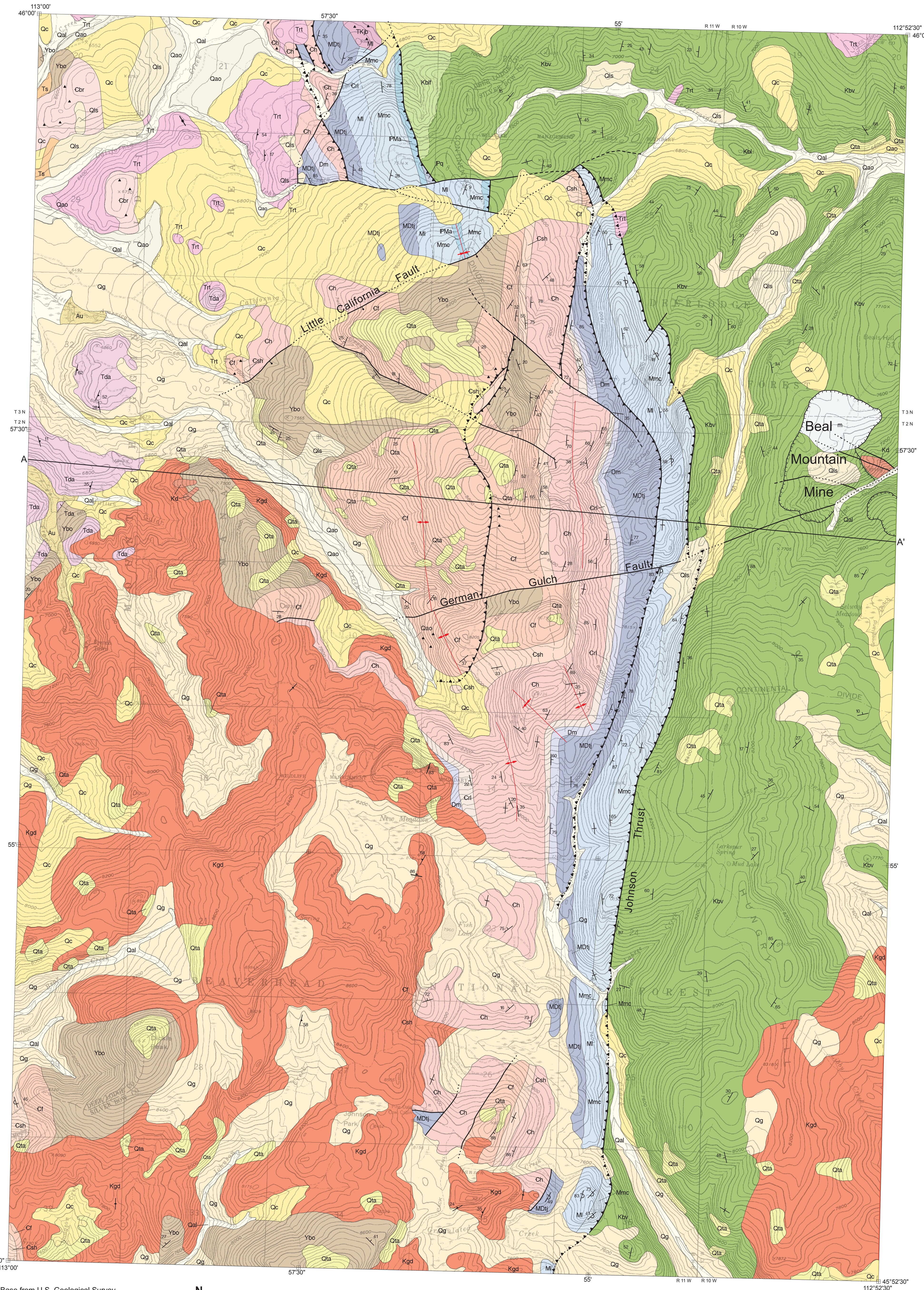

Base from U.S. Geological Survey
Dickie Peak 7.5' topographic quadrangle
Map date: 1961 Photorevised: 1988
Projection: UTM zone 12; 1927 NAD
UTM grid declination 1°24' West
1988 Magnetic North Declination 16.5° East

