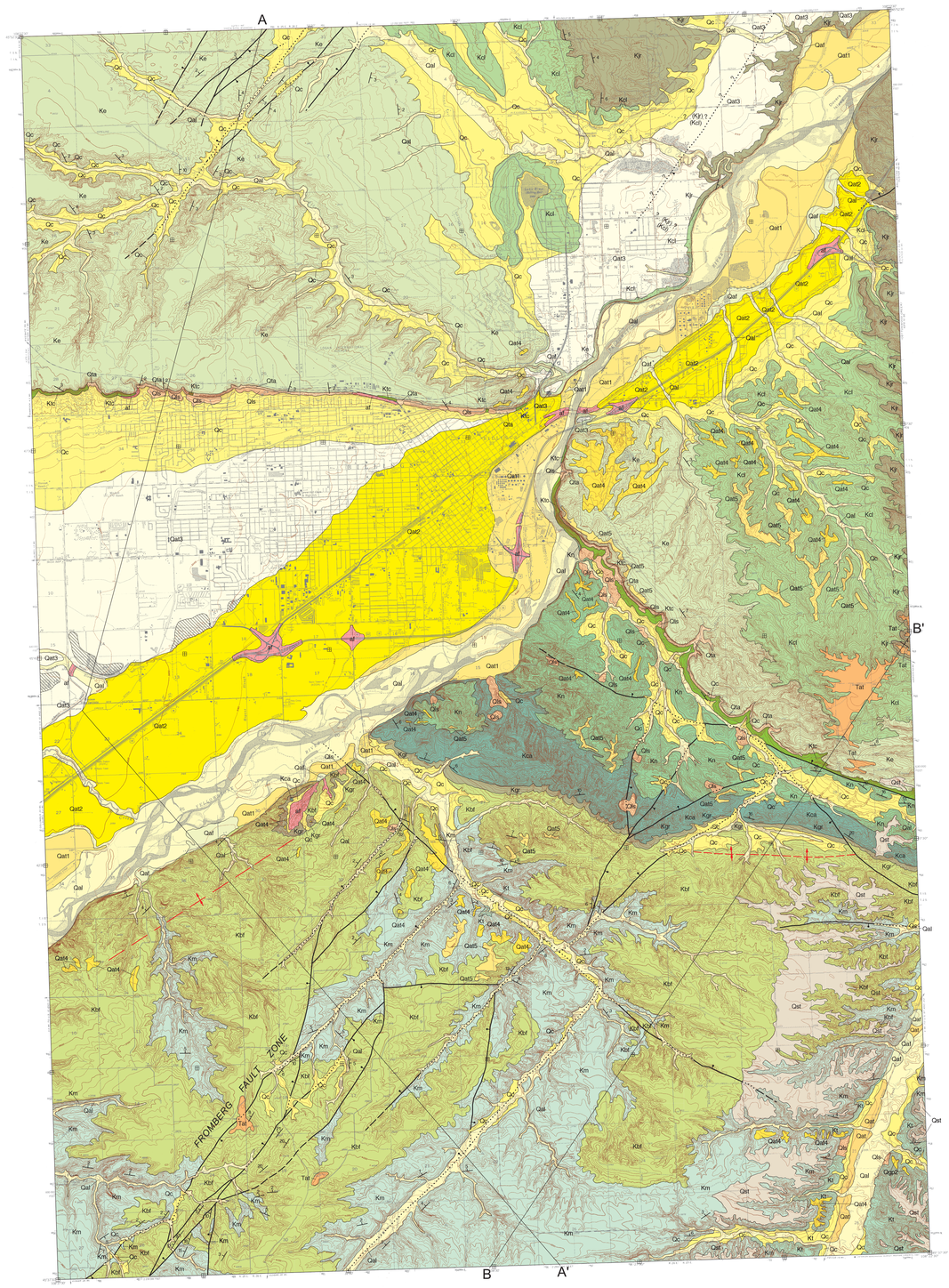
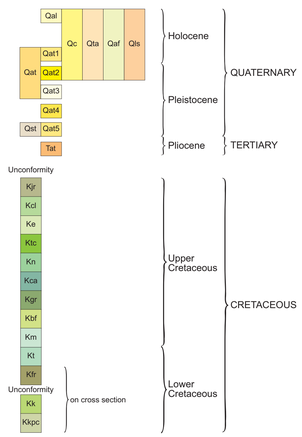
MONTANA BUREAU OF MINES AND GEOLOGY
A Department of Montana Tech of The University of Montana

