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GEOLOGIC MAP OF FRONTAL FOLD AND THRUST ZONE IN THE BLACKTAIL MOUNTAINS, BEAVERHEAD COUNTY, MONTANA

By
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This report is an outgrowth of a Master's thesis (Pecora, 1981) conducted in the central part of the Blacktail Mountains of southwestern Montana. The thesis was sponsored by the U.S. Geological Survey and was conducted as part of a multidisciplinary study of the Dillon 1° x 2° quadrangle. The thesis work led to mapping of a series of previously unrecognized thrust faults that form a convex-eastward zone of the Cordilleran thrust belt. The zone was subsequently named the Blacktail Mountains salient by Suppel and Lopez (1984). Deciphering of the structure required extensive study of Mississippian rocks, resulting in the first recognition of a thick sequence of Upper Mississippian limestone rocks in this part of southwestern Montana, and eventually definition of a new rock unit--the Snowcrest Range Group of Wardlaw and Pecora (1985).

DESCRIPTION OF MAP UNITS

Qal$_2$ Alluvium, unit two (Holocene)—In Small Horn Canyon, poorly sorted sand and soil stream gravels locally derived from the floor of the Blacktail Valley, which flanks the mountains on the northeast. The alluvium crops out as a cobblestone-pattern on an alluvial fan-terrace being incised by Small Horn Creek and Sheep Creek. Dominantly composed of coarse sand, gravel, and cobble clasts that are recycled from quartzite and limestone-pebble conglomerates of the Beaverhead Group

Qal$_1$ Alluvium, unit one (Holocene)—Dominantly well-sorted clean quartz sand derived from the Pennsylvanian Quadrant Sandstone and subjacent formations. Locally the alluvium is composed of sand and gravel composed of gneiss and limestone clasts derived from Cambrian and Archean bedrock

Qs Slump deposits (Holocene and Pleistocene)—Semiconsolidated debris that has moved downslope en-masse. Large deposits characteristically are hummocky and support pine trees that are tilted at oblique angles to other trees and to the horizontal. Smaller slumps are common along strike with the projection of mapped surface faults and form small depressions that cause pooling of water

Qrs Rockslide and avalanche deposits (Holocene and Pleistocene)—Mainly rocks of the Mississippian Snowcrest Range Group that were thrust eastward in late Cretaceous time and subsequently became detached and slumped westward on the surface of the pre-existing, gently inclined, thrust faults

Qgv Glacial valley deposits (Pleistocene)—Angular to subangular cobbles and boulders forming chaotic, hummocky valley debris deposits below cirques west of Mt. Ashbough (see T. 9 S., R. 9 W.)

Qgt Glacial outwash terraces (Pleistocene)—Medium- to coarse-grained, unconsolidated, poorly stratified sand and gravel above which is a poorly developed "A" soil horizon

Tc Conglomerate (Upper Tertiary)—Silica-cemented, clast-supported, pebble, cobble, and boulder conglomerates. Crops out at the mouth of Sheep Creek, near the Blacktail fault, and is topographically higher than the Quaternary deposits of the valley floor. Dominantly composed of Mississippian carbonate clasts, and rarely basalt clasts derived from the Lower Tertiary Blacktail Deer Creek Basalt (unit Tbb). The conglomerate rests with angular unconformity on vertical beds of the Lower Mississippian Lodgepole limestone

Tbb Blacktail Deer Creek Basalt (Lower Miocene)—Olive-gray to grayish-black, dense, extremely hard, very fine grained olivine basalt. The Blacktail Deer Creek basalt unconformably overlies map units as old as the Pennsylvanian Quadrant Sandstone

Tbbl Diabase (Lower Miocene)—Olive-gray to grayish-black very fine grained olivine diabase that is tentatively correlated with the Blacktail Deer Creek basalts. The olivine crystal form a cumulate texture. Near the mouth of Sheep Creek, the diabase intrudes a thrust fault in the Upper Mississippian Lombard Limestone; and locally near the Blacktail fault, the unit intrudes brecciated Paleozoic limestone. The basalt has been prospected for economic minerals at several localities

