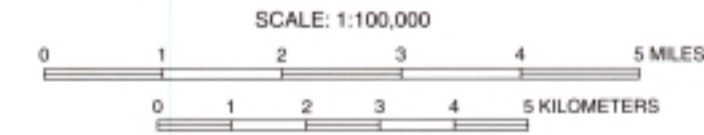


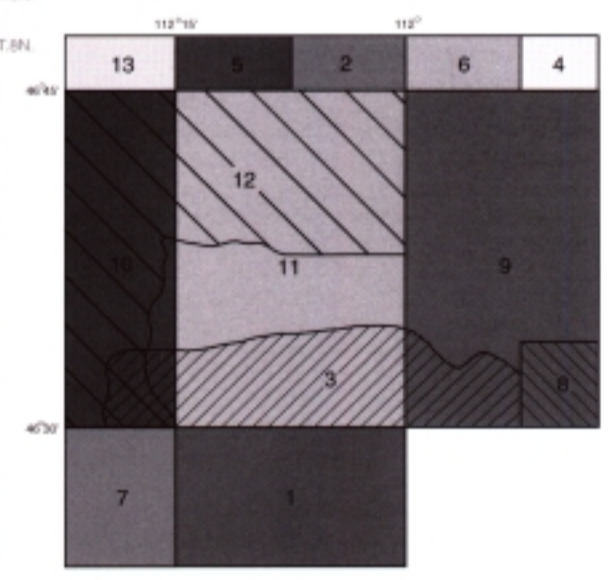
Base modified from U.S. Geological Survey topographic maps, 1:24,000 and 1:62,500 dated 1950-73; Butte North, 1975; Canyon Ferry Dam, 1975; and Elliston, 1975. (photomapped 1990), 1:100,000 metric quadrangles. Digital Line Graph data, 1998. Universal Transverse Mercator projection, zone 12 1927 North American Datum



Digital geologic cartography by Janelle Luppen, supervision by Theodore R. Brandt; plate and text layout by Theodore R. Brandt



INDEX MAP SHOWING SOURCES OF GEOLOGIC DATA



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11. Schmidt, R.G., U.S. Geological Survey, written commun., 1982. Modifications based on field geologic mapping by M.W. Reynolds, 1977, 1984.
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Subsurface bedrock geologic map of the north, west, and south margins of Helena Valley by M.W. Reynolds, 1998, 1999, scale 1:24,000, based on well-drilling records and sample examination.

EXPLANATION

<p>No bedrock data Quaternary sand, silt, clay, and gravel at the surface conceal bedrock units. Insufficient data regarding distribution of concealed bedrock units. Area includes principal bodies of water</p> <p>Pliocene(?) and Miocene sedimentary rocks Interbedded conglomerate, sandstone, siltstone, minor mudstone, and volcanic tuff. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Oligocene volcanic rocks Rhyolite intrusive bodies and flows, minor tuff, breccia, and tuffaceous sandstone. May include beds of possible Eocene age in southwest part of the map area. Unit Ovt is dominantly stratified tuff with subordinate clastic sedimentary rocks; unit is partly correlative with unit Oas. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Oligocene sedimentary rocks Interbedded sandstone, volcanic tuff, conglomerate, and minor carbonaceous siltstone and mudstone. May include beds of possible Eocene age at base. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Eocene volcanic rocks Andesitic and basaltic flows, breccia, and intrusive bodies. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Cretaceous intrusive rocks, mainly granitic Granodiorite, granite, quartz monzonite, monzonite, and some mafic intrusive rocks of the Boulder batholith, Elkhorn Mountains, Scratchgravel Hills, Broadwater and Marysville stocks, and small unnamed intrusive bodies west and northwest of Helena. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Elkhorn Mountains Volcanics Andesitic volcanic rocks, ashflow tuffs, shallow intrusive rocks, and minor conglomerate. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Upper and Lower Cretaceous sedimentary rocks Mudstone, siltstone, and thin sandstone units; some conglomerate and very thin tuff beds. Includes the Colorado Group, Kootenai Formation, and locally the Slim Sam Formation. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Jurassic sedimentary rocks Mudstone, siltstone and thin units of fine-grained sandstone, with minor carbonaceous shale and limestone beds. Includes the Morrison Formation and Ellis Group. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Permian and Pennsylvanian sedimentary rocks Silica- and calcium carbonate-cemented sandstone, thin limestone, siltstone and dolostone beds; some thin chert in upper part. Includes the Phosphoria, Quadrant, and Arnsden Formations. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Big Snowy Group Mudstone, siltstone, and thin limestone beds; calcareous sandstone, local dolostone breccia near base. Includes the Heath, Otter, and Kibbey Formations. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Madison Group Thick bedded limestone; thin bedded limestone with some calcareous siltstone in lower part. Includes the Mission Canyon Limestone and Lodgepole Limestone. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p>	<p>Pliocene(?) and Miocene</p> <p>Oligocene</p> <p>Eocene</p> <p>Upper Cretaceous</p> <p>Lower Cretaceous</p> <p>JURASSIC</p> <p>PERMIAN AND PENNSYLVANIAN</p> <p>MISSISSIPPIAN</p>	<p>Three Forks Formation and Jefferson Formation, undivided Thick bedded to laminated dolostone and minor very thin limestone; mudstone and carbonaceous mudstone in upper part; includes some Mississippian beds at the top. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Upper and Middle Cambrian carbonate rocks Thick to thin bedded limestone with dolostone at top; some limestone pebble conglomerate; mudstone at center and as partings in lower part. Includes the Hasmark, Pilgrim, Park, and Meagher Formations. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Middle Cambrian clastic rocks Micaceous mudstone and siltstone with thin limestone in upper part; quartz-cemented sandstone and conglomerate with siltstone partings in lower part. Includes the Wolsey Shale and Flathead Formation. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Intrusive rocks Medium and coarsely crystalline gabbro and diorite. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Bonner Quartzite Medium- and coarse-grained quartzite; some fine pebbles; argillite partings. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Mount Shields Formation Interbedded argillite and siltite with thin quartzite beds; quartzite beds fine upward into argillite. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Shepard and Snowslip Formations, undivided Quartzite, argillite and siltite; some calcareous argillite and limestone in Shepard Formation. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Helena and Empire Formations, undivided Dolomitic argillite and siltite; limestone and dolostone; argillite and very thin quartzite beds in lower part. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Spokane Formation Argillite and siltite with very thin limestone and quartz sandstone in uppermost and lower parts. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p> <p>Greyson Formation Siltite and argillite with quartzite in the uppermost part. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit</p>	<p>DEVONIAN</p> <p>Upper Cambrian</p> <p>Middle Cambrian</p> <p>CAMBRIAN</p> <p>LATE PROTEROZOIC</p> <p>Missoula Group</p> <p>Belt Supergroup</p> <p>MIDDLE PROTEROZOIC</p>
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Contact between rock units
Dashed where approximately located

Contact between Quaternary deposits and underlying bedrock units and contact between concealed rock units
Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Fault
Long-dashed where approximately located; short-dashed where concealed

Thrust Fault
Dotted where concealed; sawteeth on upper plate

GENERALIZED BEDROCK GEOLOGIC MAP OF THE HELENA AREA, WEST-CENTRAL MONTANA

Compiled by
Mitchell W. Reynolds