PRELIMINARY GEOLOGIC MAP OF THE HELLGATE GULCH 7.5' QUADRANGLE, WEST-CENTRAL MONTANA

by

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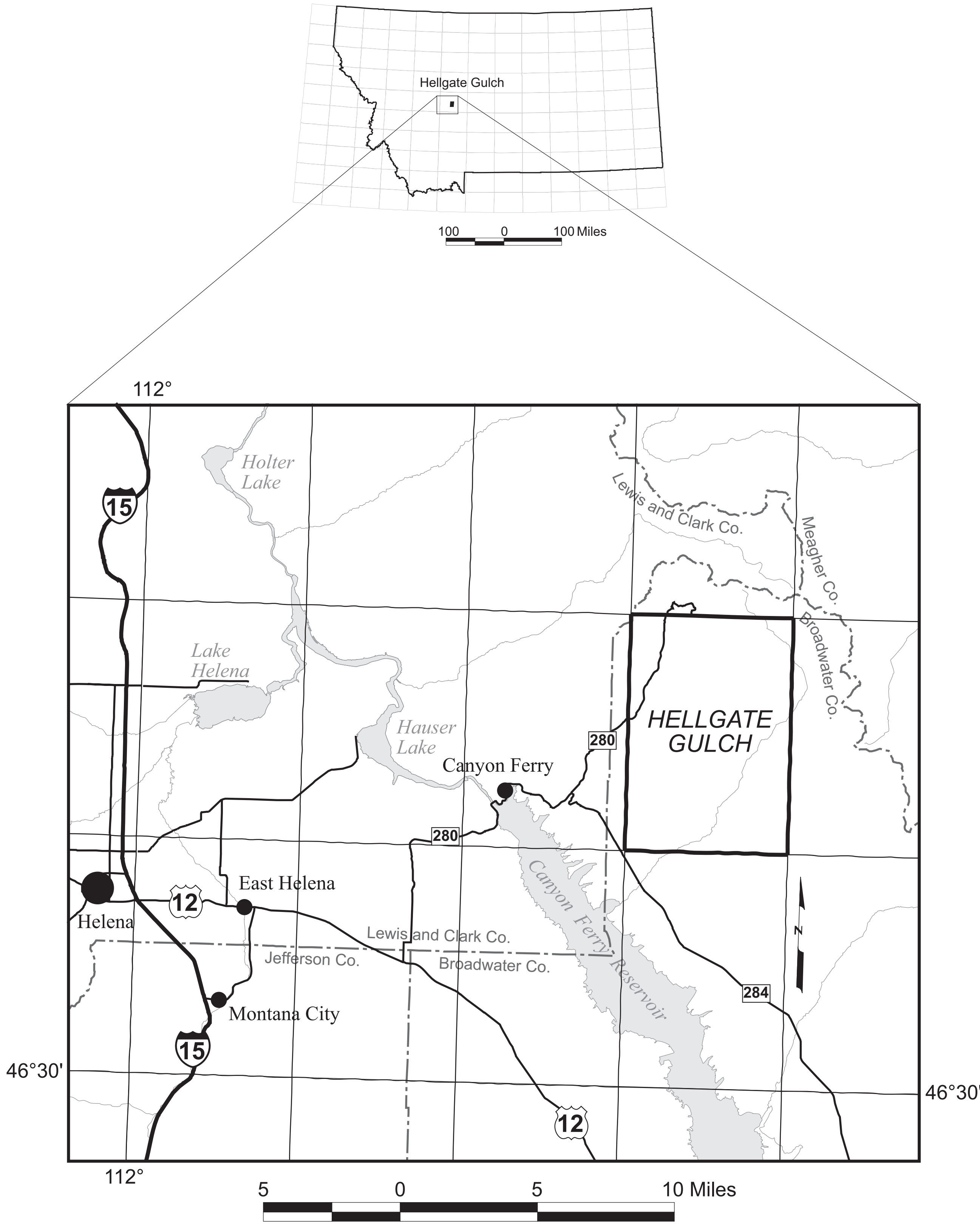


Figure 1. Location of Hellgate Gulch 7.5' quadrangle, west-central Montana.