GEOLOGIC MAP SERIES NO. 61-A
Billings 1:48,000, Lopez, 2002



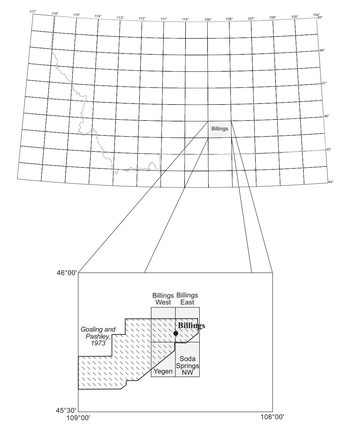
Correlation of Map Units



Legend

- Contact—Dashed where approximately located. Dotted where concealed. Queried where uncertain
- Fault—Dashed where approximately located, dotted where concealed. Queried where uncertain. Bar and ball on downthrown side
- Monocline—Dashed where approximately located, dotted where concealed. Queried where uncertain. Arrows indicate direction of dip of limbs
- Strike and dip of bed
- Strip-mined area—Terrace gravels mined to bedrock. Niobrara Shale locally exposed or under thin veneer of debris. Locations of bedrock exposures constantly change due to active commercial development
- af — Artificial fill—Compacted and uncompacted fill along roads and highways; locally covers bedrock contacts. At Billings Landfill (sections 29 and 30, T. 1 S., R. 26 E.), artificial fill constantly increasing at expense of shale bedrock and colluvium, which are strip mined and used for fill over refuse

Index map, Billings area, Yellowstone County, Montana



SCALE 1:48 000

1 0 1 2 miles

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qal Alluvium (Holocene)—Gravel, sand, silt, and clay along active channels of rivers, creeks, and tributaries. Coarse, well-rounded gravel restricted mainly to Pryor Creek and Yellowstone River drainages. Most sediment in tributary drainages is sand, silt, and clay derived from local Cretaceous sandstone and shale bedrock

Qta Talus (Holocene and Pleistocene)—Angular blocks of sandstone accumulating below cliffs of Eagle Sandstone. Blocks commonly 10 to 20 feet across

Qc Colluvium (Holocene and Pleistocene)—Locally derived slope-wash deposits mainly of sand, silt, and clay. Usually thin veneer concealing bedrock, but locally as thick as 30 feet. Along Eagle Sandstone rim rocks grades upslope into coarse talus. Commonly grades into Qal. Locally contains well-rounded cobbles derived from alluvial terrace gravel

Qaf Alluvial fan deposits (Holocene and Pleistocene)—Deposits along valley margins at base of steep tributary drainages. Display characteristic fan-shaped map pattern. Typically grade upstream into Qal. Thickness ranges from very thin at toe to as much as 50 feet near heads of fans

Qls Landslide deposits (Holocene and Pleistocene)—Unstable mixture of soil and blocks of bedrock transported down steep slopes. Characteristic hummocky surface form with concentric swales and ridges near down-slope limits. Common along steep slopes beneath the Eagle Sandstone and along steep slopes underlain by Cretaceous shales

Qat1 Alluvial terrace gravel 1 (Holocene and Pleistocene)—Gravel underlying terraces about 10 to 20 feet above present elevation of Yellowstone River. Mostly cobbles and pebbles with minor amounts of sand and silt. Clasts predominantly granitic igneous rocks, granitic gneiss, schist, and quartzite, with much less limestone and sandstones. Twenty to 40 feet thick (Gosling and Pashley, 1973)

Qat2 Alluvial terrace gravel 2 (Pleistocene)—Gravel underlying terraces about 20 to 40 feet above present elevation of Yellowstone River. Mostly cobbles and pebbles with minor amounts of sand and silt. Clasts predominantly granitic igneous rocks, granitic gneiss, schist, and quartzite, with much less limestone and sandstones. Forty to 60 feet thick(Gosling and Pashley, 1973)

Qat3 Alluvial terrace gravel 3 (Pleistocene)—Gravel underlying terraces about 50 to 90 feet above present elevation of Yellowstone River. Mostly cobbles and pebbles with minor amounts of sand and silt. Clasts predominantly granitic igneous rocks, granitic gneiss, schist, and quartzite, with much less limestone and sandstones. This deposit grades from about 20 to 30 feet of clean gravel at its southern edge to about five feet at its northern limit (Gosling and Pashley, 1973), where overlain by colluvial and alluvial fan deposits of silty clay

