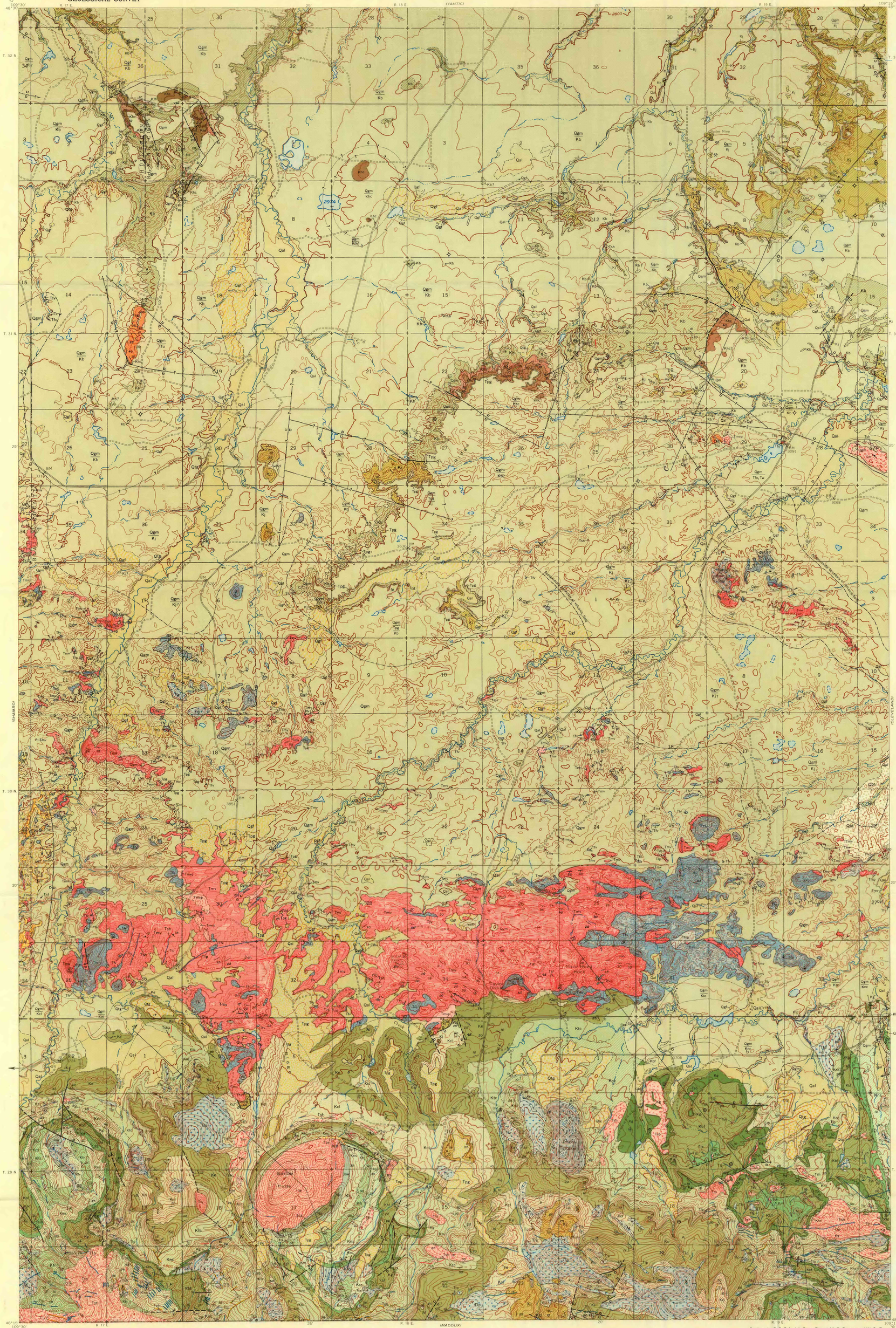
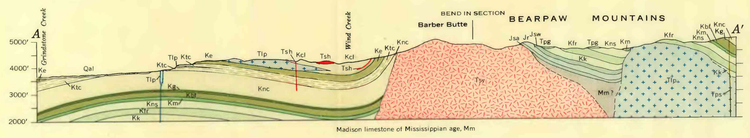
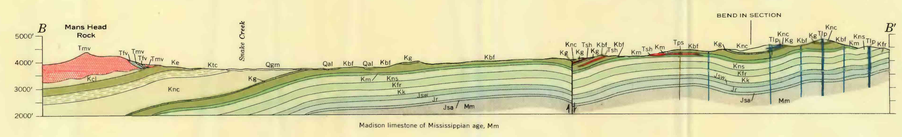
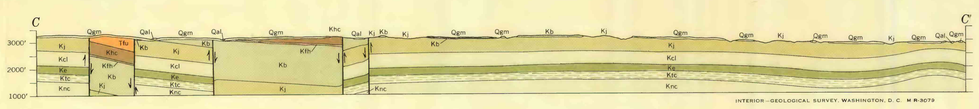


