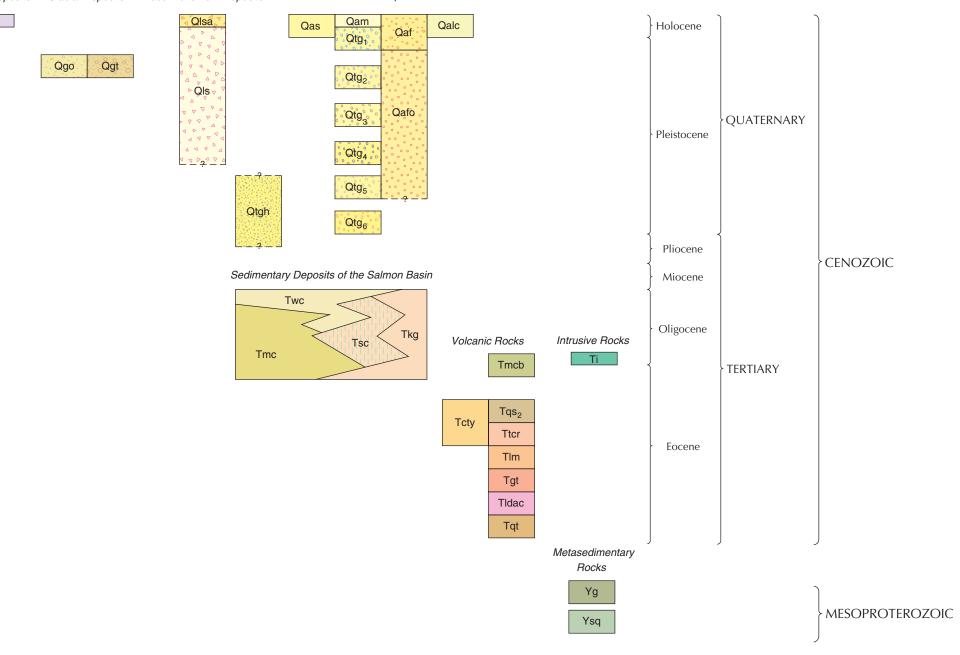


CORRELATION OF MAP UNITS

Alluvial Deposits



INTRODUCTION

The geologic map of the Baker quadrangle shows rock units exposed at the surface or underlying a thin surficial cover of soil and colluvium. Thicker surficial alluvial, glacial, and landslide deposits are shown where they form significant mappable units. Semi-consolidated to consolidated Tertiary sedimentary rocks form the undulating low hills and foothills between the Lemhi River and the basin-bounding mountains.

The map is the result of our research and field work in 2009 and 2010, and

previous research in the region by Anderson (1957 and unpublished mapping), Tucker (1975), Harrison (1985), and Blankenau (1999). Many concepts for geologic units were developed while mapping the adjacent Goldstone Mountain quadrangle (Lewis and others, 2011), part of a 1:24,000-scale collaborative mapping project started in 2007 by the Idaho Geological Survey and the Montana Bureau of Mines and Geology. Attitudes from previous mapping by Anderson (1957 and unpublished mapping), Tucker (1975), and Blankenau (1999) were used to supplement the structural data collected by the authors. Soils information is from Hipple and others (2006).

Mesoproterozoic age that form the mountains in the northeast and southwest parts of the quadrangle. In the northeast, their contact with sedimentary rocks of the ancestral Salmon basin is largely along the late Eocene-Oligocene Salmon basin detachment fault. Salmon basin sedimentary rocks vary from coarse conglomerate to shale, record a wide range of depositional environments in the basin as it formed. Much of the basin sedimentary section has been subsequently eroded. The oldest surficial deposits in the quadrangle are bouldery gravels that cap an early erosion surface on dipping sedimentary rocks. Evidence for that Pliocene or early Pleistocene surface has been mostly removed through Pleistocene drainage incision. The Quaternary deposits show evidence of glaciation, terracing, incision, and landsliding. These are characteristic of Quaternary processes that formed the thin alluvial, glacial, and mass movement deposits.

SYMBOLS

Gradational contact between infingering units; placed along zone of geomorphic expression of lithology.

Detachment fault: hachures on upper plate; dashed where approximately located; dotted where concealed.

Contact: dashed where approximately located.

