PRELIMINARY GEOLOGIC MAP OF THE NORTH HALF OF THE CHOTEAU 30´ x 60´ QUADRANGLE NORTHWESTERN MONTANA

Compiled and Mapped

by

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Montana Bureau of Mines and Geology
Open File Report 558
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This map has had preliminary reviews for conformity with technical and editorial standards of the Montana Bureau of Mines and Geology.

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INTRODUCTION

The geology of the western part of the north half of the Choteau 30´ x 60´ quadrangle is from Mudge and others (1982) who show both the bedrock geology and surficial geology (fig.1). More detailed bedrock stratigraphy for the same area is given in Mudge and Earhart (1983). The geologic map for the Choteau 30´ x 60´ quadrangle (the northeast quarter of the Choteau 1^o x 2^o quadrangle) will be released in July 2008 and will incorporate the geology presented here, which covers only the north half of the Choteau 30´ x 60´ quadrangle (fig. 2).

The western third of the Choteau 1^o x 2^o quadrangle is dominated by the spectacular Rocky Mountain Front where sedimentary beds ranging in age from Cambrian through Cretaceous have been thrust eastward along many individual thrust faults. Twenty four of these faults are shown on the east-west cross section that accompanies this map. In contrast, the Cretaceous formations of the plains east of the Rocky Mountain Front generally show a regional southwestward dip of only a few degrees. With the exception of the Virgelle Formation, Cretaceous formations are generally poorly exposed in this area. However, the Virgelle Formation has eroded to produce mesas that are formed by the erosion-resistant, brown-weathering titaniferous magnetite beds near the upper contact of this formation.

Gravel of Quaternary and probably Tertiary age veneers terraces in this area as well as along the Rocky Mountain Front to both the north and south. Glacial drift was deposited next to the Teton River near the mountain front and melting of alpine glaciers produced large outwash deposits north of Choteau, most notably Burton Bench. Glacial drift deposited by the continental ice sheet overlies Cretaceous formations in the eastern part of this quadrangle. Fine-grained sediments that may have been deposited in a glacial lake occupy some of the areas of lower elevation north and east of Choteau. Evidence of reworking of Quaternary alluvium along the Teton River west of Choteau by the 1964 flood is prominent along the Teton River west of Choteau.

