IDAHO GEOLOGICAL SURVEY
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DIGITAL WEB MAP 161
STEWART AND OTHERS

GEOLOGIC MAP OF THE CENTRAL AND LOWER BIG CREEK DRAINAGE, CENTRAL IDAHO

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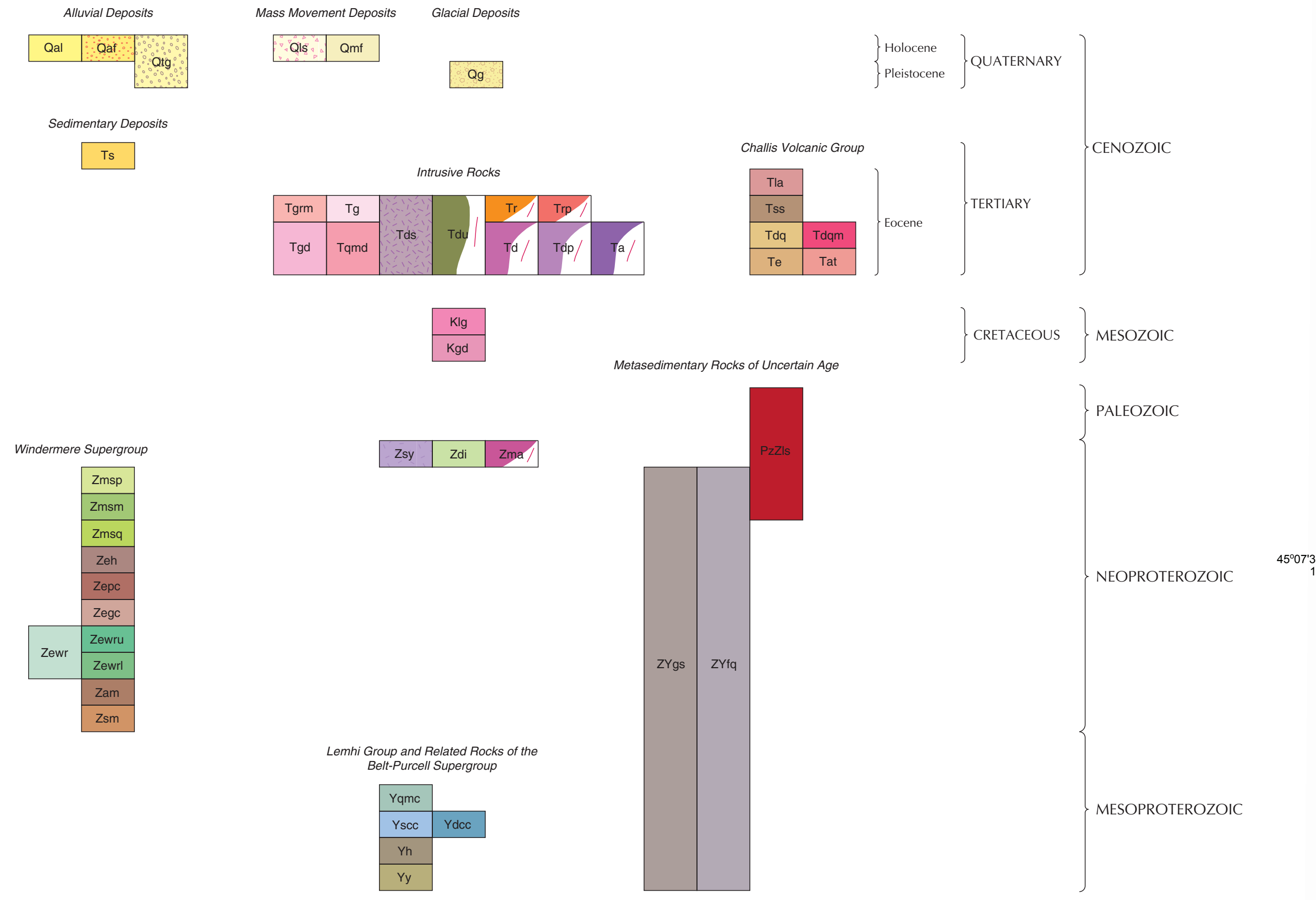
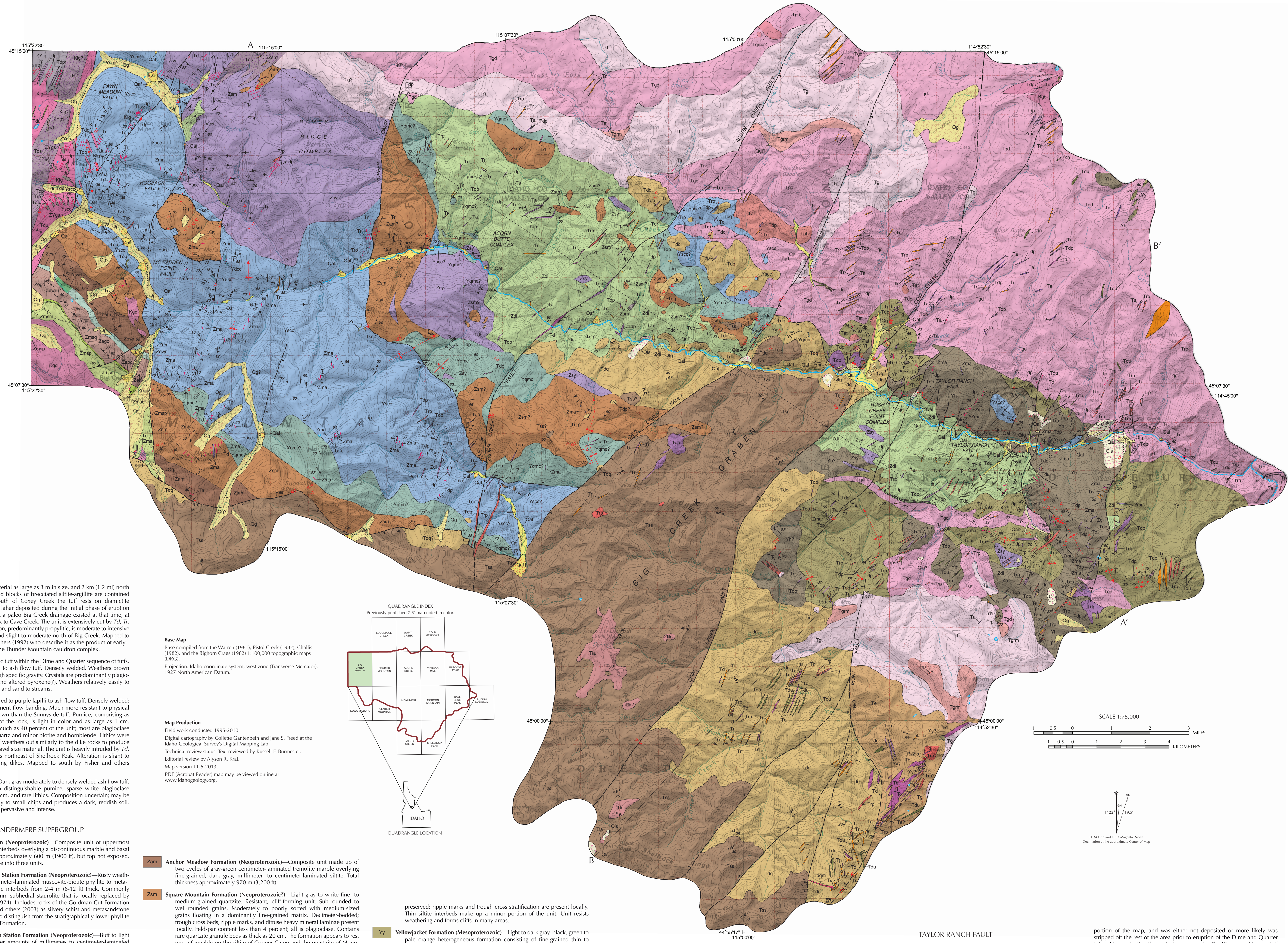
2013

