



Geological Analysis of the Northern Margin of the Boulder Batholith: An EdMap Project

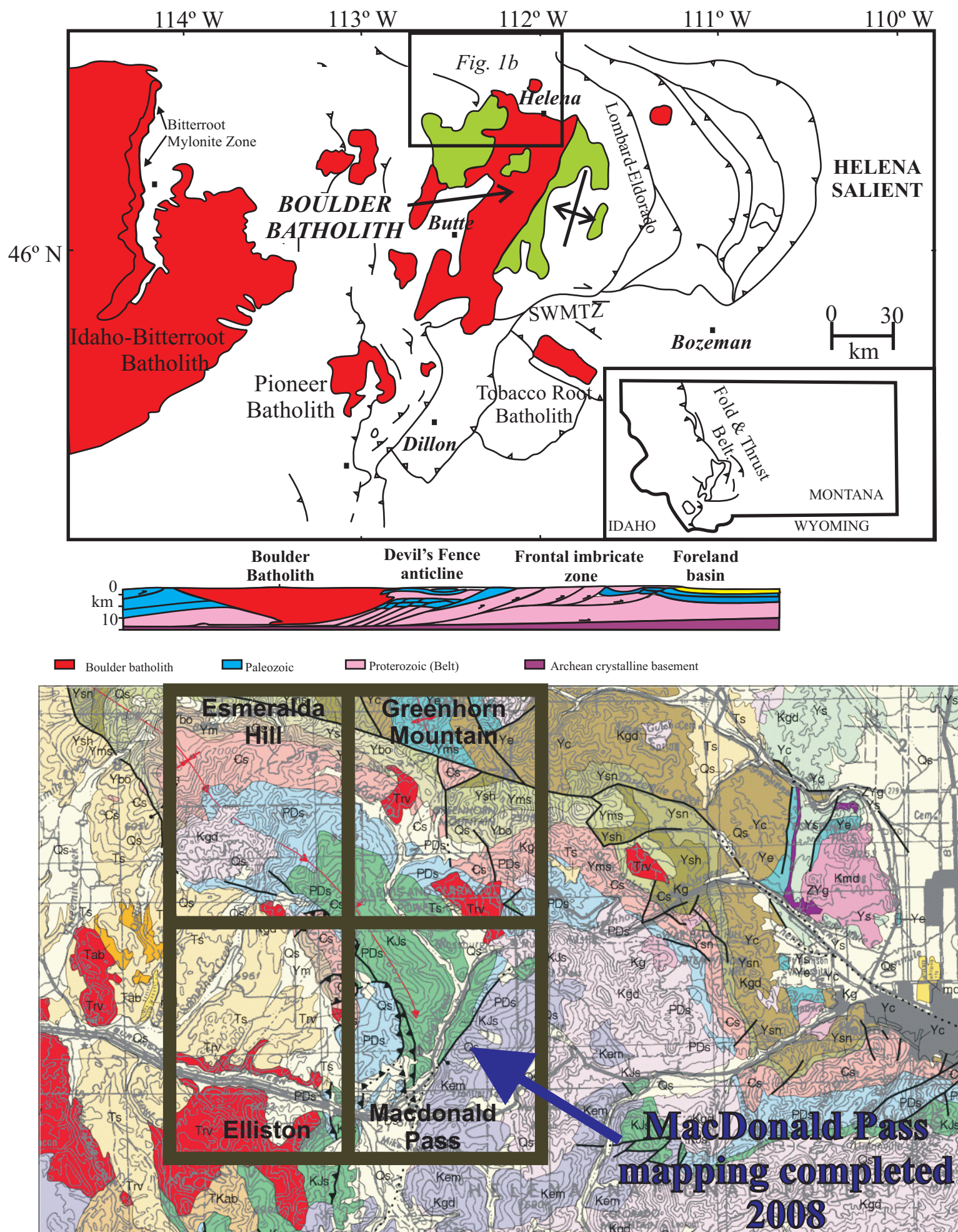
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ABSTRACT

