PROGRESS REPORT GEOLOGIC MAP OF THE RUSH VALLEY 30' x 60' QUADRANGLE, TOOELE, UTAH, AND SALT LAKE COUNTIES, UTAH (Year 1 of 3)

by

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GEOLOGIC UNIT DESCRIPTIONS

Alluvial deposits

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

Qai **Alluvial silt deposits** (Holocene to upper Pleistocene) – Silt, clay, some sand, and minor gravel deposited by streams and sheet wash within former lagoonal areas related to Lake Bonneville shorelines; thickness less than about 20 feet (6 m).

Qat **Alluvial-terrace deposits** (Holocene to upper Pleistocene) – Sand, silt, clay, and gravel in terraces above floodplains; surfaces typically 10 feet (3 m) or more above adjacent drainages; thickness is 40 feet (12 m) or less.

Qafy **Younger alluvial-fan deposits** (Holocene to upper Pleistocene) – Deposits of poorly sorted gravel with sand, silt, and clay; deposited by streams, debris flows, and flash floods on alluvial fans and in mountain valleys; 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; includes active fans and inactive fans younger than Lake Bonneville; locally abuts Lake Bonneville shorelines due to map scale constraints; thickness variable, to 100 feet (30 m) or more.

Qafb **Alluvial-fan deposits, transgressive (Bonneville) phase of Lake Bonneville** (upper Pleistocene) – Poorly sorted gravel with sand, silt, and clay in alluvial fans that are graded to the Bonneville-level shoreline; may include small areas of eolian and colluvial deposits; incised by younger alluvial deposits; thickness variable, to 100 feet (30 m) or more.

Qafo **Older alluvial-fan deposits** (upper to middle Pleistocene?) – Poorly sorted gravel with sand, silt, and clay; higher level deposits that predate Lake Bonneville and have been incised by younger alluvial deposits; may locally include small areas of lacustrine or eolian deposits; thickness variable, to 100 feet (30 m) or more.

QTaf **Oldest alluvial-fan deposits** (lower Pleistocene? to Pliocene?) – Poorly sorted gravel with sand, silt, and clay; highest level deposits that have been incised by younger alluvial deposits and etched by Lake Bonneville; present along the western margin of the Oquirrh Mountains, Soldier Canyon area; may locally include small areas of lacustrine or younger alluvial deposits; thickness variable, to 100 feet (30 m) or more.

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 and seeps near the center of valleys; thickness 0 to 30 feet (0-10 m).

Eolian deposits

Qe **Eolian deposits** (Holocene) – Windblown sand and silt in sheet and dune forms; mapped in Skull Valley; 0 to 20 feet (0-6 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; less than 15 feet (5 m) thick.

Qed **Eolian dune sand deposits** (Holocene) – Poorly to well sorted sand 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 thin fringe of unmapped sheet sand; thickness to 50 feet (15 m).

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

Lacustrine deposits (Post Bonneville)

Qpm **Playa mud** (Holocene) – Poorly sorted clay, silt, and small amounts of sand with local accumulations of gypsum, halite, and other salts; present within the playa lake bed of Rush Lake; thickness is 10 feet (3 m) or less.

Qlfy **Younger lacustrine fine-grained deposits** (Holocene) – Deposits adjacent to Rush Lake playa of clay, silt, and small amounts of sand; deposited by fluctuations of Holocene Rush Lake; thickness probably 15 feet (5 m) or less.

Qlsy **Younger lacustrine sand deposits** (Holocene) – Deposits adjacent to Rush Lake playa of sand with minor gravel; deposited by fluctuations of Holocene Rush Lake; thickness probably 15 feet (5 m) or less.

Lacustrine and Deltaic deposits (Bonneville lake cycle)

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. Several prominent erosional and depositional landforms related to Lake Bonneville exist in the map area, described below.

A small part of the Old River Bed crosses the southwest corner of the map area. The Old River Bed is an abandoned river valley present on the south part of Dugway Proving Ground and southward to the Sevier River southwest of Delta. This feature formed during the most recent episode of overflow from the Sevier basin (Lake Gunnison) northward to the Great Salt Lake basin (Lake Bonneville) (Oviatt, 1987; Oviatt and others, 1994). Where the river entered Lake Bonneville, a delta formed with various distributary channels (mapped by Clark and others, 2008); radiocarbon dating of the channels ranges from 8800 to 12,500 ^{14}C years B.P. (about 10,000 to 13,000 calendar years B.P.) (Oviatt and others, 2003).

In the north-central part of the quadrangle, the Stockton Bar developed as a transverse barrier bar and spit complex between Tooele and Rush Valleys (Gilbert, 1890; Burr and Currey, 1988, 1992). Rush Valley contains the Bonneville level shoreline and two sets of regressive-phase shorelines. These shorelines were initially described by Burr and Currey (1988, 1992) in conjunction with the Stockton Bar. The construction of the Stockton Bar (during the Bonneville transgression) caused the lake in Rush Valley to be cut off from the main body of Lake Bonneville; during the regression from the Bonneville highstand, the lake level in Rush Valley varied independently of the level in the rest of the Bonneville basin. The regressive shorelines present in Rush Valley (previously attributed to Lake Shambip, 5050 feet [1540 m] in elevation, and Lake Smelter, 5010 feet [1527 m] in elevation) do not coincide in elevation with the Provo or Gilbert levels of Lake Bonneville.

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 and very thick bedded; regressive deposits were locally reworked by waves into a thin sheet with delta ridge crests; thickness to 50 feet (15 m).

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 transgressional and 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.

Glacial deposits

Qg **Glacial deposits, undifferentiated** (upper Pleistocene) – Till present in terminal, lateral, valley-head, and end moraines, and outwash composed of fine- to coarse-grained detritus derived from glaciated bedrock; present in several cirques and valleys near Deseret Peak in the Stansbury Mountains and Flat Top Mountain of the Oquirrh Mountains (also see Mulvey, 1985); locally includes unmapped landslides and rotational slumps, particularly in cirque basins; Osborn and Bevis (2001) report these deposits are primarily of Angel Lake age (Great Basin equivalent to Pinedale of Middle Rocky Mountains) and some are older; up to 100 feet (30 m) thick.

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; 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 of Cedar Mountains, Camels Back Ridge, and Stanbury and Oquirrh Mountains; thickness to 15 feet (5 m) or more.

Qms **Landslide deposits** (Holocene to middle Pleistocene?) – Poorly sorted clay- to boulder-size material; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced bedrock; undivided as to inferred age because new research shows that even landslides with subdued morphology (suggesting they are older and have not moved recently) may continue to creep or are capable of renewed movement (Francis Ashland, UGS, verbal communication, 2009); age and stability determinations require detailed geotechnical investigations; thickness highly variable.

Qmf **Debris flow deposits** (Holocene to upper Pleistocene) – Poorly sorted mixture of fine- to coarse-grained material derived from and adjacent to Stockton Bar; thickness is 50 feet (15 m) or less.

Mixed-environment deposits

Qla **Lacustrine and alluvial deposits** (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 at surface in western Skull Valley; thickness locally exceeds 30 feet (10 m).

Qac **Alluvial and colluvial deposits** (Holocene to upper Pleistocene) – Primarily gravel, with sand, silt, and clay; forms 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).

Qea **Eolian and alluvial deposits** (Holocene) – Included below solely as stacked unit Qea/Qlf.

Human-derived deposits

Qh **Human disturbance** (Historical) – Deposits and disturbed areas from human development; Dugway Proving Ground area includes wastewater treatment lagoons, sanitary landfill, and Michael Army Airfield; also used for landfill on Skull Valley Indian Reservation, several pits and quarries, tailings area north of Stockton Bar, and large mine areas (Mercur, Ophir, Bingham); thickness generally less than about 20 feet (6 m), but mine-dump deposits may exceed 200 feet (60 m) thick.

Stacked-unit deposits

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 of Government Creek basin; 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).

Qea/Qlf

Eolian and alluvial deposits over lacustrine fine-grained deposits (Holocene/upper Pleistocene) – Windblown silt deposited in sheets adjacent to and locally covering alluvial sand and gravel in unmapped channels overlying lacustrine marl and fine-grained deposits; locally saline or gypsiferous; one exposure in Government Creek basin that is part of extensive mudflats of southern Great Salt Lake Desert; may locally include small areas of thicker eolian deposits; cover unit thickness typically less than 15 feet (5 m) thick.

Qes/Qlf

Eolian sheet sand deposits over lacustrine fine-grained deposits (Holocene/upper Pleistocene) – Windblown sand and some silt deposited in sheets; overlies lacustrine silt, clay, marl, and some sand northeast of Little Granite Mountain; locally includes areas of thicker eolian deposits; cover unit thickness typically 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 typically less than 20 feet (6 m).

Qes/Qla

Eolian sheet sand deposits over lacustrine and alluvial deposits (Holocene/Holocene to upper Pleistocene) – Windblown sheet 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 typically less than 10 feet (3 m).

Qes/Qafy

Eolian sheet sand deposits over younger alluvial-fan deposits (Holocene/Holocene to upper Pleistocene) – Windblown sheet sand and silt covering younger alluvial fans west of Johnson Pass; cover unit thickness typically less than 10 feet (3 m).

Qes/Qafo

Eolian sheet sand deposits over older alluvial-fan deposits (Holocene/upper to middle? Pleistocene) – Windblown sheet sand and silt overlying older alluvial fans near Barlow Creek of the southwestern Stansbury Mountains; cover unit thickness typically 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 the Dugway Proving Grounds airfield; cover unit thickness typically less than 20 feet (6 m).

Qlf/Qls

Lacustrine fine-grained deposits over lacustrine sand deposits (upper Pleistocene/upper Pleistocene) – Thin marl and reworked marl overlying deltaic sediments of mostly sand and some fine gravel deposited near the Stansbury shoreline; sandy beach ridges (distributary mouth bars) were formed by longshore sediment transport (Currey, 1996, in Geomatrix, 2001), and were previously mapped as faults by Sack (1993); exposures located on north side of Hickman Knolls on the Skull Valley Indian Reservation; cover unit thickness to 6 feet (2 m) or more.

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 typically less than 10 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 and on Camels Back Ridge; locally includes small bedrock exposures of map units Ts, Tac, PIPo, and Cambrian units; cover unit thickness typically less than 10 feet (3 m).

Qlg/Pz **Lacustrine gravel over Paleozoic bedrock** (upper Pleistocene/Permian to Cambrian) – Sandy and pebbly gravel overlying bedrock exposures at Hickman Knolls and unnamed knoll to north, previously mapped by Moore and Sorensen

(1979) as Ordovician carbonate rocks and quartzite and Upper Mississippian carbonate rocks (Humbug and Deseret), respectively; Hickman Knolls exposures further described as dark- to medium-gray calcitic dolomite breccia (75% of exposures), light-gray silicic limestone breccia, and light-reddish-brown strongly recrystallized limestone with abundant reddish-brown chert, suggested as lower Fish Haven Dolomite (Geomatrix, 2001); cover unit thickness typically less than 15 feet (5 m).

Pre-Bonneville Deposits
Geomatrix (2001) reported on subsurface Quaternary deposits in the vicinity of the proposed Private Fuel Storage (PFS) site on the Skull Valley Indian Reservation. The Promontory soil and associated deposits represent a period of subaerial exposure that occurred during the interpluvial period between the Little Valley and Bonneville lake cycles from about 28 to 130 ka. Deposits representing the penultimate lake cycle, the Little Valley lake cycle (130 to 160 ka), were also encountered. The oldest Quaternary deposits are pre-Little Valley alluvium and soil (older than 160 ka).

TERTIARY

Geochemical and age data for Tertiary rocks are presented in tables 2, 3, and 4, Clark (2008), NMGRL & UGS (2006), and UGS & NMGRL (2009a, 2009b). Rock names are generally from the total alkali-silica classification diagrams for volcanic rocks (Le Bas and others, 1986) and plutonic rocks (Middlemost, 1994).

IGNEOUS AND SEDIMENTARY ROCKS OF THE SOUTHERN CEDAR MOUNTAINS, SKULL VALLEY, AND SOUTHERN STANSBURY MOUNTAINS AREAS

Tsl **Salt Lake Formation** (Pliocene? to Miocene) – Exposed in the South Willow Canyon area of the Stansbury Mountains and present in the subsurface of Skull Valley and Rush Valley. Stansbury exposures are interbedded tuffaceous sandstone and conglomerate that weathers rusty-orange with carbonate, igneous, and quartzite pebbles in a fine sandy calcareous matrix (Rigby, 1958; Copfer and Evans, 2005); Perkins and others (1998) geochemically correlated a tephra in the the South Willow Canyon exposure to the Cougar Point Tuff unit XIII ash, which has an $^{40}Ar/^{39}Ar$ age of 10.94 $\pm$ 0.03 Ma (table 3). In Skull Valley, trenching at the proposed Private Fuel Storage (PFS) site exposed predominantly claystone and tuffaceous siltstone with interbeds of siliceous vitric ash (tuff) and minor gravelly sandstone (Geomatrix, 2001); gray vitric tuffs were reportedly from the Salt Lake Formation, regionally about 4 to 16 Ma in age, and white biotite-bearing ash is compositionally similar to middle Miocene (~15.4 Ma) ash beds in the Rio Grande Rift north of Santa Fe, NM (Perkins, 1998 in Geomatrix, 2001); in addition, boring A-1 encountered a tuff at 85 to 90 feet (26-27.5 m) that reportedly correlates to the 6.4 Ma Walcott tuff (SWEC, 1997; Geomatrix, 2001). Exposed thickness to about 1000 feet (300 m), but total thickness unknown.

Trr **Rhyolite of Rydalch Canyon area** (Miocene?) – Light-gray and very pale orange rhyolitic ash-flow tuff exposed south and east of Rydalch Canyon in southern Cedar Mountains; about 25% phenocrysts of feldspar, quartz, hornblende, and biotite; unable to obtain reliable age date, but appears to overlie map unit Tac; exposed thickness to 650 feet (200 m).

Ts **Tertiary strata** (Oligocene? to Eocene?) – Grayish-orange, very pale orange, and moderate-orange-pink lacustrine limestone that is locally oncolitic, moderately crystalline, indistinctly to thin bedded; underlain by small exposure of moderate-reddish-orange tuffaceous sandstone; mapped in one area southwest of Dugway (English Village); exposed thickness about 100 feet (30 m).

Tdi **Dacitic intrusions of Little Granite Mountain and White Rock** (middle Eocene) – Light-gray weathering to white and yellowish-gray porphyritic dacite; phenocrysts (~25%) of plagioclase, quartz, biotite, and amphibole (0.5-2 mm long average); groundmass is intergrowth of plagioclase, potassium feldspar, and quartz (Maurer, 1970; Moore and Sorensen, 1977); $^{40}Ar/^{39}Ar$ ages of 40.95 $\pm$ 0.32 Ma (hornblende) and 39.56 $\pm$ 0.10 Ma (biotite, less reliable) for Little Granite Mountain and 38.69 $\pm$ 0.10 Ma (sanidine) for White Rock (UGS and NMGRL, 2009a, 2009b); exposures to 9500 feet (2900 m) across.