Qat4 Alluvial terrace gravel 4 (Pleistocene)—Gravel underlying terraces about 200 to 300 feet above present elevation of Yellowstone River and Pryor Creek. These terraces exhibit a relatively steep gradient toward the Yellowstone River Valley or Pryor Creek. Cobble- and pebble-size clasts are mainly granite, granitic gneiss, schist, quartzite, and volcanic rocks. Thickness up to about 20 feet

Qat5 Alluvial terrace gravel 5 (Pleistocene)—Gravel underlying terraces about 400 to 500 feet above present elevation of Yellowstone River. Occur mainly as small discontinuous erosional remnants. Cobble- and pebble-size clasts are mainly granite, granitic gneiss, schist, and quartzite. Calcite cement locally present, especially at base. Thickness ranges from a very thin remnant to about 20 feet

Qat Alluvial terrace gravel undivided (Holocene and Pleistocene ?)—Gravel underlying terraces about 20 to 75 feet above present elevation of Pryor Creek (mapped only in the valley of Pryor Creek). Probably equivalent to Qat1, Qat2, and Qat3, but difficult to divide because of narrowness of Pryor Creek valley and erosional removal. Gravel, sand, silt, and clay derived from bedrock in the drainage basin and reworked from higher level terrace gravels. Clasts mainly andesite, limestone, and lesser amounts sandstone and quartzite

Qst Ancestral Shoshone River gravel, terrace level 1 (Pleistocene)—Gravel and sand underlying terraces about 400 feet above present altitude of Pryor Creek. Transported by ancestral Shoshone River that flowed through Pryor Gap (in Pryor Mountains to the south)(Mackin, 1937). Commonly calcite cemented near base. Clasts are mainly cobbles and pebbles of dark-colored andesitic rocks (Absaroka volcanics), and lesser amounts limestone and quartzite. Age estimated to be about 1.4 m.y. (Reheis, 1985). Ten to 50 feet thick in map area

Tat Alluvial terrace gravel 1 (Pliocene?)—Gravel underlying terrace about 900 feet above present elevation of Yellowstone River. Composed mainly of well-rounded cobbles of granitic gneiss, schist, and quartzite and minor amounts of volcanic rocks. Locally contains high but variable percentage of rounded to subrounded cobbles and smaller clasts of quartzite and siliceous siltstone and mudstone apparently derived from the Mowry Shale. About 30 to 40 feet thick. Scattered cobbles at these high elevations are common, indicating this terrace was once much more widespread. Assumed to be Pliocene because a terrace gravel of similar elevation in Pryor Creek drainage contains radiometrically dated Pliocene ash bed. That ash bed in terrace gravel about 5 miles west of the map area is dated at 2.02 m.y. (Huckleberry Ridge Ash) (Izett and Wilcox, 1982)

CRETACEOUS BEDROCK MAP UNITS

MONTANA GROUP

Kjr Judith River Formation (Upper Cretaceous)—Interbedded brownish-gray (5YR4/1)* sandy shale and light-brown (5YR6/4) to pale-yellowish-brown (10YR7/2), argillaceous, very-fine to fine-grained sandstone in beds up to 10 feet thick. Sandstones friable to moderately well indurated, cross-bedded, and burrowed to bioturbated. Exposures limited to lower beds and only eastern edge of map area

Kcl Claggett Shale (Upper Cretaceous)—Brownish-gray (5YR4/1) fissile shale with minor interbeds of light brownish gray (5YR6/1) very argillaceous sandstone. Light-brownish-gray (5YR6/1) to light-brown (5YR5/6), calcareous concretions common, often fossiliferous. The upper contact placed at the change to ledge-forming sandstones of the Judith River Formation. Thickness of the formation is 250 to 450 feet

Ke Eagle Sandstone (Upper Cretaceous)—Light-brownish-gray (5YR6/1) to very-pale-orange (10YR8/2), very-fine to fine-grained, cross-bedded sandstone, burrowed to bioturbated in part. Locally contains calcareous, light-brown (5YR6/4) sandstone concretions up to 15 feet in diameter. Three to four sandstone intervals 10 to 50 feet thick can be present with intervening sandy shale intervals as thick as 50 feet. In area southeast of Pictograph Caves State Park, a well-developed upper sandstone pinches out to north; inter-tonguing relationship of this sandstone with Claggett Shale shown in section 8, T. 1 S., R. 27 E. Farther north this upper sandstone continues as sandy shale zone in Claggett. Upper contact placed at change from sandstone to shales of Claggett Shale. Thickness from 250 to 350 feet