CORRELATION OF MAP UNITS





SYMBOLS

- Contact: approximately located.
- Fault: dashed where approximately located; dotted where concealed.
- Normal fault: ball and bar on downthrown side; dashed where approximately located; dotted where concealed.
- Low-angle normal fault: hachures on downthrown side: dashed where approximately located.
- Fault: has both strike-slip and normal motion; dashed where approximately located; dotted where concealed.
- Mylonite.
- Anticline axial trace: dashed where approximately located; arrow indicates plunge direction.
- Syncline axial trace: dashed where approximately located.
- Strike and dip of bedding.
- Strike of vertical bedding.
- Strike and dip of bedding where sedimentary structures show bedding to be upright.
- Strike and dip of bedding interpreted to be overturned based on stratigraphic relationships.
- Strike and dip of bedding where sedimentary structures show bedding to be overturned.
- Approximate strike and dip of bedding interpreted to be overturned based on stratigraphic relationships.
- Strike and dip of bedding; strike variable.
- Approximate strike and dip of bedding.
- Strike and dip of flow or compaction foliation of in volcanic rocks.
- Strike and dip of joint.
- Strike of vertical joint.
- Strike and dip of foliation.
- Strike of vertical foliation.
- Strike and dip of mylonitic foliation.
- Strike and dip of cleavage.
- Strike of vertical cleavage.
- Bearing and plunge of lineation, type unknown.
- Bearing and plunge of mylonitic lineation.
- Bearing and plunge of crenulation lineation.
- Bearing and plunge of small fold axis.
- Bearing and plunge of of asymmetrical small "S" fold showing counterclockwise rotation viewed down plunge.
- Bearing and plunge of small recumbent fold.
- Tectonic breccia.
- Quartz or quartz-carbonate vein.
- Headwall scarp of landslide.
- Arrow shows dip of fault.
- Arrow shows dip of dike.

INTRODUCTION

The central and lower parts of the Big Creek drainage are underlain by metamorphosed sediments of Mesoproterozoic age and metamorphosed sediments and volcanics of Neoproterozoic age, all of which are intruded by a wide variety of Neoproterozoic, Cretaceous, and Eocene plutonic rocks. Locally the strata are overlain by Eocene volcanic rocks, and Quaternary surficial deposits in stream bottoms and glaciated areas. The area is cut by several major faults, many of which are northeast-striking normal faults.

Geologic mapping commenced in the fall of 1995 and continued intermittently through the summer of 2010. Most of the work was conducted from backpack camps that originated from the University of Idaho Wilderness Research Station at Taylor Ranch, the Cabin Creek airstrip, the Thunder Mountain trailhead, and the Big Creek trailhead. The authors also made use of the mapping by Leonard (1963), Kirkpatrick (1974), and Lewis and others (2012) in the western part of the area and included attitudes from their work on this map. Nomenclature for the Neoproterozoic metasedimentary and metavolcanic rocks is modified from Lund and others (2003) and Lund (2004). Because of difficult access, earlier regional mapping by Shenon and Ross (1936), Cater and others (1973), and Lund (2004) was reconnaissance-level work. Our efforts have provided additional detail, but access issues remain and continued study is warranted.

DESCRIPTION OF MAP UNITS

In the following unit descriptions and later discussion of structure, we use the metric system for sizes of mineral or clast constituents of rocks, and for small-scale features of outcrops. Unit thickness and distance are given in both meters (m) and feet (ft). Grain size classification of unconsolidated and consolidated sediment is based on the Wentworth scale (Lane, 1947). Intrusive rocks are classified according to IUGS nomenclature using normalized values of modal quartz (Q), alkali feldspar (A), and plagioclase (P) on a ternary diagram (Streckeisen, 1976). Volcanic rocks are classified by total alkalies versus silica chemical composition according to IUGS recommendations (Le Maitre, 1984).

SEDIMENTARY DEPOSITS

Qal **Alluvium (Holocene)**—Silt, sand, gravel, and cobbles deposited by streams as channel or overbank deposits. Clasts are rounded and locally they are crudely stratified and sorted.

Qls **Landslide deposits (Holocene)**—Silt- to boulder-sized debris, subangular to angular and poorly sorted. Formed by sudden slope failure; characterized by hummocky surface and fan-shape in plan view.

Qmf **Mudflow deposits (Holocene)**—Clay- to boulder-sized debris, subangular to angular, poorly sorted. Formed by oversaturation and resultant flow of colluvium; characterized by marginal ridges parallel to flow direction, bulbous terminal ridge, and elongate plan view.