Normal fault: ball and bar on downthrown side; dashed where approximately located; dotted where concealed; arrow

indicates dip of fault. Anticline axial trace, approximately located; arrow

Syncline axial trace, approximately located; arrow indicates plunge.

Estimated strike and dip of bedding. • Strike and dip of bedding; ball indicates bedding known to

indicates plunge.

 80 Strike and dip of bedding.

Strike and dip of bedding, strike variable. Strike and dip of cleavage.

Strike and dip of crenulation cleavage.

Strike and dip of flow foliation.

Bearing and plunge of asymmetrical small fold showing clockwise rotation viewed down plunge. Tectonic breccia.

Headwall scarp of landslide; ticks on top of scarp.

Extent of placer-pit excavations; exposes map unit *Twc*.

Extent of gravel pit excavations.

DESCRIPTION OF MAP UNITS

Mineral modifiers are listed in order of increasing abundance. Grain size classification of unconsolidated and consolidated sediment is based on the Wentworth scale (Lane, 1947). Distances and bed thicknesses are given in abbreviation of metric units (e.g., cm=centimeter). Formation thickness and elevation are listed in both meters and feet. Multiple lithologies within a rock unit description are listed in order of decreasing abundance.

ARTIFICIAL DEPOSITS

m Made ground (Holocene)—Artificial fills and gold placer tailings. Fills orimarily dams for ponds constructed from local earth materials. Tailings from hydraulic mining form "alluvial" fans deposited onto the flood plain of Bohannon Creek.

ALLUVIAL DEPOSITS

Qam Main-stream alluvium (Holocene)—Well-rounded, moderately sorted and stratified pebble to boulder sandy gravel of the Lemhi River. Gravel clasts mostly quartzite, siltite, and volcanic rocks. Includes flood-plain areas of silt, clay, and sand. Deposits are 3-9 m (10-30 ft) thick. Weakly developed

Qas Side-stream alluvium (Holocene)—Pebble to boulder sandy gravel in stream valleys emanating from mountain fronts. Pebble to cobble sandy gravel from mountain front to confluences with the Lemhi River. Subrounded to well-rounded, moderately sorted and stratified pebble to boulder sandy gravel. Gravel clasts primarily quartzite and siltite. Silty and clayey in foothill stream valleys and localized bottomlands where sheet wash and colluvium are included. Angular to subrounded, poorly sorted, moderately stratified pebbly to cobbly sandy silt; includes minor sheet wash, colluvium, and fan deposits. Soils undeveloped to weakly developed. Deposits are 1-6 m (3-20 ft) thick.

Qalc Fine-grained alluvial and lacustrine deposits (Holocene to Pleistocene)—Silt, sand, and minor gravel deposited in closed depressions. These sediments are 1-12 m (3-40 ft) thick.

Qaf Alluvial-fan and debris-flow deposits (Holocene to late Pleistocene)—West slope of Beaverhead Mountains steep valley-side alluvial and debris-flow fans. Angular to subrounded, poorly sorted, matrix-supported pebble to boulder gravel in a sand, silt, and clay matrix. In the foothill slopes alluvial fans are primarily composed of sand, silt, and clay with common matrixsupported gravel clasts. Commonly grades into, interfingers with, and caps side-stream alluvium (Qas). Thickness of deposits varies greatly, ranging from 1 to 24 m (3 to 80 ft). Soils vary from weakly developed to moderately

Qafo Older alluvial deposits (Pleistocene)—Angular to subrounded, poorly sorted, matrix-supported pebble to boulder gravel in a matrix of sand, silt, and clay. Thickness highly varied, ranging from 1 to 15 m (3 to 50 ft). Soils moderately developed to well developed.

GRAVEL TERRACE DEPOSITS

Gravel deposits of Pleistocene alluvial terraces are composed of moderately sorted and clast-supported sandy gravel. Clasts vary from subangular to rounded pebbles, cobbles, and few boulders at mountain front, to subrounded to rounded pebbles and cobbles near the confluence with the Lemhi River. Clasts primarily subrounded to well-rounded pebbles, cobbles, and boulders of quartzite and siltite from the adjacent mountains. Terrace deposits form a relatively thin (3-9 m; 10-30 ft) cap over a streamcut bedrock surface. Several levels of terraces and terrace remnants are preserved 3-195 m (10-640 ft) above the present-day streams. These record ong-term episodic incision of the Salmon basin, which was probably driven by glacial climate during the Pleistocene. Near the Beaverhead Mountain front and adjacent to hills of Tertiary sediments, terrace gravels commonly are capped by and interfinger with alluvial-fan deposits (Qaf and *Qafo*), which are included in the terrace unit locally.