Southwest Montana experienced large-scale magmatism and regional contraction during the Late Cretaceous. Understanding the genetic linkages between these geologic processes is important for understanding the causes of mountain-building in the Cordillera. The relationship between the plutonic rocks of the Boulder batholith, the coeval volcanic rocks of the Elkhorn Mountain volcanics, and the folding and thrusting associated with foreland contraction is the subject of ongoing debate. Part of the debate is the result of incomplete field relations. We present detailed mapping of the Elliston and MacDonald Pass 7.5 minute quadrangles situated on the northern margin of the Helena salient, near the juncture between deformed Paleozoic strata, the voluminous intrusive rocks of the batholith, and the overlying volcanic rocks. Our analysis of the field relationships between the Boulder magmatic system and the folded Paleozoic rocks constrain the sequence of events that shaped the tectonomagmatic evolution of the Helena salient.

INTRODUCTION



Faculty and students from the Department of Geology at the University of Wisconsin-Eau Claire have been examining this region under the auspices of the MBGS/USGS EDMAP since 2004. Our program has focused on detailed (1:24,000) geologic mapping and associated structural, stratigraphic, geochemical, geochronologic and isotopic investigations.

ONGOING INVESTIGATION

Detailed geologic mapping in the Elliston and MacDonald Pass quadrangles and adjacent areas will focus on documenting the relationship between complexly folded and faulted Paleozoic and Mesozoic strata and intrusive rocks associated with the Boulder batholith in the northern portion of the Helena salient. The structural pattern along the northern margin of the Boulder batholith is complex, with abundant second- and third-order folds, thrust faults and cross-cutting normal faults. These rocks are intruded by satellite stocks, dikes and sills with unclear spatial and temporal relationships to the deformational features. Documentation of the timing and sequence of events between magmatic emplacement and structural deformation will provide critical timing constraints on the emplacement of the Boulder Batholith and its relation to the structural evolution of the northern Helena salient.



Prominent jointing pattern common in the Boulder Batholith

The Elliston and MacDonald Pass quadrangles are located in the northern portion of the Disturbed Belt of west-central Montana, a zone of Late Cretaceous-early Tertiary convex-eastward folds and thrust faults that place Precambrian Belt Supergroup rocks over Paleozoic and Mesozoic strata.

