PROGRESS REPORT GEOLOGIC MAP OF THE GROUSE CREEK 30' x 60' QUADRANGLE AND UTAH PART OF THE JACKPOT 30' x 60' QUADRANGLE, BOX ELDER COUNTY, UTAH, AND CASSIA COUNTY, IDAHO (Year 3 of 4)

by

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GEOLOGIC UNIT DESCRIPTIONS

QUATERNARY-TERTIARY SURFICIAL DEPOSITS

Alluvial deposits

Qay **Younger alluvium** (Holocene) – Mud, sand, and gravel in fluvial channels and valley bottoms; younger than Lake Bonneville; locally includes younger alluvial-fan deposits, and some colluvium not readily mappable at this scale; locally includes Mazama ash (6730 $\pm$ 70 ^{14}C yr B.P.) (Hallett and others, 1997); thickness is variable, generally less than 65 feet (20 m).

Qam **Alluvial mud** (Holocene) – Mud and sandy mud accumulations mostly behind lacustrine gravel barriers of Lake Bonneville; may include some thin lacustrine deposits at base; thickness is variable, generally less than 30 feet (10 m).

Qao **Older alluvium** (Holocene to Pleistocene) – Several alluvial deposits that are variable in grain size; includes alluvial-fan deposits of several levels and ages and older alluvium in terrace fills; may include small areas of Qay and QTag that are not readily mappable at 1:62,500 scale; locally, Qao may be difficult to distinguish from QTag and there is no age control; thickness is highly variable from 0 to hundreds of feet/meters.

QTag **Alluvial gravel** (Pleistocene to Pliocene?) – Primarily gravel, locally with sand and silt, in high-level alluvial deposits that cap erosional surfaces cut into older rocks (commonly unit Ts); generally poorly sorted; mapped in several drainage basins in the Goose Creek Mountains; may include small areas of Qay and/or Qao that are not mappable at 1:62,500 scale; forms several levels of varying ages, limited age control; thickness from 0 to about 30 feet (10 m).

Eolian Deposits

Qe **Eolian deposits, undivided** (Holocene) – Windblown silt and sand in dunes and sheets; most deposits are relatively small and patchy; largely derived from nearby lacustrine deposits in east part of map area; thickness is less than 15 feet (5 m).

Lacustrine Deposits

Qlk **Lacustrine carbonate-chip gravel, Great Salt Lake** (Holocene) – Lacustrine sand and gravel composed of calcium-carbonate clasts, including ooids, pellets, and rounded, irregularly shaped flakes, plates, and chips of carbonate; these clasts were formed on the floor of Great Salt Lake at times when the mud flats (Qpm) were submerged, or were precipitated from pore waters in the mud, and were later reworked by waves into barrier beaches and spits; excellent examples of such barrier beaches and spits, which formed during the high-water episodes in the mid-1980s, are present in the V-shaped exposure near the SE

corner of the map (Crocodile Mountain SE quadrangle); thickness is generally less than 10 feet (3 m).

Qlg **Lacustrine gravel, Lake Bonneville** (upper Pleistocene) – Gravel and sand in depositional lacustrine landforms, such as barrier beaches, spits, V-shaped barriers, or on piedmont slopes; locally thin unmapped gravel mantles bedrock units below the highstand of Lake Bonneville; thickness is variable, generally less than 100 feet (30 m).

Qls **Lacustrine sand, Lake Bonneville** (upper Pleistocene) – Siliciclastic sand at the Provo shoreline along Dove Creek and at the north end of Great Salt Lake; carbonate-coated sand on the Hogup Bar quadrangle offshore from the Stansbury shorezone; thickness is variable, generally less than 100 feet (30 m).

Glacial Deposits

Qgt **Glacial till** (upper to middle? Pleistocene) – Glacial till of poorly sorted gravel, sand, and mud in hummocky, eroded moraines on the floors of some glaciated valleys in the Raft River Mountains; includes some minor mixed glacial deposits that are not discernable at map scale; probably of Angel Lake age (~11 to 24 ka) (Osborn and Bevis, 2001), but no age control; thickness is variable, generally less than 100 feet (30 m).

Mass-Movement Deposits

Qms **Landslide deposits** (Holocene to middle Pleistocene) – Landslides and slumps in bedrock and surficial deposits typically developed on steeper slopes throughout the map area; locally includes deposits with bedrock blocks (bedrock map unit in parentheses); locally includes thicker accumulations of colluvium and talus (Qmct) that are difficult to depict separately at this map scale; in some cases, nivation hollow headwalls may coincide with landslide scarps; thickness is highly variable.

Qmct **Colluvium and talus** (Holocene to upper Pleistocene) – Mass-wasting deposits of clay to boulder-size debris that have moved down slope covering bedrock; deposits locally mapped where thicker and where they obscure complicated bedrock geology in the Goose Creek Mountains, but present in most of map area; thickness less than 30 feet (10 m).

Mixed-environment Deposits

Qpm **Playa mud** (Holocene) – Mud deposits (intermittently exposed) composing the bed of Great Salt Lake and some adjacent areas deposited through a mix of lacustrine and alluvial processes; we indicate the highstand shoreline of Great Salt Lake on the geologic map as the historical high water elevation (from 1873, 1986, and 1987) of 4212 feet (1284 m), and also the historical average altitude of 4200 feet (1280 m), both are shown on the 1991 U.S. Geological Survey 7.5' topographic maps; an additional shoreline of 4205 feet (1282 m) from September 1984 is also depicted on the U.S. Geological Survey topographic basemap; thickness is variable, generally less than 15 feet (5 m).

Qla **Lacustrine and alluvial deposits, undivided** (Holocene to upper Pleistocene) – Gravel, sand, and mud deposited in Lake Bonneville settings and in post-Lake Bonneville alluvial fans and streams; deposits are intermixed such that they are difficult to distinguish separately at map scale; grain size is variable; locally includes small areas of unmapped alluvial-fan, alluvial, colluvial, and eolian deposits; thickness is variable, generally less than 20 feet (6 m).

Qlag **Lacustrine and alluvial coarse-grained deposits** (Holocene to upper Pleistocene) – Generally coarse-grained mixed lacustrine and fluvial deposits of sand and gravel; locally includes finer grained deposits in small areas that are difficult to distinguish at map scale; thickness is generally less than 20 feet (6 m).

Qlaf **Lacustrine and alluvial fine-grained deposits** (Holocene to upper Pleistocene) – Generally fine-grained mixed lacustrine and fluvial deposits of clay, silt and sand; locally includes coarser grained alluvium and sandy eolian deposits in small areas that are difficult to distinguish at map scale; thickness is generally less than 20 feet (6 m).

Stacked-Unit Deposits

We map 13 stacked-unit deposits consisting of a discontinuous veneer of the first unit (surficial deposits) overlying the second unit (basin fill or bedrock). Several of these units are mapped in the southeastern portion of the map area where large expanses of basin fill and bedrock are covered by surficial deposits of Lake Bonneville and post-Bonneville deposits (mostly unit Qla). Although most bedrock in the quadrangle is partly covered by colluvium or other surficial deposits, we use stacked units to indicate those areas where bedrock is mostly obscured by thin or discontinuous surficial deposits that are derived from more than just residual weathering of underlying bedrock.

Qla/unit (Qla/rx, Qla/Tby, Qla/Ts, Qla/Tepg, Qla/Ttc, Qla/Pm, Qla/Ptbt, Qla/Psd, Qla/PIPo, Qla/Poi, Qla/IPos)
Lacustrine and alluvial deposits, undivided over unit (Holocene to upper Pleistocene over Tertiary through Pennsylvanian) – Gravel, sand and mud overlying various basin fill and bedrock units; thickness of upper unit less than 30 feet (10 m).

Qlaf/Ttc
Lacustrine and alluvial fine-grained deposits over rhyolitic tuff and conglomerate (Holocene to upper Pleistocene over Eocene) – Silt, clay and sand overlying bedrock unit; thickness of upper unit is less than 30 feet (10 m).

Qlg/Poi
Lacustrine gravel, Lake Bonneville over Oquirrh Group, interbedded sandstone and limestone unit (upper Pleistocene over Lower Permian) – Gravel and sand overlying bedrock unit; thickness of upper unit is less than 30 feet (10 m).

QUATERNARY VOLCANIC ROCK UNITS

Qb **Basalt** (Pleistocene) – Gray to dark gray, weathering to dark brown, dense to very vesicular, fine-grained basalt typically lacking noticeable phenocrysts; exposed along both sides of a low-relief fault scarp north of the Wildcat Hills; a sample analyzed by Felger and others (in preparation) just east of the map area yielded an $^{40}Ar/^{39}Ar$ groundmass age of 2.21 ± 0.02 Ma; thickness probably less than 100 feet (30 m).

Qrw **Rhyolite of the Wildcat Hills** (Pleistocene) – Gray and grayish pink to black, porphyritic, flow-foliated rhyolite lava flows and/or domes; contains up to 10% phenocrysts of quartz, sanidine, plagioclase, and biotite; prevalent lithophysae, perlite and spherulites; locally includes xenoliths of basalt, Salt Lake Formation rocks, and Paleozoic quartzite; vent area inferred to be the topographically highest part of the Wildcat Hills (Felger and others, in preparation); previously mapped and described by Howes (1972); K-Ar sanidine age of 2.1 ± 0.1 Ma (Miller and others, 1995) and $^{40}Ar/^{39}Ar$ sanidine age of 2.30 ± 0.01 Ma (Felger and others, in preparation); thickness is about 200 feet (60 m) (Felger and others, in preparation).

TERTIARY BASIN FILL AND VOLCANIC ROCK UNITS

Trd **Rhyodacite of the Wildcat Hills** (Pliocene) – Dark gray, flow-banded dacite to low-silica rhyolite lava flows with phenocrysts of plagioclase, pyroxene and quartz; large, sieve-textured plagioclase xenocrysts are most conspicuous macroscopic feature; calcite-filled fractures are prevalent, and near-vertical cooling joints are common; vitrophyre and orange and black flow-breccia are present locally; inferred to have erupted as thick flows from multiple vents; K-Ar plagioclase age of 4.4 ± 1.1 Ma (Miller and others, 1995); new U-Pb zircon data indicate the unit is about 2.9 Ma (Felger and others, in preparation); previously mapped and described by Howes (1972) and Shea (1985); greater than 200 feet (60 m) thick, and possibly greater than 500 feet (150 m) (Felger and others, in preparation).

Tby **Younger basaltic lava flows** (Pliocene and Miocene) – Gray, weathering to dark brown, fine-grained, dense to very vesicular basalt flows capping or interbedded with upper part of Salt Lake Formation (Ts) in east part of map area; contains small, sparse phenocrysts of olivine and plagioclase; includes small intrusions and scoriaceous material near vent areas; forms prominent mesas in the Black Butte and Kelton areas; columnar joints and xenoliths of Paleozoic and Tertiary sedimentary rocks are common in some flows; erupted from multiple vents; K-Ar whole-rock ages from eight flows range from 3.2 to 9.6 Ma; detailed studies of these flows were conducted by Voit (1985), Shea (1985), and Kerr (1987); up to 250 feet (75 m) thick.

Ts **Salt Lake Formation, undivided** (Miocene) – Tan, gray, pale-orange, pale-yellow, pale-green, and very light gray tuffaceous sandstone and siltstone, nontuffaceous siltstone and sandstone, shale, and tuff; locally contains thin beds of limestone, conglomerate, and lignite; locally contains pebbles to boulders of rhyolitic lava and basaltic rocks, and interbedded rhyolite ignimbrites and basaltic lava flows; contains tuff or ash beds (tephras) that Perkins (in preparation) correlates geochemically with a regional tephrochronology indicating a range

from about 6 to 16 Ma, but the base of the unit is not exposed in map area; K-Ar plagioclase age of 10.5 ± 0.8 Ma and zircon fission track age of 11.1 ± 1.7 Ma from the Dove Creek Hills area (Todd, 1983); locally, where thicker we map Tsc (conglomerate lithosome), Ta (avalanche breccia), and Tsl (limestone lithosome); these lithosomes are complexly interbedded at various intervals within unit Ts and are described below; Todd (1975?, 1983) previously mapped as interbedded fanglomerate, sandstone, and tuffaceous lacustrine rocks (her unit Ttf), Compton (1972, 1975) mapped as Tertiary sedimentary rocks, and Mytton and others (1990) mapped as Tuff of Ibex Peak and Beaverdam Formation; Ts unit thickness probably exceeds 10,000 feet (3000 m).

