

DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Preliminary geologic map of the Butte 1° x 2°
quadrangle, western Montana

by

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This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. A color slide is provided with this map to enhance legibility of some areas of the map; no guarantee is provided that all parts of the map are equally legible.

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LIST OF MAP UNITS

MAN-MADE DEPOSITS

md Placer tailings, mill tailings, mine-dump material, and slag piles

SEDIMENTARY AND VOLCANIC ROCKS AND DEPOSITS

Quaternary deposits

Qa Alluvium (Holocene)
Qg Fan, pediment, terrace, and colluvial gravel (Holocene and Pleistocene)--Locally contains mass-wasting and bog deposits in southeastern part of quadrangle
Ql Landslide deposits (Holocene and Pleistocene)
Qtr Travertine deposits (Holocene and Pleistocene)
Qo Outwash deposits (Pleistocene)
Qgl Glacial lake deposits (Pleistocene)
Qt Till (Pleistocene)--Locally subdivided into:
 Qty Younger till
 Qto Older till

Tertiary rocks and deposits

Tg Fan deposits and gravel deposits on pediment surfaces (Pliocene?)--Locally contains mass-wasting deposits of Tertiary or Quaternary age
Ts Stream and lake deposits, volcanogenic sandstone and mudstone, and volcanic ash beds (Miocene and Oligocene)
Tsg Stream and lake deposits, volcanogenic sandstone and mudstone, and volcanic ash beds mantled by fan deposits and gravel deposits on pediment surfaces (Pliocene, Miocene, and Oligocene)
Tc Conglomerate (Oligocene or Eocene)
Tvs Andesitic, latitic, and rhyolitic volcanic rocks (Eocene?)--Occurs in southern Sapphire Mountains
Trs Vitric rhyolite dikes (Eocene?)--Occurs in the southern Sapphire Mountains
Trv Rhyolitic volcanic rocks (Oligocene and Eocene)--Includes minor andesite and quartz latite flows and plugs. Occurs mainly east and northeast of Deer Lodge Valley
Tav Andesitic volcanic rocks (Oligocene or Eocene?)
Tabv Andesitic and basaltic volcanic rocks (Oligocene or Eocene)
Tvg Basaltic, andesitic, and latitic volcanic rocks and dikes (Oligocene? and Eocene)--Occurs mainly in the eastern part of Garnet Range
Tlav Latitic and andesitic volcanic rocks (Eocene?)
Tvb Basaltic, andesitic, and rhyolitic volcanic rocks and dikes (Eocene)--Occurs mainly in Bearmouth area
Tlv Lowland Creek Volcanics (Eocene)--Quartz latite, rhyolite, and dacite flows, welded tuff, and tuff
Tbv Basaltic volcanic rocks (Eocene?)

Tertiary or Cretaceous rocks

TKbv Basaltic and andesitic volcanic rocks
Cretaceous rocks

Units that occur north of Helena, Montana

Ktm Two Medicine Formation (Upper Cretaceous)
Kvt Virgelle Sandstone and Telegraph Creek Formations (Upper Cretaceous)
Kcs Colorado Group--Consists of Marias River Shale (Upper Cretaceous) and Blackleaf Formation (Lower Cretaceous)

Units that occur in area of Deer Lodge Valley

Kev Elkhorn Mountains Volcanics (Upper Cretaceous)
Kgs Golden Spike Formation (Upper Cretaceous)
Kcc Carten Creek Formation of Gwinn (1961) (Upper Cretaceous)
Kj Jens Formation of Gwinn (1961) (Upper Cretaceous)
Kc Coberly Formation of Gwinn (1961) (Upper Cretaceous)
Kb Blackleaf Formation (Lower Cretaceous)
Kbv Vaughn Member
KbvU Upper part of Vaughn Member
Kbvl Lower part of Vaughn Member
Kbtf Taft Hill and Flood Members
KbvF Lower part of the Vaughn Member and Taft Hill and Flood Members
Kk Kootenai Formation (Lower Cretaceous)
Kbk Blackleaf and Kootenai Formations (Lower Cretaceous)
Ks Golden Spike Formation and Carten Creek, Jens, and Coberly Formations of Gwinn (1961) (Upper Cretaceous), and Blackleaf and Kootenai Formations (Lower Cretaceous)--All formations not present everywhere unit occurs

