Geologic Map of the Elk City Quadrangle, Idaho County, Idaho

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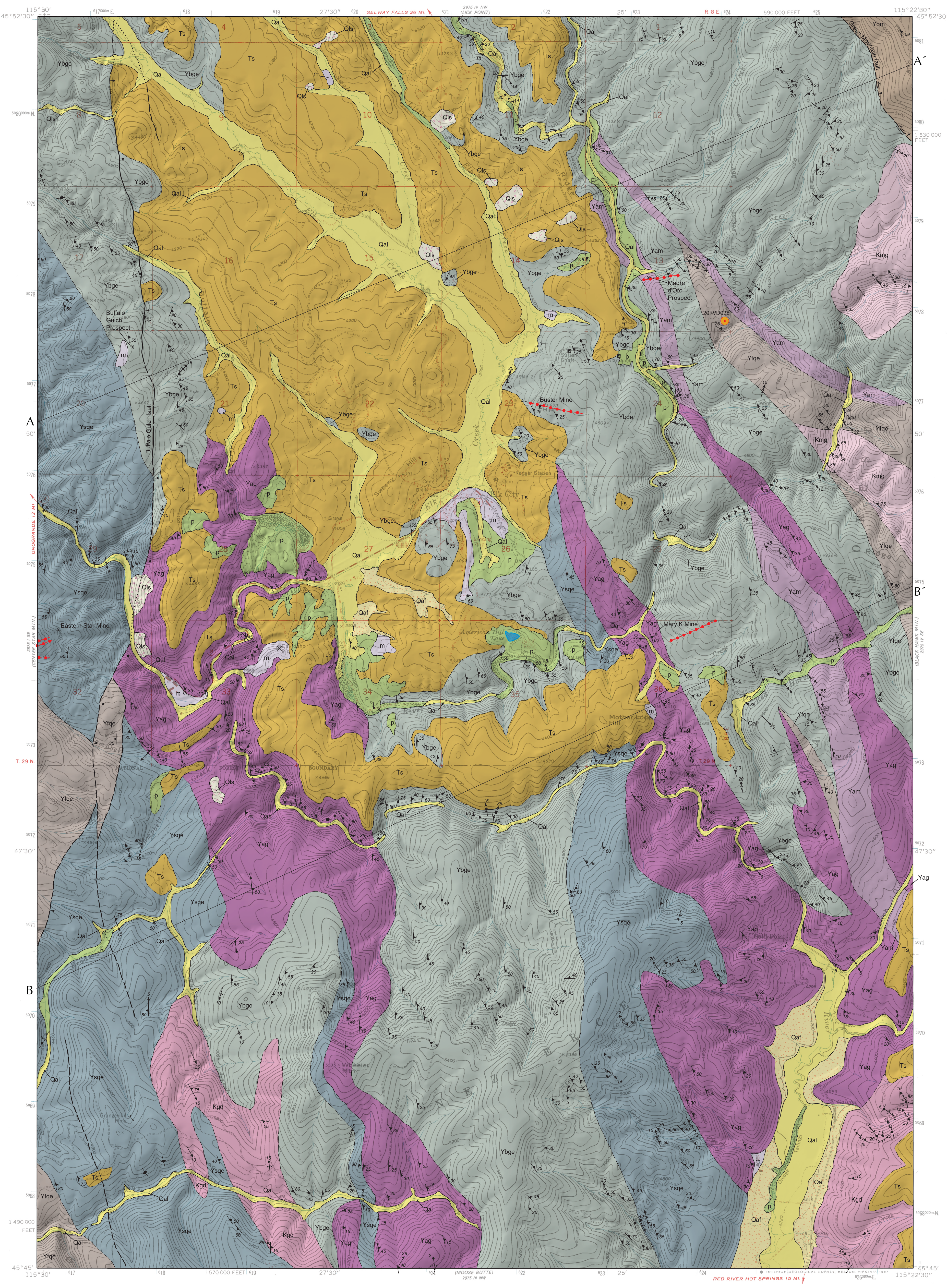
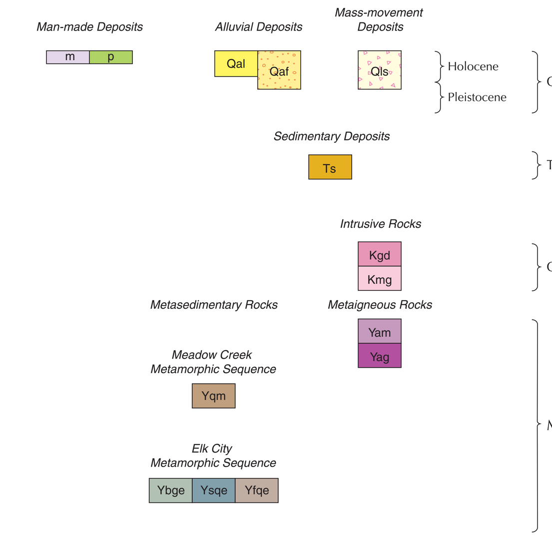


