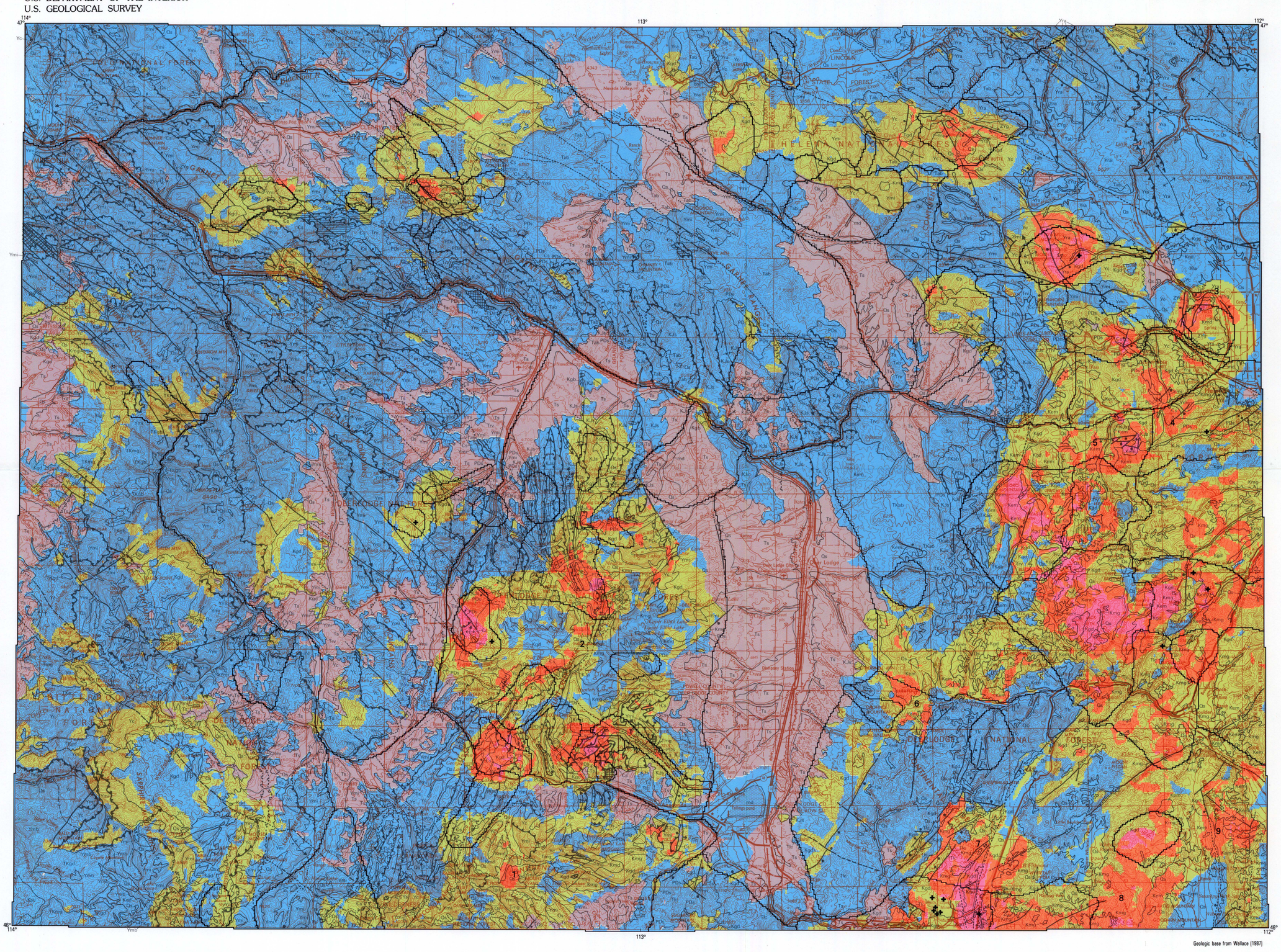
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–2050–D (SHEET 1 OF 2)
Explanatory Pamphlet Accompanies Map



Geologic base from Wallace (1987)