Jurassic rocks

Js Morrison Formation (Upper Jurassic) and Ellis Group (Swift, Rierdon, and Sawtooth Formations) (Upper and Middle Jurassic)

Cretaceous and Jurassic rocks

KJs Kootenai Formation (Lower Cretaceous) and Jurassic formations (Upper and Middle Jurassic)

Permian and Pennsylvanian rocks

PPs Shedhorn Sandstone and Phosphoria and Park City Formations (Permian), and Quadrant Quartzite (Upper Pennsylvanian)

Pennsylvanian rocks

Pq Quadrant Quartzite (Upper Pennsylvanian)

Permian, Pennsylvanian, and Mississippian rocks

- PMS** **Shedhorn Sandstone and Phosphoria and Park City Formations (Permian), Quadrant Quartzite (Upper Pennsylvanian), and Snowcrest Range Group (Lower Pennsylvanian(?) and Upper Mississippian)--All formations not present everywhere unit occurs**

Jurassic, Permian, Pennsylvanian, and Mississippian rocks

- JMS** **Morrison Formation (Upper Jurassic), Ellis Group (Upper and Middle Jurassic), Shedhorn Sandstone and Phosphoria and Park City Formations (Permian), Quadrant Quartzite (Upper Pennsylvanian), and Snowcrest Range Group (Lower Pennsylvanian(?) and Upper Mississippian)--All formations not present everywhere unit occurs**

Cretaceous, Jurassic, Permian, Pennsylvanian, and Mississippian rocks

- KMS** **Golden Spike Formation and Carten Creek, Jens, and Coberly Formations of Gwinn (1961) (Upper Cretaceous), Blackleaf and Kootenai Formations (Lower Cretaceous), Morrison Formation (Upper Jurassic), Ellis Group (Upper and Middle Jurassic), Shedhorn Sandstone and Phosphoria and Park City Formations (Permian), Quadrant Quartzite (Upper Pennsylvanian), and Snowcrest Range Group (Pennsylvanian(?) and Upper Mississippian)--All formations not present everywhere unit occurs**

Mississippian rocks

- Mm** **Madison Group and related rocks (Upper and Lower Mississippian)--**
Consists of Mission Canyon Limestone at top and Lodgepole Limestone at bottom in most of quadrangle. In western part of Garnet Range, includes Mission Canyon Limestone at top and Middle Canyon Formation and Paine Limestone below (W.J. Sando, U.S.G.S. oral commun., 1986)

Mississippian and Devonian rocks

- MDmt** **Madison Group (Upper and Lower Mississippian) and Three Forks Formation (Lower Mississippian and Upper Devonian)--Occurs in northeastern part of quadrangle**
- MDs** **Madison Group and related rocks (Upper and Lower Mississippian) and Jefferson Formation (Upper Devonian). Occurs west, southwest, and northwest of Deer Lodge Valley**

Devonian rocks

- Djm** **Jefferson and Maywood Formations (Upper Devonian)**

Devonian and Cambrian rocks

- DGs** **Devonian and Cambrian formations--Includes Jefferson and Maywood Formations (Upper Devonian) and the Red Lion and Hasmark Formations (Upper Cambrian)**

Cambrian rocks

- Erh** Red Lion and Hasmark Formations (Upper Cambrian)
Emw Western lithofacies: Silver Hill Formation and Flathead Quartzite (Middle Cambrian)--Occurs west of longitude $112^{\circ} 25'$ W.
Eme Eastern lithofacies: Park Shale, Meagher Limestone, Wolsey Shale, and Flathead Quartzite (Middle Cambrian)
--Occurs east of longitude $112^{\circ} 25'$ W.
Ees Cambrian formations, eastern lithofacies--Includes some or all of the following formations: Red Lion and Hasmark Formations (Upper Cambrian), and Park Shale, Meagher Limestone, Wolsey Shale, and Flathead Quartzite (Middle Cambrian). Occurs east of longitude $112^{\circ} 25'$ W.
Ews Cambrian formations, western lithofacies--Includes some or all of the following formations: Red Lion and Hasmark Formations (Upper Cambrian) and Silver Hill Formation and Flathead Quartzite (Middle Cambrian). Occurs west of longitude $112^{\circ} 25'$ W.