Tcr Cook Ranch Formation of Wood (1934) (Middle Oligocene)—Pale-orange, pale-green, and white rhyolitic ash-flow tuff; locally overlain by pale-red-purple to light-red, fine-grained, rhyolite porphyry that has sodersine and oligoclase phenocrysts; tentatively correlated with Cook Ranch Formation of Wood (1934). Grayish-yellow-green epidote, and quartz-gravel clasts, are present in the rhyolite matrix of the formation in the easternmost area of the map

Tru Rhyodacite (Eocene)—Pale-red hornblende and biotite rhyodacite. It forms an intrusion and/or flow that is fine- to medium-grained and displays well-developed sheeting and jointing. Unit originally assigned to middle Oligocene(?) (Pecora, 1981), but is now assigned to Eocene, based on radiometric data (R. G. Tysdal, oral comm., 1986)

Beaverhead Group

Kb$_3$ Unit three (Upper Cretaceous)—Multicolored conglomerate of sand- to cobble-size subrounded clasts of quartzite and argillite set in a matrix of light-gray to moderate-brown clay sandstone and siltstone. Clasts are dominantly pale-red-purple to grayish-green and are recycled from the Mcnamara, Garnet Range, and Mount Shields formations of the Proterozoic Belt Supergroup, which crops out in the Grasshopper Thrust Plate several miles west of the Blacktail Mountains (C. T. Nappel, written commun., 1980). The contact of unit three of the Beaverhead Group with subjacent Beaverhead units and other formations is not exposed, but is unconformable because unit three overlies several formations of different ages. The Pennsylvanian Quadrant Sandstone is the oldest formation overlain by unit three

Kb$_2$ Unit two (Upper Cretaceous)—Light- to medium-gray, oncolitic, sandy- and thick-bedded crystalline limestone. The unit may be correlated with gastropod-bearing freshwater limestone described by Lowell and Klepper (1953) in the type section of the Beaverhead at McKnight Canyon, in the Tendoy Mountains about 25 mi (40 km) south of the map area. Bulk samples from the unit in the Blacktail Mountains yielded no marine microfaunas (S. K. Wardlaw, written commun., 1982). Unit two generally overlies unit one, but locally lies beneath unit one, suggesting an intertonguing relationship. The contacts between units one and two are sharp but apparently conformable

Kb$_1$ Unit one (Upper Cretaceous)—Limestone-pebble-conglomerate with a matrix of moderate-red to reddish-brown calcareous sandstone; calcite cement; and light-gray to olive-gray sand- and gravel-size clasts derived from Mississippian and Permian formations. Unit one of the Beaverhead is thin- to thick-bedded, indistinctly stratified, and contains crudely size-graded and sorted conglomerate clasts. Medium-bedded pale-yellowish-brown quartz arenite is intercalated with the limestone-pebble-conglomerate east of the Sheep Creek thrust fault, but is absent west of the thrust in the Blacktail Mountains. West of the thrust, the unconformable contact of unit one of the Beaverhead with the underlying Kootenai Formation is sharp and is placed at the base of the stratigraphically lowest limestone conglomerate bed above heterogeneous lithologies of the lower Cretaceous Kootenai Formation (Hobe, 1977). East of the fault, the unconformable contact of unit one of the Beaverhead Group with the underlying Lower Triassic Dinwoody Limestone is sharp and is mapped at the base of the stratigraphically lowest bed of limestone-pebble-conglomerate overlying brownish-colored limestone of the Dinwoody

KJu Unnamed shale unit, Kootenai Formation, and Morrison Formation (Undivided) (Lower Cretaceous and Upper Jurassic)—The shale unit is poorly exposed, locally forming grass-covered swales. It is composed of medium-gray to yellowish-brown clay shale and mudstone, and thin interbeds of crystalline limestone that crop out as resistant ledges. The Kootenai Formation is undivided into three informal units, described in descending order. The limestone unit is pale-yellowish-brown to light-gray skeletal lime-mudstone and wackestone, and contains abundant gastropods. The mudstone unit is dusky-red to reddish-brown clay mudstone, which forms a swale separated by ledges of thin-bedded pale-yellowish-brown calcareous siltstone and lime-mudstone with thin interbedded lenses of sandstone and cherty conglomerate. The basal "salt and pepper" sandstone unit is light-gray, medium- to coarse-grained, thin- to thick-bedded, argillaceous quartz litharenite and sublitharenite, characteristically with dark-gray grains of chert. The contact of the Kootenai Formation with the underlying Morrison Formation was not mapped, but is placed at the base of the stratigraphically lowest bed of quartz litharenite above mudstone of the Morrison. The Morrison Formation is reddish-brown to yellowish-brown, nonresistant, poorly exposed, friable, thin-bedded, and unfossiliferous claystone and siltstone. The unconformable contact of the Morrison with the underlying Dinwoody Formation is mapped at the top of resistant ledges of the Dinwoody. West of the Sheep Creek thrust fault, the Morrison Formation, Kootenai Formation, and shale unit (undivided) have a maximum exposed thickness of 1,080 ft (329 m), measured from the base of the unit to gravels that cap the exposures. The Kootenai and Morrison Formations are absent east of the Sheep Creek thrust fault due to erosion prior to emplacement of the Sheep Creek thrust plate

