Base map produced by the United States Geological Survey
Argenta 1:24,000 scale quadrangle map
Control by: USGS and NOS/NOAA
Compiled from aerial photographs taken 1950
Field checked: 1952
Projection: Polyconic
Grid:1000 meter Universal Transverse Mercator Zone 12
Horizontal Datum: 1927 North American Datum

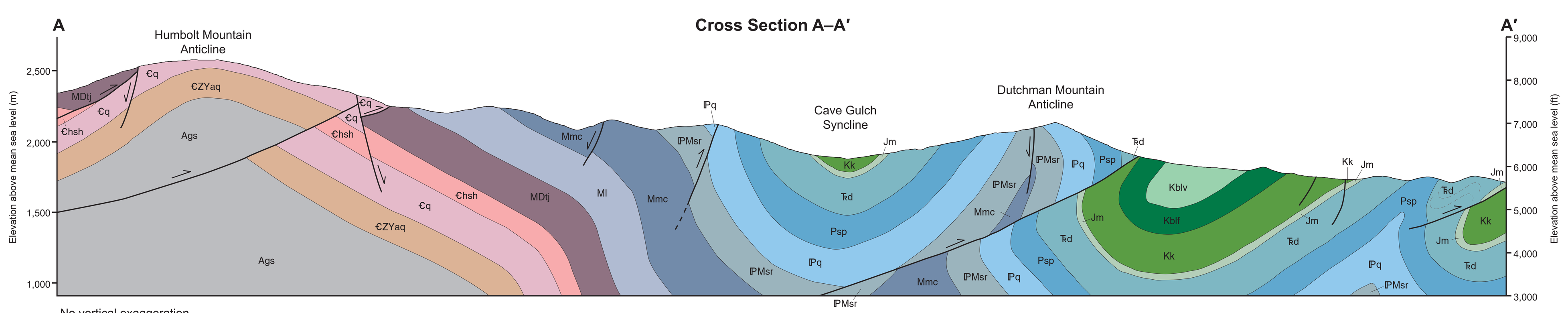
UTM GRID AND 2014 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24,000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Maps may be obtained from:
Publications Office
Montana Bureau of Mines and Geology
1300 West Park Street
Butte, Montana 59701-8997
Phone: (406) 496-4174 Fax: (406) 496-4451
http://www.mbmg.mtech.edu

Cross Section A–A′



No vertical exaggeration
Surficial units not shown
bedding
Ꞓhsh, Hasmark and Silver Hill Formation, undivided
Ags, Archean gneiss and schist (shown only on cross-section)

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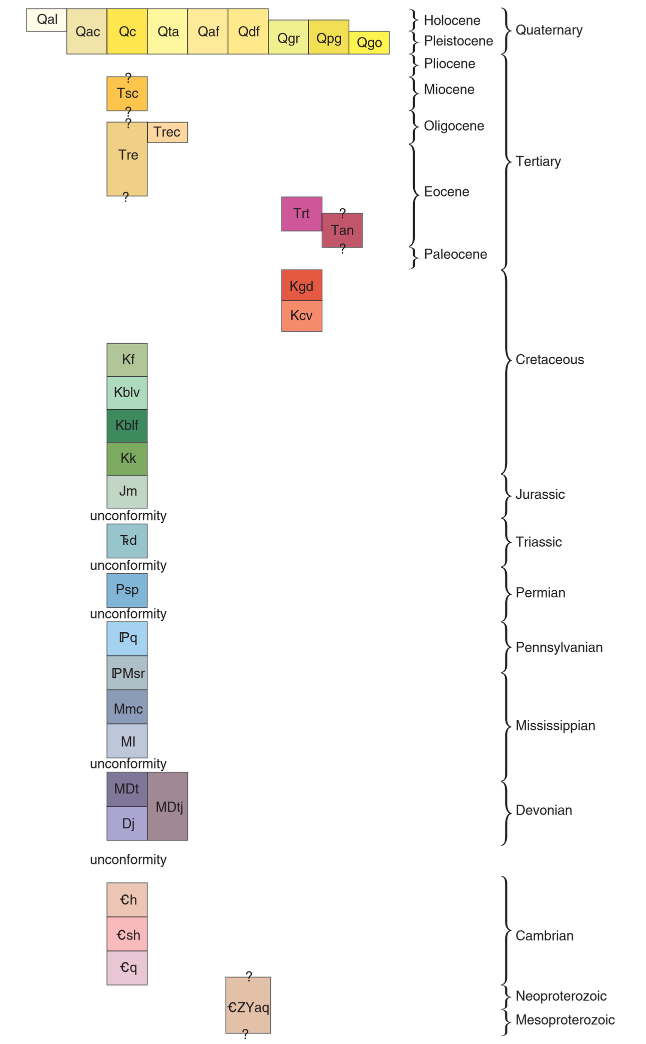
CORRELATION DIAGRAM