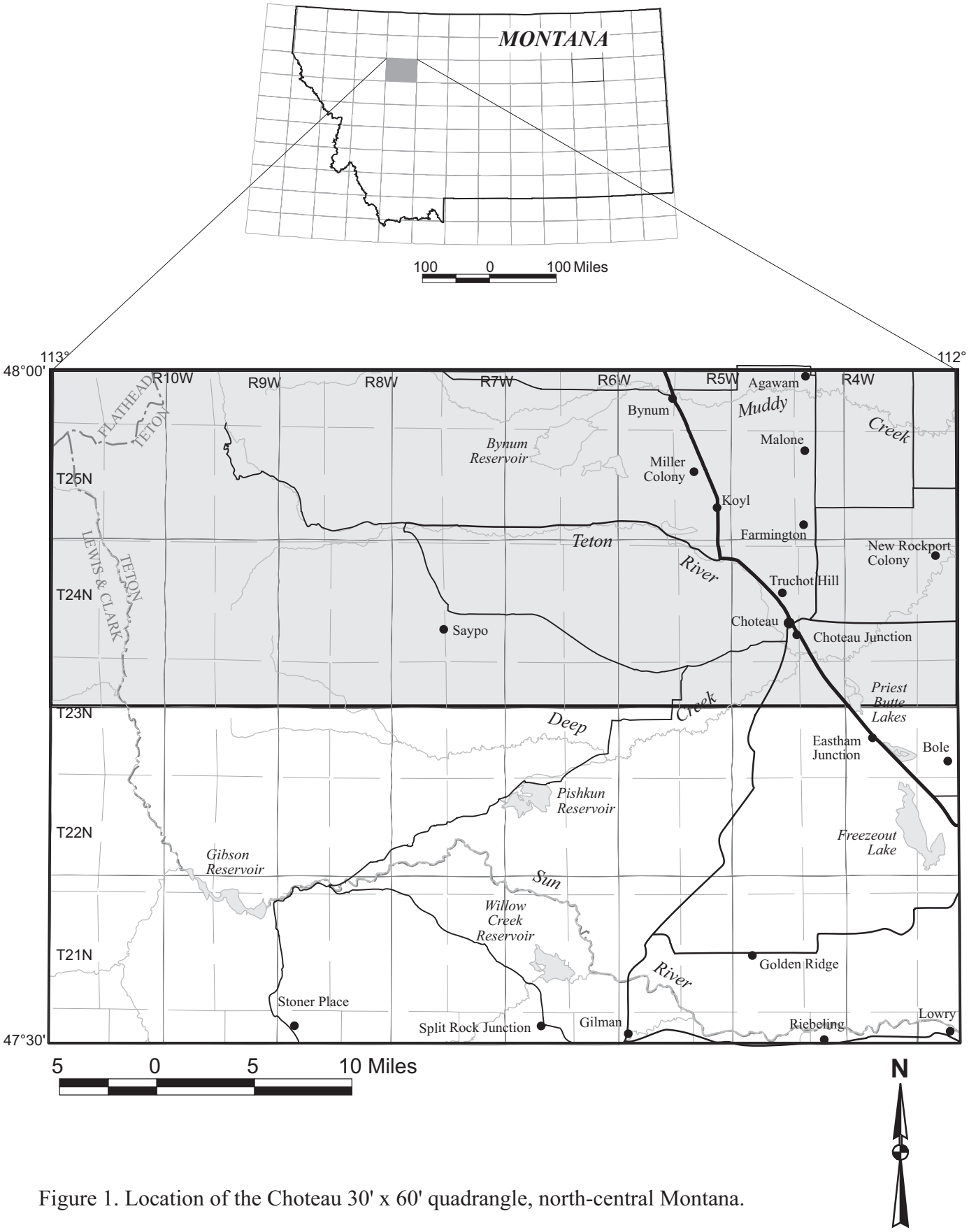
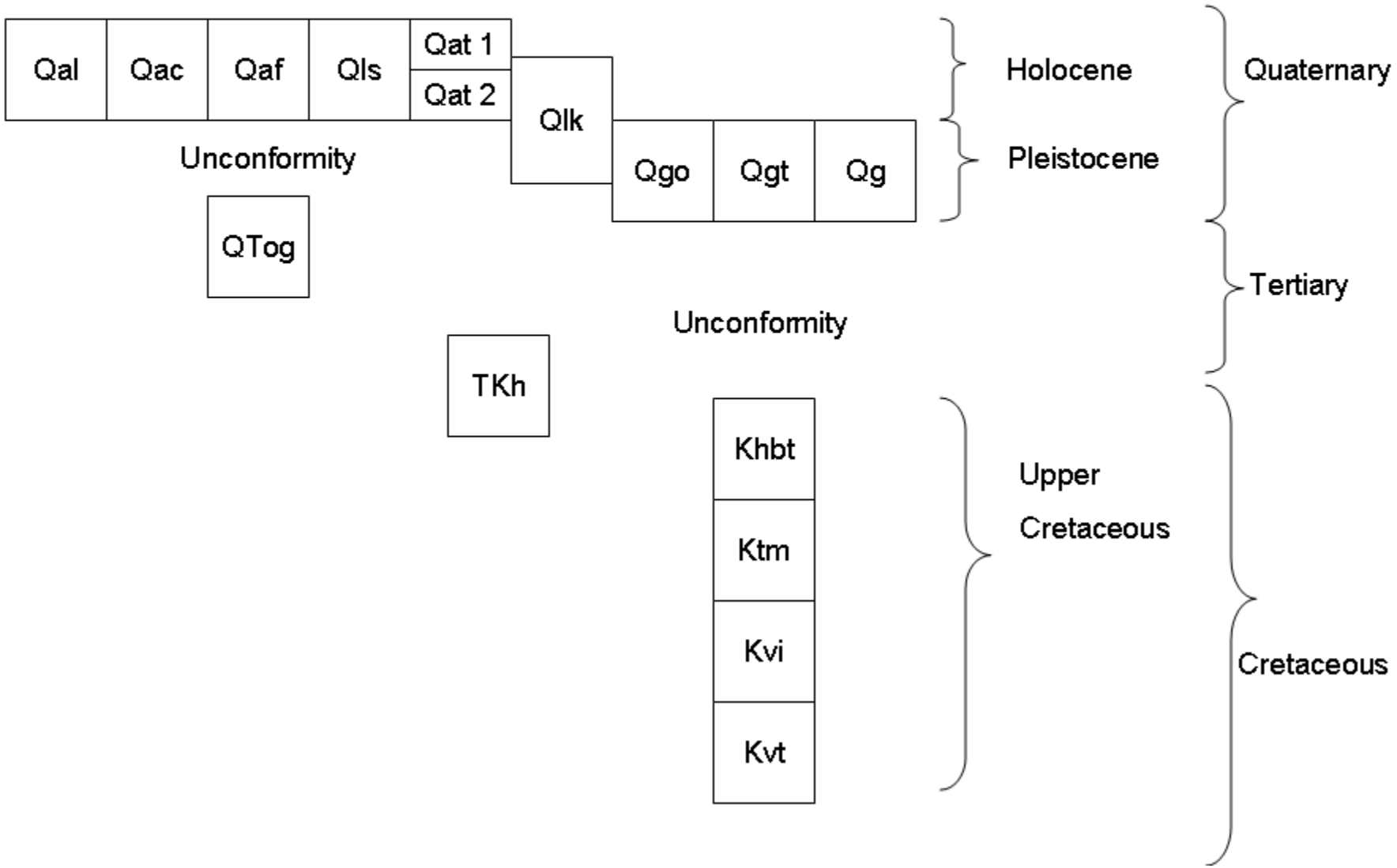


