to very thick bedded; locally with pisolites, twiggy bodies, and Girvanella (algae); present on crest and west flank of Camels Back Ridge; Dugway Ridge Formation of Staatz and Carr (1964); exposed thickness about 500 feet (150 m).

Ꞓou **Orr Formation, upper part** (Upper Cambrian) – Very light gray to light-gray, finely to moderately crystalline dolomite and limestone, and green and light-brown shale; commonly medium to thick bedded; forms less resistant and lighter-colored interval between Notch Peak Formation and Big Horse Limestone; present on east flank and crest of Camels Back Ridge; likely includes (descending order) Sneakover Limestone Member, Corset Spring Shale Member, Johns Wash Limestone Member, and Candland Shale Member; Fera Limestone of Staatz and Carr (1964); 200 feet (60 m) thick.

Ꞓob **Orr Formation, Big Horse Limestone Member** (Upper Cambrian) – Moderate-to dark-gray, tan-gray, and pink, finely to moderately crystalline limestone with some intervals weathering to light-tan to pink, and mottled; locally dolomitized; resistant interval forming cliffs and ledges that is medium- to very thick bedded; on east flank and north part of Camels Back Ridge; Straight Canyon Formation of Staatz and Carr (1964); 425 feet (130 m) thick.

Ꞓl **Lamb Dolomite** (Upper Cambrian) –Upper part less resistant and commonly rusty and pink weathering, ledges of moderate-gray oolitic and silty limestone and flat-pebble conglomerate, downward to moderate-gray dolomite and limestone with rusty-colored blebs and layers, mostly very thin to thin bedded; lower, ledge-forming part of thin to very thick bedded, moderately to coarsely crystalline, gray dolomite that locally weathers to mottled gray, pink gray, and light brown, with intervals of Girvanella (algae); present on east flank, and south and north ends of Camels Back Ridge; 900 feet (275 m) thick.

OꞒu **Lower Ordovician and Upper Cambrian strata, undivided** (Lower Ordovician? and Upper Cambrian?) –Gray-, brown-, and pink-weathering, thin- to very thick bedded dolomite and limestone; further subdivision precluded due to lack of access and exposure, but may correspond to parts of Pogonip Group, Notch Peak Formation, Orr Formation, and Lamb Dolomite; mapped on Simpson Buttes; exposed thickness about 2300 feet (700 m).

Ꞓtl **Trippe Limestone** (Middle Cambrian) –Upper part of moderate-gray limestone and possible shale, intra-formational conglomerate, and light tan-weathering dolomite that is laminated to medium bedded; lower part of light- to moderate-gray and locally mottled, laminated to very thick bedded limestone; present on northeast side of Camels Back Ridge as a generally less resistant and ledgy interval between Lamb and Pierson Cove; gradational contact with Pierson Cove below; 700 feet (215 m) thick.

Ꞓpc **Pierson Cove Formation** (Middle Cambrian) – Ledge- to cliff-forming, thin- to very thick bedded, moderate-gray limestone with some light-gray dolomite interbeds; locally dolomitized; present on northeast side of Camels Back Ridge; exposed thickness about 800 feet (245 m).

MISSISSIPPIAN STRATA OF LITTLE DAVIS MOUNTAIN

Wig Mountain thrust fault

₱Mmc **Manning Canyon Shale** (Lower Pennsylvanian to Upper Mississippian) – Gray to black, fissile, slope-forming shale with lesser light-brown and multicolored quartzite and uncommon brownish-gray, carbonaceous limestone; exposed north and south of Little Davis Mountain; interval of regional decollement; probably only lower part exposed, exposed thickness to 200 feet (60 m).

Mo **Ochre Mountain Limestone** (Upper Mississippian) – Medium- to dark-gray, thin- to thick-bedded limestone and fossiliferous limestone, black chert locally common as nodules and beds; southwestern exposures silicified; base and possibly the top are not exposed; exposed thickness is 1200 feet (370 m).

PERMIAN TO MISSISSIPPIAN STRATA OF SOUTHERN CEDAR MOUNTAINS AND WILDCAT MOUNTAIN

New fossil age data is included in table 5. Refer to figure 5 for a comparison of Oquirrh strata between this map and Maurer (1970). Oquirrh strata have been substantially remapped to conform to the stratigraphy of the Oquirrh Mountains. However, considering regional relations, and similar to Laes and others (1997) and Hintze (1988), we combine Lower Permian (Wolfcampian) and Pennsylvanian formations under the Oquirrh Group; this nomenclature differs from existing formal terminology established in the Oquirrh Mountains (Welsh and James, 1961; Tooker and Roberts, 1970), which restricts the Oquirrh Group to strata of Pennsylvanian age.

Pp **Pequop Formation** (Lower Permian [Leonardian]) – Moderate-gray cherty limestone that weathers to light gray, interbedded with light-brown to pale-red sandstone that weathers to dark brown, and some calcareous sandstone in lower part; bedding is thin to thick to indistinct, forming ledgy and cliffy outcrops; sandstone is slightly calcareous with fine to medium sand and tabular cross-bedding; limestone is finely crystalline and locally bioclastic, with black chert in nodules and thin beds; contains Parafusulina (fusulinid); Maurer (1970) mapped as Permian unnamed formation; top not exposed, and exposed thickness is 2000 feet (600 m); Maurer (1970) reported measurement of 3953 feet (1205 m) north of map area where this unit underlies Grandeur Member of Park City Formation.

P₱o **Oquirrh Group strata, undivided** (Lower Permian to Lower Pennsylvanian) – One area on south margin of Cedar Mountains where about 30 feet (10 m) thick; total thickness of Oquirrh Group strata roughly 12,350 feet (3770 m) (figure 5).

₱Pofm **Oquirrh Group, Freeman Peak-Curry Peak and Bingham Mine Formations, undivided** (Lower Permian [Wolfcampian] and Upper Pennsylvanian [Virgilian]) – One area of combined unit along Cedar thrust and north of Rydalch Canyon; only upper Bingham Mine strata present there.