CORRELATION OF MAP UNITS



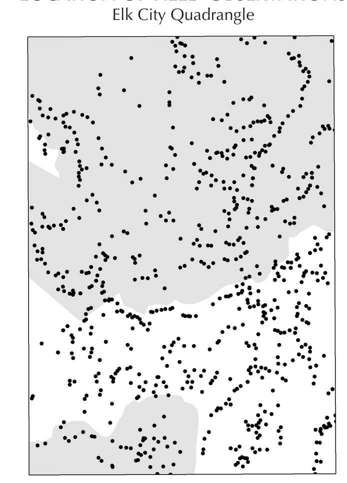
INTRODUCTION

The Elk City 7.5' quadrangle is underlain by a panel of northeast-dipping Mesoproterozoic sillimanite-grade metamorphic rocks of the Elk City metamorphic sequence, situated between the Golden metamorphic sequence to the west-southwest and the Meadow Creek metamorphic sequence to the northeast (Figure 1). The Elk City sequence belongs to the Lemhi strata of the upper Belt Supergroup (Lonn and others, 2017), and is intruded by a 1,380-1,370 Ma bimodal igneous suite that has been metamorphosed to augen gneiss and amphibolite. These metamorphic rocks are intruded and underlain by granitic rocks of the Late northern Cretaceous Atlanta lobe of the Idaho batholith. The metamorphic and igneous rocks are blanketed by an extensive, thin veneer of Miocene(?) fluvial and lacustrine sediments. Widespread historic dredging of the Miocene and Quaternary deposits for placer gold has disrupted soils and streams in much of the lowlands of the Elk City area; placer workings can be observed readily from roads along the rivers and in drainages, as well as in high-resolution aerial and LiDAR-derived imagery.

Much of the structural data and lithologic descriptions, and some of the geologic contacts presented on this map, are from field work in 1989 by Russ Burmester, aided by Joe Dragovich and Paul Riley. Many of these detailed geological data have not previously been published; however, the general geologic framework has been published at a small scale (Burmester and others, 1990; Lewis and others, 1990). Our additional detailed geologic mapping during the summer of 2020 focused primarily on the Tertiary sediments and structural history of the quadrangle. Recently flown LiDAR derived imagery, which covers ~70 percent of the Elk City quadrangle, was instrumental in augmenting new and existing ground-collected data.

LOCATION OF FIELD OBSERVATIONS

Elk City Quadrangle



SYMBOLS

Contact: solid where certain; dashed where approximately located.

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

Oblique-slip fault, left-lateral offset: dashed where approximately located; ball and bar on downthrown side.

Fault, type unknown: dashed where approximately located; dotted where concealed.

Strike and dip of joint.

Strike of vertical joint.

Strike and dip of cleavage.

Strike of vertical cleavage.

Strike and dip of foliation.

Strike of vertical foliation.

Trend and plunge of small fold axis.

Trend and plunge of asymmetrical "S" fold; sinistral shear sense.

Trend and plunge of asymmetrical "Z" fold; dextral shear sense.

Trend and plunge of lineation.

Trend and plunge of mineral lineation.

Trend and plunge of crenulation lineation.

Quartz vein.

Mine adit.

Mine shaft.

Mine.

Prospect.

20RVD028 Geochronology sample.

DESCRIPTION OF MAP UNITS

Igneous rocks are classified using International Union of Geological Sciences nomenclature and normalized values of modal quartz (Q), alkali feldspar (A), and plagioclase (P) (IUGS; Le Bas and Streckeisen, 1991). Grain size classification of unconsolidated and consolidated sediment employs the Wentworth scale (Lane, 1947). Time scale used is the Geological Society of America version 5.0 (Walker and others, 2018). Grain sizes and bedding thicknesses are given in abbreviation of metric units (e.g., dm=decimeter). Unit thicknesses, distances, and elevations are in both metric and English units. Multiple lithologies within a map unit description appear in order of decreasing abundance. Mineral modifiers are listed in order of increasing abundance.

MAN-MADE DEPOSITS

m **Made ground (Holocene)**—Altered surfaces and man-made ground. Includes piles of broken rock and sediment, excavated ground, emplaced construction materials, or other significant geomorphic alterations. Generally diverse in composition; locally derived.

p **Placered ground (Holocene)**—Meter-scale man-made piles of coarse river gravel from historical dredging placer operations. Placer deposits are extensive in the lowlands near Elk City, along river drainages, and present at higher elevations in ancient stream deposits (*Ts*). Dredge piles found in the Elk City area are extensive and significant.

ALLUVIAL DEPOSITS

Qal **Alluvium of the South Fork Clearwater River and tributaries (Holocene)**—Unconsolidated silt, sand, pebbles, and cobbles form narrow channels and floodplain deposits of the primary trunk of the South Fork Clearwater River and tributaries, including Red River and Elk Creek. Gravel deposits form bars and elongate islands within the river channels and generally consist of rounded pebbles to boulders. *Qal* in the northern half of the map is characterized by narrow meandering stream channels within a broad floodplain, up to ~460 m (1,500 ft) wide. Overbank and floodplain fines include silt to coarse sand. Overbank and beach fines include silt to coarse sand. Point bar sandy beaches are common. Thickness ~1 to 5 m (3 to 15 ft).

Qaf **Alluvial-fan deposits (Holocene to Pleistocene)**—Unconsolidated, crudely bedded silt, sand, and gravel deposits. Alluvial fans are low-angle; located near the center of the map, and as interconnected aprons along the periphery of the Red River valley in the southeast corner of the map. Clast composition reflects the local metamorphic and intrusive rocks that make up the surrounding highlands. Thickness ~1 to 15 m (3 to 50 ft).

