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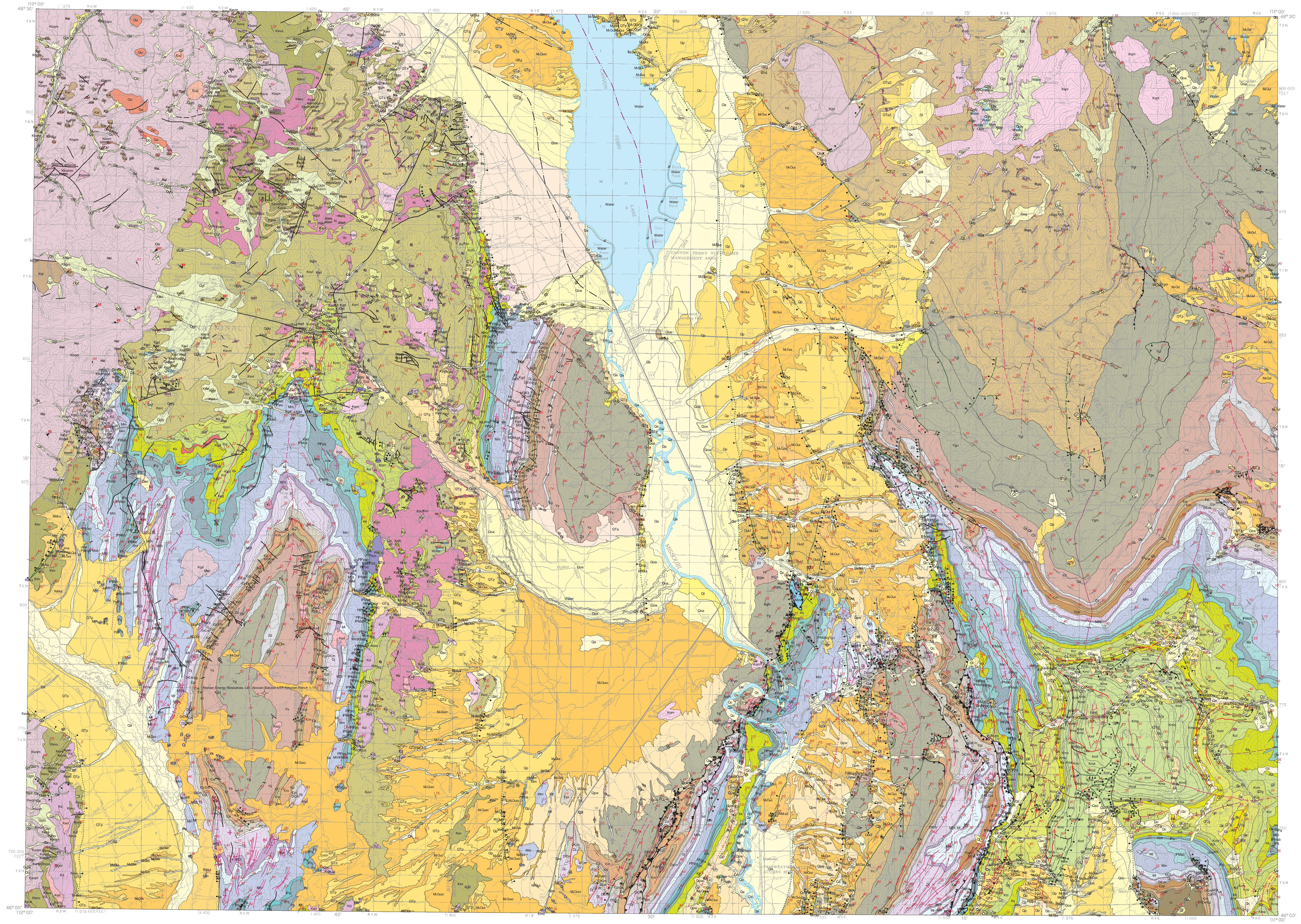

Base from U.S. Geological Survey, 1976
Photoinspected 1991

Projection and 10,000-meter grid: Universal Transverse Mercator, Zone 12,
25,000-foot ticks: Montana coordinate symtem, south zone