Qaf **Alluvial fan deposits (Holocene)**—Pebbles, cobbles, sand, and silt deposited at the mouth of streams. Locally stratified with rounded clasts.

Qtg **Terrace gravel (Holocene and Pleistocene)**—Older silt- to cobble-sized alluvial materials. Clasts are rounded and locally poorly stratified or sorted. Deposits occur as small, scattered remnants of valley fill left by former stream activity. Unit also includes delta fan and varved lacustrine deposits that accumulated when Big Creek was dammed by the Soldier Bar landslide at about 21 ka (Eversole, 2008).

Qg **Glacial till (Pleistocene)**—Unsorted to poorly sorted cobbles, boulders, and sand. Primarily ground moraine deposits. In the glacially scoured basin drained by upper Cave Creek the deposits are made up of *Tgd*, *Kgd*, and biotite gneiss clasts.

Ts **Sediment (Tertiary)**—Small fluvial gravel deposit at 6400 ft elevation on ridge between Acorn Creek and Lime Creek.

INTRUSIVE ROCKS

Tdu **Dikes, undivided (Eocene)**—Undivided dike rocks; most are probably *Tr*, *Trp*, or *Tdp*.

Tds **Dike swarm (Eocene)**—Dacite porphyry dikes make up approximately 80 percent of this unit, which is only present in the northwestern part of the area. Rhyolite porphyry dikes, rhyolite dikes, dacite dikes, and minor Cretaceous leucogranite and metasedimentary rocks comprise the remaining 20 percent. Elongate body in extreme western part of area probably intruded along a fault zone. Most of unit resistant to weathering.

Tr **Rhyolite dikes (Eocene)**—Light to medium gray rhyolite with less than 15 percent phenocrysts of quartz (as large as 2 mm; typically corroded), potassium feldspar (as large as 2 mm), and minor biotite. Phenocrysts are set in an aphanitic groundmass of quartz and feldspar. Miarolitic cavities as large as 2 mm in diameter are present locally. Dikes resist weathering and are thus overrepresented in float.

Trp **Rhyolite porphyry dikes (Eocene)**—Light gray to light pink highly porphyritic rhyolite containing as much as 70 percent phenocrysts of quartz, potassium feldspar, and plagioclase and minor biotite. Phenocrysts are as large as 20 mm, set in an aphanitic groundmass of quartz and feldspars. The dikes are as thick as 15 m (50 ft). Dikes resist weathering and are thus overrepresented in float.

Td **Dacite dikes (Eocene)**—Medium gray to dark green, fine-grained to aphanitic dacite with sparse phenocrysts of plagioclase, biotite, and hornblende. Dikes resist weathering and are thus overrepresented in float.

Tdp **Dacite porphyry dikes (Eocene)**—Dark gray to dark green dacite with conspicuous white phenocrysts of plagioclase as large as 10 mm. Phenocrysts comprise as much as 50 percent of the rock; in addition to plagioclase, phenocrysts of potassium feldspar, hornblende, biotite, and minor quartz are present in a fine-grained to aphanitic groundmass. Dikes resist weathering and are thus overrepresented in float.

Ta **Andesite dikes (Eocene)**—Dark gray to black andesite lacking phenocrysts. Rare and generally less than 2 m (6 ft) thick. Easily weathered.

Tqmd **Quartz monzodiorite (Eocene)**—Light gray medium-grained hornblende-biotite quartz monzodiorite. Weathers readily. Plagioclase makes up over 60 percent of the rock with 10 percent potassium feldspar and minor quartz. Mafic minerals comprise 20 percent, with biotite more abundant than hornblende.

Tg **Granite (Eocene)**—Pink to light gray, medium- to coarse-grained equigranular biotite granite. Potassium feldspar, quartz, and plagioclase occur in roughly equal amounts. Biotite is generally less than 5 percent. Miarolitic cavities as large as 3 mm are locally present and contain euhedral potassium feldspar and dark quartz that have grown into the open spaces. Unit weathers easily to a coarse, thick grus. Where cut by vertical joints it spalls off as large boulders leaving the less weathered granite behind to form cliffs. Where vertical joints or fractures are not present, the granite weathers easily to form basins or rounded ridges.

Tgrm **Rhyolitic roof and margin of granite (Eocene)**—Varied unit including lithologies of *Trp*, *Tr*, and *Tg*, all of which are textural variants of a single magma type; represents chill and dike zone along the roof and margin of granite bodies. Resistant to weathering. In the Mormon Mountain area unit contains roof pendants of flow banded rhyolitic ash flow tuff.

Tgd **Granodiorite (Eocene)**—Light to dark gray, fine- to medium-grained equigranular hornblende biotite granodiorite. Weathers readily, producing a thick grus of coarse sand to fine gravel size. Plagioclase is the most abundant constituent, followed by quartz and potassium feldspar. Biotite is commonly pseudohexagonal, and hornblende is a conspicuous constituent. Mafic xenoliths are found locally within the granodiorite. *Td* and *Tdp* are textural variants of the granodiorite and commonly occur along its margins. Biotite ^{40}Ar/^{39}Ar plateau age of 46.4 +/- 0.3 Ma obtained from eastward extension of this unit at Veil Falls along the Middle Fork of the Salmon River (Dennis Geist, written commun., 1996). This is a minimum (cooling) age.

Klg **Leucocratic granite (Cretaceous)**—White to light gray, fine- to medium-grained equigranular muscovite granite. Resists weathering and is typically overrepresented in float. Muscovite content as much as 15 percent, but typically 2-5 percent. Minor biotite present locally. Conway and others (2004) reported a U-Pb age on zircon from the leucogranite of 75.3 ± 0.4 Ma.

Kgd **Granodiorite (Cretaceous)**—Light gray, medium-to coarse-grained equigranular biotite granodiorite. Weathers readily, producing a thick grus of coarse sand to fine gravel size. Plagioclase feldspar is the principal constituent, followed by quartz and potassium feldspar. Biotite is the only mafic mineral present, occurring as small (less than 2 mm) well disseminated flakes that make up less than 10 percent of the rock. In the vicinity of Coyote Springs the granodiorite includes blocks of biotite gneiss.