Salt Lake Formation locally divided into the following three units:

Tsc **Salt Lake Formation, conglomerate lithosome** (Miocene) – Sedimentary breccia and conglomerate, generally dark brown to dark gray, medium to thick bedded and unbedded; rock contains densely packed pebbles to cobbles that are commonly calcite cemented; clasts range from well-rounded to angular; thickness is highly variable.

Ta **Salt Lake Formation, avalanche breccia** (Miocene) – Sedimentary breccia that contains blocks to sheets of highly fractured Permian rocks interpreted as avalanche breccia; also cherty debris from Murdock Mountain Formation that is thick bedded to unbedded, clast-supported; locally mapped as Ta, and commonly distinguished on map by adding appropriate bedrock unit symbols in parentheses, for example, Ta(Pm) is Murdock Mountain Formation breccia, and Ta(Pgr) is Grandeur Formation breccia; mapped in Goose Creek Mountains, Grouse Creek Mountains, and Dove Creek Hills area; thickness is highly variable.

Tsl **Salt Lake Formation, limestone lithosome** (Miocene) – Thin to very thin bedded, white and pale tan limestone, calcareous shale, and calcareous siltstone; some beds contain abundant gastropods and ostracodes, typically opalized or silicified; in Goose Creek Mountains, present within lower part of Ts section; variable in thickness.

Tmo **Minette of Onemile Creek** (Miocene?) – Dark, irregular lamprophyre (minette) dike that is fine grained with abundant biotite grains; cuts the schist member of the Elba Quartzite on the northwest flank of the Raft River Mountains, 1.5 miles (2.5 km) south of the Onemile Guard Station; possibly Miocene in age based on fresh and euhedral biotite (indicating post-metamorphic) (Compton, 1975), but no direct age data; as much as 3 feet (1 m) thick (Compton, 1975).

Tdh **Dacite of Holt Creek** (Miocene?) – Gray, glassy dacite with phenocrysts of andesine, ferropigeonite, and ferroaugite in lava flows and possibly a small intrusion (dome?) east of Standrod; unit mainly lies on Oquirrh Group and Ordovician rocks, but also on poorly exposed unit Ts; no age data from the map area, but Compton (1975) speculated may be about 9 Ma; as much as 240 feet (75 m) thick (Compton, 1975).

Trb **Rhyolitic welded tuffs of Goose Creek basin** (Miocene) – Multiple densely welded, rhyolite ash-flow tuff sheets that are interbedded within the Salt Lake Formation (Ts);

cooling units are locally well zoned (descending) (1) thin, gray to black vitrophyre, (2) a vapor-phase zone of gray to light-brown vesicular, ledge-forming platy tuff, commonly containing conspicuous flowage folds, (3) brown, reddish-brown, red, and purple, massive to platy, densely welded, devitrified tuff forming columar-jointed cliffs and ledges, (4) gray to black vitrophyre, and (5) gray, bedded surge deposits (Mytton and others, 1990); likely erupted from the Twin Falls and Bruneau-Jarbidge? eruptive centers in the Snake River Plain (see Pierce and Morgan, 1992; Perkins and Nash, 1995; Bonnichsen and others, 2008; Ellis and others, 2011); includes tuff of McMullen Creek and tuff of Steer Basin of Mytton and others (1990) northwest of Goose Creek in map area; tephra correlations (map area) and radiometric ages (Cassia Mountains) indicate the ignimbrites are from ~8.6 to 10.6 Ma (Perkins, in preparation; Nash and others, 2006; Ellis, 2009); also see prior studies by Perkins and others (1995) and Ellis and others (2010, 2011); individual ignimbrites are up to 40 feet (12 m) thick.

Tdi **Diabase of Indian Creek** (Miocene) – Coarse diabase that lies near the Raft River detachment fault high in the Raft River Mountains at the head of the South Fork of Indian Creek; simple ophitic texture and largely unaltered pyroxene and plagioclase (Compton, 1975); lack of crystal-plastic deformation and epidote- and chlorite-filled fractures suggests emplacement late in the protracted history of the Raft River detachment fault; $^{40}Ar/^{39}Ar$ plagioclase age of 9.93 $\pm$ 0.13 Ma (Wells and others, 2000); thickness less than 3 feet (1 m) (Compton, 1975).

Trl **Rhyolitic welded tuff of Lynn Creek** (Miocene?) – Brown-weathering, black vitrophyre and gray spherulitic welded tuff; contains small phenocrysts (~5%) of plagioclase and clinopyroxene; occurs as remnants of a welded tuff sheet (probably Snake River Plain sourced) best exposed at the west end of the Upper Narrows, Dove Creek Mountains; no direct age data from map area, but directly overlies tephra with a correlation age of 11.96 Ma (Perkins, in preparation); Compton (1972) called welded dacite tuff; about 40 feet (12 m) exposed thickness (Compton, 1972).

Tr **Rhyolites of Grouse Creek Valley** (Miocene) – Gray to purple, brown weathering, porphyritic, high-silica rhyolite flows, domes and intrusions interbedded with the Salt Lake Formation (Ts); typically contains abundant phenocrysts of smokey or pink quartz and feldspar; sparse biotite and hornblende present in some flows; strongly flow-foliated with black vitrophyre and/or pumiceous breccia locally present along flow margins; highly-altered, complexly-related, flows and intrusions with a K-Ar sanidine age of 11.7 ± 0.4 Ma are exposed on the southwest flank of the Grouse Creek Mountains (Compton, 1983); domes exposed in the Etna area (Smith, 1980) display thick flow-margin vitrophyre with well-developed columnar jointing, and have K-Ar ages of about 12.2 Ma (Evans and Brown, 1981); flows, domes and intrusions on west side of Grouse Creek Valley, which are inferred to have erupted from a structurally-controlled linear vent system (Hare, 1982; Olesen, 1984; Scarbrough, 1984), are capped by a distinct phenocryst-poor flow, and are pending $^{40}Ar/^{39}Ar$ analysis; exposed thickness up to 1000 feet (300 m).

Td **Dacites of Grouse Creek Valley** (Miocene) – Includes multiple dacitic to low-silica rhyolitic units from eruptive centers around Toms Cabin Creek, Chokecherry Spring, Burnt

Mountain, and Meadow Creek Butte; distinguished from unit Tr by presence of hornblende phenocrysts and/or lack of significant quartz; includes lava flows, domes, dikes, and plugs that locally cut Salt Lake Formation (Ts), and overlie unit Tr; K-Ar analyses of two flows include a hornblende age of 12.4 ± 0.4 Ma and biotite age of 13.2 ± 0.5 Ma (Scarbrough, 1984), but the biotite age is likely too old based on stratigraphic relationships and tephra correlation data; additional ages pending; previous studies by Hare (1982), Olesen (1984), Scarbrough (1984), Fiesinger (written communication to T.J. Felger, July 2, 2010), and Compton (written communication to D.M. Miller, 1991); from 0 to 800 feet (245 m) exposed thickness.

Trt **Rhyolites of Twin Peaks** (Miocene) – Unit includes a series of five or more rhyolite porphyry ignimbrites west of Twin Peaks, and intrusive rhyolite porphyries at Twin Peaks (stock) and Vipont mine area (sills, dikes and pipes); radiometric ages from 12.9 to 13.1 Ma, and additional ages pending; ignimbrites are interlayered within the Salt Lake Formation (unit Ts) between Hardesty and Birch Creeks, and may have vented from Twin Peaks and/or the Snake River Plain; locally, small exposures of volcanic debris flows in Birch and Hardesty Creeks; from 0 to about 600 feet (180 m) thick.

Trg **Rhyolite of Granite Creek** (Miocene) – Pale red and brown porphyritic rhyolite lava flow with abundant phenocrysts of quartz and feldspar and small, sparse mafic minerals; feldspar phenocrysts up to 1 inch (2.5 cm) in diameter present locally; weathered outcrop surfaces have a granitic look due to the abundance and coarse size of phenocrysts; flow-foliation is common, but typically obscured by closely-spaced orthogonal joints; occurs as relict patches on Permian bedrock in the Morse Canyon and Beatty Mountain areas; K-Ar determinations on samples west of map area of about 13 Ma, and informal name follows Compton (written communication to D.M. Miller, 1991); new age pending; exposed thickness approximately 200 feet (60 m).

Tbi **Intermediate-age basaltic lava flows** (Miocene) – Gray, weathering to brown, fine-grained, altered basalt lava flows interbedded with the lower part of Salt Lake Formation (Ts); zeolites and amygdules present locally; poorly exposed in small outcrops in vicinity of Death Creek Reservoir, Dairy Valley Creek, Toms Cabin Creek, and Mud Basin, and in isolated outcrops in Matlin Basin, where age is not known; a flow southwest of Mud Basin has a K-Ar whole rock age of 14.4 ± 0.4 Ma (Compton, 1983), and a flow in Death Creek just west of map area has a K-Ar whole-rock age of 14.5 ± 0.9 Ma (Fiesinger, written communication to T.J. Felger, December 2009); additional age data for similar flows outside the map area include a K-Ar whole-rock age (averaged) of 16.3 ± 2 Ma by Armstrong and others (1976) from outcrops southwest of Death Creek Reservoir, and a K-Ar whole-rock age of 18.4 ± 0.5 Ma by McCarthy and Miller (2002) southwest of Matlin Basin near Terrace Mountain, suggesting unit may include some older flows; less than 100 feet (30 m) thick.

Trcg **Granite of Road Canyon** (Oligocene?) – Light grayish-brown schistose granite porphyry with relics of feldspar phenocrysts and variable proportions of biotite and muscovite; typically occurs in few exposures between units Zss and Zu in southern Dove Creek Mountains (Compton, 1972); age pending.

Trbg **Granite of Red Butte** (Oligocene) – Light gray, weathering to reddish-tan, medium-grained, equigranular monzogranite (formerly called adamellite by Compton and others, 1977 and Todd, 1980); monzogranite consists of plagioclase (calcic to intermediate oligoclase), pinkish-gray quartz, white subhedral K-feldspar, biotite, and scarce muscovite, with accessory minerals of monazite, allanite, apatite, zircon, and magnetite; unit is exposed primarily on the west side of the Grouse Creek Mountains in Red Butte, Little Red Butte, and Ingham Canyons, but a small exposure on the east flank, together with numerous aplite-alaskite dikes and metasomatic reactions in the surrounding unit Wgg, suggest that a larger pluton underlies the central Grouse Creek Mountains (Todd, 1973); Rb-Sr whole-rock isochron age is 24.9 $\pm$ 0.6 Ma (Compton and others, 1977), and SHRIMP U-Pb zircon age of 25.3 $\pm$ 0.5 Ma (Egger and others, 2003).

Tvg **Granite of Vipont** (Oligocene) – Granitoid intrusion(s) includes four undivided phases including (descending order by age) microdiorite, medium-grained equigranular biotite-garnet granite, two-mica garnet granite/pegmatite, and medium-grained, equigranular granodiorite; geochemical data obtained by Strickland (2010) and this study; Strickland (2010) obtained U-Pb zircon ages of 28.2 $\pm$ 0.3 Ma on the two-mica garnet granite (her garnet-muscovite) phase and 28.9 $\pm$ 0.2 Ma on the granodiorite (her biotite) phase; pluton has a minimum structural thickness of 1000 feet (300 m), with an additional 330-foot (100 m) roof zone in which sills intrude lit-par-lit into roof rocks, commonly units Op, Zmp, Zcb, and Zss; pluton is variably mylonitic throughout, with strain intensity highest in the roof zone.