MASS-MOVEMENT DEPOSITS

Qls **Landslide deposits (Holocene to Pleistocene)**—Unstratified to crudely stratified silt to boulder debris flows, slumps, and slides. These debris deposits consist of subangular to angular, poorly sorted material, commonly occupying steep hillsides. Characterized by longitudinal hummocky surface visible in LiDAR-derived imagery. Hachure denotes the over-steepened headwall scarp. Most landslide deposits on the map coincide with, or are proximal to, older unconsolidated fluvial and lacustrine sediments (*Ts*).

SEDIMENTARY DEPOSITS

Ts **Unconsolidated fluvial and lacustrine sediments (Miocene?)**—Unconsolidated, well-graded to poorly sorted, orange, brown, to white gravel and sand deposits with less common clay and silt. Gravel clasts are dominantly well-rounded cobbles of white coarsely crystalline quartzite. Cross-bedded sands, gravels, and boulder conglomerate contain wood fragments (Burmester and others, 1990). These deposits are easily eroded; commonly the well-rounded white quartzite pebbles and cobbles are the only vestiges of deposits that have been mostly washed away. These sediments are well exposed on the east side of American Hill Lake, ~1.6 km (1 mi) south of Elk City, along Mother Lode Road (Figure 2). Detrital zircon analyses from sample 21RVD057 (Figure 3) shows a robust Cretaceous signature accompanied by an age population distribution akin to Belt metasediments of the Lemhi sub-basin. Many deposits have been placer mined for gold and are morphologically altered by historic mining operations. However, the ore grade in *Ts* is lower than that of nearby Quaternary stream deposits (Shenon and Reed, 1934). Minimum thickness is approximately 100 m (320 ft).

INTRUSIVE ROCKS

Kgd **Biotite granodiorite and granite (Late Cretaceous)**—Light-gray to white, medium- to coarse-grained, equigranular to porphyritic, muscovite-bearing biotite granodiorite and granite. Regionally, plagioclase feldspar is the most abundant mineral (~50 percent), followed by subhedral quartz comprising at least 20 percent of the rock, with alkali feldspar being the least abundant. Grain size typically ranges from 1 to 3 mm; locally euhedral alkali feldspar phenocrysts are as long as 1.5 cm. Weathers brown, red, and orange; surficial iron oxide staining common. Fabric is generally absent from *Kgd*, but where observed, weakly-developed foliation is the most common type, whereas lineation is uncommon. Major exposures previously mapped as 'Kmig', a migmatite rock unit, are mapped here as a variation of *Kgd*. It is generally fine-grained, exhibits a saccharoidal, friable texture, and shows crude lenses of varying mafic to felsic composition. Accessible outcrop of migmatite is along Red River road on the southeast corner of the map. These fine-crystalline *Kgd* exposures are possibly chill zones, where fingers of the Idaho batholith intruded into the overlying metasedimentary rocks. Alkali feldspar exhibits microcline grid twinning; myrmekitic texture is common along contacts between microcline and plagioclase. A sample from a roadcut along Idaho State Route 14, on the South Fork Clearwater River, 13 km (8 mi) west of Elk City (located on the west side of Center Star Mountain 7.5' quadrangle), yielded a U-Pb zircon (LA-ICP-MS) age of 89.1 ± 0.7 Ma (Sample SFC-3 from Lee, 2004).

Kmg **Megacrystic granodiorite and quartz diorite (Late Cretaceous)**—Light-gray to white, foliated to lineated, hornblende-biotite granodiorite to quartz diorite. Characterized by megacrystic alkali feldspar 2 to 6 cm in length. Common accessory minerals include subhedral sphene and euhedral epidote interpreted to be magmatic in origin. Foliation is defined by alignment of biotite, while lineation, observed in the crude foliation planes, is defined by alignment of alkali feldspar and hornblende phenocrysts. Exposed only at the northeast edge of the map. A sample collected east of Red River Hot Springs 18 km (11 mi) east-southeast of Elk City yielded a U-Pb zircon (LA-ICP-MS) age of 92.4 ± 0.6 Ma (Sample 99RL293 from Gaschnig and others, 2010).

METAIGNEOUS ROCKS

Yam **Amphibolite (Mesoproterozoic)**—Black to dark-green, fine- to medium-grained amphibolite. Amphibole is the primary mineral, generally 0.5 to 1.5 mm, comprising up to 60 percent of the rock. Plagioclase ranges from 30 to 40 percent, and equant quartz comprises up to 10 percent; those minerals range from 0.10 to 0.5 mm. Amphibolite contains minor sphene and various amounts of biotite. Outcrops typically include ~20 to 60 percent centimeter- to decimeter-scale leucocratic interstitial layers and lenses, usually folded, and granitic. Minor structurally disrupted lenses of white to gray feldspathic quartzite and white to pink augen gneiss. The decimeter-scale, folded, metamorphosed and boudinaged biotite-rich bodies that occur in the *Ybge* and *Ysqe* units are probably sills or dikes of amphibolite. Exposures of *Yam* are limited to the northeast and eastern parts of the of the map area. We infer a mafic igneous parent for this unit, which formed sills in the original Elk City sedimentary sequence. Zircon age of correlative mafic rock about 120 km (73 mi) to the southeast along the Salmon River is 1378.7 +/- 1.2 Ma (Doughty and Chamberlain, 1996). Thickness of amphibolite sills varies from ~120 to 350 m (400 to 1,100 ft) as determined from cross section.

