

**Geologic Map of the  
Silver City 7.5' Quadrangle,  
West-Central Montana**

Mapped and Compiled

by

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and  
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Montana Bureau of Mines and Geology

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## **Introduction**

The Silver City 7.5' quadrangle is situated northwest of Helena and east of the Continental Divide. The south-adjacent Austin 7.5' quadrangle was mapped concurrently by the Montana Bureau of Mines and Geology (Berg and Lonn, in press). Martin Bregman independently mapped the northern third of the quadrangle and his unpublished data are included in this report. He had previously mapped the Sheep Creek and Rattlesnake Mountain quadrangles (Bregman 1971, 1981) to the east of the Silver City quadrangle and had also been a co-author of the geologic map of the Rogers Pass 7.5-min. quadrangle (Whipple and Bregman, 1981). A generalized geologic map by Reynolds (2000) covered the southern one-third of the quadrangle at a scale of 1:100,000.

## **Geologic Summary**

Most of the quadrangle is underlain by low-grade metasedimentary rocks of the Mesoproterozoic Belt Supergroup.

Several, NNW-striking, steeply west-dipping, reverse faults occur; they are approximately parallel to the steeply west-dipping cleavage. Both probably resulted from E-W contraction in the late Cretaceous - early Tertiary Sevier thrust belt.

The Belt rocks were intruded and metamorphosed by Cretaceous granodiorite and diorite that appear to be outliers of larger intrusive bodies mapped to the east (Bregman, 1971, 1981; Reynolds, 2000).

A well-defined area of Tertiary mafic lava flows and intrusions lies north of Little Prickly Pear Creek, where it flows to the east in secs. 9, 10, and W½ sec. 11, T. 12 N, R. 5 W. Poorly exposed ash/tuffs are associated with the basalts and are interpreted to have been precursors of the lava flows. A small exposure of tuff also occurs near the old homestead up Big Sheep Creek, in sec. 22, T. 13 N, R. 5 W.

The down-to-the-south, Helena Valley normal fault, mapped as a major fault to the east of the quadrangle (Reynolds, 2000), crosses the middle part of the mapped area. It is largely concealed by Quaternary alluvium and colluvium. Another northwest to west-trending normal fault, the Canyon Creek fault (Reynolds, 2000), is primarily mapped by a color change in the soil and change in topography.

These WNW-striking faults comprise part of the Lewis and Clark line, a transverse structure interpreted as a sinistral transpressive zone active during late Cretaceous - early Tertiary compression and then reactivated as a dextral transtensional zone during Tertiary extension (Sears and Hendrix, 2004).

A geologically complex area in the southeastern part of the map, south of Willow Creek has a series of Cretaceous granodiorite dikes, perhaps 10 to 20 feet wide that have intruded the Belt rocks. They are discontinuous, and only occasionally can be traced for any significant distance

(more than 20 ft or so). They also only locally contact metamorphose the adjacent rock. This area also has some breccia exposed and several springs that may indicate faulting.

## **Descriptions of Map Units in the Silver City 7.5' Quadrangle**

- m** modified land - on this map, placer spoils piles along Silver Creek
- Qc** **Colluvium** – Poorly sorted, angular, locally derived rocks and soil on hillsides covering rock outcrops.
- Qac** **Alluvium and colluvium** – Mainly soil containing poorly sorted rocks derived from local sources; deposited by sheetwash and, to a lesser extent, fluvial processes. Generally insufficient concentration of lithologies to make an inference as to underlying bedrock. Often angular to sub-angular pebbles to cobbles in a finer grained matrix.
- Qal** **Alluvium** – Well-sorted gravel, sand, silt, and clay along active streams that consists of locally derived clasts.
- Qls** **Landslide deposits** – Unsorted, unstratified, deposits of boulders, gravel, sand, and silt; developed in the Spokane Formation and the Greyson Formation.
- Qaf** **Alluvial fan deposits** – Poorly sorted, angular to subangular, boulders, gravel, to fine-grained clasts. Deposited at the mouths of small drainages; the extent of the fans were mapped based on aerial photographs. They consist of locally derived rocks and are similar to colluvium except for their geomorphic expression and extent.
- Tab** **Andesitic basalt** – Dark gray to black, tight, locally with flattened vesicles. Locally has columnar jointing formed. Includes small associated occurrences of ash/tuff can be found at the margins of (and therefore underlying?) the basalt flows.
- Kda** **Dacite** – Small dikes and irregular bodies mapped on the basis of float of reddish brown dacite. Contains sparse quartz and feldspar (K-feldspar?) phenocrysts in a dense, fine-grained groundmass. Intrusions are irregular bodies and in the southeastern part of the map area are short discontinuous dikes.
- Kgd** **Granodiorite** – Dikes and sills that range in composition from tonalite to granite are included in this category. Some have large phenocrysts of plagioclase, orthoclase, and quartz in a fine grained, microcrystalline groundmass (Knopf, 1963).