TRd Dinwoody Formation (Lower Triassic)—Moderate-brown, thin-bedded, skeletal lime-mudstone and interbedded calcareous clay mudstone. The lime-mudstone contains laminae of silt and clay, and debris of pelecypods and brachiopods. *Lingula* sp? and *Claria* sp? casts and molds are common on bedding planes. West of the Sheep Creek thrust fault, the Dinwoody is as thick as 430 ft (131 m), but thins southward beneath a pre-Middle Jurassic regional unconformity. The Dinwoody is less than one-half this thickness east of the thrust and is erosionally truncated beneath a pre-Late Cretaceous angular unconformity. Folds and bedding plane thrust faults caused repetition of Dinwoody strata west of the Sheep Creek thrust. The contact of the Dinwoody Limestone with the underlying Permian Phosphoria Formation was placed beneath a distinct mudstone unit at the base of the Dinwoody (Schock and others, 1981, p. 63)

Pp Phosphoria Formation (Permian)—The Phosphoria Formation of the map area is comprised of a complex assemblage of intertonguing rock units. In descending order the units are as follows: Blacktail Member, interbedded and intertonguing Tosi Chert Member and Shedhorn Sandstone, Retort Phosphatic Shale Member, Franson Tongue, Rex Chert Member, and Grandeur Tongue (Cressman and Swanson, 1964; Yochelson, 1968; Schock and others, 1981). The Blacktail Member is yellowish-brown to grayish-orange silty clay mudstone that contains thin interbeds of chert and crinoidal packstone. The Tosi Chert Member is medium-gray thick-bedded chert and interbedded quartz litharenite and siltstone. The Shedhorn Sandstone is a yellowish-brown to brownish-gray, very fine- to medium-grained, thin- to thick-bedded, poorly indurated, friable, dirty, cherty, glauconitic, quartz litharenite. The Retort Phosphatic Shale Member, at the type section west of the Sheep Creek thrust fault, is grayish-black, thin-bedded, papery, organic-mudstone and oil shale with interbedded moderate- to grayish-brown, thin-bedded phosphorite and pelletal phosphatic-mudstone. A few tens of meters east of the thrust, however, the Retort is represented by poorly exposed phosphatic-mudstone; thick beds of oil shale or organic-rich mudstone apparently are absent. The Franson Tongue is light- to medium-gray dolostone with nodular chert and interbedded light-olive-gray to yellowish-gray chert and sandstone. The Rex Chert Member is light-yellowish-brown to black, thick-bedded, vitreous chert that commonly is fractured and razor-sharp in outcrops west of the Sheep Creek thrust fault. The Grandeur Tongue is dark-yellowish-orange, thin-bedded, sandy mudstone and interbedded light- to medium-gray dolostone.

The Blacktail Member, Tosi Chert Member, and Shedhorn Sandstone are not exposed within the map area east of the Sheep Creek thrust fault. They are probably thin or absent beneath a regional disconformity at the base of the superjacent Dinwoody Limestone (Schock and others, 1981). The three stratigraphic units are present west of the thrust fault. The contacts between units of the Phosphoria in the Blacktail Mountains commonly are gradational and have complex intertonguing relationships, documented by Cressman and Swanson (1964). The contact of the base of the Phosphoria (Grandeur Tongue) with underlying Upper Mississippian and Pennsylvanian Quadrant Sandstone is a regional erosional unconformity, and in the map area was placed at the top of the stratigraphically highest bed of quartz arenite overlain by carbonate or sandy mudstone of the Grandeur Tongue