Base from U. S. Geological Survey map of Maddux quadrangle, Montana

Geology by R.G. Schmidt, Bruce Bryant, W. T. Pecora, and W. G. Ernst, assisted by R.D. Bentley, W. B. Bryan, Jr., R. L. Borst, J. E. Cotton, E. J. Olsen, and D. J. Milton, 1954–57







INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C. M R-3079

GEOLOGIC MAP AND SECTIONS OF THE LLOYD QUADRANGLE, BLAINE COUNTY, MONTANA

SCALE 1:31 680

1 0 1 2 3 MILES

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

QUATERNARY

Recent

Qal — **Alluvium**

Gravel, sand, silt, and clay in valleys and undrained depressions; deposited by streams and slope runoff; locally includes rubble and mud of colluvium and landslides; not mapped along minor tributaries; maximum thickness about 10 feet

Pleistocene

Qgf — **Glaciofluvial deposits**

Stratified but poorly sorted gravel, sand, silt, and clay; locally varved and thinly laminated; deposited by melt water from wasting late Pleistocene ice sheet; grades into ground moraine; locally suitable for road surfacing and construction purposes; topographic expression on broad surfaces commonly hummocky terrain of kames and kettles; maximum thickness greater than 30 feet

Qgm / Qbt — **Ground moraine**

Yellowish-gray to light-gray clay-rich to sandy or pebbly till containing scattered and unsorted erratics as much as 10 feet in diameter; deposited over northern part of quadrangle by southeastward-advancing late Pleistocene ice sheet; forms prominent bluffs along many postglacial stream valleys; erratics include great variety of angular to rounded and polished stones transported from Precambrian-shield area of Canada, well-rounded stones of quartzite from gravel plains of Alberta, and rocks of local origin; yields poorly drained alkali-rich gravel-capped soil; develops plastic gumbo material during rains; maximum thickness in filled preglacial valleys more than 100 feet. Qgm; terminal part of boulder train along east-central border of quadrangle, Qbt

Qtg — **Terrace gravel**

Poorly sorted sandy and bouldery gravel of local origin, deposited by streams at different levels during early Pleistocene time; highest level is about 120 feet above present flood plains; maximum thickness about 30 feet

Pliocene(?)

Tpg — **Pediment gravel**

Poorly sorted boulder gravel of local origin deposited as slope wash and by streams on bench surfaces in mountains and in plains area; represents high pediment surface about 200 feet above present flood plains; Tiger Ridge is largest remnant of pediment surface in quadrangle; probably developed in late Pliocene time; maximum thickness about 30 feet

UNCONFORMITY

INTRUSIVE ROCKS

Tps / Tps — **Porphyritic potassic syenite**

Light-gray, greenish-gray, and light-green coarsely porphyritic massive rock characterized by large phenocrysts of zoned sanidine and small prisms of green aegirite in a fine-grained matrix; generally displays planar fabric; as mapped, includes several subsilicic-alkalic to silicic-alkalic varieties; forms dikes and small plugdike bodies in southern and eastern part of quadrangle

Tlp / Tlp — **Porphyritic latite**

Light- to dark-gray, greenish-gray, brownish-gray, light-brown, and tan fine-grained commonly porphyritic massive intrusive rock forming stocks, plugs, dikes, and sills; essential minerals sanidine and plagioclase (oligoclase to andesine) occurring as phenocrysts and in fine-grained groundmass; rock commonly contains inclusions of several types of Precambrian-basement rocks; principally quartz latite and latite; probable chemical and intrusive equivalent of felsic flow rocks, Tfv; represents several episodes of irruption in magmatic sequence

Tsy — **Syenite**

Light- to dark-gray and greenish-gray medium- to coarse-grained porphyritic massive intrusive rock occurring in stocks in southern part of quadrangle; essential minerals: sanidine, aegirine-augite, and biotite; accessory minerals magnetite, apatite, and thomsonite