## **Mesoproterozoic Belt Supergroup Rocks**

From oldest to youngest, the Belt units are the Greyson Formation, the Spokane Formation, and the Helena Formation. The Greyson and Spokane are in both fault and depositional contact. The depositional contact is somewhat interpretive with the Spokane picked at the first near-shore and

sub-aerial sedimentary features: ripple marks, soft, irregular mud blobs, and polygonal mud cracks. The Greyson Formation was deposited in deeper water and lacks these features.

**Yh Helena Formation** – The upper 300 m (1,000 ft) consists of dark gray limestone interbedded with dark gray calcareous argillite. Below this interval, the Helena Formation is characterized by cycles containing a basal clastic zone of tan to gray siltite and fine-grained quartzite, overlain by tan dolomite, and capped by dark gray argillaceous limestone (Schmidt and others, 1994). Molar tooth structure, non-polygonal crinkle cracks, recessive weathering, and calcitic pods are common. The Helena Formation is reported to be 1,220 m (3,900 ft) thick in this area (Schmidt and others, 1994).

**Ys Spokane Formation** – Grayish red, dark greenish red, and purplish red, microlaminated argillite and siltite; contains abundant mud cracks, ripple marks, etc. The Spokane Formation in this quadrangle contains many areas where “target” rocks, areas of concentric bleaching around a central grain, can be found, especially in the hills west of Little Prickly Pear Creek. These bleached circles are sometimes single occurrences and are locally also “constellations” of numerous small circles. The target rocks are the result of radioactive decay. According to Bregman (written comm, 2009 the central nodule is high in strontium, rubidium or any one of a number of radioactive elements derived from the Grenville Highlands way off to the "east (?)" of the deposition area. The "target rocks" are usually found in the Spokane which is normally maroon (though there are some relatively thin light green beds throughout). The age of the rocks, about 1.2 (?) billion years old. Enough time for the heat generated by the radioactive decay to cook (bleach) the color out of the Spokane. Because heat radiates out in a sphere from the nodules, the circles are actually spheres (or ellipsoids) sliced by the shale layers. There probably are the same element nodules in the other Belt rocks (Greyson, Empire, etc.), but since their normal color, or weathered color can be not much different than the bleached out portions, they would be veritably invisible.

The steep outcrops along Little Prickly Pear Creek are pale green, grading to maroon towards the top of the ridge. The Spokane, where it is near an intrusive body, is “baked” or metamorphosed to a hard, dark maroon to black rock but retains the sedimentary structures that are diagnostic. Top not exposed, but thickness to the south was estimated to be 1,000 m (3,200 ft) (Schmidt and others, 1994).

**Yg Greyson Formation** – Dark gray, commonly rusty, and tan weathering; siltite and argillite with some quartzite in the upper section. Thin, planar beds. Weathers into thin slabs with well developed, closely spaced joints. The contact between the overlying Spokane and the older Greyson is gradational but is picked by the first appearance of shallow water, sedimentary structures like ripple marks, rip-up clasts, mushy, squashed mud pebbles, and polygonal mud cracks diagnostic of the Spokane. The Greyson has none of these. Base not exposed, but was estimated to be a minimum of 5,500 ft thick to the east of the area (Bregman, 1981).