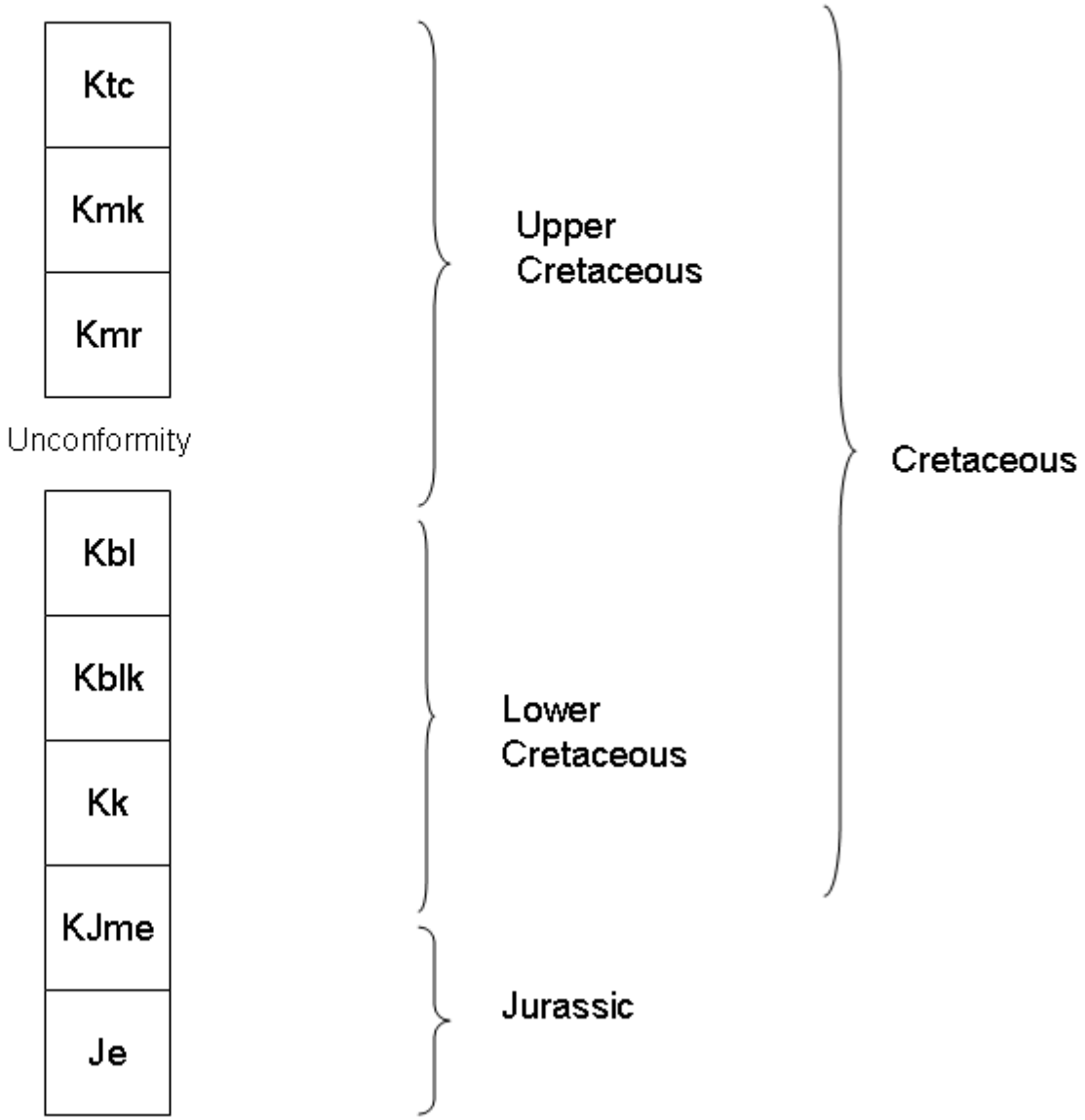
Figure 1. Location of the Choteau 30' x 60' quadrangle, north-central Montana.

Correlation of Map Units

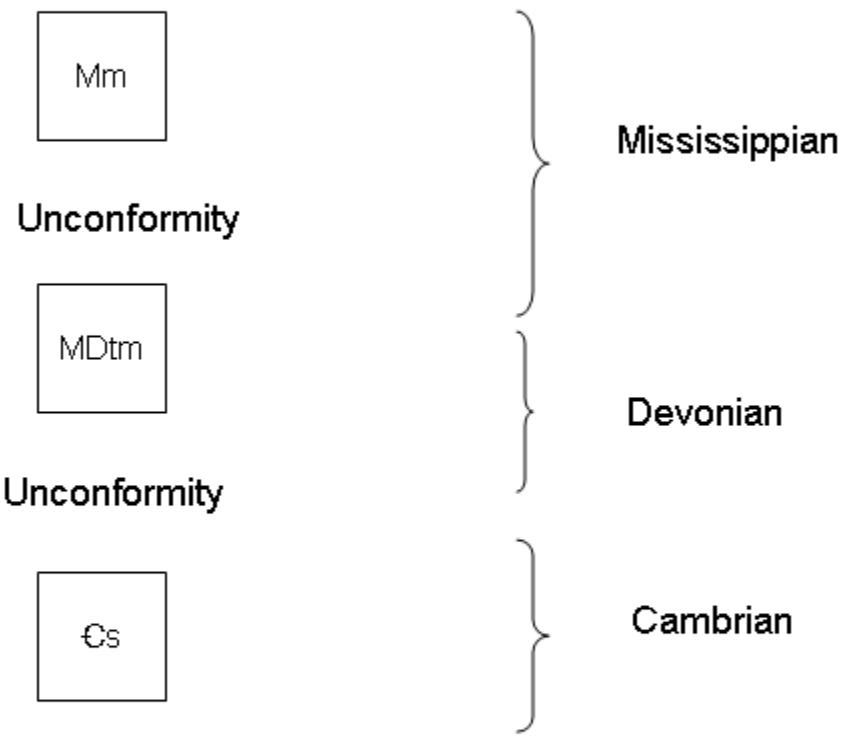
North Half of Choteau 30´ x 60´ Quadrangle