Pofc **Oquirrh Group, Freeman Peak and Curry Peak Formations, undivided** (Lower Permian [Wolfcampian]) – Medium- to dark-gray, weathering to yellowish-gray, calcareous, fine-grained sandstone and siltstone with uncommon very pale orange, medium-gray and pale-red orthoquartzite and sandy limestone; laminated to thick-bedded unit breaks into chips and plates forming rounded hills and slopes with occasional ledges; "worm trail" markings common on bedding planes in lower part of unit; also contains Schwagerina and Triticites cf. T. meeki (fusulinids); corresponds to most of Maurer's Unit 4 and Unit 5; 3500 feet (1070 m) thick.

Unconformity?

₱obm **Oquirrh Group, Bingham Mine Formation** (Upper Pennsylvanian [Virgilian-Missourian]) – Very pale orange to pale-red calcareous sandstone with lesser medium-gray sandy limestone; thin- to medium-bedded, forming ledges and slopes; fossils include brachiopods, bryozoans, and fusulinids (Triticites and Pseudofusulinella); corresponds to upper part of Maurer's Unit 3 and lower part of Unit 4; upper contact mapped at uppermost substantial limestone bed; 2800 feet (850 m) thick.

₱obw **Oquirrh Group, Butterfield Peaks Formation and West Canyon Limestone, undivided** (Middle to Lower Pennsylvanian [Desmoinesian-Morrowan]) – Combined unit mapped in small exposures of southern Cedar Mountains, on Wildcat Mountain in one small area above the Bonneville shoreline, and as stacked unit Qlg/IPobw on most of Wildcat Mountain where only reconnaissance conducted due to access restrictions.

₱obp **Oquirrh Group, Butterfield Peaks Formation** (Middle to Lower Pennsylvanian [Desmoinesian-Morrowan]) – Medium- to dark-gray, sandy limestone, cherty limestone, and fossiliferous limestone interbedded with light-brown calcareous sandstone and quartzite; thin- to very thick bedded, forming ledges, cliffs, and slopes of a cyclic character; lower part forms ledgy escarpment; limestone is finely crystalline to bioclastic; gray, yellow-brown, and black chert occurs as spherical nodules and semi-bedded masses; contains sandy laminae and horizontally-flattened concretionary structures; fossils include Chaetetes and Syringopora (colonial corals), rugose corals, fusulinids (Fusulina, Beedeina), brachiopods, and bryozoans; corresponds to Maurer's Unit 2 and most of Unit 3; 5400 feet (1650) thick.

₱Mwm **Oquirrh Group, West Canyon Limestone and Manning Canyon Shale, undivided** (Lower Pennsylvanian [Morrowan] to Upper Mississippian) – Combined unit in small exposures of southern Cedar Mountains.

₱owc **Oquirrh Group, West Canyon Limestone** (Lower Pennsylvanian [Morrowan]) – Medium- to dark-blue-gray and brown-gray limestone and fossiliferous limestone with sparse chert; weathers to gray and yellow-brown; thin- to medium-bedded, forming ledges and slopes; corresponds to Maurer's Unit 1; 500 to 800 feet (150-245 m) thick.

₱Mwc **Manning Canyon Shale** (Lower Pennsylvanian to Upper Mississippian) – Gray to black, fissile, slope-forming shale with lesser light-brown and multicolored quartzite and uncommon brownish-gray, carbonaceous limestone; typically forms dark shaley slopes littered with quartzite fragments; interval of regional decollement; probably 1500 to 2000 feet (450-600 m) thick (Maurer, 1970).

faults

Mgb **Great Blue Limestone** (Upper Mississippian) – Medium- to dark-gray, medium- and thick-bedded, finely crystalline or bioclastic limestone that forms rugged ledges; gray and black chert locally common in upper part; no obvious shaley intervals; fossils include colonial and horn corals, crinoids, and bryozoan fragments; top not exposed; 2440+ feet (745+ m) thick (Maurer, 1970).

Mh **Humbug Formation** (Upper Mississippian) – Yellow-brown and gray sandstone and quartzite, and medium- to dark-gray limestone mostly in middle part; forms slopes and ledges; sandstone weathers to brown and maroon, is fine to medium grained, thin to medium bedded; limestone is thin to medium bedded with numerous thin horizontal black chert stringers, and locally common corals and brachiopods; base not exposed; 1014+ feet (310+ m) thick (Maurer, 1970).

Note on Granite Peak:
Granite Peak (elevation 7082 feet [2159 m]) is the highest point of an unnamed mountain of largely granitic rock on Dugway Proving Ground. The name Granite Peak is used on the USGS 7.5' topographic maps of this area. This mountain has informally been called by different names, including the Granite Range (Butler and others, 1920), Granite Mountain (Hanley and others, 1950; Stokes, 1963; Moore and Sorenson, 1979), Granite Peak Mountain (Fowkes, 1964; Moore and McKee, 1983), and Granite Peak (Ives, 1946, 1949; Bullock, 1976). Although DPG personnel typically (informally) refer to this feature as Granite Mountain (Rachel Quist, U.S. Army DPG, verbal communication, August 2005), some confusion remains since Granite Mountain is the formal name applied to three different mountains in Utah located in Juab, Iron, and Washington Counties (see U.S. Geological Survey Geographic Names Information Systems website). The inappropriately named Granite Mountain in Juab County is located about 43 miles (69 km) to the southwest of Granite Peak in the northern Confusion Range and consists largely of carbonate rock! Considering all of the above, we continue to apply the existing name Granite Peak to this mountain of granitic rock.

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Selected Additional

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Table 1. Ages and elevations of major shorelines of Lake Bonneville in Dugway Proving Ground and adjacent areas.