SCALE 1:24,000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Maps may be obtained from: Publications Office
Montana Bureau of Mines and Geology
1300 West Park Street
Butte, Montana 59701-8997
Phone: (406) 496-4174
Fax: (406) 496-4451
http://www.mbmg.mtech.edu

INTRODUCTION

The Dickie Peak quadrangle is located in the northern Pioneer Mountains, approximately 20 miles southwest of Butte, Montana. The mountainous terrain lies along the Continental Divide, within the Montana fold and thrust belt on the western edge of the Boulder batholith. Mesoproterozoic- through Cretaceous-age sedimentary rock, Cretaceous intrusions, Tertiary volcanics, and Tertiary and Quaternary surficial deposits are exposed within the quadrangle (Moore, 1956; Noel, 1956; Lewis, 1990; Ruppel and others, 1993).

The Montana Bureau of Mines and Geology selected the Dickie Peak 7.5′ quadrangle for new mapping because 1) the stratigraphy of the Mesoproterozoic Belt Supergroup, Cambrian, and Cretaceous rocks was in need of revision, and 2) the existing mapping in this area was completed prior to recognition of the nearby Eocene Anaconda Metamorphic Core Complex (O'Neill and others, 2002; Kalakay and Lonn, 2002; O'Neill and others, 2004). Regional-scale thrust faults exist in the area but the overall structural and stratigraphic complexity of the area indicated the role of extensional tectonics needed to be more thoroughly evaluated.

STRATIGRAPHY

The Dickie Peak quadrangle includes Mesoproterozoic through Cretaceous sedimentary rocks and unconsolidated Tertiary and Quaternary surficial deposits. The Mesoprotoerozoic and Cambrian units described below (Description of Map Units) reflect a significant revision of the stratigraphy from that used on earlier maps (Moore, 1956; Noel, 1956; Lewis, 1990; Ruppel and others, 1993). The major change is recognition of a complete Cambrian section (Flathead, Silver Hill, Hasmark, and Red Lion Formations) as described by Emmons and Calkins (1913) for the Philipsburg area. The Flathead and Red Lion Formations had not been previously mapped in the quadrangle.

Quartzite and argillite originally mapped by Lewis (1990) as Ordovician based on the presence of trace fossils is herein reinterpreted as the Cambrian Flathead Formation. The trace fossils present (including Skolithos and Planolites) are common in Cambrian strata and the burrowed quartzites can be found in stratigraphic continuity with micaceous, pale green shale typical of the basal Silver Hill Formation. O'Neill and others (1996) describe an interval of mudstone and shale within the Flathead Formation in the nearby Highland Mountains, consistent with what is observed in the Dickie Peak quadrangle.

Other notable stratigraphic revisions include reinterpretation of a faul- bound klippen of Cretaceous Kootenai Formation (Lewis, 1990) as the Devonian Maywood and Cambrian Hasmark and Red Lion Formations. Also, the Blackleaf Formation is remapped as the Flood and Vaughn Members rather than the five informal map units used by Lewis (1990).

STRUCTURE

The major structures in the Dickie Peak quadrangle record Laramide compression overprinted by subsequent Eocene extension. The largest and oldest fault in the quadrangle is the regionally significant Johnson Thrust Fault originally mapped by Moore (1956). The fault strikes north-south, dips steeply to the west, and places Mesoproterozoic through Paleozoic rocks over the Lower Cretaceous Blackleaf Formation. The hanging wall rocks are folded into a broad anticline with a gentle west limb and steep east limb. The Johnson Thrust has been interpreted to underlie the Grasshopper thrust plate, one of five major thrust plates in the mid- to late-Cretaceous thrust belt of southeast and west-central Montana (Ruppel and others, 1981).

Younger northeast-striking faults offset the Johnson Thrust. The Little California Fault (Lewis, 1990) and the German Gulch Fault (Hastings and Harrold, 1988) displace rocks as young as the Lower Cretaceous Blackleaf Formation within the quadrangle. Just to the west of the quadrangle, the German Gulch Fault displaces Eocene volcanic rocks (Ruppel and others, 1993).

