GEOLOGIC MAP OF THE DODSON 30' x 60' QUADRANGLE

NORTH-CENTRAL MONTANA

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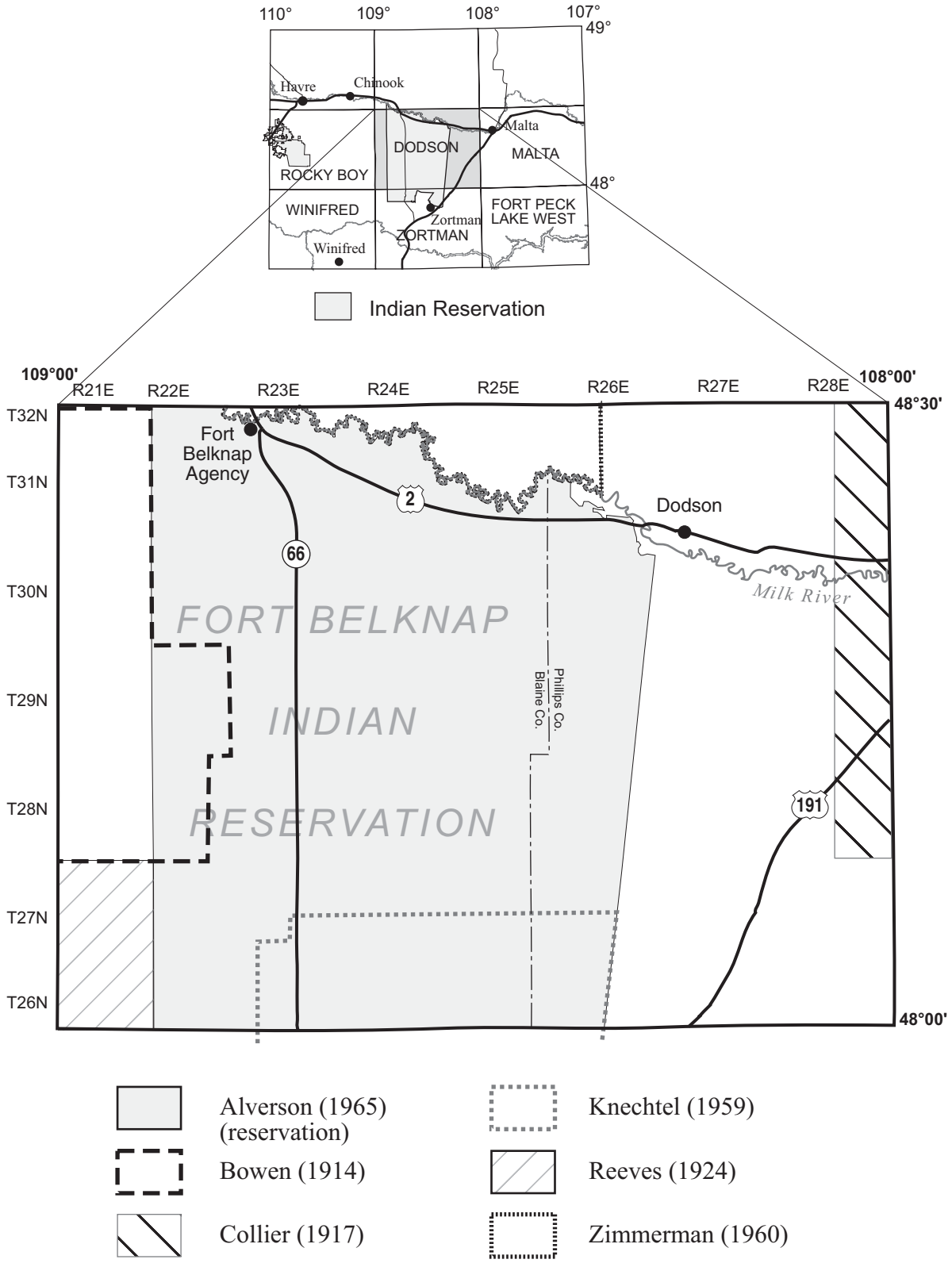


Figure 1. Location map for Dodson 30' x 60' quadrangle showing areas covered by older geologic maps within the quadrangle (see Sources of Previous Geologic Mapping), and location of adjacent geologic maps published by MBMG.