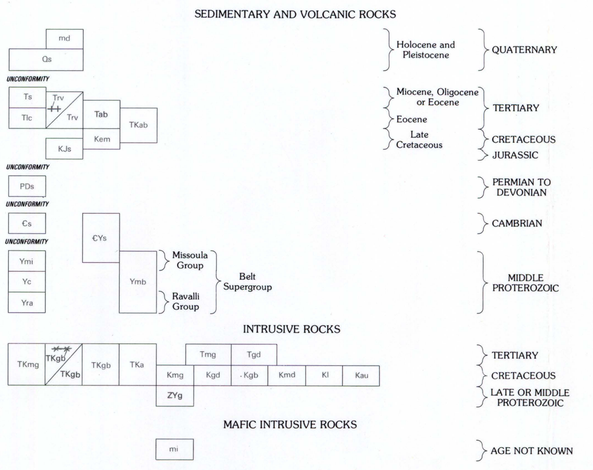
Map *A*. Map showing mineral resource potential for vein and replacement deposits of gold, silver, copper, lead, zinc, tungsten, and manganese

EXPLANATION

Mineral resource potential

- Very high—Corresponds to scores of 19–22 on map K
- High—Corresponds to scores of 15–18 on map K
- Moderate—Corresponds to scores of 9–14 on map K
- Low—Corresponds to scores of 0–8 on map K
- Unknown—Areas covered by Tertiary and Quaternary rocks
- Boundary of mining district or geographic area—See map C
- ✚ Locations of 14 most productive vein-and replacement-type mines having production of more than $5 million
- 5 Areas of high and very high potential discussed in text

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

MAN-MADE DEPOSITS

md — **Placer and mill tailings, mine dumps, and slag piles (Holocene)**

SEDIMENTARY AND VOLCANIC ROCKS

Qs — **Surficial deposits (Holocene and Pleistocene)**—Alluvium, fan and terrace gravel, colluvium, gravel deposits on pediment surfaces, and landslide and travertine deposits (Holocene and Pleistocene); till, glacial lake, and outwash deposits (Pleistocene)

Ts — **Sedimentary deposits and rocks (Tertiary)**—Fan and gravel deposits (Pliocene) on pediment surfaces (Pliocene?) and conglomerate, sandstone, mudstone, and volcanic ash beds (Miocene, Oligocene, or Eocene?)

Trv — **Rhyolitic volcanic rocks (Miocene, Oligocene, and Eocene)**—In most of quadrangle, consists mainly of rhyolitic, quartz latitic, and latitic volcanic rocks (Oligocene and Miocene). Includes rhyolitic and dacitic plugs and dikes (lower Tertiary). In Bearmouth area, rhyolitic rocks interbedded with lesser amounts of basaltic, andesitic, and latitic volcanic rocks and dikes (Eocene). In southern Sapphire Mountains, rocks are mainly rhyolitic and latitic volcanic rocks and lesser amounts of andesitic flows and dikes (Eocene?)

Tab — **Andesitic and basaltic volcanic rocks (Oligocene and Eocene)**—In most of quadrangle, consists of andesitic, basaltic, and latitic volcanic rocks (Eocene) and basaltic and andesitic volcanic rocks (Oligocene or Eocene). In eastern Garnet Range, consists of basaltic, andesitic, and latitic volcanic rocks and dikes (Oligocene? and Eocene)

Tlc — **Lowland Creek Volcanics (Eocene)**—Rhyolite and dacite flows, welded tuff, and air-fall tuff

TKab — **Andesitic and basaltic volcanic rocks (Early Tertiary or Late Cretaceous)**—Mainly basaltic and andesitic flows, flow breccia, and air-fall tuff east and northeast of Deer Lodge

Kem — **Elkhorn Mountains Volcanics (Late Cretaceous)**—Andesitic, quartz latitic, and basaltic air-fall tuff, breccia, welded tuff, and flows