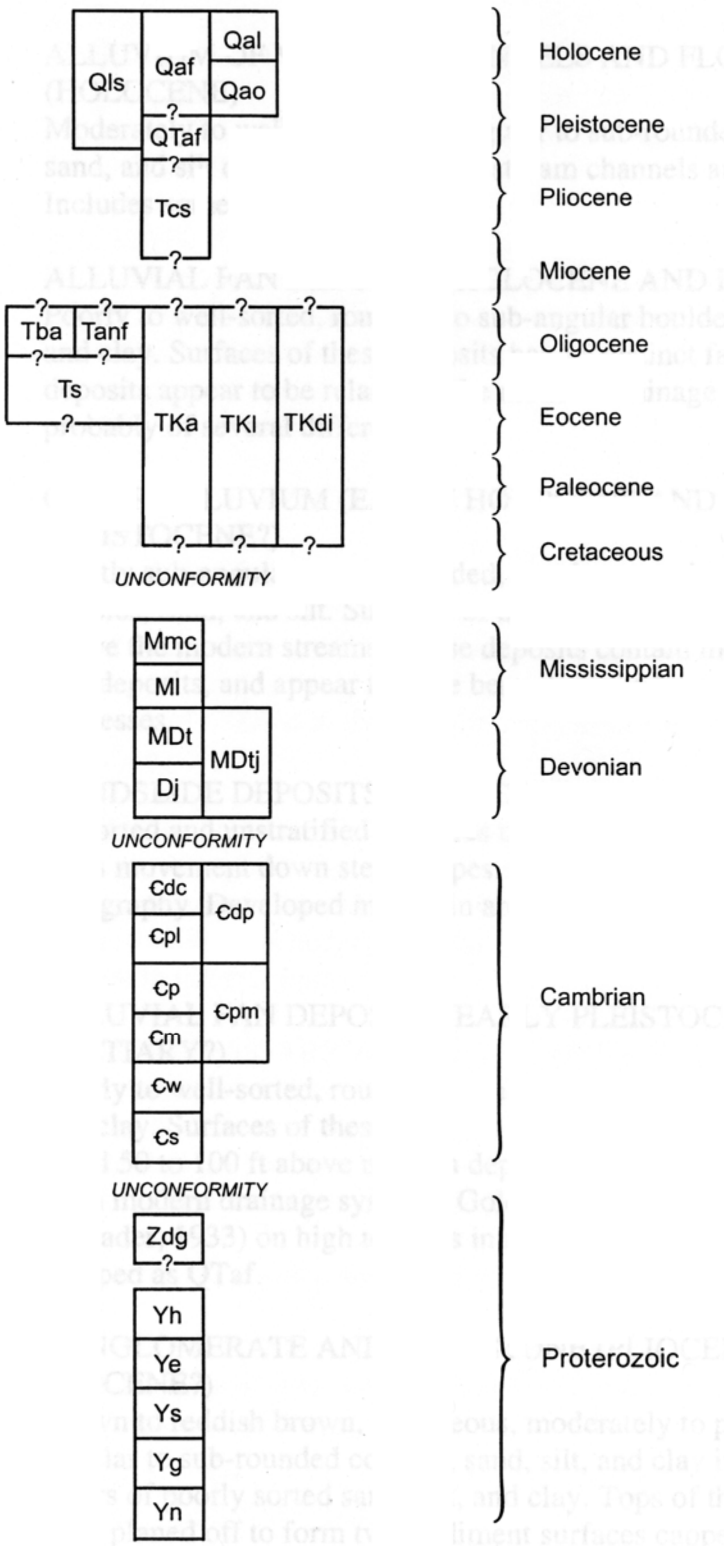


Figure 2. . Age correlation of map units.

DESCRIPTION OF MAP UNITS

Qal — ALLUVIUM OF MODERN CHANNELS AND FLOOD PLAINS (HOLOCENE)
Moderately to well-sorted, sub-angular to sub-rounded boulders, cobbles, sand, and silt deposited in modern stream channels and flood plains. Includes some small areas of Qaf.