Zma **Mafic dikes (Neoproterozoic?)**—Dark, highly altered or weathered, aphanitic to fine-grained, equigranular diorite to andesite consisting primarily of plagioclase and hornblende. Easily weathered and thus underrepresented on map. Suspected to be fine-grained equivalents of *Zdi*.

Zdi **Diorite (Neoproterozoic)**—Predominantly medium-grained diorite composed of white plagioclase and as much as 60 percent black euhedral to subhedral hornblende. Quartz and biotite occur as minor constituents. Also includes a fine-grained variety (microdiorite), fine- to coarse-grained gabbro, and unmapped syenite similar to the *Zsy*. The diorite weathers relatively easily to a fine, dark soil. Interpreted as metavolcanic rocks by Leonard (1963), but as mafic intrusive rocks comagmatic with *Zsy* by Lund and others (2009) and on this map.

Zsy **Syenite (Neoproterozoic)**—White to light gray, medium-grained syenite; includes subordinate diorite described above (*Zdi*). Locally exhibits a weak foliation. Perthitic alkali feldspar is the dominant mineral and unit contains as much as 25 percent hornblende and biotite (although typically less than 15 percent). Quartz and magnetite are minor constituents. The Ramey Ridge complex was studied in more detail by Leonard (1963), who mapped an outer zone containing abundant amphibolite inclusions and an inner zone characterized by a relative scarcity of inclusions. Lund and others (2009) obtained a U-Pb zircon age of 651 ± 5 Ma from a sample collected on the east side of Ramey Ridge.

CHALLIS VOLCANIC GROUP

Tla **Latite (Eocene?)**—Dark gray, red weathering, very fine-grained, phenocryst-poor (2 percent or less) flow rock. May be an andesite. Plagioclase and blocky green pyroxene phenocrysts locally present. Groundmass is largely plagioclase laths. Generally dense, but locally vesicular to scoriaceous with flattened and distorted vesicles containing zeolites. Weathers to rounded blocks, and forms a dark fine-grained soil. Uppermost unit stratigraphically and thus only tentatively correlated with Eocene Challis Volcanic Group.

Tss **Sunnyside tuff (Eocene)**—White to pink moderately to densely welded rhyolitic lapilli to ash flow tuff made up of multiple cooling units. Weathers to coarse light colored sand or to plates in densely welded zones. Pumice, white to pale green, comprises from 0 to 30 percent of the rock. Pumice is 0.3 to 3 cm in size, typically moderately and locally highly flattened. Crystals make up from 20 to 60 percent of the rock, are 0.5 to 2 mm in size, and consist of plagioclase and potassium feldspar (as much as 60 percent of crystals) and quartz (commonly smoky; as much as 55 percent of crystals). Biotite is a minor constituent (less than 5 percent). Lithic fragments, primarily of volcanics but also quartzite and siltite, locally comprise as much as 40 percent. Near Cougar Peak, subrounded clasts of Cretaceous intrusive rock, quartzite, and schist are locally common and as large as 70 cm. Unit is locally intensely altered, particularly west of longitude 115. It does not support vegetation, and is easily eroded to form white scars on hillsides. It is the contributor of the clay-sized white material that forms debris flows or 'blowouts' on Monumental and Big creeks after heavy rains. Vitrophyres occur locally; in the Black Pole area banded vitrophyre is common and weathers to form rounded boulders. Unit rarely cut by dikes. Mapped to south by Fisher and others (1992) who described it as the product of a late-stage eruption from the Thunder Mountain cauldron complex.

Tdq **Dime and Quarter tuff (Eocene)**—Multiple cooling units of light gray to light green locally purple lithic lapilli to ash flow tuff of dacitic composition. Densely welded. Much more resistant to physical and chemical breakdown than the Sunnyside tuff. Weathers initially to 1-4 cm plates with irregular wavy surfaces that locally display an orange weathering rind. Weathers further to form chips as large as 1 cm and a dark soil. Pumice comprises 0-25 percent but locally as much as 50 percent. Pumice is 0.5 to 4 cm in size in plan view, light to dark gray green rarely white and moderately to highly flattened, with flattening less pronounced north of Big Creek. Pumice clasts contain plagioclase, potassium feldspar(?), biotite, and hornblende. Crystals as large as 2 mm make up less than 20 percent of the rock and are predominately plagioclase, with lesser quartz, potassium feldspar, as much as 5 percent biotite, and minor hornblende. Hornblende is more common north of Big Creek and locally occurs as acicular crystals as long as 2 mm. Potassium feldspar less common north of Big Creek. Lithics, generally less than 3 cm in size, comprise from 10 to 60 percent of the tuff and consist of volcanic fragments, quartzite, siltite-argillite, and rarely of two-mica granite blocks; along the ridge 1 km (0.6 mi) southwest of Shellrock Peak it contains blocks of volcanic material as large as 3 m in size, and 2 km (1.2 mi) north of Mile Hi house-sized blocks of brecciated siltite-argillite are contained within it. At the mouth of Coxey Creek the tuff rests on diamictite interpreted as a basal lahar deposited during the initial phase of eruption and demonstrates that a paleo Big Creek drainage existed at that time, at least from Acorn Creek to Cave Creek. The unit is extensively cut by *Td*, *Tr*, and *Trp* dikes. Alteration, predominantly propylitic, is moderate to intensive south of Big Creek, and slight to moderate north of Big Creek. Mapped to south by Fisher and others (1992) who describe it as the product of early-phase eruption from the Thunder Mountain cauldron complex.

Tdqm **Mafic tuff (Eocene)**—Mafic tuff within the Dime and Quarter sequence of tuffs. Dark gray lithic lapilli to ash flow tuff. Densely welded. Weathers brown and has a relatively high specific gravity. Crystals are predominantly plagioclase, minor quartz, and altered pyroxene(?). Weathers relatively easily to contribute small chips and sand to streams.

Te **Ellis tuff (Eocene)**—Gray-red to purple lapilli to ash flow tuff. Densely welded; locally exhibits prominent flow banding. Much more resistant to physical and chemical breakdown than the Sunnyside tuff. Pumice, comprising as much as 15 percent of the rock, is light in color and as large as 1 cm. Crystals comprise as much as 40 percent of the unit; most are plagioclase feldspar with lesser quartz and minor biotite and hornblende. Lithics were not observed. This tuff weathers out similarly to the dike rocks to produce angular cobble and gravel size material. The unit is heavily intruded by *Td*, *Tr*, *Trp*, and *Tdp* dikes northeast of Shellrock Peak. Alteration is slight to intensive near intruding dikes. Mapped to south by Fisher and others (1992).