Tsh / Tsh — **Shonkinitic rocks**

Dark-gray to black fine- to coarse-grained locally porphyritic massive intrusive rocks forming stocks, plugs, dikes, and sills; as mapped, includes mafic syenite; essential minerals sanidine, augite, and biotite; some varieties contain nepheline and euhedral analcime; sanidine commonly encloses other minerals poikilitically; chemical and intrusive equivalent of mafic flow rocks, Tmv; represent several episodes of irruption in magmatic sequence

EXTRUSIVE ROCKS

Tat — **Analcime trachyte**

Greenish-gray fine-grained porphyritic rock forming flows and volcanic breccias; groundmass has pronounced trachytic texture; essential minerals sanidine and analcime; occurrence restricted to youngest part of volcanic pile, in southwestern part of quadrangle; total aggregate thickness less than 100 feet; chemical and extrusive equivalent of porphyritic potassic syenite, Tps

Tfr — **Felsic flow rocks**

Light-gray, brownish-gray, and yellowish-gray commonly massive or, rarely, vesicular flows and flow-breccia layers; as mapped, includes some sills, dikes, plugs, and irregular intrusive bodies indistinguishable from and merging with flow units; petrographic types principally quartz latite but include some latite and trachyte; rocks commonly porphyritic and characterized by phenocrysts of sanidine, plagioclase (oligoclase to andesine), and prismatic augite in altered fine-grained to glassy groundmass; interlayered with mafic flow rocks and mafic pyroclastic rocks throughout volcanic pile; generally characterized by presence of wide variety of inclusions of Precambrian basement rocks; aggregate thickness probably exceeds 5,000 feet; extruded from plugs and dikes during several different episodes of eruption; most varieties chemical equivalent of intrusive porphyritic latite, Tlp

Tfvp — **Felsic pyroclastic rocks**

Light-gray, brownish-gray, yellowish-brown, greenish-gray and variegated breccias, tuff-breccias, and tuffs interlayered with mafic and felsic flow rocks at two localities in southeastern part of quadrangle; composed chiefly of fragments of felsic volcanic rocks (latite, quartz latite) but locally containing fragments of mafic volcanic rocks and many inclusions of Precambrian basement rocks; unit predominantly breccia and tuff-breccia containing blocks as much as 4 feet in diameter; total aggregate thickness probably less than 100 feet in this quadrangle

Tmv — **Mafic flow rocks**

Flows and flow-breccia layers of vesicular highly altered and oxidized reddish-gray or purplish-red to dark-gray rock alternating with irregular lenticular masses of dark-gray to black massive rock; individual flows and flow-breccia layers irregular or tabular in form and commonly of wide areal extent; unit probably contains some dikes, sills, and plugs which cannot be distinguished from flow rocks; as mapped, includes several subsilicic-alkalic varieties such as mafic phonolite, mafic analcime phonolite, mafic pseudoleucite phonolite, mafic latite, and mafic trachyte; analcime-rich varieties abundant; rocks commonly fine grained, but one or more minerals generally present as phenocrysts; interlayered with felsic volcanic rocks but easily distinguished in field from these rocks by darker color and mineral composition if unaltered and by zeolitic minerals if altered; aggregate thickness about 10,000 feet; extruded from dikes and plugs; chemical equivalent of shonkinitic rocks, Tsh

Tmvp — **Mafic pyroclastic rocks**

Light- to dark-gray, dark-green and black, and red to purplish breccias and tuff-breccias interlayered with mafic and felsic flow rocks at several different stratigraphic horizons in the volcanic pile; composed chiefly of fragments of mafic volcanic rocks but locally contains abundant fragments of felsic volcanic rocks and inclusions of Precambrian basement rocks; unit predominantly tuff-breccia containing blocks as much as 3 feet in diameter; aggregate thickness in volcanic pile probably less than 1,500 feet

ANGULAR UNCONFORMITY

SEDIMENTARY ROCKS

Tw — **Wasatch formation equivalent**

Variegated beds of siltstone, crossbedded sandstone, and bentonitic mudstone and claystone; channel-conglomerate lenses in upper part; pebbles and cobbles in conglomerate characteristically crushed and fractured and recemented; pebbles and cobbles composed essentially of quartzite from Precambrian Belt series; Cretaceous porphyritic volcanic rocks, including welded tuff; and limestone of Paleozoic age; early Eocene age indicated by fossil teeth and fossil plants; maximum thickness 650 feet, but only 3 small exposures representing perhaps 10–20 feet of beds and covering less than 1 acre are present in the east and west-central parts of this quadrangle