Qaf — ALLUVIAL FAN DEPOSITS (HOLOCENE AND PLEISTOCENE)
Poorly to well-sorted, rounded to sub-angular boulders, cobbles, sand, silt, and clay. Surfaces of these deposits have a distinct fan shape. These deposits appear to be related to the modern drainage basins, but are probably of several different ages.

Qao — OLDER ALLUVIUM (EARLY HOLOCENE AND LATE PLEISTOCENE?)
Mostly sub-angular to sub-rounded, poorly to moderately sorted boulders, cobbles, sand, and silt. Surfaces of these deposits now stand 15 to 25 ft above the modern streams. These deposits contain more boulders than do Qal deposits, and appear to have been deposited mostly by debris flow processes.

Qls — LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)
Unsorted and unstratified mixtures of mud and boulders transported by mass movement down steep slopes. Characterized by irregular topography. Developed mostly in areas underlain by Tertiary sediments (Ts).

QTaf — ALLUVIAL FAN DEPOSITS (EARLY PLEISTOCENE AND LATE TERTIARY?)
Poorly to well-sorted, rounded to sub-angular boulders, cobbles, sand, silt, and clay. Surfaces of these deposits have a distinct fan shape and now stand 50 to 100 ft above modern deposits. They do not appear to emanate from modern drainage systems. Gold-bearing gravels (Pardee and Schrader, 1933) on high terraces in upper Avalanche Gulch were also mapped as QTaf.

Tcs — CONGLOMERATE AND SANDSTONE (PLIOCENE AND LATE MIOCENE?)
Brown to reddish brown, calcareous, moderately to poorly sorted, sub-angular to sub-rounded cobbles, sand, silt, and clay interbedded with layers of poorly sorted sand, silt, and clay. Tops of these deposits have been planed off to form two pediment surfaces capped by lag gravels and possibly loess. Reynolds (1987) postulated a Late Miocene to Pliocene age for these deposits, and they are probably correlative with the Sixmile Creek Formation.

Tba BASALT (LATE OLIGOCENE?)
Black to reddish-brown, vesicular to massive basalt flows. Some basalt contains small feldspar phenocrysts. Overlies Tertiary sediments (Ts). Reynolds (1987) suggested a Late Oligocene age for similar basalt east of the Hellgate Gulch quadrangle.

Tanf ANDESITE FLOWS (LATE OLIGOCENE?)
Dark-gray to reddish-brown, altered, porphyritic andesite containing large plagioclase phenocrysts as much as one-half inch long in an aphanitic groundmass. Mertie and others (1951) mapped this unit as intrusive, but its stratigraphic position above Tertiary sediments (Ts) in Cow Gulch suggests that it is a flow.

Ts SEDIMENTARY ROCKS, UNDIVIDED (OLIGOCENE AND EOCENE?)
Interbedded conglomerate, tuffaceous siltstone, and volcanic ash perched near the crest of the Big Belt Mountains and overlain by volcanic rocks. Probably correlative with the Renova Formation. Less than 200 ft is exposed in the quadrangle, but Mertie and others (1951) reported a thickness of 2000 ft in the Canyon Ferry area west of the quadrangle boundary.

TKa ANDESITE INTRUSIONS (TERTIARY AND LATE CRETACEOUS)
Dark-gray to brown, fine-grained, microporphyritic (Mertie and others, 1951) intrusive andesite in sills, dikes, and one small stock near the eastern quadrangle boundary. Small lath-shaped plagioclase crystals can be seen in hand samples.

TKdi DIORITE (TERTIARY AND LATE CRETACEOUS)
Biotite-hornblende diorite in thick, steeply-dipping dikes that appear to be oriented parallel to cleavage. Although Mertie and others (1951) and Reynolds (1987) assigned a Late Proterozoic age to these dikes, they appear to post-date Cretaceous folds and we interpret them to be Late Cretaceous or early Tertiary. The dikes are associated with gold mineralization (Pardee and Schrader, 1933; Reynolds, 1987).

