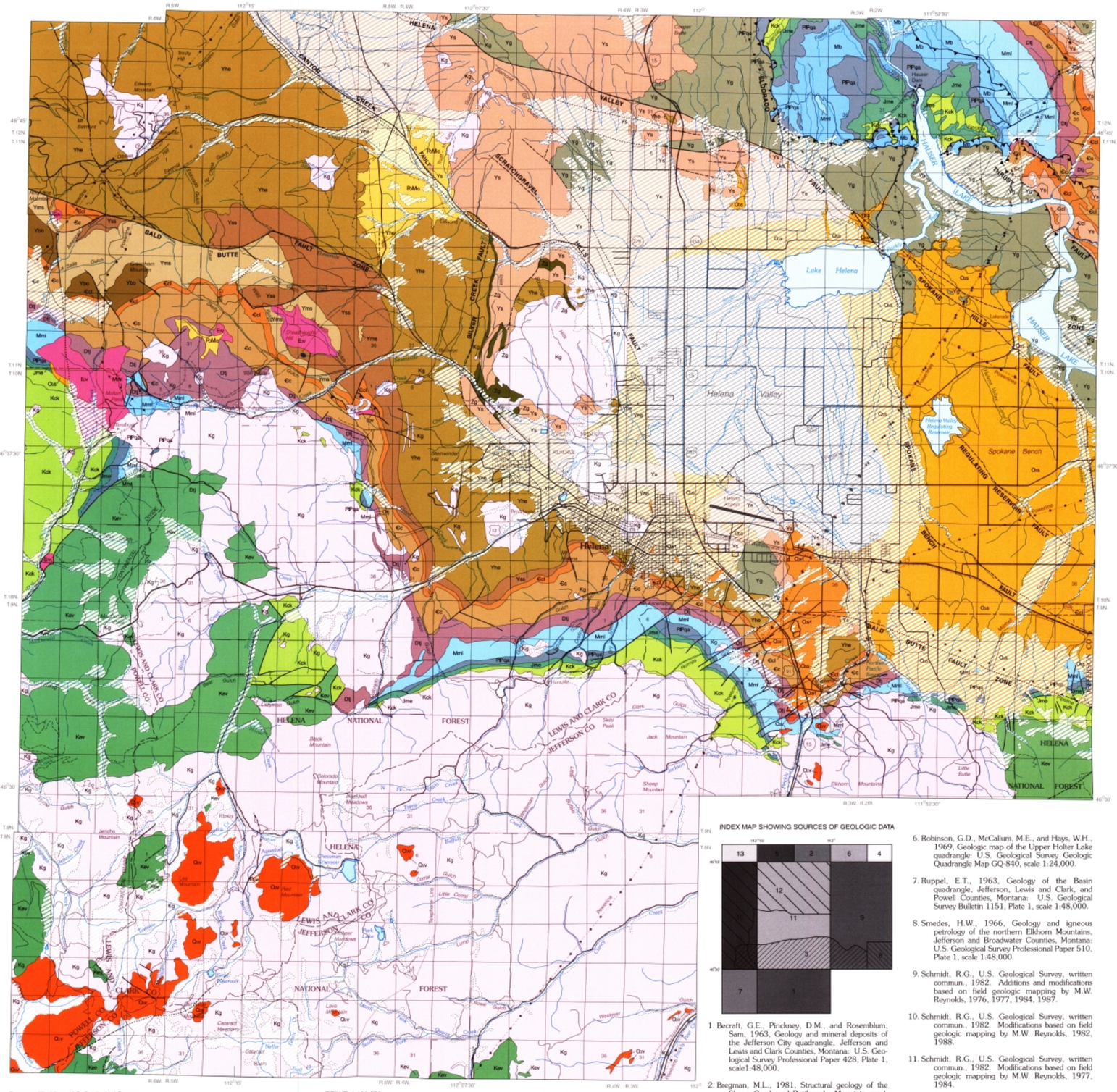
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
LEWIS AND CLARK COUNTY WATER QUALITY PROTECTION DISTRICT

WATER-RESOURCES INVESTIGATIONS REPORT 00-4212
Geologic map PLATE 1 OF 3
Thamke, J.N., 2000
Hydrology of Helena area bedrock, west-central Montana, 1993-98



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; (photoinspected 1990), 1:100,000 metric quadrangles. Digital Line Graph data, 1998. Universal Transverse Mercator projection, zone 12
1927 North American Datum

SCALE: 1:100,000

0 1 2 3 4 5 MILES

0 1 2 3 4 5 KILOMETERS

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

1. Becraft, G.E., Pinckney, D.M., and Rosemblum, Sam, 1963, Geology and mineral deposits of the Jefferson City quadrangle, Jefferson and Lewis and Clark Counties, Montana: U.S. Geological Survey Professional Paper 428, Plate 1, scale1:48,000.

2. Bregman, M.L., 1981, Structural geology of the Sheep Creek and Rattlesnake Mountain quadrangles, Lewis and Clark County, Montana: Montana Bureau of Mines and Geology Geologic Map 26, scale 1:24,000.

