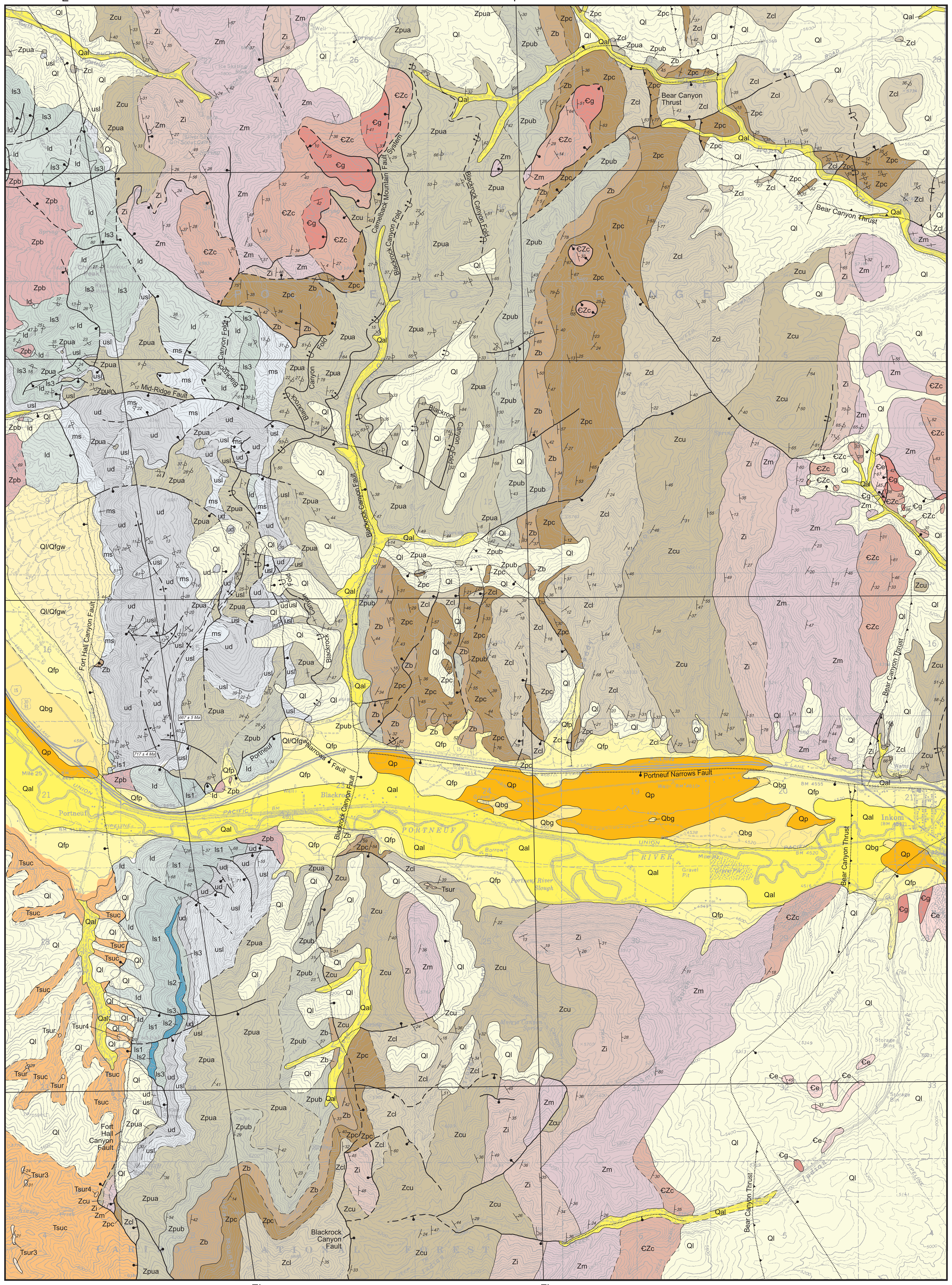
Geologic Map Of The Inkom Quadrangle, Bannock County, Idaho

D. W. Rodgers, S.P. Long, N. McQuarrie, W. D. Burgel, and C. F. Hersley

2006



Base map from USGS Digital Raster Graphic.

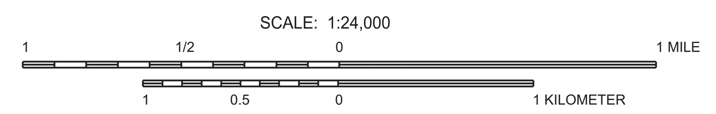
Control by USGS and USC & GS.

Topography by photogrammetric methods from aerial photographs taken 1969. Field checked 1971.