TKl LATITE (TERTIARY AND LATE CRETACEOUS)
Light-gray, porphyritic latite sills and dikes with feldspar phenocrysts in an aphanitic groundmass.

Mmc MISSION CANYON LIMESTONE OF THE MADISON GROUP (UPPER MISSISSIPPIAN)
Pale-brown, brown-gray, and brown-black micrite and fossiliferous micrite. Weathers light-gray to yellow-gray, gray-orange, and light- to dark-brown. Bedding is thick to massive and indistinct. Contains minor brecciated beds and black or dark-yellowish chert in thin beds or zones as much as 3 ft thick. Thickness of the Madison Group, including underlying

Lodgepole Limestone, is estimated to be 1000 ft (Mertie and others, 1951).

Ml LODGEPOLE LIMESTONE OF THE MADISON GROUP (LOWER MISSISSIPPIAN)

Moderate-brown to dark-brown-gray, and olive-black, thin to medium bedded, sparse to fossiliferous biomicrite. Weathers light gray, yellow-gray, and yellow-brown. Minor light-colored chert in places. Fresh surfaces have slight petroliferous odor. Fossils include brachiopods, crinoid stems, corals, and bryozoans. Thickness of the Lodgepole Limestone in this quadrangle is about 700 ft.

MDtj THREE FORKS FORMATION AND JEFFERSON DOLOMITE, UNDIVIDED

MDt THREE FORKS FORMATION (LOWER MISSISSIPPIAN AND UPPER DEVONIAN)

Red, gray-brown, and dark-yellow-brown, poorly bedded shale and minor fine-grained sandy, micaceous shales or shaly limestones with poorly preserved fossils. Weathers dark-gray to brown, with abundant limonitic stain in places. Pseudomorphic crystals of limonite after pyrite are common. Estimated thickness is 100 to 200 ft.

Dj JEFFERSON DOLOMITE (UPPER DEVONIAN)

Gray, gray-brown, and dark-brown, very fine- to medium-grained, sucrosic dolomite, with subordinate white, gray, and brown-gray limestone. Weathers white, yellow-gray, and gray-brown, with a sugary surface. Bedding is thin to massive, with thin laminations evident on some weathered surfaces. Some beds are brecciated and may be collapse breccias resulting from solution of evaporites. Minor light-gray, brown-weathering chert is present along some bedding planes. Freshly broken surfaces can have a strong petroliferous odor. Thickness 500-600 ft.

Єdp DRY CREEK SHALE AND PILGRIM LIMESTONE, UNDIVIDED (UPPER CAMRIAN)

Єdc DRY CREEK SHALE (UPPER CAMBRIAN)

Poorly exposed brown shale to sandy shale, somewhat micaceous. Estimated thickness 50 ft (Mertie and others, 1951).

Єpl PILGRIM LIMESTONE (UPPER CAMBRIAN)

Upper part consists of light-gray, medium-grained dolomite with a granular texture. Bedding ranges in thickness from one to several feet and can display brown and tan mottling on weathered surfaces. Lower part consists of thin-bedded, yellow-brown, and olive-gray to dark-gray micritic limestone with light-gray, yellow, and reddish, muddy-limestone interbeds, discontinuous flat-pebble limestone conglomerate, and medium-grained oomicrite. Weathered surfaces often show irregular yellowish-orange to reddish claystone mottles, giving it an appearance similar to Meagher limestone, but it can usually be distinguished by presence of flat-pebble conglomerate or oomicrite. Thickness about 500 ft (Mertie and others, 1951).

Єpm PARK SHALE AND MEAGHER LIMESTONE, UNDIVIDED (MIDDLE CAMBRIAN)

Єp PARK SHALE (MIDDLE CAMBRIAN)
Poorly exposed, green-gray to light-olive gray, micaceous siltstone and shale. Often weathers to splinter-shaped fragments and pencil slate. Pseudomorphic crystals of limonite after pyrite are common in places. Thickness 80-160 ft.