1927 North American Datum

MONTANA

QUADRANGLE LOCATION

SCALE 1:100 000

CONTOUR INTERVAL 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
ELEVATIONS SHOWN TO THE NEAREST METER

Digital database by Theodore R. Brandt
Supplementary point digital data by Kenzie J. Turner
Color design of geologic map by Mitchell W. Reynolds
Correlation of map units, and Index to geologic mapping drafted by Lisa Ramirez Rukstales
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PRELIMINARY GEOLOGIC MAP OF THE TOWNSEND 30' x 60' QUADRANGLE, MONTANA

By

Mitchell W. Reynolds and Theodore R. Brandt

2006

LIST OF MAP UNITS

Symbol	Unit
Qa	Alluvium (Holocene)
Qc	Colluvium (Holocene)
Qac	Alluvium and colluvium, undivided (Holocene)
af	Artificial fill (Holocene)
dt	Dredge tailings (Holocene)
Ql	Landslide deposit (Holocene and Pleistocene)
Qt	Terrace gravel (Holocene and Pleistocene)
Qp	Pediment gravel (Holocene? and Pleistocene)
Qbg	Boulder gravel (Holocene or Pleistocene)
Qpw	Pediment gravel with windblown silt and sand (Holocene? and Pleistocene)
Qoa	Old alluvium (Holocene or Pleistocene)
Qog	Old gravel (Holocene or Pleistocene)
Qag	Alluvium and glacial till, undivided (Holocene? and Pleistocene)
Qgt	Glacial till, undifferentiated (Pleistocene)
Qgtc	Older glacial till and associated colluvium (Pleistocene)
Qgty	Glacial till, younger till where more than one age of till is recognized (Pleistocene)
Qgto	Glacial till, older till where more than one age of till is recognized (Pleistocene)
QTa	Older alluvium (Pleistocene or Pliocene)
QTg	Older gravel (Pleistocene or Pliocene)
QTp	Older pediment gravel, undivided (Pleistocene and Pliocene)
QTp1	Older pediment gravel, lower level where two levels of gravel are adjacent across the underlying bedrock surface (Pleistocene and Pliocene)
QTp2	Older pediment gravel, higher level where two levels of gravel are adjacent across the underlying bedrock surface (Pleistocene and Pliocene)
QTb	Basalt (Pleistocene? or Pliocene?)
PMis	Sedimentary rocks, undivided (Pliocene and Miocene)
MiOgs	Sedimentary rocks, undivided (Miocene and Oligocene)
MiOgs2	Sandstone and conglomerate tongue
MiOgs1	Orange-red conglomerate and sandstone tongue
MiOgf	Fort Logan Formation (Miocene and Oligocene)
MiOgsc	Sedimentary rocks, undivided, covered with discontinuous veneer of gravel, loess, sand (Miocene and Oligocene)
MiOgts	Vitric tuff and tuffaceous sedimentary rocks (Miocene and Oligocene)
Ogs3	Dunbar Creek Formation (Oligocene)
	Climbing Arrow Formation (Oligocene and Eocene?)
Ogs2	Upper part (Oligocene)
Ogs1	Lower part (Oligocene and Eocene?)
Ogr	Rhyolite shallow intrusive bodies and flows (Oligocene)
Ogb	Basalt (Oligocene)
Eoql	Quartz latite (Eocene)
Tl	Lamprophyre (Tertiary?)
	Maudlow Formation (Upper Cretaceous)
Kmh	Maudlow Formation, unit h
Kmg	Maudlow Formation, unit g
Kmf	Maudlow Formation, unit f
Kme	Maudlow Formation, unit e
Kmd	Maudlow Formation, unit d
Kmc	Maudlow Formation, unit c
Kmb	Maudlow Formation, unit b
Kma	Maudlow Formation, unit a
Kev	Elkhorn Mountains Volcanics, undivided (Upper Cretaceous)
Kevu	Upper member
Kevm	Middle member
Keva	Ashflow tuff (present in Kevm and locally in Kevl)
Kevl	Lower member
Ks	Slim Sam Formation (Upper Cretaceous)
Ke	Eagle Sandstone (Upper Cretaceous)