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

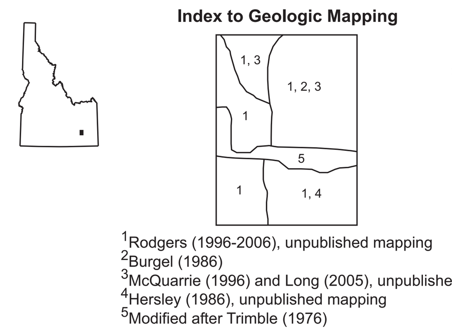
Datum is mean sea level.

UTM GRID AND 1971 MAGNETIC NORTH DECLINATION AT CENTER OF MAP

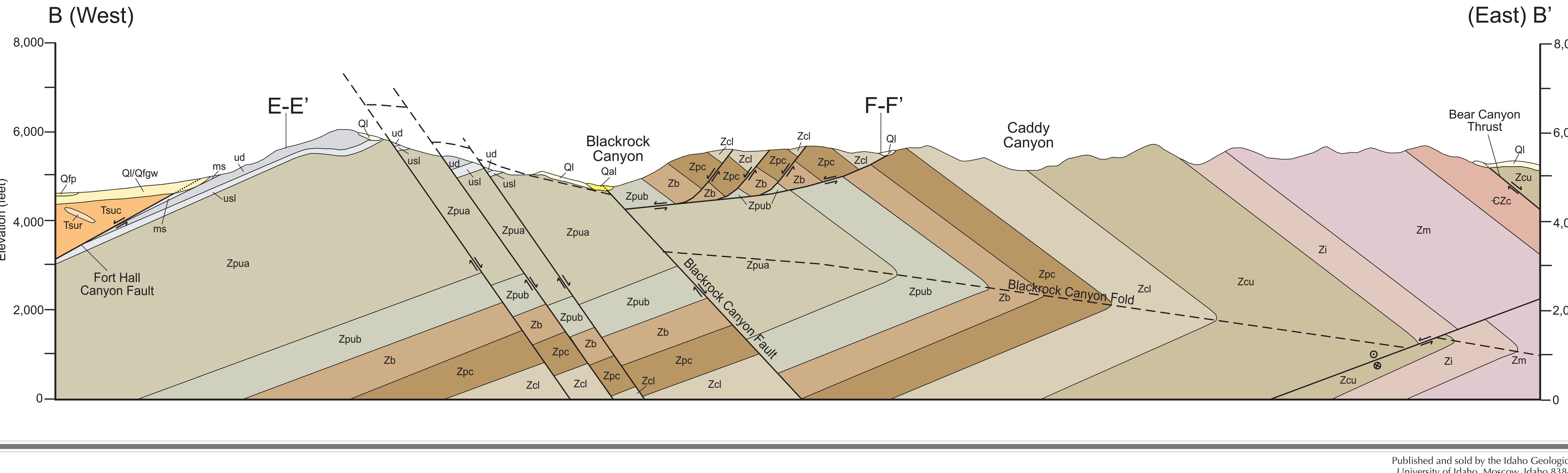


CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS

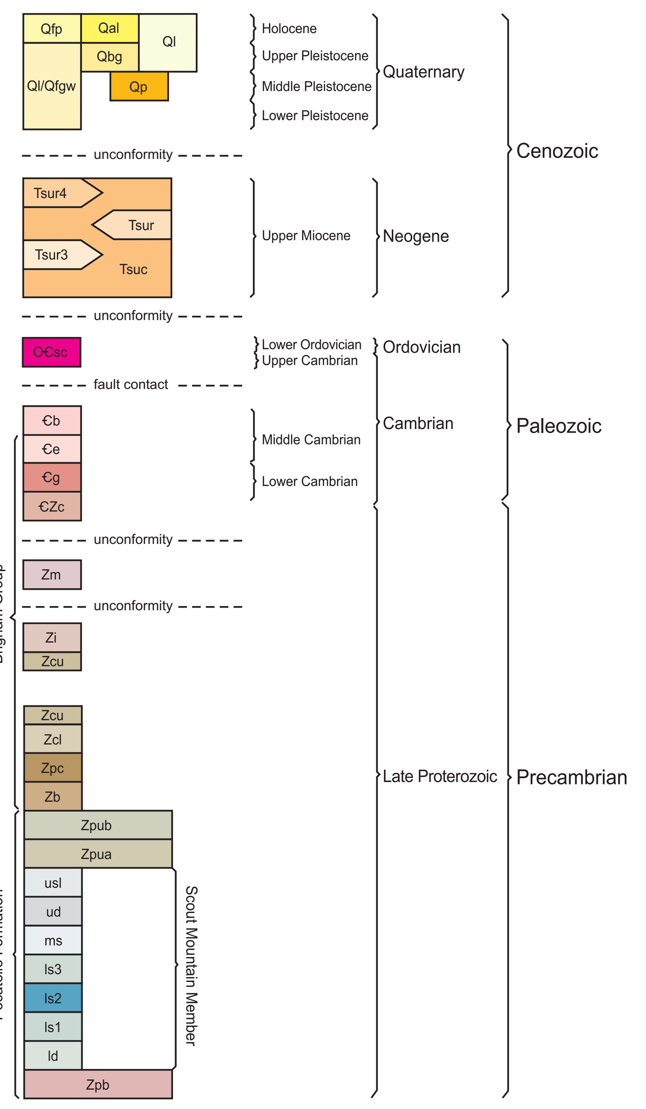
Index to Geologic Mapping



[1]Rodgers (1996-2006), unpublished mapping
[2]Burgel (1986)
[3]McQuarrie (1996) and Long (2005), unpublished mapping
[4]Hersley (1986), unpublished mapping
[5]Modified after Trimble (1976)



Correlation Of Map Units



Symbols

- Contact: dashed where approximate, dotted where concealed
- Normal fault: dashed where approximate, dotted where concealed. Bar and ball on downthrown side
- Thrust fault: dashed where approximate, dotted where concealed. Teeth on upthrown side
- Anticline axial trace: dashed where approximate, dotted where concealed
- Syncline axial trace: dashed where approximate, dotted where concealed
- Overturned anticline axial trace: dashed where approximate, dotted where concealed
- Overturned syncline axial trace: dashed where approximate, dotted where concealed
- 667 ± 5 Ma Sample location and age for U-Pb geochronolgy
- Strike and dip of bedding
- Strike and dip of overturned bedding
- Strike of vertical bedding

Description Of Map Units

The following map unit descriptions are based on personal field observations and generally agree with the descriptions of Trimble (1976) and Link et al. (1987). Published descriptions by Crittenden et al. (1971), Harper and Link (1982), Jansen (1986), Link (1982, 1983), LeFebre (1984), Link et al. (1985), Burgel (1986), and Kellogg et al. (1994) provide additional details concerning specific map units.

Qal **ALLUVIUM (Holocene)**--Unconsolidated mud, silt, sand, and gravel deposited in the floodplain of the Portneuf River and its major tributaries. Thickness 0-30(?)m (0-100 ft)

Qfp **ALLUVIAL FAN DEPOSITS OF THE LOWER PORTNEUF VALLEY (Holocene)**--Poorly consolidated mud, silt, sand, and gravel. Thickness 0-20(?)m (0-70 ft)