Lake Cycle and Phase	Shoreline (map symbol)	Age: radiocarbon years B.P.	Age: calendar years B.P.[1]	Elevation feet (meters)
Lake Bonneville				
Transgressive Phase	Stansbury (S)	22,000-20,000[2]	24,400-23,200	4450-4480 (1357-1366)
	Bonneville (B) flood	15,500-14,500[3]	18,000-16,800	5220-5262 (1591-1604)
Regressive Phase	Provo (P)	14,500-12,000[4]	16,800-13,500[5]	4860-4880 (1482-1488)
	Gilbert	11,000-10,000[6]	12,800-11,600	Not exposed

[1]Calendar-calibrated ages of most shorelines have not been published. Calendar-calibrated ages shown here, except for the age of the end of the Provo shoreline, are from D.R. Currey, University of Utah (written communication to Utah Geological Survey, 1996; cal yr B.P. = 1.16 ^{14}C yr B.P.).
[2]Oviatt and others (1990); Currey (written communication to Utah Geological Survey, 1996, assumed a maximum age for the Stansbury shoreline of 21,000 ^{14}C yr B.P., which is used in the conversion to calendar years).
[3]Oviatt and others (1992), Oviatt (1997).
[4]Godsey and others (2005) revised the timing of the occupation of the Provo shoreline and subsequent regression; Oviatt and others (1992) and Oviatt (1997) proposed a range from 14,500 to 14,000 ^{14}C yr B.P. Oviatt and Thompson (2002) summarized many recent changes in the interpretation of the Lake Bonneville radiocarbon chronology.
[5]Calendar-calibrated age of the end of the Provo shoreline estimated by interpolation from data in Godsey and others (2005), table 1, who used Stuiver and Reimer (1993) for calibration.
[6]Murchison (1989), figure 20.

Table 2. Summary of U-Pb zircon age analyses from Granite Peak.

Map Number	Sample Number	Map Unit	Rock Name	7.5' Quadrangle	Latitude (N)	Longitude (W)	Weighted Average ^{238}U/^{206}Pb Age Mean (Ma)
Jgd1	GP102605-3	Jgd	Granodiorite	Granite Peak	40°05'16.2"	113°16'45.9"	149.8±1.3
Jg1	GP081605-9	Jg	Granite porphyry	Granite Peak	40°07'40"	113°18'23"	148.8±1.3

Notes:
Location data in NAD27.
Analyses performed by Eric H. Christiansen (Brigham Young University) and Jeffrey D. Vervoort (Washington State University).
Analyses by laser ablation-inductively coupled mass spectrometry.
See Christiansen and Vervoort (in preparation) for complete presentation of data.

Table 3. Summary of ^{40}Ar/^{39}Ar age analyses from Dugway Proving Ground and adjacent areas.

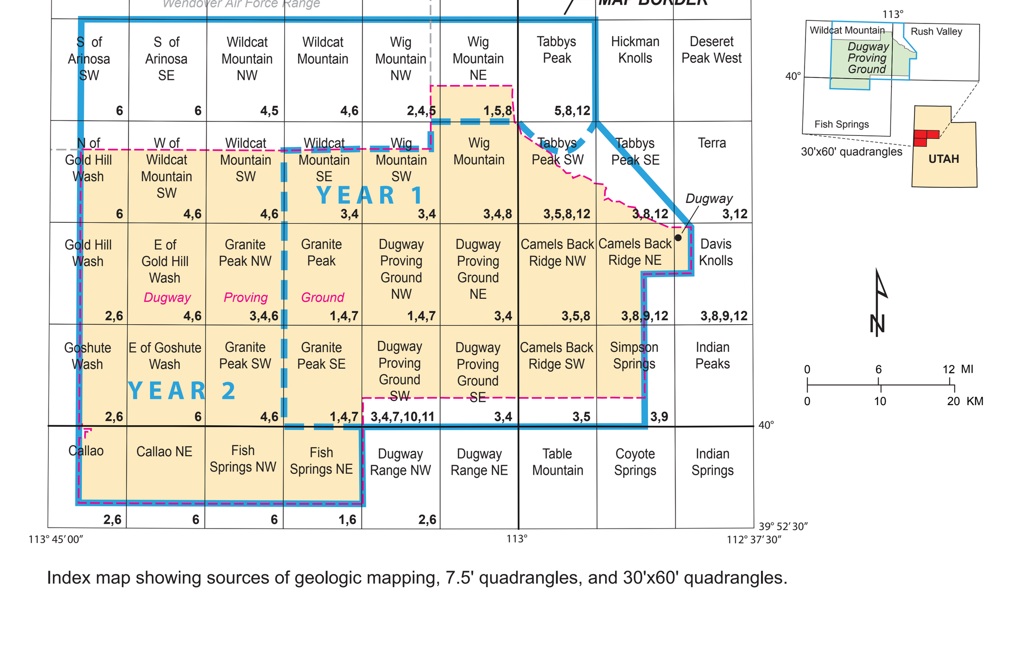
Map Number	Sample Number	Map Unit	Rock Name	7.5' Quadrangle	Latitude (N)	Longitude (W)	Age ± 2sd (Ma)	Material Dated	Comments
Trd1	GP081605-6c	Trd	Rhyolite	Granite Peak	40°07'44"	113°17'04"	7.78 ± 0.05	sanidine	single-crystal laser fusion
Trs1	SM071405-11	Trs	Rhyolite	Granite Peak SE	40°03'55.4"	113°16'18.5"	8.20 ± 0.05	sanidine	single-crystal laser fusion
Jgd1	GP102605-3	Jgd	Monzonite	Granite Peak SE	40°05'16.2"	113°16'45.9"	15.97 ± 0.04	biotite	step heating, plateau age
Jgd1	GP102605-3	Jgd	Monzonite	Granite Peak SE	40°05'16.2"	113°16'45.9"	27.13 ± 0.05	K-feldspar	integrated age
Jg2	GP102605-1	Jg	Granite	Granite Peak	40°09'58.2"	113°15'56.2"	13.69 ± 0.12	muscovite	step heating, plateau age
Jg2	GP102605-1	Jg	Granite	Granite Peak	40°09'58.2"	113°15'56.2"	19.14 ± 0.08	K-feldspar	integrated age
Tdi1	FM083105-1	Tdi	Dacite	Camels Back Ridge NE	40°12'08"	112°50'16"	40.95 ± 0.32	hornblende	step-heating, plateau age
Tdi1	FM083105-1	Tdi	Dacite	Camels Back Ridge NE	40°12'08"	112°50'16"	39.56 ± 0.10	biotite	integrated age
Tdi2	D-4	Tdi	Dacite	Tabbys Peak SW	40°19'17.9"	112°54'01.1"	38.69 ± 0.10	sanidine	laser total fusion
Tac1	D-7	Tac	Andesite	Wig Mountain	40°21'37.8"	113°00'04.0"	41.73 ± 0.24	hornblende	furnace step-heat
Tac3	D-17	Tac	Andesite	Tabbys Peak SW	40°18'39.6"	112°56'36.3"	38.17± 0.47	groundmass concentrate	furnace step-heat
Tac5	D-42	Tac	Andesite	Wig Mountain NE	40°26'55.3"	113°01'57.8"	40.66 ± 0.45	groundmass concentrate	furnace step-heat
Taci1	D-6	Taci	Andesite	Wig Mountain	40°20'03.3"	113°01'42.2"	39.55 ± 0.22	groundmass concentrate	furnace step-heat
Taci2	D-40	Taci	Andesite	Tabbys Peak	40°27'47.7"	112°59'13.8"	40.61 ± 0.78	groundmass concentrate	furnace step-heat

