PREPARED PARTLY ON BEHALF OF THE
U.S. ATOMIC ENERGY COMMISSION

Contact
Long dashed where approximately located; short dashed where indefinitely located; dotted where concealed; queried where doubtful

High-angle fault, showing dip where known
Long dashed where approximately located; short dashed where indefinitely located; dotted where concealed; queried where doubtful. U, upthrown side; D, downthrown side; arrows indicate relative strike-slip movement

Thrust fault
Dashed where approximately located; sawteeth on upper plate

Anticline
Showing crestline and direction of plunge of axis. Dashed where approximately located; dotted where concealed

Syncline
Showing troughline and direction of plunge of axis. Dashed where approximately located

Strike and dip of beds

Strike and dip of foliation

Strike of vertical foliation

Strike and dip of foliation and plunge of lineation

Quarry

Shaft
Short bar indicates inclined; circle indicates caved or flooded

Adit
Short bar indicates caved

Radioactivity anomaly in or adjacent to metalliferous quartz veins

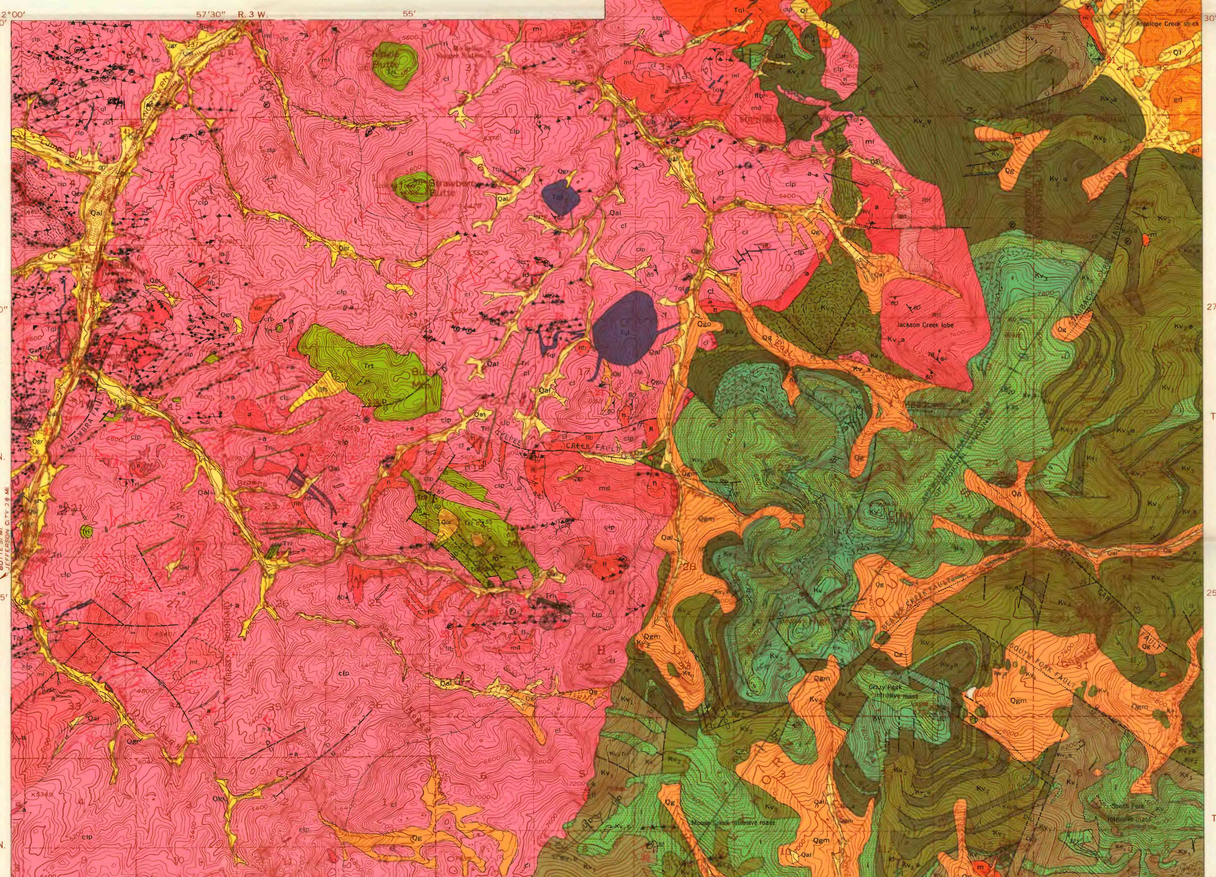
Metalliferous quartz veins or adjacent altered wallrock from which samples containing more than 0.1 percent U_3O_8 have been collected

Radioactivity anomaly in or adjcent to chalcedony veins

Chalcedony veins or adjacent altered wallrock from which samples containing more than 0.1 percent U_3O_8 have been collected