Klc Telegraph Creek Formation (Upper Cretaceous)—Shale and sandy shale, brownish-gray (5YR4/1) to medium-dark-gray (N4) with thin, interbedded sandstone. Dusky-red (5R2/6) concretions common near base. Sandstone beds thicker and more abundant upward, grading into Eagle Sandstone. Contact with Eagle placed beneath first cliff-forming sandstone. Maximum thickness about 150 feet

COLORADO GROUP

Kn Niobrara Shale (Upper Cretaceous)—Shale, olive-gray (5Y4/1) and dark-brownish-gray (5YR3/1) fissile. Abundant thin bentonite beds. Upper half calcareous, containing few very thin bentonite beds, and near top contains laminae and thin beds of calcareous sandstone and sandy limestone. Concretions medium-light-gray (N6) to pale-yellowish-brown (10YR6/2) and from few inches to one or two feet in diameter commonly present. *Inoceramus* prisms common. Upper contact placed at change from calcareous shales to non-calcareous shales of Telegraph Creek. Zone of dusky-red (5R2/6) concretions just above contact also help establish its position. In Billings area approximately 700 feet thick

Kca Carlile Shale (Upper Cretaceous)—Shale, dark-gray (N3) to dark-bluish-gray (5B3/1) fissile. Interval about mid-section contains laminae and thin beds of argillaceous, platy, light-brownish-gray (5YR6/1) to light-olive-gray (5Y6/1) sandstone that supports thick growth of pine trees, but otherwise nearly bare of soil and vegetation. Septarian nodules and concretions common, ranging from light-gray (N7) to dark-yellowish-orange (10YR6/6). Upper contact marked by zone of closely-spaced, gray septarian concretions with veins of brown calcite at base of Niobrara. 250 to 300 feet thick

Kgr Greenhorn Formation (Upper Cretaceous)—Shale, dark-bluish-gray (5B3/1) calcareous, fossiliferous. Typically poorly exposed, but forms very light-brownish-gray (5YR7/1) soil upon weathering. Locally, base is marked by zone of closely spaced, gray, calcareous, septarian concretions, above very-light-greenish-gray bentonite bed about two feet thick in underlying Belle Fourche Shale. Contact with Carlile marked by change to non-calcareous shale. About 75 feet thick

Kbf Belle Fourche Shale (Upper Cretaceous)—Shale, dark-gray (N3) fissile, containing several thick bentonite beds in lower part. Thin sandstone bed commonly containing small chert pebbles, and zone of very-dusky-purple (5P2/2) to glossy-grayish-black (N2), ironstone concretions near base. Light-gray (N7), brownish-gray (5YR4/1), and large (up to 4 feet in diameter) light-brown (5YR5/6) to dark-yellowish-orange (10YR6/6) concretions characteristic. "Frontier-like" sandstone present in upper part that is fine- to medium-grained, salt-and-pepper sandstone, and very thin to absent in eastern part of map area and about 1 to 2 feet thick in west. Contact with Greenhorn marked by abrupt change to very calcareous shale. Thickness is 350 to 400 feet

Km Mowry Shale (Upper Cretaceous)—Interbedded, siliceous, very-fine to fine-grained sandstone, siltstone, and shale. Sandstones and siltstones mostly light gray (N7) to medium gray (N5), with a "silvery" sheen. Some sandstone beds in Billings area highly silicified, resulting in very hard quartzite. Shales are fissile and mainly medium-dark-gray (N4). Bentonite beds common, 1 to 4 feet thick, including prominent beds at base and near top. Fish scales on bedding planes of sandstones and siltstones nearly ubiquitous and characteristic of the formation. Thin, coarse lag deposit containing fish bones, fish teeth, and chert pebbles near the middle of the section. Upper contact of Mowry marked by thick bentonite above last fish scale-bearing sandstone. Basal contact placed at change from dark-gray fissile Thermopolis Shale to characteristic "silvery" sandstone and siltstone of Mowry containing fish scales. Thickness about 250 feet

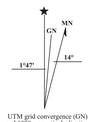
Kt Thermopolis Shale (Lower Cretaceous)—Upper 50 feet shale, dark-gray (N3) fissile, with few thin bentonite beds. Interval below this, about 200 feet dark-gray (N3) to brownish-gray (5YR4/4) and olive-gray, (5GY4/1) fissile shale with thick interbeds and laminae olive-gray and light-olive-gray(5Y6/1) argillaceous sandstone. Common bentonite beds and zones of iridescent very-dusky-purple (5P2/2) to grayish-black (N2) iron stone concretions. Only upper part of the Thermopolis is exposed in the map area. Thickness 550 to 600 feet