Ql **LOESS (Holocene and Upper Pleistocene)**--Unconsolidated silt. Mantles hillsides and pediments. Thickness 0-20m (0-70 ft)

Qbg **BONNEVILLE FLOOD GRAVELS (Upper Pleistocene)**--Unconsolidated cobble- to boulder-sized gravel deposited adjacent to ledges of the basalt of Portneuf Valley during the Bonneville Flood. Thickness 0-20m (0-70 ft)

Ql/Qfgw **LOESS-COVERED ALLUVIAL FAN GRAVELS OF WISCONSIN AGE (Upper to Lower Pleistocene)**--Poorly to moderately consolidated mud, silt, sand, and gravel predating the modern floodplains of the Portneuf River. Thickness 0-20m (0-70 ft)

Qp **BASALT OF PORTNEUF VALLEY (Middle Pleistocene)**--Basalt. Dark gray, massive tholeiitic basalt with common zones of vesicles and autobrecciation. Mineralogy includes pyroxene, plagioclase, and rare olivine. Forms laterally extensive flat terraces terminated by cliffs and ledges, and may show scour features associated with the Bonneville Flood. Comprises two flow units each a few 10's of meters thick. Lower flow unit dated at 0.43±0.07 Ma (whole-rock, Ar-Ar) (Rodgers, unpub. data).

STARLIGHT FORMATION, UPPER MEMBER (Upper Miocene)--Conglomerate, rhyolite air-fall tuff, and rare sandstone and marl. Conglomerate and intercalated rocks were assigned by Trimble (1976) to the Lower member of the Starlight Formation but geologic mapping, radiometric dating, and geochemical analyses indicate these rocks overlie, and are younger than, the 10.3 Ma Tuff of Arbon Valley (Kellogg and others, 1994) which composes the Middle member of the Starlight Formation (Trimble, 1976). Divided into informal units including conglomerate and intercalated tuff units including four tuffs which are regionally persistent in the Pocatello South quadrangle (Tsur1 and Tsur2; Rodgers and Othberg, 1999) and Inkom quadrangle (Tsur3, Tsur4). Formation age is constrained by an $^{40}Ar/^{39}Ar$ age of 7.39 Ma for Tsur4 and a correlation age of 8.2±0.5 for Tsur1 (Rodgers and Othberg, 1999).