Tac **Andesitic and dacitic rocks of southern Cedar Mountains** (middle 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, biotite; calc-alkaline affinities are similar to those of other Oligocene-Eocene rocks in the region (Clark, 2008); erupted from local vents mapped as Taci; $^{40}Ar/^{39}Ar$ age of 38.17 $\pm$ 0.47, and also ages (from adjacent map area) of 41.73 $\pm$ 0.24 Ma (hornblende) and 40.66 $\pm$ 0.45 (groundmass) (UGS and NMGRL, 2009b); exposed thickness to 1200 feet (370 m).

Taci **Andesitic intrusions of southern Cedar Mountains** (middle Eocene) – Dark-gray porphyritic to aphanitic andesitic intrusions associated with local vents for extrusive suite of calc-alkaline volcanic rocks (Tac); phenocrysts of feldspar, hornblende, and lesser biotite; columnar jointing of exposures common; $^{40}Ar/^{39}Ar$ age of 40.61 $\pm$ 0.78 Ma (groundmass) from Tabbys Peak (UGS and NMGRL, 2009b); exposures to 1600 feet (490 m) across.

Tvs **Intermediate volcanic rocks of Stansbury Mountains** (middle Eocene) – Interlayered lahars, debris flows, lava flows, and tuff described by Davis (1959); light-gray lahars are thin to very thick bedded with mostly cobble-size clasts, and gray to pale-red debris flows are indistinctly bedded with shattered clasts to boulder-size; lahars and debris flows contain clasts of pale-red and moderate- to dark-gray intermediate volcanic rocks; latitic lava flows are moderate gray weathering to light gray brown with small phenocrysts of plagioclase and biotite;

tuff is pumice rich; exposures in South Willow Canyon area of Stansbury Mountains; Moore and McKee (1983) reported K-Ar ages of about 39 to 42 Ma north of the map area; exposed thickness to about 1400 feet (430 m).

IGNEOUS AND SEDIMENTARY ROCKS OF SOUTHERN OQUIRRH MOUNTAINS, SOUTH MOUNTAIN, AND WESTERN TRAVERSE MOUNTAINS

These rocks are present at and near the Bingham, Stockton (Rush Valley), Ophir, and Mercur mining districts. Bingham district rocks were divided into four informal compositional suites by Waite (1996) and Waite and others (1997): (1) younger volcanic suite, (2) older volcanic suite, (3) nepheline minette-shoshonite suite (within the older volcanic suite), and (4) Bingham intrusive suite. Biek and others (2005) and Biek (2006a) informally referred to the younger suite as the Volcanic and Intrusive Rocks of the West Traverse Mountains, and combined the latter three suites as the Volcanic and Intrusive Rocks of the Bingham Canyon Suite. We also group the igneous rocks into younger and older suites, and further separate the suites into extrusive and sedimentary rocks, and intrusive rocks. The terminology for the intrusive rocks of the Bingham district (after Lanier and others, 1978) is based on historic useage at Bingham mine (for the purpose of separating similar rock units); it is entrenched and does not necessarily reflect their appropriate geochemical compositions and current rock classifications.

Younger Volcanic and Intrusive Suite (lower Oligocene to upper Eocene, ~30-37 Ma)
Younger Extrusive and Sedimentary Rocks

Tvbs **Younger volcanic breccia** (lower Oligocene) – Dark-gray to black, angular to subangular, pebble- to boulder-size clasts of intermediate-composition volcanic rocks set in a well-lithified matrix of reddish-brown devitrified glass and lithic and crystal fragments; clasts generally make up more than 50% of the rock and contain phenocrysts of plagioclase, hornblende, and biotite in dark-gray to black glassy matrix; forms broad sloping surface of South Mountain and Black Ridge in the west Traverse Mountains; K-Ar age on clast of 30.7 $\pm$ 0.9 Ma (Moore, 1973); thickness to 300 feet (90 m).

Tvfs **Younger lava flows** (lower Oligocene) – Intermediate composition lava flows that are strongly flow foliated (typically subvertical) with reddish-brown and dark-gray to black layering; underlies and compositionally identical to volcanic breccia unit (Tvbs) at South Mountain in west Traverse Mountains; no age data; maximum exposed thickness likely exceeds 1000 feet (300 m).

Tvfb **Intermediate lava flows of Black Ridge** (lower Oligocene) – Dark-gray to pinkish-gray porphyritic intermediate-composition lava flows with common phenocrysts of plagioclase and rare to common biotite and hornblende; locally flow banded; forms boulder-covered slopes; likely derived from volcanic centers of west Traverse Mountains including Step Mountain, South Mountain, and nearby smaller vents; no radiometric age data, but overlies Tvlb; exposed thickness may exceed 600 feet (180 m).

Tvlb **Lahars and debris flows of Black Ridge** (lower Oligocene) – Pebbles to boulders of intermediate-composition volcanic rocks and uncommon quartzite pebbles in a matrix of white to light-gray crystal lithic tuff; contains some thin, poorly exposed lava flows; forms poorly exposed slopes covered with resistant volcanic clasts in Black Ridge area of west Traverse Mountains; $^{40}Ar/^{39}Ar$ ages from near base of unit are 31.68 ± 0.24 Ma from adjacent map area (Biek, 2005) and 32.12 ± 0.14 Ma (Deino and Keith, 1997); maximum thickness likely exceeds 1000 feet (300 m).

Trf **Rhyolitic lava flows of Tickville Gulch** (lower Oligocene) – Rhyolite vitrophyre flows and lesser blocky flow breccia of green, pink, white, and black colors; flows contain phenocrysts of biotite and plagioclase in a glassy groundmass and are locally altered and chalky; probably erupted from concealed vent near Tickville Wash; K-Ar age of 31.2 ± 0.9 Ma (Moore and others, 1968; Moore, 1973); thickness may exceed 1500 feet (460 m).

Tvfa **Basaltic andesite lava flow** (lower Oligocene) – Dark-gray, very fine grained basaltic andesite flow with abundant reddish-brown cinders and local volcanic bombs; contains small olivine phenocrysts altered to iddingsite; forms deeply eroded vent area at Camp Williams; somewhat disturbed $^{40}Ar/^{39}Ar$ age of 32.86 ± 0.48 Ma (Biek and others, 2005); exposed thickness to 120 feet (35 m).

Younger Intrusive Rocks

Tdi **Dacitic dike** (early Oligocene) – Light-gray dacite porphyry with phenocrysts of plagioclase, hornblende, and biotite in a fine-grained matrix; present near Oak Springs Hollow of western Traverse Mountains; $^{40}Ar/^{39}Ar$ age of 32.05 ± 0.13 Ma (Biek and others, 2005); 75 to 90 feet (23-27 m) thick.

Tri **Rhyolitic intrusions** (early Oligocene? to late Eocene) – Rhyolitic intrusions of Shaggy Peak (Rose-Butterfield Canyon area), Tickville Gulch area, Dry Mountain-Ophir area, and Eagle Hill-Mercur area. Shaggy Peak plug or dome is light- to medium-gray porphyritic rhyolite that contains a border phase with abundant plagioclase, quartz, and biotite phenocrysts and generally near vertical flow foliations, and an interior phase with slightly larger phenocrysts and little or no flow foliation (Biek, 2006a); $^{40}Ar/^{39}Ar$ age of 35.49 ± 0.13 Ma (Biek and others, 2005) and prior K-Ar age of 33.0 ± 1.0 Ma (Moore, 1973). Eagle Hill Rhyolite is white, tan to pink rhyolite and rhyolite porphyry; usually aphanitic with ~1% phenocrysts of quartz and rare biotite, locally flow banded; occurs as dikes and sills at Mercur (Mako, 1999); K-Ar age of 31.6 ± 0.9 Ma (Moore, 1973).

Tai **Andesitic intrusion** (late Eocene) – Medium-gray andesite porphyry with abundant plagioclase phenocrysts and common hornblende and minor biotite in a medium-grained matrix; forms plug that includes two dikes with subhorizontal, columnar cooling joints at Step Mountain near mouth of Rose Canyon (Biek, 2006a); $^{40}Ar/^{39}Ar$ age of 36.26 ± 0.18 Ma (Biek and others, 2005).

Tpqmi **Porphyritic quartz monzonite intrusions** (middle? to late Eocene) – Intrusions at the former Lark townsite and Porphyry Hill area. Lark intrusion is light- to medium-gray granodiorite (dacite) porphyry with abundant phenocrysts of plagioclase and biotite and lesser hornblende in fine-grained groundmass; typically weathers to grussy or clayey soils; present near mouth of Butterfield Canyon near former Lark townsite (Swenson, 1975; Biek and others, 2005); prior K-Ar ages from Bingham tunnel portal (adjacent to map area) of 36.9 ± 0.9 Ma (hornblende) and 36.9 ± 1.0 Ma (biotite) (Moore and others, 1968). Porphyry Hill-area intrusions are medium gray quartz monzonite porphyry with small phenocrysts of K-feldspar, plagioclase, biotite, and quartz in a fine-grained groundmass of predominantly K-feldspar; present as small dikes and sills on Porphyry Hill and Porphyry Knob north of Mercur (Mako, 1999); K-Ar age of 36.7 ± 0.5 Ma from Porphyry Hill (Moore and McKee, 1983).

Older Volcanic and Intrusive Suite (middle Eocene, ~37-40 Ma) – Data indicate that the older suite rocks are largely comagmatic with the Bingham intrusive complex (Waite and others, 1997) and contain significantly higher chromium and barium concentrations and are more magnetic than the younger suite (Pulsifer, 2000).

Older Extrusive and Sedimentary Rocks

Tvfo **Nepheline minette and shoshonite lava flows** (middle Eocene) – Dark-gray minette with abundant phenocrysts of olivine and minor phlogopite and pyroxene, and another minette with little olivine and more abundant phlogopite and pyroxene; also includes red, aa-type, shoshonite and olivine latite lava flows with abundant small phenocrysts of olivine, pyroxene and biotite (Pulsifer, 2000; Maughan, 2001; Biek and others, 2005); exposed near the Rose-Butterfield Canyon area of Oquirrh Mountains; minette $^{40}Ar/^{39}Ar$ age of 37.82 ± 0.14 Ma (Deino and Keith, 1997) and prior K-Ar age of 38.5 ± 0.3 Ma (Moore and McKee, 1983); exposed thickness to 150 feet (45 m).

Ts **Lacustrine strata** (middle Eocene) –Yellowish-brown, brownish–gray, and light-gray, typically thin-bedded and tuffaceous mudstone, siltstone, oncolitic limestone, and volcaniclastic sandstone; locally silicified; one exposure near Butterfield Canyon; interlayered with Tvfou and Tvlo; exposed thickness about 150 feet (45 m) (Biek and others, 2005; Biek, 2006a).

Tvfou **Older intermediate lava flows** (middle Eocene) – Dark-gray lava flows of intermediate composition derived from Bingham intrusive complex; interlayered with and difficult to differentiate from the older lahars and debris flows (Tvlo); present between Butterfield and Rose Canyons; no age data; exposed thickness likely exceeds 1000 feet (300 m).

Tvlo **Older lahars and debris flows** (middle Eocene) – Pebbles to boulders of intermediate-composition volcanic rocks in a matrix of lithic and crystal fragments; locally contains mostly mafic clasts or lenses of quartzitic and calcareous sandstone clasts derived from adjacent Oquirrh outcrops; contains some thin discontinuous lava flows of intermediate composition (Pulsifer, 2000; Maughan, 2001; Biek and others, 2005); generally forms rubbly slopes between Butterfield and Rose Canyons and along south flank of Bingham mine, and on northeast flank of South Mountain; Bingham area ^{40}Ar/^{39}Ar ages of 38.68 $\pm$ 0.13 Ma from waterlain tuff near top of unit (Maughan, 2001) and 39.18 $\pm$ 0.11 Ma from clast near base of unit (Deino and Keith, 1997); thickness may exceed 4000 feet (1200 m).

Older Intrusive Rocks

Tqmi **Quartz monzonite porphyry intrusion** (middle Eocene?) – Altered part of the Soldier Canyon stock with K-spar and quartz phenocrysts and limonite staining (Lufkin, 1965); Laes and others (1997) suggested intrusion may be related to Bingham stock which has a K-Ar age of 37.6 $\pm$ 0.07 (Moore, 1973).

Tmi **Monzonite intrusions** (middle Eocene?) –Monzonite intrusions of Spring Gulch, Soldier Canyon, and Bingham (Last Chance) areas. Fine- to medium-grained, equigranular, containing augite, hornblende, biotite, and magnetite, and ranging compositionally from diorite to quartz monzonite; the Spring Gulch monzonite crops out just north of the Calumet mine east of Stockton (Krahulec, 2005); Tmi also present at the Soldier Canyon stock (Lufkin, 1965) and near the axis of Long Ridge anticline (Laes and others, 1997; Tooker, 1992); the monzonites of the Stockton/Rush Valley district are similar in appearance and composition to the Last Chance stock in the Bingham district (Krahulec, 2005) which has a prior K-Ar age of 38.6 $\pm$ 0.18 Ma (Moore, 1973), and U-Pb age of 38.55 $\pm$ 0.19 Ma and ^{40}Ar/^{39}Ar age of 38.40 $\pm$ 0.16 Ma (Parry and others, 2001); K-Ar age of 38.0 $\pm$ 1.1 Ma (Moore, 1973) from monzonite porphyry stock of the Calumet Mine area.

Tli **Latite to dacite porphyry sills and dikes** (middle Eocene) – Greenish-gray to dark-gray latite to dacite porphyry with abundant phenocrysts of plagioclase and hornblende and lesser biotite; present north of Butterfield and Middle Canyons in Oquirrh Group strata of south flank of Bingham mine area; K-Ar age of 37.1 $\pm$ 1.1 Ma (Moore, 1973), ^{40}Ar/^{39}Ar age of 38.84 $\pm$ 0.19 Ma (Deino and Keith, 1997); 0 to about 400 feet (120 m) thick.

Tqli **Quartz latite porphyry dikes** (middle Eocene) – Fine-grained, biotite, quartz latite porphyry with large potassium feldspar phenocryts (to 1 inch [3 cm]) and some augite; named the Raddatz porphyry (along Continental fault) in the Stockton/Rush Valley district where it forms dikes (Krahulec, 2005), and also may crop out on Bald Mountain (north of Ophir); K-Ar age of 38.6 $\pm$ 1.1 Ma (Moore, 1973), ^{40}Ar/^{39}Ar age on Raddatz dike of 39.4 Ma $\pm$ 0.34 Ma age (Kennecott, unpublished date in Krahulec, 2005).

Tbi **Basalt sill** (middle Eocene) – Dark-gray basalt sill intruding Oquirrh strata on South Mountain; may be related to unit Tvfo; K-Ar age of 40.1 $\pm$ 0.5 Ma (Moore and McKee, 1983); previously called a nepheline basalt (Gilluly, 1932; Moore and McKee, 1983); only largest sill mapped, about 50 feet (15 m) thick.

TERTIARY-CRETACEOUS

TKc **Conglomerate** (Eocene? to upper Cretaceous?) – White, rusty-brown, and orange-red pebbly conglomerate, pebbly sandstone, and gritstone; clasts reflect local sources including quartzitic sandstone and black chert likely from Oquirrh Group, and Paleozoic carbonates; medium- to crudely bedded and moderately to very resistant; present in western Traverse Mountains and South Willow Canyon of Stansbury Mountains; thickness to about 200 feet (60 m).