The Dickie Peak quadrangle is within the complexly deformed hanging wall of the Eocene Anaconda Core Complex to the west (O'Neill and others, 2002; Kalakay and Lonn, 2002; O'Neill and others, 2004). The strongly brecciated sedimentary rocks, volcanic deposits, and Tertiary sediments exposed in the northwest part of the quadrangle are characteristic deposits of the transported and extended terrane in the hanging wall of the complex (O'Neill and Lageson, 2003, Kalakay and others, 2003).

IGNEOUS AND METAMORPHIC ROCKS

Granodiorite and minor diorite related to the Pioneer batholith (Ruppel and others, 1993) underlie large areas in the southern part of the quadrangle. A potassium-argon (K-Ar) date on biotite from a granodiorite sample in the adjacent Wise River quadrangle yielded a Late Cretaceous age of 76.4±2.6 Ma (Marvin and others, 1983). A reset K-Ar date of 74.8±2.8 Ma was obtained from a diorite sample at the Beal Mountain Mine (Hastings and Harrold, 1988). The northwest part of the quadrangle is underlain by Eocene Lowland Creek volcanic rocks, which range in composition from dacite to rhyodacite.

Contact metamorphism has affected sedimentary rocks in the quadrangle near contacts with the intrusive bodies. The Blackleaf Formation consists largely of hornfels, quartzite, and metaquartzite. Much of the Hasmark Formation is dolomitic marble.

ECONOMIC GEOLOGY

The Beal Mountain Mine is located in the northeast corner of the Dickie Peak quadrangle. The Beal deposit is a low-grade hydrothermal gold and silver reserve hosted by the clastic rocks of the Vaughn Member of the Blackleaf Formation (Hastings and Harrold, 1988; Wilke, 1996). It lies within the contact metamorphic aureole of the Cretaceous Boulder batholith. The presence of calc-silicate minerals associated with the diorite suggests similarities with high temperature gold skarns, however, the Beal deposit occurs entirely within a clastic protolith rather than a carbonate-dominated protolith (Wilke, 1996). The Beal Mine operated from 1988-1998.

Historical placer and small lode deposits are scattered throughout the quadrangle. The most extensive placer workings can be found in French Gulch and along Little American Creek.

DESCRIPTION OF MAP UNITS

Qal — ALLUVIUM (HOLOCENE)—unconsolidated, brown to gray, poorly to well-stratified deposits of silt, sand and gravel along modern stream channels. Probably less than 3 meters thick.

Qc — COLLUVIUM (HOLOCENE AND PLEISTOCENE)- unconsolidated, angular, poorly sorted gravel and boulder deposits with a matrix of sand, silt, and sparse clay. Extensive deposits found along gentle slopes, especially in north part of quadrangle where they may represent alluvial fan deposits. Thickness not determined.

Qls — LANDSLIDE DEPOSITS (HOLOCENE AND LATE PLEISTOCENE) —unconsolidated mixture of soil and blocks of bedrock transported down slope by mass wasting, characterized by hummocky topography.

Qta — TALUS (HOLOCENE AND PLEISTOCENE)—unconsolidated, locally derived deposits of angular boulders of quartzite and granitic bedrock. Thickness not determined.

Qao — OLDER ALLUVIUM (PLEISTOCENE?)—unconsolidated, light brown to light gray, poorly sorted sand and gravel deposits. Locally contains cobbles and boulders. Deposits are generally adjacent to but topographically higher than modern stream channels. Thickness not determined.

Qg — GLACIAL DEPOSITS, UNDIVIDED (HOLOCENE AND PLEISTOCENE)—poorly sorted, unconsolidated deposits of silt, sand, gravel, and boulders. Maximum thickness probably less than 100 feet (30 meters).

Ts — VALLEY-FILL SEDIMENT, UNDIVIDED (MIOCENE TO EOCENE?)—very pale orange to grayish orange, soft, unconsolidated to moderately indurated clay, silt, and sand with subordinate gravel. Thickness not determined.

Tda — DACITE OF LOWLAND CREEK VOLCANICS (EOCENE)- medium to dark gray, aphanitic,vesicular dacite flows and autobreccias. Massive to scoriaceous with local flow-banding, weathers dark red to grayish red (Lewis, 1990). Thickness not determined.