Correlation of Map Units - Continued



Correlation of Map Units – Continued



DESCRIPTIONS OF MAP UNITS
NORTH HALF OF CHOTEAU 30' x 60' QUADRANGLE

Note: Thicknesses are given in feet because the maps used in the field were 7.5' quadrangle maps with contour intervals in feet. To convert feet to meters (the contour interval on this map is in meters) multiply feet by 0.3048.

Qal – Alluvium of modern channels and flood plains – Fluvial deposits of locally derived silt, sand, pebbles, and cobbles.

Qac – Alluvium and colluvium, undivided – Shown for the Pine Butte Swamp area south of the Teton River where alluvium cannot be distinguished from colluvium.

Qaf – Alluvial fan deposit – Developed on the Kevin Member of the Marias River Formation below exposures of the Virgelle and Telegraph Creek formations.

Qls – Landslide deposit – Developed on clayey beds in the Two Medicine Formation and also the Kevin Member of the Marias River Formation. The present landslide in the Kevin Member of the Marias River Formation along the Teton River south of the New Rockport Colony slid on January 2, 1967.

Qat 1 – Alluvium of youngest alluvial terrace – Terraces developed north of the Teton River can best be seen along U.S. Highway 89, 3.5 miles northwest of Choteau where the highway climbs above the present Teton River flood plain. The youngest terrace lies approximately 10 ft above the present Teton River flood plain.

Qat 2 – Alluvium of second youngest alluvial terrace - This terrace lies approximately 10-15 ft above Qat 1.

Qlk – Lake deposit – These sediments consist of brown to black silt and clay beds. Chalmers (1968) provides a detailed stratigraphic section of these lake deposits and discusses the probablility that they were deposited in a glacial lake.

Qgo – Glacial outwash deposit – Glacial outwash deposits form extensive gravel plains at elevations lower than QTog. The gravel that consists almost exclusively of limestone clasts derived from exposures in the Rocky Mountain Front. The largest of these deposits is Burton Bench that was deposited when meltwater flowed through Ralston Gap south of Bynum. Farther north the meltwater flowed along the valley now occupied by Muddy Creek and formed the outwash deposit at the northern boundary of this map.

Qg – Glacial deposit, undivided – Glacial drift as mapped in the mountainous western part of this area.

Qgt – Glacial till – Includes both glacial till near the Rocky Mountain Front along the Teton River that was deposited by mountain glaciers and that in the northeastern part of the map area deposited by the Continental ice sheet. The extent of the till deposited by the Continental ice sheet is recognized not only by its hummocky topography, but also by the occurrence of pebbles, cobbles, and boulders of granitic igneous rocks and metamorphic rocks. Where glacial till overlies the Kevin Shale along the Teton River south of the New Rockport Colony, the upper few feet of the Kevin Shale are deformed and mixed with glacial erratics.

QTog – Older gravels – Remnants of older gravel are found on terraces in the area west of Bynum Reservoir and around Choteau and to the southeast. These deposits are not nearly as extensive as similar deposits in the area between Augusta and that covered by this map. The dominant lithology of clasts in these gravels deposits is gray limestone, presumably eroded from the exposures of limestone of the Madison Group in the Rocky Mountain Front. An estimated 5 percent or less of the clasts are immature sandstone, perhaps derived from Cretaceous formations exposed to the west. Rare pink to white quartzite clasts occur in some of the gravels. It is inferred that these were derived from quartzite in the Belt Supergoup that is exposed in the Sun River Valley west of the Rocky Mountain Front. QTog along the Sun River west of Augusta, and forming extensive deposits between Augusta and Choteau, consists mainly of similar quartzite. Because quartzite of the Belt Supergroup is not now exposed along the Rocky Mountain Front, it is most likely that these quartzite cobbles and pebbles were carried by an ancestral Sun River drainage. However, in the Choteau area, limestone derived from exposures along the Rocky Mountain Front as well as quartzite clasts occurs in this same gravel.

TKh – Hypabyssal intrusive or flows – Trachyandesite (Paleocene or upper Cretaceous) – Sills, dark grayish-brown, aphanatic groundmass of feldspar with phenocrysts of plagioclase, potassium feldspar, pyroxene, and quartz (Mudge, 1972).