Cambrian and uppermost Belt Supergroup

- EYsg** Silver Hill Formation and Flathead Quartzite (Middle Cambrian), and Pilcher Quartzite and Garnet Range Formation of Missoula Group (Middle Proterozoic)--Pilcher Quartzite absent south of latitude $46^{\circ} 35'N$.

Middle Proterozoic rocks

Belt Supergroup

Missoula Group

- Ypi** Pilcher Quartzite
Ygr Garnet Range Formation
Ym McNamara Formation
Ybo Bonner Quartzite
Yms Mount Shields Formation
 Yms3 Member Three
 Yms2 Member Two
 Yms1 Member One
 Ymsc Carbonate lithofacies in upper part of Member One
 --Occurs west of longitude $113^{\circ} 00'$ W.
Ysh Shepard Formation--Absent south of latitude $46^{\circ} 30' N$.
Ysn Snowslip Formation
Ymg Missoula Group--Includes Pilcher Quartzite, Garnet Range and McNamara Formations, Bonner Quartzite, Mount Shields, Shepard, or Snowslip Formations; all formations not present at any locality

Rocks of the middle Belt carbonate

Yh **Helena Formation**
 Yhl **Lower Member**
 Wallace Formation
 Ywu **Upper Member**--Occurs in northeastern part of quadrangle
 Ywm **Middle Member**--Occurs in western and southwestern parts of
 quadrangle
Yws **Wallace and Snowslip Formations**

Ravalli Group (Occurs in northeastern part of quadrangle)

Ye **Empire Formation**
Ys **Spokane Formation**
Yg **Greyson Formation**

HIGH-GRADE METAMORPHIC ROCKS OF UNCERTAIN BELT SUPERGROUP PROTOLITH

Belt Supergroup--Metamorphosed during Late Cretaceous or Tertiary time

Ybsh **Biotite-muscovite schist and interbedded quartzite and lesser amounts
 of quartzofeldspathic gneiss**
Ybqg **Quartzofeldspathic gneiss and migmatite, and lesser amounts of biotite-
 muscovite schist**
Ybcg **Calc-silicate gneiss and migmatite, and lesser amounts of
 quartzofeldspathic and biotite-muscovite schist**

INTRUSIVE ROCKS

ROCKS OF THE IDAHO BATHOLITH, BITTERROOT LOBE

Tertiary Rocks

Tbmi **Muscovite-biotite granodiorite, biotite granodiorite, and monzogranite**

Tertiary or Late Cretaceous Rocks

TKbi **Biotite-muscovite monzogranite and muscovite-biotite granodiorite**
TKhd **Hornblende-biotite granodiorite**

Late Cretaceous Rocks

Kgdi **Biotite granodiorite and hornblende-biotite granodiorite**
Kgti **Foliated biotite granodiorite and hornblende-biotite tonalite**
Kbgi **Foliated biotite granodiorite**
Kaui **Augen gneiss**

ROCKS OF THE SAPPHIRE BATHOLITH

Late Cretaceous rocks

Kmlm	Leucomicromonzogranite porphyry in sills, dikes, and pods
Kgds	Porphyritic and equigranular hornblende-biotite granodiorite of outer zone
Kmgs	Porphyritic and equigranular muscovite-biotite monzogranite of inner zone

ROCKS OF ANACONDA BATHOLITHIC SUITE

Early Tertiary Rocks

Tgds	Biotite granodiorite of the Seymour Creek stock
Tgda	Granodiorite and dacite dikes
Tmgh	Biotite-muscovite monzogranite of Hearst Lake stock
Tmgp	Equigranular to porphyritic muscovite-biotite granodiorite of Pintlar Creek batholith

Tertiary and Late Cretaceous Rocks

TKp	Pegmatite
TKgm	Hornblende-biotite granodiorite of Maloney Basin stock
TKbb	Biotite granodiorite of Beaverhead Mountain stock
TKmpm	Biotite monzogranite porphyry of La Marche Creek stock

Early and Late Cretaceous Rocks

Kbmm	Biotite monzogranite of Mill Creek stock
Kqds	Hornblende quartz diorite, granodiorite, tonalite, quartz monzodiorite, and diorite of Storm Lake stock--Also forms dikes, sills, and pods
Kgs	Biotite-hornblende granodiorite of Short Peak stock