Tat **Andesitic tuff (Eocene)**—Dark gray moderately to densely welded ash flow tuff. This unit contains no distinguishable pumice, sparse white plagioclase crystals as large as 2 mm, and rare lithics. Composition uncertain; may be latite. Weathers rapidly to small chips and produces a dark, reddish soil. Propylitic alteration is pervasive and intense.

WINDERMERE SUPERGROUP

Moores Station Formation (Neoproterozoic)—Composite unit of uppermost phyllite with marble interbeds overlying a discontinuous marble and basal quartzite. Thickness approximately 600 m (1900 ft), but top not exposed. Informally divided here into three units.

Zmsp **Phyllite of the Moores Station Formation (Neoproterozoic)**—Rusty weathering, light gray, millimeter-laminated muscovite-biotite phyllite to metasiltite with rare marble interbeds from 2-4 m (6-12 ft) thick. Commonly contains brown 2-4 mm subhedral staurolite that is locally replaced by sericite (Kirkpatrick, 1974). Includes rocks of the Goldman Cut Formation described by Lund and others (2003) as silvery schist and metasandstone that we were unable to distinguish from the stratigraphically lower phyllite of the Moores Station Formation.

Zmsm **Marble of the Moores Station Formation (Neoproterozoic)**—Buff to light gray marble and lesser amounts of millimeter- to centimeter-laminated calc-silicate rock. Thickness 0-30 m (0-100 ft); unit pinches out locally.

Zmsq **Quartzite of the Moores Station Formation (Neoproterozoic)**—Tan fine-grained quartzite and calc-silicate gneiss in decimeter-thick beds. Quartzite on ridge west of Placer Creek is moderately sorted. Entirely calc-silicate gneiss and calcareous quartzite on Hogback Ridge east of the Big Creek airstrip. Thickness approximately 15-200 m (50-600 ft).

Edwardsburg Formation (Neoproterozoic)—Metamorphosed mafic volcanogenic rocks with minor discontinuous felsic volcanic rocks and diamictite. First recognized and described by Leonard (1962), who noted a 'family resemblance' to metavolcanic rocks in northeastern Washington and southeastern Idaho. The latter were subsequently determined to be Neoproterozoic (Lund and others, 2003, and references therein), substantiating the correlation. Thickness approximately 900 m (3,000 ft).

Zeh **Hogback Rhyolite Member (Neoproterozoic)**—Metamorphosed felsic volcanic rocks containing phenocrysts of plagioclase and quartz. Dacite based on silica versus total alkalies composition listed in Lund and others (2003) and classification system of Le Maitre (1984). Found only on Hogback Ridge east of the Big Creek airstrip. Interpreted to be an ash flow tuff by Lund and others (2003), who obtained a U-Pb zircon date of 684 ± 5 Ma from a sample collected on Hogback Ridge. We did not find evidence of a pyroclastic origin, but do not discount the possibility. Thickness there approximately 300 m (1,000 ft).

Zepc **Placer Creek Member (Neoproterozoic)**—Metamorphosed, poorly sorted, matrix-supported conglomerate (diamictite) with volcanogenic(?) matrix and stretched clasts as long as 15 cm. Most clasts are 2-8 cm and consist of hornblende-phyric mafic volcanic rocks, quartzite, siltite, and calc-silicate rocks. Clasts are rounded and stretched as much as twice their width; bearing of elongation is 90-120°, plunging 50-55°. Lund and others (2003) interpreted these deposits to be of glacial origin. The small size of the clasts and lack of striations do not support a glacial origin; instead, the diamictites may be turbidite or debris flow deposits similar to those of the diamictite unit within the Apple Creek Formation south of Salmon, Idaho (Tysdal, 2003). Thickness 0-40 m (0-140 ft).

Zegc **Golden Cup Member (Neoproterozoic)**—Metamorphosed mafic volcanic flows and mafic volcaniclastic sediments. Massive, medium- to coarse-grained amphibolite with common hornblende porphyroblasts (after pyroxene or perhaps an earlier hornblende). Kirkpatrick (1974) reported two generations of hornblende; both are partially replaced by biotite. Rare relict 2-5 mm plagioclase phenocrysts and possible filled vesicles. Leonard (1962) reported a relict ophitic texture now consisting of albite-oligoclase laths embedded in porphyroblastic blue-green hornblende and dark green biotite. Whole-rock chemical data indicate a tholeiitic basalt composition (Lund and others, 2003). Increasing tremolite and calcite with siltite interbeds in the lower third of the member probably indicate that the deposit is volcaniclastic. Thickness approximately 700 m (2,300 ft).

Zewr **Wind River Meadows Member, undivided (Neoproterozoic)**—Upper diamictite and lower quartzite. Locally divided into two informal units below.

Zewru **Wind River Meadows Member, upper part (Neoproterozoic)**—Matrix-supported diamictite containing sparse (< 10 percent) rounded 1-4 cm clasts of quartzite, siltite, and calc-silicate rocks. Sand and silt matrix is calcareous in part. Matrix locally metamorphosed to calc-silicate minerals. Referred to as the lower diamictite by Lund and others (2003). Thickness approximately 135 m (450 ft).

Zewrl **Wind River Meadows Member, lower part (Neoproterozoic)**—Tan, fine-grained, feldspar-poor quartzite and laminated siltite. Thickness approximately 75 m (250 ft).

Base Map

Base compiled from the Warren (1981), Pistol Creek (1982), Challis (1982), and the Bighorn Crags (1982) 1:100,000 topographic maps (DRG).

Projection: Idaho coordinate system, west zone (Transverse Mercator). 1927 North American Datum.

Map Production

Field work conducted 1995-2010.

Digital cartography by Collette Gantenbein and Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.

Technical review status: Text reviewed by Russell F. Burmester.

Editorial review by Alyson R. Kral.

Map version 11-5-2013.