KJs — **Sedimentary rocks (Cretaceous and Jurassic)**—In northeast corner of quadrangle, consists of Two Medicine Formation, Virgelle Sandstone, Telegraph Creek Formation, Marias River Shale (Upper Cretaceous), and Blackleaf Formation (Lower Cretaceous). In area west, northwest, and north of Deer Lodge, consists of Golden Spike Formation and Carten Creek (originally spelled "Carter Creek" by Gwinn (1961) and now changed to "Carten Creek" to conform to U.S. Board on Geographic Names), Jens, and Coberly Formations of Gwinn (1961) (Upper Cretaceous); Blackleaf and Kootenai Formations (Lower Cretaceous); Morrison Formation (Upper Jurassic); and Ellis Group (Upper and Middle Jurassic)

PDs — **Sedimentary rocks (Permian, Pennsylvanian, Mississippian, and Devonian)**—Consists of Shedhorn Sandstone, Phosphoria and Park City Formations (Permian), Quadrant Quartzite (Middle Pennsylvanian), Snowcrest Range Group (Lower Pennsylvanian and Upper Mississippian), Madison Group and related rocks (Upper and Lower Mississippian), Three Forks Formation (Lower Mississippian and Upper Devonian), and Jefferson (Upper Devonian) and Maywood Formations (Upper and Middle Devonian). In the Butte quadrangle, the formations of the Snowcrest Range Group (Conover Ranch, Lombard, and Kibbey Formations) are too thin to map as separate formations (Wardlaw, oral commun., 1986). Three Forks Formation occurs only in northeastern part of quadrangle

Cs — **Sedimentary rocks (Cambrian)**—Includes Red Lion Formation (Upper Cambrian) and Hasmark Formation (Upper and Middle Cambrian). Also includes the underlying Park Shale, Meagher Limestone, and Wolsey Shale (Middle Cambrian) in northeast part of quadrangle, all of which are laterally equivalent to the Silver Hill Formation (Middle Cambrian) in west, southwest, and northwest parts of quadrangle. Flathead Quartzite at base (Middle Cambrian) present in entire quadrangle

CYs — **Sedimentary rocks (Cambrian and Middle Proterozoic)**—Consists of lower Paleozoic and upper Middle Proterozoic rock units that are structurally superposed or are too thin to show at this scale. Red Lion (Upper Cambrian) and Hasmark (Upper and Middle Cambrian) Formations, Silver Hill Formation (Middle Cambrian), or Flathead Quartzite (Middle Cambrian) may be present overlying any of these Middle Proterozoic units: Pilcher Quartzite, Garnet Range, or McNamara Formations (Middle Proterozoic)

BELT SUPERGROUP (MIDDLE PROTEROZOIC)

Ymi — **Missoula Group**—Consists of Pilcher Quartzite, Garnet Range and McNamara Formations; Bonner Quartzite; and Mount Shields, Shepard, and Snowslip Formations

Yc — **Middle Belt carbonate rocks**—Mainly consists of upper and middle members of the Wallace Formation west of long 113°30' W. and the laterally equivalent Helena Formation east of long 113°30' W.

Yra — **Ravalli Group**—Consists of Empire, Spokane, and Greyson Formations

Ymb — **Metamorphosed rocks of the Belt Supergroup**—Consists of quartzite, biotite-muscovite schist, quartzofeldspathic gneiss, calc-silicate gneiss, and migmatite. Metamorphosed during Late Cretaceous or early Tertiary time

INTRUSIVE ROCKS

Tmg — **Granitic rocks (Tertiary)**—Mainly muscovite-biotite granite and monzogranite

Tgd — **Granodioritic rocks (Tertiary)**—Mainly quartz monzodiorite and granodiorite

TKmg — **Granitic rocks (Tertiary and Late Cretaceous)**—Consists of foliated and nonfoliated biotite-muscovite monzogranite, leucomonzogranite, and granodiorite

TKgd — **Granodioritic rocks (Tertiary and Late Cretaceous)**—Mainly foliated and nonfoliated biotite granodiorite, hornblende-biotite granodiorite, tonalite, and quartz diorite

TKgb — **Gabbroic rocks (Tertiary and Late Cretaceous)**—Consists of gabbro, microgabbro, and diorite

TKa — **Alkalic rocks (Tertiary or Late Cretaceous)**—Pyroxenite, leucosyenite, and hornblende syenite