Tsuc **CONGLOMERATE UNIT**--Clast-supported, moderately indurated cobble conglomerate with clasts derived from pre-Tertiary rocks in the region. Reddish-orange to reddish-brown matrix which is typically sandy but locally tuffaceous. Very rare sandstone and marl interbeds. Contains two persistent but discontinuous air-fall tuff beds (described below) and other lenses of air fall tuff. Abrupt lower contact, located west of map area, is placed at the base of cobble conglomerate which coincides with the top of Cambrian/Late Proterozoic bedrock or more rarely with the top of air-fall tuff (Tsur1). Forms gravel-covered slopes with very rare outcrops. Maximum thickness (including intercalated air-fall tuff units) measured from fault-bounded top to unconformity at base is about 600m (2000 ft).

Tsur4 **RHYOLITE AIR-FALL TUFF, UNIT 4**--Laminated to thick-bedded, white to light gray, air-fall tuff. Tuff contains glass shards (>95%), sanidine crystals (<1%) and lithic fragments (<5%). Abrupt upper and lower contacts. Forms slopes and rare ledges. Occurs as discontinuous lenses and pods near or at the top of the Tertiary section. Electron microprobe and X-Ray fluorescence analysis of glass shards support a correlation with the informally named Faust ash (M. Perkins, pers. comm.), whose age is 7.39±0.03 Ma (sanidine, $^{40}Ar/^{39}Ar$) in the Pocatello South quadrangle (Rodgers and Othberg, 1999). Thickness as much as 15m (50 ft).

Tsur3 **RHYOLITE AIR-FALL TUFF, UNIT 3**--Laminated to thick-bedded, white to light gray, air-fall tuff. Tuff contains glass shards (>95%), sanidine crystals (<1%) and lithic fragments (<5%). Abrupt upper and lower contacts. Forms slopes and rare ledges. Occurs as discontinuous lenses and pods located approximately 500m above the base of the formation. Age unknown. Thickness as much as 15m (50 ft)

Tsur **RHYOLITE AIR-FALL TUFF**--Laminated to thick-bedded, white to light gray, air-fall tuff. Tuff contains glass shards (>95%), sanidine crystals (<5%) and lithic fragments (<5%). Abrupt upper and lower contacts. Forms slopes and rare ledges. Occurs as discontinuous lenses and pods. Age and correlation to other tuff units is not known. Thickness as much as 5m (18 ft).

O€sc **ST. CHARLES FORMATION (Lower Ordovician to Upper Cambrian)**-- Shown in cross-section only, rocks of the St. Charles Formation presumably underlie the map area, based on mapping in adjacent areas (Riesterer et al., 2000).

€b **BLOOMINGTON FORMATION (Middle Cambrian)**--Shown in cross-section only, rocks of the Bloomington Formation presumably underlie the map area, based on mapping in adjacent areas (Riesterer et al., 2000).

€e **ELKHEAD LIMESTONE (Middle Cambrian)**--Limestone. Most limestone is thick-bedded to massive, oolitic, bioclastic, medium to light gray. Subordinate limestone is thin- to thick-bedded, medium gray micrite with uncommon tan silty partings. Lower contact is concealed. Forms low ledges. Structural thickness in map area is 130m (430 ft).

BRIGHAM GROUP--Originally described as the Brigham Quartzite by Anderson (1928), a name dropped by Crittenden et al. (1971) and Trimble (1976) who divided it into Gibson Jack Formation, Camelback Mountain Quartzite, Mutual Formation, Inkom Formation, Caddy Canyon Quartzite, and Papoose Creek Formation. Link et al. (1987) placed these formations into the formally defined Brigham Group.

€g **GIBSON JACK FORMATION (Lower Cambrian)**--Shale, siltstone and sandstone. Shale and siltstone are olive green. Sandstone is tan, fine-grained, well sorted and resistant. Lower contact is concealed. Forms slopes. Inferred thickness is about 240m (800 ft).

€Zc **CAMELBACK MOUNTAIN QUARTZITE (Lower Cambrian and Late Proterozoic)**--Quartzite with basal conglomerate and uncommon thin shale beds. Quartzite is thick-bedded, white to cream to gray, medium- to coarse-grained, moderately well sorted, well rounded with planar cross stratification. Its protolith was a quartz arenite. The lower contact is placed at base of a resistant pebble conglomerate with pink, red and purple quartzite clasts. Link et al. (1987) interpret the lower contact as a regionally persistant sequence boundary. Unit is resistant, forms cliffs and small ledges that cap hills and forms large blocky float. Minimum thickness is 430m (1420 ft).