Kfr Fall River Sandstone (Lower Cretaceous)—Lower 10 feet medium-dark-gray (N4) fissile shale. Upper 10 to 20 feet thinly bedded, fine-grained, quartzose, light-brownish-gray (5YR6/1) to moderate-yellowish-brown (10YR5/4) sandstone with thin shale interbeds and partings. Sandstone coarsens and beds thicken slightly up section. Thickness about 30 feet. Only shown on cross sections, represented by labeled thick line

Kk Kootenai Formation (Lower Cretaceous)—Main body—Mostly reddish-brown (10R4/6), olive-gray (5Y4/2), and dusky-purple (5P3/2) mudstones with interbedded, lenticular, fine- to coarse-grained sandstones. Locally thick lenticular sandstone present at top. Total thickness 250 to 350 feet Only shown on cross sections

Kkpc Pryor Conglomerate Member (Lower Cretaceous)—Basal member of Kootenai Formation. Brown conglomerate and pebbly, coarse-grained sandstone. Important aquifer in the area south and southwest of Billings. From 20 to 40 feet thick. Only shown on cross sections represented by labeled thick line

*Colors and numerical color values are from Goddard and others, 1948.



UTM grid convergence (GN) and 1989 magnetic declination (MN) at center of map
Diagram is approximate

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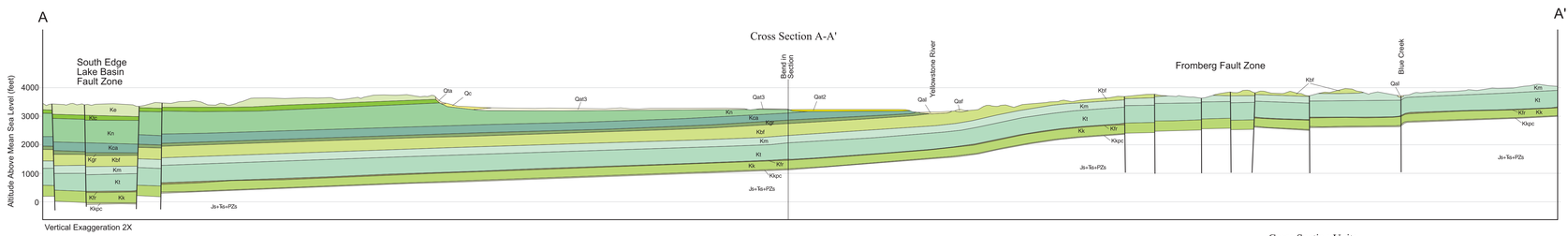
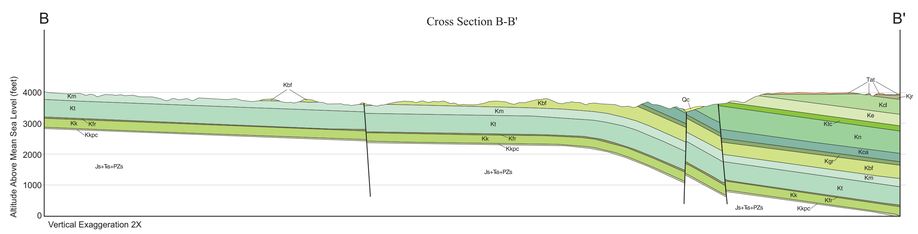
Cross Section A-A'



Cross Section B-B'



Cross Section Units

- Qal — Alluvium of modern channels and flood plains
- Qc — Colluvium
- Qta — Talus deposit
- Qaf — Alluvial fan deposit
- Tat — Alluvium of alluvial terrace deposit (B only)
- Qat2 — Alluvium of second youngest alluvial terrace level (A only)
- Qat3 — Alluvium of third youngest alluvial terrace level (A only)
- Kjr — Judith River Formation (B only)
- Kcl — Claggett Shale (B only)
- Ke — Eagle Formation
- Klc — Telegraph Creek Formation
- Kn — Niobrara Formation
- Kca — Carlile Formation
- Kgr — Greenhorn Formation
- Kbf — Belle Fouche Shale
- Km — Mowry Shale
- Kt — Themopolis Formation
- Kfr — Fall River Formation
- Kk — Kootenai Formation
- Kkpc — Pryor Conglomerate
- Js-Ts-PZs — Jurassic, Triassic, and Paleozoic Formations

Montana Bureau of Mines and Geology
Geologic Map Series No. 61-A

Geologic Map of the Billings Area, Yellowstone County, Montana

David A. Lopez

2002

Maps may be obtained from
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