Correlation Chart of Map Units
Dodson 30’ x 60’ Quadrangle

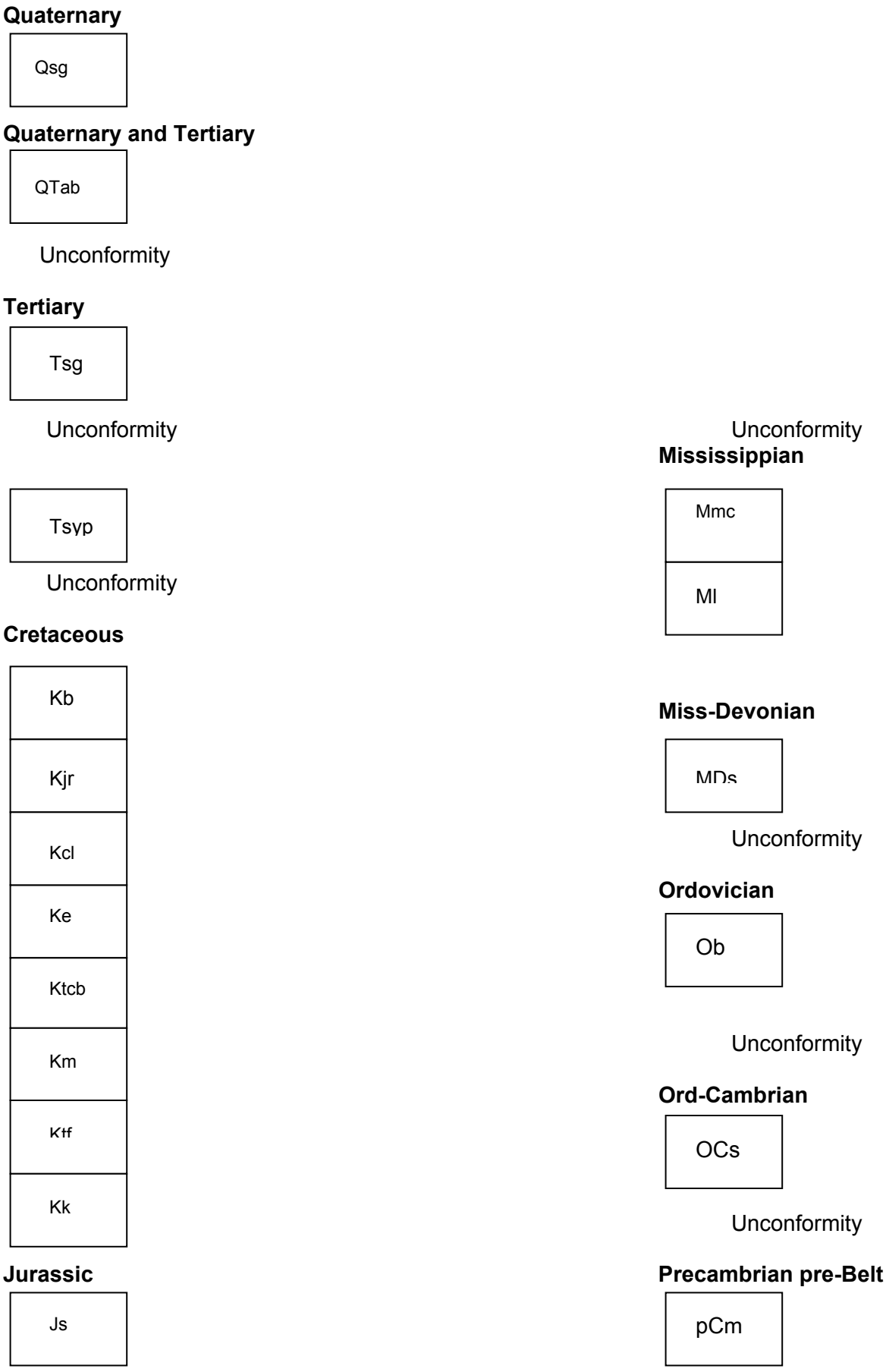


Figure 2. Correlation chart of map units.

Description of Map Units

NOTE: Descriptions of map units are extensively taken from Alverson (1965) and/or Knechtel (1959) in their respective texts and plates. Conversion of feet to meters in this report: ft/3.28 = [m].