ROCKS OF THE FLINT CREEK BATHOLITHIC SUITE

Early Tertiary or Late Cretaceous Rocks

Kbnp	Porphyritic muscovite-biotite monzogranite of Mt. Powell batholith
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Late Cretaceous Rocks

Kgdr	Locally foliated hornblende-biotite granodiorite of Royal stock
Kgdp	Hornblende-biotite granodiorite of Philipsburg batholith
Kgdc	Hornblende-biotite granodiorite of Cable stock

Early and Late Cretaceous Rocks

Kqdr	Quartz diorite, diorite, leucogranodiorite, and metasedimentary rocks of Racetrack Creek intrusive and metamorphic complex
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ROCKS OF THE BOULDER BATHOLITH

Late Cretaceous Rocks

Kgp	Medium-grained granite porphyry
Kpl	Leucomonzonite of Knopf (1963) at Priest Pass
Kgra	Graphophyre of Knopf (1963)
Kqmw	Porphyritic and equigranular quartz monzonite of Wilson Park stock
Ka	Aplite, alaskite, and pegmatite dikes, sills, and pods
Kmgd	Porphyritic biotite-hornblende monzogranite and granodiorite of Boulder batholith
Kgdu	Unionville granodiorite of Knopf (1963)
Kd	Diorite of Smedes (1968)

STOCKS, DIKES, AND SILLS

Early Tertiary Rocks

Tqmd	Quartz monzodiorite
Tgb	Gabbro, microgabbro, and diorite plugs, dikes, and sills
Tgd	Granodiorite stocks and dacite dikes and flows
Td	Dacite of Knopf (1963)
Tqmm	Hornblende-biotite granodiorite of Marysville stock
Tgl	Biotite monzogranite stock of Lost Creek

Early Tertiary or Late Cretaceous Rocks

TKmg	Biotite monzogranite, biotite-muscovite monzogranite, leucomonzogranite, and granodiorite plugs, stocks, dikes, and sills
TKgd	Biotite and hornblende-biotite granodiorite stocks, sills, and dikes
TKgb	Gabbro, microgabbro, and diorite plugs, sills, and dikes
TKgp	Tonalite, quartz diorite, and granodiorite of Gird Point stock
TKmw	Biotite monzogranite of Welcome Creek stock

Late Cretaceous Rocks

Kgdb	Porphyritic hornblende-biotite granodiorite and muscovite-biotite monzogranite of Big Spring Creek stock
Kmgb	Biotite monzogranite of Broadwater stock
Kgdw	Porphyritic hornblende-biotite granodiorite of Wallace Creek stock
Kl	Latite
Kqmd	Hornblende-biotite granodiorite of Dalton Mountain stock
Kqmb	Hornblende-biotite granodiorite of Blackfoot City stock
Kgdh	Hornblende-biotite granodiorite of Henderson Creek stock
Kqmo	Hornblende-biotite granodiorite of Ogden Mountain stock
Kgdg	Porphyritic hornblende-biotite granodiorite of Garnet stock
Kgdm	Hornblende-biotite granodiorite of Miners Gulch stock
Kqmh	Hornblende-biotite granodiorite of Mineral Hill stock
Kmg	Monzogranite
Kgd	Granodiorite
Kgb	Microgabbro, gabbro, and diabase plugs, sills, and dikes
Kdi	Diabase sills and dikes
Kdp	Diorite porphyry and equigranular diorite

Early Cretaceous Rocks

Kps Pyroxenite, leucosyenite, and hornblende syenite of Skalkaho Mountain stocks
Kqms Augite-hornblende monzonite of Scratch Gravel Hills stock
Kqmg Hornblende-clinopyroxene-biotite granodiorite of Granite Butte stock

Late Proterozoic Rocks

Zd Gabbro, microgabbro, and diorite dikes and sills--Occur mainly in the northeastern part of quadrangle

Late or Middle Proterozoic Rocks

ZYd Gabbro, microgabbro, and diorite dikes and sills--Occur mainly in northwestern part of quadrangle

Age Not Known

dp Diorite porphyry
di Diabase
gb Gabbro, microgabbro, and diorite

MAP SYMBOLS

————— **Contact between units**—Long-dash where approximately located; short-dash where concealed by younger deposits

FAULTS

[Long-dash where approximately located; short-dash where concealed by younger deposits; queried where location uncertain.]