Oto, Gravel of first terrace (Holocene to Late Pleistocene)—Forms terrace 3-9 m (10-30 ft) above modern streams. Soils weakly developed. Includes giantboulder debris flow that forms the mouth of Pratt Creek. This deposit with boulders up to several meters across was probably derived from a rock avalanche in the steep-sided glacial valley up Pratt Creek.

Gravel of second terrace (Late? Pleistocene)—Forms terrace 12-24 m (40-80 ft) above modern streams. Soils moderately developed. Gravel of third terrace (Middle? Pleistocene)—Forms terrace 37-49 m (120-

160 ft) above modern streams. Soils well developed. Gravel of fourth terrace, (Middle? Pleistocene)—Forms terrace 61-110 m (200-360 ft) above modern streams. Soils well developed.

Gravel of fifth terrace (Early? Pleistocene)—Forms terrace 122-146 m (400-480 ft) above the modern streams. Soils of original terrace surface eroded away. Gravel of sixth terrace (Early? Pleistocene to Pliocene)—Forms terrace remnants 168-195 m (550-640 ft) above Lemhi River. Soils of original

terrace surface eroded away.

Otgh High-elevation terrace gravel deposits (Pleistocene)—Subrounded to well rounded pebble to boulder sandy gravel. Forms terrace remnants at least 120 m (400 ft) above modern streams. Two rounded-gravel deposits are at 225 and 415 m (740 and 1,360 ft) above the Lemhi River. Deposits are 6 m (20 ft) thick. Soils of original terrace surface eroded away.

MASS MOVEMENT DEPOSITS

Olsa Deposits of active landslides (late Holocene)—Unstratified, poorly sorted silty clay and gravelly silty clay. Deposited by slumps, slides, and debris flows from slope failures in Tertiary sediments. Directly related to and formed after development of water ditches and irrigation.

Landslide deposits (Holocene to Pleistocene)—Unstratified, poorly sorted silty clay and gravelly silty clay. Deposited by slumps, slides, and debris flows that primarily occur in Tertiary sediments. For some, map shows the landslide scarp and the headwall (steep area adjacent to and below the landslide scarp) from which material broke away (see Symbols).

GLACIAL DEPOSITS

Qgt Till deposits of last local glacial maximum (Pleistocene)—Poorly sorted sandy to clayey boulder till. Clasts subangular to subrounded. Forms end moraines. Late Pinedale Glaciation equivalent. Soils weakly developed. Thickness as much as 20 m (65 ft).

Qgo Outwash gravels of last local glacial maximum (Pleistocene)—Subrounded to rounded, well-sorted sandy cobble to boulder gravel. Forms outwash terrace 12 m (40 ft) above Sandy Creek. Soils weakly developed. Primarily Pinedale equivalent. Thickness 3-9 m (10-30 ft). Probably overlies streamcut surface on bedrock.

TERTIARY SEDIMENTARY DEPOSITS AND VOLCANIC ROCKS OF THE SALMON BASIN

Janecke and Blankenau (2003) interpreted the Salmon basin as one of several supradetachment basins that formed in east-central Idaho and western Montana between 46 and 31 Ma (late middle Eocene to early Oligocene). Blankenau (1999) studied the structure and stratigraphy in the southern portion of the Salmon basin. He described and mapped basin sedimentary rocks and interpreted their stratigraphic and structural relationships in the basin. Previously, sedimentary rocks of the Salmon basin were described, subdivided, and mapped by Anderson (1957) and Tucker (1975). Harrison (1985) studied the sedimentology of the basinfilling sediments, identified a series of gradational facies, and described and sketch-mapped several lithostratigraphic units. In contrast to Anderson's ideas, she demonstrated that the basin sediments are conformable, and their lithologic distribution resulted from depositional environments that varied by proximity to the active, basin-bounding fault. The sediments were deposited in alluvial-fan, braided-stream, mixed-channel and flood-plain, and lake environments in a downfaulted subsiding basin. Harrison (1985) defined laterally gradational and interfingering, coarser and finer grained lithostratigraphic units. The units are local and informal: Harrison's "Formation" is changed to "formation," and her Mulkey Creek "Member" is changed to "formation" because the map distribution suggests equal status with the other units. Blankenau (1999) mapped the sedimentary rocks south of Haynes and Sandy creeks. His lithologic units and described facies help define the ancestral basin's tectonic setting and resulting depositional environments. Several local informal units from his map are included here in the following basin-wide lithostratigraphic map units. Most units are semi-consolidated; cementation is restricted to thin beds of sandstone and conglomerate, which are not laterally extensive. As a result, outcrops are rare and many slopes are covered with thin sheet wash and colluvium. Conglomerate beds weather to a gravelly soil mantle. Where bedding attitudes are nearly horizontal, cemented sandstone and conglomerate beds form low, flat benches that can be misinterpreted as Quaternary