Quaternary

Qsg — SAND AND GRAVEL. Alluvium of modern streams and associated flood plains; includes colluvium, terrace deposits, and glacial outwash. Thickness not measured.

Quaternary and Tertiary

QTab — ALLUVIUM OF DISSECTED BRAID PLAINS. Described by Knechtel (1959) as “older alluvium of gravel benches”, and by Alverson (1965) as “terrace deposits.” Following from Knechtel (1959), the deposits possibly represent remnants of alluvial braid-plain sedimentation across broad surfaces flanking the Little Rocky Mountains. Thickness ranges from a few ft to 30 ft [9 m] or more.

Tertiary

Tsg — TERTIARY SAND AND GRAVEL (MIOCENE). Equivalent to Flaxville Formation. Thickness not measured.

Tsyp — SYENITE PORPHYRY (EARLY TERTIARY). Commonly highly shattered and impregnated by silica veins; locally vuggy (Knechtel, 1959; Alverson, 1965).

Unconformity

Cretaceous

Kb — BEARPAW SHALE (UPPER CRETACEOUS). Dark-gray fissile marine shale, weathering lighter-gray; contains thin beds of white bentonite, and numerous calcareous concretions. Forms gentle slopes and rounded hills; outcrops are few and generally poor; exposed surfaces commonly dessication-cracked and minimally vegetated. No complete section preserved; incomplete thickness ranges from 600 to 700 ft [183 to 213 m] in map area (Alverson, 1965, p. F 30).

Kjr — JUDITH RIVER FORMATION (UPPER CRETACEOUS). Light-tan to light-gray, fine- to medium-grained, strongly lenticular, resistant sandstone that weathers to buff and light-orangish brown, interbedded with lesser amounts of siltstone, light-gray shale and claystone, and local thin lignite beds. Thickness of an incomplete measured section by

Alverson (1965, p. F 28) is 101 ft [31 m]; drill holes in the area record thicknessess of 365 ft [111 m], 530 ft [162 m], and as much as 890 ft [271 m] (Alverson, 1965, p. F 28) although this last thickness suggests possible fault repetition in the well.

Kcl CLAGGETT FORMATION (UPPER CRETACEOUS). Dark-gray clayey shale weathering to brownish gray; a few bentonite beds near base. Interbedded in upper part with thin beds of buff-colored sandstone that increase in number upward forming transition into overlying Judith River Formation. Characterized, particularly in upper part, by large, ovoid, orange-weathering septarian concretions, commonly fossiliferous and highly fractured, and commonly with associated aggregates of cone-in-cone structure. Thicknesses of 495 ft [151 m] and 475 ft [145 m] in two drill holes are reported by Alverson (1965, p. F 26).

Ke EAGLE FORMATION (UPPER CRETACEOUS). Lower sandstone (Virgelle) weathers yellow to buff, massive to cross-stratified, fine- to medium-grained, resistant sandstone with interbedded gray siltstone and shale; generally forms steep cliffs and weathers to rounded forms controlled by extensive jointing; thickness of sandstone is 125 ft [38 m] near Lodgepole, MT, but decreases eastward across map area to only a few feet in thickness at Phillips County line. Upper part of formation, about 50 ft [15 m] thick, composed of gray and tan shale and siltstone; a prominent zone of polished, primarily black, chert pebbles marks top of formation. Additional formation thickness data from wells reported by Alverson (1965, p. F 24-25) range from 310 to 945 ft [95 to 288 m]

Ktcb TELEGRAPH CREEK FORMATION THROUGH BELLE FOURCHE SHALE, UNDIVIDED (UPPER CRETACEOUS) (from Knechtel, 1959, plate 52, in part; equivalent to Knechtel's Warm Creek Shale). Unit includes, in descending order, Telegraph Creek, Niobrara, Carlile, Greenhorn, and Belle Fourche Formations; exposed primarily in south-central map area where dips too steep to map formations separately. Interval composed primarily of dark marine shales; creamy-weathering calcareous shale of Greenhorn Formation overlying thin, platy, locally fossiliferous sandstones of Mosby Sandstone Member of Belle Fourche Formation forms the only distinctive interval within the sequence. Thickness approximately 1,100 ft [335 m] (Knechtel, 1959, p. 741-742; Alverson, 1965, p. F 22-23).