—————● **Fault**—Bar and ball on downthrown side

=====>● **Strike-slip or oblique-slip fault**—Arrows show apparent directions of lateral slip. Ball and bar on downthrown side

▼▼▼▼ **Thrust fault**—Sawteeth on upper plate. Open sawteeth where location of fault determined by trace on air photo. Dashed with open sawteeth where concealed by younger deposits

FOLDS

[Showing trace of axial plane, direction of plunge, and dip direction of limbs. Short-dash where covered by younger deposits]

↕—————▶ **Anticline**

↻—————▶ **Overtured anticline**

↓—————▶ **Syncline**

↻—————▶ **Overtured syncline**

STRUCTURAL ZONES

~~~~~ **Shear zone**



**Zone of imbricate thrust faults in Cretaceous, Jurassic, Permian, Pennsylvanian, and Mississippian strata**



**Zone of imbricate thrust faults in Mississippian, Devonian, and Cambrian strata**



**Zone of imbricate thrust faults in Mesozoic and Paleozoic strata**

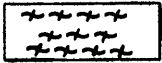


**Zone of imbricate thrust faults in Cambrian and Middle Proterozoic strata**

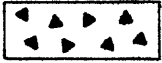


**Zone of imbricate thrust faults in Helena and Wallace Formations and in Missoula Group**

## LITHOLOGIC SYMBOLS



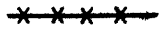
Zone of silicified carbonate rock and sheared carbonate rock