PMq Quadrant Sandstone (Upper Mississippian and Pennsylvanian)—Pale-reddish-brown to light-gray, fine- to medium-grained, well-sorted, quartz arenite and orthoquartzite; interbedded sandy crystalline limestone and dolostone locally present in the lower one-half of the formation. West of the Sheep Creek thrust fault, the Quadrant forms talus slopes and rubble piles of hard vitreous orthoquartzite that has a "honeycombed" or fretted fabric of fine silica-filled joints and fractures. East of the Sheep Creek thrust, the lower part of the Quadrant locally contains carbonate interbeds and is clean, medium- to thick-bedded quartz arenite that is poorly to well cemented by silica. The upper part of the Quadrant is thick-bedded, cliff forming, and appears as massive beds of eolian quartz arenite with steeply inclined cross-beds forming dune-sized foresets that are separated by gently westward-dipping bedding planes. Strike-and-dip measurements shown on the map mostly represent rarely exposed westward-dipping bedding planes that separate foresets, rather than highly variable crossbeds and laminations within individual foresets.

The contact of the Quadrant Sandstone with the underlying Upper Mississippian Snowcrest Ranch Formation is sharp, but conformable. The contact was mapped at the base of the stratigraphically lowest Quadrant Sandstone bed above which there are no reddish-mudstones or typical heterogeneous fine-grained clastic beds of the Snowcrest Ranch Formation. In the absence of the Snowcrest Ranch Formation, due to a facies change or tectonic thinning, the conformable contact of the Quadrant with the underlying Lombard Limestone is gradational over a few tens of meters and is arbitrarily placed at the point where the thick sequences of limestone and shale typical of the Lombard are overlain by dolostones and quartz arenites of the Quadrant

Snowcrest Range Group

Mcr Conover Ranch Formation (Upper Mississippian)—This unit, named by Wardlaw and Pecora (1985), is a heterogeneous assemblage of lithologies dominated by pale-reddish-brown to pale-reddish-purple, silty claystone, and lesser interbedded skeletal lime-mudstone, calcareous sandstone and siltstone. Crystalline limestone and dolostone, cherty grainstone, and phosphatic claystone crop out locally. Cherty conglomerate with limestone clasts having brachiopods weathering in relief, crops out at the base of the formation at the type section above Sheep Creek (Sloss and Moritz, 1951; Wardlaw and Pecora, 1985). In the central part of the map area, the formation is absent due to a facies change, nondeposition, and locally, tectonic thinning, but it reappears in the southernmost part of the area. The contact of the Conover Ranch Formation with the underlying Upper Mississippian Lombard Limestone is sharp, but conformable, and is mapped at the base of the first conglomerate or reddish-mudstone bed above limestones or dark-gray shales of the Lombard

Mlb Lombard Limestone (Upper Mississippian)—This formation is divided into upper and lower members, but is not subdivided on the map.

The upper member of the Lombard Limestone is almost entirely olive-gray in color. It is comprised of foraminiferal, pelletal, crinoidal, coralline, and brachiopodal lime-mudstone, wackestone, and packstone, and contains interbeds and partings of dark-gray flaggy and platy argillaceous lime-mudstone and locally, dark-gray fissile clay shale. Thick claystone beds with a diverse brachiopod assemblage crop out in some areas. Oyssiferous bituminous coal crops out locally forming interbeds within limestones of the upper member. The upper member contains black shale and coal, which are not present in the lower member, and also contains more clastic detritus and bioclastic grains. Rugose corals Caninia (Siphonophyllia? aff. C. excentrica?) up to 5 in. (12.7 cm) long form laterally persistent marker beds, commonly in wackestone of the upper half of the upper member. The mutual contact of the upper and lower members was not mapped because of structural complexities; a few exposures reveal a gradational change, over a few meters from the lime-mudstone of the lower member to skeletal lime-mudstone, wackestone, and packstone of the upper member.