Tepg **Granite, granodiorite, and diorite of Emigrant Pass** (Eocene) – Pluton crops out in three lobes; eastern lobe is mainly granite consisting of about equal parts of quartz, K-feldspar, and plagioclase, with accessory biotite; granodiorite occurs locally in the eastern lobe and makes up most of the western lobe; more mafic rocks, primarily quartz diorite, diorite, and monzonite, make up the southwestern lobe; garnet-bearing leucogranite forms thick dikes in the western lobe and a broad marginal zone along its west side; aplite and pegmatite dikes occur throughout the pluton; Tepg pluton has sharp intrusive contact; oriented fabrics are vague, but feldspar and quartz are deformed in many cases; Egger and others (2003) obtained SHRIMP U-Pb zircon ages of 34.3 $\pm$ 0.3 (east), 36.1 $\pm$ 0.2 (west), and 41.3 $\pm$ 0.3 Ma (southwest) indicating a three-stage intrusion.

Ttc **Rhyolitic tuff and conglomerate** (Eocene) – Rhyolitic ash-flow tuff with abundant crystals of quartz, sanidine, plagioclase, and biotite, and clasts of pumice in an altered matrix that is red, green, and white or gray; slightly to moderately welded with flattened pumice visible in some outcrops; soft-weathering, and poorly exposed in vicinity of Baker Hills and Peplin Mountain; previously studied by Voit (1985); eruptive center inferred to be in area between Peplin Mountain and Table Mountain based on complex relationship between tuff and outcrops that may represent a shallow intrusion; an associated boulder conglomerate apparently overlies the tuff, and is typically expressed as a lag of large boulders of chert and various plutonic rocks not seen in outcrop; $^{40}Ar/^{39}Ar$ sanidine age of 39.60 ± 0.05 Ma on tuff; unit also includes one isolated outcrop of lithologically similar tuff that crops out on unit TRd in the hanging wall of the Twin Peaks detachment fault, west of Rocky Pass, southwestern Grouse Creek Mountains, with prior K-Ar ages by Compton (1983) and new U-Pb SHRIMP zircon age of 36 Ma (A. Konstantinou, Stanford University, written

communication to D.M. Miller, June 7, 2012); exposed thickness approximately 150 feet (45 m).

Tbo **Older trachybasaltic lava flows** (Eocene?) – Gray to greenish gray and reddish gray, altered, and highly weathered trachybasaltic flows and flow breccia; contains up to 20% phenocrysts of iddingsite or altered pyroxene; poorly exposed in rubbly slopes near Ombey, southwest of Peplin Mountain; an Eocene age is inferred because the Eocene tuff and conglomerate (unit Ttc) overlies the trachybasalt and contains basaltic fragments (Voit, 1985); exposed thickness approximately 100 feet (30 m).

TRIASSIC TO ARCHEAN ROCK UNITS

Map unit exposures are incomplete and unit thicknesses highly variable due to structural deformation; some estimates are provided.

TRd **Dinwoody Formation** (Triassic) – Thin-bedded shale, siltstone, limestone, and sandstone; shale is green, siltstone is red to brown, limestone is chocolate brown to medium gray, and sandstone is red to brown; limestone and calcareous siltstone are typically fossiliferous with abundant mollusks and gastropods; forms gentle slopes in the Goose Creek Mountains, Grouse Creek Mountains, and Matlin Mountains; locally, unit includes small exposures of overlying Thaynes Formation that are difficult to map separately due to similar lithofacies and complicated structure; fossils indicate an Early Triassic age (Young, 1981; Compton and others, 1983; Todd, 1983); mapped as Thaynes Formation by Compton (1983) and Todd (1983) but diagnostic fossils are lacking; as mapped, may include some Thaynes Formation.

Pg **Park City Group, Gerster Formation** (Permian) – Interbedded yellowish-gray-weathering cherty limestone and dolomite, and black and gray chert, the latter in nodules and beds as much as 12 inches (30 cm) thick; limestone ranges from bioclastic and phosphatic, to sparsely sandy or argillaceous, and most limestone is silicified; dolomite is pure or cherty, with silicification concentrated in sandy areas; productid brachipods are diagnostic (Stifel, 1964: McCarthy and Miller, 2002); mapped in the Grouse Creek Mountains and Matlin Mountains; limestone beds in the Matlin Mountains locally contain lower Wordian (now considered Middle Permian) fossils (Todd, 1983).

Pm **Park City Group, Murdock Mountain Formation** (Permian) – Primarily black and pale gray chert, gray to brown sandstone, and pale gray limestone; upper part poorly exposed, consists of thinly interbedded chert, sandstone, limestone and siltstone, typically with one to three 16-foot thick (5 m) black chert ledges; lower part consists of cliff-forming, thin to medium-bedded black chert with siltstone, limestone, and dolomite partings; low in this section large nodules of limestone and dolomite are common; thin beds of cherty rocks are present throughout; lack of shale and presence of chert throughout the unit are diagnostic; occurs in the Goose Creek Mountains, Matlin Mountains, and Hogup Mountains, and queried in one exposure on west side of Grouse Creek Mountains; unit was previously mapped as Rex Chert Member of the Phosphoria Formation (Stifel, 1964; Young, 1981), and black chert unit and Plympton Formation (Todd, 1983); mollusks and brachipods in the Matlin

Mountains support what now is considered a Middle Permian age (Todd, 1975?; Todd, 1983); measured thickness in the Hogup Mountains to the south is 1157 feet (353 m) (Stifel, 1964).

Ppm **Phosphoria Formation, Meade Peak Tongue** (Permian) – Thinly bedded siltstone, shale, limestone, chert, and sandstone; much of the siltstone and sandstone is calcareous; colors range greatly, from black to medium gray and brown to tan, but black and dark gray phosphatic shale is diagnostic; forms slopes with rare outcrop in Goose Creek Mountains, but no exposure in the Matlin Mountains between units Pm and Pgr.

Pgr **Park City Group, Grandeur Formation** (Permian) – Light-colored tan to gray dolomite, medium bedded, with sandstone and chert beds; chert is dark gray to light gray; sandstone is brown to gray, forms thick beds; wisps of fine brown sand in dolomite are common, and define cross-laminae; gray limestone in places; sandstone more abundant in upper part; light-colored dolomite and light chert are diagnostic; forms cliffs and steep slopes in the Goose Creek Mountains and Matlin Mountains; Todd (1975?, 1983) previously mapped the unit as the Kaibab Limestone; exposures in the Matlin Mountains include *Timanodictya*(?) sp., an unusual ramose bryozoan of Early Permian age, and brachiopods from the lower part of the unit indicate an Early Permian (Leonardian) age (Todd, 1983).

Ptbt **Trapper Creek, Badger Gulch, Third Fork Formations, undivided** (Permian) – Combined unit of primarily calcareous sandstone and siltstone, and platy limestone present in the Goose Creek Mountains and Matlin Mountains; *Trapper Creek Formation* includes calcareous sandstone, thin to medium bedded, and siltstone, limestone; *Badger Gulch Formation* consists of laminated to thin-bedded, platy, dark-gray to black, silty limestone; less common laminae and thin beds of siltstone are browner than limestone; some beds bioclastic, typically containing crinoid fragments, *Spirifer* brachiopods, and fusulinids; *Third Fork Formation* includes gray and brown, slope-forming, calcareous, platy sandstone and arkose, and silty limestone. Combined unit corresponds to the interbedded limestone and sandstone unit (the "patterned sandstone or unit") of Todd (1975?, 1983) in the Matlin Mountains area; fusulinids from the Goose Creek Mountains are Leonardian (Young, 1981), and in the Matlin Mountains foraminifera and brachipods indicate an Early Permian (Leonardian and late Wolfcampian?) age (Todd, 1975?; Todd, 1983); difficult to determine thickness in the map area, type section in Cassia Mountains is 3004 feet (916 m) thick (Mytton and others, 1983).

Psd **Sandstone and dolomite** (Permian) – Informal unit that corresponds to the Loray? Formation and Diamond Creek Sandstone of Stifel (1964) in the Hogup Mountains; we do not consider Stifel's nomenclature appropriate for this interval; upper part is yellow to gray, fine-grained calcareous sandstone and silty, cherty limestone and dolomite that is poorly exposed; lower part is calcareous sandstone and orthoquartzite that is cross-bedded, siliceous and calcareous, with several arenaceous limestone beds near base; no age control for this unit; unit Psd may be laterally equivalent to unit Ptbt through a facies change or across a thrust fault; thickness is 6270 feet (1910 m) (Stifel, 1964).

PIPo **Oquirrh Group, undivided** (Permian and Pennsylvanian) – Combined unit in the Goose Creek Mountains, Dove Creek Mountains, Raft River Mountains, Matlin Mountains, and Baker Hills where the unit is structurally disturbed and there is little age control; includes (descending) gray to tan sandstone and calcareous sandstone, and quartzite; platy, tan-, maroon-, and gray-weathering, sandy to silty limestone and subordinate calcareous sandstone; dark-blue-gray fossiliferous limestone with sandy interbeds; all rocks show low-grade metamorphism; calcite and quartz grains recrystallized and fine-grained white mica present; locally includes small exposures of unit IPMdc at base due to map scale constraints; combined unit thickness is up to 3000 feet (900 m) in the map area (Compton and others, 1983), and the Oquirrh is approximately 13,100 feet [4000 m] thick just south in the Bovine Mountains (Jordan, 1983).

Oquirrh Group, locally divided into three informal units after Jordan (1979, 1983):

We extend Jordan's subdivisions in the Bovine and Grouse Creek Mountains eastward to the Hogup Mountains and Wildcat Hills based on similar lithofacies and ages.

Poi **Oquirrh Group, interbedded sandstone and limestone unit** (Permian) – The upper formational unit of the Oquirrh Group consists of a variety of interbedded rocks, all of them thinly bedded; upper part mainly thinly bedded silty to sandy limestone, with bioclastic detritus, quartzite, and conglomerate; lower part chiefly calcareous sandstone interbedded with siltstone and clayey siltstone; fossils are common; Early Permian (Wolfcampian) age from fossils (Stifel, 1964; Jordan, 1979; Felger and others, in preparation).

IPos **Oquirrh Group, sandstone unit** (Pennsylvanian) – Primarily medium- to dark-gray sandstone with less prominent sandy to silty limestone, siltstone, and thinly bedded sandstone, orthoquartzite, and conglomerate; sandstone is feldspathic, cemented strongly by carbonate, and crops out boldly in pale- and dark-brown ledges; interbedded with fossiliferous sandy to silty limestone and calcareous siltstone; Late Pennsylvanian (Virgilian and Missourian) age from fossils (Stifel, 1964; Jordan, 1979).

IPol **Oquirrh Group, limestone unit** (Pennsylvanian) – Limestone with thin interbeds of sandstone, sandy and silty limestone, and calcareous siltstone; conglomerate with chert, limestone, and sandstone clasts occurs locally; thicker beds tend to be highly fossiliferous, with large silicified bryozoans, as well as crinoid and brachiopod fragments; some beds contain chert nodules; Middle to Early Pennsylvanian age (Jordan, 1979; Wells, 2009; this study).

IPMx **Marble tectonite** (Pennsylvanian and Mississippian) – Tectonite of probable lower Oquirrh Group rocks and thin unit IPMdc at base; light-gray to tan, and dark blue-gray calcitic and dolomitic marble that is highly deformed and banded, fossiliferous; contains abundant crinoids, minor brachiopods, lenses of siltstone and chert; near base, thin phyllite, schist and quartzite likely represents unit IPMdc; commonly crops out within the cores of recumbent synclines; a major low-angle fault (Emigrant Spring fault) separates unit IPMx from

Ordovician units; present in Goose Creek Mountains, Grouse Creek Mountains, and Raft River Mountains; thickness is up to 130 feet (40 m) (Wells, 2009).