Trt — RHYODACITE TUFF OF LOWLAND CREEK VOLCANICS (EOCENE)—light gray to purplish gray, poorly to moderately indurated (non-welded) ash-flow tuff. Weathers yellow gray to gray, contains crystals of quartz, sanidine and biotite, locally with flattened pumice fragments or lithic volcanic fragments (Lewis, 1990). Thickness not determined.

TKjb — JASPEROID BRECCIA (TERTIARY OR CRETACEOUS?)—brownish red, dense, silicified breccia. Contains angular, dark and light gray clasts of chert and minor quartzite in a jasperoid matrix. Thickness not determined.

Kgd — GRANODIORITE OF DODGSON CREEK PLUTON (LATE CRETACEOUS)—mostly medium gray and medium-grained, slightly porphyritic and gneissic granodiorite and tonolite (Lewis, 1990). Pluton has a K-Ar date on biotite of 76.4 ± 2.6 Ma from sample from adjacent Wise River quadrangle (Marvin and others, 1983).

Kd — DIORITE (LATE CRETACEOUS)—dark gray to dark bluish gray, fine- to medium-grained diorite. Contains plagioclase, biotite, hornblende, and rare pyroxene (Lewis, 1990). Occurs only as small outcrops near pluton contacts with country rock. A K-Ar age of 74.8 Ma has been determined from a thermally reset biotite from a sample from the Beal Mountain Mine (Hastings and Harrold, 1988).

Kbv — VAUGHN MEMBER OF BLACKLEAF FORMATION (CRETACEOUS)—siltstone, mudstone, shale with subordinate sandstone, volcaniclastic sandstone, and conglomerate with chert and quartzite pebbles. Sandstone is light gray to yellow brown, often with volcanic detritus. Fine grained layers are yellow brown and dark gray, partly calcareous. Conglomerate occurs as discontinuous lenses up to 20 feet (6 meters) thick. Contact metamorphosed to green, black and brown hornfels, white to green quartzites, and metaconglomerates near contact with granodiorite. Dyman and others (1994) measured a thickness of approximately 2,200 feet (670 meters) for the Vaughn Member at Jerry Creek, approximately 3.5 miles southeast of the Dickie Peak quadrangle.

Kblf — FLOOD MEMBER OF BLACKLEAF FORMATION (CRETACEOUS)—medium to dark gray mudstone, shale and siltstone with subordinate light gray, calcareous sandstone, limestone and conglomerate. Mudstone is locally thinly laminated, calcareous, and rich in calcareous nodules. Contact metamorphosed to hornfels and quartzite near contact with granodiorite. Dyman and others (1994) measured a thickness of approximately 785 feet (240 meters) for the Flood Member at Jerry Creek, approximately 3.5 miles southeast of the Dickie Peak quadrangle.

IPq — QUADRANT FORMATION (PENNSYLVANIAN)—quartzite and minor sandstone. Light tan to light gray, massive to thick-bedded, vitreous quartzite and minor fine- to medium-grained, quartz sandstone, yellowish orange siltstone, and limestone. Occurs as a thin sliver of outcrop and float in north part of quadrangle. Thickness not determined.

IPMa — AMSDEN FORMATION (PENNSYLVANIAN AND UPPER MISSISSIPPIAN)—moderate reddish brown, calcareous siltstone, fine sandstone, and shale. Often weathers with light tan spots. Poorly exposed and usually marked by reddish soil. Thickness estimated at 300 feet (91 meters).

Mmc — MISSION CANYON LIMESTONE (UPPER AND LOWER MISSISSIPPIAN)—light gray, massive and thick-bedded, fossiliferous limestone with chert beds and nodules and zones of solution breccia. The upper part of the formation contains pale red to grayish orange limestone breccias. Thickness variable due to faulting but at least 1,000 feet (300 meters).

Ml — LODGEPOLE LIMESTONE (LOWER MISSISSIPPIAN)—thin- to thick-bedded, dark gray, finely crystalline limestone, locally contains abundant coral and brown or black chert nodules and ribbons. The lower part is thin-bedded, laminated, shaly (argillaceous) limestone. Thickness approximately 600 feet (183 meters) but varies considerably due to faulting.