LIST OF MINES IDENTIFIED BY NUMBER

1. Last Hope
2. Chicago-Montana
3. Economy
4. Dobler
5. Liverpool
6. Tycoon
7. Meadow
8. New Stake
9. Legal Tender
10. Mammoth
11. Alhambra (Sullivan)
12. W. Wilson
13. President
14. Copper Jack
15. Tall Pine
16. Badger
17. Pilot
18. Golden Gate and Euclid
19. Katy
20. Willard group
21. Good Cheer
22. Black Bear
23. Middlesex
24. B & G
25. Eagle's Nest
26. White Pine
27. War Eagle
28. Bell (Fleming, Steinbrenner)
29. Carbonate Chief
30. Bosphorus
31. Buzz
32. Moonlight



Base from U.S. Geological Survey topographic quadrangles: Clancy and East Helena, 1950, 1:24 000

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1966—G65146

Geology by Harry W. Smedes, 1953–55; assisted by Paul E. Myers, 1953

GEOLOGIC MAP OF THE NORTHERN ELKHORN MOUNTAINS, MONTANA

APPROXIMATE MEAN DECLINATION, 1966

SCALE 1:48 000

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

MONTANA
LOCATION MAP

EXPLANATION

Note: All prebatholith rocks are thermally metamorphosed. High-grade hornfels and granulitic rocks of the pyroxene hornfels facies occur along the margins of the Boulder batholith and related bodies. Away from the margins the metamorphic grade diminishes and the rocks grade into hornfels, quartzite, marble, and greenstone of the albite-epidote-hornfels facies

QUATERNARY

Recent

Qal — Alluvium

Qf — Alluvial fan

Qc — Colluvium

Qls — Landslide debris

Qtr — Travertine at Alhambra Hot Springs

Pleistocene

Qgr — Gravel
Conspicuous as high terraces along major streams

Qg, Qgm, Qgo — Glacial deposits
Qg, *glacial deposits undivided*
Qgm, *moraine*
Qgo, *outwash*

Late Tertiary or Pleistocene

QTg — Gravel
Alluvial fans, mudflows, and bouldery rock veneer

QTls — Landslide debris

TERTIARY OR QUATERNARY

ANGULAR UNCONFORMITY

Ts — Poorly consolidated beds of ash, gravel, sand, silt, clay, and tuff; lake beds of Knopf (1913) and Lorenz and Swenson (1951)

TERTIARY

Eocene

Tri, Trb, Trp, Trt — Rhyolite
Tri, *platy flow-banded intrusive rocks and lava*
Trb, *intrusive breccia plug and dike*
Trp, *massive rhyolite porphyry*
Trt, *tuff, breccia, and tuffaceous sandstone, undivided*

UNCONFORMITY

Tq — Quartz latite
Dikes and plugs; includes a few small bodies of andesitic and basaltic intrusive rocks; dacite of Knopf (1913)

ld — Porphyry dikes including lamprophyre
Probably range in age from early batholith to post-batholith

CRETACEOUS OR TERTIARY

Upper Cretaceous or Paleocene

Rocks of the Boulder batholith

a — Alaskite and related felsic rocks
Includes alaskite, aplite, pegmatite, and potassic granite

lgd — Leucogranodiorite

c, cl, clp, ml, mlp, md, fl, flb, +a — Butte Quartz Monzonite and related rocks
Coarse-, medium-, and fine-grained quartz monzonite and minor amounts of granodiorite. Coextensive with Clancy Granodiorite
c, *undivided*
cl, *coarse-grained, light-gray, very sparsely porphyritic to nonporphyritic*
clp, *same as* cl *but contains conspicuous phenocrysts of K-feldspar*
ml, *medium-grained, light-gray, nonporphyritic*
mlp, *same as* ml *but contains conspicuous phenocrysts of K-feldspar*
md, *medium-grained, dark-gray, nonporphyritic*
fl, *fine-grained, light-gray, porphyritic in various degrees*
flb, *similar to* fl *but contains an aplitic groundmass; probably includes hybrid rock*
+a, *area cut by many small unmapped dikes of alaskite and related felsic rocks*

gd — Granodiorite of the Antelope Creek stock
Coarse- and medium-grained, light- and medium-colored granodiorite

m — Early mafic rocks
Coarse- to fine-grained, mostly dark-colored rocks of the Kokoruda Ranch complex, a large dike near the Antelope Creek stock, and several plugs. Includes melanorite and hyperite, syenogabbro, syenodiorite, monzonite, and augite quartz monzonite. Relations between rock types not known. Rock units were not mapped separately; general locations of samples studied are shown in Smedes (1962b)

Upper Cretaceous

Elkhorn Mountains Volcanics

Kv_3 — Upper unit
Characterized by thin-bedded waterlaid volcanic sedimentary rocks and by absence of ash-flow tuff and lava. Over 2,000 feet thick