Notes:
Location data in NAD27.
All analyses performed at the New Mexico Geochronology Research Laboratory, Socorro, New Mexico.
Results for Jgd1 and Jg2 are considered cooling ages rather than intrusion ages.
NMGRL reported unreliable age data for samples D-2, D-15, D-25, D-47, as samples were too felsic for good groundmass concentrate analysis and/or were unable to separate any other datable mineral phases.
See UGS & NMGRL (2007), UGS & NMGRL (2008), UGS & NMGRL (in preparation) for complete presentation of data.

Table 4. Fossil identifications and ages from Dugway Proving Ground and adjacent areas.

Sample No.	Map Unit	Rock Type	7.5' Quadrangle	Latitude (N)	Longitude (W)	Fossil Type	Fauna	Preservation & Abrasion	Calcareous Algae Present	Age
D-77	Pp	biomicrite wackestone	Wig Mountain NE	40°24'05.2"	113°02'06.2"	fusulinid	*Parafusulina*	Poor	None	lower Leonardian
D-74	Pp	biomicrite wackestone	Wig Mountain NE	40°29'06.5"	113°07'07.3"	fusulinid	*Parafusulina, Schwagerina*	Poor	None	Leonardian
D-60	Pofc	silicified shale	Wig Mountain NE	40°23'25.8"	113°01'16.8"	fusulinid	*Schwagerina longisimoidea*	Poor	None	middle Wolfcampian
D-69	Pofc	biomicrite wackestone	Tabbys Peak	40°27'48.0"	112°59'49.6"	fusulinid	*Triticites* cf. *T. meeki*	Good	None	lower Wolfcampian
D-75	Pofc	biomicrite mudstone	Tabbys Peak	40°28'10.9"	112°58'46.9"	fusulinid	*Triticites* cf. *T. meeki*	Fair	None	lower Wolfcampian
D-76	₱obm	biomicrite wackestone	Tabbys Peak	40°29'53.8"	112°56'41.1"	fusulinid	*Triticites*	Fair	None	Virgilian
D-68	₱obm	biomicrite wackestone	Tabbys Peak	40°23'37.1"	112°59'45.3"	fusulinid	*Triticites*	Fair	None	Virgilian
D-52	₱obm	biomicrite wackestone	Tabbys Peak SW	40°21'18.4"	112°59'14.5"	fusulinid	*Pseudofusulinella, Triticites*	Fair	None	lower Virgilian
D-57	₱obm	biosparite packstone	Tabbys Peak SW	40°19'31.0"	112°58'13.0"	fusulinid	*Triticites cullomensis*	Good	None	lower Virgilian
D-71	₱obm	biomicrite mudstone	Tabbys Peak	40°23'05.6"	112°59'05.3"	fusulinid	*Triticites*	Good	None	Missourian
D-78	₱obm	biomicrite wackestone	Tabbys Peak SW	40°20'04.3"	112°58'34.9"	fusulinid	*Triticites*	Fair	None	Missourian
D-70	₱obp	biomicrite wackestone	Tabbys Peak	40°23'08.4"	112°58'34.7"	fusulinid	*Beedeina*	Fair	Fragments	lower Desmoinesian
D-50	₱owc	crinoidal packstone	Tabbys Peak	40°22'38.9"	112°57'57.4"	conodont	*Adetognathus lautus*	-	-	latest Mississippian to early Permian

Note: Location data based on NAD27.
Fusulinids identified by A.J. Wells (independent).
Conodonts identified by S.R. Ritter (Brigham Young University).



Index map showing sources of geologic mapping, 7.5' quadrangles, and 30'x60' quadrangles.