Єm MEAGHER LIMESTONE (MIDDLE CAMBRIAN)
Fine-grained, mottled, orange-brown and light-gray limestone that weathers light-gray to blue-gray. Some coarser-grained beds appear to contain recrystallized oolites or sand-size limestone fragments. Appears massive but is thin- to medium-bedded, commonly with a wavy appearance. Near top and base are thin, discontinuous light-gray, yellow, and red limestone layers. Thickness is 250 to 300 ft.

Єw WOLSEY SHALE (MIDDLE CAMBRIAN)
Green-gray to olive-gray, noncalcareous, micaceous shale with subordinate interbedded lenses of olive-gray to brown, fine-grained, calcite-cemented quartzitic sandstone. Animal burrows and trails are common. Thin-bedded and poorly exposed. Thickness estimated to be 80 to120 ft, but locally tectonically thickened by intraformational folds.

Єf FLATHEAD SANDSTONE (MIDDLE CAMBRIAN)
White, light-brown, and pink to red-purple, silica- and hematite-cemented quartzarenite. Weathers dark-red, dark-brown, and black, often with limonite staining. Fine- to coarse-grained with discontinous conglomeratic beds in the basal part of section. Bedding is generally indistinct although purple to white banding is common and cross-bedding is evident on some weathered surfaces. Thickness is about 200 ft (Mertie and others, 1951).

Zdg DIORITE AND GABBRO (LATE PROTEROZOIC?)
Greenish-black, medium-grained, hornblende diorite and poikilitic gabbro in sill-like bodies that appear to cut section at low angles. A Late Proterozoic age is inferred because bodies only intrude Belt rocks, are cut off at the Cambrian-Precambrian unconformity (Mertie and others, 1951), and have been folded by Cretaceous deformation.

Yh HELENA FORMATION (MIDDLE PROTEROZOIC)
Tan-weathering, wavy but parallel, lenticular and even couplets of dark-

green dolomitic siltstone and light-green dolomitic argillite without mud cracks, interbedded with brown-weathering dolomite and minor white quartzite. Pods of carbonate, frequently weathered-out, are common. Cleavage is well-developed and obscures bedding. About 900 feet thick in the quadrangle. Not present in the footwall of the Moors Mountain Thrust in the northeast corner of the quadrangle.

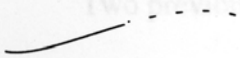
Ye EMPIRE FORMATION (MIDDLE PROTEROZOIC)
Greenish-gray, dense siltite and argillite in even and lenticular couplets and microlaminae. The Empire Formation is a transitional unit between the Spokane and Helena Formations, so it includes red, mudcracked couplets near its base and dolomitic beds toward its top. Eight hundred to 1000 feet thick (Mertie and others, 1951). Not present in the footwall of the Moors Mountain Thrust in the northeast corner of the quadrangle

Ys SPOKANE FORMATION (MIDDLE PROTEROZOIC)
Maroon-weathering, mostly red siltite and argillite in mudcracked couplets, couples, and microlaminae. Mudcracks, mud-chip rip-up clasts, ripple marks, and salt casts are common. Some quartzite beds as much as 6 inches thick are present. Some beds are dolomitic. Cleavage is intensely developed and obscures bedding. Formation is 1500 to 2000 ft thick in the quadrangle (Mertie and others, 1951).

Yg GREYSON FORMATION (MIDDLE PROTEROZOIC)
Greenish-gray-weathering siltite and argillite in even couplets and microlaminae. Characterized by the absence of mudcracks and other desiccation features, by the thin, regular, parallel beds, and by layers rich in wispy black material that is probably carbon (Don Winston, personal communication, 2002). Cleavage is well developed and obscures bedding. Medium-grained, calcareous quartzite beds 4 to 6 inches thick and containing ripple crossbeds are scattered through the section. The middle and upper parts of the Greyson contain intervals several hundred feet thick that are dominated by these quartzite beds. Thickness of the Greyson is 5100 to 7600 ft (Reynolds, 1987).