Ktc	Telegraph Creek Formation (Upper Cretaceous)
Kc	Colorado Group sedimentary rocks, undivided (Upper and Lower Cretaceous)
Kcu	Upper part (Upper and Lower Cretaceous)
Kcm	Middle part (Lower Cretaceous)
Kcl	Lower part (Lower Cretaceous)
Kk	Kootenai Formation (Lower Cretaceous)
Kal	Alaskite and related felsic rocks (Late Cretaceous)
Kg	Granite (Late Cretaceous)
Kqm	Quartz monzonite (Late Cretaceous)
Kbqm	Butte quartz monzonite (Late Cretaceous)
Kbqmf	Alaskite and related felsic rocks within the Butte quartz monzonite
Kbqmm	Butte quartz monzonite, medium grained
Kwqm	Quartz monzonite of the Wilson Park pluton (Late Cretaceous)
Kmo	Monzonite (Late Cretaceous)
Kgd	Granodiorite (Late Cretaceous)
Kqd	Quartz diorite (Late Cretaceous)
Ksd	Syenodiorite (Late Cretaceous)
Ki	Andesitic intrusive rocks related to Elkhorn Mountains Volcanics (Late Cretaceous)
Kad	Andesite and diorite intrusive rocks (Late Cretaceous)
Kb	Basalt (Late Cretaceous)
Kd	Diorite porphyry (Late Cretaceous)
Km	Mafic igneous rocks, undivided (Late Cretaceous)
Kl	Lamprophyre (Late Cretaceous)
Jm	Morrison Formation (Jurassic)
Jme	Morrison Formation and Ellis Group, undivided (Jurassic)
Je	Ellis Group, undivided (Jurassic)
Pp	Phosphoria Group (Permian)
PIPpq	Phosphoria Group (Permian) and Quadrant Formation (Pennsylvanian), undivided
IPq	Quadrant Formation (Pennsylvanian)
IPa	Amsden Formation (Pennsylvanian)
IPMab	Amsden Formation (Pennsylvanian) and Big Snowy Group (Upper Mississippian), undivided
Mb	Big Snowy Group, undivided (Upper Mississippian)
Mmu	Mission Canyon and Lodgepole Limestones, undivided (Upper and Lower Mississippian)
Mm	Mission Canyon Limestone (Upper and Lower Mississippian)
Ml	Lodgepole Limestone (Lower Mississippian)
MDt	Three Forks Formation (Lower Mississippian and Upper Devonian)
Du	Upper and Middle Devonian rocks, undivided
Dj	Jefferson Formation (Upper Devonian)
D€m	Maywood Formation (Upper and Middle Devonian), locally includes some Cambrian rocks
€pp	Pilgrim Formation (Upper Cambrian) and Park Shale (Upper and Middle Cambrian), undivided
€pi	Pilgrim Formation (Upper Cambrian)
€p	Park Shale (Upper and Middle Cambrian)
€m	Meagher Limestone (Middle Cambrian)
€wf	Wolsey Formation and Flathead Sandstone, undivided (Middle Cambrian)
€w	Wolsey Formation (Middle Cambrian)
€f	Flathead Sandstone (Middle Cambrian)
Zd	Diorite (Neoproterozoic)
	Belt Supergroup (Mesoproterozoic)
Ye	Empire Formation
Ys	Spokane Formation
Yg	Greyson Formation, undivided
Ygu	Greyson Formation, upper member
Ygm	Greyson Formation, middle member
Ygl	Greyson Formation, lower member
Yn	Newland Formation, undivided
Ynu	Newland Formation, limestone-bearing upper part
Ynl	Newland Formation, lower part
Yl	Lahood Formation

Contact—Dashed where approximately located; dotted where concealed

Fault—Dashed where approximately located; short dashed where inferred; dotted where concealed; queried where uncertain

Normal fault—Dashed where approximately located; short dashed where inferred; dotted where concealed. Ball and bar on downthrown side

Reverse fault—Dashed where approximately located; short dashed where inferred; dotted where concealed

Thrust fault—Dashed where approximately located; short dashed where inferred; dotted where concealed. Sawteeth on upper plate