Wimpey Creek formation (Oligocene and Eocene)—Vitric siltstone, bentonite, mudstone, and carbonaceous shale with interbeds of conglomerate and sandstone. Colors vary from white to greenish gray and pinkish brown. Locally stained and cemented with iron and manganese. Mostly distinguished by poorly consolidated fissile carbonaceous shale and bentonitic beds. Bed thicknesses range from a few millimeters to a few meters. Depositional environments vary from proximal mixed-load streams, to sandy mixed-load streams, to flood-basin swamps and ponds on the basin floor (Harrison, 1985). Toward the basin detachment fault the unit grades and interfingers with the conglomerate-rich Kriley Gulch formation (Tkg). Also grades and interfingers basinward with the Salmon City formation (Tsc) and the Mulkey Creek formation (Tmc). Gradational contact with these units estimated from geomorphic expression of lithology. Forms gently sloping, low-relief, and "badlands" topography that is prone to erosion and landsliding when wet.

Tsc Salmon City formation (Oligocene and Eocene)—Fine- to coarse-grained, moderate to well-sorted vitric quartz arenites interbedded with vitric siltstone, shale, and minor conglomerate. Outcrops generally buff colored. Bed thicknesses range from 50 cm to 3 m. Depositional environments predominantly distal sandy stream and distal shallow braided stream deposits in basin-axis longitudinal stream system (Harrison, 1985). Includes portions of Blankenau's (1999) Tertiary sandstone and the middle conglomerate of the sedimentary rocks of Tendoy. Depending on location within the depositional basin, the unit grades into and interfingers with the Wimpey Creek formation (*Twc*), the Mulkey Creek formation (*Tmc*), and the Kriley Gulch formation (Tkg). Gradational contact with these units estimated from geomorphic expression of lithology. Forms smooth, relatively steep slopes with intermixed ledges formed by thin beds of cemented conglomerate.

Mulkey Creek formation (Oligocene and Eocene)—Thin- to medium-bedded vitric to siliceous siltstone and finely laminated shale. Includes minor beds of carbonaceous shale with well-preserved plant remains representative of the Haynes Creek Flora (Axelrod, 1998). The unit coarsens upward into common vitric arenite and quartz arenite beds. Sample of thin tuff interbed dated at 31 Ma (Axelrod, 1998). Deposited in shallow lake at southern end of actively subsiding basin. Over time, the lake filled giving way to flood basin and longitudinal stream environments. Includes portions of Blankenau's (1999) shale facies of the sedimentary rocks of Tendoy. Interfingers laterally with the Salmon City formation (Tsc), and grades upward into and interfingers with the Wimpey Creek formation (Twc). Gradational contact with these units estimated from geomorphic expression of lithology. Forms badland topography and bright white and buff outcrops. Surface commonly displays finely spaced mudcracks or "popcorn" weathering.

Intercalated basalt (Oligocene and Eocene)—Thin flow or sill of basalt or andesite, either interbedded with siltstone and shale or intruded into the sedimentary rocks along bedding.