Paleocene

Tfu — **Fort Union formation**

Yellowish-gray and grayish-brown thick-bedded ledge-forming sandstone; light-gray thin-bedded sandstone; greenish-gray siltstone and sandy shale; bentonitic siltstone, and carbonaceous shale; Paleocene age indicated by abundant fossil flora; maximum thickness about 1,300 feet but only partial sections exposed in this quadrangle

Upper Cretaceous — Montana group

Khc — **Hell Creek formation**

Light-gray to greenish-gray siltstone and claystone, calcareous in upper part; and light-gray sandstone, ledge forming in lower part; beds of carbonaceous shale and of black to brownish-gray carbonaceous bentonitic claystone in lower part; brownish-gray calcareous silty limestone concretionary beds as much as 3 feet thick in upper part, weathering to reddish gray; many outcrop areas strewn with abundant concretionary nubbles as much as 3 inches in diameter; vertebrate-bone fragments and fossil plants rare, thickness about 125 feet but only partial sections exposed in this quadrangle

Kfh — **Fox Hills sandstone**

Light-gray thin- and thick-bedded sandstone, weathering to yellowish orange; lower part forms ledges and contains discoid calcareous sandstone concretions as much as 4 feet thick that weather dark reddish brown; light-gray cannonball concretions in upper part; light-gray shale partings in lower part; thickness about 60 feet

Kb — **Bearpaw shale**

Dark-gray fissile shale, light-gray gypsiferous clay, thin bentonite beds, and numerous ovoid massive and septarian gray limestone concretions containing diagnostic marine invertebrate fossils, principally Baculites compressus; *on steep slopes commonly forms slumps and landslide topography; develops poorly drained, alkali-rich gumbo soil; weathered surfaces characterized by abundant gypsum crystals; uppermost part locally sandy; maximum thickness about 1,200 feet*

Kj — **Judith River formation**

Light-gray sandstone, light-gray siltstone and gypsiferous claystone, reddish-brown lignite beds and carbonaceous shale, and lenses of dark-brown crossbedded concretionary sandstone; oyster-shell beds and minable lignite extensive in upper part; thick-bedded, ledge-forming sandstone in lower part; ovoid calcareous sandstone concretions weathering to orange brown characteristic throughout formation; thickness ranges from 550 to 650 feet

Kcl — **Claggett shale**

Brownish-black fissile shale, light-gray gypsiferous clay, thin bentonite beds, and numerous ovoid yellow-brown septarian limestone concretions containing diagnostic marine invertebrate fossils, principally two species of Baculites; *basal part characterized by multiple bentonite beds; top characterized by fossiliferous sandy and silty beds; develops poorly drained, alkali-rich gumbo soil; forms slumps and landslide topography; maximum thickness about 500 feet, but thinner in structurally disturbed areas*

Ke — **Eagle sandstone**

Light-gray thick- and thin-bedded sandstone, thin-bedded shale and siltstone, and thin carbonaceous mudstone; lower part (Virgelle sandstone member) is massive bluff-forming concretionary sandstone as much as 80 feet thick, is an excellent aquifer; in places top of formation contains one or more chert-pebble conglomerate beds as much as a foot thick; upper part yields abundant natural gas in Bowes dome in northeastern part of quadrangle; thickness about 275 feet

Upper Cretaceous — Colorado shale

Ktc — **Telegraph Creek formation equivalent**

Thin-bedded light-gray sandstone, blue-black mudstone, black shale, thin lenses of concretionary limestone with diagnostic marine fossils; forms "transition beds" between Eagle sandstone and Niobrara shale equivalent; thickness ranges from 200 to 300 feet

Knc — **Niobrara shale and Carlile shale equivalents**

About 850 feet of dark-gray to black shale with massive and septarian, ovoid and discoid limestone concretions and subordinate sandstone, limestone, and bentonite beds; uppermost 600 feet is equivalent to Niobrara shale, characterized by dark-gray papery shale, many bentonite beds, as much as 18 inches thick, thin sandstone beds, thin limestone beds, limestone concretions, and diagnostic marine fossils; basal 250 feet probably equivalent to Carlile shale, characterized by black silty and sandy hard nonfossiliferous shale, absence of bentonite beds, and red-brown to yellow-brown ferruginous concretions near base that weather out as clay-ironstone fragments (lower red-chip zone of Reeves)