MAP SYMBOLS

- Contact: dashed where approximately located
- Fault: dashed where approximately located; dotted where concealed, bar and ball on downthrown side; questioned where uncertain
- Thrust fault: teeth on upthrown block; dashed where approximately located; dotted where concealed
- Plunging anticline axial trace: dashed where approximately located; dotted where concealed
- Plunging syncline axial trace: dashed where approximately located; dotted where concealed; questioned where uncertain, large arrowhead shows direction of plunge
- Overturned anticline: dashed where approximately located; dotted where concealed, large arrowhead shows direction of plunge
- Overturned syncline: dashed where approximately located; dotted where concealed, large arrowhead shows direction of plunge
- Strike and dip of inclined beds
- Strike and dip of overturned beds
- Strike of vertical beds
- Horizontal bedding
- Strike and dip of joints
- Strike of vertical joints
- Strike and dip of cleavage
- Strike of vertical cleavage
- Geochronology sample point location (see table 1)

INTRODUCTION

The Montana Bureau of Mines and Geology (MBMG), in conjunction with the STATEMAP advisory committee, selected the Argenta 7.5′ quadrangle in southwest Montana for detailed mapping as part of the MBMG's ongoing effort to complete the Dillon 30′ x 60′ (scale 1:100,000) geologic map. A key goal of the mapping was to reevaluate the Mesoproterozoic rocks in the northwest part of the quadrangle using new stratigraphic interpretations for the southern Belt Basin developed by the MBMG and the Idaho Geologic Survey in the west-adjacent Salmon 30′ x 60′ quadrangle (Lonn and others, 2019).

The Argenta quadrangle is located northwest of Dillon, Montana and encompasses the mountains and foothills at the southeastern end of the Pioneer Mountains (fig. 1). The quadrangle is within the Argenta Mining District where gold, silver, copper, lead, and zinc were produced from lode and placer deposits (Geach, 1972). The best access is via gravel roads along Rattlesnake Creek. The majority of the quadrangle is public land administered by the U.S. Forest Service and the Bureau of Land Management.

PREVIOUS MAPPING AND METHODS

The Argenta quadrangle is included in small-scale mapping by Ruppel and others (1993, scale 1:250,000) and larger-scale mapping by Myers (1952, scale 1:31,680) and Hobbs (1967, scale 1:24,00; fig. 2). Unpublished mapping by Alan English (MBMG) and the University of Montana Western geology field camp students, under the direction of Dr. Rob Thomas, was compiled for parts of this map. New field mapping was completed in 2015, using a U.S. Geological Survey 1:24,000-scale topographic base map, 2009 orthoimagery from the National Agricultural Imagery Program (NAIP), and a handheld Trimble Juno GPS for locating sample and field observation point data. Rock samples collected for U-Pb geochronology were processed at the MBMG mineral separation laboratory. Zircon was isolated from selected samples by standard density and magnetic separation techniques. Zircon separates were analyzed by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) by Jesse Mosolf, MBMG, at the University of California, Santa Barbara.

GEOLOGIC SUMMARY

The oldest rocks in the quadrangle are exposed in the core of the Humbolt Mountain Anticline (fig. 1). These sedimentary units were previously interpreted as part of the Mesoproterozoic Belt Supergroup (Myers, 1952; Ruppel and others, 1993), however, we interpret them as Cambrian (map unit Ꞓq) and Cambrian and/or Neoproterozoic and/or Mesoproterozoic (map unit ꞒZYaq). We assign the uppermost part of these rocks (map unit Ꞓq), consisting of light gray quartz arenite with discontinuous intervals of dark gray argillite, as Cambrian based on the discovery of abundant trace fossils (fig. 3) in argillite at the top of Humbolt Mountain. This uppermost unit may correlate with the basal Cambrian Flathead Formation, which is generally considered Middle Cambrian. However, the reported occurrence of Treptichnus pedum (Trippe, 2019), the trace fossil whose first appearance defines the Precambrian–Cambrian boundary (Brasier and others, 1994), suggests this unit could be Early Cambrian.

Underlying the gray quartzites and dark argillites are poorly exposed, predominantly red and green micaceous argillites and interbedded feldspathic quartzites (map unit ꞒZYaq). We tentatively interpret this unit as Cambrian, Neoproterozoic, and/or Mesoproterozoic based on its stratigraphic position below map unit Ꞓq and the recent work by Kovalchuk (2017) and Trippe (2019) who also suggest parts of it could be Neoproterozoic or younger.