DEVONIAN TO CAMBRIAN STRATA OF CAMELS BACK RIDGE AND SIMPSON BUTTES

We apply the regional stratigraphic names of Hintze and Robison (1975) and Hintze (1980) to Devonian through Cambrian strata of Camels Back Ridge rather than local names of the Dugway Range (Staatz and Carr, 1964; Staatz, 1972).

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

Fault

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

Dsy **Sevy Dolomite** (Lower Devonian) – Moderate-gray, finely crystalline dolomite that 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, and contains some intervals of light-gray dolomite; contains gray and red chert in beds, masses and nodules, and rust-colored case hardened surfaces; 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 is cherty, resistant, moderate-gray dolomite at top underlain by brown-weathering, less resistant, thin-bedded dolomite; both parts are 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 of this unit; upper part is dark-gray and moderate-gray, finely to moderately crystalline dolomite, underlain by moderate-gray intraformational conglomerate, 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

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

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

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

Cl **Lamb Dolomite** (Upper to Middle Cambrian) – Largely present on east flank of Camels Back Ridge; upper part less resistant, mostly very thin to thin bedded, and commonly rusty and pink weathering, consists of ledges of moderate-gray oolitic and silty limestone and flat pebble conglomerate, underlain by moderate-gray dolomite and limestone with rusty-colored blebs and layers; lower part of more resistant gray dolomite, moderate to coarsely crystalline, that locally weathers to mottled gray, pink gray, and light brown, and contains intervals of *Girvanella* (algae), thin- to very thick bedded interval forming ledges; 900 feet (275 m) thick.

OCu **Lower Ordovician and Upper Cambrian strata, undivided** (Lower Ordovician? and Upper Cambrian?) – Carbonate rocks of Simpson Buttes; gray-, brown-, and pink-weathering dolomite and limestone, thin to very thick bedded; 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; exposed thickness about 2300 feet (700 m).

Ctl **Trippe Limestone** (Middle Cambrian) – Present on northeast side of Camels Back Ridge; forms generally less resistant and ledgey interval between Lamb and Pierson Cove; upper part is moderate-gray, laminated and nodular limestone, shale, intraformational conglomerate, and light-tan-weathering dolomite that is laminated to medium bedded; lower part is light- to moderate-gray, locally mottled, laminated to very thick bedded limestone; gradational contact with Pierson Cove below; 700 feet (215 m) thick.

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

MISSISSIPPIAN STRATA OF LITTLE DAVIS MOUNTAIN

Onaqui fault

IPMmc

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 about 200 feet (60 m). Could also refer to this unit as the Chainman Shale.

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

PERMIAN TO MISSISSIPPIAN STRATA OF SOUTHERN CEDAR MOUNTAINS

Fossil age data from Clark and others (2008) is included in table 5. The Oquirrh Group has been substantially remapped to conform to the stratigraphy of the Oquirrh Mountains; refer to figure 3 for a comparison of Oquirrh strata between this map and Maurer (1970). The total thickness of Oquirrh Group strata is roughly 12,350 feet (3770 m). Following Laes and others (1997) and Hintze and Kowallis (2009), we combine Lower Permian (Wolfcampian) and Pennsylvanian formations under the Oquirrh Group, although this nomenclature differs from existing terminology established in the Oquirrh Mountains (Welsh and James, 1961; Tooker and Roberts, 1970).

PIPo **Oquirrh Group strata, undivided** (Lower Permian to Lower Pennsylvanian) – One area of combined unit on south margin of Cedar Mountains; exposed thickness about 50 feet (15 m).

PIPofm

Oquirrh Group, Freeman Peak-Curry Peak, and Bingham Mine Formations, undivided (Lower Permian and Upper Pennsylvanian, Wolfcampian-Virgilian) – One area along Cedar thrust, north of Rydalch Canyon.

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 local ledges; "worm trail" markings are common bedding plane feature in lower part of unit; also contains *Schwagerina* and *Triticities* cf. *T. meeki* (fusulinids); corresponds to most of Maurer's (1970) Unit 4 and Unit 5; 3500 feet (1070 m) thick.

Unconformity?

IPobm **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, forms ledges and slopes; fossils include brachiopods, bryozoans, fusulinids (*Triticites and Pseudofusulinella*); corresponds to upper part of Maurer's (1970) Unit 3 and lower part of Unit 4; upper contact mapped at uppermost substantial limestone bed; 2800 feet (850 m) thick.

IPobw **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.

IPobp **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, forms ledges, cliffs, and slopes of a cyclic character, but lower part forms ledgey escarpment; limestone is finely crystalline to bioclastic; gray, yellow-brown, and black chert present 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 (1970) Unit 2 and most of Unit 3; 5400 feet (1650) thick.

IPMwm

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

IPowc

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 unit forms ledges and slopes; corresponds to Maurer's (1970) Unit 1; 500 to 800 feet (150-245 m) thick.

IPMmc

Manning Canyon Shale (Lower Pennsylvanian to Upper Mississippian, Morrowan-Chesterian) – 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.

Faults

Mgb **Great Blue Limestone** (Upper Mississippian) – Medium- to dark-gray, medium- and thick-bedded, finely crystalline limestone and 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 (744+ m) thick.

Mh **Humbug Formation** (Upper Mississippian) – Yellow-brown and gray sandstone and quartzite, and medium- to dark-gray limestone that is mostly in the 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 (309+ m) thick.

TRIASSIC TO CAMBRIAN STRATA OF SOUTHERN STANSBURY MOUNTAINS

Triassic to Permian stratigraphy of the Martin Fork syncline area was modified from Jordan and Allmendinger (1979).

Trtw **Thaynes Limestone and Woodside Formation, undivided** (Lower Triassic) – Thaynes consists of light- to medium-gray and brown gastropod- and pelecypod-containing limestone, sandstone, and siltstone; the unit is resistant, bioturbated, and medium bedded (irregularly); regionally contains *Meekoceras* (ammonite) at base of unit (Kummel, 1954); underlying Woodside contains pale-red and brown siltstone and calcareous sandstone, greenish-brown shale, minor light-gray laminated limestone, that is poorly exposed and forms slopes; exposed thickness of Thaynes is 590 feet (180 m) and Woodside is 210 feet (65 m), and combined unit thickness is 800 feet (245 m).

Ppfm **Park City Formation, Franson Member, and Phosphoria Formation, Meade Peak Phosphatic Shale Tounge, undivided** (Upper to Lower Permian) – Franson consists of moderate-brown and gray limestone and sandy limestone, calcareous sandstone, with minor shale that is medium bedded; Meade Peake consists of pale-red, brown, and dark-gray shale, with lesser bedded chert and phosphorite that forms a distinct red-brown-weathering slope or saddle; Franson is 280 feet (85 m) and Meade Peak is 230 feet (70 m) thick, and combined unit thickness is 510 feet (155 m).

Ppg **Park City Formation, Grandeur Member** (Lower Permian) – Gray cherty and bioclastic limestone, sandy and cherty dolomite, calcareous sandstone, quartzite, and bedded chert; medium- to thick-bedded ledge former; thickness is 500 feet (150 m).

Pdc **Diamond Creek Sandstone** (Lower Permian) – Moderate-gray, weathering to light-brown, fine-grained calcareous sandstone that is thin to medium bedded; thickness is about 350 feet (105 m).

Pk **Kirkman Formation** (Lower Permian) – Moderate-gray to light-brown limestone, calcareous sandstone, fossiliferous carbonate conglomerate, and oncolitic limestone; limestone is locally bioclastic and cherty, and laminated with chert stringers and nodules; thin to thick bedded; exposed thickness is about 400 feet (120 m).

Martin Fork thrust fault – Oquirrh Group, Freeman Peak Formation omitted; Martins Fork Spring thrust (Tooker, 1983)

Oquirrh strata of the southern Stansbury Mountains were evaluated by Wright (1961), Armin (1979), Armin and Moore (1981), and Jordan (1979). New and existing fossil data is presented in table 5. It appears that both the upper (Freeman Peak Formation) and lower (West Canyon Limestone) parts of the Oquirrh Group have been truncated and omitted by faults near their respective contacts with enclosing units of regional decollement (Kirkman Formation above and Manning Canyon Shale below).

Pofc **Oquirrh Group, Freeman Peak and Curry Peak Formations** (Lower Permian, Wolfcampian) – Dark-gray calcareous sandstone and siltstone that weathers to tan and light brown gray, minor dark-gray limestone and limestone conglomerate; irregularly thin to medium bedded; mostly talus covered unit with few ledges; maximum exposed thickness is about 3500 feet (1100 m).

Unconformity?

IPobm **Oquirrh Group, Bingham Mine Formation** (Upper Pennsylvanian, Virgilian-Missourian) – Grayish-yellow and orangish-brown-weathering calcareous sandstone and siltstone, quartzite, and lesser interbeds of gray limestone; thin to medium bedded forming talus covered slopes with local ledges; thickness is about 8000 feet (2450 m).

IPobp **Oquirrh Group, Butterfield Peaks Formation** (Middle to Lower Pennsylvanian, Desmoinesian-Morrowan) – Cyclically interbedded intervals of gray limestone and light-grayish-yellow quartzite, calcareous sandstone and siltstone; limestone is locally sandy, bioclastic, and cherty; thin to thick bedded with limestone ledges and cliffs and intervening slope-forming siliceous intervals; exposed thickness to 6000 feet (1800 m).

Broad Canyon-Big Hollow fault – West Canyon Limestone omitted in map area. This fault has had several names and interpretations: Broad Canyon fault (Rigby, 1958; Cashman, 1992), Broad Canyon thrust (Tooker and Roberts, 1971; Sorensen, 1982; Tooker, 1983), and Central Range fault (Copfer and Evans, 2005).

IPMmc

Manning Canyon Shale (Lower Pennsylvanian to Upper Mississippian, Morrowan-Chesterian) – Black to olive-brown shale and siltstone, dark-gray carbonaceous limestone, and red-brown quartzite and sandstone; slope-forming unit within Big Hollow; exposed thickness 0 to 1300 feet (0-400 m).

Mgb **Great Blue Limestone, undivided** (Upper Mississippian) – Mapped as combined unit in the Vickory Mountain and Deadman anticline areas where the Long Trail Shale is not well exposed or absent; thickness about 1600 feet (490 m).

Mgbu **Great Blue Limestone, upper limestone member** (Upper Mississippian) – Dark-blue-gray locally fossiliferous and cherty limestone with minor sandstone; medium to thick bedded ledge to cliff former; thickness is 800 feet (240 m).

Mgbs **Great Blue Limestone, Long Trail Shale Member** (Upper Mississippian) – Dark-green calcareous shale with a few thin interbeds of quartzitic sandstone; medial slope forming unit; thickness is 30 to 80 feet (10-25 m).

Mgbl **Great Blue Limestone, lower limestone member** (Upper Mississippian) – Dark-blue-gray locally fossiliferous and cherty limestone with minor sandstone; medium to thick bedded ledge to cliff former; thickness is 700 feet (210 m).

Mh **Humbug Formation** (Upper Mississippian) – Alternating gray limestone and sandy limestone with lenticular brown sandstone and quartzite; slope and ledge former with considerable colluvium from clastic beds; thickness is 700 feet (210 m).

Md **Deseret Limestone** (Upper to Lower Mississippian) – Gray limestone and sandy limestone, locally cherty and fossiliferous, ledge former; lower part is shale of the slope forming Delle Phosphatic Member; thickness is 525 feet (160 m).

MDgs **Gardison Limestone, Fitchville Formation, Pinyon Peak Limestone, Stansbury Formation, undivided** (Lower Mississippian to Upper Devonian) – Combined unit north of head of Dry Canyon; see individual unit descriptions below; Stansbury Formation thins northward to zero near head of Indian Hickman Canyon; thickness is about 1200 feet (370 m).

Mg **Gardison Limestone** (Lower Mississippian) – Upper part is cherty, bioclastic limestone that is thin to thick bedded, and lower part is thinner bedded fossiliferous limestone with some local dolomite and sandy limestone; thickness is 700 feet (210 m).

Unconformity

MDfs **Fitchville Formation, Pinyon Peak Limestone, Stansbury Formation, undivided** (Lower Mississippian to Upper Devonian) – Combined unit south of Dry Canyon head; Fitchville-Pinyon Peak is dark-gray cliff-forming limestone with calcite blebs, underlain by thin-bedded dolomite, and a lower part of tan argillaceous irregular bedded limestone; Stansbury Formation is distinctive carbonate-clast conglomerate with rounded and commonly oblate light- and dark-gray carbonate clasts from 0.5 to 4 inches (1-10 cm) in diameter in a tan sandy dolomite matrix; Fitchville-Pinyon Peak thickness is about 450 feet (140 m), Stansbury thickness is about 0 to 60 feet (0-20 m), and combined unit thickness is about 500 feet (150 m).

MDfp **Fitchville Limestone and Pinyon Peak Formation, undivided** (Lower Mississippian to Upper Devonian) – Gray, medium-bedded limestone (Fitchville) overlying gray to tan sandy and silty limestone that is locally bioclastic and irregularly bedded (Pinyon Peak); exposed in small hills west of South Mountain; thickness is about 200 feet (60 m).

Dst **Stansbury Formation** (Upper Devonian) – White quartzite that weathers to tan and pale red, is locally cross-bedded, thin to medium bedded; exposed in quarry and adjacent hills west of South Mountain; exposed thickness is 200 feet (60 m).

Major unconformity – Stansbury uplift (Rigby, 1959a; Morris and Lovering, 1961)

DOu **Simonson, Sevy, Laketown, and Ely Springs Dolomites, undivided** (Middle Devonian to Upper Ordovician) – Combined dolomite units include dark-gray, coarsely to medium crystalline dolomite (Simonson); very light gray, finely crystalline dolomite (Sevy); gray, medium- to thick-bedded, coarsely to medium crystalline dolomite (Laketown); dark-gray and mottled, medium crystalline dolomite (Ely Springs); Ely Springs previously mapped as the Fish Haven Dolomite; thickness is 0 to about 2000 feet (600 m).

Unconformity – Tooele Arch (Hintze, 1959); Eureka Quartzite missing

Op **Pogonip Group, undivided** (Middle to Lower Ordovician) –Blue-gray-weathering limestone and reddish-tan-weathering silty limestone with lesser intraformational conglomerate and minor shale; thin to medium bedded in ledgey exposures; upper part is about 100 feet (30 m) of slope-forming black to dark-brown shale, lesser siltstone and sandstone (Kanosh Shale); previously mapped as Kanosh Shale and Garden City Formation; thickness is 0 to 1350 feet (410 m).

Clark and Kirby (in press) reevaluated the Cambrian stratigraphy of the Stansbury Mountains. These strata closely resemble the western Utah section (Hintze and Robison, 1975) rather than the East Tintic Mountains section as initially applied by Rigby (1958) and perpetuated by Sorensen (1982) and Copfer and Evans (2005). Our revised terminology includes the following units (descending order): Notch Peak Formation; Orr Formation, upper part, includes Sneakover Limestone Member, Corset Spring Shale Member, and Johns Wash Limestone Member?; Orr Formation, Big Horse Limestone Member; Lamb Dolomite; Trippe Limestone (Fish Springs Member and lower member); Pierson Cove Formation; Wheeler Formation; Swasey Limestone; Whirlwind Formation; Dome Limestone; Chisholm Formation; Howell Limestone; Pioche Formation; Prospect Mountain Quartzite (figure 4).