Strike-slip fault—Arrows show relative direction of displacement; dashed where approximately located; short dashed where inferred; dotted where concealed

Detachment fault—Dotted where concealed. Teeth on upper plate

Fault—Inferred from gravity survey

Fault—Inferred from aeromagnetic survey

Anticline—Showing trace of axial surface. Dashed where approximately located; short dashed where inferred; dotted where concealed; queried where uncertain

Plunging anticline—Showing trace of axial surface. Dashed where approximately located; dotted where concealed

Overturned anticline—Showing trace of axial surface and direction of dip of limbs. Dashed where approximately located

Inverted anticline—Beds in both limbs are overfolded and dip toward trace of axial surface shown. Dashed where approximately located; dotted where concealed

Syncline—Showing trace of axial surface. Dashed where approximately located; short dashed where inferred; dotted where concealed; queried where uncertain

Plunging syncline—Showing trace of axial surface. Dashed where approximately located; dotted where concealed

Overturned syncline—Showing trace of axial surface and direction of dip of limbs. Dashed where approximately located; dotted where concealed

Inverted syncline—Beds in both limbs are overturned and dip away from trace of axial surface shown. Dashed where approximately located; dotted where concealed

Dikes and sills

Strike and dip of bedding—Selected attitudes only

- **Horizontal**
- 40 **Inclined**
- 65 **Overturned**
- **Vertical**

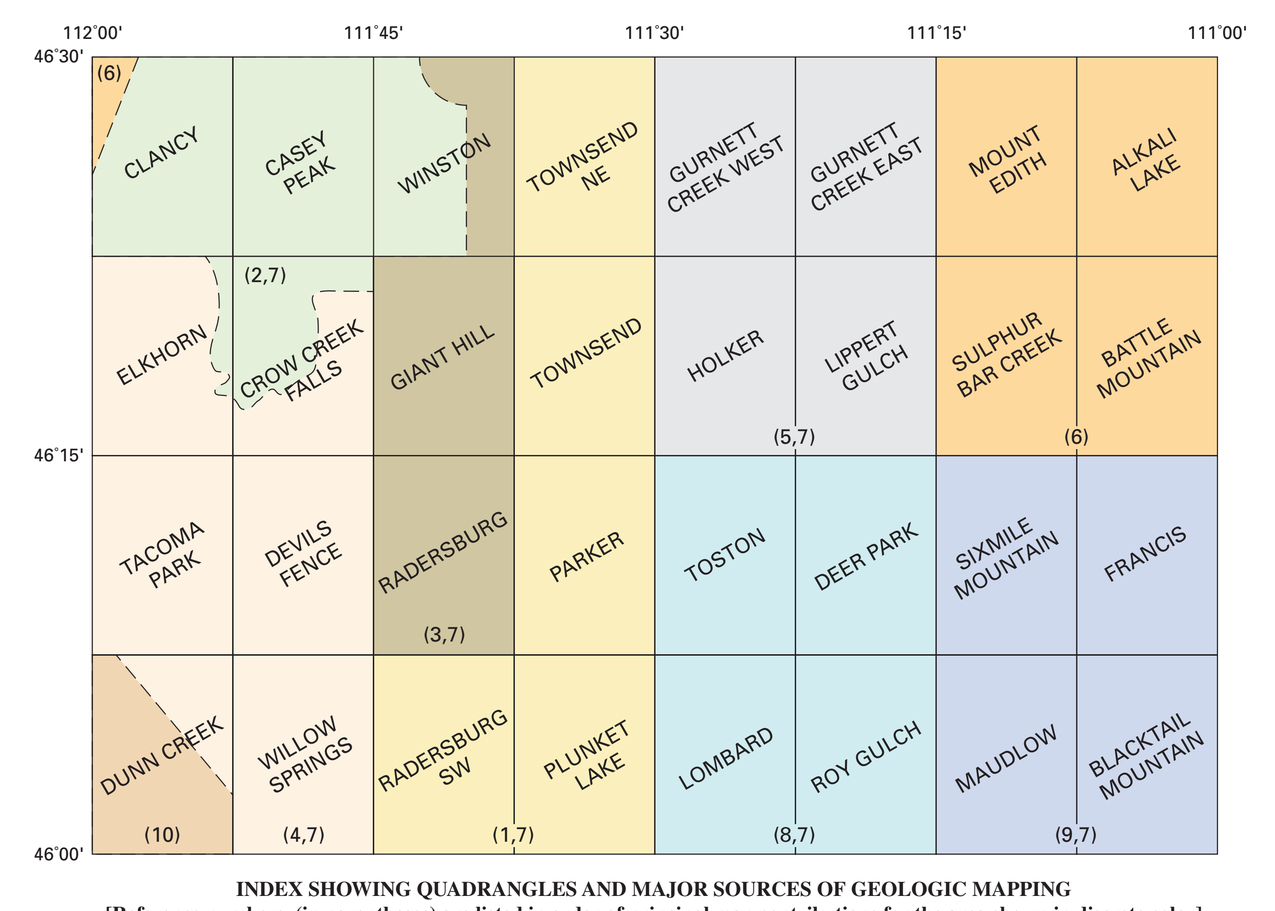
20 **Inclined layering in igneous rock**—Showing strike and dip