The majority of the quadrangle is underlain by Paleozoic and Mesozoic carbonate and clastic rocks exposed in a series of northeast-trending folds. Cretaceous igneous rocks, including small intrusions and minor volcanic flows associated with the Pioneer Batholith, intrude and overlie the folded sedimentary strata. Cenozoic volcanic and sedimentary deposits are widespread in the southern part of the map. The volcanic rocks include rhyolitic tuffs and isolated andesite flows that are part of the Eocene Dillon Volcanic Group (Fritz and others, 2007). These volcanic rocks erupted during onset of regional Eocene extension in southwest Montana (e.g., Foster and others, 2010), and are overlain by middle Eocene to early Miocene sedimentary deposits of the Renova Formation.

In the central part of the map, north of Rattlesnake Creek, cobble conglomerate within the Renova Formation (map unit Trec) represents fluvial basin-margin facies associated with Paleogene drainage basins. The finer-grained, ash-rich sandstones (map unit Tre) reflect basin-interior facies (Barber and others, 2012). Younger cobble and boulder gravel deposits dominated by rounded quartzite clasts are interpreted as alluvial-fan and debris flow deposits correlated with the Miocene to Pliocene Sixmile Creek Formation (Thomas and Sears, 2020).

The youngest deposits in the quadrangle are Quaternary surficial deposits. Argenta Flats is underlain by a large Pleistocene glacial outwash fan that is an important aquifer in the Beaverhead Valley (Thomas and others, 2007). Extensive quartzite talus and colluvium mantle the slopes of Humbolt and Dutchman mountains (fig. 1). Alluvium and colluvium occur throughout the map area.

STRUCTURE

The oldest structures in the Argenta quadrangle are northeast-trending folds and thrust faults associated with Late Cretaceous crustal shortening at the leading edge of the Cordilleran fold-thrust belt of southwest Montana (Ruppel and Lopez, 1984). The folds, including the Humbolt and Dutchman Mountain Anticlines and the Cave Gulch Syncline, range from upright to overturned and generally plunge to the north. The thrust faults also trend northeast, dip to the west, and locally cut the fold limbs. The thrust fault in the northwest corner of the map was interpreted by Ruppel and others (1993) as a klippe related to the nearby Grasshopper Thrust (fig. 1, Kelley Thrust of Myers, 1952). Our interpretation, based partly on the recognition of previously unmapped Cambrian rock around Humbolt Mountain, shows it as an imbricate thrust in the footwall of the Grasshopper Thrust, similar to the other mapped thrusts in the quadrangle.

The youngest structures are steep, generally northwest and northeast-trending Cenozoic Basin and Range extensional faults that offset the older structures. Rare, poorly exposed fault surfaces indicate both dip-slip and strike-slip motion. No Quaternary faults have been mapped in the quadrangle but the epicenter of the 2005 Mw 5.6 Dillon earthquake (Stickney, 2007) was located approximately 11 km (7 mi) northeast of the quadrangle (fig. 1).

DESCRIPTION OF MAP UNITS

Qal **Alluvium (Holocene)**—Unconsolidated gravel, sand, silt, and clay deposited by Rattlesnake Creek and small tributaries. Clasts generally subrounded to well-rounded and consist predominantly of quartzite. Thickness as much as 10 m (33 ft).

Qac **Alluvium and colluvium (Holocene and Pleistocene?)**—Unconsolidated sand, silt, and clay, and subordinate gravel, deposited on gentle slopes by sheetwash and gravity processes. Variable thickness, generally less than 10 m (33 ft).

Qc **Colluvium (Holocene and Pleistocene)**—Unconsolidated, locally derived slope deposit that contains angular, poorly size-sorted clasts, generally pebble size and larger. Thickness less than 10 m (33 ft).

Qta **Talus deposit (Holocene and Pleistocene)**—Unconsolidated, locally derived apron-like deposit with angular clasts on and below steep slopes. Includes some rock-slide deposits. Variable thickness, typically less than 10 m (33 ft).

Qaf **Alluvial-fan deposit (Holocene and Pleistocene)**—Unconsolidated, poorly sorted cobbles, gravel, sand, and silt forming fan-shaped deposit. Thickness probably less than 6 m (20 ft).

Qdf **Debris-flow deposit (Holocene and Pleistocene)**—Angular, subangular, and subrounded clasts of chaotic and unstratified boulders and cobbles and subordinate finer-grained sediment. Some fine sediment probably has been removed by erosion leaving coarser clasts as lag deposits. Up to approximately 15 m (50 ft) thick.