PDF (Acrobat Reader) map may be viewed online at www.idahogeology.org.

Zam **Anchor Meadow Formation (Neoproterozoic)**—Composite unit made up of two cycles of gray-green centimeter-laminated tremolite marble overlying fine-grained, dark gray, millimeter- to centimeter-laminated siltite. Total thickness approximately 970 m (3,200 ft).

Zsm **Square Mountain Formation (Neoproterozoic?)**—Light gray to white fine- to medium-grained quartzite. Resistant, cliff-forming unit. Sub-rounded to well-rounded grains. Moderately to poorly sorted with medium-sized grains floating in a dominantly fine-grained matrix. Decimeter-bedded; trough cross beds, ripple marks, and diffuse heavy mineral laminae present locally. Feldspar content less than 4 percent; all is plagioclase. Contains rare quartzite granule beds as thick as 20 cm. The formation appears to rest unconformably on the siltite of Copper Camp and the quartzite of Monumental Creek. Thickness approximately 1,350 m (4,500 ft).

LEMHI GROUP AND RELATED ROCKS OF THE BELT-PURCELL SUPERGROUP

Yqmc **Quartzite of Monumental Creek (Mesoproterozoic)**—Quartzitic strata named for exposures along lower Monumental Creek. West of Monumental Creek near Center Mountain unit is light to medium gray to gray-green, fine- to very fine-grained quartzite, siltite, and minor argillite. Quartzite dominates the upper part of the unit, with the lower part composed mostly of thinner bedded siltite and some argillite. Quartzite, some of which is argillaceous and contains from 10 percent to 25 percent feldspar, forms beds as thick as 0.5 m. Siltite beds are less than 10 cm thick, and argillite is 1 mm to 1 cm in thickness. Graded beds, soft sediment deformation, ripple marks, and rare mud cracks are preserved locally. Much of the unit is phyllitic. These rocks are moderately resistant to weathering, forming low cliffs and rounded peaks such as Center Mountain. Strata at Center Mountain are possibly correlative with quartzite above the banded siltite unit at the Blackbird Mine (Evans and Green, 2003).

Yscc **Siltite of Copper Camp (Mesoproterozoic)**—Light to dark gray-green siltite, calcareous and dolomitic siltite, dark gray to black argillite in the upper portion of the unit, and light gray fine-grained siltite and quartzite in the lower portion. Named for exposures along Big Creek near Copper Camp, about 3 km (2 mi) west of the mouth of Ramey Creek. Tentatively includes fine-grained strata with minor clean quartzite in beds less than 1 m thick depositionally above the contact with the Hoodoo Quartzite southeast of Horse Mountain. Feldspar in quartzite is plagioclase except locally near contacts with *Zsy* where secondary potassium feldspar occurs. West of Hogback fault unit is typically phyllitic and locally contains abundant calc-silicate minerals. Beds as thick as 20 cm compose most of the lower part of the unit, with graded beds, ripple marks, and rare cross beds preserved locally. These lower strata are probably equivalent to the argillaceous quartzite described to the east by Ekren (1988) that rest stratigraphically above the Hoodoo Quartzite east of the Yellowjacket mine. The lower strata may also correlate with the coarse siltite unit of the Apple Creek Formation south of the Blackbird Mine. Graded siltite to argillite couplets that dominate the upper part of the unit consist of centimeter-scale light siltite layers grading upward to millimeter-scale dark argillite. Graded beds, soft sediment deformation structures, and ptygmatically folded silt-filled cracks are common. Similar rocks to the east near Cobalt have been mapped as the banded siltite unit of the Apple Creek Formation (Tysdal, 2003). Throughout much of the area, the siltite of Copper Camp is internally folded, which increases its apparent thickness. A minimum thickness of 1500 m (5000 ft) is likely.

Ydcc **Diamictite of the siltite of Copper Camp (Mesoproterozoic)**—Matrix-supported diamictite in two intervals east and south of McFadden Point. Contains rounded siltite, quartzite, and calc-silicate clasts as large as 15 cm across in a siltite and very fine-grained quartzite matrix. Quartzite clasts are both feldspathic and feldspar poor. Matrix is relatively dark, containing abundant biotite, chlorite, and opaque oxides, along with sericite and local calcite and actinolite. Clasts are locally stretched, indicating shearing. May be similar to intraformational conglomerate mapped by Connor and Evans (1986) in the Leesburg quadrangle northwest of Salmon, Idaho. Thickness 0-40 m (0-130 ft).

Yh **Hoodoo Quartzite (Mesoproterozoic)**—White to light gray, fine- to coarse-grained, medium- to thick-bedded hornfelsed quartzite. Feldspathic in part; potassium feldspar well in excess of plagioclase (typically 10-20 percent versus 5 percent or less plagioclase). Sedimentary structures are rarely well preserved; ripple marks and trough cross stratification are present locally. Thin siltite interbeds make up a minor portion of the unit. Unit resists weathering and forms cliffs in many areas.

Yy **Yellowjacket Formation (Mesoproterozoic)**—Light to dark gray, black, green to pale orange heterogeneous formation consisting of fine-grained thin to medium bedded feldspathic quartzites, thin bedded siltites, and dark thinly laminated argillites, all of which have been metamorphosed to varying grades of hornfels; and thin to medium bedded calc-silicates. Rare thin carbonate beds are also present. Locally phyllitic. Sedimentary structures such as pinch and swell laminates, graded bedding, ripple marks, and cross stratification are observed locally. In area northeast of Dave Lewis Peak unit is gneissic, highly injected with igneous material, and contains metamorphic biotite. Gneissic texture is best developed immediately east of the north-south fault 2 km (1.2 mi) northeast of the peak.

METASEDIMENTARY ROCKS OF UNCERTAIN AGE

PzZls **Limestone (Neoproterozoic or Paleozoic)**—Light to medium gray occasionally white where altered by intrusive contact. Unfossiliferous micrite, which has locally prominent boxwork structure. Occurs as rare pods near Two Point Peak and east of Towhead Basin. Pods are as long as 15 m and occur within intrusive and volcanic rocks. Shenon and Ross (1936) speculated that these rocks might be Paleozoic in age, but no fossils have been found.