Khbt – Horsethief Formation and Bearpaw–Horsethief transition unit – The Horsethief Formation is mostly gray to gray-brown , fine-to medium-grained, crossbedded sandstone. The upper 20-40 ft commonly contains lentils of titaniferous magnetite. The Bearpaw–Horsethief transition unit of Cobban (1955) beneath the Horesthief consists of dark gray to gray mudstone interbedded with light-to medium-gray mudstone and fine-to medium-grained sandstone (Mudge and others,1982).

Ktm – Two Medicine Formation – Generally poorly exposed with some areas of badlands topography. Gray-green and gray mudstone with minor sandstone in upper and middle parts with gray-green, olive drab, and gray sandstone and mudstone in lower part. Upper and middle parts locally contain reddish-gray, red- brown, and purple interbeds of mudstone. Thickness is about 2,200 ft (Mudge and others,1982). Also contains rare lenticular massive sandstone beds up to 3 ft thick and some bentonite beds 1-3 ft thick.

Kvi – Virgelle Formation – The Virgelle Formation forms mesas and buttes surrounded by spectacular sandstone cliffs where the erosion-resistant titaniferous magnetite bed at the top of this formation protects underlying more easily eroded sandstone. The Virgelle Formation is easily recognizable from a distance by the brown-weathering titaniferous magnetite beds above sandstone that appear white from a distance. Brown-weathering sandstone concretions are prominent just below the uppermost titaniferous magnetite beds. The sandstone is calcite cemented with prominent cross beds and some ripple marks. Color of the sandstone on a weathered surface ranges from dark yellowish brown (10YR 4/2) to yellowish gray (5Y 7/2). Thickness is estimated to range between 95 and 115 ft.

Kvt – Virgelle and Telegraph Creek Formations, undivided

Ktc – Telegraph Creek Formation – The Telegraph Creek Formation forms lightly vegetated, relatively gentle slopes below the cliffs of the Virgelle Formation and above the grass-covered gentle topography of the Kevin Member of the Marias River Formation. This formation consists of interbedded sandstone and mudstone with the sandstone beds becoming more massive and abundant in the upper part. Black chert, feldspar, and quartz are the major detrital constitiuents of this calcite-cemented sandstone where individual calcite grains surrounding many detrital grains range up to 2 mm across and are recognized by the reflection of sunlight from a cleavage plane. Crossbedding and oscillation ripple marks occur in sandstone that is locally, irregularly interlayered with siltstone that weathers to form an irregular hummocky surface. Color of the sandstone on a weathered surface is olive gray (5Y 4/1) and thickness of this formation in the Choteau area is approximately 130 ft.

Kmr – Marias River Formation – Mainly dark-gray marine mudstone that ranges from 1200-300 ft thick (Mudge and Earhart, 1983).

Kmk – Kevin Member of the Marias River Formation - The Kevin Member is the uppermost member of the Marias River Formation and is poorly exposed in the Choteau area. Thickness ranges from approximately 600 to 700 ft and this member consists mainly of dark-gray shale beds with lesser gray-weathering concretionary limestone, very fine-grained sandstone, reddish-weathering ironstone concretions and numerous thin bentonite beds in the lower part.

Thickness ranges from 600 to 700 ft (Vuke and others, 2002). Color of weathered exposures of the Kevin Member is dark, yellowish brown (10YR 4/2)

Kbl – Blackleaf Formation – Consists of gray marine mudstone and interbedded sandstone with thickness that ranges from 660-850 ft (Mudge and Earhart, 1983).

Kblk – Blackleaf and Kootenai Formations , undivided

Kk – Kootenai Formation – Nonmarine, gray-green and maroon mudstone with numerous lenticular, poorly-sorted, greenish-gray sandstone beds, locally crossbedded with lenticular basal conglomerates. Thickness from 650 to more than 1000 ft) (Mudge, 1972 and Mudge and Earhart, 1983).

KJme – Mount Pablo Formation, Morrison Formation and Ellis Group, undivided The Mount Pablo Formation (formerly referred to as the western facies of the Morrison Formation) consists of limestone, mudstone, sandstone, and conglomerate with a maximum thickness of 300 ft. The Morrison Formation is mainly grayish-green, tuffaceous siltsone with interbedded sandstone and limestone with a maximum thickness of 100 ft (Mudge, 1972 and Mudge and Earhart, 1983).

Je – Ellis Group, undivided – Composed of three formations in descending order: Swift, Rierdon, and Sawtooth. The Swift Formation consists of sandstone and shale and ranges up to more than 60 m (200 ft) thick in the northern part of the Choteau quadrangle. The upper part of the Rierdon Formation consists of calcareous gray-brown siltstone and claystones; the lower part dark gray laminated shale and claystone. Thickness is as much as to180 ft in the north. The Sawtooth Formation consists of two members in the northern part of the area with a total thickness of 236 ft. The upper member is siltstone and the lower member consists of dark-gray shale with some siltstone, sandstone, and a few limestone beds (Mudge, 1972, and Mudge and Earhart, 1983).

Mm – Madison Group, undivided – Consists mainly of limestone and dolomite ranging through calcitic dolomite and dolomitic limestone with chert and minor calcareous shale, thickness 900-1800 ft (Mudge, 1972).