Kmg — **Granitic rocks (Late Cretaceous)**—Mainly granite porphyry, biotite monzogranite porphyry, biotite monzogranite, biotite-muscovite monzogranite, biotite-muscovite granodiorite, quartz monzonite, microleucomonzogranite, leucomonzonite, aplite, alaskite, and pegmatite

Kgd — **Granodioritic rocks (Late Cretaceous)**—Consists of foliated and nonfoliated biotite-hornblende granodiorite, biotite-hornblende granodiorite porphyry, biotite-hornblende monzogranite, and tonalite

Kgb — **Gabbroic rocks (Late Cretaceous)**—Diorite, diorite porphyry, gabbro, microgabbro, and diabase

Kmd — **Monzodioritic rocks (Late(?) Cretaceous)**—Mainly hornblende quartz diorite, granodiorite, tonalite, quartz monzodiorite, diorite, quartz diorite, leucogranodiorite, and augite-hornblende monzonite

Kl — **Latite (Late Cretaceous)**—Sill in northeastern corner of map

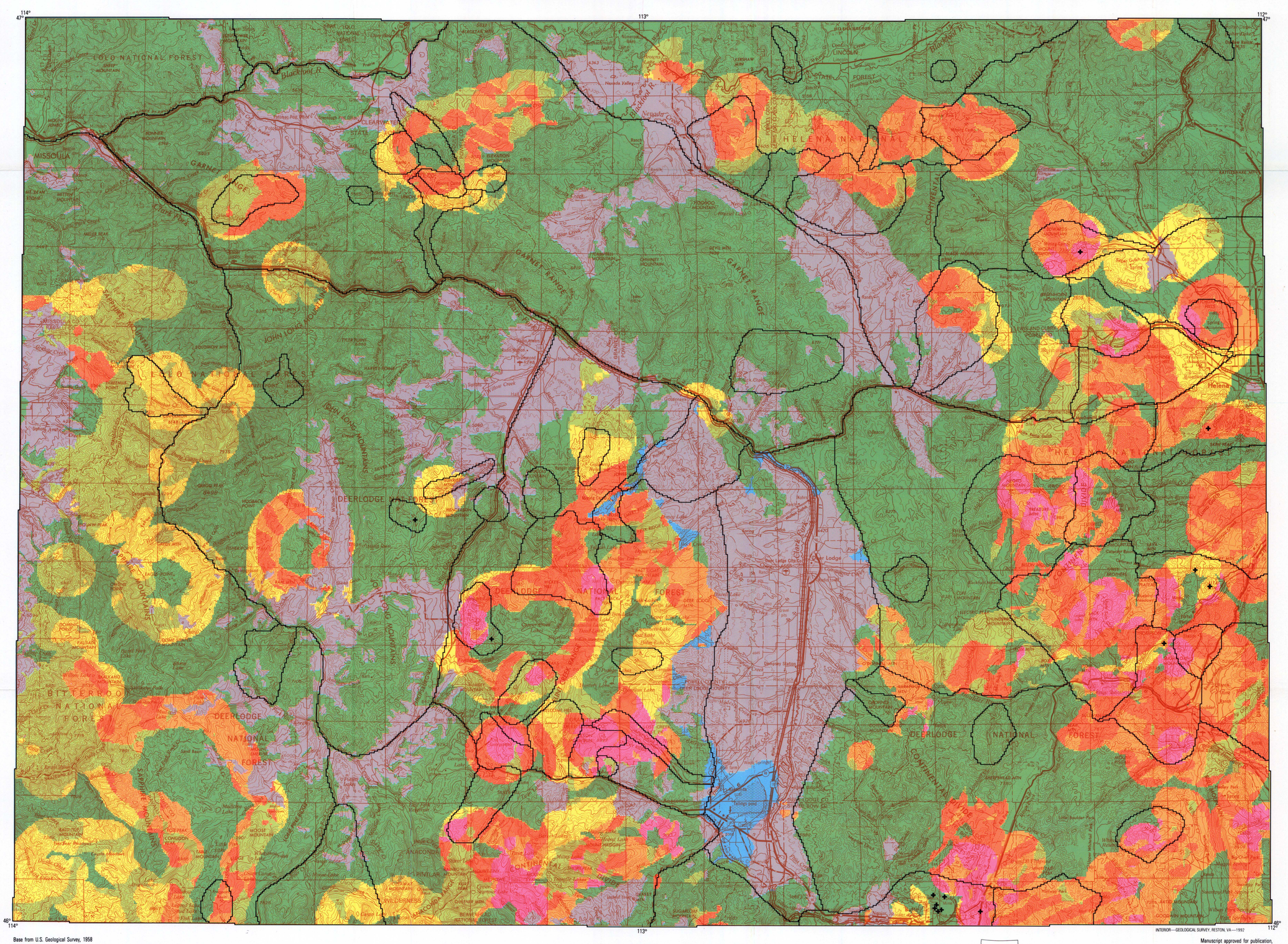
Kau — **Augen gneiss (Late Cretaceous)**—Part of the Idaho batholith in southwestern corner of map