Kriley Gulch formation (Oligocene and Eocene)—Matrix-poor breccia, matrix-supported conglomerate, and clast-supported conglomerate; includes interbeds of ashes, vitric siltstone and sandstone. Silica and hematite cement are common near the basin detachment fault. Clast sizes commonly pebbles and cobbles, but large boulders locally occur as lag deposits from weathered and eroded beds. Beds are predominantly breccia and matrix-supported conglomerate lower in the unit, but transition upward to better sorted and cross-stratified clast-supported conglomerate. East of the Lemhi River, clast compositions are primarily Mesoproterozoic quartzite, siltite, and argillite derived from the adjacent Beaverhead Mountains. West of the Lemhi River, lower part of unit is predominantly debris-flow breccia with a high percentage of volcanic clasts derived from the Challis Volcanic Group. Depositional environments vary from proximal fan and fan head at the base of the unit to mid fan and proximal braided stream in the upper part (Harrison, 1985). Includes portions of Blankenau's (1999) middle conglomerate of the sedimentary rocks of Tendoy, and the conglomerate of Kenney Creek of the sedimentary rocks of Sacagawea. Percentage of fine-grained beds increases laterally, and depending on location within the depositional basin, the unit grades and interfingers with the Salmon City formation (Tsc), Wimpey Creek formation (Twc), and the Mulkey Creek formation (Tmc). Gradational contact with these units estimated from geomorphic expression of lithology. Forms steep slopes with coarse gravelly soils and resistant ridges capped with common lag pebbles and cobbles, and occasional lag boulders.

CHALLIS VOLCANIC GROUP

DIGITAL WEB MAP 141

OTHBERG AND OTHERS

Younger Challis tuff and sandstone, undivided (Eocene)—Volcanic and sedimentary rocks overlying the mafic lavas (Tlm). Includes Tuff of Curtis Ranch (Ttcr) and overlying quartz-sanidine welded tuff (Tqs.) along Withington Creek at the western map boundary, Tqs, resting directly(?) on Tlm on the north side of Haynes Creek, and lapilli-crystal-lithic tuff and interbedded sandstone higher(?) in the section east and west of Kadletz Creek. Ttcr and Tqs, are described below. The lapilli-crystal-lithic tuff contains potassium feldspar and quartz phenocrysts, and dark gray fine-grained quartzite clasts similar to those found in Tqt. Alternative explanation is that the Kadletz Creek area contains a remnant high with rocks that predate the mafic lavas rather than overlie them (*Tgt* rather than Tcty). Interlayered sandstone in the Kadletz Creek area contains subangular clasts of quartz, potassium feldspar, and plagioclase.

Younger quartz-sanidine welded tuff (Eocene)—White to pale green or gray-green with euhedral chatoyant sanidine and smoky quartz in a fine ash

groundmass (Tqs, of Blankenau, 1999). Degree of welding varies. Ttcr Tuff of Curtis Ranch (Eocene)—White to greenish white tuff containing abundant biotite and lesser amounts of smoky quartz, plagioclase, and angular volcanic and quartzite lithics (Tcr of Blankenau, 1999). Pumice is abundant to rare and typically concentrated at the top of the unit. Sandstone present locally at base. Typically poorly welded, but densely welded in places.

Mafic lava flows (Eocene)—Black to dark green-gray or dark brown-black aphanitic to porphyritic lava flows; locally vesicular (Tl of Blankenau, 1999). Includes dark brown shoshonite and medium gray to light brown latite. Shoshonite groundmass contains small plagioclase laths, olivine, and possibly pyroxene. A sample from a roadcut near the western map boundary (45.0213N, 113.7420W) contained rare xenocrystic clusters as much as 1 cm across of fine-grained olivine, and plagioclase xenocrysts as long as 6 mm. Latite groundmass is extremely fine grained and largely plagioclase that is aligned in a trachytic texture. A few 1 mm phenocrysts of plagioclase are present; similarly sparse olivine phenocrysts are largely altered to iron oxide. Interbedded with the flows are thin biotitic tuffs and volcaniclastic sandstones. Secondary chalcedony and calcite are common. Forms brown cobbly colluvial slopes that typically armor less resistant

Tgt Green tuff (Eocene)—Green to light green biotite tuff containing abundant euhedral biotite, smoky quartz, minor subhedral sanidine, and pumice in a white to light green ash groundmass. Also contains chert-bearing siltstone. (Tgt of Blankenau, 1999).

sedimentary units.