MDtm – Three Forks Formation, Jefferson Dolomite, and Maywood Formation – The Three Forks Formation is generally an evaporate-solution breccia that consists of angular fragments (mostly less than 1 m across) of pale, yellowish-brown dolomite and dolomitic limestone and ranges in thickness from 50-200 ft; the Jefferson Formation consists mainly of limestone and dolomite and ranges from 620-800 ft thick; the Maywood Formation consists of thinly bedded somewhat fossiliferous limestone and dolomitic limestone with greenish-gray mudstone with thickness from 50-280 ft; Mudge, 1972).

^s – Upper and Middle Cambrian sedimentary rocks undivided – Includes in descending order: Devils Glen Dolomite, Switchback Shale, and Steamboat Limestone. The Devils Glen Dolomite is thick bedded, light gray dolomite, 105-115 ft thick; the Switchback Shale is mostly noncalcareous, greenish-gray, thinly laminated, clayey shale with thin interbeds of dolomite, limestone, sandstone, and conglomerate, 75-15 ft thick; and the Steamboat Limestone consists of alternating sequences of limestone and dolomite, and calcareous shales 217-266 ft thick (Mudge, 1972).

m – modified land

MAP SYMBOLS

Contact – Approximately located. Dotted where concealed beneath glacial deposits or alluvium.

Normal Fault – Bar and ball on downthrown side.

Thrust Fault – Sawteeth on upper plate. Dotted where concealed.

Anticline – Trace of axial plane. Dotted where trace is concealed.

Syncline – Trace of axial plane. Dotted where trace is concealed.

Strike and dip of inclined beds

Horizontal beds

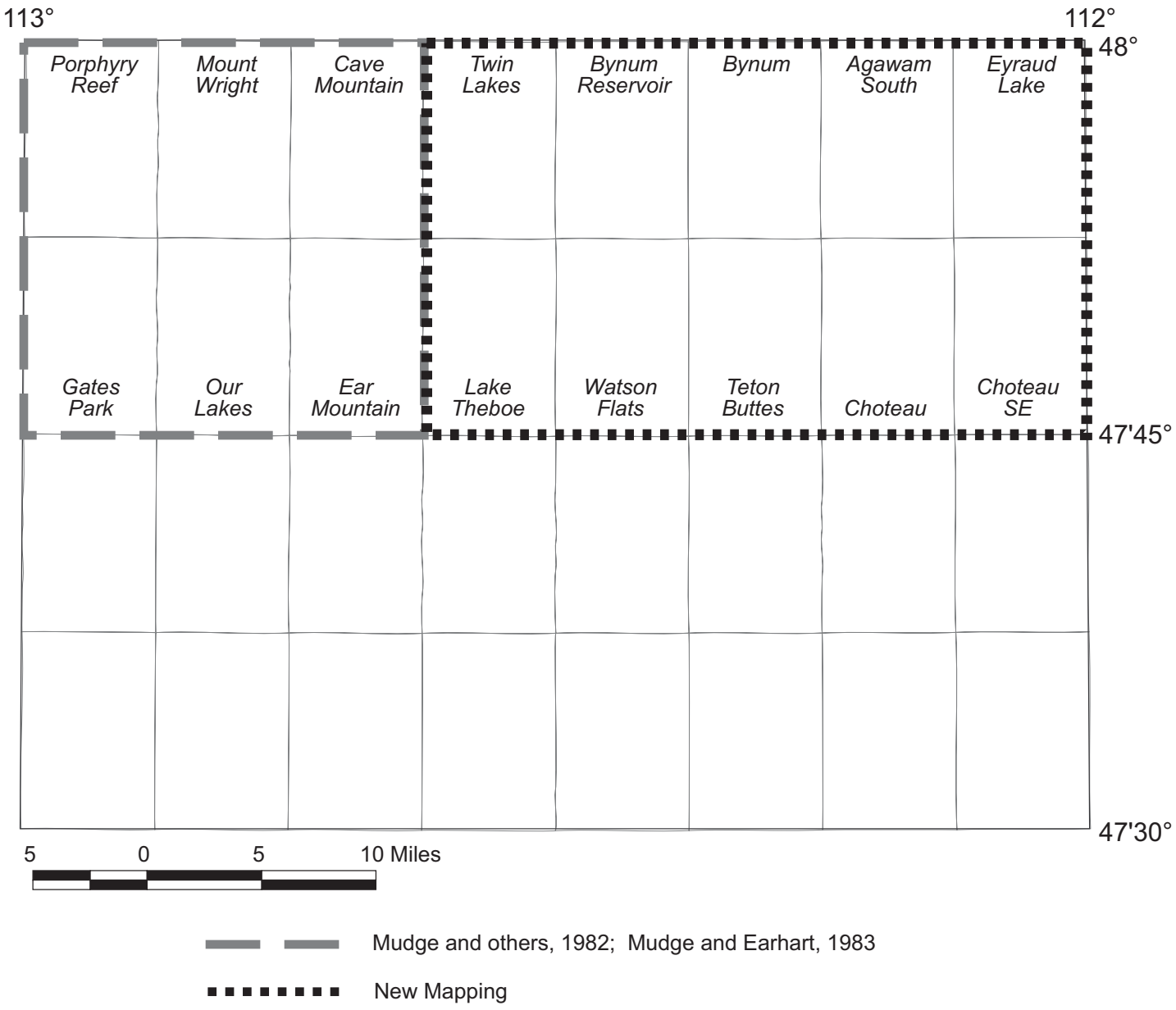


Figure 2. Published geologic maps used in compilation of the north half of the Choteau 1:100,000 scale quadrangle.