IPMdc

Diamond Peak Formation and Chainman Shale, undivided (metamorphosed) (Pennsylvanian and Mississippian) – Dark-gray to black phyllite and fine-grained semi-schist, gray carbonaceous sandstone, gray pebble and cobble conglomerate, and gray marble; conglomerate is clast supported with clasts of quartzite, siltstone, black shale, and chert; metamorphosed to lower greenschist facies; crops out in Goose Creek Mountains eastward through Raft River Mountains; unit is nowhere complete, with faulted upper and lower contacts in many places; maximum exposed thickness is about 750 feet (230 m) (Compton, 1972, 1975; Compton and others, 1983).

Dg **Guilmette Formation (metamorphosed)** (Devonian) – Pale- to medium-gray marble with subordinate dolomite; marble is commonly banded parallel to thick beds that locally contain poorly preserved fossils, including crinoid fragments; quartz sand is abundant in some beds, as are thin siliceous sheets that weather out as brown ribs; white intricately curving spaghetti-like forms (trace fossil *Amphipora*) are fairly common and serve to distinguish the formation from otherwise similar limestone of the lower Oquirrh unit; exposed in southern Grouse Creek Mountains; thickness as much as 650 feet (200 m) (Compton and others, 1983).

Dsi **Simonson Dolomite (metamorphosed)** (Devonian) – Pale-gray and pale-yellowish brown metadolomite interbedded with pale-gray marble (locally with chert nodules); some beds with rounded grains of quartz; exposed in southern Grouse Creek Mountains; thickness as much as 330 feet (100 m) (Compton and others, 1983).

OZu **Ordovician-Neoproterozoic rocks, undivided** (Ordovician to Neoproterozoic) – Quartzite, schist, and marble; combined unit in a few exposures of Goose Creek Mountains where mapping is ongoing, or units are tectonically thinned.

Oee **Ely Springs Dolomite and Eureka Quartzite, undivided** (Ordovician) – Combined unit in small exposures due to map scale constraints.

Oes **Ely Springs Dolomite (metamorphosed)** (Ordovician) – Dark-gray to silver-gray dolomite that is finely crystalline, and locally shows thin bedding; dolomite is characterized by medium- and dark-gray laminae 1-3 mm thick, commonly fossiliferous, and locally contains dark chert nodules; thicker exposures are overlain by and mixed with some massive pale tan dolomite, commonly brecciated; the only recognizable fossils are scarce relics of crinoid fragments; occurs in Goose Creek Mountains eastward through Grouse Creek Mountains; locally, may include small exposures of overlying Laketown Dolomite; Ely Springs previously referred to as Fish Haven; as much as 600 feet (180 m) thick in the Black Hills, Raft River Mountains (Compton, 1972, 1975; Compton and Todd, 1983).

Oe **Eureka Quartzite (metamorphosed)** (Ordovician) – White to pale-gray quartzite locally interlayered with medium-gray dolomite; quartzite is partly brecciated, but elsewhere shows distinct tabular thin beds containing sparse, disseminated white mica; as mapped by

Compton, may locally include part of upper Pogonip Group rocks; present in Goose Creek through Raft River Mountains; marked variations in thickness due to structure, as much as 250 to 400 feet (80-120 m) thick (Compton, 1972, 1975; Compton and others, 1983).

Op **Pogonip Group (metamorphosed)** (Ordovician) – Gray and pale-brown marble, typically strongly banded and crystalline, with metamorphic mica, tremolite, and other silicates, interlayered with mica-quartz-calcite schist and dolomite marble; primarily Pogonip Group, but unit likely includes some thin overlying Ordovician rocks (quartzite and phyllitic metashale); much of the unit is tectonically deformed and has low-angle faults as upper and lower contacts; occurs in Goose Creek Mountains eastward to Raft River Mountains; conodonts from upper Pogonip Group yielded Early Ordovician ages (Wells, 2009); approximate maximum thickness is 500 feet (150 m) (Compton, 1972, 1975; Compton and others, 1983; Wells, 2009).

Zmc **Schist of Mahogany Peaks and Quartzite of Clarks Basin, undivided** (Neoproterozoic) – Locally mapped as combined unit due to map scale constraints.

Zmp **Schist of Mahogany Peaks** (Neoproterozoic) – Dark-brown schist that is biotitic and locally graphitic; in places contains porphyroblasts of garnet and staurolite or chlorite, muscovite, scarce biotite, and pink garnet; may be interlayered with quartzite, especially near its lower contact; exposed in Dove Creek Mountains, Raft River Mountains, and Warm Spring Hills area; Neoproterozoic age assignment here from detrital zircon studies (Link and Johnston, 2008); up to 300 feet (90 m) thick (Compton, 1972, 1975; Compton and others, 1983).

Zcb **Quartzite of Clarks Basin** (Neoproterozoic) – Gray to white quartzite that weathers light gray to greenish gray, in flaggy layers separated by partings of white mica (and locally kyanite and chloritoid) schist; contains minor K-feldspar and plagioclase grains; upper part locally is white, flaggy quartzite with scattered pink garnets, while lower part is medium gray and thicker bedded; occurs in Goose Creek Mountains eastward to Raft River Mountains; extensively quarried for decorative stone; thickness as much as 400 feet (120 m) (Compton, 1972, 1975; Compton and others, 1983).

Zss **Schist of Stevens Spring** (Neoproterozoic) – Gray schist composed mainly of fine-grained white mica and quartz; less common chlorite and graphite form disc-shaped lenses, characteristic of the unit; locally contains reddish-brown garnet, as grains up to 1 inch (2 cm) in diameter, and veins of white quartz; local intercalations of tan- to orange-weathering feldspathic schist (meta-tuff?) and feldspar-biotite-muscovite-quartz rocks (meta-rhyolite porphyry?); lenses of fine-grained hornblende schist or hornblende-plagioclase rocks may occur near the base of the unit; present from the Goose Creek Mountains eastward to the Raft River Mountains; thickness from about 165 to 600 feet (50-180 m) (Compton, 1972, 1975; Compton and others, 1983).

Zy **Quartzite of Yost** (Neoproterozoic) – White quartzite that is sparsely to moderately muscovitic, and in beds 1 foot (0.3 m) thick or less; strikingly green quartzite, colored by chromian mica, occurs in the Upper Narrows area, and pale-greenish-gray variants are found elsewhere in the Dove Creek Mountains and western Raft River Mountains; locally

magnetite-rich quartzite and hematitic schist form thin layers in the Buck Hollow quadrangle; some of the thicker beds along Johnson Creek, western Raft River Mountains, contain small quartz pebbles and coarse grains of K-feldspar; beds in the Clarks Basin area contain as much as 10 percent K-feldspar; up to 400 feet (120 m) thick (Compton, 1972).

Zu **Schist of Upper Narrows** (Neoproterozoic) – Dark-brown and gray, biotitic, feldspathic and quartzose schist and gneiss; commonly contains stringers of quartz or quartz-feldspar about 1 inch (2.5 cm) thick and a few feet long that appear to be metamorphic segregations; includes thin phyllitic layers in upper part, and locally garnet porphyroblasts and thin quartzite layers; small bodies of amphibolite crop out in Upper Narrows (Dove Creek Mountains and Cedar Hills); thickness up to 1500 feet (460 m), thickest near the Upper Narrows (Compton, 1972, 1975).

Zus **Schist of Upper Narrows, muscovite-quartz schist member** (Neoproterozoic) – An extensive lens of muscovite-quartz schist with phyllite, muscovite-feldspar schist, and chloritic schist; lies within upper part of unit Zu in the Dove Creek Mountains; 500 feet (150m) thick (Compton, 1972).

Ze **Elba Quartzite** (Neoproterozoic) – Pale-gray, brown, and green, quartzite, feldspathic quartzite, muscovite quartzite, and muscovite schist; locally conglomeratic near base, brown weathering and distinctly laminated where dolomitic; present from the Goose Creek Mountains eastward to the Raft River Mountains; locally quarried for decorative stone; thickness from 0 to 1500 feet (460 m) (Compton, 1972, 1975; Compton and others, 1983; Wells, 2009).

Zes **Elba Quartzite, schist member** (Neoproterozoic) – Dark-brown to dark-gray, quartz-mica-feldspar schist and foliated cataclasite present within unit Ze in the Raft River Mountains; as thick as 600 feet (180 m) (Compton, 1975; Wells, 2009).

Green Creek Complex of Armstrong (1968), divided into five units:

Wgg **Granite and granite gneiss** (Archean) – Light-gray, weathering to tan, gneissic to massive, medium- to coarse-grained, granular to porphyritic, biotite and biotite-muscovite monzogranite; K-feldspar megacrysts as much as 2 inches (5 cm) long are present locally; less metamorphosed to east; foliation increases upward; intrudes older schist (Wgs); in Grouse Creek Mountains contains common rafts of semipelitic schist and amphibolite (unit Wgms), as well as isoclinally folded bodies of gneissic trondhjemite (unmapped); locally converted to mylonite gneiss; uppermost 7 to 10 feet (2-3 m) consists of mica-quartz-albite schist that may represent weathering profile; termed adamellite by Compton (1972, 1975), Compton and others (1977), Todd (1980); U-Pb zircon ages by Strickland and others (2011) and Isakson (2012) average 2.574 Ga.

Wgt **Metamorphosed trondhjemite and pegmatite** (Archean) – White, gneissose to pegmatitic rocks composed of quartz and sodic plagioclase; sparse biotite is altered to foliated aggregates of chlorite and white mica, and the resulting pale gneiss is laced by pegmatite, which locally contains K-feldspar; locally pegmatite is dominant and is deformed and altered

(Compton, 1975); exposed in and near Clear Creek area of eastern Raft River Mountains; we are evaluating the new data from Isakson (2012) suggesting a Cretaceous age for this unit.

Wgms **Metamorphosed mafic igneous rocks and older schist** (Archean) – Combined unit of schist and amphibolite in a few exposures within unit Wgg east of the Red Butte pluton, Grouse Creek Mountains; originally described by Compton and others (1983), and later studied by Dudash (2001).

Wgm **Metamorphosed mafic igneous rocks** (Archean) – Dark-green to dark-gray to black, medium-grained gneissic amphibolite, hornblende schist, and hornblende metagabbro; present in eastern Raft River Mountains; intrudes older schist (Wgs), but no other age data; thickness variable (Wells, 2009).

Wgs **Older schist** (Archean) – Fine-grained, mica-feldspar-quartz schist and schistose phyllite in the eastern Raft River Mountains; U-Pb zircon age from Clear Creek area of ~2.650 Ga (Isakson, 2012); up to 1000 feet (300 m) thick on northeast flank of Raft River Mountains (Compton, 1975).

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REFERENCES

* Denotes source of geologic mapping. See "Sources of Geologic Mapping Data" in map explanation.

Armstrong, R.L., 1968, Mantled gneiss domes in the Albion Range, southern Idaho: Geological Society of America Bulletin, v. 79, p. 1295–1314.

Armstrong, R.L., 1970, Geochronology of Tertiary igneous rocks, eastern Basin and Range Province, western Utah, eastern Nevada, and vicinity, U.S.A.: Geochim. et Cosmochim. Acta, v. 34, p. 203–232.

Armstrong, R.L., and Hills, F.A., 1967, Rb-Sr and K-Ar geochronologic studies of mantled gneiss domes, Albion Range, southern Idaho, USA: Earth and Planetary Science Letters, v. 3, p. 114–124.

Armstrong, R.L., Speed, R.C., Gravenstein, W.C., and Young, A.Y., 1976, K–Ar dates from Arizona, Montana, Nevada, Utah, and Wyoming: Isochron/West, no. 16, p. 1–6.

Bonnichsen, B., Leeman, W.P., Honjo, N., McIntosh, W.C., and Godchaux, M.M., 2008, Miocene silicic volcanism in southwestern Idaho-geochronology, geochemistry, and evolution of the central Snake River Plain: Bulletin of Volcanology, v. 70, p. 315–342.

*Compton, R.R., 1972, Geologic map of the Yost [15'] quadrangle, Box Elder County, Utah, and Cassia County, Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-672, 7 p., 2 sheets, scale 1:31,680.

*Compton, R.R., 1975, Geologic map of the Park Valley [15'] quadrangle, Box Elder County, Utah, and Cassia County, Idaho: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-873, 6 p., 1 sheet, scale 1:31,680.