Sedimentary breccia in middle member of Wallace Formation



Area of metamorphosed rocks of the Missoula Group and rocks of the middle Belt carbonate adjacent to the Bitterroot Lobe of the Idaho batholith



Dikes—Age and composition labeled on map

## EXPLORATORY DRILL-HOLES

O 1000 Drill-hole for oil and gas, geothermal, or mineral exploration.  
Number indicates depth in feet.

## PRINCIPAL SOURCES OF GEOLOGIC MAP INFORMATION

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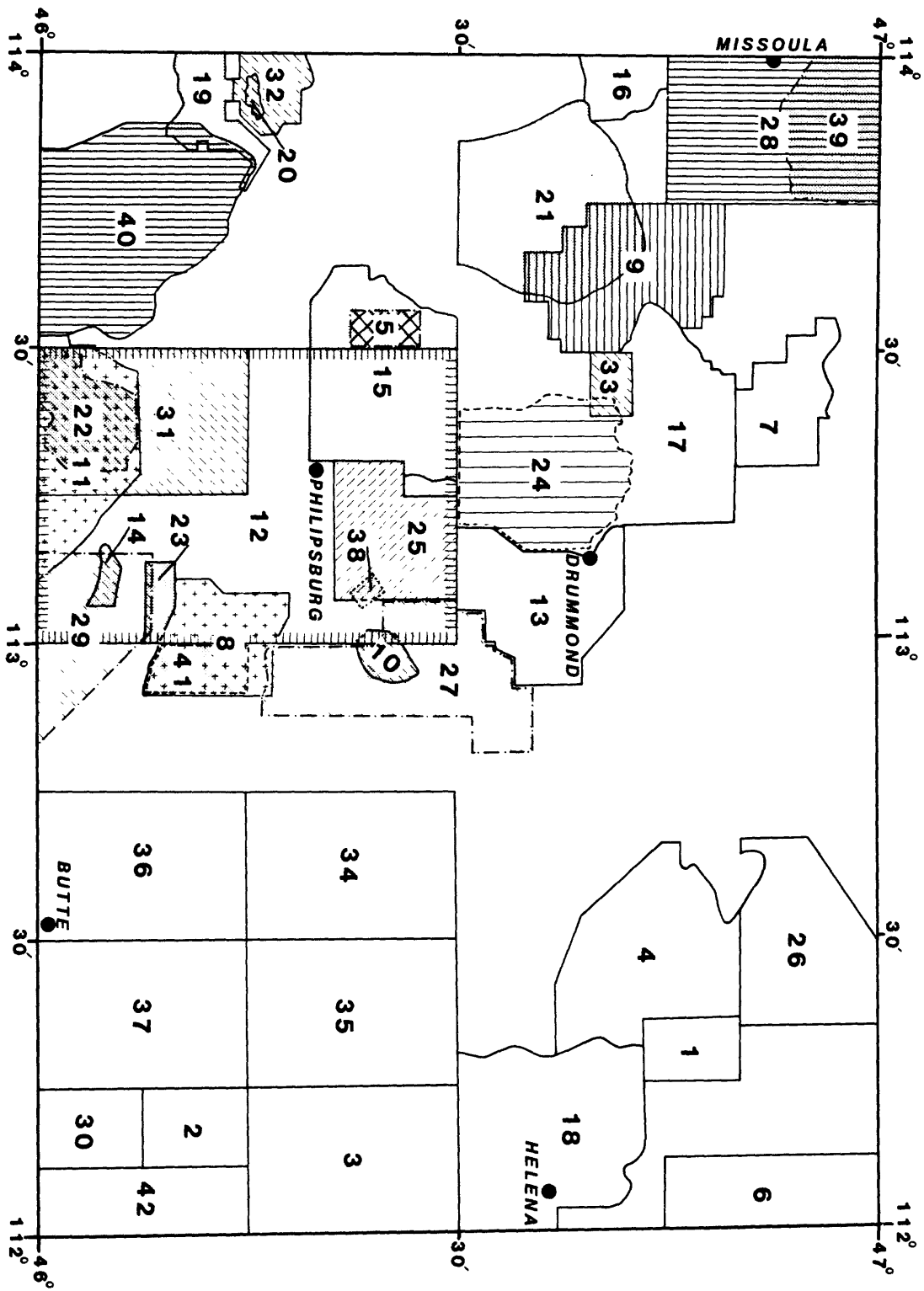
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#### AREAS OF RESPONSIBILITY FOR GEOLOGIC MAPPING

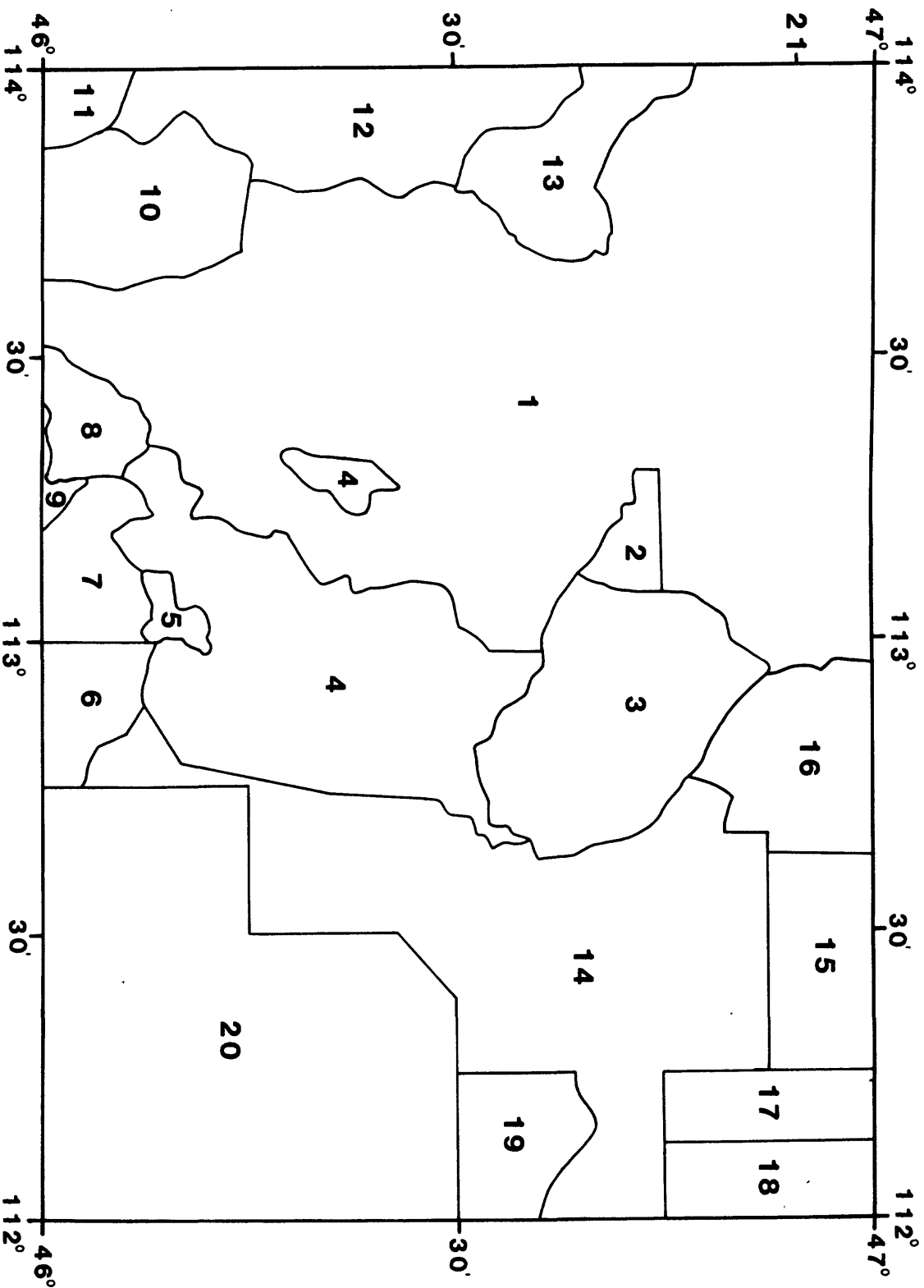
1. C. A. Wallace, 1975-1980. Assisted by D. M. Scarborough 1975-1976, A. B. French, 1977, D. J. Lidke, 1982-1983, S. E. Zarske, 1979 and 1981, L. J. Homen 1979, J. P. Fox, 1981, and M. R. Waters, 1983.
2. C. A. Wallace and A. B. French, 1977.
3. A. B. French, 1978.
4. M. R. Waters, 1979-1982. Assisted by J. D. Mow, 1981-1982.
5. D. J. Lidke, 1979-1980.
6. R. A. Yeoman, 1981-1982.
7. J. E. Elliott, M. J. Blaskowski, and B. A. Heise, 1981-1982. Assisted by J. S. Loen, 1982.
8. D. J. Lidke, 1981-1982. Assisted by P. E. Thomas and A. J. Simons, 1981, and P. D. Bustamante and S. E. Riley, 1982.
9. J. M. O'Neill, 1981-1982, and D. A. Lopez, 1981. Assisted by D. C. Ferris, 1981-1982.

