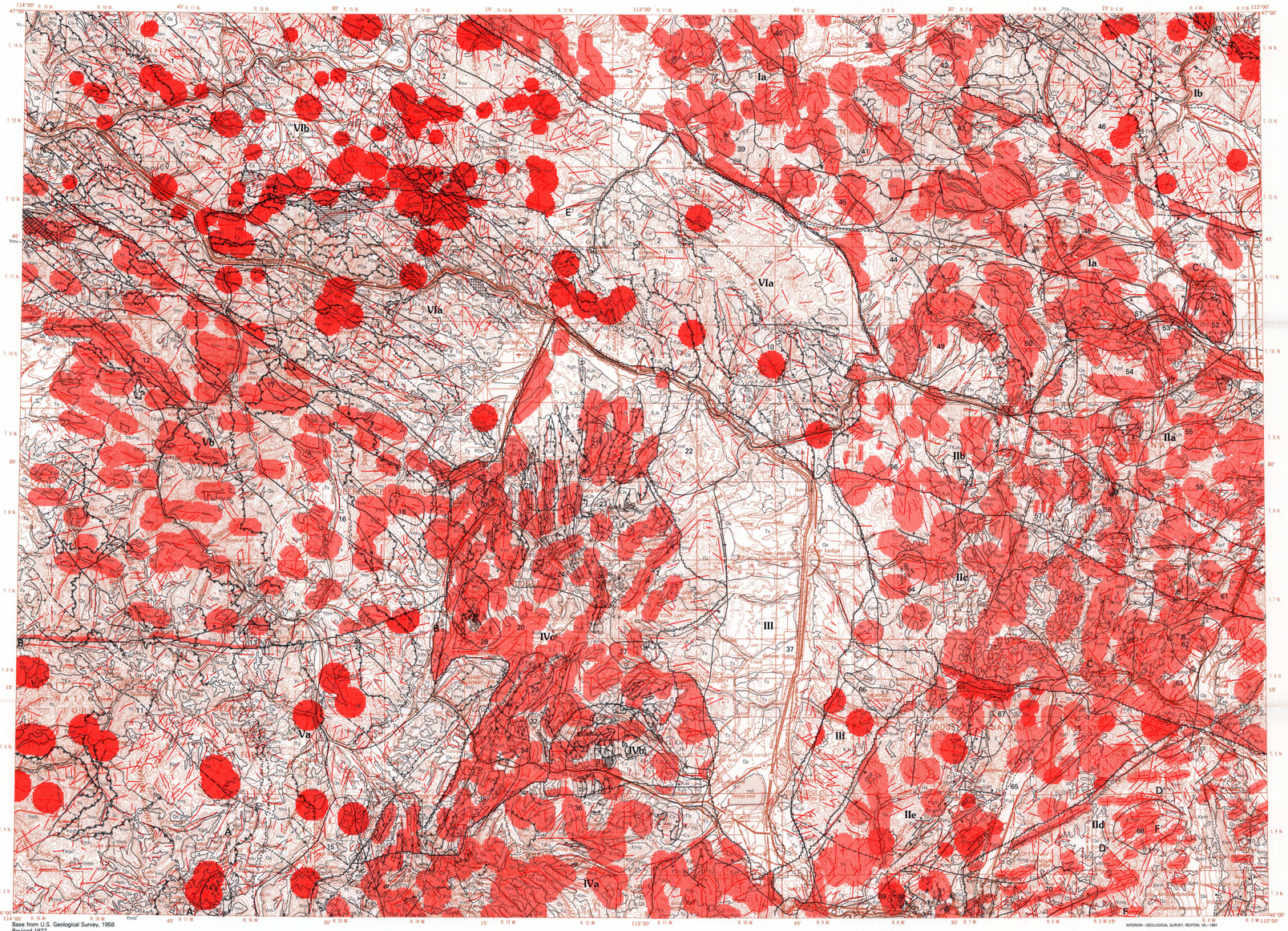
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–2050–B
Explanatory pamphlet accompanies map



EXPLANATION

Linear feature—Mapped from a Landsat Multispectral Scanner (MSS) image and a side-looking airborne radar (SLAR) image mosaic

Areas around linear features and intersections that exhibit the highest spatial association with mines and prospects within each subdomain. Summary statistics are listed in table 1.

Linear features

Intersections

A A′ **Lineament**

IV **Subdomain number**

Subdomain boundary

x **Mine or metallic mineral occurrence**

64 **Boundary of metal mining districts and areas** (Elliott and others, 1987). Numbers keyed to following list.