Tidac Dacite lava flows (Eocene)—Purple to purple-gray or dark brown dacite or andesite lava flows containing phenocrysts of euhedral biotite, hornblende, and plagioclase along with minor amounts of quartz and augite(?) in a fine crystalline groundmass (Tldac of Blankenau, 1999). Near the top of the sequence are aphanitic layers like those of the *Tlm* unit. Absent at surface west of Lemhi River.

Tqt Quartzite-bearing ash-flow tuff (Eocene)—White, pinkish red, white-gray, or pink-gray welded tuff containing abundant angular gray quartzite lithics and less abundant smoky quartz and plagioclase (Tqt of Blankenau, 1999). Poorly to densely welded.

INTRUSIVE ROCKS

Tertiary intrusion (early Oligocene?)—Dark red to gray andesitic intrusion. A whole-rock 40 Ar/ 39 Ar age determination of 37.08 \pm 0.21 Ma has an unreliable age spectrum and is probably too old (Blankenau, 1999, sample JB96-145). The intruded sediments may be as young as those dated at 31 Ma located 2.5 km (1.5 mi) to the southwest where probable Oligocene volcanism is also documented by a mafic lava or sill intercalated with fine-grained sedimentary rocks (see *Tmcb* description).

MESOPROTEROZOIC STRATA

Low metamorphic grade metasedimentary rocks of Mesoproterozoic age are exposed in the northeast and southwest corners of the quadrangle. Those in the southwest were assigned to the Gunsight Formation by Evans and Green (2003), a correlation with which we agree. Those in the northeast, assigned to the Gunsight and Apple Creek formations, were shown separated by a low-angle fault (Evans and Green, 2003). We did not find evidence of this fault, and instead of assigning Lemhi Group names, have given the rocks there a lithologic unit assignment (*Ysq*), and tentative correlations to other Lemhi Group formations, consistent with our mapping to the north in the Bohannon Spring quadrangle (Lewis and others, 2009).

Gunsight Formation (Mesoproterozoic)—Quartzite, siltite, and argillite. Quartzite very feldspathic and dark, but weathers light gray where not iron stained. Lowest exposures have tabular to channel-shaped beds 10 cm to 3 m thick in thinning upward stacks, separated by 1-10 m thick intervals of more thinly bedded quartzite and siltite. Upper exposed part much thinner bedded and more poorly exposed. Load bases more common in lower part; bedding surfaces covered with muscovite and light-colored mud chips or flakes more common in upper part. Atypical hornfels-like hardness, dark color, and paucity of dark laminations that are common to Yg elsewhere attributed to higher grade or different metamorphism here. Neither base nor top exposed, but thickness in the type section about 30 km (20 mi) to the south-southeast is about 1,800 m (6,000 ft; McBean, 1983). Includes two isolated bodies east of the main mass that may be landslide blocks (see

Ysq Siltite, quartzite, and argillite (Mesoproterozoic)—Laminated siltite and argillite with coarser and thicker intervals. Lowest exposures are decimeter-scale dark brown stained, dark gray siltite and very fine-grained quartzite interbedded with thinner siltite and dark argillite. Grades upward to the northeast through finer grained intervals with graded couplets and couples of light-weathering dark siltite and darker gray to green argillite. Thin bedding uneven, contorted, and perhaps fluidized. Above that, includes cosets of decimeter-scale coarser quartzite and graded beds as thick as 1 m with quartzite bases. Orange weathering, sparsely carbonatebearing quartzite farther northeast beyond the map boundary possibly Big Creek Formation. This is consistent with tentative correlation of *Ysq* with the type Inyo Creek Formation of the Lemhi Group (Ruppel, 1975) and rocks below the Inyo Creek that are not exposed in the Lemhi Range. Thickness uncertain because of deformation, but a minimum of 2,400 m (8,000 ft)

STRUCTURE

Several faults and folds traverse the quadrangle. Extensional faults in the southeast corner of the map are discussed by Blankenau (1999) and are shown in a simplified map by Janecke and others (2001). These faults typically bound Tertiary units and control their distribution.

FAULT "C"

The "C" fault of Blankenau (1999) is thought to cut Tertiary strata in the southeast corner of the map. We did not see evidence for faulting in the few places we traversed it, but exposures are poor and a large-displacement down-to-the-west fault is required along or east of the Lemhi River to repeat the Challis section.

FAULT "G"

The "G" fault of Blankenau (1999) is postulated to cross the southeast corner of the map. We did not investigate the fault in detail, but have included it here on the basis of apparent offset of Challis volcanic units along the lower part of Kenney Creek. It may offset fault C in the same area.