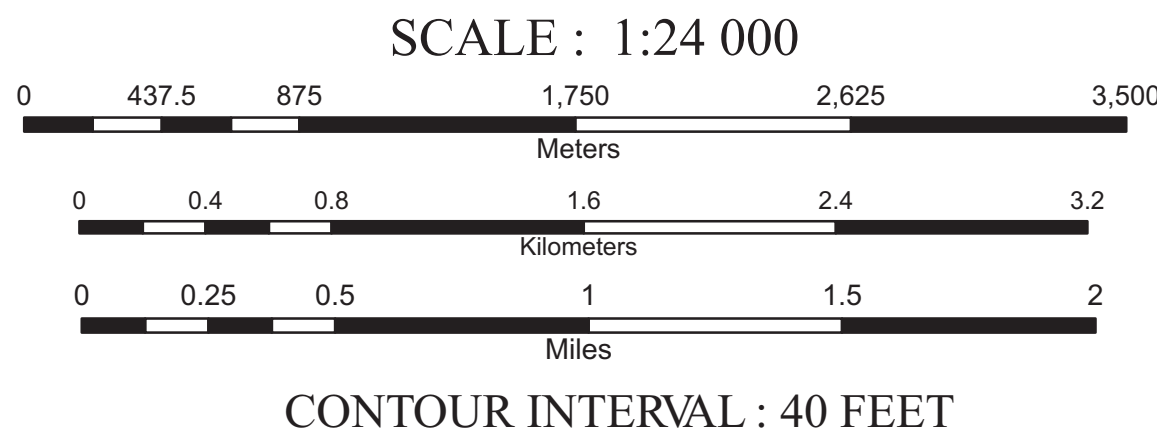
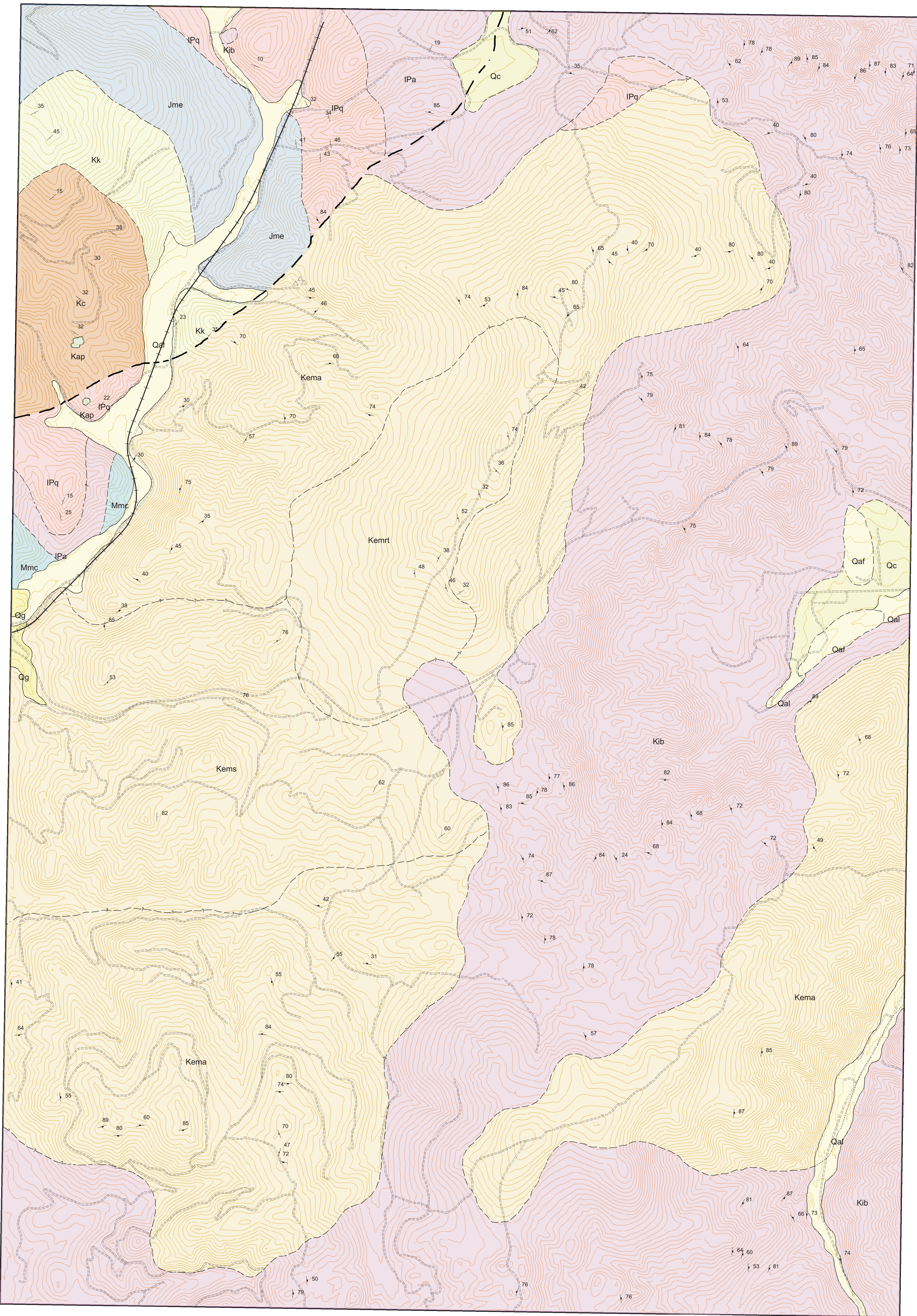


Excellent example of the nature of the structural control of the nature of exposure.