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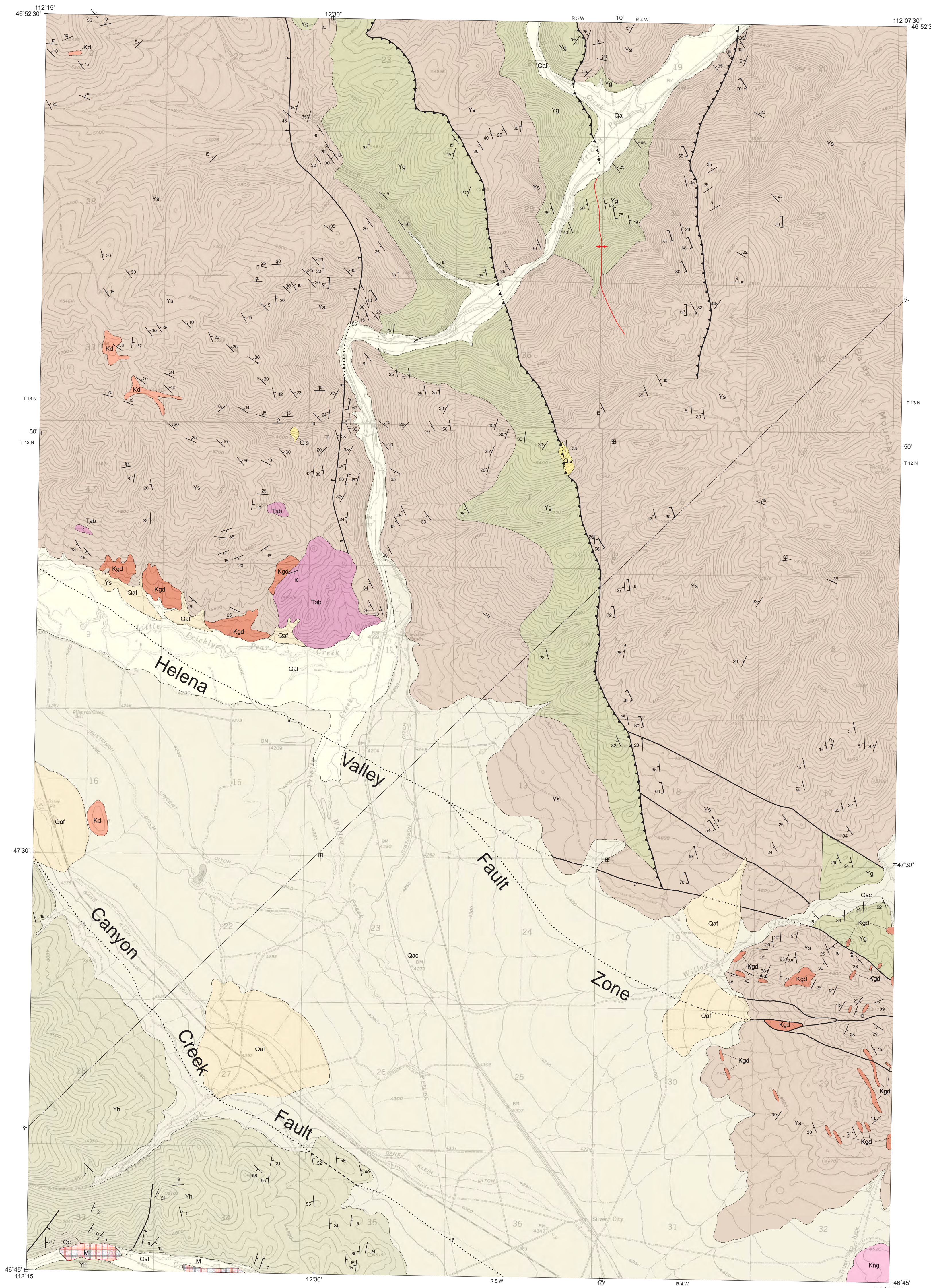
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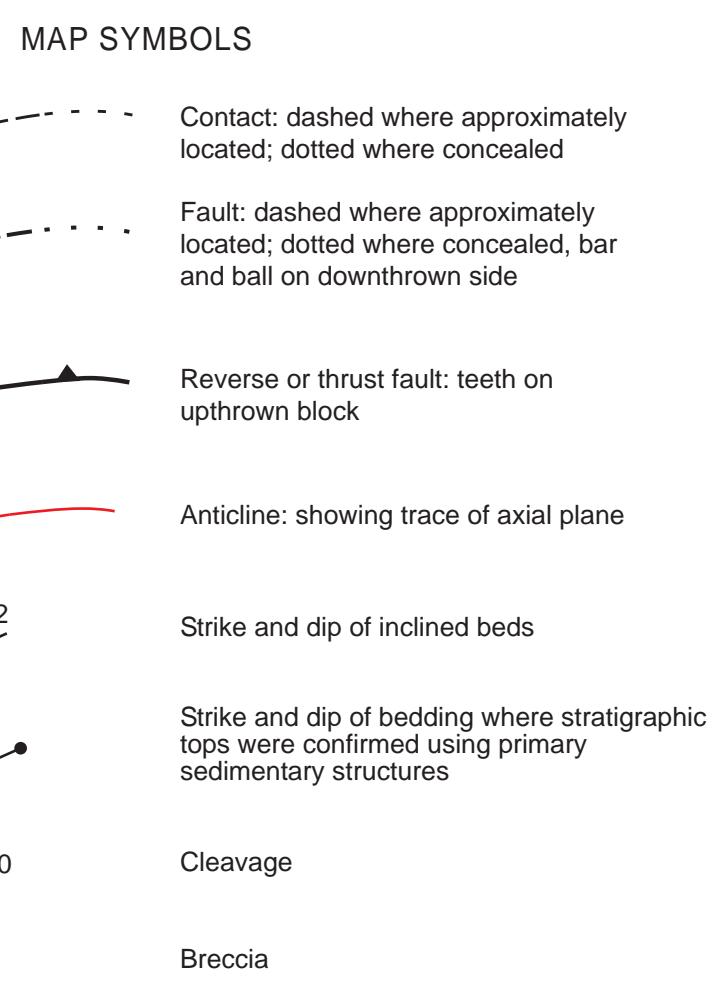