Zm **MUTUAL FORMATION (Late Proterozoic)**--Quartzite with uncommon shale and pebble conglomerate interbeds. Quartzite is medium- to thick-bedded, pink to purple, medium-to coarse-grained, well rounded, moderately to poorly sorted. Its protolith was probably a subarkosic to sublithic arenite. Pebble conglomerate is poorly sorted, with purple, pink and red clasts in a white to purple matrix. Shale is fine-grained, dark purple and occurs rarely as interbeds. The lower contact is placed at the base of the lowest purple quartzite. Link et al. (1987) interpret the lower contact as a regionally persistant sequence boundary. Unit is resistant, but rarely forms small ledges and occurs mostly as float. Minimum thickness is 900m (3000 ft).

Zi **INKOM FORMATION (Late Proterozoic)**--Shale and siltstone. Fine-grained, thin-bedded to laminated, and olive green except at top where it becomes dark purple. Lower contact is placed at top of highest quartzite or conglomerate. Non-resistant beds form uncommon small ledges. Thickness about 250m (825 ft).

Zcu **CADDY CANYON QUARTZITE, UPPER MEMBER (Late Proterozoic)**--Quartzite and conglomerate with minor thin-bedded shale. Pebble conglomerate is located at top of member and contains numerous white to pink quartzite pebbles. Base of conglomerate was interpreted by Link et al. (1987) as a regionally persistant sequence boundary. Quartzite is thick-bedded to massive, pink, red, maroon and rarely purple, fine- to medium-grained, and moderately to well sorted. Its protolith was probably a subarkosic arenite. Lower contact of upper member placed at base of discontinuous thin-bedded olive green shale, at top of discontinuous limestone, and/or at base of red quartzite. Forms small blocky outcrops with talus. Thickness ranges from 600m (2000 ft) north of Portneuf Gap to 400m (1300 ft) south of Portneuf Gap.

Zcl **CADDY CANYON QUARTZITE, LOWER MEMBER (Late Proterozoic)**--Quartzite with uncommon shale. Quartzite is massive to thick-bedded, white to beige, vitreous, moderately sorted, well rounded, and fine- to medium-grained. Its protolith was a quartz arenite. Shale is tan to olive, thinly bedded and coarsens upward to sandstone. Lower contact is placed at base of lowest quartzite. Forms a resistant cap on hilltops and blocky float. Thickness ranges from 700m (2300 ft) north of Portneuf Gap to 500m (1650 ft) south of Portneuf Gap.

Zpc **PAPOOSE CREEK FORMATION (Late Proterozoic)**--Intercalated argillite and quartzite. Argillite is dark gray to green to rust colored. Quartzite is light gray to brown, fine-grained and well sorted. Thinly interbedded argillite and quartzite are distorted by common syneresis structures and other soft sediment deformation. The gradational lower contact is placed at the top of the highest limestone bed. Forms low ledges. Thickness ranges from 280-400m (925-1320 ft).

Zb **BLACKROCK CANYON LIMESTONE (Late Proterozoic)**--Limestone or dolomite marble with intercalated quartzite and shale. Limestone and dolomite are dark gray, massive (upper half) or medium-bedded (lower half) with small resistant lamina of sandstone or chert. Occurs as interbeds or lenses within fine-grained laminated quartzite in the lower half or shale and siltstone (similar to Papoose Creek Formation) in the upper half. Lower contact is placed at base of lowest limestone. Forms ledges and slopes. Thickness ranges from 180-350m (600-1150 ft).

POCATELLO FORMATION (Late Proterozoic)--Interbedded metavolcanic rocks, metadiamictite, quartzite, conglomerate, limestone and argillite. Divided into three members, in descending order the upper member, Scout Mountain Member, and the Bannock Volcanic Member.

Zpub **UPPER MEMBER, UNIT B**--Laminated quartzite. Quartzite is brown to tan to gray, well-sorted, well-rounded, fine- to medium-grained, medium-bedded, and displays pronounced laminations due to color variation. Protolith is probably a subarkosic arenite to quartz arenite. Laminations become uncommon or absent upsection. Gradational lower contact placed at top of highest phyllite. Slope-former with small ledges. Thickness is approximately 300m (1000 ft).

Zpua **UPPER MEMBER, UNIT A**--Thin-bedded, well laminated phyllite and argillite. Phyllite is blue-gray to silver, with laminations approximately 2-5 mm thick. Argillite is medium-to dark-gray to black, weathering to a reddish brown. Abrupt lower contact placed at base of lowest phyllite. Slope former with rare ledges and abundant talus. Structural thickness is approximately 350-430m (1120-1420 ft).