Qgr **Gravel deposit (Holocene and Pleistocene)**—Poorly sorted gravel, sand, and silt with angular to well-rounded cobbles that consist dominantly of quartzite and limestone. Occurs as isolated deposits in and along smaller drainages and includes alluvium, small debris flows, alluvial fan deposits, and colluvium. Thickness up to 5 m (15 ft).

Qpg **Pediment gravel (Holocene and Pleistocene)**—Thin accumulations of cobbles, pebbles, and scattered small boulders with a sand and silt matrix capping low-relief, eroded bedrock surfaces. Light brown weathered quartzite cobbles that appear to be the Quadrant Formation are most abundant. Occurs as a cobble lag deposit in some places. Thickness as much as 5 m (15 ft).

Qgo **Glacial outwash deposit (Pleistocene)**—Weakly stratified deposit of sand and gravel with abundant, locally derived, rounded to subrounded cobbles and boulders. Quartzite and feldspathic quartzite clasts are most abundant; weathered granitic clasts, argillite, hornfels, limestone, sandstone, and volcanic clasts are less abundant. Forms an extensive outwash fan deposit that underlies Argenta Flats. Also occurs as an isolated deposit overlying bedrock north of Rattlesnake Creek near the western edge of the map. Domestic well logs indicate the gravels are as much as 13 m (42 ft) thick and are underlain by up to 90 m (295 ft) of clay-rich gravel and cobble layers that may also be outwash.

Tsc **Gravel and conglomerate deposits (Miocene?)**—Unconsolidated, poorly sorted, massive to crudely bedded, gravel and conglomerate in a matrix of sand, silt, and clay. Clasts are subangular to subrounded cobbles and boulders (some up to 2 m in diameter) consisting dominantly of quartzite with subordinate sandstone, argillite, limestone, chert, volcanic, and plutonic rock. Unconformably overlies Eocene rhyolite tuff (map unit Trt) in southeast corner of the map. May be equivalent to the Miocene Sweetwater Creek member of the Sixmile Creek Formation, which has been interpreted as debris flows on alluvial fans (Thomas and Sears, 2020). Thickness as much as 90 m (300 ft).

Trec **Conglomerate and sandstone (Tertiary: Oligocene)**—Angular to subrounded pebbles and cobbles in a poorly sorted, silt to granule, calcareous matrix. Thin to thick beds with irregular contacts are generally massive with rare normal to inverse grading. Clasts, up to 35 cm (14 in), are moderately indurated and consist of light to dark gray, blocky, angular to subangular limestone (58 percent), sandstone and siltstone (21 percent), quartz sandstone (12 percent), feldspathic quartzite (8 percent), tuff (4 percent), and chert (4 percent) (Barber, 2013). This unit has been interpreted by Barber (2013) as proximal debris-flow-dominated, alluvial fan deposits. The youngest grain from a sample collected for detrital zircon analysis (FP13-4, Schwartz and others, 2019) yielded a U-Pb age of 25.2 ± 0.1 Ma, suggesting Oligocene deposition. Base not exposed but as much as about 90–120 m (300–400 ft) thick.

Tre **Renova Formation (Tertiary: Oligocene–Eocene)**—Very pale orange, grayish orange, white, and pale yellowish brown tuffaceous mudstone, organic-rich siltstone, tuff, and fine- to coarse-grained sandstone. Sandstone intervals are poorly sorted, often micaceous, with angular to subrounded granules, pebbles, and cobbles. Cobble-size clasts are predominantly quartzite, limestone, and volcanic rock. Locally contains petrified wood, paper shales, and clay-rich intervals that weather to a "popcorn" texture. Estimated thickness around 790 m (2,600 ft) thick.

Trt **Rhyolite tuff (Tertiary: Eocene)**—Massive, white-weathering, vitric tuff. Contains broken phenocrysts (up to ~30 percent) of alkali feldspar, quartz, biotite, and occasional amphibole in a vitric groundmass composed of cuspate glass shards that are mostly fresh, but are locally devitrified. Tuff intervals commonly contain small fragments (~5 mm) of pumice, volcanic debris, fine-grained sedimentary rock, and silicified wood fragments. Thin intervals of planar, low-angle cross bedding is observed locally. This unit yielded a U-Pb age of 41.2 ± 0.2 Ma (table 1, sample DN-AR1). Base not exposed but at least 60 m (200 ft) thick.

Tan **Andesite flows (Tertiary: Eocene)**—Dark brown to black andesite flows with an aphanitic groundmass and <2–3 percent phenocrysts of olivine, pyroxene, rare plagioclase, and quartz. Forms isolated, knobby outcrops that weather pale reddish brown to black and often have a vesicular texture.