Yag **Augen gneiss of Red River (Mesoproterozoic)**—White, light-gray, to pink biotite-rich granitic gneiss with alkali feldspar augen megacrysts, plagioclase, and quartz. Alkali feldspar megacrysts measure up to 5 centimeters in length, commonly display rapakivi texture, and range in shape from euhedral in weakly strained gneiss, to lozenge-shaped with well-developed porphyroclast mantle structure and strain shadows in strongly strained rocks (Figure 4). Brown to red iron-oxide staining very common where weathered. Fine-grained, compositionally layered angular blocks and tabular bodies concentrated near the margins are probably inclusions of surrounding *Ybge*. Age from zircons in the augen gneiss of Red River is 1,370 ± 100 Ma (Evans and Fischer, 1986). More precise age is likely close to that of correlative intrusions along and south of the Salmon River to the southeast of Elk City (1,383 ± 4 to 1,377 ± 4 Ma; Aleinikoff and others, 2012) and 105 km (65 mi) northwest (1,379 ± 12 Ma; Lewis and others, 2007). Erodes as competent blocks that are rounded and produce abundant grus horizons where weathered. A granite or granodiorite parent is inferred for *Yage*, which intruded as sills into sedimentary Elk City sequence wallrock. Sills vary from ~150 to 1,200 m (~500 to 4,000 ft) in thickness as determined from cross sections.

METASEDIMENTARY ROCKS

Meadow Creek metamorphic sequence

Yqm **Quartzite of Meadow Creek (Mesoproterozoic)**—White to light-gray, speckled, fine-grained biotite quartzite. Quartzite exhibits a sugary, commonly friable, texture, especially along freshly broken surfaces, with lower abundance of competent, crystallized rock. Compositional layering with thin horizons of biotite, which ranges from ~2 to 60 centimeters in thickness, may be relict bedding. Regionally, unit contains up to 20 percent alkali feldspar and ~5 to 10 percent biotite (Burmester and others, 1990). Muscovite is present but rare. Schistosity commonly parallels compositional layering. Exposed in the northeast corner of the map, where it is juxtaposed with the Elk City metamorphic sequence by the Green Mountain fault (Figure 1).

Elk City metamorphic sequence

Ybge **Biotite gneiss (Mesoproterozoic)**—Fine- to medium-grained biotite (-muscovite) quartz-feldspar gneiss and minor intercalated muscovite-biotite (-quartz) schist. Biotite content varies widely in gneiss lithologies, ranging from ~5 to 30 percent and can be as long as 5 mm. Muscovite makes up 20 percent of the rock locally. Alkali feldspar makes up to 10 percent, and plagioclase up to 5 percent of the rock; both are generally 0.20 to 1 mm long. The main gneiss lithology in this unit consists of mm- to cm-scale, crudely- to well-layered, quartzo-feldspathic metagraywacke. Layering may be relict bedding. Lenses of muscovite-biotite quartz schist, generally meter-scale, within *Ybge* exposures are locally abundant and indicate that this unit may grade laterally into the schist and quartzite of *Ysqe*. Schistose horizons commonly contain cm-scale sillimanite-quartz lenticular nodules. Garnet is present in schistose lenses, but rare. Outcrops of *Ybge* commonly include cm- to m-scale leucocratic sills and dikes that typically exhibit ptygmatic folding (Figure 5). Some of these leucocratic intrusions are granitic to granodioritic pegmatites. Thickness ranges from ~210 to 1,200 m (710 to 3,700 ft) and likely reflects structural thickening or thinning due to folding and faulting; thickness determined from cross section.

Ysqe **Schist and quartzite (Mesoproterozoic)**—Interlayered quartz-mica schist and variably micaceous quartzite. Schist layers contain as much as 45 percent coarse-grained mica (biotite dominant with lesser muscovite). Feldspar, mostly alkali, makes up to ~5 to 25 percent of the rock, and quartz comprises from 30 to 75 percent. Accessory minerals include magnetite, fibrous sillimanite, and rare garnet. Biotite ranges from 0.25 to 3 mm in length. Sillimanite is commonly concentrated with quartz in 1 to 4 cm long lens-shaped nodules, lending a spotted appearance to the rock in hand sample. This schist commonly grades laterally into the biotite gneiss of *Ybge*. As in the biotite gneiss, cm-scale dikes and sills of ptygmatically-folded, leucocratic pegmatite of granitic to granodioritic composition, are common within this unit. Quartzite varies from dark gray, coarse grained (2 to 5 mm) and highly crystalline to light gray and fine grained (0.20 to 1 mm) sugary texture. Iron staining from weathering of magnetite crystals (2 to 4 millimeters in diameter) is common. Partings typically are 5 to 30 centimeters apart. Thickness ranges from ~360 to 430 m (1,200 to 1,400 ft); rock unit likely structurally thickened or thinned due to folding and faulting. Thickness determined from cross section.