Map no.	Name	Map No.	Name
1	Rattlesnake Creek area	36	Anaconda Range area
2	Garnet Range area	37	Deer Lodge Valley area
3	Clinton district	38	Blackfoot River area
4	Copper Cliff district	39	Big Blackfoot (Ogden Mountain) district
5	Coloma district		
6	Garnet (First Chance) district	40	Lincoln Gulch area
7	Top O'Deep district	41	McClellan Gulch district
8	Elk Creek area	42	Seven-up Pete Gulch area
9	Bear Creek area	43	Stemple-Gould district
10	Garrison district	44	Nevada Creek area
11	Sapphire Mountains area	45	Finn district
12	Welcome Creek district	46	Little Prickly Pear area
13	Rock Creek area	47	Wolf Creek district
14	Frog Pond Basin district	48	Marysville (Silver Creek) district
15	Moose Lake district	49	Ophir (Snowshoe Creek, Carpenter Creek) district
16	John Long Mountains area		
17	Alps district	50	Dog Creek area
18	Black Pine (Combination) district	51	Austin district
19	Henderson Creek area	52	Scratchgravel Hills area
20	Flint Creek Range area	53	Sevenmile Creek area
21	Dunkleberg district	54	Stemwinder Hill area
22	Pioneer (Gold Creek) district	55	Helena (Last Chance) district
23	Rose Mountain (Gold Creek) district	56	North Boulder Mountains area
		57	Elliston district
24	Princeton (Boulder Creek) district	58	Rimini (Vaughn) district
25	Douglas Creek (Gird Creek) district	59	Clancy district
26	Maxville area	60	Basin (Cataract) district
27	Racetrack (Danielsville) district	61	Wickes (Colorado) district
28	Philipsburg district	62	Amazon district
29	Red Lion (Hidden Lake) district	63	Boulder (Comet) district
30	Lost Creek district	64	Emery (Zosell) district
31	Blue-Eyed Nellie district	65	South Boulder Mountains area
32	Olson Gulch district	66	Oro Fino district
33	Johnson Basin district	67	Lowland district
34	Georgetown (Southern Cross, Cable, Gold Coin) district	68	Big Foot (State Creek) district
		69	Butte (Summit Valley) district
35	Silver Lake district	70	Pipestone district

NOTE

This map is part of a folio of maps of the Butte 1° × 2° quadrangle, Montana, prepared under the Conterminous United States Mineral Assessment Program. Other publications in this folio include Wallace and others (1986) and Rowan and Segal (1989).

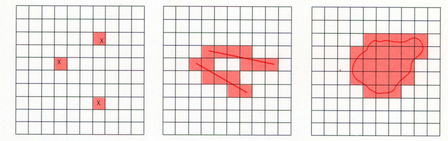
REFERENCES CITED

Elliott, J.E., Loen, J.S., Wise, K.K., and Blaskowski, M.J., 1987, Mines and prospects of the Butte 1° × 2° quadrangle, Montana: U.S. Geological Survey Open-File Report 86–632, scale 1:250,000.

Gwinn, V.E., 1961, Geology of the Drummond area, central-western Montana: Montana Bureau of Mines and Geology Special Publication 21.

Rowan, L.C., and Segal, D.B., 1989, Map showing locations of exposures of limonitic rocks and hydrothermally altered rocks in the Butte 1° × 2° quadrangle, Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I–2050–A, scale 1:250,000.

Wallace, C.A., Schmidt, R.G., Lidke, D.J., Waters, M.R., Elliott, J.E., French, A.B., Whipple, J.W., Zarske, S.E., Blaskowski, M.J., Heise, B.A., Yeomen, R.A., O'Neill, J.M., Lopez, D.A., Robinson, G.D., and Klepper, M.R., 1986, Preliminary geologic map of the Butte 1° by 2° quadrangle, west-central Montana: U.S. Geological Survey Open File Report 86–292, scale 1:250,000.



5	5	4	4	3	2	2	2	3	3					
4	4	3	3	2	1	1	1	2	3					
3	3	2	2	2	1	0	1	2	3					
3	2	1	1	1	1	1	2	3						
3	2	1	0	1	2	2	2	3	4					
3	2	1	1	1	2	2	2	3	4					
4	3	2	2	2	1	1	1	2	3					
4	4	3	3	2	1	0	1	2	3					
5	5	4	3	2	1	1	1	2	3					
6	5	4	4	3	2	2	2	3	3					