Km MOWRY FORMATION (UPPER CRETACEOUS). Medium-gray, brittle, siliceous shale weathering light-silvery blue to white, commonly with orange stain; contains abundant fish scales locally; commonly forms light-colored areas on slopes and commonly supports lodgepole pine. Thickness 70 ft [21 m] (Alverson, 1965).

Ktf THERMOPOLIS SHALE AND FALL RIVER SANDSTONE, UNDIVIDED (LOWER CRETACEOUS) (from Knechtel, 1959, in part; thicknesses from Knechtel, 1959). Thermopolis Shale composed of dark-bluish gray shale

bearing common small ferruginous concretions and occasional thin, white bentonite layers; a medial 25-foot [7.6-m] sandstone interval (Cyprian Sandstone) present on west side of Little Rocky Mountains is not present on the north flank of the mountains in this quadrangle; a thin layer of predominantly black, polished chert pebbles forming its upper surface was not recognized by Alverson (1965) but is present regionally within the shale even when sand is absent. Fall River Sandstone, First Cat Creek Sandstone of subsurface usage. Not identified by Alverson (1965) in quadrangle, but described for rest of Little Rocky Mountains by Knechtel (1959) as composed, in lower part, of massively bedded, arkosic, coarse-grained sandstone with locally common small "clay pellets", and composed, in upper part, of dark-gray shale, siltstone, and argillaceous sandstone. This upper part probably is the only lithology properly assigned to the marine transgressive Fall River Sandstone; the underlying arkosic sandstone is more likely an upper Kootenai Formation lithology as Knechtel (1944) first considered it. Total thickness of combined formations approximately 600 ft [183 m] (Alverson, 1965, p. F21; Knechtel, 1959, p. 739).

Kk — KOOTENAI FORMATION (LOWER CRETACEOUS). Three distinct lithologic units recognized by Alverson (1965), following Knechtel (1944). Upper part is 25 ft [7.6 m] of coarse-grained arkosic sandstone; middle part is 85 ft [26 m] of variegated maroon, green, and tanish, commonly mottled mudstones with interbedded, laterally discontinuous light-gray sandstones and mudstones; lower part is 80 ft [24 m] of tan, coarse-grained, arkosic, thick-bedded, chert-bearing, locally cross-stratified, locally conglomeratic sandstone with light-gray shale interbeds; bed of light-gray, dense limestone at base. Total thickness 190 ft [58 m] (Alverson, 1965, p. F19). Note: Knechtel (1959) places upper unit into overlying First Cat Creek (Fall River) Sandstone which is an unusual assignment not followed in this report.

Jurassic

Js — SEDIMENTARY ROCKS, UNDIVIDED (MIDDLE AND UPPER JURASSIC) (from Alverson, 1965). Comprises two formations of Ellis Group, from top to bottom of unit. Swift Sandstone contains primarily light- and dark-gray shale with calcareous concretions; some glauconitic sandstone beds in upper part; abundant silicified *Belemnites* in lower part; about 240 ft [73 m] thick. Rierdon Formation composed of light- to dark-gray, clayey limestone that weathers white or light-buff; the limestone commonly weathers into rounded, pebble-size fragments that litter outcrop surface; about 140 ft [43 m] thick. Basal formation of Ellis Group, the Piper (Sawtooth) Formation, apparently is absent in Little Rocky Mountains, although Alverson (1965, p. F18) reports a thin sandstone bed at the base of the Rierdon that might be a Sawtooth lithology. Also, no Upper Jurassic Morrison Formation is reported by Alverson (1965) for northern flank of Little Rocky Mountains (part of this report), although Knechtel (1959, p. 737) reports 60 to 65 ft [18 to 20 m] exposed on small

domes on south side of Little Rockies. Estimated total thickness of Jurassic beds approximately 380 ft [116 m] (Alverson,1965, p. F 18).

Unconformity

Mississippian

Mmc MISSION CANYON FORMATION (MIDDLE MISSISSIPPIAN) (from Knechtel, 1959, plate 52). Massively bedded, white to light-buff, crystalline to fragmental limestone; locally cross-bedded, with nodules and lenses of cherty material; numerous solution cavities in upper part; forms massive white cliffs surrounding core of Little Rocky Mountains. Thickness about 330 ft [100 m] in quadrangle area (Alverson, 1965, p. F 17).