SELECTED REFERENCES

Geologic Map Used in Compilation

Mudge, M.R., Earhart, R.L., Whipple, J.W., and Harrison, J.E., 1982, Geologic and structure map of the Choteau 1^{o} x 2^{o} quadrangle, western Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I-1300, scale 1:250,000.

Mudge, M.R., and Earhart, R.L., 1983, Bedrock geologic map of part of the Northern Disturbed Belt, Lewis and Clark, Teton, Pondera, Glacier, Flathead, Cascade, and Powell counties, Montana: U.S. Geological Survey Miscellaneous Investigations Series Map I-1375, map scale 1:125,000.

Other Sources of Information.

Chalmers, A.L., 1968, Quaternary glacial geology and geomorphology of the Teton drainage area, Teton County, Montana: Bozeman, Montana State University, M.S. thesis, 83 p.,map scale 1:62,500.

Cobban, W.A., 1955, Cretaceous rocks of northwestern Montana, *in* Billings Geological Society Guidebook, 6^{th} Annual Field Conference, 1955, p. 107–119.

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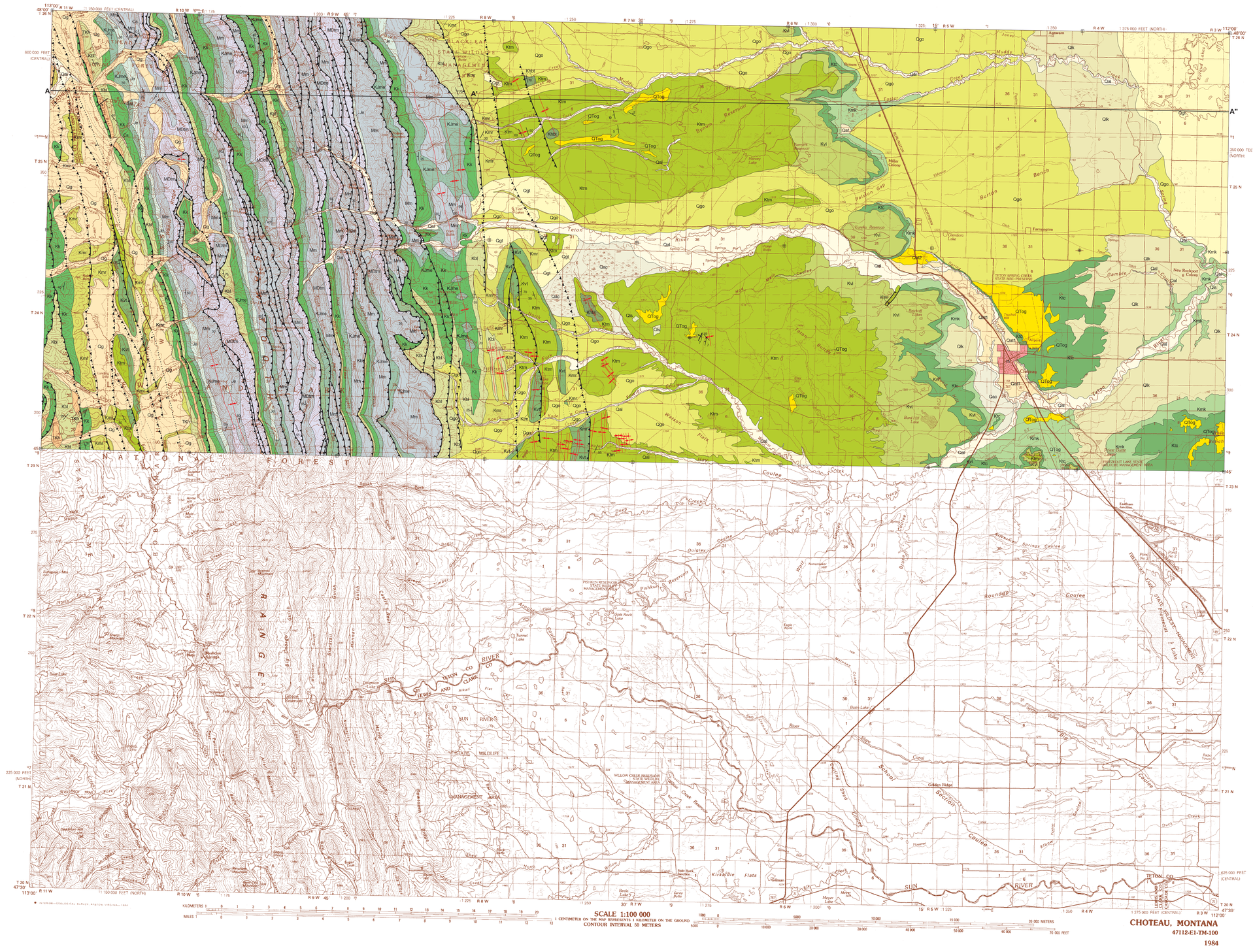
Lorenz, J.C., 1981, Sedimentary and tectonic history of the Two Medicine Formation, Late Cretaceous (Campanian), northwestern Montana: Princeton, N.J., Princeton University, Ph.D. dissertation, 225 p.