Yn NEWLAND FORMATION (MIDDLE PROTEROZOIC)
Tan-weathering argillaceous limestone and calcareous argillite in thin, parallel, very regular beds separated by dark gray, carbon-rich(?) bands. Cleavage is well-developed and obscures bedding. The Newland Formation is 7000 to 10,600 ft thick (Reynolds, 1987), but only about 2000 ft are exposed in the quadrangle (Mertie and others, 1951).

MAP SYMBOLS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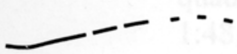
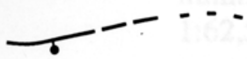
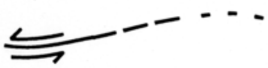
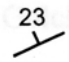

Fault: unknown sense of movement, dashed where approximately located; dotted where concealed

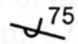

Normal fault: dashed where approximately located; dotted where concealed; bar and ball on downthrown side


Reverse or thrust fault: teeth on upthrown block

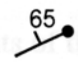

Strike-slip fault: dashed where approximately located, dotted where concealed. Arrows along fault trace indicate relative strike-slip displacement



Strike and dip of bedding



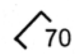
Strike and dip of overturned bedding



Strike and dip of bedding where statigraphic tops were confirmed using primary sedimentary structures


Horizontal bedding

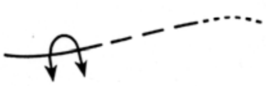

Vertical bedding

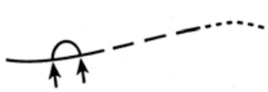


Cleavage


Anticline: showing trace of axial plane and plunge direction where known; dotted where concealed


Syncline: showing trace of axial plane and plunge direction where known; dotted where concealed


Overturned anticline: showing trace of axial plane and direction of dip of bedding; dashed where approximately located, dotted where concealed


Overturned syncline: showing trace of axial plane and direction of dip of bedding; dashed where approximately located, dotted where concealed


Andesite sills and dikes


Latite sills and dikes


Vertical line indicates mapping boundary between divided and undivided units

SOURCES OF PREVIOUS MAPPING

Two previously published maps include the entire Hellgate Gulch quadrangle:

Mertie, J.B., Fischer, R.P., and Hobbs, S.W., 1951, Geology of the Canyon Ferry quadrangle, Montana: U.S. Geological Survey Bulletin 972, 97 p., map scale 1:48,000.

Pardee, J.T., and Schrader, F.C., 1933, Metalliferous deposits of the greater Helena mining region, Montana: U.S. Geological Society Bulletin 842, 318 p., map scale 1:62,500.