Cum **Upper and Middle Cambrian strata, undivided** (Upper and Middle Cambrian) – Combined unit of several formations that are difficult to map separately due to poor exposure and difficult access; includes carbonates and shales of the Orr, Lamb, Trippe, Pierson Cove, Wheeler, Swasey, Whirlwind, Dome, Chisholm, and Howell formations; northward the upper part of the section was removed by erosion associated with the Stansbury uplift; thickness roughly 1500 to 5000 feet (450-1500 m).

Cmu **Middle Cambrian strata, undivided** (Middle Cambrian) – Several carbonate and shale rock units composing the upper plate of a low-angle normal fault on the southwest margin of the Stansbury Mountains; may include the lower Trippe, Pierson Cove, Wheeler, and Swasey formations; thickness roughly 1500 feet (450 m).

Cp **Pioche Formation** (Middle and Lower Cambrian) – Red-brown and green-brown shale and phyllitic shale, gritty sandstone, a medial silty limestone interval with *Girvanella* and pisolites, and thin quartzite in lower part; thin to medium bedded; thickness is about 300 feet (90 m) or less.

Cpm **Prospect Mountain Quartzite** (Lower Cambrian) – Medium-bedded, medium- to coarse-grained quartzite; uppermost part is reddish-brown, medium- to thick-bedded, pebbly quartzite; majority is thin to thick bedded, light-gray to very light gray, commonly reddish-brown-weathering quartzite; lowermost part is light-pink, brown, and maroon quartzite conglomerate and is lithologically similar to the underlying and unexposed Mutual Formation; exposed in core of the Deseret anticline along crest of Stansbury Mountains; approximately 4200 feet (1280 m) exposed.

PERMIAN TO CAMBRIAN STRATA OF SOUTH MOUNTAIN, SOUTHERN OQUIRRH MOUNTAINS, AND WESTERN TRAVERSE MOUNTAINS

The Permian-Pennsylvanian rocks of the southern Oquirrh Mountains are considered part of the Bingham Sequence, present south of the North Oquirrh thrust fault (Tooker and Roberts, 1970). Considering regional relations, and similar to Laes and others (1997) and Hintze and Kowallis (2009), we combine Lower Permian (Wolfcampian) and Pennsylvanian formations under the Oquirrh Group; this nomenclature differs from existing terminology established in the Oquirrh Mountains (Welsh and James, 1961; Tooker and Roberts, 1970), which restricts the Oquirrh Group to strata of Pennsylvanian age. Regarding the South Mountain-Stockton area, relations suggest these rocks are in a different thrust plate, but we disagree with Tooker and Roberts separate terminology of formational units (South Peak, Salvation, and Rush Lake) that constitute the Oquirrh Group rocks in their South Mountain nappe (Tooker and Roberts, 1988; Tooker and Roberts, 1992; Tooker and Roberts, 1998; Tooker, 1999); instead, we use nomenclature of the Bingham Sequence. We also revised the mapping and stratigraphic interpretations of Welsh and James (1998) on South Mountain, but further evaluation is needed. New fossil data is provided in table 5.

Pdk **Diamond Creek Sandstone and Kirkman Formation, undivided** (Lower Permian, Leonardian? to Wolfcampian) – Gray to tan, weathering to red brown, fine-grained sandstone and quartzite; weathers to chips and blocks; the Kirkman may be represented by a 30-foot-thick (10 m) sandy limestone at base of unit and some overlying sandstone; top not exposed, incomplete thickness is 2600 feet (790 m).

Pofp **Oquirrh Group, Freeman Peak Formation** (Lower Permian, Wolfcampian) – Light-brown, weathering to red brown, fine-grained sandstone; resistant and jointed forming blocky exposures; thickness is 2900 feet (880 m).

Pocp **Oquirrh Group, Curry Peak Formation** (Lower Permian, Wolfcampian) – Dark-gray, weathering to light gray and tan, thin-bedded, calcareous sandstone and siltstone with worm trails, and some minor quartzite and limestone intervals; thickness is 1800 feet (550 m).

Unconformity?

IPo **Oquirrh Group, Bingham Mine and Butterfield Peaks Formations, undivided** (Upper to Lower Pennsylvanian) – Combined unit in small exposures of western Traverse Mountains.

Tooker and Roberts (1970, 1998) separated the Bingham Mine Formation into the Markham Peak and Clipper Ridge Members based on lithology. Swenson (1975, p. 28) did not consider the type locality of the Markham Peak Member to represent a valid section and instead informally referred to these two divisions as the upper and lower members following Welsh and James (1961). Although subsequent Kennecott maps largely followed Swenson's mapping, they used the names Markham and Clipper Members for the upper and lower parts (Swenson and Kennecott, 1991; Laes and others, 1997). We use Swenson's informal two-member terminology only in the vicinity of Bingham mine; only the lower member is present in the map area.

IPobm **Oquirrh Group, Bingham Mine Formation** (Upper Pennsylvanian, Virgilian-Missourian) – Brown-weathering, fine-grained quartzitic sandstone and calcareous sandstone, with interbeds of medium-gray, fine-grained sandy and cherty limestone; sandstones predominate over limestones; thickness is 5300 to 6500 feet (1600-2000 m).

IPoml **Oquirrh Group, Bingham Mine Formation, limestone unit** (Upper Pennsylvanian, Virgilian-Missourian) – Limestone intervals locally mapped to define structure in the Bingham Mine Formation; thickness is 200 feet (60 m) or less.

IPobml

Oquirrh Group, Bingham Mine Formation, lower member (Upper Pennsylvanian, Missourian?) – Unit includes the basal Jordan and Commercial Limestone marker beds (important Bingham ore hosts); most of the unit consists of light-gray to brownish-tan, banded orthoquartzite and calcareous quartzite with thin interbedded, light- to medium-gray, calcareous, fine-grained sandstone, limestone, and siltstone, and minor shale; thickness is about 3100 feet (945 m).

The Butterfield Peaks Formation was divided into upper and lower parts on Laes and others' (1997) map after Swenson (1975, p. 26). The upper part corresponds to the sandier upper portion of Swenson, while the lower part corresponds to Swenson's middle and lower parts, which contain more limestone. Swenson and Kennecott's (1991) map did not include this separation, and we do not find it useful regionally.

IPobp **Oquirrh Group, Butterfield Peaks Formation** (Middle to Lower Pennsylvanian, Desmoinesian-Morrowan) – Cyclically interbedded limestone, fossiliferous limestone, arenaceous, cherty, and argillaceous limestone, calcareous quartzite, orthoquartzite, and calcareous sandstone; limestone predominates over quartzite and sandstone; limestone contains locally abundant brachiopod, bryozoan, coral, and fusulinid fauna; thickness is 9000 feet (2765 m).

IPobl **Oquirrh Group, Butterfield Peaks Formation, limestone unit** (Middle to Lower Pennsylvanian, Desmoinesian-Morrowan) – Limestone intervals locally mapped to define structure in the Butterfield Peaks Formation; thickness is 200 feet (60 m) or less.

IPowc **Oquirrh Group, West Canyon Limestone** (Lower Pennsylvanian, Morrowan) – Limestone that is cyclically bedded, thin to medium bedded, arenaceous, bioclastic, cherty, densely crystalline, and argillaceous, with thin calcareous quartzite in upper part; fossils include abundant brachipods, common byrozoans, and rare corals, mollusks, pelecypods, and trilobites; thickness about 1115 feet (340 m).

IPMmc

Manning Canyon Shale (Lower Pennsylvanian to Upper Mississippian, Morrowan to Chesterian) – Dark-gray calcareous and carbonaceous shale with interbeds of limestone; also contains thin- to medium-bedded, dark-brown quartzite in lower half; thickness is 1140 feet (347 m).

Mgbu **Great Blue Limestone, upper limestone member** (Upper Mississippian) – Limestone, cherty and argillaceous limestone, and calcareous shale; sparsely fossiliferous and thin to medium bedded; also called Mercur limestone member (Gordon and others, 2000); locally shale is present within the upper limestone member of the southern Oquirrh Mountains that can be mapped separately (Laes and others, 1997), although Tooker (1987) thought this shale was in a separate structural block; thickness of upper limestone member is 1545 feet (470 m), and possibly thicker per Gilluly (1932).

Mgbs **Great Blue Limestone, Long Trail Shale Member** (Upper Mississippian) – Black calcareous and carbonaceous shale in upper part, fossiliferous argillaceous limestone and silty limestone in lower part; thin-bedded, slope-forming interval between enclosing limestones; maximum thickness is 110 feet (33 m).

Mgbl **Great Blue Limestone, lower limestone member** (Upper Mississippian) – Limestone and argillaceous limestone, locally fossiliferous (brachipods, corals, bryozoans), interbedded with calcareous sandstone and sandy limestone; thin to medium bedded and locally silicified (jasperoid of Laes and others, 1997); also called Silveropolis limestone member (Gordon and others, 2000); upper part of lower limestone member (mineralized interval) was called the Mercer series (Laes and others, 1997) and Mercur member (Mako, 1999); thickness is 500 to 850 feet (150-260 m).

Mh **Humbug Formation** (Upper Mississippian) – Gray limestone interbedded with brown-weathering lenticular sandstone and quartzite; thin to medium bedded; thickness is 650 feet (200 m).

Md **Deseret Limestone** (Upper to Lower Mississippian) – Blue-gray cherty limestone and limestone that is medium to very thick bedded; contains thin Delle Phosphatic Shale Member at base; thickness is 650 feet (200 m).

Mg **Gardison Limestone** (Lower Mississippian) – Gray limestone and cherty limestone that is very fossiliferous; upper part is thicker bedded, sandy, and cherty, and lower part more thin bedded and less resistant; thickness is 460 feet (140 m).

Unconformity

MDfp **Fitchville Formation and Pinyon Peak Limestone, undivided** (Lower Mississippian and Upper Devonian) – Gray, coarsely crystalline dolomite that weathers dark gray; within upper cliffy part of unit is one massive bed that contains conspicuous white calcite fossil casts up to a few inches in diameter, called the "eye bed" (Gilluly, 1932); some thin limestone and sandstone beds are present in slope below this bed; forms prominent cliff and slope in Dry and Ophir Canyons of the Oquirrh Mountains; thickness is 185 feet (56 m).

Unconformity

Cambrian rock units are only exposed in the core of the Ophir anticline of the southwestern Oquirrh Mountains. Gilluly (1932) noted the lithologic similarities of Cambrian units in the Oquirrh Mountains to the East Tintic Mountains area, but was unsure of direct correlations and thus applied local names that were subsequently adopted by Tooker (1987, 1999), although not formalized in USGS Geologic Names Lexicon. Rigby (1959b) used East Tintic terminology for the Cambrian rock units in the Oquirrh Mountains, which were also used on Laes and others (1997) map. We conclude that although there are similarities to the East Tintic section, the lithofacies present warrant use of the local names of Gilluly (1932).

Cly **Lynch Dolomite** (Upper to Middle Cambrian) – Light-gray dolomite, and a few limestone beds in lower half; lower part includes dark-gray dolomite containing twiggy bodies (short white carbonate rods); thick-bedded, prominent cliff-forming unit in Ophir Canyon; may correlate with Opex Formation?, and Cole Canyon and

Bluebird Dolomites in the East Tintics (Gilluly, 1932; Morris and Lovering, 1961); thickness from 825 to 1050 feet (250-320 m).

Cb **Bowman Limestone** (Middle Cambrian) – Mottled shaley limestone, intraformational conglomerate, and oolitic limestone; includes a shaley/hornfels unit about 40 feet (12 m) thick at base; sparse trilobite fauna; may correlate with upper part of Herkimer Limestone in East Tintics (Gilluly, 1932; Morris and Lovering, 1961); thickness is 280 feet (85 m).

Ch **Hartmann Limestone** (Middle Cambrian) – Banded gray mottled thin-bedded silty and shaley limestone; oolitic toward the top, and containing sparse trilobite fauna; may correlate to the lower part of Herkimer Limestone and Teutonic Limestone in East Tintics (Gilluly, 1932; Morris and Lovering, 1961); thickness is 655 feet (200 m).

Cop **Ophir Formation** (Middle to Lower Cambrian) – Gray shale and micaceous shale, with several beds of mottled shaley limestone in middle of unit, and sandy shale and quartzite near base; brachiopod and trilobite (*Olenellus*) fauna (Gilluly, 1932); thickness is 320 feet (98 m).

Ct **Tintic Quartzite** (Lower Cambrian) – White quartzite that weathers to reddish brown; bedding is thick and locally irregular and cross-bedded; only upper part exposed in core of Ophir anticline, where it becomes increasingly shaley and grades into the overlying Ophir Formation; exposed thickness to 300 feet (90m).

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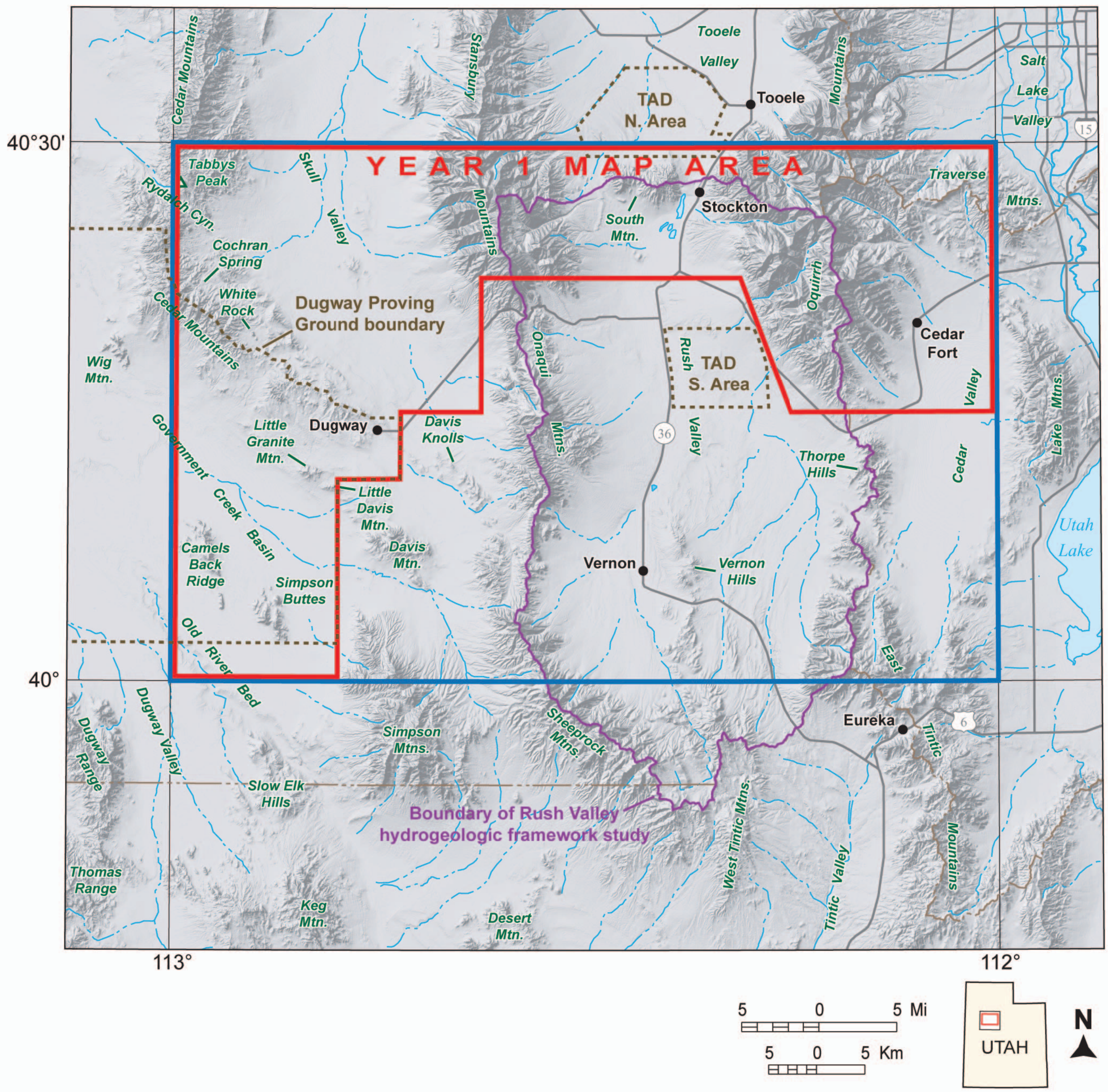