Compton, R.R., 1983, Displaced Miocene rocks on the west flank of the Raft River-Grouse Creek core complex, Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., eds., Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 271–279.

*Compton, R.R., 1991, Geologic map of the Dairy Valley [15'] quadrangle, Nevada and Utah: unreleased manuscript map and explanation prepared for U.S. Geological Survey Open-File Report, scale 1:31,680.

*Compton, R.R., Todd, V.R., and Jordan, T.E., 1983 (unpublished), Compiled geologic map of the central and southern Grouse Creek Mountains: manuscript prepared for U.S. Geological Survey, explanation and map scale 1:31,680. Map includes unpublished mapping from Stanford University field geology classes in southern Grouse Creeks led by Compton in

1970s, as well as mapping by Todd (1973; 1979?) and unpublished mapping by Jordan for her 1983 publication. Submitted to the Utah Geological Survey in 2005 by V.R. Todd.

Compton, R.R., Todd, V.R., Zartman, R.E., and Naeser, C.W., 1977, Oligocene and Miocene metamorphism, folding, and low-angle faulting in northwestern Utah: Geological Society of America Bulletin, v. 88, p. 1237–1250.

Curry, D.R., 1982, Lake Bonneville—Selected features of relevance to neotectonic analysis: U.S.Geological Survey Open-File Report 82-1070, 30 p., scale 1:500,000.

Dohrenwend, J.C., 1984, Nivation landforms in the western Great Basin and their paleoclimatic significance: Quaternary Research, v. 22, p. 275–288.

*Dudash, S.L, 2001, Polymetamorphism of > 2.5 Ga pelitic schist in the Grouse Creek Mountains, northwest Utah: Flagstaff, Northern Arizona University, M.S. thesis, 256 p.

Egger, A.E., Dumitru, T.A., Miller, E.L., Savage, C.F.I., and Wooden, J.L., 2003, Timing and nature of Tertiary plutonism and extension in the Grouse Creek Mountains, Utah: International Geology Review, v. 45, p. 497–532.

Ellis, B.S., 2009, Rhyolitic explosive eruptions of the central Snake River Plain, Idaho-investigations of the lower Cassia Mountains succession and surrounding areas: University of Leicester, U.K., unpublished Ph.D. thesis, 169 p.

Ellis, B.S., Barry, T.L., Branney, M.J., Wolff, J.A., Bindeman, I., Wilson, R, and Bonnichsen, B., 2010, Petrologic constraints on development of a large-volume, high temperature, silicic magma system—the Twin Falls eruptive centre, central Snake River Plain: Lithos, v. 120, Issue 3-4, p. 475–489.

Ellis, B.S., Branney, M.J., Barry, T.L., Barfod, D., Bindeman, I., and Wolff, J.A., and Bonnichsen, B., 2011, Geochemical correlation of three large-volume ignimbrites from the Yellowstone hotspot track, Idaho, USA: Bulletin of Volcanology, DOI 10.1007/s00445-011-0510-z, p. 1–17.

Evans, S.H., Jr., and Brown, F.H., 1981, Summary of potassium-argon dating—1981: Contract report by Department of Geology and Geophysics, University of Utah, Salt Lake City, prepared for U.S. Department of Energy, Division of Geothermal Energy, Contract No. DE-AC07-80ID12079, 35 p.

*Felger, T.J., Miller, D.M., and Fleck, R.J., in preparation, Geologic map of the Kelton Pass SE and Monument Peak SW quadrangles, Box Elder County, Utah: Utah Geological Survey Miscellaneous Publication, scale 1:24,000.

Hallett, D.J., Hills, L.V., and Clague, J.J., 1997, New accelerator mass spectrometry radiocarbon ages for the Mazama tephra layer from Kootenay National Park, British Columbia, Canada: Canadian Journal of Earth Science, v. 34, p. 1202–1209.

*Hare, E.M., 1982, Structure and petrography of the Tertiary volcanic rocks between Death Creek and Dairy Valley Creek, Box Elder County, Utah: Logan, Utah State University, M.S. thesis, 64 p., scale 1:12,000.

*Howes, R.C., 1972, Geology of the Wildcat Hills, Utah: Logan, Utah State University, M.S. thesis, 43 p., scale 1:12,000.

*Hurlow, H.A., 2008, Compiled geologic map of the Curlew Valley drainage basin, Box Elder County, Utah and Oneida and Cassia Counties, Idaho, *in* Hurlow, H.A. and Burke, N., Geology and ground-water chemistry, Curlew Valley, northwestern Utah and south-central Idaho—implications for hydrogeology: Utah Geological Survey Special Study 126, plate 1, scale 1:100,000.

Isakson, V.H., 2012, Constraining the origin and evolution of the basement rocks in the Raft River-Albion-Grouse Creek core complex, northwestern Utah and southern Idaho: Pullman, Washington State University, M.S. thesis, 94 p.

Jordan, T.E., 1979, Lithofacies of the upper Pennsylvanian and lower Permian western Oquirrh Group, northwest Utah: Utah Geology, v. 6, no. 2, p. 41–56.

Jordan, T.E., 1983, Structural geometry and sequence, Bovine Mountain, northwestern Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., editors, Structural and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 215–227.

*Kerr, S.B., 1987, Petrology of Pliocene (?) basalts of Curlew Valley (Box Elder County) Utah: Logan, Utah State University, M.S. thesis, 84 p.

Le Bas, M.J., Le Maitre, R.W., Streckheisen, A., and Zenettin, B., 1986, A chemical classification of volcanic rocks based on the total alkali-silica diagram: Journal of Petrology, v. 27, p. 745–750.

Link, P.K., and Johnston, S., 2008, Proterozoic paleogeography and stratigraphy of the Snake range, eastern Nevada and Albion-Grouse Creek Ranges, southern Idaho: Detrital zircon constraints and stratigraphic surprises: Geological Society of America Abstracts with Programs, v. 40, no. 6, p. 145.

*Mapel, W.J., and Hail, W.J., Jr., 1959, Tertiary geology of the Goose Creek district, Cassia County, Idaho, Box Elder County, Utah and Elko County, Nevada: U.S. Geological Survey Bulletin 1055-H, 254 p., scale 1:1:63,360.

*Martinez, C.M. (compiler), 2001, Geologic map of the Rocky Pass Peak quadrangle, Utah: preliminary map submitted to Utah Geological Survey, part of incomplete Ph.D dissertation, Stanford University, scale 1:24,000.

McCarthy, P.T., and Miller, D.M., 2002, Geologic map of the Terrace Mountain East quadrangle, Box Elder County, Utah: Utah Geological Survey MP02-02, 14 p., 1 plate, scale 1:24,000.

Miller, D.M., Nakata, J.K., Oviatt, C.G., Nash, W.P., and Fiesinger, D.W., 1995, Pliocene and Quaternary volcanism in the northern Great Salt Lake area and inferred volcanic hazards, *in* Lund, W.R., editor, Environmental and Engineering Geology of the Wasatch Front Region: Utah Geological Association Publication 24, p. 469–482.

Miller, D.M., and Oviatt, C.G., 1994, Geologic map of the Lucin NW quadrangle, Box Elder County, Utah: Utah Geological Survey Map 158, 14 p., 2 plates, scale 1:24,000.

Mytton, J.W., Morgan, W.A., and Wardlaw, B.R., 1983, Stratigraphic relations of Permian units, Cassia Mountains, Idaho *in* Miller, D.M., Todd, V.R., and Howard, K.A., editors, Structural and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 281–303.

*Mytton, J.W., Williams, P.L,, and Morgan, W.A., 1990, Geologic map of the Stricker 4 quadrangle, Cassia, Twin Falls, and Jerome Counties, Idaho: U.S. Geological Survey Miscellaneous Investigations Series Map I-2052, scale 1:48,000.

Nash, B.P., Perkins, M.E., Christensen, J.N., Lee, D.C., and Halliday, A.N., 2006, The Yellowstone hotspot in space and time-Nd and Hf isotopes in silicic magmas: Earth Planetary Science Letters, v. 247, p. 143–156.

*Nelson, D.T., and Jewell, P.W., in preparation/manuscript, Geologic map of unconsolidated deposits in the Hogup Bar quadrangle, Box Elder County, Utah: University of Utah, unreleased EDMAP project, and part of Ph.D. dissertation submitted to Utah Geological Survey, scale 1:24,000.

*Olesen, M.C., 1984, Structure and petrology of Tertiary volcanic rocks in parts of Toms Cabin Spring and Dairy Valley quadrangles, Box Elder County, Utah: Logan, Utah State University, M.S. thesis, 84 p., scale 1:12,000.

Osborn, G., and Bevis, K., 2001, Glaciation in the Great Basin of the western United States: Quaternary Science Reviews, v. 20, p. 1377–1410.

Oviatt, C.G., Currey, D.R., and Miller, D.M., 1990, Age and paleoclimatic significance of the Stansbury shoreline of Lake Bonneville, northeastern Great Basin: Quaternary Research, v. 33, p. 291–305.

Perkins, M.E., in preparation, Tertiary tephrochronology of the Grouse Creek 30' x 60' quadrangle and adjacent areas: Utah Geological Survey Open-File Report.

Perkins, M.E., Nash, W.P., Brown, F.H., and Fleck, R.J., 1995, Fallout tuffs of Trapper Creek, Idaho—A record of Miocene explosive volcanism in the Snake River Plain volcanic province: Geological Society of America Bulletin, v. 107, p. 1484–1506.

Pierce, K.L., and Morgan, L.A., 1992, The track of the Yellowstone hotspot-volcanism, faulting, and uplift, *in* Link, P.K., Kuntz, M.A., Platt, L.B., editors, Regional geology of eastern Idaho and western Wyoming: Geological Society of America Memoir 179, p. 1–53.

*Sack, D., Nadon, G., and Cavas, M.P., in preparation/manuscript, Geologic map of the Matlin quadrangle, Box Elder County, Utah: Athens, Ohio University, unreleased EDMAP project, scale 1:24,000.

*Scarbrough, B.E., 1984, Structure and petrology of Tertiary volcanic rocks in parts of Toms Cabin Spring and Lucin NW quadrangles, Box Elder County, Utah: Logan, Utah State University, M.S. thesis, 77 p., scale 1:12,000.

Shea, R.M, 1985, Bimodal volcanism in the northeast Basin and Range—Petrology of the Wildcat Hills, Utah: Salt Lake City, University of Utah, M.S. thesis, 79 p.

*Smith, K.W., 1980, Structure and petrology of Tertiary volcanic rocks near Etna, Utah: Logan, Utah State University, M.S. thesis, 83 p., scale 1:12,000.

*Stifel, P.B., 1964, Geology of the Terrace and Hogup Mountains, Box Elder County, Utah: Salt Lake City, University of Utah, Ph.D. dissertation, 174 p., 14 plates, scale 1:63,360.

Strickland, A., 2010, Polyphase deformation and metamorphism—A geochronologic perspective: Palo Alto, Stanford University, Ph.D dissertation, 257 p.

Strickland, A., Miller, E.L., and Wooden, J., 2011, Syn-extensional crustal melting and plutonism in the Albion-Raft River-Grouse Creek metamorphic core complex: Journal of Geology, v. 119, p. 185–206.

*Todd, V.R., 1973, Structure and petrology of metamorphosed rocks in central Grouse Creek Mountains, Box Elder County, Utah: Palo Alto, Stanford University, unpublished Ph.D. dissertation, 316 p., scale 1:31,680.

*Todd, V.R., 1975?, Bedrock geologic maps of the Matlin, Prohibition Spring, Warm Spring Hills, Red Dome, Runswick Wash, and Russian Knoll quadrangles, Box Elder County, Utah: U.S. Geological Survey manuscript, unreleased mapping conducted during postdoctoral research, scale 1:24,000. Submitted to the Utah Geological Survey in 2005 by V.R. Todd.