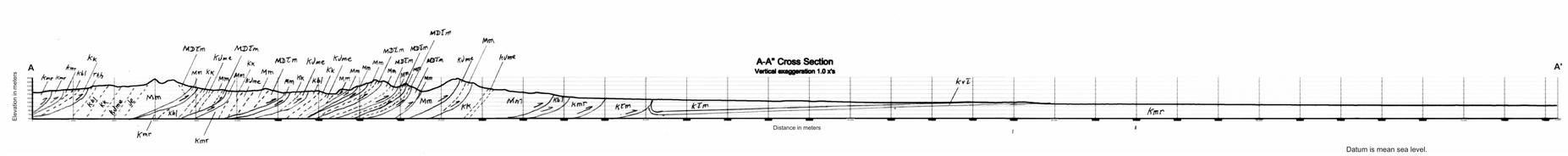
Mudge, M.R., 1972, Pre-Quaternary rocks in the Sun River Canyon area, northwestern Montana: U.S. Geological Survey Professional Paper 663-A, 142 p.

Patton, T.W., 1991, Geology and hydrology of the Burton Bench and Teton Valley aquifers: Montana Bureau of Mines and Geology Open-file Report MBMG 238, 155 p., map scale 1:100,000.

Vonhoff, J.A., 1969, Tertiary gravels and sands in the Canadian Great Plains: Saskatoon, University of Saskatchewan, Ph.D. dissertation, 278 p., map scale 1:250,000 all in Canada.

Vuke, S.M., Colton, R.B., and Fullerton, D.S., 2002, Geologic map of the Great Falls North 30’ x 60’ quadrangle, central Montana: Montana Bureau of Mines and Geology Open-file Report MBMG 459, 14 p. text and map scale 1:100,000.





Datum is mean sea level.

Note: For clarity surficial deposits are not shown. Dashed formational contacts in cross section indicate the uncertainty of contacts in this area of intense deformation in the Montana Disturbed Belt.

MAP UNITS

- Qal — Alluvium of modern channels and flood plains
- Qac — Alluvium and colluvium, undivided
- Qaf — Alluvial fan deposit
- Qls — Landslide deposit
- Qat1 — Alluvium of youngest alluvial terrace
- Qat2 — Alluvium of second youngest alluvial terrace
- Qlk — Lake deposit
- Qgo — Glacial outwash deposit
- Qg — Glacial deposit, undivided
- Qgt — Glacial till
- QTog — Older gravels
- TKh — Hypabyssal intrusive or flows
- Khbt — Horsethief Formation and Bearpaw-Horsethief transition unit
- Ktm — Two Medicine Formation
- Kvl — Virgelle Formation
- Kvt — Virgelle and Telegraph Creek Formations, undivided
- Klc — Telegraph Creek Formation
- Kmr — Marias River Formation
- Kmk — Kevin Member of Marias River Formation
- Kbl — Blackleaf Formation
- Kblk — Blackleaf and Kootenai Formations, undivided
- Kk — Kootenai Formation
- KJme — Mount Pablo Formation, Morrison Formation, and Ellis Group, undivided
- Je — Ellis Group, undivided
- Mm — Madison Group, undivided
- MDtm — Three Forks Formation, Jefferson Dolomite and Maywood Formation
- Cs — Sedimentary rocks, undivided
- m — Modified

For a more detailed description of the map units and symbols, please refer to the text accompanying this map.

Porphyry Peak	Mount Wright	Cave Mtn	Twin Lakes	Bynum Reservoir	Bynum	Agawam South	Eynaud Lakes
Gates Park	Our Lakes	Ear Mtn	Lake Thibode	Watson Flats	Teton Buttes	Choteau	Choteau SE

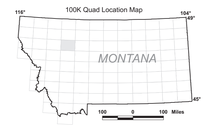
Base from U.S. Geological Survey
Choteau 30' x 60' topographic quadrangle
Map date: 1984
Projection: UTM zone 12; 1927 NAD

UTM grid declination 1°07" West
1980 Magnetic North Declination 17.5° East

100K Quad index

HUNGRY HORSE RESERVOIR	VALIER	CONRAD
SWAN PEAK	CHOTEAU	GREAT FALLS NORTH
SEELEY LAKE	DEARBORN RIVER	GREAT FALLS SOUTH

100K Quad Location Map



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Geologic Map of Part of the Choteau 30' x 60' Quadrangle, North Central Montana

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GIS production: Ken Sandau and Paul Thale, MBMG. Map layout: Susan Smith, MBMG.

Maps may be obtained from
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