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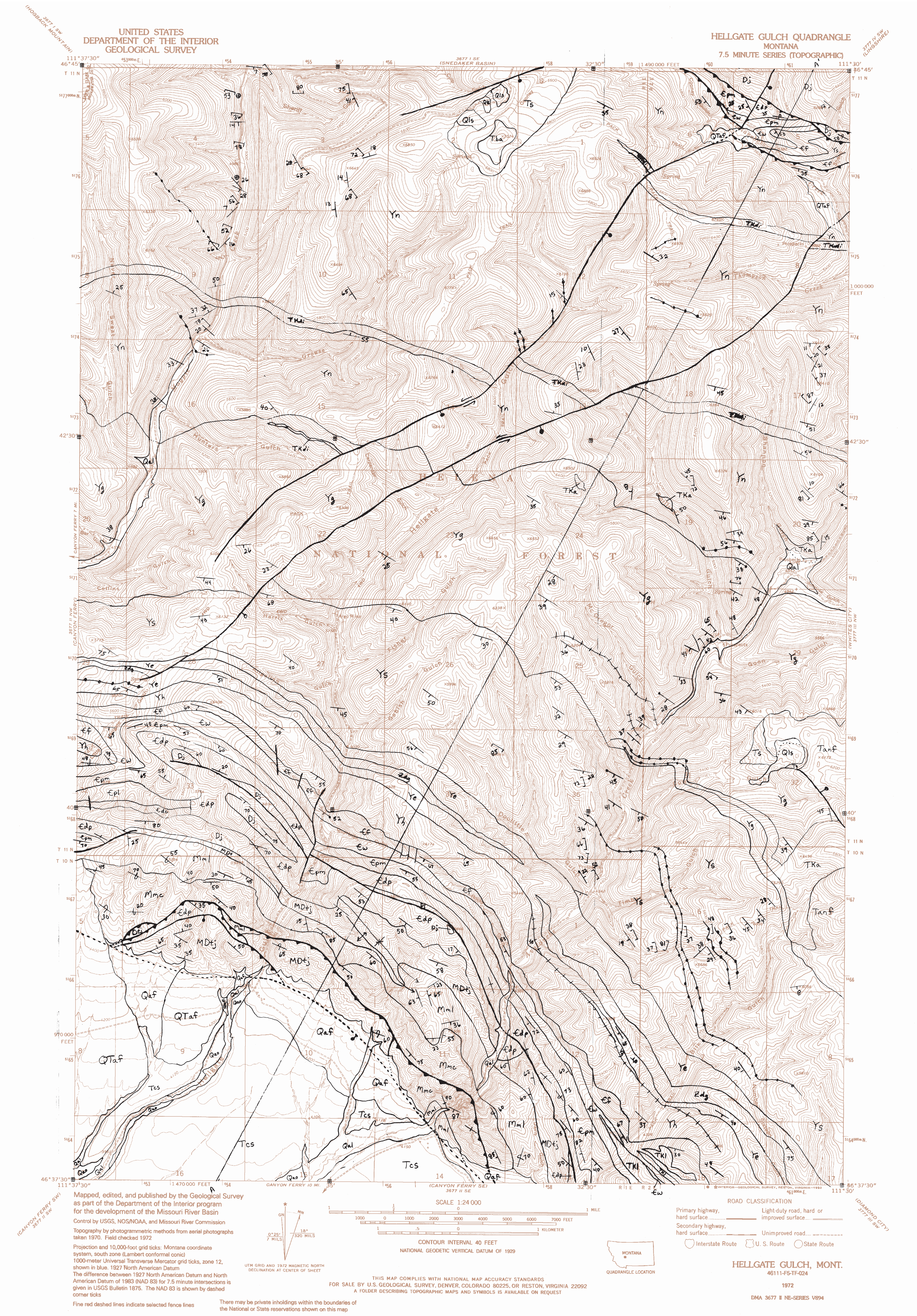

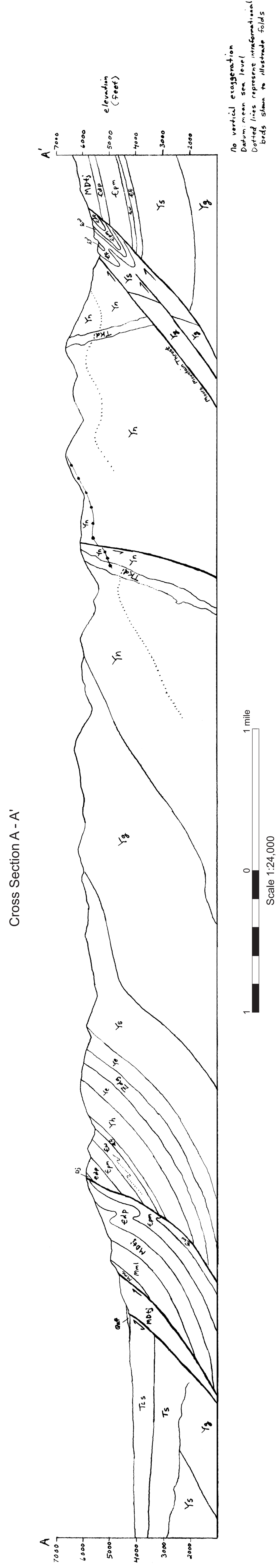

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Preliminary Geologic Map of the Hellgate Gulch 7.5 Minute Quadrangle Western Montana

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

Maps may be obtained from
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