Figure 1. *Location map showing primary geographic features in the Rush Valley 30' x 60' quadrangle and hydrogeologic framework study area. TAD is Tooele Army Depot. The year 1 map area includes part of the Dugway Proving Ground and adjacent areas mapping project by Clark and others (2008).*

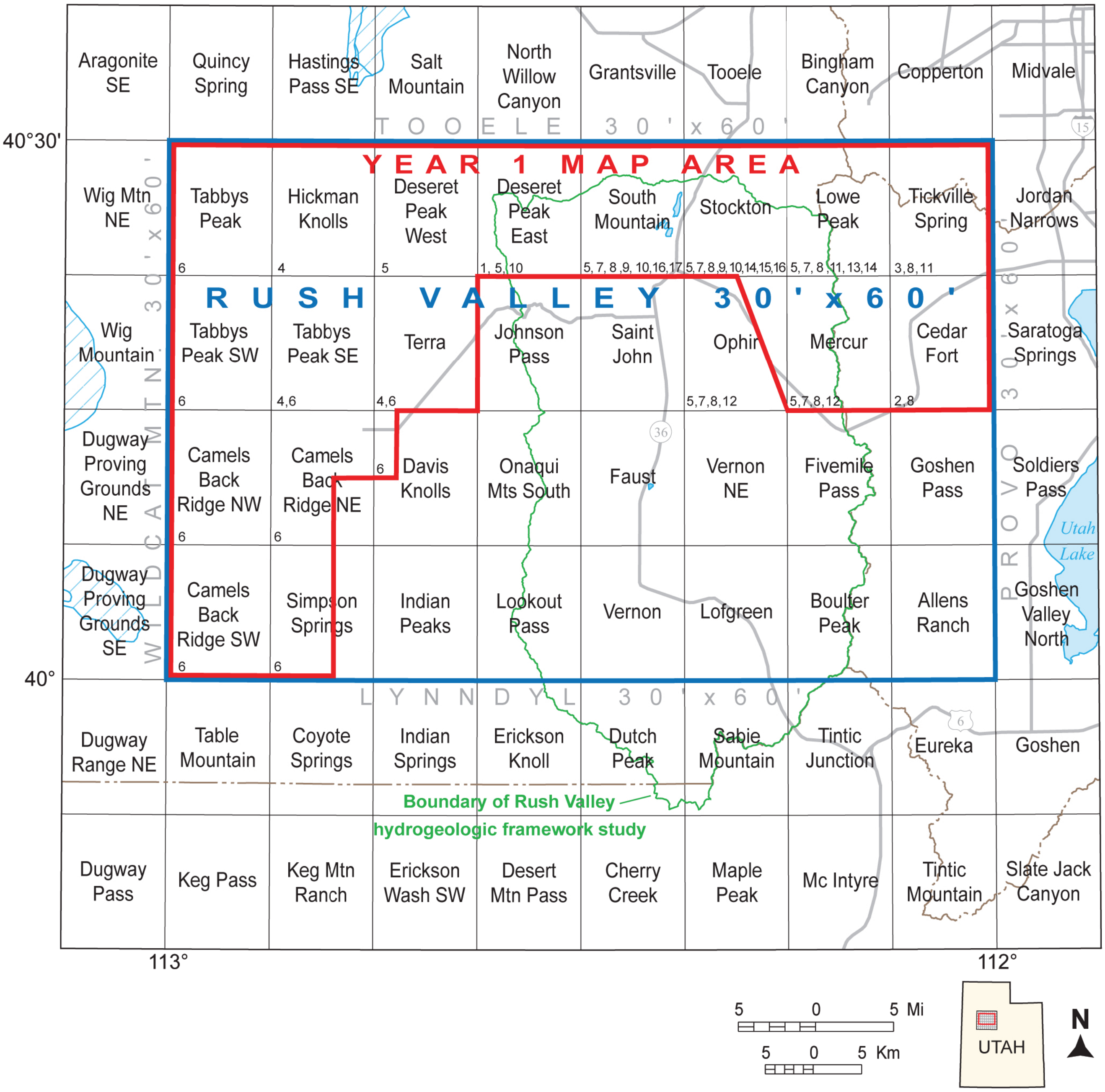

Figure 2. *Index map showing primary sources of geologic mapping in part of the Rush Valley 30' x 60' quadrangle, 7.5' quadrangles, and hydrogeologic framework study boundary.*

Sources of Geologic Map Data

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Maurer (1970)

Time-stratigraphic 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
Total Thickness		6807 (2075)	8402+ - 10,584+ (2562+ - 3229+)	

This Map

Map unit		Cochran Spring section Feet (Meters)	Overall Feet (Meters)	Sample Numbers	Time-stratigraphic unit		
P₽o	Pofc	2713 (827)	3500 (1070)	— D-60 — D-75 D-69	Wolfcampian	Lower	PERMIAN
P₽o	₽obm	1000 (305) fault	2800 (850)	— D-76 D-68 — D-52 D-57 — D-71	Misso. -Virgil.	Upper	PENNSYLVANIAN
P₽o	₽obp	fault 2660 (811)	5400 (1650)	— D-70	Atokan-Desmoinesian	Middle	PENNSYLVANIAN
P₽o	₽owc	500 (150)	500-800 (150-245)	— D-50	Morro-wan	Lower	PENNSYLVANIAN
		6873 (2095)	12,350 (3770)				

Figure 3. *Comparison of Oquirrh strata of the southern Cedar Mountains. 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.*

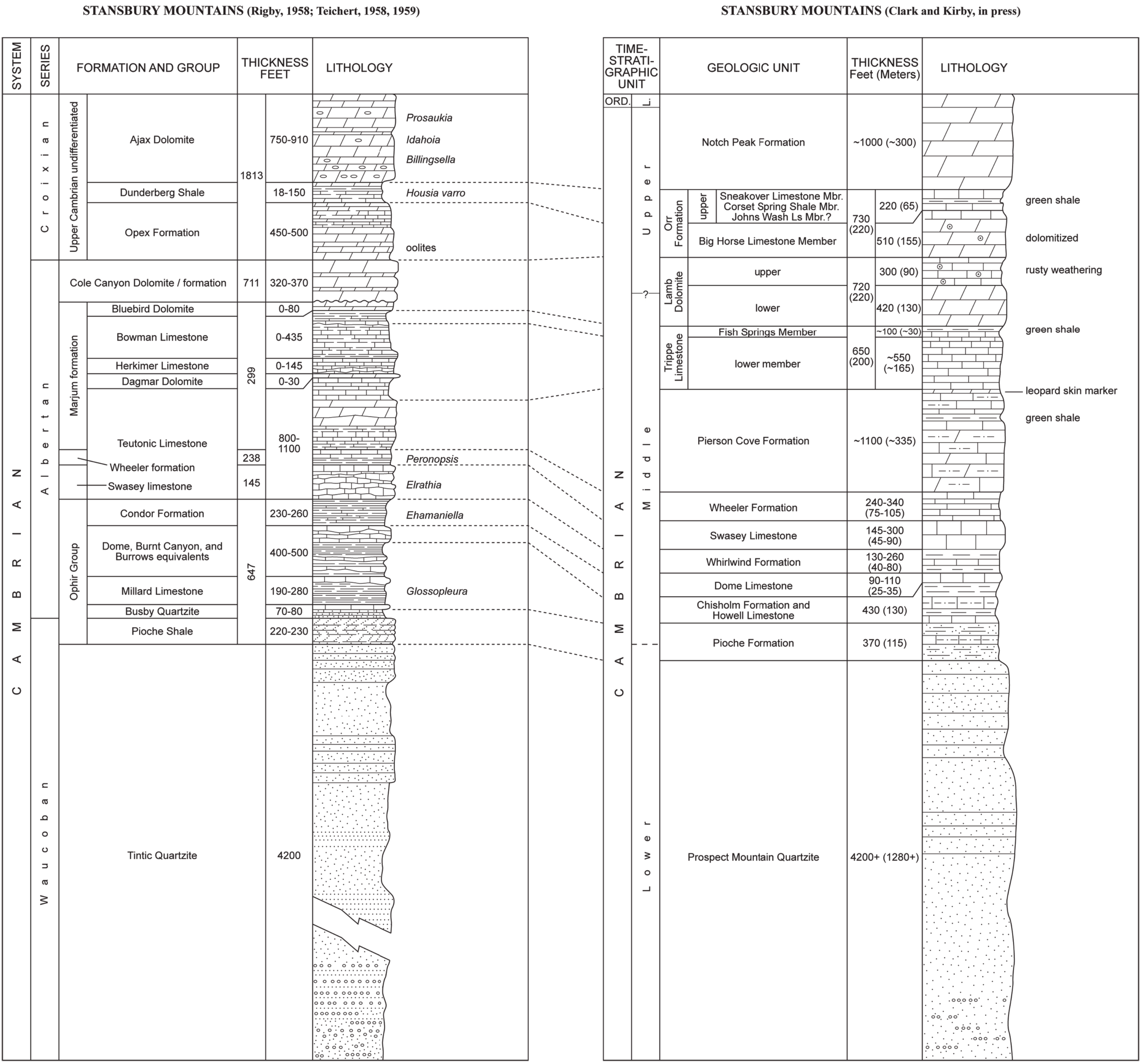


Figure 4. *Comparison of Cambrian stratigraphy of the Stansbury Mountains. The stratigraphy used in this map is the western Utah-type rather than the East Tintic-type.*

Table 1. *Ages and elevations of major shorelines of Lake Bonneville in part of the Rush Valley 30' x 60' quadrangle.*

Lake Cycle and Phase	Shoreline (map symbol)	Age: radiocarbon years B.P.	Age: calendar-calibrated years B.P.	Elevation feet (meters)
Lake Bonneville				
Transgressive Phase	Stansbury (S)	22,000-20,000[1]	27,000-24,000[2]	4460-4470 (1360-1363)
	Bonneville (B)	15,000-14,500[3]	18,300[4]-17,400[5]	5170-5270 (1576-1607)
	flood			
Regressive Phase	Provo (P)	14,500-12,000[6]	17,400[5]-14,400[7]	4800-4880 (1463-1488)
	Gilbert	10,500-10,000[8]	12,500-11,500[9]	Not present

[1] Oviatt and others (1990).
[2] Calendar calibration using Fairbanks and others (2005; http://www.radiocarbon.ldeo.columbia.edu/research/radcarbcal.htm).
[3] Oviatt and others (1992), Oviatt (1997).
[4] Oviatt (written communication, 2009), using Stuiver and Reimer (1993) for calibration.
[5] CRONUS-Earth Project (2005), using Stuiver and others (2005) for calibration.
[6] 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.
[7] Godsey and others (2005), using Stuiver and Reimer (1993) for calibration.
[8] Oviatt and others (2005).
[9] Calendar calibration of data in Oviatt and others (2005), using Stuiver and Reimer (1993) and Hughen and others (2004).

Note: Burr and Currey (1988, 1992) reported that regressive-phase shorelines in Rush Valley fluctuated independently from the main body of Lake Bonneville subsequent to construction of the Stockton Bar. These regressive-phase shoreline elevations are 5050 feet (1539 m) and 5010 feet (1527 m).

Table 2. Selected major- and trace-element whole-rock analyses for the Rush Valley 30' x 60' Quadrangle.

Sample #	Map Unit	Rock Name	7.5' Quadrangle	Latitude (N)	Longitude (W)	SiO2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	Cr_2O_3	TiO_2	MnO	P_2O_5
D-47	Trr	Rhyolite	Tabbys Peak	40°26'18.0"	112°56'57.2"	68.97	14.05	1.31	2.04	0.37	2.74	3.98	<0.01	0.1	0.03	0.03
D-48	Trr	Rhyolite	Tabbys Peak	40°25'10.8"	112°58'38.3"	67.55	14.38	2.96	2.61	0.89	3.18	4.45	<0.01	0.36	0.03	0.14
D-49	Trr	Rhyolite	Tabbys Peak	40°22'38.1"	112°57'38.9"	68.18	14.87	2.12	2.2	1.02	3.18	3.78	<0.01	0.43	0.01	0.17
D-51	Trr	Rhyolite	Tabbys Peak	40°23'11.7"	112°57'13.1"	75.73	14.96	0.61	0.71	0.16	0.06	0.05	<0.01	0.45	<0.01	0.14
D-10	Tac	Andesite	Tabbys Peak SW	40°21'33.4"	112°59'42.4"	59.97	16.24	6.19	4.83	1.78	2.95	3.62	<0.01	0.84	0.08	0.25
D-12	Tac	Andesite	Tabbys Peak SW	40°20'12.9"	112°58'21.1"	59	16.41	7.34	6.22	3.86	2.66	2.24	0.01	0.81	0.11	0.19
D-15	Tac	Dacite	Tabbys Peak SW	40°20'33.7"	112°58'07.7"	62.68	15.82	5.65	4.27	1.68	2.81	3.87	<0.01	0.76	0.07	0.25
D-17	Tac	Andesite	Tabbys Peak SW	40°18'39.6"	112°56'36.3"	60.15	15.85	6.89	5.05	2.96	2.73	3.62	0.01	0.94	0.1	0.29
D-19	Tac	Dacite	Tabbys Peak SW	40°19'01.9"	112°56'32.6"	63.54	15.71	5.77	4	1.88	2.85	3.69	0.01	0.66	0.06	0.22
D-20	Tac	Andesite	Tabbys Peak SW	40°19'05.1"	112°56'26.7"	61.8	16.34	5.8	4.44	2.09	2.82	3.8	0.01	0.71	0.08	0.24
D-21	Tac	Dacite	Tabbys Peak SW	40°19'06.1"	112°56'23.8"	61.21	16.03	5.69	4.26	1.71	3	3.64	<0.01	0.67	0.06	0.23
D-25	Tac	Andesite	Tabbys Peak SW	40°16'13.7"	112°56'23.9"	61.01	15.33	6.25	4.56	2.79	2.78	3.72	0.01	0.75	0.09	0.24
D-31	Tac	Andesite	Tabbys Peak SW	40°16'11.5"	112°52'39.7"	60.04	14.74	6.5	4.89	3.44	2.55	3.47	0.01	0.76	0.09	0.25
D-32	Tac	Andesite	Tabbys Peak SW	40°16'06.8"	112°53'04.2"	58.71	15.13	7.55	5.36	4.21	2.24	3.43	0.02	0.99	0.11	0.29
D-37	Tac	Dacite	Camels Back Ridge NE	40°13'40.9"	112°48'36.5"	63.03	14.6	6.32	4.11	3.1	2.83	3.46	0.01	0.64	0.08	0.21
D-38	Tac	Andesite	Tabbys Peak SE	40°15'04.8"	112°46'02.3"	60.56	14.88	7.2	4.63	3.31	2.52	3.59	0.02	0.85	0.08	0.26
D-46	Tac	Andesite	Tabbys Peak	40°27'58.0"	112°54'25.1"	61.24	16.09	5.63	4.67	2.64	3.32	2.75	0.01	0.88	0.07	0.24
D-40	Taci	Andesite	Tabbys Peak	40°27'47.7"	112°59'13.8"	59.96	16.84	6.8	5.89	3.25	2.84	2.34	<0.01	0.77	0.1	0.18
FM083105-1	Tdi	Dacite	Camels Back Ridge NE	40°12'08"	112°50'16"	67.9	15.29	3.62	2.69	1.44	3.55	3.6	<0.01	0.5	0.05	0.18
D-4	Tdi	Dacite	Tabbys Peak SW	40°19'17.9"	112°54'01.1"	63.46	14.65	3.7	3.51	1.95	3.34	3.73	0.01	0.53	0.05	0.18
				UTM Easting	**UTM Northing**											
RV-1	Tvs	Latite	Deseret Peak East	366898	4484096	60.02	16.2	6.58	4.78	1.82	3.13	3.95	<0.01	0.79	0.06	0.36
RV-13	Tbi	Basalt	South Mountain	377814	4480547	49.55	13.36	9.29	8.54	10.91	2.58	2.3	0.11	1.24	0.15	0.519