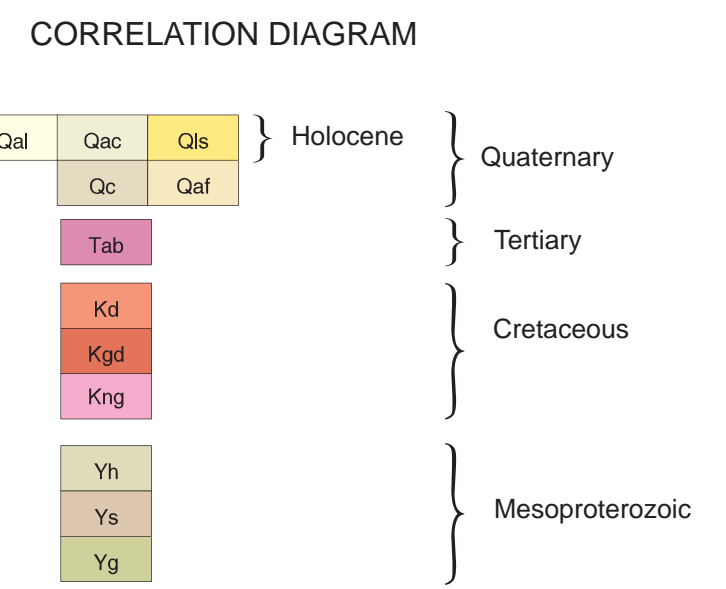
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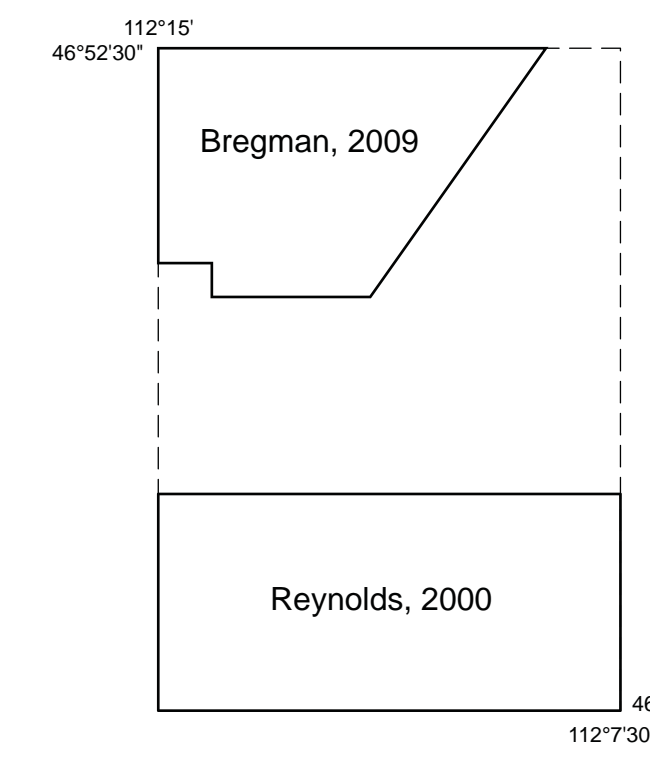
**MAP UNITS**