Kg — **Greenhorn limestone equivalent**

Blue-gray thin-bedded silty and sandy limestone and calcareous and noncalcareous shale; limestone beds more abundant in upper and lower parts of unit and break characteristically into rock slabs and plates at outcrops; diagnostic marine fossils, particularly Inoceramus labiatus *and fish scales; when struck with hammer, rock has sonorous ring and pronounced fetid odor; weathered faces coated with orange lichen growths; thickness 20–40 feet; shown as single line on some parts of map where attitude is steep to vertical*

Kbf — **Belle Fourche shale equivalent**

Dark-gray to black marine shale, with subordinate sandstone and bentonite beds and scarce limestone concretions in upper part; locally contains a well-defined unit 4–10 feet thick about 150 feet below base of Greenhorn limestone equivalent, composed of mudstone, arkosic grit, and chert-pebble sandstone; thickness about 200 feet

Km — **Mowry shale equivalent**

Thin-bedded and laminated shale, brittle siliceous shale, and very fine-grained sandstone; gray on fresh outcrops but grayish white to bluish white on weathered surfaces; some parting slabs contain abundant fish scales as much as 3 inches across but most less than half an inch across; thickness about 75 feet

Kns — **Newcastle sandstone and Skull Creek shale equivalents**

About 300 feet of nonfossiliferous black shale, sandstone, and subordinate bentonite; upper 100–200 feet is equivalent to Newcastle sandstone, characterized by many thin beds of glauconitic sandstone (iron-stained on weathered surfaces) and mudstone; basal 100 feet is equivalent to Skull Creek shale, characterized by black hard silty and sandy shale similar lithologically to Carlile shale equivalent

Lower Cretaceous

Kfr — **Fall River sandstone equivalent**

Black shale, dark-gray mudstone, gray sandstone, and chert-pebble beds; a sandy and muddy unit, locally containing abundant chert pebbles as much as an inch across, characterizes the top 25–50 feet; rare phosphatic nodules in black shale in basal 25 feet; rare fossil prints of Inoceramus bellevuensis *in thin sandstone beds of lower part; sandy worm trails and ripple marks locally abundant; thickness about 200 feet*

Kk — **Kootenai formation**

White to light-gray arkosic sandstone, variegated siltstone and shale, and dark-gray limestone beds and lenses; lower part contains thin beds of carbonaceous shale and lenticular sandstone that weathers orange brown; reddish-gray and greenish-gray shale dominant in upper part; lower part may include beds of Morrison age; thickness about 275 feet

Upper Jurassic — Ellis group

Jsw — **Swift formation**

Brown to brownish-gray thin-bedded sandstone and dark-gray to greenish-gray marine noncalcareous shale and siltstone; locally contains thin conglomerate composed of fossil fragments, principally of belemnites; upper part contains thin beds of papery carbonaceous shale, possibly of Morrison age; thickness about 160 feet

Jr — **Rierdon formation**

Light-gray, brownish-gray, and bluish-gray thin-bedded calcareous shale and light-brown to brownish-gray dense limestone; locally fossiliferous; exposed at Barber Butte; maximum thickness about 200 feet

Middle Jurassic

Jsa — **Sawtooth formation**

Grayish-white, thin-bedded siltstone and gray to black massive fossiliferous thick-bedded petroliferous limestone, oolitic at top; maximum thickness about 100 feet, but only upper 60 feet exposed at Barber Butte

CRETACEOUS — JURASSIC — TERTIARY — CRETACEOUS

Contact

Dashed where inferred; dotted where concealed; queried where doubtful

Fault, showing dip

Dashed where inferred; dotted where concealed; queried where doubtful. U, upthrown side; D, downthrown side

Probable limit of volcanic rocks

Anticline

Showing trace of axial plane. Dotted where approximately located

Strike and dip of beds and lava flows

Approximate strike and dip of beds and lava flows

Strike of vertical beds and lava flows

Horizontal attitude of beds and lava flows

Strike and dip of foliation

Strike of vertical foliation

Qgm / Kb — **Bedrock concealed by ground moraine, queried where uncertain**

>>>>> — **Line of measured stratigraphic section. (v's point upward)**

Coal prospect

Adit

Gravel or sand pit

Small prospect pit

Gas well

Abandoned gas well

Dry hole