Notes:
Major oxides reported in weight percent by x-ray fluorescence (XRF); minor and trace elements reported in ppm by inductively coupled plasma-mass spectrometry (ICP-MS).
All analyses performed by ALS Chemex Labs, Inc., Sparks, NV.
Rock names from total alkali-silica diagram of LeBas and others (1986).
LOI is loss on ignition.
Latitude/Longitude location data based on NAD27. UTM location data based on NAD27 Zone 12.
Some data also reported in Clark (2008).
Tickville Spring quadrangle data reported by Biek (2006b).

SrO	BaO	LOI	Total	Ag	Ba	Ce	Co	Cr	Cs	Cu	Dy	Er	Eu	Ga	Gd	Hf	Ho	La	Lu	Mo	Nb
0.04	0.16	4.57	98.38	<1	1490	72.2	0.6	<10	3	<5	2.47	1.63	1.06	17.6	3.76	4.2	0.49	41.6	0.26	<2	14
0.05	0.16	1.84	98.6	<1	1305	45.7	6.5	40	4.42	16	2.43	1.49	0.95	16.2	3.26	4.3	0.48	25.9	0.21	<2	11.4
0.06	0.18	2.25	98.46	<1	1625	88.9	4.7	30	3.17	10	2.04	1.12	1.23	21.2	4.18	5.7	0.35	50.4	0.14	<2	18.1
0.01	0.08	6.43	99.37	<1	678	89.6	2.1	30	1.29	12	1.88	1.01	1.08	20.7	4.09	5.5	0.33	51	0.13	<2	17.4
0.06	0.15	2.06	99.01	<1	1245	79.9	12.9	20	1.59	10	4.61	2.54	1.71	21.1	5.96	5.8	0.87	45	0.37	<2	13.5
0.03	0.1	1.02	100	<1	863	81.4	20.3	130	3.08	18	5.34	3.15	1.65	20.3	6.26	6.3	1.06	43.2	0.45	3	17.2
0.05	0.15	1.54	99.6	<1	1325	86.7	14.7	50	4.49	12	3.79	2.68	1.44	22.6	5.73	6.7	0.88	48.8	0.36	2	20.8
0.05	0.16	1.18	99.98	<1	1395	92.2	23.3	140	4.9	20	4.54	2.98	1.67	24.2	6.66	7.3	0.97	49.2	0.39	4	20.2
0.05	0.15	1.49	100.1	<1	1350	88.4	14.2	70	4.7	18	3.85	2.71	1.48	23	5.84	6.7	0.89	50.2	0.38	2	19.7
0.05	0.16	1.49	99.83	<1	1350	86.9	13.2	70	5.51	8	3.64	2.56	1.41	21.7	5.6	6.2	0.85	47.7	0.36	3	17.1
0.06	0.16	1.92	98.64	<1	1420	85.8	13.3	60	4.11	17	3.54	2.46	1.46	21.5	5.63	6.3	0.82	48.9	0.34	2	17.1
0.05	0.15	1.69	99.42	<1	1255	87.9	16.4	130	3.9	22	3.91	2.79	1.48	19.8	5.84	6.6	0.91	47.6	0.38	2	19.2
0.05	0.16	2.38	99.33	<1	1245	85.5	20.7	170	4.7	32	3.72	2.73	1.39	20.6	6.03	6.6	0.9	47.8	0.37	2	19.1
0.05	0.13	1.2	99.42	<1	1100	88.3	27.1	220	3.82	32	4.35	3.03	1.58	20.7	6.48	6.8	1.01	46.8	0.41	3	18.6
0.05	0.18	1.25	99.87	<1	1375	78.1	20	140	4.17	30	2.56	2.06	1.25	20	4.9	5.5	0.69	44.4	0.25	3	14.1
0.05	0.15	1.34	99.43	<1	1140	82.1	18.5	160	4.85	25	3.81	2.66	1.45	19.6	5.78	6.1	0.91	44.3	0.32	2	17.3
0.05	0.15	2.26	100	<1	1215	120	18.8	100	2.29	27	2.86	1.98	1.49	20.9	6.19	6.9	0.64	66.6	0.21	3	23.7
0.04	0.09	0.96	100.05	<1	740	75.1	19.6	40	2.3	16	3.87	2.89	1.34	20.2	5.35	5.7	0.95	41	0.39	2	20.1
0.06	0.19	0.91	99.99	<1	1775	108.5	8.7	70	2.5	8	3	1.7	1.5	20	4.9	6	0.6	61.6	0.2	<2	15
0.07	0.17	3.15	98.5	<1	1505	115	10.6	110	6.3	15	3.43	1.9	1.49	18.7	5.58	5.8	0.6	64.9	0.24	2	18
0.06	0.16	1.83	99.75	<1	1410	95.1	16.1	60	4.82	19	5.38	3.34	1.86	22.1	7.34	6.7	1.11	50.7	0.47	<2	13.7
0.08	0.21	0.75	99.58	<1	1645	109.5	39.3	690	2.27	77	3.52	2.07	2.09	17.7	5.94	3.9	0.74	58.5	0.27	<2	25.4

Nd	Ni	Pb	Pr	Rb	Sm	Sn	Sr	Ta	Tb	Th	Tl	Tm	U	V	W	Y	Yb	Zn	Zr
23.9	<5	28	7.26	130	3.83	1	304	1	0.48	17.2	<0.5	0.23	3.72	8	5	14.7	1.73	39	130
18.9	7	25	5.18	135.5	3.52	1	409	0.8	0.46	12.7	0.5	0.2	3.1	45	1	13.9	1.48	41	142
30.9	9	32	9.12	161.5	4.63	2	568	1.5	0.48	22.8	0.6	0.14	6.04	57	3	9.7	1.03	40	192
30.9	5	12	9.26	3.9	4.61	2	26.2	1.4	0.44	23.5	<0.5	0.12	9.82	42	6	9.2	0.95	18	184
34.4	<5	19	9.55	120	6.18	1	515	0.9	0.84	13.95	<0.5	0.37	2.95	135	2	23.8	2.44	82	214
34.1	14	17	9.55	80.2	6.19	2	300	1.2	0.91	11.6	<0.5	0.46	2.89	154	2	27.5	2.85	85	232
36.5	11	26	10.15	152	6.53	3	473	1.7	0.83	19.4	0.5	0.39	5.74	133	5	27.6	2.53	73	259
40.5	18	26	10.9	143.5	7.18	3	545	1.5	0.93	17.2	0.5	0.45	4.61	188	4	30.3	2.77	96	271
36.5	15	29	10.15	145	6.55	3	464	1.7	0.85	19.95	0.6	0.4	5.77	113	5	27.5	2.49	74	261
35.4	7	27	9.84	135.5	6.21	3	490	1.6	0.82	18	0.5	0.38	4.83	122	29	25.5	2.45	74	240
35.1	15	28	9.81	122.5	6.25	2	524	1.3	0.78	18.05	<0.5	0.37	4.74	104	5	25.7	2.46	75	236
37	19	25	10.05	136	6.39	3	440	1.4	0.84	17.75	<0.5	0.43	4.52	127	4	27.9	2.65	70	257
36.5	35	24	10.05	135	6.37	3	479	1.4	0.87	18	<0.5	0.41	4.77	144	3	28.7	2.61	78	257
38.2	38	21	10.35	121	6.93	2	466	1.2	0.93	16.6	<0.5	0.44	3.73	183	3	31.8	2.91	84	265
32.1	32	25	8.79	133	5.49	2	438	1	0.68	19.4	0.5	0.29	4.72	117	4	21.4	2.01	68	222
36	22	24	9.59	138	6.44	2	460	1.2	0.83	16.35	0.5	0.37	4.18	165	3	27.4	2.54	72	246
45.7	44	25	13.25	105	6.99	2	482	1.6	0.78	28.1	<0.5	0.26	5.04	100	3	19.8	1.6	82	266
30.9	11	19	8.51	84.9	5.45	3	347	1.3	0.81	14.35	<0.5	0.41	3.65	152	3	28.2	2.69	74	219
37.3	14	49	11.2	127.5	5.7	2	634	1.1	0.6	21	<0.5	0.2	3.4	67	1	16.7	1.5	59	198
42	31	33	12.6	144	6.36	2	574	1.8	0.68	26.6	<0.5	0.24	9.13	67	2	15.7	1.62	63	193
42	15	29	11.25	139	7.72	2	583	0.8	0.97	16.4	<0.5	0.46	3.86	139	1	31.4	3.17	107	229
43.7	205	13	12.85	56.5	6.82	1	626	1.3	0.8	11	<0.5	0.27	2.41	158	1	16.8	1.59	89	149

Table 3. Summary of ash-bed (tephra) data from the Salt Lake Formation in the Rush Valley 30' x 60' quadrangle.

Sample Number	7.5' Quadrangle	Latitude (N)	Longitude (W)	Tephra Name	Age (Ma)	Error (Ma)	Age Type	Comments	Reference
A-1 (85')	Hickman Knolls	tbd	tbd	Walcott	6.4	0.2	correlation?	ash analysis by W.P. Nash	SWEC, 1997
A-1 (90')	Hickman Knolls	tbd	tbd	Walcott	6.4	0.2	correlation?	ash analysis by W.P. Nash	SWEC, 1997
sb87-11	Deseret Peak East	40.497440°	112.562570°	Cougar Point Tuff unit XIII	10.94	0.03	correlation	in steep, narrow gully	Perkins, unpub data
TR1-4 (8')	Hickman Knolls	tbd	tbd	-	~15.4	-	interpolation?	ash analysis by M.E. Perkins	Geomatrix, 2001
TR1-1 (8')	Hickman Knolls	tbd	tbd	-	~16 to 4	-	interpolation?	ash analysis by M.E. Perkins	Geomatrix, 2001
TR1-2 (10')	Hickman Knolls	tbd	tbd	-	~16 to 4	-	interpolation?	ash analysis by M.E. Perkins	Geomatrix, 2001
TR1-3 (5')	Hickman Knolls	tbd	tbd	-	~16 to 4	-	interpolation?	ash analysis by M.E. Perkins	Geomatrix, 2001

Notes:
Location data based on NAD83.
Skull Valley area samples are from the subsurface, depths in feet indicated in parentheses; locations to be determined (tbd).

Table 4. Summary of $^{40}Ar/^{39}Ar$ and K-Ar age analyses from the Rush Valley 30' x 60' quadrangle.