Kgd **Granodiorite (Late Cretaceous)**—Medium- and fine-grained, light to medium gray, granodiorite and quartz monzonite. Hornblende and biotite are the dominant mafic minerals. Occurs as several isolated bodies that may be satellite intrusions to the Uphill Creek Pluton (Snee, 1978, 1982) of the Pioneer Batholith. This unit yielded a U-Pb age of 71.0 ± 0.5 Ma (table 1, sample DN-AR2), similar to an $^{40}Ar/^{39}Ar$ biotite age of 71.5 ± 0.6 Ma reported by Snee (1982) for a sample collected near the town of Argenta.

Kcv **Cold Spring Creek volcanics (Late Cretaceous)**—Variegated, intercalated sequence of porphyritic lava flows and ash-flow tuff. Named for exposures along Cold Spring Creek (southeast of quadrangle) described by Ivy (1988). Porphyritic lavas are generally dark colored with phenocrysts of plagioclase, orthopyroxene, clinopyroxene, hornblende, biotite, and quartz in an aphanitic groundmass. Poorly exposed tuffs contain varying amounts of pumice fragments and accidental clasts of porphyry lava. Ivy (1988) reported $^{40}Ar/^{39}Ar$ hornblende ages spanning ~80–76 Ma for this unit. U-Pb zircon ages from nearby mapping (Mosolf, 2021; Mosolf, in prep.) ranged from 71.7 ± 0.6 and 73.1 ± 0.8 Ma. Thickness as much as 490 m (1,600 ft) south of the map area.

Kf **Frontier Formation (Late Cretaceous)**—Dominantly gray, brown, brownish gray, and greenish gray siltstone and mudstone, and subordinate medium- to coarse-grained, and locally very coarse-grained sandstone, conglomerate, limestone, and minor porcellanite. The beds of mudstone, siltstone, limestone, and sandstone form fining-upward depositional cycles tens of meters thick. Sandstones and conglomerates are rich in quartz and chert. Conglomerate clasts are rounded pebbles and small cobbles. Volcaniclastic sandstone and bentonitic mudstone occur in upper part. Lower 100–200 m (330–660 ft) is distinctive brown to brownish gray siltstone and mudstone. Top not exposed but thickness is about 900 m (3,000 ft) north of the quadrangle (Tysdal and others, 1994; Dyman and Tysdal, 1998).

Kblv **Blackleaf Formation, Vaughn Member (Early to Late Cretaceous)**—Olive green, yellowish green, bright green, and gray green, hard, dense, and calcareous siltstone and porcellanitic (silicified) mudstone. Subordinate gray, greenish gray and olive gray, fine- to medium-grained, and locally coarse-grained lithic sandstone, with high percentage of volcaniclastic debris, and matrix-supported conglomerate and conglomeratic sandstone with clasts mostly of chert and quartzite. An association of distinctive lithologies is present in the uppermost part, which consists of maroon mudstone and siltstone, gray freshwater limestone or locally very calcareous mudstone and siltstone, dark gray shale, and bright green porcellanite. Upper contact is mapped at top of a porcellanite bed, interbedded with micritic limestone, that directly overlies the highest maroon mudstone (Tysdal and others, 1994; Dyman and Tysdal, 1998). A porcellanite bed approximately 25 m (80 ft) below the top of the Vaughn in the Frying Pan Basin yielded a U-Pb age of 94.8 ± 0.5 Ma (Zartman and others, 1995). Thickness approximately 584 m (1,916 ft).

Kblf **Blackleaf Formation, Flood Member (Early Cretaceous)**—Upper part: pale brown to brownish gray, fine- to medium-grained and locally coarse-grained to conglomeratic, quartz- and chert-rich lithic sandstone, and conglomerate. Trough crossbedding common in sandstone. Middle part dominantly gray mudstone, shale, and minor interbeds of siltstone and quartz-rich sandstone. Lower part: medium gray and locally green and red calcareous siltstone and mudstone, gray shale, and gray, calcareous, fine- to medium-grained sandstone that is rich in quartz and chert grains (Tysdal and others, 1994; Dyman and Nichols, 1988). Thickness 183–213 m (600–700 ft).

Kk **Kootenai Formation (Early Cretaceous)**—Mapped as one unit, but consists of four distinct units (after Myers, 1952). Combined thickness of all units is approximately 274–305 m (900–1000 ft).

Gastropod limestone member: Light gray, thick-bedded, gastropod coquina or gastropod-rich limestone that may also contain charophytes and ostrocodes. Forms conspicuous ridges.