ZYfq **Feldspathic quartzite (Mesoproterozoic)**—Light to medium gray fine-grained feldspathic quartzite and minor siltite in the extreme northwestern part of the area. Centimeter to decimeter bedded. Feldspar content from 10 to 40 percent. Metamorphic biotite as much as 3 percent. Thickness uncertain.

ZYgs **Gneiss and schist (Mesoproterozoic)**—Biotite-muscovite gneiss and muscovite-biotite schist present in elongate screens less than 100 m (30 ft) across separating larger intrusions of Cretaceous leucogranite and Tertiary dikes west of the Fawn Meadow fault. Foliations and orientations of screens generally strike to the north-northwest and dip steeply. Thickness uncertain.

FAULTS

HOGBACK FAULT

The Hogback fault strikes north-south in the western part of the map and offsets the Proterozoic section along Big Creek. It has apparently undergone at least two episodes of movement. Initial right-lateral movement offset the basal Neoproterozoic section by 4,000 m (12,000 ft) and may have initiated during the Precambrian as indicated by *Zma* dikes intruding cleaved zones that parallel the fault. Reactivation as a normal fault with down-to-the-east movement after the Cretaceous is shown by a Cretaceous granodiorite stock in contact with *Yscc* strata unaffected by the intrusion. Less likely is that the right-lateral Hogback fault, together with the left-lateral Fawn Meadow fault (described below) were originally normal faults bounding a Neoproterozoic graben containing sub-horizontal strata, and that the entire graben was subsequently rotated to the south. This would have left the strata nearly vertical and the bounding normal faults as apparent strike-slip faults. Higher metamorphic grade of the lowermost strata between the Fawn Meadow and Hogback faults provides some evidence for such a scenario.

FAWN MEADOW FAULT

The Fawn Meadow fault strikes north-south near the west map boundary (Conway and others, 2004). It is at the eastern edge of an approximately 2 km (1.2 mi) wide zone heavily intruded by Cretaceous leucogranite and Tertiary dikes. Silicification, potassic alteration, and mineralization are common along and parallel to the fault. Shenon and Ross (1936) noted the extensive silicification at the Independence mine, immediately west of the map, which is associated with this structure. Much of the deformation and mineralization appears to pre-date Eocene dikes emplaced along the fault, but some of the dikes are altered and mineralized. Evidence of both ductile and brittle movement is observed. Mylonite along the fault immediately west of the map contains gently north-plunging lineations, indicating strike-slip motion. Offset of Proterozoic strata is difficult to document because of intrusions and alteration, but early left-lateral motion is likely (Conway and others, 2004). Post-Eocene brittle movement is shown by Eocene-age dikes that are brecciated along the fault. The Eocene movement was down-to-the-east normal faulting that exposed the highly intruded zone west of the fault.

MCFADDEN POINT FAULT

The McFadden Point fault in the east-central part of the map is characterized by abundant breccia and appears to be a low-angle normal fault (detachment fault) that juxtaposes Square Mountain and Apple Creek strata. An alternative but less likely interpretation is that the contact is an angular unconformity along which local brecciation has occurred. The age of this fault is poorly constrained; it appears to be cut by the Hogback fault and therefore probably pre-dates the post-Cretaceous movement on that fault.

THUNDER MOUNTAIN CAULDRON COMPLEX AND RELATED FAULTS

Eruption of the Sunnyside tuff led to collapse of the Thunder Mountain cauldron complex and structural displacement of the rocks within the Big Creek drainage into three blocks with contrasting structural styles. In block one, west of the Cave Creek fault, the cauldron complex collapsed primarily along the bounding fault that runs east-west just south of Marble and Center mountains, leaving volcanic deposits north of that fault relatively flat as shown by the presence of the Dime and Quarter tuff at similar elevations both north and south of Big Creek. The Acorn Creek fault parallels the Cave Creek fault and shares its sense of movement. Block two is the Big Creek graben to the east. There, collapse was along the Cave Creek fault on the west and the Cow Creek fault on the east. The northeastern termination of the graben is a sinuate fault just north of Big Creek. The outcrop pattern of the Sunnyside tuff suggests that this block is not tilted, with the exception of the portion north of Big Creek. Block three is east of the Cow Creek fault and is bounded on the east by the Two Point fault. To the south, the Two Point fault forms the eastern edge of what has been considered the Thunder Mountain cauldron complex (Fisher and others, 1992). The Two Point fault drops the Dime and Quarter tuff down to the west in a normal sense into contact with the Ellis tuff. This fault is joined by three other normal faults which share its sense of movement and are subsidiary to it. The outcrop pattern of the Dime and Quarter and Sunnyside tuffs indicates that subsidence was accommodated by tilting the entire block west of the fault down towards the south.

COPPER CAMP FAULT

A major fault crosses Big Creek at Copper Camp and drops Neoproterozoic Square Mountain quartzite into contact with syenite of the Ramey Ridge pluton. This fault displaces *Tg* and *Tgd*, demonstrating movement after emplacement of the Eocene intrusive rocks. Pre-Eocene movement is possible but not demonstrated by field relations.

TAYLOR RANCH FAULT

A north-dipping mylonitic shear zone extends from Pioneer Creek and Taylor Ranch northwest along the north contact of the dioritic Rush Creek Point complex. This shear zone is truncated by the Cow Creek fault to the northwest and could not be traced with certainty more than a short distance beyond Pioneer Creek to the southeast. Mylonitic lineation along the fault plunges gently to the east, suggestive of strike-slip motion. At Pioneer Creek the dioritic rocks are highly chloritized in addition to containing a mylonitic fabric. The northwest alignment of Neoproterozoic plutons (Rush Creek Point, Acorn Butte, and Ramey Ridge complexes) parallels this structure, suggesting that it may date from the Neoproterozoic.

GEOLOGIC HISTORY

The geologic record preserved in the middle and lower portion of the Big Creek drainage began with deposition of the Mesoproterozoic Yellowjacket Formation, the base of which is not exposed. The fine-grained clastics of the Yellowjacket are overlain by the Hoodoo Quartzite here and to the east (Ekren, 1988). The siltite of Copper Camp and the quartzite of Monumental Creek complete the package of Mesoproterozoic rocks. Portions of the siltite of Copper Camp are tightly folded. This style of deformation is not present in the Neoproterozoic deposits lying above it, which indicates a period of compressional deformation prior to deposition of the Neoproterozoic rocks. Evidence of an angular unconformity on the quartzite of Monumental Creek was seen north of Marble Mountain and is consistent with late Mesoproterozoic or early Neoproterozoic deformation and uplift.