4	4	3	3	3	3	3	3	4	4					
4	3	2	2	2	2	2	2	3	3					
3	2	1	1	1	1	1	1	2	2					
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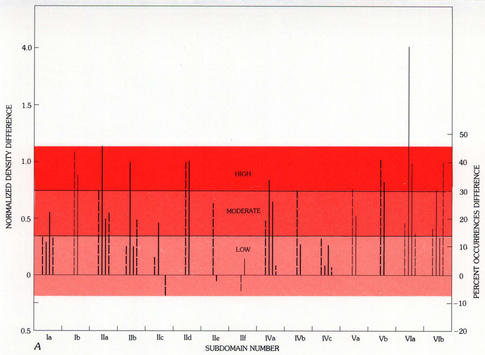
2	1	0	0	1	1	0	0	0	1					
2	1	1	0	0	0	1	1	1	1					
3	2	1	1	1	0	0	1	2	2					
4	3	2	2	1	1	1	1	2	3					
4	4	3	3	2	2	2	2	3	4					
5	5	4	4	3	3	3	3	4	4					

B

Figure 2.—Diagrams showing *A*, grid cell representation of points, lines, and polygon, and *B*, proximity maps of points and lines represented in 2*A*.



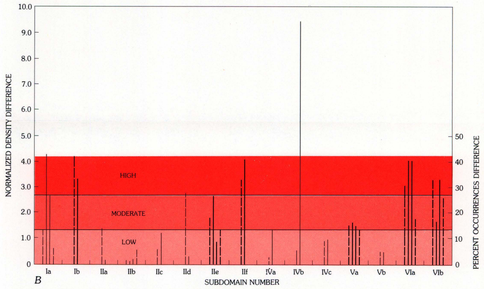


Figure 3.—Normalized density (solid line) and percentage of metallic mineral occurrences (dashed line) differences between subdomains and entire quadrangle for *A*, linear feature trends and *B*, intersections. Heavy lines represent trends and intersections boldfaced in table 1, listed in table 2, and shown on the map; when multiple trends and intersections are shown, they progress from left to right in accordance with the table 1 listing order. The same proximity was used for calculating quadrangle and subdomain values (table 1). Red shading divides normalized density into high, moderate, and low ranges. Average percentage of occurrences differences for linear feature trends and intersections is 18 percent and 17 percent, respectively.

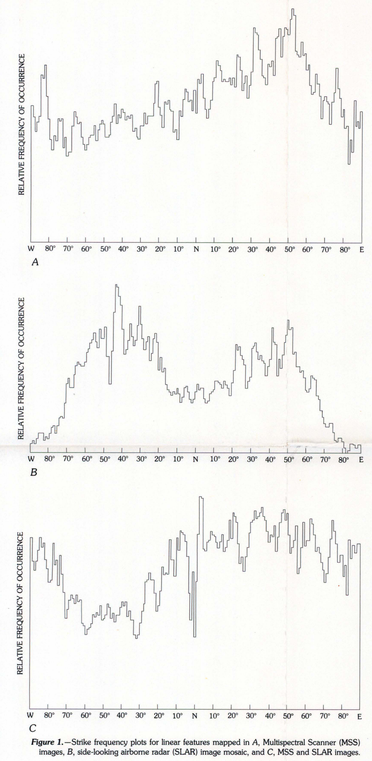


Figure 1.—Strike frequency plots for linear features mapped in *A*, Multispectral Scanner (MSS) images, *B*, side-looking airborne radar (SLAR) image mosaic, and *C*, MSS and SLAR images.

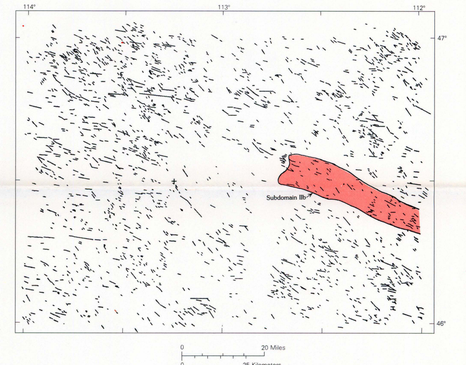
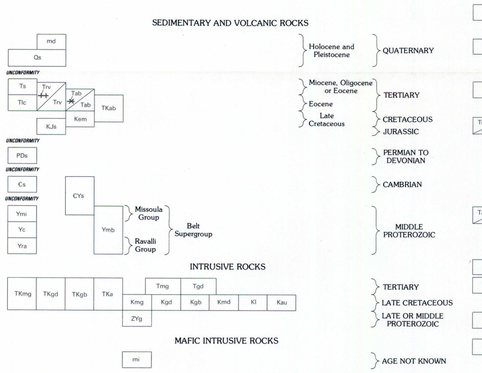


Figure 4.—Map showing concentration of NW and WNW linear features within subdomain **IIb**.

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 sediment 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 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, breeccia, 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 Corbenly 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

MAP SHOWING THE ASSOCIATION OF LINEAR FEATURES WITH METALLIC MINES AND PROSPECTS IN THE BUTTE 1° × 2° QUADRANGLE, MONTANA

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1991

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