Yfqe **Feldspathic quartzite and schist (Mesoproterozoic)**—White to gray impure quartzite and biotite schist. Compositional layering on the centimeter scale is defined by thin layers of schist intercalated with massive quartzite horizons. Quartzite typically contains ~20 to 30 percent alkali feldspar (with minor amounts of plagioclase feldspar) and about 10 percent micaceous (biotite dominant with minor muscovite) minerals. Quartz grains are commonly 0.25 to 1 mm across, but as large as 3 to 5 millimeters in highly recrystallized rocks. Sugary texture is common, except in the northeastern part of the quadrangle, where the rock is highly strained and crystalline. Centimeter- to decimeter-scale leucocratic pegmatite dikes and sills are also common within this unit. This quartzite unit differs from *Yqm* by having a coarser quartz grain size, more feldspar, and more abundant schist horizons. Detrital zircon analyses from the northeastern exposure of *Yfqe* (Figure 3) show an abundance of ages between 1,650 and 1,800 Ma, similar to the rocks of the Lemhi subbasin of the Mesoproterozoic Belt Supergroup (Lonn and others, 2017). Thickness in map unknown due to structure-bound exposures.

GEOPHYSICAL DATA

Magnetic and conductive properties of the Orogrande shear zone (Figure 1) were surveyed by Fugro Airborne Surveys Corporation in 2010 for Premium Exploration Inc., in effort to help target shear zone related gold deposits. Fugro employed an airborne Dighem multi-coil, multi-frequency electromagnetic system with high sensitivity cesium magnetometer to conduct their survey. Residual magnetics and apparent resistivity aid in delineating the magnetic and conductivity characteristics of the different lithologies, while the electromagnetic data, represented as EM anomalies, reflect probable conductive and deep-weathering rock zones. These geophysical survey data are exclusively from a north-south strip on the westernmost quarter of the map. Though coverage was limited, these data provided helpful information for reconciling fault and lithologic contact placements where exposure is poor.

DETRITAL ZIRCON DATA

A feldspathic quartzite sample (20RVD028) and a sediment sample from *Ts* (21RVD057) were collected for detrital zircon analysis. U-Pb zircon ages were determined by Darin Schwartz using LA-ICP-MS methods at the Boise State University Isotope Geochronology Laboratory, and plotted with Isoplot 3.0 (Ludwig, 2003). Sample 21RVD057 was collected from a roadcut near American Hill Lake, ~1.6 km (1 mi) south of Elk City. The probability density plot shown in Figure 3 exhibits a similar peak circa 1,684 Ma, likely reflecting the contribution by Mesoproterozoic metasedimentary rocks. Another robust peak around 92 Ma reflects the ever-present granitic rock of the Idaho batholith. Sample 20RVD028 was collected from an exposure of crystalline feldspathic quartzite (*Yfqe*), southwest, and proximal to, the Green Mountain fault. Most of the detrital zircon grains fall within an age group that ranges from ~1,650 to 1,800 Ma. These analyses, shown as a probability density plot (Figure 3), yielded a provenance record that indicate *Yfqe* is Mesoproterozoic and thus included in the Lemhi strata of the upper Belt Supergroup (Lonn and others, 2017). Due to similarities in metamorphic grade, mineral composition, and conformable contacts, we export this interpretation to the full breadth of the Elk City metamorphic sequence.

STRUCTURE

The structural and deformation history of the Elk City quadrangle is long lived, exhibiting pervasive contractional deformation and local brittle faulting that accommodated contractional, transpressional, and extensional deformation. The average foliation of the Elk City metamorphic sequence dips moderately (~40 degrees) east-northeast, while the mean lineation plunges shallowly (~10 degrees) to the southeast. The map area lies along the eastern margin of the northern extent of the Late Cretaceous Atlanta lobe of the Idaho batholith, where intrusion of the batholith rocks largely pre-dates, or is synchronous to, the regional-scale deformation events.

Dragovich and others (2009) outlined a detailed structural analysis of the Elk City 7.5' quadrangle and the area to the north and east, identifying five primary deformation events including Miocene to recent normal faulting. Four of these deformation events are preserved in the Mesoproterozoic metasedimentary rocks and are ductile in nature, yielding folds, foliations, and lineations (e.g., Reid, 1959; Dragovich and others, 2009).

Deformation event one (D1) is characterized by northwest-striking, moderately to gently northeast-dipping foliation and rare isoclinal folds likely generated by structural transposition of original bedding accompanied by greenschist-grade metamorphism.

Deformation event two (D2) consists of upright to overturned-to-the-southwest tight folds with axial planar foliation defined by mica alignment that is distinct from D1 foliation. It is postulated that these D2 folds, which are generally meter-scale M, S, and Z-folds, could be smaller-scale parasitic folds of larger, map-scale structures (e.g., Reid, 1959; Dragovich and others, 2009), though we did not recognize these map-scale folds in the quadrangle. The megacrystic granodiorite (*Kmg*) records an L-S magmatic fabric subparallel to D2 axial planar fabric (Dragovich and others, 2009), suggesting that the emplacement of the megacrystic granodiorite is syntectonic, and thus approximately Late Cretaceous (92.4 ± 0.6 Ma from Gaschnig and others, 2010). D2 fabric orientation shows northeast-southwest shortening and minor extension in the northwest-southeast as evident by mineral and stretching lineation along the fold axes.