*Todd, V.R., 1979?, Bedrock geologic maps of parts the Potters Creek, Emigrant Pass, Ingham Canyon, Rocky Pass Peak quadrangles, Box Elder County, Utah: U.S. Geological Survey, unpublished mapping in Ph.D. dissertation area, scale 1:24,000. Maps include slight modifications after 1983. Submitted to the Utah Geological Survey in 2005 by V.R. Todd.

Todd, V.R., 1980, Structure and petrology of a Tertiary gneiss complex in northwestern Utah, *in* Crittenden, M.D., Jr., Coney, P.J., and Davis, G.H., editors, Cordilleran metamorphic core complexes: Geological Society of America Memoir 153, p. 349–383.

Todd, V.R., 1983, Late Miocene displacement of pre-Tertiary and Tertiary rocks in the Matlin Mountains, northwestern Utah, *in* Miller, D.M., Todd, V.R., and Howard, K.A., editors, Tectonic and stratigraphic studies in the eastern Great Basin: Geological Society of America Memoir 157, p. 239–270.

Voit, R.L., 1985, Petrology and mineralogy of Tertiary volcanic rocks west and southwest of Kelton, Box Elder County, Utah: Logan, Utah State University, M.S. thesis, 90 p.

*Wells, M.L., 2009, Geologic map of the Kelton Pass quadrangle, Box Elder County, Utah, and Cassia County, Idaho: Utah Geological Survey Miscellaneous Publication 09-3, scale 1:24,000, 3 plates, 27 p., scale 1:24,000 (plate 1) and 1:12,000 (plate 2), pdf on CD.

Wells, M.L., Snee, L.W., and Blythe, A.E., 2000, Dating of major normal fault systems using thermochronology—an example from the Raft River detachment, Basin and Range, western United States: Journal of Geophysical Research, v. 105, p. 16,303–16,327.

*Young, A.R., 1981, Geology of the Goose Creek Mountain area, Box Elder County, Utah and Elko County, Nevada: Salt Lake City, University of Utah, manuscript/incomplete Ph.D. dissertation, variously paginated, map in 3 plates, scale 1:31,680. Submitted to the Utah Geological Survey.

Sources of Geologic Mapping Data

Listed by project year and 7.5' quadrangle (in italics)

Year 1 Area

Peplin Flats, Crocodile Mountain NE, Hogup Bar, Crocodile Mountain SE – Stifel (dissertation map 1964, 1:31,680), Hurlow (2008, 1:100,000), Nelson and Jewell (dissertation map in prep., 1:24,000), Felger revisions 2010

Kelton Pass SE, Curlew Junction – Howes (thesis map 1972, 1:12,000)

Kelton Pass, Black Butte, Peplin Flats, Curlew Junction, Kelton Pass SE – Kerr (thesis map, 1987, 1:40,000, 1:12,000)

Runswick Wash, Russian Knoll, Red Dome, Matlin – Todd (manuscript maps 1975?, 1:24,000), Sack and others (in prep., 1:24,000)

Curlew Junction – Hurlow (2008, 1:100,000)

Black Butte – Hurlow (2008, 1:100,000), Felger revisions 2010

Kelton Pass SE – Hurlow (2008, 1:100,000), Felger and others (in prep., 1:24,000)

Kelton Pass – Wells (2009, 1:24,000)

Year 2 Area

Buck Hollow, Yost, Lynn Reservoir, Dennis Hill – Compton (1972, 1:31,680)

Standrod, Rosevere Point, Rosette, Park Valley – Compton (1975, 1:31,680)

Potters Creek, Warm Spring Hills, Emigrant Pass, Prohibition Spring – Todd (dissertation map, 1973, 1:31,680), Todd (manuscript maps 1979?, 1:24,000), Compton and others (manuscript map 1983, 1:31,680)

Potters Creek – Dudash (thesis map 2001, no scale)

Revisions to bedrock mapping by Wells 2011

Year 3 Area

Nile Spring, Pole Creek – Mapel and Hail (1956, 1:63,360), Mytton and others (1990, 1:48,000)

Nile Spring, Pole Creek, Cotton Thomas Basin, Kimbell Creek, Dry Canyon Mountain, Judd Mountain, Death Creek Reservoir, Grouse Creek, Ingham Canyon, Rocky Pass Peak, Toms Cabin Spring, Dairy Valley – Young (manuscript map 1981, 1:31,680)

Ingham Canyon, Rocky Pass Peak – Compton and others (manuscript map 1983, 1:31,680)

Rocky Pass Peak – Martinez (manuscript map 2001, 1:24,000)

Grouse Creek – Smith (thesis map 1980, 1:12,000)

Grouse Creek, Death Creek Reservoir, Dairy Valley – Hare (thesis map 1982, 1:12,000)

Dairy Valley, Toms Cabin Spring – Olesen (thesis map 1984, 1:12,000), Scarbrough (thesis map 1984, 1:12,000)

Death Creek Reservoir, Dairy Valley – Compton (manuscript map 1991, 1:31,680)

Nile Spring, Pole Creek, Dry Canyon Mountain – Clark revisions 2011-2012

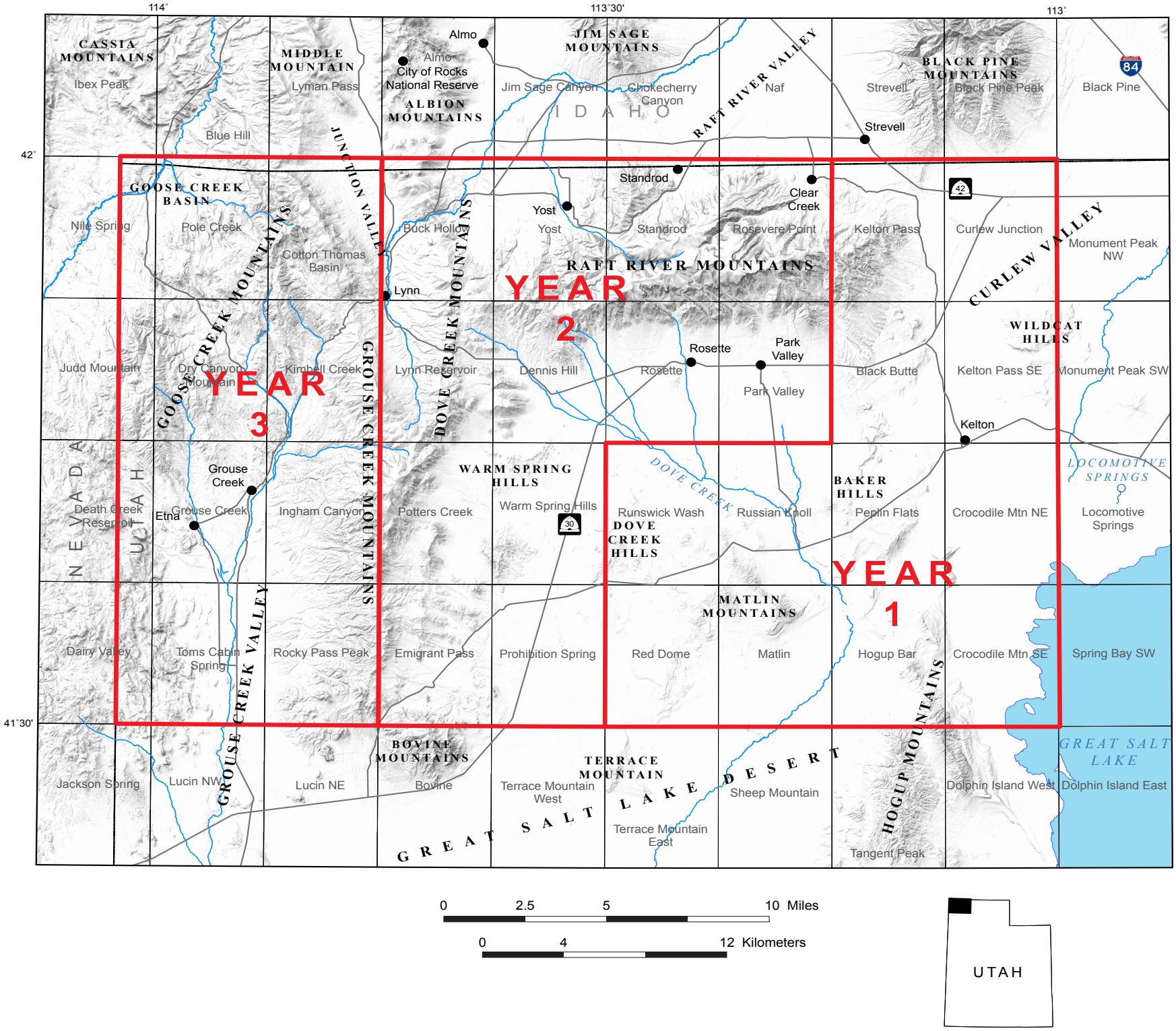
Pole Creek, Cotton Thomas Basin, Kimbell Creek – Wells mapping and revisions 2009-2012

Judd Mountain, Dry Canyon Mountain, Cotton Thomas Basin, Kimbell Creek, Death Creek Reservoir, Grouse Creek, Ingham Canyon, Rocky Pass Peak – Miller revisions 2010-2012

Death Creek Reservoir, Grouse Creek, Dairy Valley, Toms Cabin Spring – Felger revisions 2010-2012

Year 1, 2 and 3 Areas
Surficial deposit mapping and revisions by Oviatt 2009-2012

Revisions by Miller, Clark, and Felger 2009-2012


114°
113°30'
113°
42°
41°30'
CASSIA MOUNTAINS
Ibex Peak
MIDDLE MOUNTAIN
Lyman Pass
Almo
City of Rocks National Reserve
ALBION MOUNTAINS
JIM SAGE MOUNTAINS
Jim Sage Canyon
Chokecherry Canyon
IDAHO
RAFT RIVER VALLEY
Naf
Strevell
BLACK PINE MOUNTAINS
Black Pine Peak
Black Pine
84
Blue Hill
JUNCTION VALLEY
GOOSE CREEK BASIN
Nile Spring
Pole Creek
Cotton Thomas Basin
Buck Hollow
Yost
Standrod
Clear Creek
Rosevere Point
Kelton Pass
Curlew Junction
42
CURLEW VALLEY
Monument Peak NW
RAFT RIVER MOUNTAINS
YEAR 2
Lynn
GOOSE CREEK MOUNTAINS
YEAR 3
Judd Mountain
Dry Canyon Mountain
Kimbell Creek
GROUSE CREEK MOUNTAINS
Lynn Reservoir
DOVE CREEK MOUNTAINS
Dennis Hill
Rosette
Park Valley
Black Butte
WILDCAT HILLS
Kelton Pass SE
Monument Peak SW
Kelton
NEVADA
UTAH
Grouse Creek
Etna
Death Creek Reservoir
Ingham Canyon
Potters Creek
WARM SPRING HILLS
Warm Spring Hills
30
DOVE CREEK
Runswick Wash
DOVE CREEK HILLS
Russian Knoll
BAKER HILLS
Peplin Flats
Crocodile Mtn NE
LOCOMOTIVE SPRINGS
Locomotive Springs
YEAR 1
MATLIN MOUNTAINS
Dairy Valley
Toms Cabin Spring
GROUSE CREEK VALLEY
Rocky Pass Peak
Emigrant Pass
Prohibition Spring
Red Dome
Matlin
Hogup Bar
HOGUP MOUNTAINS
Crocodile Mtn SE
Spring Bay SW
Jackson Spring
Lucin NW
Lucin NE
BOVINE MOUNTAINS
Bovine
TERRACE MOUNTAIN
Terrace Mountain West
Terrace Mountain East
GREAT SALT LAKE DESERT
Sheep Mountain
Tangent Peak
Dolphin Island West
GREAT SALT LAKE
Dolphin Island East
0 2.5 5 10 Miles
0 4 12 Kilometers
UTAH

LIST OF GEOLOGIC UNITS

QUATERNARY-TERTIARY SURFICIAL DEPOSITS

Alluvial Deposits

- Qay — Younger alluvium
- Qam — Alluvial mud
- Qao — Older alluvium
- QTag — Alluvial gravel