SCOUT MOUNTAIN MEMBER--Divided into several informal units, in descending order: upper sandstone and limestone unit, upper diamictite unit, middle sandstone unit, lower sandstone units, lower diamictite unit (units modified from LeFebre, 1984; Link, 1983).

usl **UPPER SANDSTONE AND LIMESTONE**--Quartzite with minor limestone, marble, dolomite breccia and cobble conglomerate. Quartzite is a medium- to coarse-grained, light brownish-gray to green, poorly sorted lithic arenite with trough and planar cross-stratification, slump folds, flute casts, graded beds and ripples. Discontinuous limestone is dark gray, thick-bedded, and has thin laminae of tan sandstone. Rare marble is pink to white, laminated to massive. Very thin dolomite breccia is pink, thin-bedded, poorly sorted, angular, matrix- to clast-supported with clasts as big as 2 cm in diameter, and forms a distictive marker bed. Cobble conglomerate is a matrix- to clast-supported quartzite with clasts of quartzite cobbles and limestone rip-up clasts, and occurs as lenses in the northwestern map area. Light gray limestone and orange-tan dolomite appear to form a thin layer at the base of the unit. Uncommon, thin, sandy limestone interbeds occur at the top of the unit. Lower contact is placed above the highest diamictite bed. Forms small ledges and angular blocky talus. Age of 667±5 Ma (U-Pb, zr) obtained from volcanic tuff located 20m above base (Fanning and Link, 2004). Thickness ranges from 0-200m (0-670 ft.).

ud **UPPER DIAMICTITE**--Massive diamictite. Matrix is fine- to medium-grained, dark gray to green argillite and fine-grained quartzite. Clasts range from grt to cobble size and are generally quartzite with some volcanic, plutonic and sedimentary rock. Lower contact placed at base of lowest diamictite. Forms ledges and blocky float. Thickness ranges from 0-380m (0-1250 ft.). Absent north of the Mid-Ridge fault.

ms **MIDDLE SANDSTONE**--Quartzite. Massive, medium-grained, moderately sorted, brown to tan with distinctive white feldspar grains. Its protolith was probably a sub-feldspathic quartz arenite. Gradational lower contact placed at base of lowest feldspathic quartzite. Forms ledges and blocky float. Thickness ranges from 0-100m (0-330 ft.).

ls3 **LOWER SANDSTONE, UNIT 3**--Quartzite. Massive to thick-bedded, light brown to gray, fine- to medium-grained, vitreous quartzite. The protolith was a quartz arenite. Abrupt lower contact placed at the top of diamictite, or above cobble conglomerate. Forms ledges and blocky float. Thins abruptly southward, total thickness ranges from 0-250m (0-825 ft.).

ls2 **LOWER SANDSTONE, UNIT 2**--Clast-supported cobble conglomerate. Clasts are rounded to subrounded pebbles to cobbles consisting of predominantly quartzite with rare granite and argillite. Matrix consists of coarse-grained lithic arenite similar in composition to lower sandstone unit 1. Local interbeds of lithic arenite and matrix-supported conglomerate. Lower contact is placed at the lowest conglomerate. Resistant cliff-former. Thins abruptly northward, thickness ranges from 0-30m (0-100 ft.).

ls1 **LOWER SANDSTONE, UNIT 1**--Brown sandstone, green siltstone and sandstone, and dark gray to black quartzite. Brown sandstone is moderately well-sorted with rounded quartz grains and angular lithics. Protolith is a lithic arenite to quartz arenite. Green siltstone is thinly laminated and interbedded with massive to medium-bedded green, fine-grained sandstone. Black sandstone is medium- to coarse-grained, moderately well sorted; its protolith was probably a sublithic arenite. Lower contact is placed at the top of diamictite. Forms cliffs, ledges and extensive talus slopes. Thins abruptly to the north, thickness ranges from 0-300m (0-1000 ft).

ld **LOWER DIAMICTITE**--Massive to rarely bedded diamictite. Matrix is dark green to dark brown, fine-grained sandstone and argillite. Pebble- to cobble-sized clasts are typically angular, green to black volcanic rocks (near base), rounded quartzites and rarely rounded plutonic rocks. Gradational lower contact placed at the base of the lowest diamictite. Ledge- and slope-former. Thickness ranges from 0-400m (0-1320 ft).

Zpb **BANNOCK VOLCANIC MEMBER**--Massive metavolcanic breccia and metabasalt. Breccia contains olive green to tan, poorly sorted, matrix-supported clasts in a green silty matrix. Metabasalt is a greenstone composed of chlorite, quartz, feldspar and epidote, and contains flattened vesicles filled with secondary chlorite, epidote, and albite. Lower contact not exposed. Slope- and ledge-former. Age inferred to be 717±4 Ma (U-Pb, zr) based on dating of rhyolite clast in overlying Scout Mountain upper diamictite (Fanning and Link, 2004). Maximum exposed thickness is 420m (1380 ft).