ZYg — **Gabbroic rocks (Late or Middle Proterozoic)**—Gabbro, microgabbro, and diorite dikes and sills

MAFIC INTRUSIVE ROCKS OF UNCERTAIN AGE

mi — **Diorite and diorite porphyry, diabase, gabbro, microgabbro, and diorite**

- **Contact**—Long-dashed where inferred or approximately located; short-dashed where concealed by younger deposits
- **Normal fault**—Ball and bar on apparent downthrown block. Long-dashed where inferred or approximately located; short-dashed where concealed by younger deposits
- **Strike-slip or oblique-slip fault**—Arrows show inferred direction of relative lateral movement. Ball and bar show apparent direction of dip-slip offset. Long-dashed where inferred or approximately located; short-dashed where concealed by younger deposits
- **Thrust fault**—Sawteeth on upper plate. Short-dashed and open sawteeth where concealed by younger deposits
- **Anticline**—Shows trace of axial plane, direction of plunge, and dip directions of limbs. Short-dashed where concealed by younger deposits
- **Syncline**—Shows trace of axial plane, direction of plunge, and dip directions of limbs. Short-dashed where concealed by younger deposits
- **Overturned anticline**—Shows trace of axial plane, direction of plunge, and dip directions of limbs. Short-dashed where concealed by younger deposits
- **Overturned syncline**—Shows trace of axial plane, direction of plunge, and dip directions of limbs. Short-dashed where concealed by younger deposits
- **Zone of imbricate thrust faults**
  - **In Mississippian, Devonian, and Cambrian strata**
  - **In Wallace and Helena Formations and Missoula Group strata**
  - **In Mississippian, Pennsylvanian, Permian, Jurassic, and Cretaceous strata**
  - **In Cambrian and Middle Proterozoic strata**
- **Silicified shear zone**—In Mississippian and Devonian strata



Base from U.S. Geological Survey, 1958
Revised 1977

Map *B*. Map showing mineral resource assessment submodel associations

EXPLANATION

Submodel associations—H, Host rock submodel; P, Plutons submodel; C, Geochemical submodel; G, Geophysical submodel; FL, Fault submodel + linear feature submodel; A, Alteration submodel

- H+P+C+G+FL+A
- H+P+C+G+FL
- H+P+C+G (±A)
- H+P+C (±FL±A)
- H+P (±G±FL±A)
- H (±C±G±FL±A)
- ±C±G±FL±A
- Areas covered by Tertiary and Quaternary sedimentary rocks
- Boundary of mining district or geographic area—See map C
- ✚ Locations of 14 most productive vein- and replacement-type mines having production of more than $5 million

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1992
Manuscript approved for publication, June 19, 1989

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 200 FEET
SUPPLEMENTARY CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MAPS SHOWING MINERAL RESOURCE ASSESSMENT FOR VEIN AND REPLACEMENT DEPOSITS OF GOLD, SILVER, COPPER, LEAD, ZINC, MANGANESE, AND TUNGSTEN IN THE BUTTE 1° × 2° QUADRANGLE, MONTANA

By
J.E. Elliott, C.A. Wallace, G.K. Lee, J.C. Antweiler, D.J. Lidke, L.C. Rowan,
W.F. Hanna, C.M. Trautwein, J.L. Dwyer, and S.H. Moll

1992

For sale by U.S. Geological Survey Map Distribution, Box 25286, Federal Center, Denver, CO 80225