D3 structures are rare in the Elk City quadrangle but are more common to the northeast where they are characterized as meter-scale, gentle-open folds with most fold axes plunging shallowly to moderately northeast (Reid, 1959; Dragovich and others, 2009). This deformation is speculated to have occurred in response to exhumation of arc-affinity rocks to the north (Dragovich and others, 2009).

The fourth deformation event (D4) is represented regionally by micro-chevron folds and retrograde metamorphism, along with brittle, dip-slip, faulting related to northwest-southeast extension, possibly as old as Eocene (Reid, 1959; Dragovich and others, 2009).

D5 is the most recent (Miocene or younger) and is characterized by north-striking, down-to-the-east, brittle normal faults and fault breccias. This generation of faulting likely created Tertiary basins across the region, including the one in which Tertiary sediments (*Ts*) covering much of the northern half of the Elk City 7.5' quadrangle, were deposited.

BUFFALO GULCH FAULT

The Buffalo Gulch fault is a north-striking, moderately dipping, down-to-the-east normal fault. It can be traced for almost the entire north-south length of the quadrangle on the western side of the map but is most conspicuous in the west-central part. The LiDAR-derived imagery shows geomorphologic features along this fault's scarp that suggest a primarily normal, dip-slip sense of motion. These geomorphologic features include a linear, north-trending, segmented trough, a meter-scale hanging wall graben, and numerous benches in the hanging wall. The Buffalo Gulch fault, a D5 structure, forms the western boundary of the Elk City basin and is thought to be Miocene or younger.

GREEN MOUNTAIN FAULT

The Green Mountain fault is named after Green Mountain, located 29 kilometers (18 miles) east-northeast of Elk City (Figure 1), where it was originally mapped (Lewis and others, 1990). Northwest-striking in the northeast corner of the map, it juxtaposes the sugary quartzite of the Mesoproterozoic Meadow Creek metamorphic sequence in the hanging wall against the Elk City metamorphic sequence rocks, *Yag* and *Yam* in the footwall to the southwest. The biotite gneiss (*Ybge*), impure quartzite and schist (*Yfqe*), and amphibolite (*Yam*) proximal to the Green Mountain fault exhibit recrystallization and high-strain textures that could be genetically related to movement on this structure. The fault is characterized by a steep zone of mylonitized rock that has a northwest-striking, steep northeast-dipping foliation, and a shallow northwest-plunging stretching lineation. Lenses of leucocratic granodiorite form dm-scale boudins perpendicular to the stretching lineation. Outcrop kinematic indicators, mostly S-C fabrics and rotated grains documented ~6 km to the east in the neighboring quadrangle (Black Hawk Mountain 7.5' quadrangle), indicate left-lateral sense of motion with a small component of down-to-northeast (normal) shear, parallel to the stretching lineation. The normal component of shear inferred from small-scale fabrics is corroborated by macroscale observations. Dragovich and others (2009) suggested that deformation on the Green Mountain fault post-dates intrusion of the megacrystic granodiorite (*Kmg*), as indicated by cross-cutting relationships observed east of the Elk City 7.5' quadrangle, and thus is estimated to be Late Cretaceous or younger.

NOTE ON THE RED HORSE CREEK FAULT, WHICH HAS BEEN OMITTED FROM THE MAP

A change to the original interpretation of the structural geologic framework of the area (e.g., Burmester and others, 1990; Lewis and others, 1990) is our omission of the Red Horse Creek fault. This fault was shown as a northeast-striking vertical fault that cut and offset rocks of the Elk City metamorphic sequence, and was named after Red Horse Creek, located on the eastern central part of the quadrangle (Burmester and others, 1990). From Red Horse Creek proper, the fault trace was originally interpreted to cross the map at a bearing of approximately 240 degrees, with much of its length along the Red River south of Elk City. Our mapping efforts in 2020 found no conclusive evidence for major offset across the proposed fault, and we have deemed the fault an unnecessary structure.

MINES AND PROSPECTS

The Elk City 7.5' quadrangle includes the majority of the northwestern half of the historic Elk City mining district (Shenon and Reed, 1934; Lorain and Metzger, 1938; Reid, 1959). Placer workings are common, and remnants of these surface operations can be found in almost every stream valley in the map area. Historic non-placer workings include the Mary K, Madre d'Oro, and Mother Lode mines, and the Eastern Star and Buffalo Gulch prospects. Lode deposits in the district coincide with structurally controlled, narrow, en-echelon, steep dipping, east to northeast-striking, quartz veins hosted in Mesoproterozoic metasedimentary and Late Cretaceous granitic rocks. Ore shoots are generally steep-dipping and subparallel to the dip direction of the quartz veins. The quartz veins are as much as ~6 meters (20 feet) wide, as long as ~90 meters (300 feet) in length, and are commonly enveloped in dark-gray gouge that separates the quartz from the wall rock (Shenon and Reed, 1934). The Buffalo Gulch deposit, characterized as a disseminated gold deposit of low grade, is an exception to this rule.

Mines and larger prospects with adequate records are described below. In addition to the references provided below, unpublished maps and reports for all properties can be found through the interactive map ("Mines" web app) on the Idaho Geological Survey website (https://www.idahogeology.org/webmap). Property codes (e.g., EC0017) are provided below to help with website queries. Technical reports by Bema Industries Ltd. (1988) and by GeoSim Services (2012) can be found on the Idaho Geological Survey website by examining "Property Details" in the "Mines" web app (https://www.idahogeology.org/webmap?show=mines) for the Buffalo Gulch prospect (IGS ID = EC0017).