Sample Number	Map Unit	Rock Name	7.5' Quadrangle	Latitude (N)	Longitude (W)	Age (Ma)	Material Dated	Laboratory	Comments	Reference
$^{40}Ar/^{39}Ar$ Analyses										
TS102103-5	Tdi	Dacite	Tickville Spring	40°25'05.7"	112°03'57.6"	32.05 ± 0.13	biotite	NMGRL	furnace step-heat, somewhat disturbed	Biek and others, 2005; NMGRL and UGS, 2006
Tick 28	Tvlb	Dacite	Tickville Spring	-	-	32.12 ± 0.14	plagioclase	Berkeley	plateau age	Deino and Keith, 1997
TS33104-7	Tvfa	Basaltic andesite	Tickville Spring	40°25'03.0"	112°03'59.8"	32.86 ± 0.48	groundmass concentrate	NMGRL	furnace step-heat, disturbed	Biek and others, 2005; NMGRL and UGS, 2006
TS33104-4	Tri	Rhyolite	Tickville Spring	40°29'44.1"	112°05'05.7"	35.49 ± 0.13	sanidine	NMGRL	laser total fusion	Biek and others, 2005; NMGRL and UGS, 2006
TS32904-3	Tai	Andesite	Tickville Spring	40°28'26.5"	112°04'00.2"	36.26 + 0.18	biotite	NMGRL	furnace step-heat	Biek and others, 2005; NMGRL and UGS, 2006
Tick 43	Tvfo	Minette	Tickville Spring	40°26'48"	112°06'30"	37.82 + 0.14	whole rock	Berkeley	plateau age	Deino and Keith, 1997
Tick-113	Tvlo	waterlain tuff	Tickville Spring	40°26'42.500"	112°06'4.051"	38.68 + 0.13	sanidine	Berkeley	plateau age	Maughan, 2001
Bing-6	Tli	Latite	Tickville Spring	40°29'42"	112°07'24"	38.84 + 0.19	plagioclase	Berkeley	plateau age	Deino and Keith, 1997
D-17	Tac	Andesite	Tabbys Peak SW	40°18'39.6"	112°56'36.3"	38.17± 0.47	groundmass concentrate	NMGRL	furnace step-heat	Clark and others, 2008: UGS and NMGRL, 2009b
Tick 23	Tvlo	Latite clast	Tickville Spring	40°28'47"	112°07'11"	39.18 ± 0.11	biotite	Berkeley	plateau age	Deino and Keith, 1997
FM083105-1	Tdi	Dacite	Camels Back Ridge NE	40°12'08"	112°50'16"	39.56 + 0.10	biotite	NMGRL	integrated age, low K2O%	Clark and others, 2008; UGS and NMGRL, 2009a
D-4	Tdi	Dacite	Tabbys Peak SW	40°19'17.9"	112°54'01.1"	38.69 ± 0.10	sanidine	NMGRL	laser total fusion	Clark and others, 2008: UGS and NMGRL, 2009b
D-40	Taci	Andesite	Tabbys Peak	40°27'47.7"	112°59'13.8"	40.61 + 0.78	groundmass concentrate	NMGRL	furnace step-heat	Clark and others, 2008: UGS and NMGRL, 2009b
FM083105-1	Tdi	Dacite	Camels Back Ridge NE	40°12'08"	112°50'16"	40.95 ± 0.32	hornblende	NMGRL	step-heating, plateau age	Clark and others, 2008; UGS and NMGRL, 2009a
K-Ar Analyses										
9	Tvbs	Hornblende latite tuff-breccia	Tickville Spring	40°28'00"	112°02'24"	30.7 + 0.9	biotite		W Traverse Mtns - South Mountain	Moore, 1973
11	Trf	Biotite rhyolite vitrophyre	Tickville Spring	40°25''12"	112°01'12"	31.2 + 0.9	biotite		W Traverse Mtns - Tickville Gulch rhyolite flow	Moore, 1973
12	Tri	Fine-grained biotite rhyolite	Mercur	40°18'24"	112°12'12"	31.6 + 0.9	biotite		Oquirrh Mtns - Mercur district, Eagle Hill rhyolite plug	Moore, 1973
10	Tri	Biotite rhyolite vitrophyre	Tickville Spring	40°29'48"	112°05'00"	33.0 + 1.0	biotite		W Traverse Mtns - Shaggy Peak plug	Moore, 1973
WT-41	Tpqmi	Biotite granodiorite porphyry	Mercur	40°20'45"	112°13'20"	36.7 + 0.5	biotite		Oquirrh Mtns - Porphyry Hill at Ophir	Moore and McKee, 1983
6	Tli	Quartz latite porphyry dike	Lowe Peak	40°29'36"	112°12'24"	37.1 + 1.1	biotite		Oquirrh Mtns - Middle Canyon area	Moore, 1973
7	Tmi	Monzonite porphyry stock	Stockton	40°26'48"	112°19'48"	38.0 + 1.1	biotite		Oquirrh Mtns - Stockton District, Calument Mine area	Moore, 1973
69-TS-32	Tvfo	Nepheline basalt	Tickville Spring	40°25'40"	112°05'45"	38.5 + 0.3	whole rock		Oquirrh Mtns - South of Bingham mine	Moore and McKee, 1983
5	Tqli	Quartz monzonite porphyry sill	Stockton	40°30'00"	112°19'00"	38.6 + 1.1	biotite		Oquirrh Mtns - Selkirk Canyon area	Moore, 1973
69-SM-2	Tbi	Nepheline basalt	South Mountain	40°27'55"	112°26'30"	40.1 + 0.5	whole rock		South Mountain dike	Moore and McKee, 1983

Notes:
Location data in NAD27.
NMGRL is New Mexico Geochronology Research Laboratory, Socorro, New Mexico.
See UGS & NMGRL (2009a, 2009b) for complete presentation of data.
Selected Ar/Ar analyses are plotted on the geologic map.

Table 5. *Fossil identifications and ages from Rush Valley 30' x 60' quadrangle.*

Data from southern Cedar Mountains by Clark and others (2008)

Sample No.	Map Unit	Rock Type	7.5' Quadrangle	Latitude (N)	Longitude (W)	Fossil Type	Fauna	Preservation & Abrasion	Calcareous Algae Present	Age
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	IPobm	biomicrite: wackestone	Tabbys Peak	40°29'53.8"	112°56'41.1"	fusulinid	*Triticites*	Fair	None	Virgilian
D-68	IPobm	biomicrite: wackestone	Tabbys Peak	40°23'37.1"	112°59'45.3"	fusulinid	*Triticites*	Fair	None	Virgilian
D-52	IPobm	biomicrite: wackestone	Tabbys Peak SW	40°21'18.4"	112°59'14.5"	fusulinid	*Pseudofusulinella, Triticites*	Fair	None	lower Virgilian
D-57	IPobm	biosparite: packstone	Tabbys Peak SW	40°19'31.0"	112°58'13.0"	fusulinid	*Triticites cullomensis*	Good	None	lower Virgilian
D-71	IPobm	biomicrite: mudstone	Tabbys Peak	40°23'05.6"	112°59'05.3"	fusulinid	*Triticites*	Good	None	Missourian
D-78	IPobm	biomicrite: wackestone	Tabbys Peak SW	40°20'04.3"	112°58'34.9"	fusulinid	*Triticites*	Fair	None	Missourian
D-70	IPobp	biomicrite: wackestone	Tabbys Peak	40°23'08.4"	112°58'34.7"	fusulinid	*Beedeina*	Fair	Fragments	lower Desmoinesian
D-50	IPowc	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).

New data from South Mountain and Stansbury Mountains

Sample No.	Map Unit	Rock Type	7.5' Quadrangle	UTM easting	UTM northing	Fossil Type	Fauna	Preservation & Abrasion	Calcareous Algae Present	Age
RV-14	Pdk	biosparite: grainstone	South Mountain	376552	4480811	fusulinid	*Schwagerina*	Fair-Poor	None	upper-lower Wolfcampian
RV-15	Pocp	biomicrite: mudstone	South Mountain	380477	4482046	fusulinid	*Triticites, Schwagerina*	Poor	None	Wolfcampian
970	IPobm	biomicrite: mudstone	South Mountain	379087	4481294	fusulinid	*Triticites*	Fair	None	upper Missourian to Virgilian
1199	IPobm	calcareous sandstone	South Mountain	378234	4473502	fusulinid	*Triticites*	Poor	None	Missourian
969	IPobp	biomicrite: wackestone	South Mountain	382340	4478834	fusulinid	*Fusulina*	Poor	None	lower Desmoinesian
RV-17	Pofc	biosparite: packstone	Deseret Peak East	369168	4480498	fusulinid	*Triticites* cf. *T. meeki*	Good	None	lower Wolfcampian
RV-8	Pofc	biosparite: packstone	Deseret Peak East	370238	4476875	fusulinid	*Schwagerina, Triticites*	Poor	None	lower Wolfcampian
RV-11	IPobm	biosparite: packstone	Deseret Peak East	369748	4476679	fusulinid	*Triticites*	Poor	None	Virgilian
RV-9	IPobm	biomicrite: wackestone	Deseret Peak East	369291	4476561	fusulinid	*Triticities* cf. *T. Cullomensis*	Fair	None	Virgilian
RV-2	IPobm	biosparite: packstone	Deseret Peak East	368446	4482113	fusulinid	*Triticites*	Fair	None	Virgilian
RV-5	IPobm	wackestone	Deseret Peak East	368170	4481247	fusulinid	*Triticites*	Good	None	Missourian
RV-4	IPobp	biomicrite: wackestone	Deseret Peak East	368020	4481295	fusulinid	*Wedekindellina*	Fair	None	lower Desmoinesian
RV-6	IPobp	sandstone	Deseret Peak East	367900	4480583	fusulinid	*Wedekindellina* cf. *W. ultimata*	Good	None	lower Desmoinesian

Note: Location data based on NAD83 (UTM, Zone 12).
Fusulinids identified by A.J. Wells (independent).

Data from Stansbury Mountains by Armin and Moore (1981)

Locality Number	Sample Number	Township, Range, Section	7.5' Quadrangle	Approx. UTM Easting	Approx. UTM Northing	Fossil Type	Fauna	Map Unit	Age
S18	77-AF-46	4S., 6W., 28	Deseret Peak East	tbd	tbd	fusulinid	*Schwagerina* sp.	Pofc	Wolfcampian
S19	77-AF-48	4S., 6W., 29	Deseret Peak East	tbd	tbd	fusulinid	*Triticites* sp., *Schwageria?* sp.	Pofc	Wolfcampian
S14	77-AF-30	4S., 6W., 29	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp., *Triticites* sp.	IPobm	Virgilian or Wolfcampian
S22	77-AF-80	5S., 6W., 4	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp.	IPobm	Late Pennsylvanian or Early Permian
S16	77-AF-40	5S., 6W., 5	Deseret Peak East	tbd	tbd	fusulinid	*Triticites* sp.	IPobm	Late Pennsylvanian or Early Permian
S17	77-AF-42	5S., 6W., 4	Deseret Peak East	tbd	tbd	fusulinid	*Triticites?* Sp.	IPobm	Late Pennsylvanian or Early Permian
S12	77-AF-20	4S., 6W., 20	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp.	IPobm	Late Pennsylvanian
S23	77-AF-82	5S., 6W., 4	Deseret Peak East	tbd	tbd	fusulinid	*Triticites?* sp.	IPobm	Late Pennsylvanian
S15	77-AF-36	5S., 6W., 5	Deseret Peak East	tbd	tbd	fusulinid	*Triticites* sp.	IPobm	Late Pennsylvanian
S11	77-AF-19	4S., 6W., 19	Deseret Peak East	tbd	tbd	fusulinid	*Triticites* sp.	IPobp	Late Pennsylvanian
S20	77-AF-51	4S., 6W., 19	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp., *Triticites* sp.	IPobm	Virgilian(?)
S24	78-AF-7	4S., 6W., 30	Deseret Peak East	tbd	tbd	fusulinid	*Triticites* sp.	IPobm	Virgilian(?)
S13	77-AF-25	4S., 6W., 30	Deseret Peak East	tbd	tbd	fusulinid	*Triticites* sp.	IPobm	Virgilian(?)
S21	77-AF-55	4S., 6W., 19	Deseret Peak East	tbd	tbd	fusulinid	*Triticites* sp.	IPobm	Virgilian
S25	78-AF-16	5S., 6W., 16	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp., *Triticites* sp.	IPobm	Missourian (?)
S26	78-AF-22	4S., 6W., 19	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp., *Triticites* sp.	IPobm	Missourian (?)
S27	78-AF-23	4S., 6W., 31	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp., *Triticites?* sp.	IPobm	Missourian (?)
S4	77-AF-35	5S., 6 W., 6	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp., *Triticites* sp.	IPobm	early Missourian?
S5	77-AF-45	5S., 6W., 16	Deseret Peak East	tbd	tbd	fusulinid	*Pseudofusulinella* sp., *Triticites* sp.	IPobm	early Missourian?
S2	77-AF-18	4S., 7W., -	Deseret Peak East	tbd	tbd	fusulinid	*Beedeina?* sp.	IPobp	Desmoinesian?
S3	77-AF-21	4S., 7W., -	Deseret Peak East	tbd	tbd	fusulinid	*Beedeina?* sp.	IPobp	Desmoinesian?
S7	77-AF-88	5S., 6 W., 17	Deseret Peak East	tbd	tbd	brachiopod	*Mesolobus* cf. *M euampygus* (Girty)	IPobp	Desmoinesian
S10	Seq 6-6	4S., 7 W., -	Deseret Peak East	tbd	tbd	fusulinid	*Beedeina* sp.	IPobp	Desmoinesian
S1	77-AF-13	5S., 6W., 7	Deseret Peak East	tbd	tbd	fusulinid	*Fusulinella* sp.	IPobp	Atokan
S6	77-AF-87	5S., 6W, 17	Deseret Peak East	tbd	tbd	fusulinid	*Fusulinella* sp.	IPobp	Atokan
S9	Seq 5-6	5S., 6 W., 18	Deseret Peak East	tbd	tbd	fusulinid	*Fusulinella* sp.	IPobp	Atokan

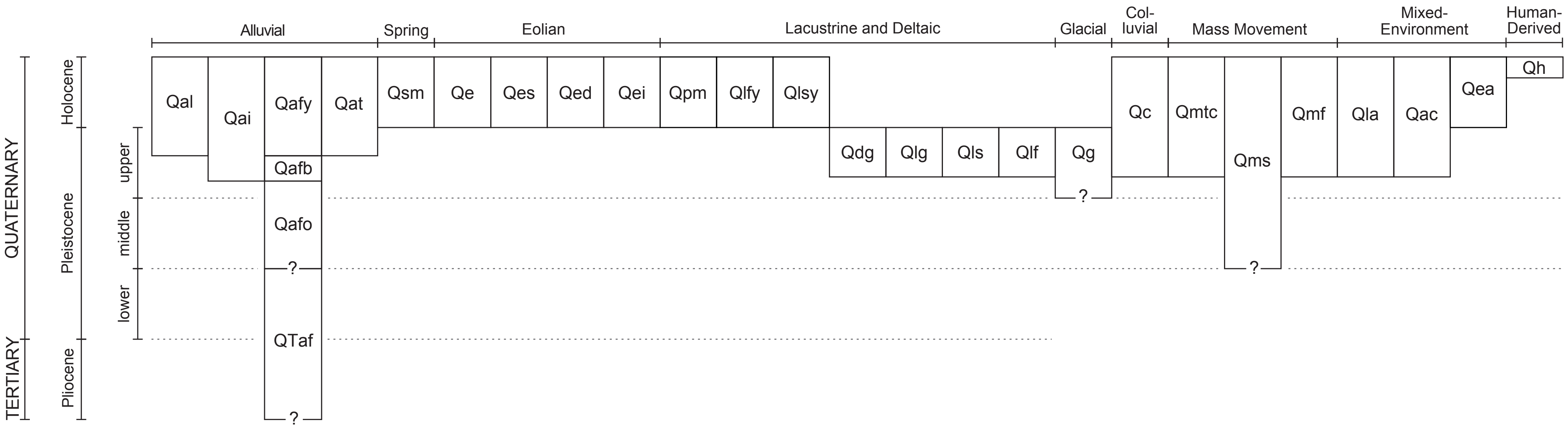
Note: Samples are plotted on our geologic map based on locations from Armin and Moore's geologic map. Approximate location coordinates to be determined.
Map unit designations are modified from Armin and Moore (1981).
Fossil identification by C.H. Stevens.
Wright (1961) also reported fossil data from measured sections in the Stansbury Mountains, but is not included since it lacks detailed location information.