Eolian Deposits

- Qe — Eolian deposits, undivided

Lacustrine Deposits

- Qlk — Lacustrine carbonate-chip gravel, Great Salt Lake
- Qlg — Lacustrine gravel, Lake Bonneville
- Qls — Lacustrine sand, Lake Bonneville

Glacial Deposits

- Qgt — Glacial till

Mass-Movement Deposits

- Qms — Landslide deposits
- Qmct — Colluvium and talus

Mixed-Environment Deposits

- Qpm — Playa mud, Great Salt Lake
- Qla — Lacustrine and alluvial deposits, undivided
- Qlag — Lacustrine and alluvial coarse-grained deposits
- Qlaf — Lacustrine and alluvial fine-grained deposits

Stacked-Unit Deposits

- Qla/rx — Lacustrine and alluvial deposits over undivided basin fill and bedrock
- Qla/Tby — Lacustrine and alluvial deposits over younger basaltic lava flows
- Qla/Ts — Lacustrine and alluvial deposits over Salt Lake Formation, undivided
- Qla/Tepg — Lacustrine and alluvial deposits over granite, granodiorite, and diorite of Emigrant Pass
- Qla/Ttc — Lacustrine and alluvial deposits over rhyolitic tuff and conglomerate
- Qlaf/Ttc — Lacustrine and alluvial fine-grained deposits over rhyolitic tuff and conglomerate
- Qla/Pm — Lacustrine and alluvial deposits over Park City Group, Murdock Mountain Formation
- Qla/Ptbt — Lacustrine and alluvial deposits over Trapper Creek, Badger Gulch, Third Fork Formations, undivided
- Qla/Psd — Lacustrine and alluvial deposits over sandstone and dolomite
- Qla/PIPo — Lacustrine and alluvial deposits over Oquirrh Group, undivided
- Qla/Poi — Lacustrine and alluvial deposits over Oquirrh Group, interbedded sandstone and limestone unit
- Qlg/Poi — Lacustrine gravel over Oquirrh Group, interbedded sandstone and limestone unit
- Qla/Pos — Lacustrine and alluvial deposits over Oquirrh Group, sandstone unit

QUATERNARY VOLCANIC ROCK UNITS

- Qb — Basalt
- Qrw — Rhyolite of Wildcat Hills

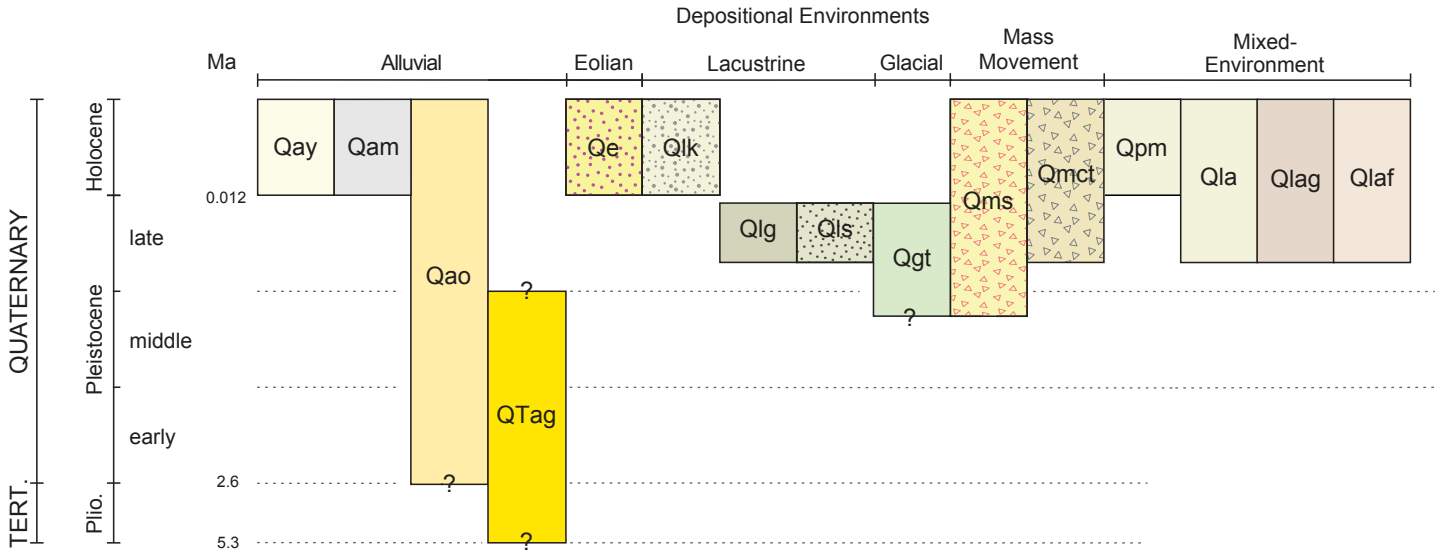
TERTIARY BASIN FILL AND VOLCANIC ROCK UNITS

- Trd — Rhyodacite of Wildcat Hills
- Tby — Younger basaltic lava flows
- Ts — Salt Lake Formation, undivided
- Tsc — Salt Lake Formation, conglomerate lithosome
- Ta — Salt Lake Formation, avalanche breccia
- Tsl — Salt Lake Formation, limestone lithosome
- Tdi — Minette of Onemile Creek
- Tmo — Dacite of Holt Creek
- Tdh — Rhyolitic welded tuffs of Goose Creek basin
- Trb — Diabase of Indian Creek
- Trl — Rhyolitic welded tuff of Lynn Creek
- Tr — Rhyolites of Grouse Creek Valley
- Td — Dacites of Grouse Creek Valley
- Trt — Rhyolites of Twin Peaks
- Trg — Rhyolite of Granite Creek
- Tbi — Intermediate-age basaltic lava flows
- Trcg — Granite of Road Canyon
- Trbg — Granite of Red Butte
- Tvg — Granite of Vipont
- Tepg — Granite, granodiorite, and diorite of Emigrant Pass
- Ttc — Rhyolitic tuff and conglomerate
- Tbo — Older trachybasaltic lava flows

TRIASSIC TO ARCHEAN ROCK UNITS

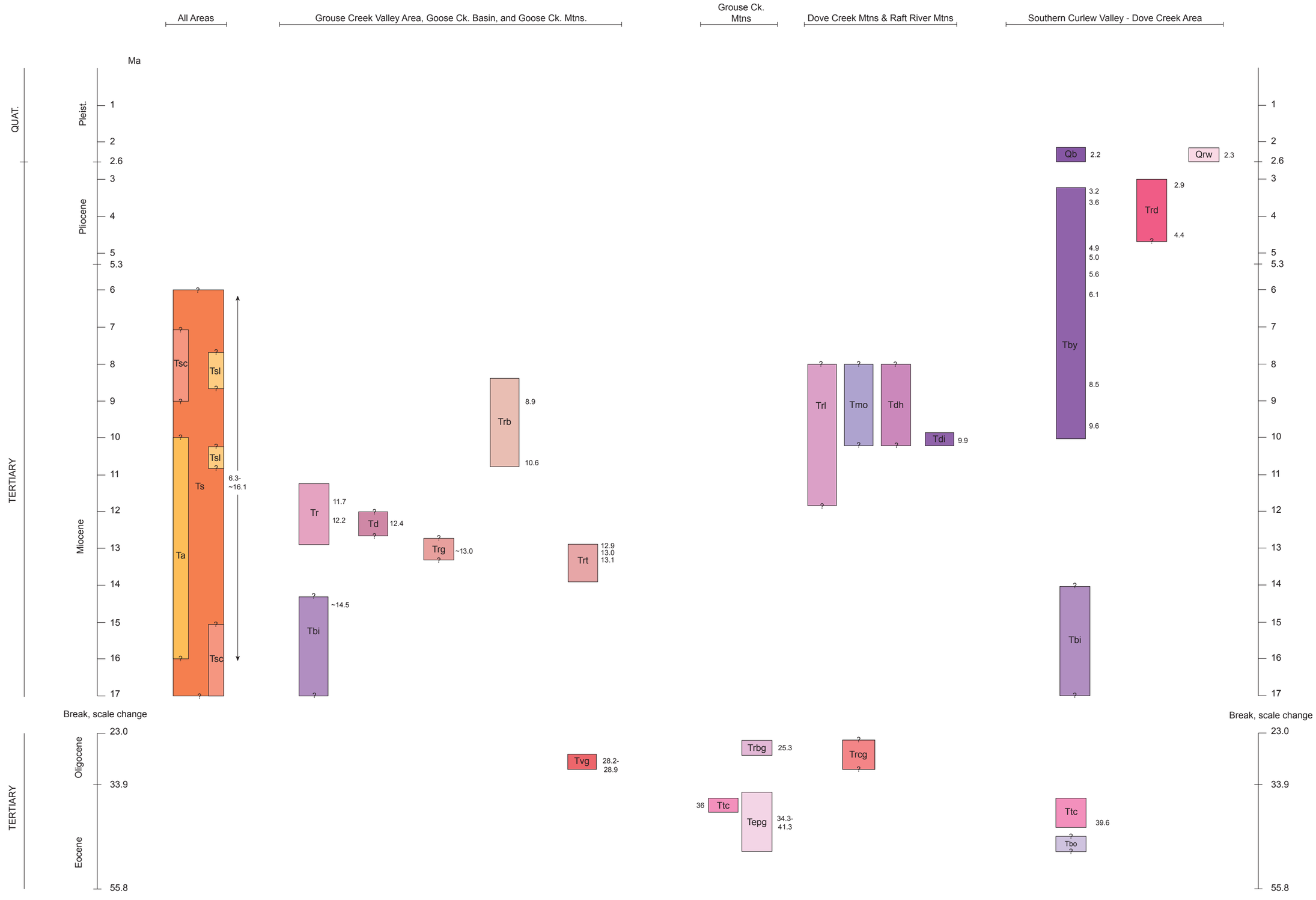
- Ꞧd — Dinwoody Formation (includes some Thaynes Fm.)
- Pg — Park City Group, Gerster Formation
- Pm — Park City Group, Murdock Mountain Formation
- Ppm — Phosphoria Formation, Meade Peak Tongue
- Pgr — Park City Group, Grandeur Formation
- Ptbt — Trapper Creek, Badger Gulch, Third Fork Formations, undivided
- Psd — Sandstone and dolomite
- PIPo — Oquirrh Group, undivided
- Poi — Oquirrh Group, interbedded sandstone and limestone unit
- IPos — Oquirrh Group, sandstone unit
- IPol — Oquirrh Group, limestone unit
- IPMx — Marble tectonite
- IPMdc — Diamond Peak Formation and Chainman Shale, undivided (metamorphosed)
- Dg — Guilmette Formation (metamorphosed)
- Dsi — Simonson Dolomite (metamorphosed)
- OZu — Ordovician - Neoproterozoic rocks, undivided (metamorphosed)
- Oee — Ely Springs Dolomite and Eureka Quartzite, undivided (metamorphosed)
- Oes — Ely Springs Dolomite (metamorphosed)
- Oe — Eureka Quartzite (metamorphosed)
- Op — Pogonip Group (includes some overlying units of mostly marble, metamorphosed)
- Zmc — Schist of Mahogany Peaks and Quartzite of Clarks Basin, undivided
- Zmp — Schist of Mahogany Peaks
- Zcb — Quartzite of Clarks Basin
- Zss — Schist of Stevens Spring
- Zy — Quartzite of Yost
- Zu — Schist of Upper Narrows
- Zus — Schist of Upper Narrows, muscovite-quartz schist member
- Ze — Elba Quartzite
- Zes — Elba Quartzite, schist member
- Wgg — Green Creek Complex, granite and granite gneiss
- Wgt — Green Creek Complex, metamorphosed trondhjemite and pegmatite
- Wgms — Green Creek Complex, meta mafic igneous and older schist
- Wgm — Green Creek Complex, metamorphosed mafic igneous rocks
- Wgs — Green Creek Complex, older schist