3. Knopf, Adolf, 1963, Geology of the northern part of the Boulder bathylith and adjacent area, Montana: U.S. Geological Survey Miscellaneous Investigations Map I-381, scale 1:48,000.

4. Reynolds, M.W., and Hays, W.H., U.S. Geological Survey, written commun., 1997.

5. Robinson, G.D., U.S. Geological Survey, written commun., 1971. Modifications based on field geologic mapping by M.W. Reynolds, 1982, 1985, and 1988.

6. Robinson, G.D., McCallum, M.E., and Hays, W.H., 1969, Geologic map of the Upper Holter Lake quadrangle: U.S. Geological Survey Geologic Quadrangle Map GQ-840, scale 1:24,000.

7. Ruppel, E.T., 1963, Geology of the Basin quadrangle, Jefferson, Lewis and Clark, and Powell Counties, Montana: U.S. Geological Survey Bulletin 1151, Plate 1, scale 1:48,000.

8. Smedes, H.W., 1966, Geology and igneous petrology of the northern Elkhorn Mountains, Jefferson and Broadwater Counties, Montana: U.S. Geological Survey Professional Paper 510, Plate 1, scale 1:48,000.

9. Schmidt, R.G., U.S. Geological Survey, written commun., 1982. Additions and modifications based on field geologic mapping by M.W. Reynolds, 1976, 1977, 1984, 1987.

10. Schmidt, R.G., U.S. Geological Survey, written commun., 1982. Modifications based on field geologic mapping by M.W. Reynolds, 1982, 1988.

11. Schmidt, R.G., U.S. Geological Survey, written commun., 1982. Modifications based on field geologic mapping by M.W. Reynolds, 1977, 1984.

12. Schmidt, R.G., Loen, J.S., Wallace, C.A., and Mehnert, H.H., 1994, Geology of the Elliston region, Powell and Lewis and Clark Counties, Montana: U.S. Geological Survey Bulletin 2045, Plate 1, scale 1:62,500.

13. Wallace, C.A., comp., 1987, Generalized geologic map of the Butte 1° x 2° quadrangle, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-1925, scale 1:250,000.

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

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

TERTIARY

Pliocene(?) and Miocene

Pliocene(?) and Miocene sedimentary rocks (PMs)

Interbedded conglomerate, sandstone, siltstone, minor mudstone, and volcanic tuff. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Oligocene

Oligocene volcanic rocks (Ov, Ovt)

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 Os. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Oligocene sedimentary rocks (Os)

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

Eocene

Eocene volcanic rocks (Ev)

Andesitic and basaltic flows, breccia, and intrusive bodies. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

CRETACEOUS

Upper Cretaceous

Cretaceous intrusive rocks, mainly granitic (Kg)

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

Elkhorn Mountains Volcanics (Kev)

Andesitic volcanic rocks, ashflow tuffs, shallow intrusive rocks, and minor conglomerate. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Lower Cretaceous

Upper and Lower Cretaceous sedimentary rocks (Kck)

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

JURASSIC

Jurassic sedimentary rocks (Jme)

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

PERMIAN AND PENNSYLVANIAN

Permian and Pennsylvanian sedimentary rocks (PIPqa)

Silica- and calcium carbonate-cemented sandstone, thin limestone, siltstone and dolostone beds; some thin chert in upper part. Includes the Phosphoria, Quadrant, and Amsden Formations. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

MISSISSIPPIAN

Big Snowy Group (Mb)

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

Madison Group (Mml)

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

DEVONIAN

Three Forks Formation and Jefferson Formation, undivided (Dtj)

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

CAMBRIAN

Upper Cambrian

Upper and Middle Cambrian carbonate rocks (Ec)

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

Middle Cambrian

Middle Cambrian clastic rocks (Ecl)

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

LATE PROTEROZOIC

Intrusive rocks (Ei)

Medium and coarsely crystalline gabbro and diorite. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

MIDDLE PROTEROZOIC

Belt Supergroup

Missoula Group

Bonner Quartzite (Ybo)

Medium- and coarse-grained quartzite; some fine pebbles; argillite partings. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Mount Shields Formation (Yms)

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

Shepard and Snowslip Formations, undivided (Yss)

Quartzite, argillite and siltite; some calcareous argillite and limestone in Shepard Formation. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Helena and Empire Formations, undivided (Yhe)

Dolomitic argillite and siltite; limestone and dolostone; argillite and very thin quartzite beds in lowest part. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Spokane Formation (Ys)

Argillite and siltite with very thin limestone and quartz sandstone in uppermost and lowest parts. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Greyson Formation (Yg)

Siltite and argillite with quartzite in the uppermost part. Diagonal ruling denotes area across which Quaternary deposits overlie the bedrock unit

Contact between rock units

Dashed where approximately located

Contact between Quaternary deposits and underlying bedrock units and contact between concealed rock units

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