10 **Inclined foliation in layered gneiss or schist**—Showing strike and dip

30 **Inclined joint**—Showing strike and dip

Vertical joint—Showing strike and dip

Norcen Energy Resources, Ltd. Kimpton Ranch 1-11 — **Oil or gas test hole**—Showing operator and hole number



INDEX SHOWING QUADRANGLES AND MAJOR SOURCES OF GEOLOGIC MAPPING
[Reference numbers (in parentheses) are listed in order of principal map contributions for the area shown in discrete color]

MAJOR SOURCES OF GEOLOGIC MAPPING

1. Freeman, V.L., Ruppel, E.T., and Klepper, M.R., 1958, Geology of part of the Townsend Valley, Broadwater and Jefferson Counties, Montana: U.S. Geological Survey Bulletin 1042-N, p. 481-556, Plate N, scale 1:48,000. Modified using geologic mapping of source 7.

2. Greenwood, W.R., Ludington, Steve, Miller, W.R., and Hanna, W.F., 1990, Mineral Resources of the Elkhorn Wilderness Study area, Broadwater and Jefferson Counties, Montana: U.S. Geological Survey Bulletin 1805, 37 p., Plate 1, scale 1:48,000. Modified using geologic mapping of source 7.

3. Klepper, M.R., Ruppel, E.T., Freeman, V.L., and Weeks, R.A., 1971, Geology and mineral deposits, east flank of the Elkhorn Mountains, Broadwater County, Montana: U.S. Geological Survey Professional Paper 665, 66 p., Plate 1, scale 1:48,000. Modified using geologic mapping of source 7.

4. Klepper, M.R., Weeks, R.A., and Ruppel, E.T., 1957, Geology of the southern Elkhorn Mountains, Jefferson and Broadwater Counties, Montana: U.S. Geological Survey Professional Paper 292, 82 p., Plates 1-3, scale 1:48,000. Modified using geologic mapping of source 7.

5. Nelson, W.H., 1963, Geology of the Duck Creek Pass quadrangle, Montana: U.S. Geological Survey Bulletin 1121-J, p. J1-J56, Plate 1, scale 1:62,500. Modified using geologic mapping of source 7.

6. Reynolds, M.W., U.S. Geological Survey, unpublished detailed geologic mapping, scale 1:24,000.

7. Reynolds, M.W., U.S. Geological Survey, unpublished reconnaissance and local detailed geologic mapping, scale 1:24,000.

8. Robinson, G.D., 1967, Geologic map of the Toston quadrangle, southwestern Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-486, scale 1:24,000. Modified using geologic mapping of source 7.

9. Skipp, Betty, and Peterson, A.D., 1965, Geologic map of the Maudlow quadrangle, southwestern Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-452, scale 1:24,000. Modified using geologic mapping of source 7.

10. Weeks, R.A., 1974, Geologic map of the Bull Mountain area, Jefferson County, Montana, U.S. Geological Survey Open-File Report 74-354, Scale 1:48,000.

CORRELATION OF MAP UNITS