Red mudstone member: Variegated shale and mudstone, dominated by red, orange, and purple, and subordinate light and medium gray colors, interbedded with minor reddish quartz- and chert-rich lithic sandstone. Poorly exposed, recessive unit.

Fine-grained limestone member: Pale yellowish-gray to pale brown, dense limestone and shaly limestone with interbedded shale.

Basal sandstone and mudstone: Upper part recessive, mostly reddish and greenish mudstone; lower part is ridge-forming, coarse- to medium-grained, cross-bedded to massive, brown to yellowish gray chert-rich lithic sandstone with local lenses of chert-rich conglomerate and limestone pebble conglomerate; interbedded with reddish and greenish mudstone.

Jm **Morrison Formation (Jurassic)**—Green, red, and gray variegated mudstone, shale, and siltstone with thin, interbedded yellowish brown to grayish orange, very fine-grained sandstone and siltstone beds, and thin, gray limestone beds. Thickness about 45–55 m (150–175 ft).

Ꞓd **Dinwoody Formation (Lower Triassic)**—Interbedded shale, limestone, and calcareous sandstone characterized by distinctive pale to light grayish brown weathered surfaces and the presence of phosphatic pelecypod Lingula. Upper part has massive calcareous, rippled sandstone beds as much as 1 m (3 ft) thick with shaley interbeds. Massive, gray, pinkish gray weathering limestone as much as 1 m (3 ft) thick is a major component in the upper part. Lower part is predominantly olive drab, chippy-weathering, hard fissile shale with interbedded dark brown weathering, silty limestone beds 10 cm (4 in.) or thinner. Thickness about 244 m (800 ft).

Psp **Shedhorn and Phosphoria Formations, undivided (Permian)**—Upper part is brownish gray to dark gray, laminated or thin- to thick-bedded chert, grayish brown quartz sandstone, and cherty sandstone. The mostly fine-grained, well-sorted quartz sandstone often has cylindrical burrows and is interpreted as the Shedhorn Formation described by McKelvey and others (1959). Lower part of the unit is dark gray to black, carbonaceous and phosphatic mudstone with scarce phosphate beds, grayish and gray-brown cherty quartz sandstone, cherty or sandy dolomite, fine-grained dolomitic sandstone, and yellowish tan sandy siltstone with subordinate beds of vitreous quartz sandstone. Poorly exposed, typically covered by colluvium and talus of underlying Quadrant Formation. Thickness approximately 183–215 m (600–700 ft).

IPq **Quadrant Formation (Pennsylvanian)**—Light gray to light yellowish brown, fine-grained, vitreous quartz sandstone. Beds are mostly thick to massive, occasionally with faint cross-laminations. Locally, the basal quartz sandstone beds are interbedded with thin intervals of limestone or dolomite and locally have gray limestone rip-up clasts. Forms resistant ridges typically covered with conifers. Thickness approximately 244 m (800 ft).

IPMsr **Snowcrest Range Group (Pennsylvanian and Mississippian)**—Originally mapped as Amsden Formation (Myers, 1952; Hobbs, 1967) but shown here as the Snowcrest Range Group, which includes the Conover Ranch, Lombard, and Kibbey Formations (Wardlaw and Pecora, 1985). Total thickness of Snowcrest Range Group is about 238 m (780 ft) but localized outcrop-scale folds, especially in the Lombard, make thickness estimates problematic.

Conover Ranch Formation—Pale reddish and pale yellowish, thin-bedded, calcareous mudstone with minor interbeds of limestone, calcareous sandstone, and siltstone. Some beds contain brachiopods, bryozoan debris, crinoid columnals, and belemnite fragments.

Lombard Formation—Upper unit is fossilifereous, thin- to thick-bedded, lime-mudstone and limestone with rare chert lenses. Brachiopod, rugose corals, oncolites, and coquina lenses are common. Lower unit is poorly fossiliferous, thin to thick, indistinctly bedded, lime-mudstone and gray limestone.

Kibbey Formation—Gray quartzite and yellowish, calcareous sandstone beds interbedded with siltstone and shale.

Mmc **Mission Canyon Formation (Mississippian)**—Light gray, thick-bedded, fossiliferous, often cliff-forming limestone with irregular chert bands. Myers (1952) mapped the Mission Canyon as two units that were combined for this map. The upper part is light- to dark gray, commonly well-bedded, fine- to medium-grained, with rare coarse-grained beds of crinoidal debris, and minor light to dark gray, thin-bedded dolomitic, locally sandy or cherty limestone. The lower part is generally a coarser-grained limestone with abundant crinoids and some intervals of thin-bedded limestone and dolomitic limestone. Becomes coarsely crystalline marble near intrusions. Thickness variable as a result of deformation but estimated to be about 360 m (1,375 ft) thick.