Acknowledgments

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MacDonald Pass 7.5 Minute Quadrangle

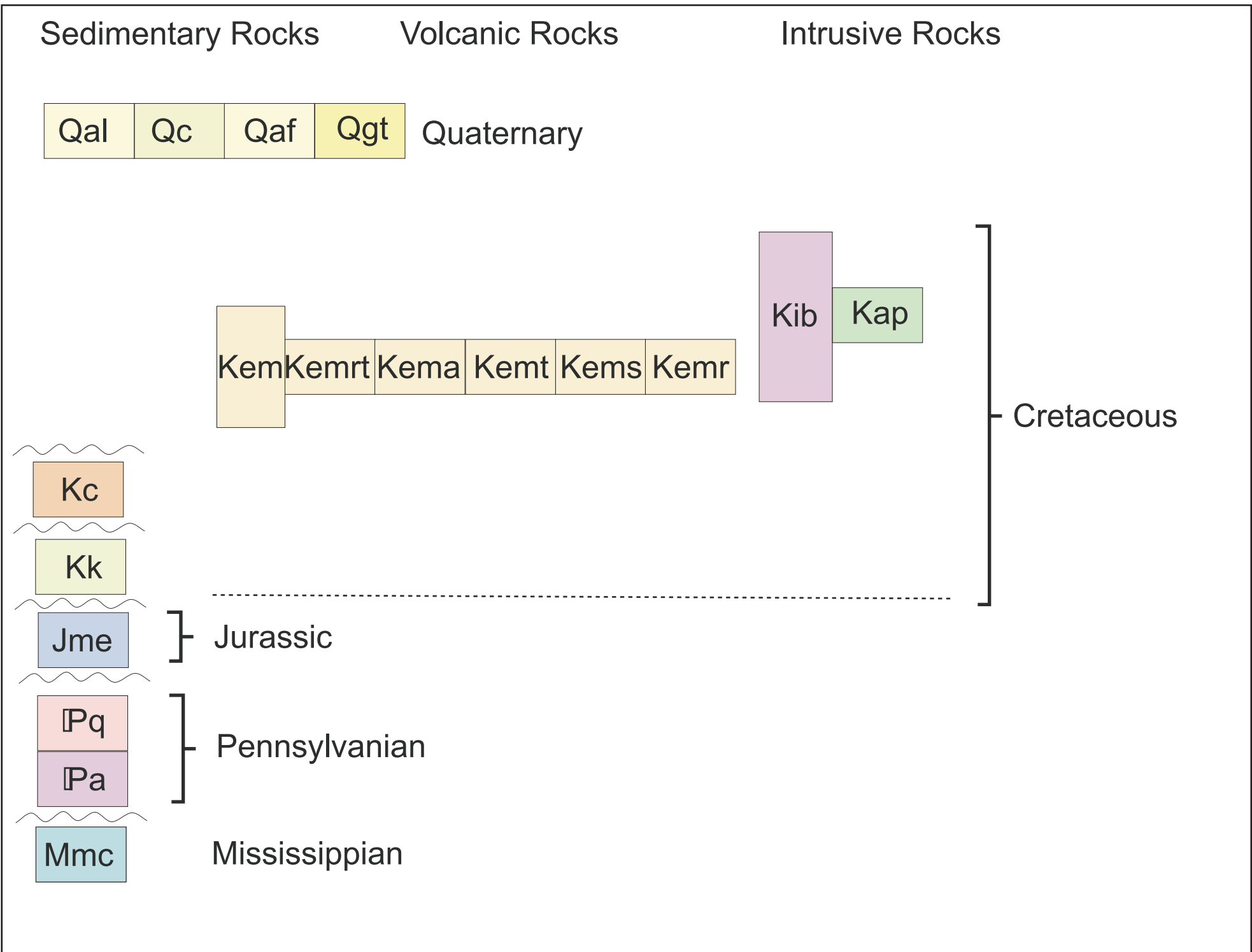


CONTOUR INTERVAL : 40 FEET



Map Symbols

- Flow Foliation
- Bedding
- Joint
- Breccia Zone
- Contacts
 - Known
 - Approximate
 - Covered
 - Inferred
- Normal Fault