CORRELATION OF QUATERNARY–TERTIARY SURFICIAL GEOLOGIC UNITS

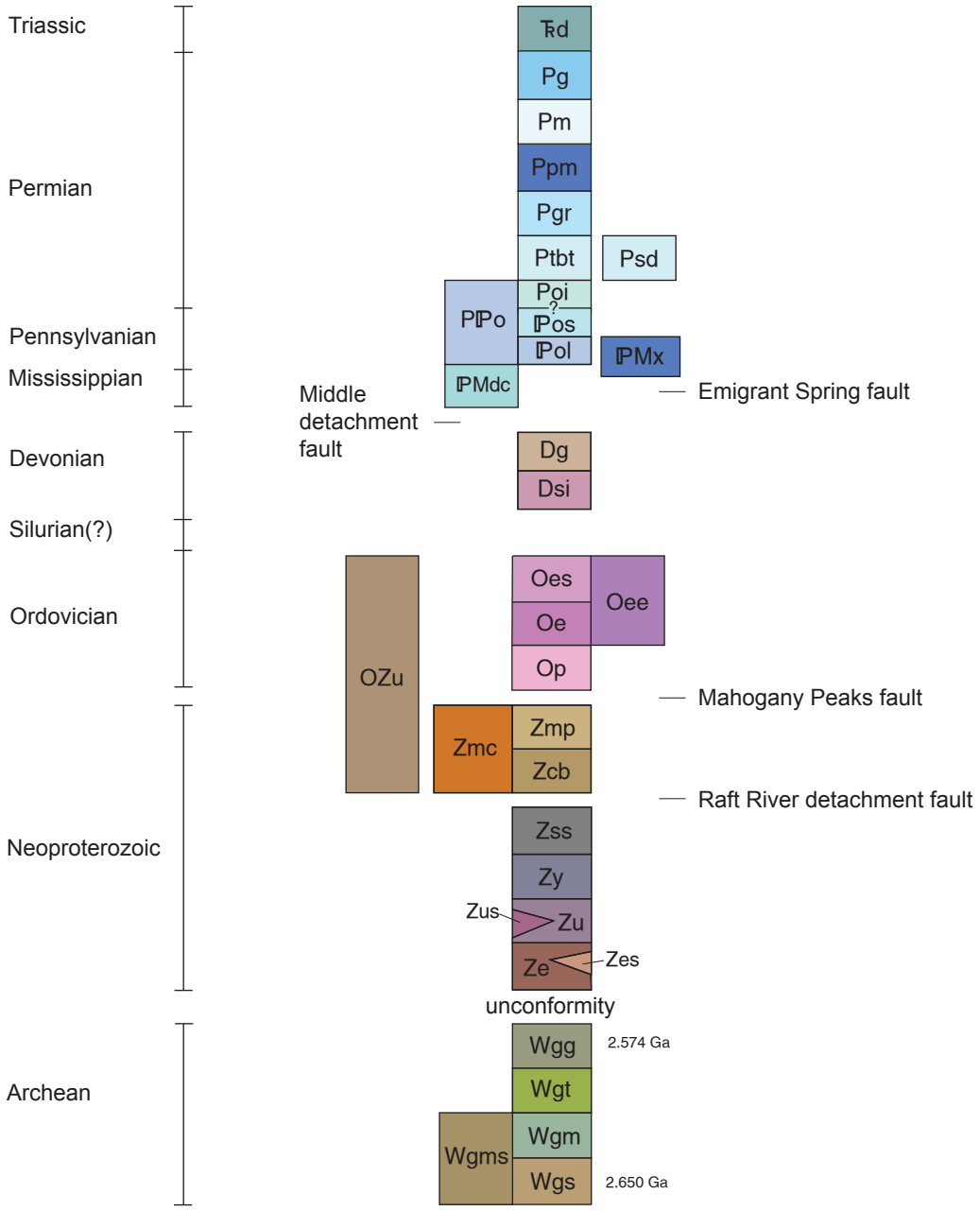


Age control on surficial deposits is limited

CORRELATION OF QUATERNARY AND TERTIARY BASIN FILL AND ROCK UNITS



CORRELATION OF TRIASSIC TO ARCHEAN ROCK UNITS



GEOLOGIC SYMBOLS

Contact – Dashed where gradational

Marker bed

Lineament

Steeply dipping normal fault – Dashed where approximately located, dotted where concealed; bar and ball on downthrown side

Strike-slip fault – Dashed where approximately located, dotted where concealed; arrows indicate relative movement

Fault of uncertain geometry and origin – Dashed where approximately located, dotted where concealed

Thrust fault – Dotted where concealed; sharp teeth on hanging wall

Twin Peaks
Middle
Raft River

Detachment fault – Dotted where concealed; smooth teeth on hanging wall

Emigrant Spring
Mahogany Peaks
not named

Low-angle normal (attenuation) fault – Dotted where concealed; boxes on hanging wall

Anticline – Dashed where approximately located, dotted where concealed; arrow indicates direction of plunge

Syncline – Dashed where approximately located, dotted where concealed; arrow indicates direction of plunge

Overturned anticline – Dashed where approximately located, dotted where concealed; arrow indicates direction of plunge

Overturned syncline – Dashed where approximately located, dotted where concealed; arrow indicates direction of plunge

Minor plunging anticline

Minor plunging syncline

Lake Bonneville shorelines and shorezones -

B — Bonneville shoreline – Dashed where approximately located; dotted where concealed

P — Provo shoreline – Dashed where approximately located; dotted where concealed

S — Stansbury shorezone – two lines for upper and lower limits; dotted where concealed; shorezone altitude data from Oviatt and others (1990)

Great Salt Lake shorelines and shorezones -

G — Gilbert shoreline and shorezone – two lines for upper and lower limits; dotted where concealed; shorezone altitude data from Currey (1982)

GSLh — Great Salt Lake historical highstand shoreline (circa 1873, 1986, 1987)

GSLa — Great Salt Lake historical average altitude

Glacial cirque headwall

Nivation hollow headwall - Ticks indicate single- or double-sided; locally may coincide with landslide scarps; determined from aerial photo examination, see Dohrenwend (1984)

Landslide scarp

Qla/PIPo — Stacked-unit deposit - indicates thin cover of the first unit overlying the second unit

Sedimentary bedding attitude -

Horizontal

20 — Inclined

Inclined approximate

Vertical

75 — Overturned

Metamorphic or igneous foliation attitude -

20 — Inclined

Inclined approximate

Vertical

Horizontal

Mineral lineation

Geochronology sample

Geochemistry sample

Tephrochronology sample

Fossil sample

Drill hole, abandoned

Volcanic vent

Shaft

Adit

Mine or quarry

Sand and gravel pit

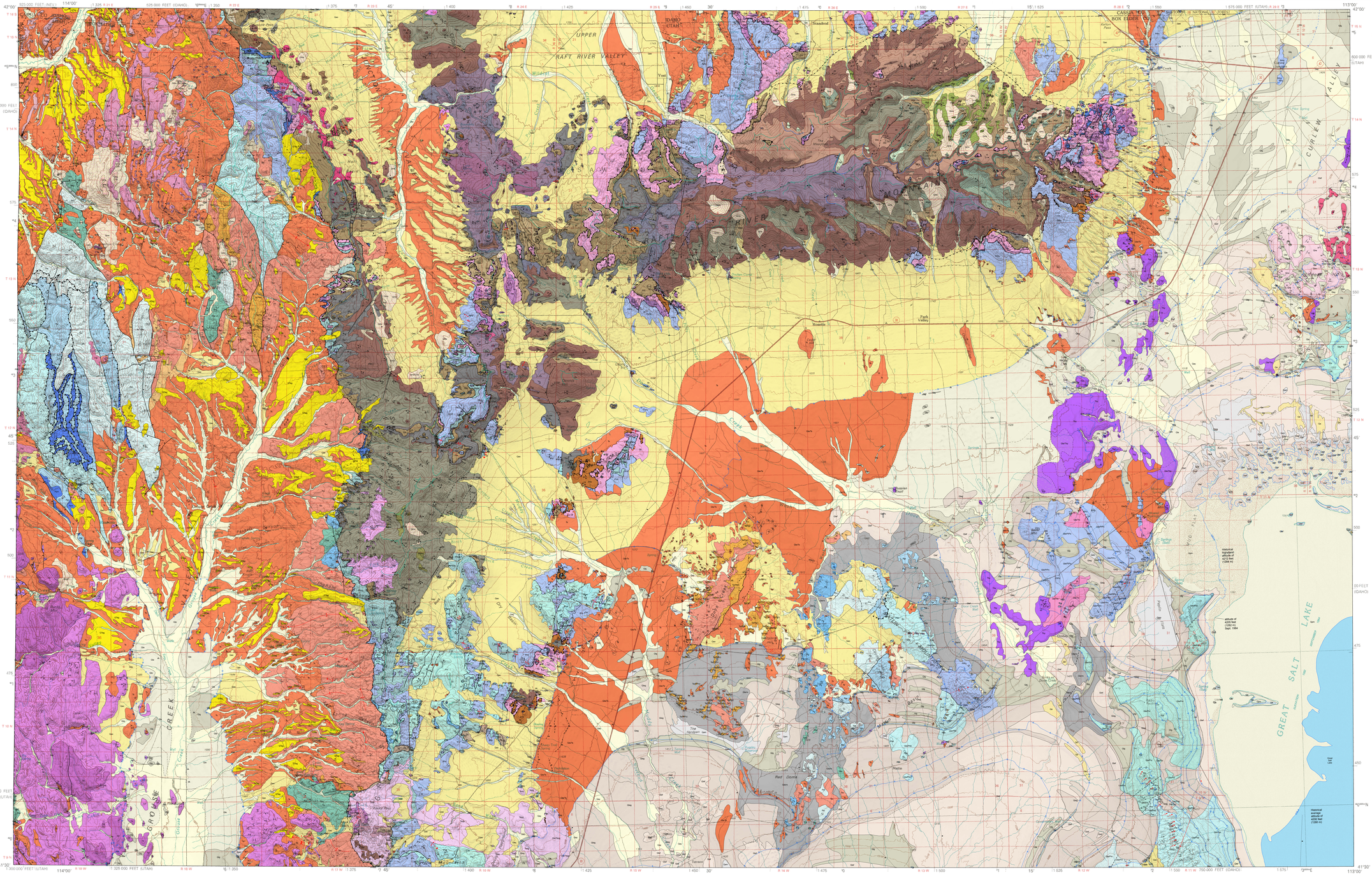


Plate 1
Utah Geological Survey Open-File Report 598

Utah Geological Survey
a division of
Utah Department of Natural Resources
in cooperation with
U.S. Department of the Interior
U.S. Geological Survey

PROGRESS REPORT GEOLOGIC MAP OF THE GROUSE CREEK 30' x 60' QUADRANGLE AND UTAH PART OF THE JACKPOT 30' x 60' QUADRANGLE, BOX ELDER COUNTY, UTAH, AND CASSIA COUNTY, IDAHO (Year 3 of 4) 2012

by

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SCALE 1:62,500

1 0.5 0 1 2 3 4 MILES

1 0.5 0 1 2 3 4 5 6 KILOMETERS

CONTOUR INTERVAL 50 METERS
SUPPLEMENTARY CONTOUR INTERVAL 10 METERS

UTAH
QUADRANGLE LOCATION

12°
APPROXIMATE MEAN DECLINATION, 2012

Disclaimer

This open-file release is a progress report that provides the results of the third year of mapping of a four-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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This geologic map was funded by the Utah Geological Survey and the U.S. Geological Survey, National Cooperative Geologic Mapping Program through USGS STATEMAP award numbers G09AC00152, G10AC00086, G11AC20249, and FEDMAP. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

This map is a plot of Geographic Information System (GIS) files created to visually represent the content of the GIS data files. It is not a published map and it contains many features that do not meet UGS cartographic standards, such as automatically generated labels that may overlap other labels and lines.

Base from USGS Grouse Creek 30' x 60' Quadrangle (1987)
and USGS Jackpot 30' x 60' Quadrangle (1982)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1866

Mapping by authors 2009-2012

GIS and Cartography: Basia Matyjasik and Jay C. Hill

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