Ml **Lodgepole Formation (Mississippian)**—Gray to dark gray, thin- to medium-bedded, fossiliferous limestone. Thinner beds and shaly partings are common near base, beds are thicker with rare shaly partings near the top. Common fossils are corals, crinoids, and rare brachiopods. The Lodgepole in this area has less chert than in other areas of Montana to the north and east. Becomes coarsely crystalline marble near intrusions. Thickness variable as a result of deformation but generally about 290 m (950 ft) thick.

MDtj **Three Forks and Jefferson Formations, undivided (Mississippian and Devonian)**

MDt **Three Forks Formation (Mississippian and Devonian)**—Brown, argillaceous, fossiliferous limestone interlayered with black to dark gray, carbonaceous shale, grayish green shale, and light tan, silty sandstone. Recessive and mapped on the basis of float. Metamorphosed to hornfels near intrusions. Thickness approximately 75 m (250 ft).

Dj **Jefferson Formation (Devonian)**—Upper part is yellowish-weathered solution breccia of fine-grained calcite marble. Lower part is medium- to thick-bedded, dark gray to brown, coarsely crystalline, weakly mottled dolomite with strong petroliferous odor on fresh surfaces. Outcrops commonly covered with white and orange lichen. Thickness approximately 200 m (650 ft).

Ꞓh **Hasmark Formation (Cambrian)**—Light gray to bluish gray, thin- to very thick-bedded, medium crystalline dolomite with minor magnesium limestone intervals. Basal part contains common peloids, succeeded upward by oolitic and pisolitic intervals, algal-mat carbonate, minor intraformational conglomerate, and thin quartz sandstone beds. Weathers very light gray to pale brown with a gritty, laminated surface. Minor replacement chert nodules and chert beds, a few centimeters to decimeters thick, distinguish unit from Jefferson Formation (Dj). Exposed thickness is approximately 122 m (400 ft).

Ꞓsh **Silver Hill Formation (Cambrian)**—Thin-bedded, olive green to olive gray, micaceous shale and argillite with interbedded reddish quartz sandstone and siltstone. Mapped on the basis of float in northwest corner of the map, southwest of Humbolt Mountain. Thickness not determined but as much as 60 m (200 ft) thick in the southern Pioneer Mountains and locally absent as a result of erosion (Myers, 1952).

Ꞓq **Quartz sandstone (Cambrian)**—Light gray to grayish orange, moderate to poorly sorted, medium- to coarse-grained quartzite with subordinate dark argillite and pale reddish quartzite interbeds. The gray quartzite has subangular to rounded quartz grains with rare (< 1–2 percent) dark grains, and < 3 percent plagioclase feldspar. Commonly forms talus but where exposed, outcrop is medium- to thick-bedded, massive to cross-bedded, with localized lenses and discontinuous beds of well-rounded quartz granules and pebbles. Interbedded argillite is dark gray to grayish-green, laminated to ripple cross-laminated, with thin interbeds of fine- to coarse-grained, gray to pale reddish quartzite with up to 15 percent potassium feldspar, and rare quartzite and siltite pebble lenses that are often glauconitic. Argillite beds are poorly exposed but appear to be laterally discontinuous. Cambrian trace fossils, including *Cruziana* (trilobite feeding trail) and *Paleophycus striatus* (dwelling burrow), and several unidentified horizontal and vertical burrows, are relatively common, especially in float around and at the top of Humbolt Mountain (T. 5 S., R. 10 W., sec. 29). Based on the presence of Cambrian trace fossils, the argillite may correlate with the Silver Hill Formation and the quartzite with the Flathead Formation; however, the lower part of the sequence could be older. The upper and lower contacts are poorly exposed but estimated thickness is 244 m (800 ft).

ꞒZYaq **Argillite and quartzite (Cambrian and Mesoproterozoic)**—Dark gray to grayish green argillite and shale interbedded with grayish red, pale reddish, and grayish green, fine- to coarse-grained, feldspathic and non-feldspathic quartzite. Argillite beds are typically laminated, 2–5 cm (1–2 in) thick, micaceous, and cap the quartzite beds or form intervals of fissile shale up to 3 m (10 ft) thick. Bedding surfaces can have nodular, wrinkled, or cracked structures interpreted as microbial mats (Kovalchuk, 2017). Quartzite beds range in thickness from 5 cm to about 0.3 m (2 in to 1 ft). Common sedimentary structures include ripple marks, cross-bedding, and less commonly, distorted bedding and mudchips. Mostly mapped on basis of float but good exposures can be found in gullies and abandoned prospect pits in sections 7 and 18, T. 6 S., R. 10 W. Estimated thickness about 221 m (725 ft) based on a borehole (Pearson, 1996) in the west adjacent Ermont 7.5′ quadrangle.