Geologic Units

Cenozoic

- Qal Quaternary Alluvium (Holocene):** Light-gray to light-brown, moderately to well sorted, crudely stratified boulder, cobble, pebble, sand, silt, and clay. Heterolithic clasts include Paleozoic carbonate and siliciclastic rocks, plutonic and volcanic rocks. Unit restricted to modern stream drainages. Thickness varies; generally <35 ft (~10 m)
- Qc Quaternary Colluvium (Holocene):** Discontinuous veneer of unconsolidated sand, gravel, cobbles and boulders
- Qaf Quaternary Alluvial Fan (Holocene):** Unconsolidated crudely stratified polymict boulder, cobble conglomerate and intercalated coarse-grained sandstone. Forms lobe-shaped deposits with a convex up topographic profile and hummocky surface in valley bottoms
- Qg Quaternary Glacial Terrace:** Glacial terrace: crudely stratified unconsolidated clay, sand and gravel of probable glaciofluvial origin

Mesozoic

Cretaceous Volcanic Rocks

- Kema Cretaceous Elkhorn Mountain Andesite:** andesite flows, breccia and hypabyssal dikes, and sills
- Kemrt Cretaceous Elkhorn Mountain Rhyolite Tuff:** rhyolite welded to non-welded tuff, and lapilli tuff
- Kems Cretaceous Elkhorn Mountain Sediment:** volcanoclastic conglomerate, sandstone, and siltstone

Cretaceous Intrusive Rocks

- Kib Cretaceous Boulder Batholith:** Intrusive rocks of the Boulder Batholith, undivided; Medium to coarse grained, equigranular to potassium-feldspar-porphyritic biotite granite to granodiorite

Cretaceous Sedimentary Rocks

- Kc Colorado Group:** Recessive, orange, brown and red thinly bedded, thin laminated fine-grained sandstone, siltstone and shale
- Kk Kootenai Formation:** Light-gray to brown, medium-bedded, moderately sorted, chert-lithic arenite; commonly displays large low-angle cross-stratification (150-350 ft (~50-100 m))
- Kap Cretaceous Andesite Porphyry:** Andesite porphyry

Jurassic Sedimentary Rocks

- Jme Jurassic Morrison Formation and Ellis Group:** Morrison Formation and Ellis Group, undivided; recessive succession characterized by a lower portion of thin-bedded, calcite-cemented, lithic arenite, sandy siltstone, siltstone, and shale yielding orange, red, tan, and dark-gray, sandy siltstone regolith and an upper portion of thin- to medium-bedded, orange to red quartz arenite, thin-bedded siltstone, shale, and sandy micrite (125-225 ft (~40-70 m))

Paleozoic

Pennsylvanian Sedimentary Rocks

- IPq Quadrant Formation:** Cliff-forming unit of buff-yellow and pink, medium-thick bedded, silica-cemented, cross-stratified, quartz arenite. Locally contains chert nodules and thin calcareous silt laminations. Contains basal unit of dolomitic, cross-stratified quartz arenite to sandy dolomite. (150-350 ft (~50-100 m))
- IPa Amsden Formation:** Recessive unit of light-gray to tan, thinly laminated, thin-bedded quartz arenite, siltstone, shale, and silty micrite that produces distinctive reddish-brown regolith (100-165 ft (~30-50m))

Mississippian Sedimentary Rocks

- Mmc Mission Canyon Formation:** Thick to massively bedded, medium- to dark-gray, fossiliferous (rugose corals, sponges, and bioclastic hash) wackestone, packstone and locally rudstone. Displays characteristic scalloped surface and locally abundant thin, dark-gray chert nodules. Coarsely crystalline in part. Massive character commonly makes determination of bedding orientation difficult. (575-825 ft (~175-250 m))

Geologic Map of Macdonald Pass 7.5' Quadrangle, West-Central Montana

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