The Neoproterozoic saw deposition of sands of the Square Mountain quartzite, calcareous fine-grained clastics of the Anchor Meadow Formation, and the volcaniclastics and volcanic flows of the Edwardsburg Formation. The Edwardsburg Formation records bimodal volcanism in the Hogback Rhyolite Member and the mafic flows of the Golden Cup Member (Lund and others, 2003). A late Neoproterozoic bimodal intrusive event produced the dioritic stocks of Rush Creek Point and Acorn Butte complexes, and the syenitic Ramey Ridge complex (Lund and others, 2009). The upper two members of the Edwardsburg Formation are absent at Sugar Mountain, outside of the map 16 km (10 miles) south of the Big Creek airstrip, which suggests that the phyllite and marble of the Neoproterozoic Moores Station Formation rest on a post Edwardsburg unconformity at that locality and perhaps within the Big Creek area as well. If the Hogback and Fawn Meadow faults are graben bounding normal faults as postulated in the structure section above, they most likely were active either prior to or after deposition of the Moores Station Formation.

No subsequent geologic activity is recorded in the area until the Cretaceous, when granodiorite and leucogranite of the Idaho batholith were intruded. Probably synchronous with this was metamorphism of the surrounding rocks to greenschist facies, and folding of the Proterozoic rocks that left them in their present overturned to nearly vertical orientation. If the Hogback fault developed due to strike-slip movement, it initiated following folding of the Proterozoic rocks. Gold mineralization in the western part of the area is likely to have been associated with intrusion of leucogranite, or soon thereafter, as subsequent Eocene dikes cut mineralized rock (Conway and others, 2004).

During the Eocene, three volcanic units blanketed the area filling in the Big Creek drainage, bimodal plutons were intruded, and major structural dislocation occurred. The first event recorded is deposition of the Ellis tuff, erupted from the Van Horn Peaks caldera to the southeast near Challis, Idaho (Fisher and others, 1992). The Ellis tuff is only present in the southeast portion of the map, and was either not deposited or more likely was stripped off the rest of the area prior to eruption of the Dime and Quarter tuff, which rests directly on Proterozoic rocks. The Dime and Quarter tuff was erupted from the Thunder Mountain cauldron complex centered just south of the map and is of dacitic composition in contrast with the later rhyolite of the Sunnyside tuff. The Dime and Quarter tuff has its intrusive equivalent in the Tertiary granodiorite, along with dacite porphyry, dacite, and andesite dikes. The tuff was deposited in the bottom of a paleo-Big Creek canyon, as described in the *Tdq* section above, and rests on the Proterozoic sediments and intrusives that had been eroded to form the paleodrainage.

Eocene volcanism continued with eruption of the Sunnyside tuff during the final eruptive phase of the Thunder Mountain cauldron complex. This massive eruption emptied enough of its near-surface magma chamber to cause collapse of the overlying material and formation of the Thunder Mountain cauldron complex and Big Creek graben as described in the structure section above. Eruption of the Sunnyside tuff was accompanied by emplacement of intrusive equivalents, the *Tg* with its *Tgrm* carapace, and *Trp* and *Tr* dikes. The latite of Lookout Mountain, overlying the Sunnyside tuff, was erupted in what was probably the final event of Challis-aged volcanism, though an Oligocene age is also possible.

Since the Eocene much of the volcanic deposits along Big Creek have been eroded to expose the Proterozoic rocks in which the pre-Challis canyon was cut. High benches, noted especially north of Taylor Ranch, were cut during this period of denudation, and one small remnant of a cobble and gravel deposit (*Ts*) laid down during this process is still preserved. Higher elevations of the area were glaciated during the Pleistocene to produce lakes, U-shaped valleys, and leave glacial till deposits. Glacial runoff greatly accelerated exhumation of the pre-Challis canyon. More recently, alluvial and mass movement deposits have further modified the canyon and brought it to its present state. A major landslide at Soldier Bar temporarily dammed up Big Creek and left behind lake bed deposits (Eversole, 2008). Another large slide at Lime Creek also dammed Big Creek.

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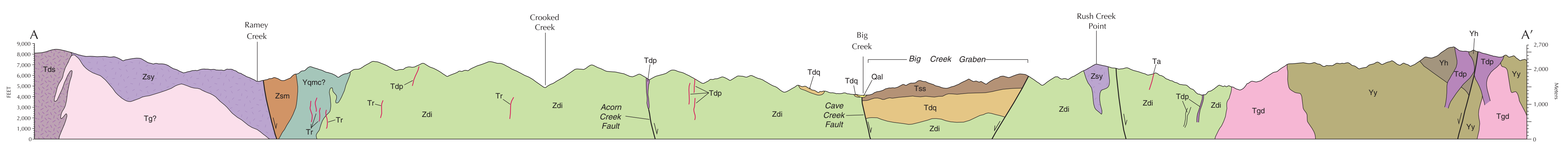

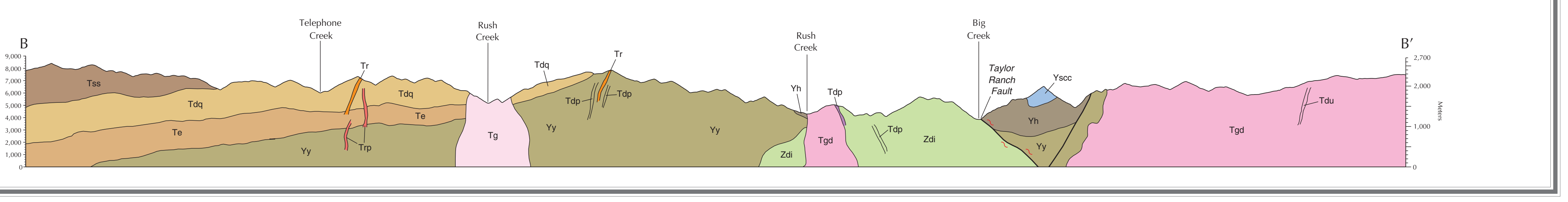

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