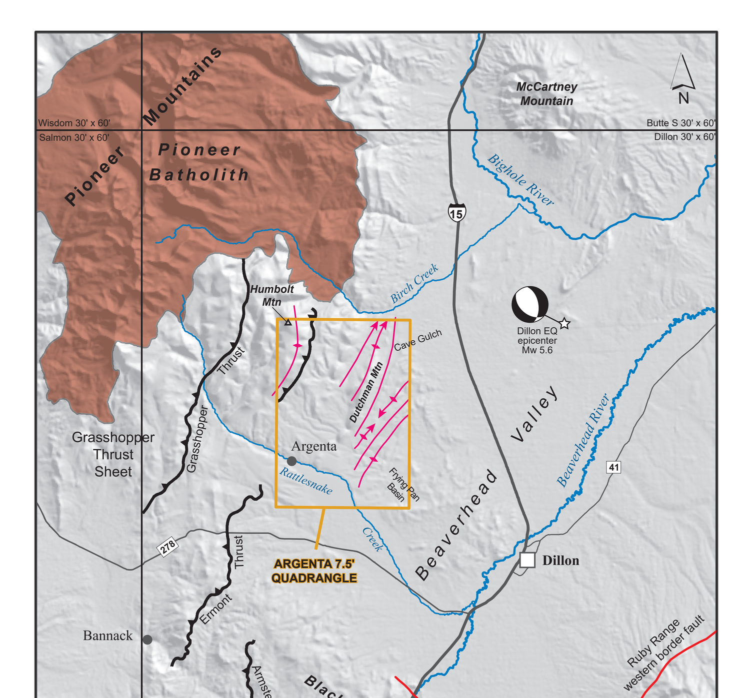


Figure 1. Simplified tectonic map of the area near the Argenta 7.5′ quadrangle. Quaternary faults (Stickney and others, 2000) are shown in red.

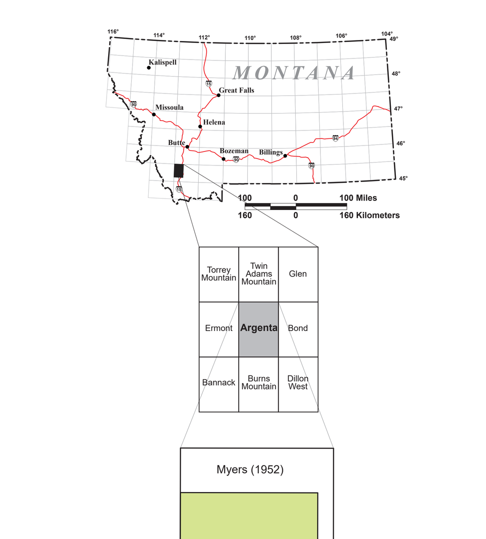


Figure 2. Sources of mapping. The entire quadrangle was mapped by Ruppel and others (1993) for the Dillon 1:250,000-scale geologic map.

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Table 1. U-Pb zircon geochronology

Sample	Lithology	Unit	Latitude (°N)	Longitude (°W)	Mineral	No. of Spot Analyses[a]	Age (Ma)	2σ	MSWD
DN-AR1	Rhyolite tuff	Trt	45.2895	-112.8186	zircon	14	41.2	0.2	0.21
DN-AR2	Granodiorite	Kgd	45.2800	-112.8717	zircon	16	71.0	0.5	0.99

Note. Reported ages are the weighted mean of the ^{207}Pb corrected $^{206}Pb/^{238}U$ ages obtained for each sample. MSWD is the Mean Square Weighted Deviation. Zircon separates were prepared at the MBMG and analyzed by LA-ICPMS at the University of California, Santa Barbara. Latitudes and longitudes are in the 1984 World Geodetic Survey (WGS84) datum.

Figure 3. Trace fossils collected from the Humbolt Mountain area (map unit Ꞓq). (A) *Cruziana* trail (outlined by dashed line) showing the central paired leg grooves and parallel furrows on the outside edges. *Cruziana* are considered trilobite feeding tracks. (B) Numerous branched and unbranched horizontal trace fossils, including *Planolites*, on bedding surface. (C) Sand-filled burrows (outlined by dashed lines). (D) Vertical *Skolithos* burrows (dark circular impressions on bedding surface).

Montana Bureau of Mines and Geology

Geologic Map 100

Geologic Map of the Argenta 7.5′ Quadrangle, Southwest Montana

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