Geologic History

The volcanic rocks, glaciogenic diamictites, and thick sections of quartzose sandstone and mudstone in the Inkom quadrangle record rifting of the North American continent and the establishment of a passive continental margin by earliest Cambrian time (Link et al., 1993 and references therein). Two rifting events appear to be recorded in the region (Link et al., 1993; Link and Fanning, 2004). Evidence for the earlier rift is the association of the Bannock Volcanic Member with the lower diamictite of the Scout Mountain Member. The Bannock Volcanic Member has a chemical signature similar to tholeiitic basalts and its trace element signature suggests it was formed in a continental rift setting (Harper and Link, 1986; Link et al., 1994). Other evidence for rifting includes coarse-grained and mineralogically immature sediments inferred to be deposited in a syndepositional environment within fault-bounded basins (Stewart, 1972; Link et al., 1994). A glacial origin for the diamictites was proposed based on 1) thick successions of massive or crudely bedded diamictite with both extra- and intra-basinal clasts, 2) locally striated or faceted stones in the diamictite, 3) dropstones and isolated sediment pods in laminated fine-grained sedimentary rocks, and 4) the lateral persistence of correlative diamictite throughout the Cordillera (Link et al., 1994). Fanning and Link (2004) obtained two U-Pb zircon ages from the Scout Mountain member within the Inkom quadrangle: an age of 717±4 Ma for a rhyolite clast in the upper diamictite and an age of 667±5 Ma for a volcanic tuff just above the upper diamictite.

A later rifting event occurred in latest Proterozoic time, during deposition of the Brigham Group, and produced a passive margin along the length of the Cordillera (Link et al., 1993). Analysis of Early Paleozoic passive margin subsidence indicates that thermal subsidence did not begin until 600-545 Ma, well after the 667 Ma rifting event recorded by the Scout Mountain Member (Bond et al., 1983; Bond and Kominz, 1984, Link et al., 1994). This suggests two continental rifting events affected western North America during the Late Proterozoic.

The Brigham Group was deposited on a subsiding passive margin west of the Cordilleran hingeline (Link et al., 1987). The quartzites, siltstones and rare limestones and shales that comprise the Brigham Group were deposited in shallow marine to braided stream environments (Link et al., 1993). The strata were previously interpreted to represent a conformable succession of shallow marine sandstones and siltstones (Crittenden et al., 1971; Trimble, 1976). Reevaluation of the Brigham Group in light of sequence stratigraphy indicates that the strata exposed in the Inkom quadrangle contains four stratigraphic sequences bounded by regional disconformities (Link et al., 1987; Levy et al., 1994).

The Cambrian Elkhead Limestone overlies the Brigham Group and represents the transition from siliciclastic to carbonate deposition in the Cordilleran miogeocline (Link et al., 1987). Most of the subsequent succession of Paleozoic sedimentary rocks was removed by faulting or erosion from the Inkom quadrangle.

After a long period of non-deposition, proximal volcanism related to the formation of the Eastern Snake River Plain occurred in the middle Miocene (Rodgers et al., 1990; Pierce and Morgan, 1992). Huge volumes of silicic air-fall tuffs and ash flow tuffs erupted on the Plain (Morgan et al., 1984), disrupting drainages and accumulating in low-lying regions. 8.2-7.4 Ma distal tuffs associated with this event are interbedded with conglomerate to form the Upper Member of the Starlight Formation, which accumulated in a half-graben in the western Inkom quadrangle and adjacent Pocatello South quadrangle (Rodgers and Othberg, 1999)

Geologic History - Continued

After several million years of uplift and erosion, during which the modern drainage system was established, the 0.43±0.07 Ma (Rodgers, unpub. data) valley-confined Portneuf Basalt flowed westward across the quadrangle (Trimble, 1976). This basalt was scoured by the ~14,500 B.P. Bonneville Flood, which initiated when pluvial Lake Bonneville catastrophically drained through Red Rock Pass near the Utah border. Floodwaters reached a maximum depth of nearly 100m at the Portneuf Gap and deposited a thick layer of fluvial gravels that surround and underlie the modern Portneuf River (O'Connor, 1990; Trimble, 1976)

Rocks in the Inkom Quadrangle experienced several phases of deformation including Cretaceous shortening, late Cenozoic east-west extension and latest Cenozoic north-south extension (Trimble, 1976; Burgel et al., 1987; Rodgers and Othberg, 1999).

Cretaceous shortening in the Inkom quadrangle was accomplished by folding, thrust faulting, and cleavage development. The Bear Canyon thrust (Kellogg, 1992) is present in the east-central region of the quadrangle, where it places Caddy Canyon Quartzite over Mutual Formation and Camelback Mountain Quartzite (cross-section BB'), and in the northeastern part of the quadrangle where the fault ramps downsection to place Papoose Creek Formation over lower Caddy Canyon Quartzite (cross-section DD'). This fault is interpreted to be an east-dipping, east-vergent thrust (Kellogg et al., 1999) based upon well-defined geometric relations in the Bonneville Peak Quadrangle to the east (Riesterer et al., 2000). The thrust is not apparent in surface exposures south of the Portneuf River, which we attribute to offset by the younger Camelback Mountain fault system (cross-section AA').