M	Modified land
Qal	Alluvium of modern channels and flood plains
Qac	Alluvium and colluvium, undivided
Qc	Colluvium
Qaf	Alluvial fan deposit
Qls	Landslide deposit
Tab	Andesite and basalt
Kd	Diorite
Kgd	Granodiorite
King	Non porphyritic granodiorite
Yh	Helena Formation
Ys	Spokane Formation
Yg	Greyson Formation

For a more detailed description of the map units and symbols, please refer to the text accompanying this map.

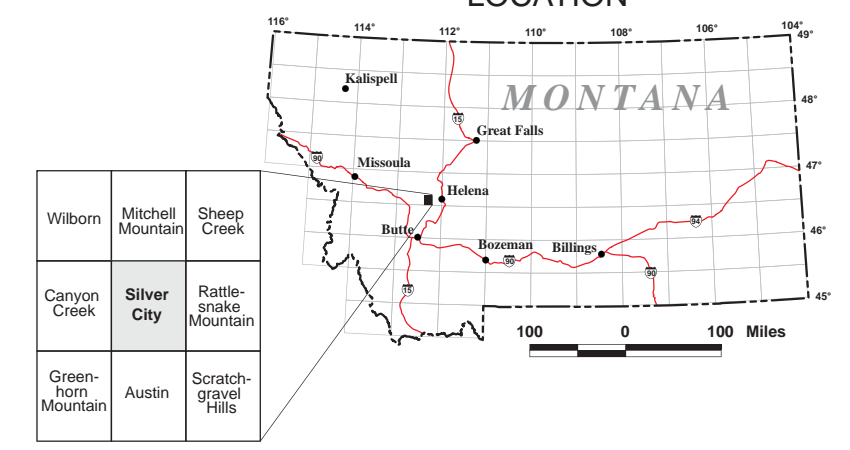


**PREVIOUS MAPPING**

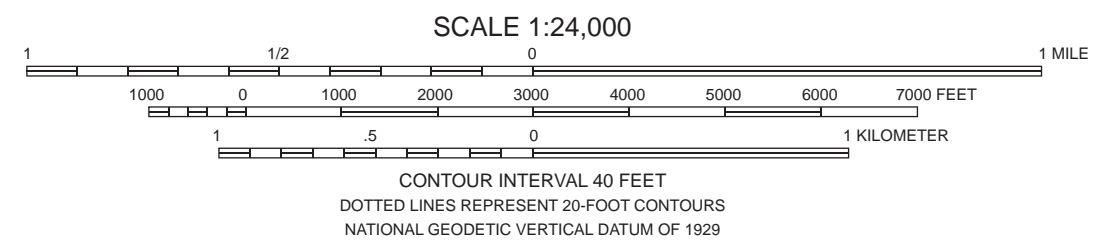


Lewis, 1998; entire quadrangle at 1:250,000 scale  
Wallace, 1987; entire quadrangle at 1:250,000 scale

**LOCATION**

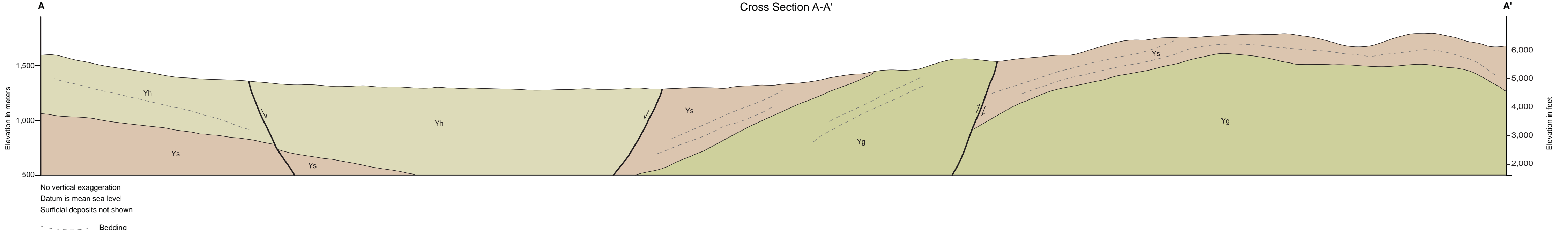


Base from U.S. Geological Survey  
Silver City 7.5' topographic quadrangle  
Map date: 1962 Photoinspected: 1976  
Projection: UTM zone 12; 1927 NAD  
UTM grid declination 0°52' West  
1962 Magnetic North Declination 19° East



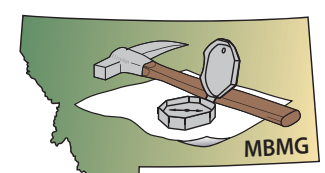
Maps may be obtained from: Publications Office  
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Butte, Montana 59701-8997  
Phone: (406) 496-4174  
Fax: (406) 496-4451  
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**Cross Section A-A'**



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GIS production: Ken Sandau and Paul Thale, MBMG. Map layout: Susan Smith, MBMG.