MDtj — THREE FORKS AND JEFFERSON FORMATIONS, UNDIVIDED (MISSISSIPPIAN AND DEVONIAN)
THREE FORKS FORMATION (DEVONIAN AND MISSISSIPPIAN)—mudstone, shale, limestone, limestone breccia. Poorly exposed, dark gray, pale orange, and greenish gray mudstone and shale, locally densely fossiliferous. Includes subordinate beds of calcareous sandstone, siltstone, argillaceous limestone, limestone breccia, and shale breccia. Thickness estimated from 50 to 130 feet (15 to 40 meters).
JEFFERSON FORMATION (DEVONIAN)—medium to very dark gray, thin- to thick-bedded, coarse-grained dolomite and dolomitic limestone, sedimentary breccia intervals near top. Stromatoporoidal structures (rounded, concentrically banded algal heads), bryozoans, calcite veins, and burrows fairly common. Petroliferous odor on fresh surfaces. Faulting and folding makes thickness estimates problematic but thickness is estimated at about 490 to 650 feet (150 to 200 meters).

Dm — MAYWOOD FORMATION (MISSISSIPPIAN AND DEVONIAN)—thin-bedded, reddish gray, gray, and yellowish gray dolomitic limestone and dolomite interbedded with calcareous shale, siltstone, and minor white calcareous quartzite. Typically poorly exposed. Thickness about 100 feet (30 meters).

Ꞓrl — RED LION FORMATION (CAMBRIAN)—lower part consists of red, reddish brown, and yellowish brown siltstone and shale, some calcareous, with locally abundant trace fossils. Upper part is light to dark gray, micritic limestone with interbedded, discontinuous, thin, reddish argillite layers. The argillite stands in relief on weathered surfaces and imparts a wavy, ribbon-like texture to the bedding. Thickness about 250 feet (76 meters).

Ꞓbr — Angular blocks of brecciated Hasmark and Flathead Formations. Age and origin is uncertain. Possibly a landslide deposit but a tectonic origin cannot be ruled out. Thickness unknown.

Ꞓh — HASMARK FORMATION (CAMBRIAN)—massive to medium-bedded, light gray dolomite with interbedded dark grayish black dolomite and minor thin, clean quartzite beds near base (Lewis, 1990). Faint laminations often visible on weathered surfaces. Metamorphosed to coarsely crystalline dolomitic marble near intrusive contacts. Faulting and folding makes thickness estimates problematic but thickness is approximately 600 to 1,000 feet (183 to 305 meters).

Ꞓsh — SILVER HILL FORMATION (CAMBRIAN)—lower part is thin-bedded, olive green to olive gray, micaceous shale and argillite with interbedded reddish quartzite and siltite. Upper part is interbedded nodular and silty limestone and thin-bedded siltstone and sandstone. Dark gray limestone beds commonly contain wavy, yellow brown silty seams that impart a "black and gold" color to rock. Near intrusive contacts, shale is metamorphosed to grayish black hornfels. Thickness about 400 feet (122 meters).

Ꞓf — FLATHEAD FORMATION (CAMBRIAN)—pale orange to yellowish brown, thin- to medium-bedded clean quartzite with interbeds of fine-grained sandstone and olive green and pale red mudstone and shale. Faulting and folding makes thickness estimates problematic but estimated thickness is about 600 feet (183 meters).

Ybo — BONNER FORMATION (MESOPROTEROZOIC)—pale red to pink, fine- to coarse-grained feldspathic quartzite with mud chips and some pebbles. Thin- to thick-bedded with cross-bedding. Thickness not determined.