MARY K (BLACK PINE) MINE (EC0039)

Formerly known as the Black Pine Mine, the Mary K Mine is located 2.4 km (1.5 mi) southeast of Elk City. Shenon and Reed (1934) characterize the Mary K quartz vein as a high-grade bonanza gold-bearing vein with accessory sulfides hosted within non-mineralized augen gneiss and biotite gneiss. The west-southwest-striking, northwest-dipping (70 degrees) Mary K vein is described as having an envelope of dark-gray gouge whose thickness changes along strike; a thicker gouge envelope accompanied by a thinner vein seem to be coincident where strike is farther east of north (Figure 6 from Shenon and Reed, 1934). Bond Resources acquired the Mary K property in 2019 and has commenced with exploration drilling and has begun excavation of a new portal as of summer 2020.

MADRE d'ORO PROSPECT (EC0003)

This prospect is located on the east side of the American River, ~3 km (2 mi) northeast of Elk City. Development of this property consists of approximately ~330 m (1,100 feet) of tunnel accompanied by a few shallow prospect pits (Shenon and Reed, 1934). An east-striking quartz vein, with a steep (~80 degrees) north dip, hosted by a hornblendite (*Yam*) sill was the target (Shenon and Reed, 1934).

EASTERN STAR (EC0547)

The target quartz veins of the Eastern Star property straddle the boundary between the Elk City quadrangle and the Center Star Mountain 7.5' quadrangle to the west. While most of this property is located outside and to the west of the map, the eastern extent of the semi-parallel vein system encroaches the west-central part of the map, ~2 km (1.6 miles) south of the South Fork Clearwater River. Historic workings include shallow shafts and trenches. The quartz-vein system of Eastern Star is hosted by strongly sheared Mesoproterozoic gneiss and schist, and has been intruded by leucocratic sills and dikes. Gold-bearing quartz veins are commonly accompanied by silicified wall rock and a broad sericite halo. The Eastern Star is, as of 2021, under Idaho Strategic Resources, Inc. ownership.

BUFFALO GULCH (EC0017)

The Buffalo Gulch prospect is located 3.2 km (2 mi) west-northwest of Elk City in the western portion of the Elk City mining district. Low-grade gold and silver mineralization was discovered here in the 1980s by Bema Gold Corporation. Mineralization is in heavily weathered and oxidized metasedimentary rock units where accompanied by granitic to granodioritic intrusions. Hydrothermal mineralization is speculated to be related to the north-striking Buffalo Gulch fault (Figure 1), where the prospect is located in the footwall, west of the fault trace. Gold mineralization at Buffalo Gulch is low-grade, disseminated, and generally housed in gold-bearing arsenic-rich pyrite. Very thin, northwest-striking, quartz and limonite veins with pervasive sericite and clay alteration also host concentrated gold mineralization.

PLACER DEPOSITS

Placer mining is a long and storied practice in the Elk City area, where the hallmark dredge-piles and hillside ditches are common across the landscape and have significantly altered the geomorphology of the area. Most of the Elk City placer deposits are within the basin containing Elk Creek, American River, and their respective tributaries (Loraine and Metzger, 1938; Reid, 1960). In the Elk City area, there are two stages of placer gold deposits, which range in age and precious mineral concentration. The 'high-level type' placer workings are processed Miocene(?) sediments (*Ts*) and have been assessed as generally low grade (Shenon and Reed, 1934). Placer deposits within modern streams and drainages are active fluvial systems that are eroding, recycling, and transporting the Miocene(?) sediments and the underlying metamorphic and igneous rocks, forming small gravel deposits with gold concentrations high enough to have warranted small-scale commercial operations (Shenon and Reed, 1934).

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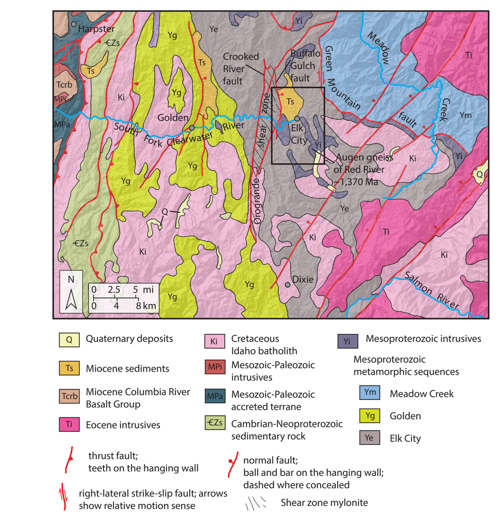


Figure 1. Simplified geologic map of the Elk City 30' x 60' quadrangle. Black rectangle outlines Elk City 7.5' quadrangle.

Figure 2. Hillside roadcut exposure of *Ts* on the east side of American Hill Lake near the center of the map area, ~1 km (0.6 mi) south of Elk City. Small child for scale. Picture taken in 1989.