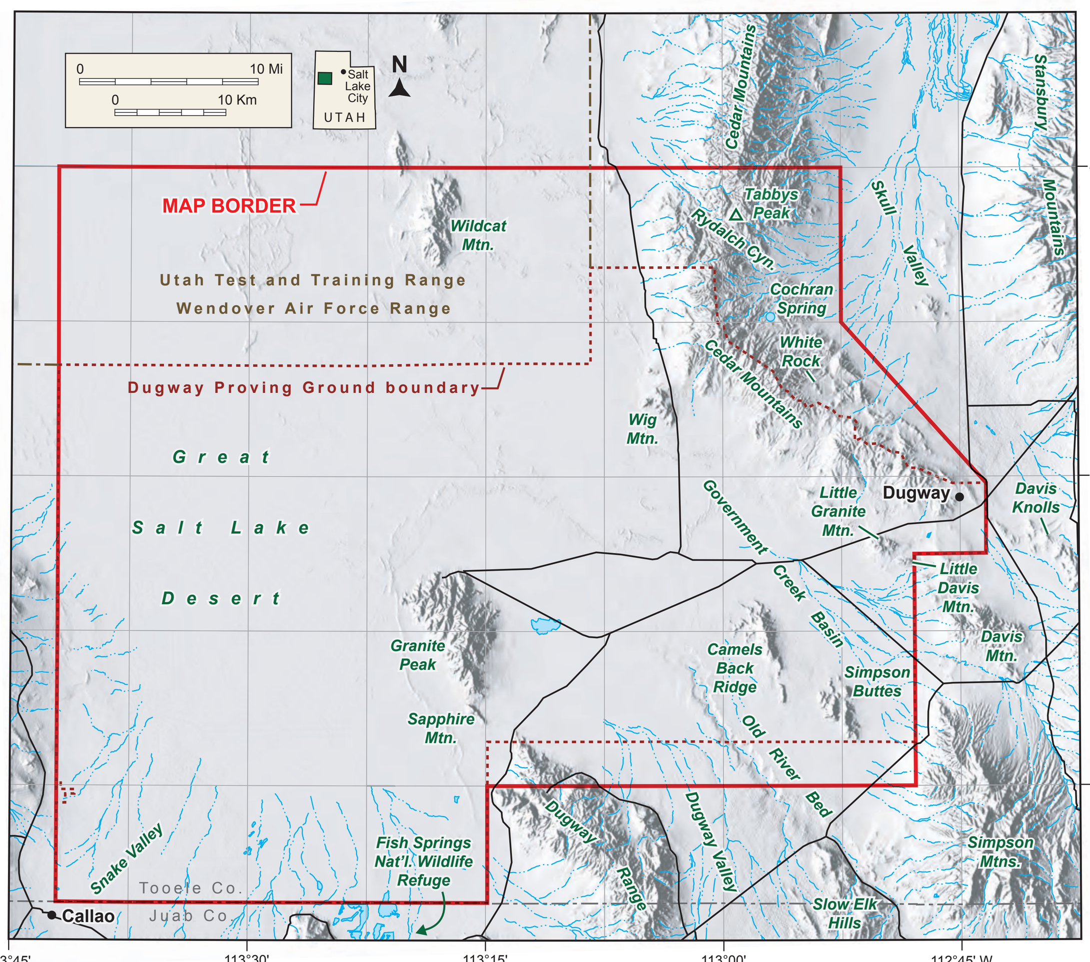


Figure 1. Location map showing primary geographic features associated with Dugway Proving Ground and adjacent areas.

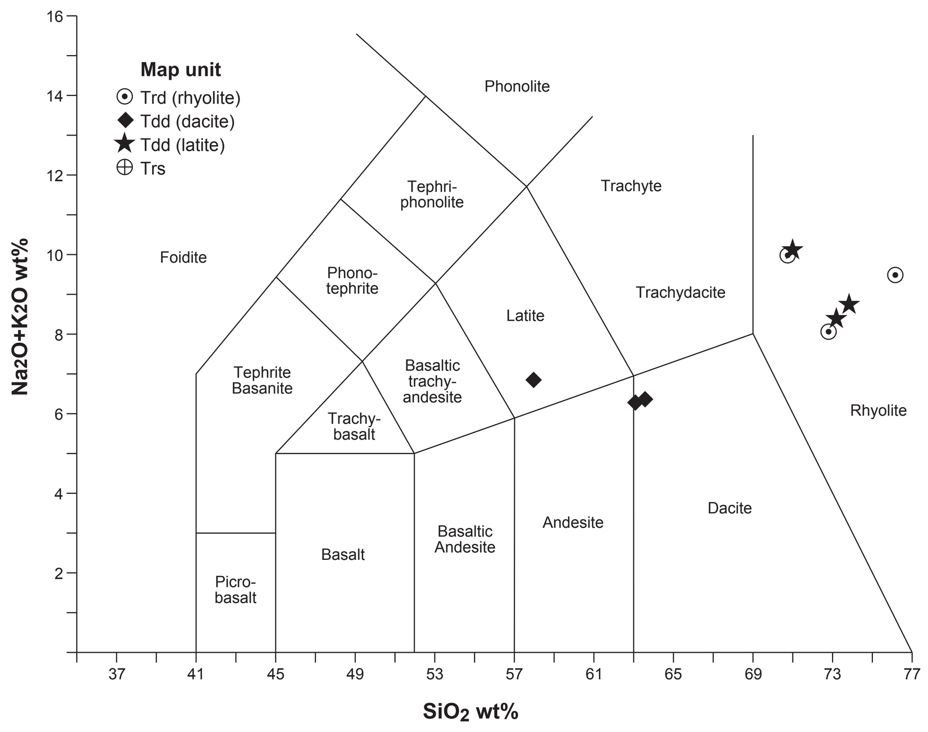


Figure 2. Total alkali-silica classification plot (after LeBas and others, 1986) for Tertiary dikes and volcanic rocks of the Granite Peak and Sapphire Mountain area.