GEOLOGIC SYMBOLS

Symbol	Explanation
	Contact – Angled where scratch
	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 hanging wall
	Reverse Fault – Dotted where concealed; teeth on hanging wall
	Low-angle normal fault – Dotted where concealed; half circles on hanging wall
	Lineament – From air photo interpretation
	Igneous dike (map unit Tqli)
	Igneous dike (map unit Tdi)
	Igneous dike (map unit Tpqmi)
	Igneous dike (map unit Tri)
	Axial trace of anticline – Dashed where approximately located, dotted where concealed; arrow shows plunge
	Axial trace of overturned anticline – Dashed where approximately located, dotted where concealed; arrows shows plunge
	Axial trace of syncline – Dashed where approximately located, dotted where concealed; arrow shows plunge
	Axial trace of overturned syncline – Dashed where approximately located, dotted where concealed; arrows shows plunge
	Major shorelines of the Bonneville lake cycle (see table 1) –
B	Bonneville shoreline
P	Provo shoreline
X	Regressional shoreline
S	Stansbury shoreline
	Lake Bonneville crest of barrier ridge or delta ridge
	Delta distributary channel crest
H	Holocene shoreline of Rush Lake
	Strike and dip of bedding (refer to index map for prior mapping sources) –
20	Inclined from current mapping
20	Inclined from Clark and others (2008)
20	Inclined from prior mapping
	Inclined approximate from Clark and others (2008)
	Vertical from current mapping
	Vertical from prior mapping
50	Overturned from current mapping
50	Overturned from prior mapping
	Sand and gravel pit
	Mine or quarry
	Shaft
	Rock sample location and number for geochemical analyses and Ar/Ar age (see tables 2, 4)
	Rock sample location and number for prior Ar/Ar age analyses (see table 4)
	Rock sample location and number for geochemical analyses (see table 2)
	Tephra location and number for geochemical analyses and age (see table 3)
	Fossil sample location and number for age evaluation (see table 5)
Qed/Qlf	Indicates thin cover of the first unit overlying the second unit

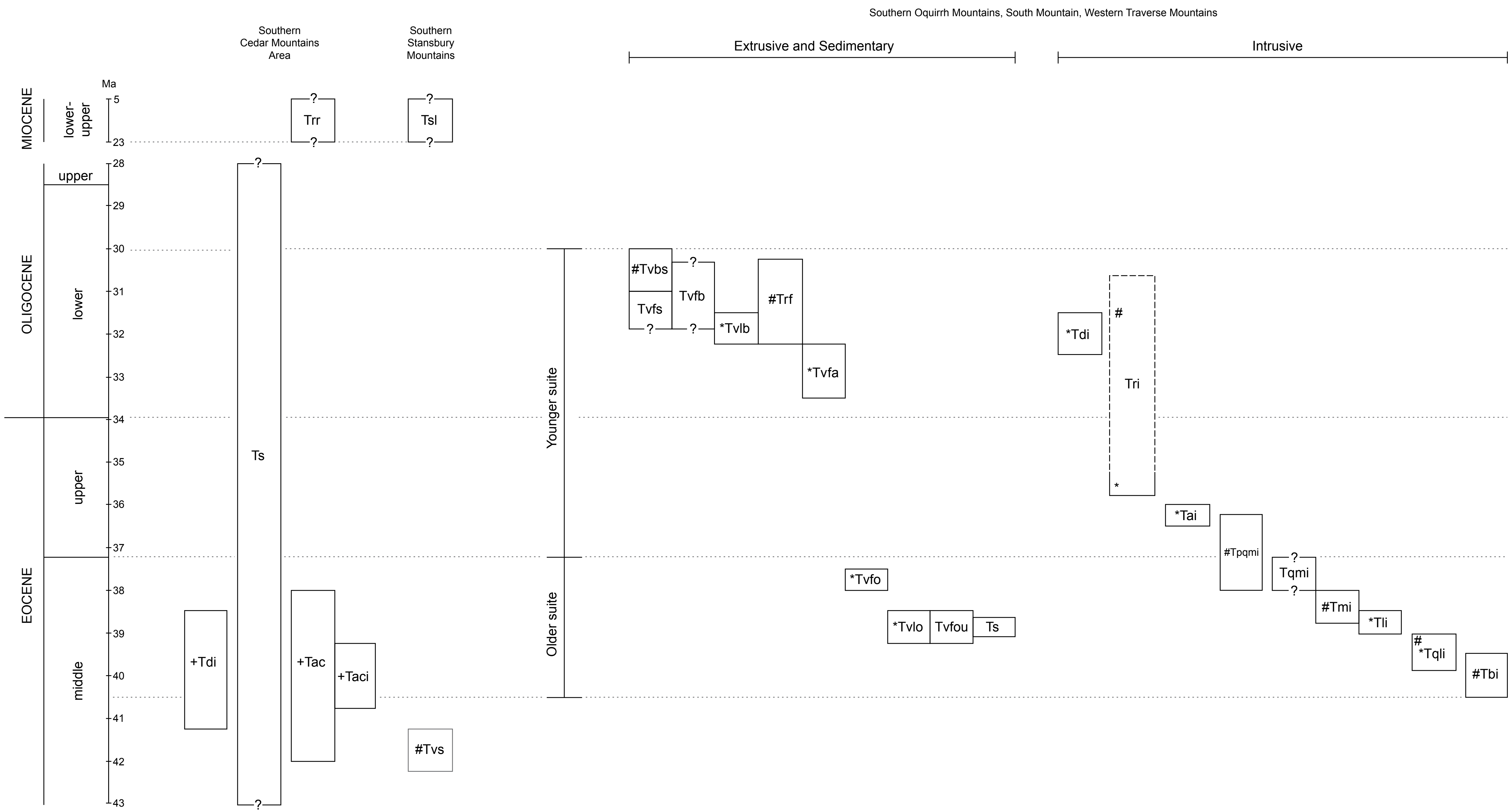
CORRELATION OF QUATERNARY GEOLOGIC UNITS

Rush Valley 30' x 60' Quadrangle (year 1)



CORRELATION OF TERTIARY GEOLOGIC UNITS

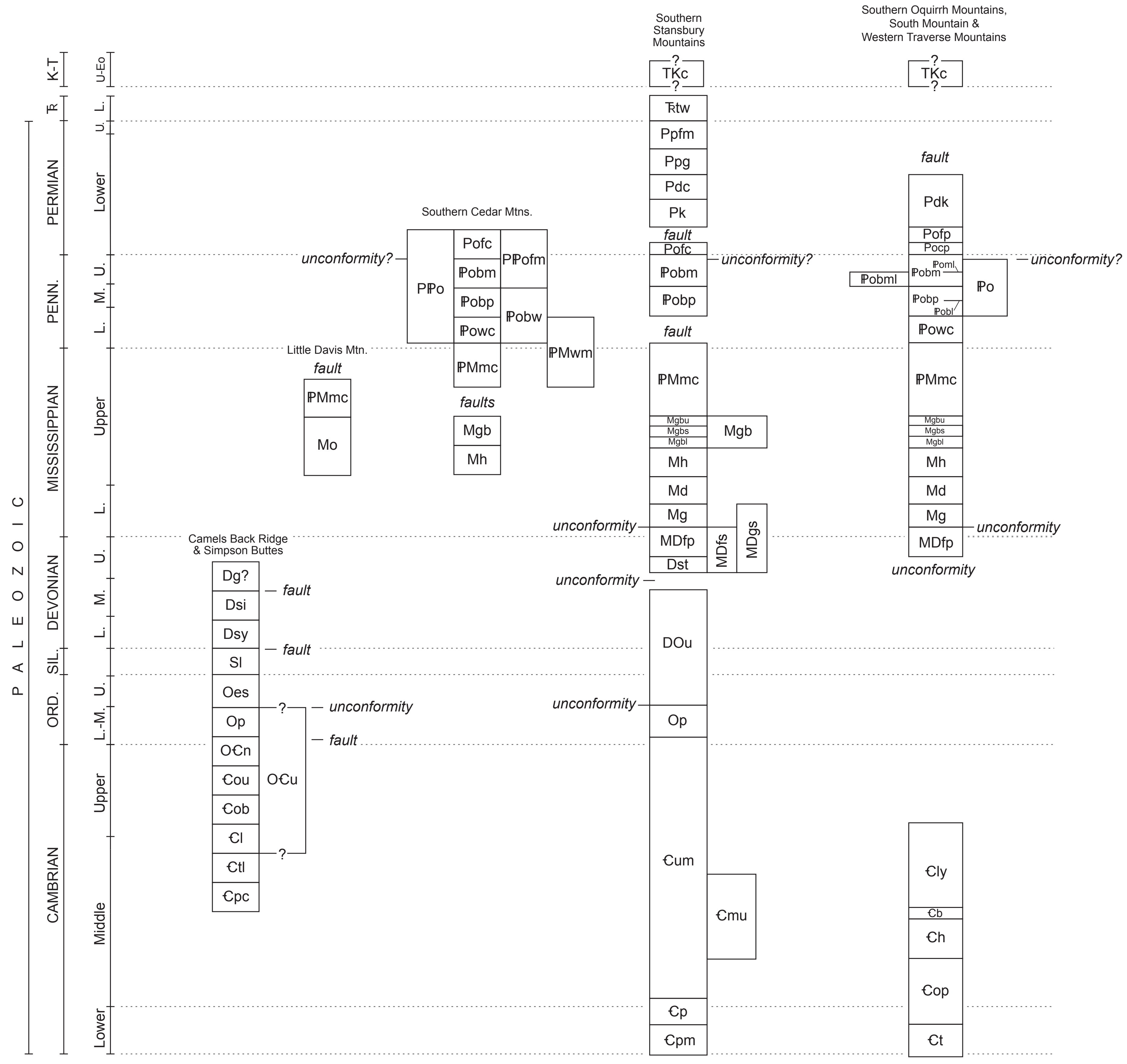
Rush Valley 30' x 60' Quadrangle (year 1)



+ New $^{40}Ar/^{39}Ar$ age
* $^{40}Ar/^{39}Ar$ age
# K-Ar age

CORRELATION OF MESOZOIC AND PALEOZOIC GEOLOGIC UNITS

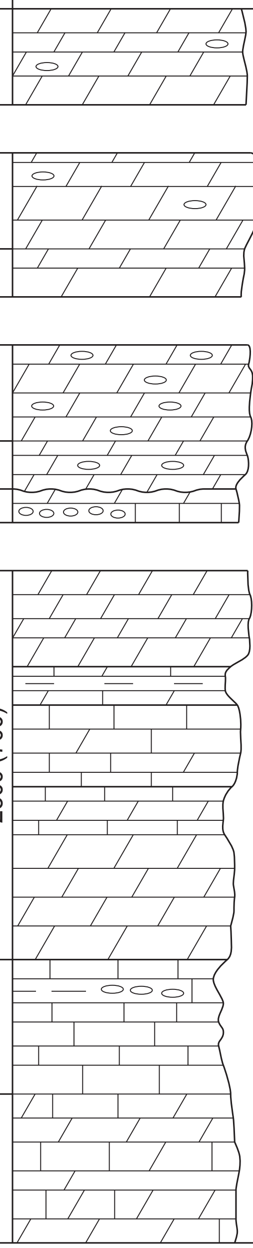
Rush Valley 30' x 60' Quadrangle (year 1)



LITHOLOGIC COLUMN

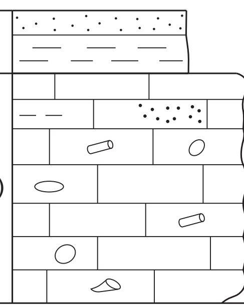
Camels Back Ridge and Simpson Buttes

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



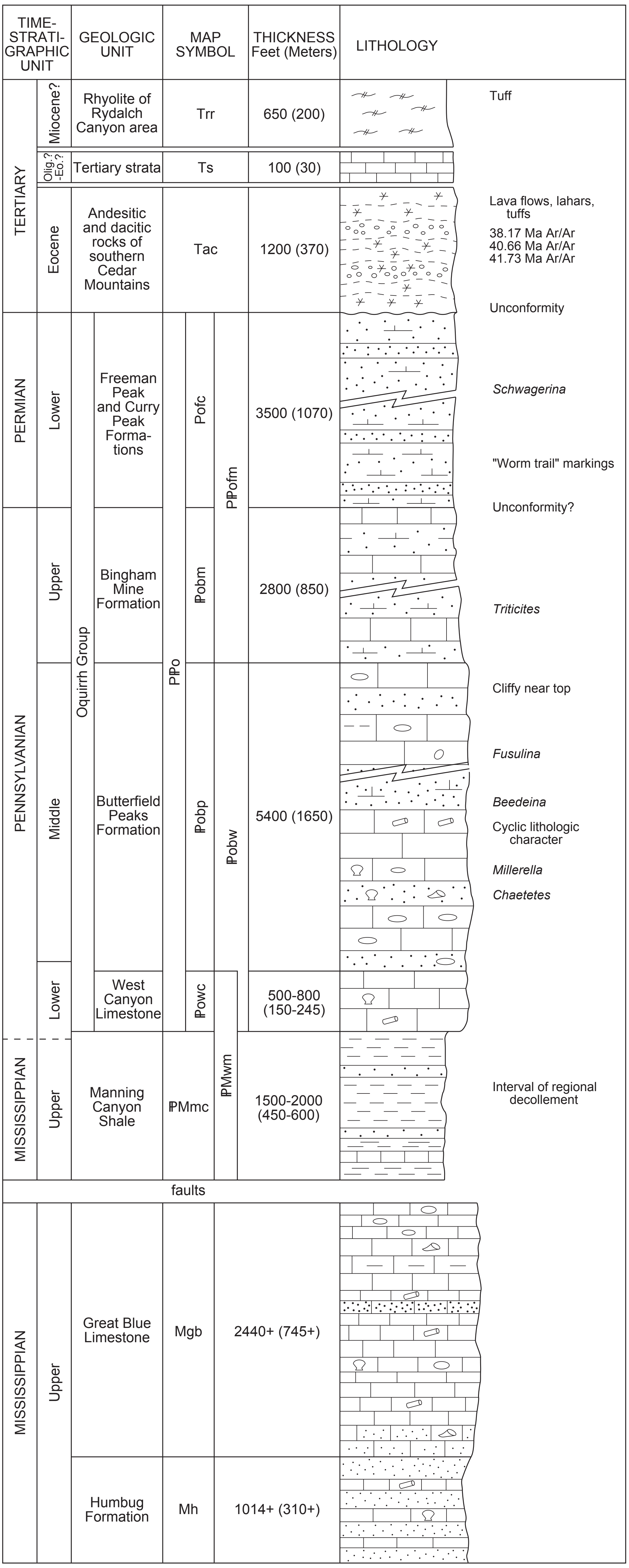
LITHOLOGIC COLUMN

Little Davis Mountain

TIME-STRATIGRAPHIC UNIT		GEOLOGIC UNIT	MAP SYMBOL	THICKNESS Feet (Meters)	LITHOLOGY
Onaqui fault					
MISSISSIPPIAN	Upper	Manning Canyon Shale	₱Mmc	200+ (60+)	
		Ochre Mountain Limestone	Mo	1200+(370+)	

LITHOLOGIC COLUMN

Southern Cedar Mountains



Intrusive units Tdi, Taci

Plate 1
Utah Geological Survey Open-File Report 555
Progress Report Geologic Map of the Rush Valley 30' x 60' quadrangle,
Tooele, Utah, and Salt Lake Counties, Utah (year 1 of 3)

UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources

SCALE 1:62 500

Progress Report Geologic Map of the Rush Valley 30' x 60' Quadrangle, Tooele, Utah, and Salt Lake Counties, Utah (Year 1 of 3)

2009

by

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APPROXIMATE MEAN DECLINATION, 2009

QUADRANGLE LOCATION

Disclaimer
This open-file release is a progress report that provides the public with the results of the first year of mapping of a three-year project. The map is incomplete and inconsistencies, errors, and omissions have not been resolved. The map may not conform to UGS policy and editorial standards and it may be premature for an individual or group to take actions based on its contents.

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Base from USGS Rush Valley 30'x60' Quadrangle (1979)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1886

Shaded relief generated from 10 meter NED (National Elevation Dataset)

Mapping by authors 2008-2009

Digital Cartography: Kent Brown, Basia Matyjasik, Jim Parker, Rich Emerson, Donald Clark, Stefan Kirby

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