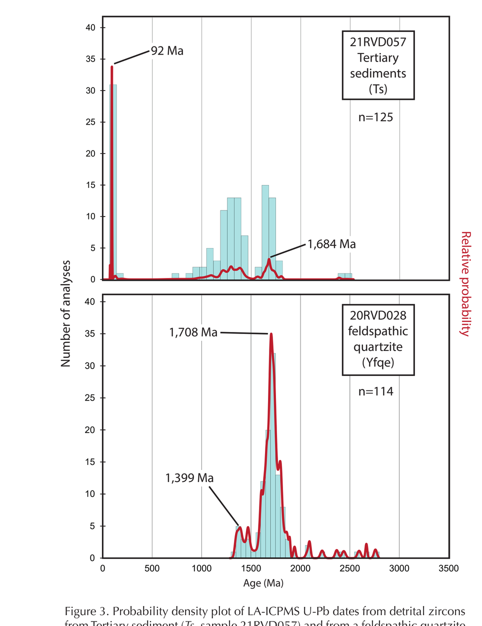
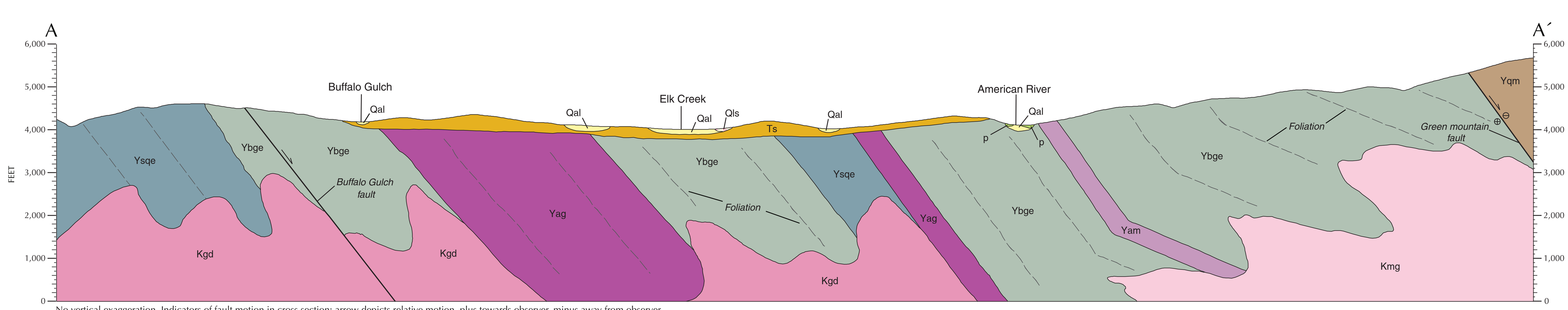


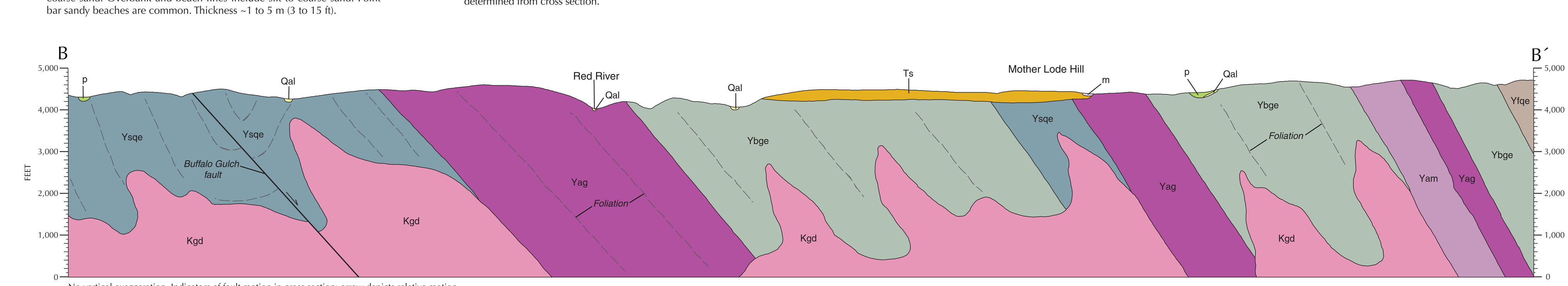
Figure 3. Probability density plot of LA-ICPMS U-Pb dates from detrital zircons from Tertiary sediment (*Ts*, sample 21RVD057) and from a feldspathic quartzite (*Yfqe*, sample 20RVD028) in the Elk City 7.5' quadrangle. Location for sample 21RVD057 is 45°48'47"W; 115°25'54"N, while 20RVD028 is 45°50'37"W; 115°24'9"N (NAD27) . Analytical work by Darin Schwartz at Boise State University. Plotted using Ludwig, 2003.

Figure 4. Fresh roadcut surface of the augen gneiss of Red River (*Yag*) 3.5 km (2.2 mi) southeast of Elk City.

Figure 5. Outcrop exposure of Mesoproterozoic biotite gneiss (*Ybge*) with pervasive, ptygmatically folded, leucocratic sills and dikes. Exposure located in the northeast corner of the map, southwest of Flatiron Ridge. Rock hammer for scale. Photo taken in 1989.



No vertical exaggeration. Indicators of fault motion in cross section: arrow depicts relative motion, plus towards observer, minus away from observer.



No vertical exaggeration. Indicators of fault motion in cross section: arrow depicts relative motion.

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