Kv_2, Kv_2a — Middle unit
Kv_2, *undivided basaltic to rhyodacitic epiclastic and pyroclastic debris and lava. Many rock units are shown separately in Smedes (1962b)*
Kv_2a, *rhyolitic ash-flow tuff, mostly welded.*
3,800 to 7,500 feet thick

Kv_1, Kv_1b', Kv_1a' — Lower unit
Kv_1, *undivided basaltic to rhyodacitic epiclastic and pyroclastic debris and lava. Many rock units are shown separately in Smedes (1962b)*
Kv_1b, *andesitic tuff breccia marker bed*
Kv_1a, *thin nonwelded to partly welded quartz latitic ash-flow tuff*
About 2,500 feet thick

Porphyritic basaltic and andesitic intrusive rocks
Partly contemporaneous with, and partly younger than, the Elkhorn Mountains Volcanics. Rock types were not mapped separately; general locations of samples studied are shown in Smedes (1962b).
Larger dikes shown by lines; scattered small intrusives shown by pattern

UNCONFORMITY

Slim Sam Formation

Ksu — Upper unit
Medium- to coarse-grained tuffaceous sandstone and andesitic tuff, siltstone, mudstone, and shale. 450 to 1,100 feet thick

Ksl — Lower unit
Feldspathic sandstone and siltstone and laminated siliceous mudstone and shale, 150 to 1,150 feet thick

Lower and Upper Cretaceous

Colorado Formation

Kcu — Upper unit
Dark-gray to black shale, siltstone, and minor amounts of mudstone and sandstone. About 100 feet thick

Kcm — Middle unit
Cherty and feldspathic sandstone and siltstone and light-gray delicately laminated very siliceous mudstone. About 580 feet thick

Kcl — Lower unit
Dark-gray siliceous sandstone, siltstone, and mudstone. About 215 feet thick

Lower Cretaceous

Ks — Kootenai Formation
Upper part olive-gray, yellowish-brown, yellowish-gray, and yellowish-green siltstone, fine-grained sandstone, and limestone; two beds of fresh-water limestone occur near top. Basal 70 feet composed of grayish-orange, yellowish-brown, and very light to medium-gray cherty limestone. About 540 feet thick

Upper Jurassic

Jm — Morrison Formation
Olive-brown, purple, and vari-colored siltstone, shale, and fine-grained sandstone; sandstone in lower part commonly calcareous, cherty, and cross-bedded. About 270 feet thick

Js — Swift Formation
Poorly bedded yellowish highly calcareous cherty marine sandstone. About 50 feet thick

Jms — Morrison and Swift Formations undivided
About 320 feet thick

JURASSIC

EROSIONAL UNCONFORMITY

Pp — Phosphoria Formation
Comprises three units. Upper unit is about 25 feet of phosphatic quartzite; middle unit is about 40 feet of quartzite and chert; lower unit is about 25 feet of cherty limestone and light-gray quartzite mottled with pale-red chert. About 90 feet thick

PERMIAN

PPq — Quadrant Formation
Comprises four units. Upper unit is about 115 feet of spotted vitreous quartzite, local shaly partings, and limestone lenses; next unit is about 20 feet of spotted sandstone and calcareous siltstone containing some beds of quartzite and dark-gray shaly limestone; next unit is about 50 feet of very fine grained limestone in beds, lenses, and pods within quartzite beds; lower unit is about 200 feet of medium- to light-gray vitreous quartzite containing spotted texture. About 400 feet thick

PENNSYLVANIAN

Upper Mississippian and Pennsylvanian

PMs — Amsden Formation
Poorly exposed thin-bedded pale-grayish-red siltstone and minor amounts of medium-gray siltstone; pale-red-purple dolomite near middle of formation. About 180 feet thick

MISSISSIPPIAN AND PENNSYLVANIAN

EROSIONAL UNCONFORMITY(?)

Lower and Upper Mississippian

Mmc — Mission Canyon Limestone
Thick-bedded to massive light-colored crystalline limestone; breccias of probable solution-collapse origin occur locally in the upper part. About 790 feet thick

Lower Mississippian

Madison Group

Mlp — Lodgepole Limestone
Comprises two units. Upper unit is about 235 feet of medium- and thick-bedded gray limestone; lower unit is about 580 feet of thin-bedded gray limestone containing dark-gray dolomitic siltstone in lower part. About 815 feet thick

MISSISSIPPIAN

CRETACEOUS

Xenoliths

ta — Tactite and contaminated igneous rock

Strongly sheared rocks
Schist, schistose amphibolite, and granulitic rocks

Metalliferous quartz vein
Queried where doubtful

Chalcedony vein and vein zone; contains various amounts of quartz
Locally called reefs

Silicified rock

Hydrothermally altered rock
Largely sericitized or kaolinized