Ml LODGEPOLE FORMATION (LOWER AND MIDDLE MISSISSIPPIAN). Light- to dark-gray-weathering, thin-bedded limestone; locally stained red from weathering of interbedded red shales. Thickness about 800 ft [244 m] (Alverson, 1965, p. F 17).

Mississippian and Devonian

MDs SEDIMENTARY ROCKS, UNDIVIDED (MISSISSIPPIAN AND DEVONIAN) (from Knechtel, 1959, plate 52). Includes, in descending order, Three Forks Shale (Mississippian(?) and Devonian), Jefferson Limestone (Devonian), and Maywood Formation (Devonian). Three Forks Shale, poorly exposed, consists of light-gray to light-green, calcareous claystone and siltstone. Jefferson Limestone has three distinct units: upper unit composed of light-gray to buff, sandy, massively bedded to locally slabby limestone and dolomite; middle unit composed of shale, siltstone, and thinly laminated dolomite and limestone; lower unit composed of dark-gray and brownish gray, finely crystalline limestone that commonly weathers whitish; Alverson (1965) reports a total Jefferson thickness of about 500 ft [152 m]. Maywood Formation composed of shale, siltstone, limestone, and dolomite weathering bright-red in upper part, and light-gray, light-green, yellow, and brown in lower part. Lower 5 ft [1.5 m] are pinkish-weathering, silty, platy dolomite. Thickness of total map unit averages 685 ft [209 m] (Knechtel, 1959, p. 730-732).

Unconformity

Ordovician

Ob BIGHORN DOLOMITE (ORDOVICIAN). Dolomitic limestone; upper half gray to white, thin-bedded, hard dolomite; lower part massive, dappled-gray dolomitic limestone with bluish cast locally; weathered surfaces commonly pitted (from Knechtel, 1959, plate 52). Thickness about 450 ft [137 m] (Alverson, 1965. P. F15) .

Unconformity

Ordovician and Cambrian

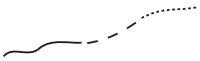
OCs DRY CREEK SHALE AND UNNAMED SHALE (EARLY ORDOVICIAN(?) AND CAMBRIAN), AND FLATHEAD SANDSTONE (CAMBRIAN), UNDIVIDED. Shale, dolomite, and intraformational conglomerate of the Dry Creek Shale, about 60 ft [18 m] thick (Alverson, 1965), and underlying unnamed greenish gray shale, about 900 ft [274 m] thick (Alverson, 1965) are probably equivalent to the Emerson Formation of Knechtel (1959). Flathead Sandstone, about 50 ft [15 m] thick (Alverson, 1965), composed of light-gray, green, and tan sandstone with some interbedded fine-grained conglomerate (Knechtel 1959, p. 727). Total thickness of unit approximately 1,010 ft [310 m].

Unconformity

Precambrian pre-Belt

pCm METAMORPHIC ROCKS, UNDIVIDED (PROTEROZOIC) (from Knechtel, plate 52). Metasedimentary rocks, primarily biotite schist and gneiss; metavolcanic rocks, primarily hornblende gneiss and amphibolite; also younger pre-Belt(?) ferromagnesian rocks forming a few dikes and sills.

Map Symbols



Contact; dashed where approximate, dotted where concealed.

Normal fault; dashed where approximate, dotted where concealed; ball and bar on down-thrown side.

Thrust fault; dashed where approximate, dotted where concealed; sawteeth on upper plate.

Limit of continental glaciation; hachures on ice side.

References

Sources of Previous Geologic Mapping in Quadrangle

Alverson, D. C., 1965, Geology and hydrology of the Fort Belknap Indian Reservation, Montana: U. S. Geological Survey Water-Supply Paper 1576-F, p. F1-F59; plate 1, map scale 1:162,500.

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Additional Sources of Geologic Information

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Knechtel, M. M., 1944, Oil and gas possibilities of the plains adjacent to the Little Rocky Mountains, Montana: U. S. Geological Survey Oil and Gas Investigations Preliminary Map 4, scale 1 inch = 4 mi; reprinted in Parker, J. M., ed., Little Rocky Mountains - Montana, southwestern Saskatchewan: Billings Geological Society Fourth Annual Field Conference Guidebook (1953), in back pocket.