10. C. A. Wallace, 1979-1980, D. J. Lidke, 1980, and M. R. Waters, 1983. Assisted by S. E. Zarske, L. J. Homen, and D. J. Tosline, 1979-1980.
11. S. E. Zarske, 1981-1982. Assisted by P. D. Bustamante, 1981.
12. C. A. Wallace, 1975. C. A. Wallace, D. J. Lidke, and S. E. Zarske, 1981-1982. Assisted by M. J. Blaskowski, P. D. Bustamante, D. L. Rineer, S. E. Riley, and J. P. Fox, 1982, and D. C. Ferris, 1981.
13. D. J. Lidke, 1982-1983, C. A. Wallace, 1975-1976 and 1982-1983, and S. E. Zarske, 1982. Assisted by S. E. Riley, D. L. Rineer, and P. D. Bustamante, 1982.
14. R. G. Schmidt, 1975-1982. Assisted by R. Hazelwood, 1977, T. M. Gracanin, 1978, T. F. Gawloski, 1979, C. E. Diercks, 1982, and N. W. Schmidt 1977-1979.
15. J. W. Whipple, 1977-1978.
16. J. W. Whipple, 1977, and R. G. Schmidt, 1979-1981.
17. R. G. Schmidt and J. W. Whipple, 1978-1979, and G. D. Robinson, 1970-1971.
18. G. D. Robinson, 1968, M. L. Bregman, 1970, and R. G. Schmidt, 1979.
19. R. G. Schmidt and G. D. Robinson, 1979.
20. R. G. Schmidt, 1979-1982. Compiled from published maps and field checked.
21. M. R. Klepper, Preliminary reconnaissance mapping in much of Butte quadrangle during 1965-1970 and 1972-1974.



PRINCIPAL SOURCES OF GEOLOGIC MAP INFORMATION





AREAS OF RESPONSIBILITY FOR GEOLOGIC MAPPING