SALMON BASIN DETACHMENT

The range front fault in the northeast part of the quadrangle was mapped by Tucker (1975) and later interpreted as a low-angle detachment fault by Blankenau (1999). It is well exposed along Kenny Creek just east of the map where conglomerate is in contact with cataclasite formed from Proterozoic rocks. There the detachment has a dip of less than 15 degrees. Tucker mapped a breccia unit in the footwall of the fault along the range front that has been depicted using symbols on the present map.

Several folds whose axes trend north-south to north-northeast have affected the Tertiary strata. A detailed discussion of these and other folds southeast of the map is given by Blankenau (1999).

REFERENCES

Anderson, A.L., 1957, Geology and mineral resources of the Baker guadrangle, Lemhi County, Idaho: Idaho Bureau of Mines and Geology Pamphlet 112, 71 p. Axelrod, D.I., 1998, The Oligocene Havnes Creek flora of eastern Idaho: University of California Publications in Geological Sciences, v. 143,

Blankenau, I.I., 1999, Cenozoic structural and stratigraphic evolution of the

southeastern Salmon basin, east-central Idaho: Utah State University M.S. thesis, 143 p., 3 plates. Evans, K.V., and G.N. Green, 2003, Geologic map of the Salmon National Forest and vicinity, east-central Idaho: U.S. Geological Survey Geologic Investigations Series Map I-2765, 19 p., scale 1:100,000.

Harrison, S.L., 1985, Sedimentology of Tertiary sedimentary rocks near Salmon, Idaho: University of Montana Ph.D. dissertation, 175 p. Hipple, Karl, Karen Langersmith, Rulon Winward, Dal Ames, and Bradley Duncan, 2006, Soil survey of Custer-Lemhi area, Idaho, parts of Blaine, Custer, and Lemhi counties: United States Department of Agriculture, Natural Resources Conservation Service, 1270 p., soil maps at http://websoilsurvey.nrcs.usda.gov/app/.

Janecke, S.U. and J.J. Blankenau, 2003, Extension folds associated with Paleogene detachment faults in SE part of the Salmon Basin, in D.R. Lageson, and R.B. Christner, eds., 2003 Tobacco Root Geological Society Field Conference at the Belt Symposium IV: Northwest Geology, v. 32, p. 51-73. Janecke, S.U., J.J. Blankenau, C.J. Van Denburg, and B.S. Van Gosen, 2001, Map of normal faults and extensional folds in the Tendoy Mountains and Beaverhead Range, southwest Montana and eastern Idaho: U.S. Geological Survey Miscellaneous Field Studies Map MF-2362, scale 1:100,000.

Lane, E.W., 1947, Report of the subcommittee on sediment terminology: Transactions of the American Geophysical Union, v. 28, no. 6, p. 936-938. Lewis, R.S., K.L. Othberg, L.R. Stanford, R.F. Burmester, J.D. Lonn, and M.D. McFaddan, 2011, Geologic map of the Goldstone Mountain quadrangle,

Lemhi County, Idaho: Idaho Geological Survey Digital Web Map 134, scale 1:24,000. Lewis, R.S., K.L. Othberg, R.F. Burmester, J.D. Lonn, L.R. Stanford, and M.D. McFaddan, 2009, Geologic map of the Bohannon Spring quadrangle, Lemhi County, Idaho and Beaverhead County, Montana: Idaho

Geological Survey Digital Web Map 113 and Montana Bureau of Mines and Geology Open File 583, scale 1:24,000. McBean, A.J., II, 1983. The Proterozoic Gunsight Formation, Idaho-Montana: Stratigraphy, sedimentology, and paleotectonic setting: The Pennsylvania State University M.S. thesis, 235 p. Ruppel, E.T., 1975, Precambrian Y sedimentary rocks in east-central Idaho:

U.S. Geological Survey Bulletin 889-A, 23 p. Tucker, D.R., 1975, Stratigraphy and structure of Precambrian Y (Belt?) metasedimentary and associated rocks, Goldstone Mountain quadrangle, Lemhi County, Idaho, and Beaverhead County, Montana: Ohio, Miami University Ph.D. dissertation, 221 p., scale 1:48,000.