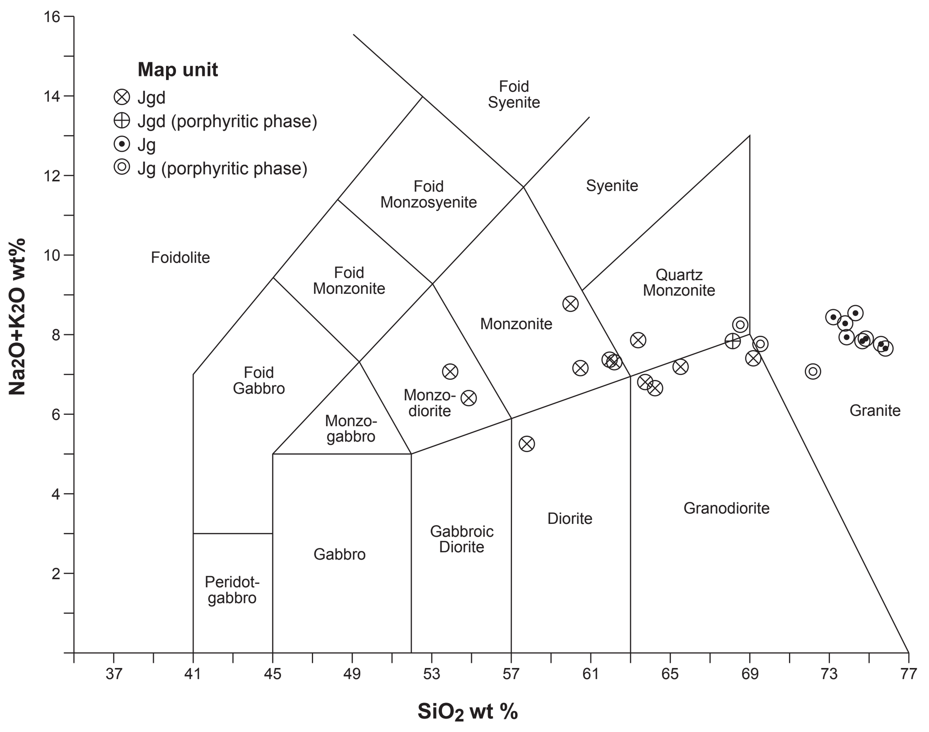


Figure 3. Total alkali-silica plot (after Middlemost, 1994) with field names for plutonic rocks of Granite Peak.

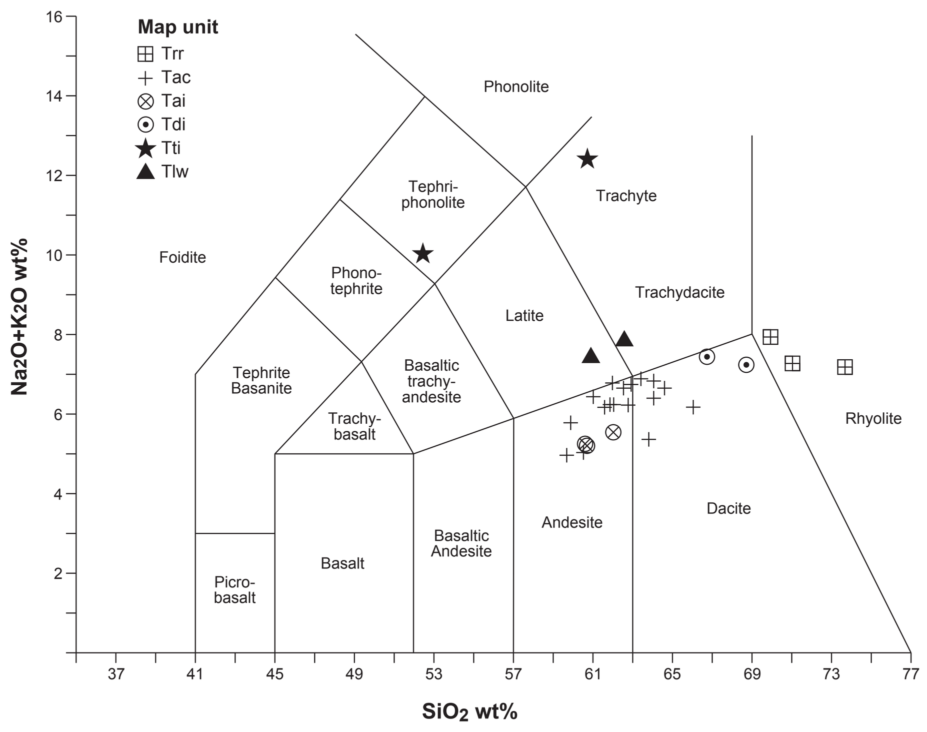


Figure 4. Total alkali-silica plot (after LeBas and others, 1986) for extrusive and intrusive rocks from southern Cedar Mountains and northern Dugway Range.

Maurer (1970)

Time-strati-graphic unit		Cochran Spring section Feet (Meters)	Overall Feet (Meters)	Oquirrh Formation unit
PERMIAN	Wolf-campian	340+ (104+)	1935+ - 2750 (590+ - 838)	Unit 5
PENNSYLVANIAN	Virgilian	2762 (842)	2762 - 3000 (842 - 915)	Unit 4
PENNSYLVANIAN	Desmoines.- Missourian	2556 (779)	2556 - 3000+ (779 - 915+)	Unit 3
PENNSYLVANIAN	Morrowan - Atokan	715 (218)	715 - 1400 (218 - 427)	Unit 2
MISS.	? Chest.	434 (132)	434 (132)	Unit 1
		6807 (2075)	8402+ - 10,584+ (2562+ - 3229+)	

This Map

Map unit		Cochran Spring section Feet (Meters)	Overall Feet (Meters)	Sample Numbers	Time-strati-graphic unit	
PPo	Pofc	2713 (827)	3500 (1070)	D-60; D-75 D-69	Wolfcampian	PERMIAN
PPo	Pobm	1000 (305) fault	2800 (850)	D-76 D-68; D-52 D-57; D-71	Misso.-Virgil.	PENNSYLVANIAN
PPo	Pobp	fault 2660 (811)	5400 (1650	D-70	Atokan-Desmoinesian	PENNSYLVANIAN
PPo	Powc	500 (150)	500-800 (150-245)	D-50	Morro-wan	PENNSYLVANIAN
		6873 (2095)	12,350 (3770)			

Figure 5. Comparison of Oquirrh strata of the southern Cedar Mountains. Maurer (1970) provided thicknesses for his units measured in the Cochran Spring section and overall estimates. Our work indicated the Cochran Spring section is incomplete and provide revised thickness estimates. The stratigraphy used in this map for the Lower Permian (Wolfcampian) and Pennsylvanian formations is based on that of the Oquirrh Mountains/Bingham mining district.