A large, east-vergent recumbent anticline, the Blackrock Canyon fold (Kellogg et al., 1999), involves the Pocatello Formation and possibly several overlying formations (cross-sections AA', BB', CC', DD'). Evidence for the Blackrock Canyon fold includes overturned rocks throughout the crest of the Pocatello Range (Link, 1982). They are separated from upright rocks by an axial trace that is best exposed northwest of China Peak, in the headwaters of Blackrock Creek, and along the southwest side of Blackrock Canyon. LeFebre (1984) and Burgel (1986) recognized the significance of folding in the region, although the geometry of the Blackrock Canyon fold is different than they and others (Link et al., 1985; Burgel et al., 1986) envisioned. Fine-grained rocks of the overturned Pocatello Formation have a pervasive subhorizontal cleavage that is parallel to the axial plane of the Blackrock Canyon fold. Parasitic folds in the Blackrock Canyon Limestone and the Papoose Creek Formation share similar orientations and axial planes.

The second phase of deformation was late Cenozoic east-west extension. One fault system is characterized by subhorizontal attitudes, west-trending striations, stratigraphic elimination, and bedding-to-fault angles of ~40°. The fault system shown in cross section DD', which Trimble (1976) named the Camelback Mountain fault, appears to have slipped ~7500 m if we are correct in correlating its hanging wall strata to equivalent units in the hanging wall of the Bear Canyon Thrust. A similar restoration of the fault system shown in cross-section AA', which we (and Trimble, 1976) correlate to the Camelback Mountain fault system, suggests a slip amount of ~4500 m for this fault. A range-bounding normal fault, the Fort Hall Canyon fault, strikes north along the western edge of the quadrangle. In most places it drops the Tertiary Starlight Formation against Proterozoic rocks of the Pocatello Formation (Burgel et al., 1987). The fault dips ~30° west and has bedding-to-fault angles of ~70° (upright Pocatello Formation) and ~55° (Starlight Formation) (cross-section AA'). Slip amount is difficult to estimate, since reconstructions depend upon the correct restoration of the older Camelback Mountain fault system, but 3500 m is a viable minimum estimate. Small synthetic and antithetic north-striking normal faults are prevalent throughout the quadrangle. Their dips are moderate to steep, they display much smaller amounts of offset (100s of m) and they cut through rocks of the Brigham Group and Pocatello Formation. No age constraints are evident on these smaller faults, but their similar orientation to the Fort Hall Canyon fault argues for a genetic link. Overall, the style and geometry of the Camelback Mountain and Fort Hall Canyon faults are interpreted to reflect significant extension via domino-style normal faulting. Though geometrically dissimilar, they may share a genetic link with the Bannock Range detachment fault described by Carney and Janecke (2005).

The last phase of deformation was north-south extension. This extension is recorded by high- angle normal faults that dip north or south and show small (typically 100's of m) offset. These faults generally, but not always, cut north-striking normal faults. The largest of these is the Portneuf Narrows fault, which slipped about 1200 m and juxtaposes upright and overturned limbs of the Blackrock Canyon Fold (cross-section EE'). Trimble (1976) and Link and LeFebre (1983) interpreted the Portneuf Narrows fault to be a Mesozoic tear fault, but this interpretation is not favored because the fault dips 50° south and because formations north and south of the fault show no more than 1 km of dextral separation.

Shortening in the map area is associated with deep-seated deformation in the hinterland of the Cretaceous Idaho-Wyoming thrust belt (Armstrong and Oriel, 1968; Kellogg, 1992). Uplift of the folded, upper greenschist facies Proterozoic rocks provides evidence for a concealed frontal ramp, located west of the quadrangle, in the underlying Putnam thrust (Rodgers and Janecke, 1992). The late Cenozoic east-west extension displayed in the Inkom quadrangle is representative of Basin and Range extension in this area (Burgel et al., 1987; Kellogg et al., 1999). The latest Cenozoic north-south extension indicates a change in the local stress field, possibly in response to subsidence of the Eastern Snake River Plain. Thermal and tectonic subsidence of the Plain has created flexural extension along its margins (McQuarrie and Rodgers, 1998), expressed in the map area as steep, east- to northeast-striking normal faults with minor offset. The mutually cross-cutting relation of the north-south and east-west fault sets indicate an overlap in time and space of Basin and Range extension and Eastern Snake River Plain subsidence.

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