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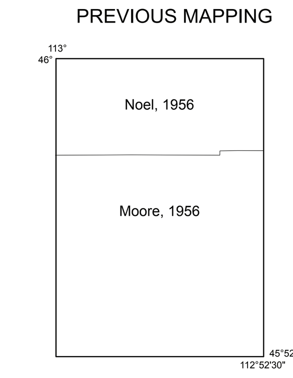
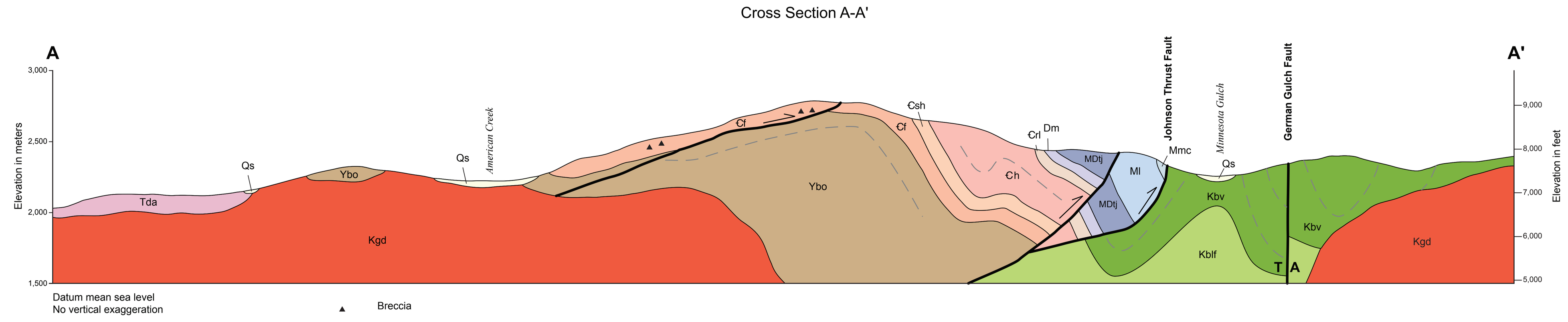
PREVIOUS MAPPING



Entire quadrangle: Lewis, 1990; and Ruppel and others, 1993, as part of Dillon 1:250K quadrangle

Cross Section A-A'



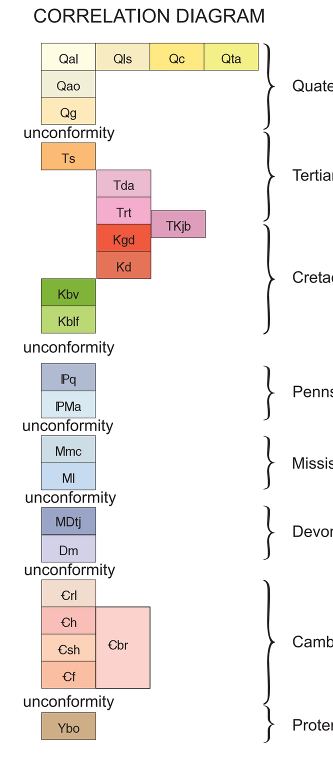
Datum mean sea level
No vertical exaggeration

Breccia
Diagrammatic beds and folds
Qs Undifferentiated surficial deposits

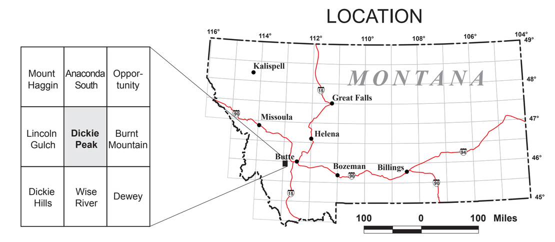
MAP SYMBOLS

- Contact: dashed where approximately located; dotted where concealed
- Fault: Dashed where approximately located, dotted where concealed, bar and ball on downthrown side. Arrows along fault trace indicate relative strike-slip displacement.
- Reverse or thrust fault: teeth on upthrown block; dashed where approximately located; dotted where concealed
- Anticline: showing trace of axial plane and plunge direction where known; dotted where concealed
- 32 Strike and dip of inclined beds
- 75 Strike and dip of overturned bedding
- Vertical bedding
- 75 Strike and dip of foliation
- Zone of tectonic brecciation or brecciation and shearing
- Beal Mountain Mine
- m Mine tailings
- Au Gold placer spoils

CORRELATION DIAGRAM



LOCATION



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

MBMG Open-File 601

Geologic Map of the Dickie Peak 7.5' Quadrangle Southwest Montana

Catherine McDonald

2011