LITHOLOGIC COLUMN
Northern Dugway Range, Sapphire Mountain, and Granite Peak

TIME-STRATI-GRAPHIC UNIT		GEOLOGIC UNIT	SYMBOL	THICKNESS Feet (Meters)	LITHOLOGY
TERT.	Mio.	Rhyolite of Sapphire Mountain	Trs	450+ (140+)	8.2 Ma Ar/Ar
Not in contact					
MISSISSIPPIAN	Upper	Ochre Mountain Limestone	Mo	700+ (200+)	
MISSISSIPPIAN	Lower	Woodman Formation	Mw	785 (240)	
MISSISSIPPIAN	Lower	Joana Limestone	Mj	315 (95)	Unconformity*
DEVONIAN	Upper/Middle	Guilmette Formation	Dg	2180+ (660+)	Hanauer Formation*; Gilson Dolomite*; Stromatoporoids; Goshoot Formation*
DEVONIAN	Middle	Simonson Dolomite	Ds	1080+ (330+)	Engelmann Fm.*
Buckhorn fault					
CAMB.	Lower	Prospect Mountain Quartzite	Ꞓpm	450+ (140+)	

Intrusive units Trd, Tdd, Tti, Jg, Jgd, Jgu
*Local names of Staatz (1972)

LITHOLOGIC COLUMN
Wig Mountain

TIME-STRATI-GRAPHIC UNIT		GEOLOGIC UNIT	MAP SYMBOL	THICKNESS Feet (Meters)	LITHOLOGY
Wig Mountain thrust fault					
MISSISSIPPIAN	Upper	Ochre Mountain Limestone	Mo	600+ (180+)	
MISSISSIPPIAN	Upper/Lower	Woodman Formation	Mw	1000 (300)	
MISSISSIPPIAN	Lower	Joana Limestone	Mj	300 (90)	Unconformity
DEVONIAN	U.	Guilmette Formation	Dg	400-800 (120-250)	Devonian strata thinned near Stansbury uplift
DEVONIAN	M. L.	Simonson and Sevy Dolomites	Dss	100 (30)	Light colored
SILURIAN		Laketown Dolomite	Sl	1800 (550)	Thinner-bedded markers
ORD.	U.	Ely Springs Dolomite	Oes	300 (90)	Unconformity-Tooele arch
CAMBRIAN / ORD.	Upper / L.	Notch Peak Formation	OꞒn	1000+ (300+)	

LITHOLOGIC COLUMN
Camels Back Ridge and Simpson Buttes

TIME-STRATI-GRAPHIC UNIT		GEOLOGIC UNIT	MAP SYMBOL		THICKNESS Feet (Meters)	LITHOLOGY
DEVON-IAN	M. & U.	Guilmette Formation?	Dg?	DꞒd	500+ (150+)	
FAULT						
DEVONIAN	Middle	Simonson Dolomite	Ds	DꞒd	500+ (150+)	
DEVONIAN	Lower	Sevy Dolomite	Dsy	DꞒd	250 (75)	Light, laminated dolomite
FAULT						
SILUR-IAN		Laketown Dolomite	Sl	DꞒd	500+ (150+)	Cherty
ORDO-VICIAN	Upper	Ely Springs Dolomite	Oes	DꞒd	250 (75)	Light dolomite - Floride unit
ORDO-VICIAN	M. & L.	Pogonip Group	Op	OꞒu	150+ (45+)	Unconformity - Tooele Arch
FAULT						
O. / CAMBRIAN	L. / Upper	Notch Peak Formation	OꞒn	OꞒu, DꞒd	500+ (150+)	Cliffs
CAMBRIAN	Upper	Orr Formation — upper part	Ꞓou	OꞒu, DꞒd	200 (60)	
CAMBRIAN	Upper	Orr Formation — Big Horse Limestone Member	Ꞓob	OꞒu, DꞒd	425 (130)	Upper - less resistant, rusty and pink weathering
CAMBRIAN	Upper	Lamb Dolomite	Ꞓl	OꞒu, DꞒd	900 (275) (Orr-Notch Peak total 2300 (700))	
CAMBRIAN	Middle	Trippe Limestone	Ꞓtl	DꞒd	700 (215)	Less resistant and ledgy
CAMBRIAN	Middle	Pierson Cove Formation	Ꞓpc	DꞒd	800+ (245+)	Locally dolomitized

LITHOLOGIC COLUMN
Little Davis Mountain

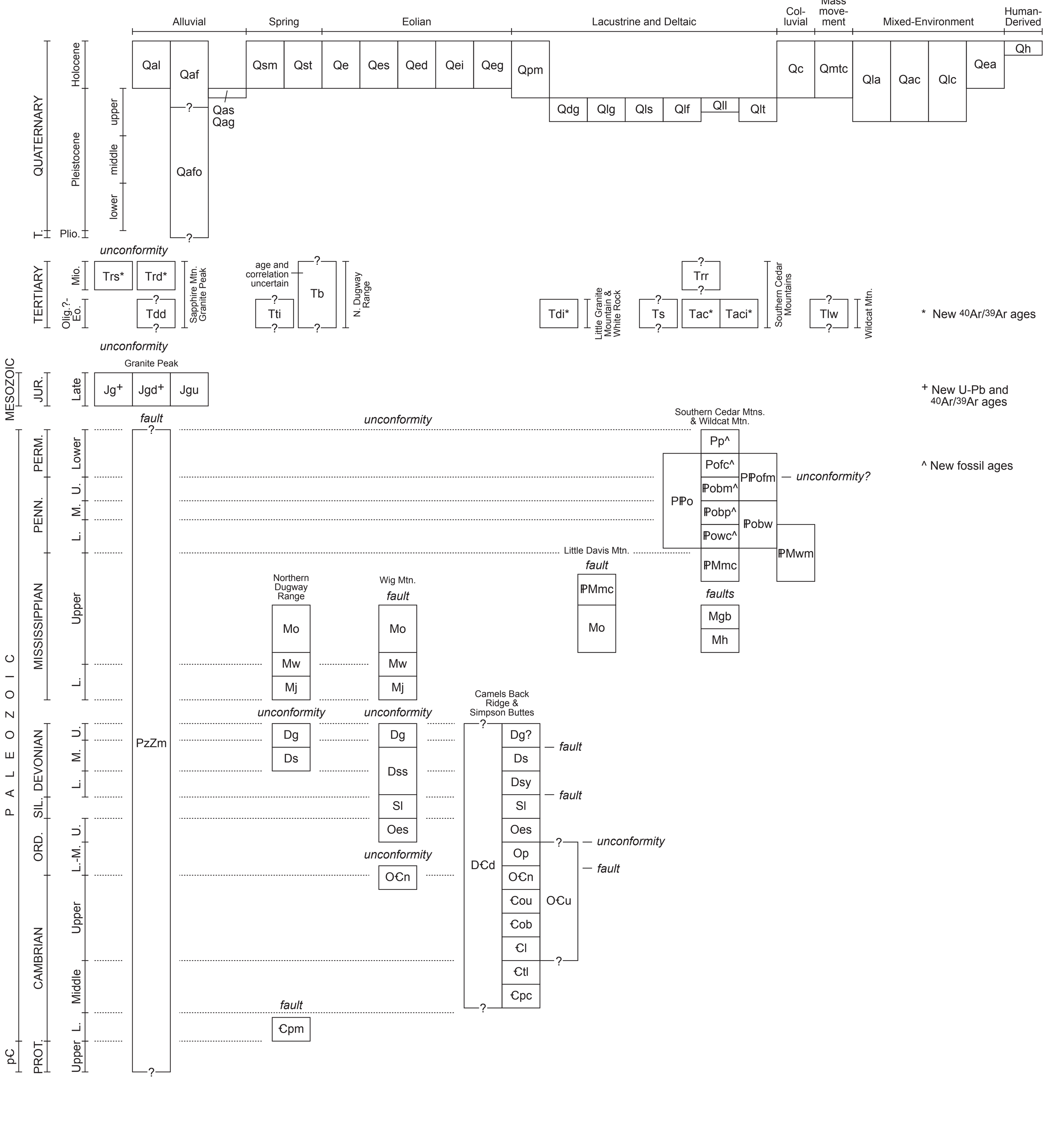
TIME-STRATI-GRAPHIC UNIT		GEOLOGIC UNIT	MAP SYMBOL	THICKNESS Feet (Meters)	LITHOLOGY
Wig Mountain thrust fault					
MISSISSIPPIAN	Upper	Manning Canyon Shale	PMmc	200+ (60+)	
MISSISSIPPIAN	Upper	Ochre Mountain Limestone	Mo	1200+(370+)	

LITHOLOGIC COLUMN
Southern Cedar Mountains and Wildcat Mountain

TIME-STRATI-GRAPHIC UNIT		GEOLOGIC UNIT	MAP SYMBOL			THICKNESS Feet (Meters)	LITHOLOGY
TERTIARY	Miocene?	Rhyolite of Rydalch Canyon area	Trr			650 (200)	Tuff
TERTIARY	Olig.?-Eo.?	Tertiary strata	Ts			12+ (4+)	
TERTIARY	Eocene	Andesitic and dacitic rocks of southern Cedar Mountains	Tac			1200 (370)	Lava flows, lahars, tuffs; 38.17 Ma Ar/Ar; 40.66 Ma Ar/Ar; 41.73 Ma Ar/Ar; Latitic rocks on Wildcat Mtn.; Unconformity - not exposed
PERMIAN	Lower	Pequop Formation	Pp			2000+ (600+)	*Parafusulina*
PERMIAN	Lower	Oquirrh Group — Freeman Peak and Curry Peak Formations	Pofc	PPo	PPofm	3500 (1070)	*Schwagerina*; "Worm trail" markings; Unconformity?
PENNSYLVANIAN	Upper	Oquirrh Group — Bingham Mine Formation	Pobm	PPo	PPofm	2800 (850)	*Triticites*
PENNSYLVANIAN	Middle	Oquirrh Group — Butterfield Peaks Formation	Pobp	PPo	Pobw	5400 (1650)	Cliffy near top; *Fusulina*; *Beedeina*; Cyclic lithologic character; *Millerella*; *Chaetetes*
PENNSYLVANIAN	Lower	Oquirrh Group — West Canyon Limestone	Powc	PPo	Pobw / PMwm	500-800 (150-245)	
MISSISSIPPIAN	Upper	Manning Canyon Shale	PMmc		PMwm	1500-2000 (450-600)	Interval of regional decollement
faults							
MISSISSIPPIAN	Upper	Great Blue Limestone	Mgb			2440+ (745+)	
MISSISSIPPIAN	Upper	Humbug Formation	Mh			1014+ (310+)	

Intrusive units Tdi, Taci

GEOLOGIC SYMBOLS

- Contact
- Normal fault, concealed – Inferred principally from gravity data; bar and ball on down-thrown side
- Steeply dipping fault – Dashed where inferred, dotted where concealed; bar and ball and/or arrows indicate relative displacement if known
- Thrust fault – Dashed where inferred, dotted where concealed; teeth on upper plate
- Low-angle normal fault – Dotted where concealed
- Lineament – From air photo interpretation
- Trd — Igneous dike
- Tdd — Igneous dike
- Axial trace of anticline – Dashed where approximately located, dotted where concealed; arrow shows plunge
- Axial trace of syncline – Dashed where approximately located, dotted where concealed; arrow shows plunge
- Major shorelines of the Bonneville lake cycle –
  - B — Bonneville shoreline
  - P — Provo shoreline
  - X — Regressional shoreline (shoreline scarps on Old River Bed delta and low beach ridges on lacustrine fine-grained deposits)
  - S — Stansbury shoreline
- Channel systems of the Old River Bed delta –
  - Exposed (eroded) – Center line, map unit Qas
  - Buried (uneroded) – Center line, map unit Qas
  - Qag — Gravel – Channel extent, map unit Qag
- Delta ridge crest associated with Old River Bed
- Strike and dip of bedding (refer to index map for prior mapping sources) –
  - 20 — Inclined from current mapping
  - 20 — Inclined from prior mapping
  - Inclined approximate from current mapping
- 20 — Strike and dip of mineral foliation
- Strike of steeply dipping joint from air photo interpretation
- Sand and gravel pit
- Adit
- Rock sample location and number for age and geochemical analyses (see tables 2 and 3; Clark, 2008)
- Rock sample location and number for geochemical analysis (see Clark, 2008)
- Fossil sample location and number for age evaluation (see table 4)
- Qed/Qlf — Indicates thin cover of the first unit overlying the second unit

CORRELATION OF GEOLOGIC UNITS