The lower member is olive-gray and locally pale-red purple, relatively unfossiliferous, and indistinctly bedded lime-mudstone. The lime-mudstone and skeletal lime-mudstones are commonly pelletal, spiculan, and intreclastic and contain fine laminations of clay and locally thin thread-like anastomosing burrows. The contact of the lower member with the underlying Upper Mississippian Kibbey Sandstone is conformable, but sharp, and is placed at the top of the stratigraphically highest reddish-colored clastic bed of the Kibbey

Mk Kibbey Sandstone (Upper Mississippian)—In the map area the formation can be divided into three informal units, which are described in descending order. The upper unit of the Kibbey Sandstone is yellow, medium- to thick-bedded, very fine to fine-grained quartz arenite that locally contains interbedded claystone and sandy siltstone. The middle unit is a clay- and pseudo-algal-laminated crystalline dolostone and sandy dolostone, sandstone evaporite-solution-breccia, and limestone-solution-breccia. Aphanitic dolomite commonly fills subvertical solution cracks in the sandstone breccia and locally there is minor interbedded limestone breccia. The lower unit is medium-orange, thin- to medium-bedded calcareous clay mudstone, sandy siltstone, and very fine to fine-grained quartz arenites. It commonly contains minor silt to very fine sand grains of detrital chert, zircon, and tourmaline(?). The contact of Kibbey Sandstone with the underlying Lower Mississippian Mission Canyon Limestone is a regional unconformity (Wardlaw and Pecora, 1985) which, in the map area, is represented by an irregular surface of limestone solution-breccia at the top of the Mission Canyon. The unconformity is characterized by large collapse-breccia cavities that are partly in-filled by Kibbey strata. The contact is arbitrarily mapped at the stratigraphically lowest exposure of reddish-colored sandstone typical of the Kibbey

Madison Group

Mmc Mission Canyon Limestone (Lower Mississippian)—This formation contains three members that are recognized over a broad region (Sando, 1972; Smith and Gilmour, 1979). The members are described in descending order. The Bullridge Member is moderate-red to light-olive-gray collapse-solution-breccia. The breccia is composed of fragments of light-olive-gray coarsely crystalline limestone and dolostone that "float" in a matrix of pale-red claystone, which becomes sandy upward. The cliffy middle unit, the limestone member, has an upper part composed of massive-weathering olive-gray to light-gray, medium- to thick-bedded, skeletal lime-mudstone, crystalline limestone, and crystalline dolostone; and a lower part composed of medium-gray oolitic and crinoidal crystalline limestone and dolostone solution-breccia. The lower limestone member is olive-gray to yellowish-gray, crystalline limestone, medium- to thick-bedded, crinoidal wackestone, packstone, and grainstone, and finely crystalline dolostone. Medium- to dark-gray chert is common as stringers and nodules.

The contact of the Mission Canyon Limestone with the underlying Lower Mississippian Lodgepole Limestone is conformable and is mapped at the base of the stratigraphically lowest medium- to thick-bedded limestone bed above which there is no thin-bedded shale. Both the lower contacts and the thickness of the Mission Canyon Limestone are variable due to lateral changes in the amount of shale, which defines the contact of the formation with similar limestones included in the underlying Lodgepole Limestone. The thickness of the Mission Canyon ranges from 800 ft (244 m) to over 1,000 ft (305 m), depending on the degree of paleokarst and collapse at the top of the formation, and facies changes with the underlying Lodgepole Limestone at the base of the formation. The apparent thickness of the Mission Canyon significantly exceeds 1,000 ft (305 m) on the covered north slopes of the Blacktail Mountains. Here the Mission Canyon is overturned and complexly folded at a few exposures and the great thickness is due in part to structural complexities caused by eastward-directed thrust displacement, which took place both on intraformational solution breccia/salt zones and on subjacent shales of the Lodgepole Limestone

Mlp Lodgepole Limestone (Lower Mississippian)—The Lodgepole contains three members that are recognized on a regional basis (Sandberg and Klapper, 1967; Sando and Dutro, 1974; and Smith and Gilmour, 1979). The third member, the basal Cottonwood Canyon Member, was not recognized, owing to poor exposures. If present, the member could be only about 1 ft (1 m) or so thick.

The upper half of the Woodhurst Member, the upper member, is characterized by brownish-gray, rhythmically thin-bedded, skeletal lime-mudstone, wackestone, packstone, and moderate red to light-gray interbedded calcareous shales. Skeletal lime-mudstone locally has desiccation cracks filled with calcareous claystone. The Woodhurst Member has a diverse and abundant assemblage of brachiopods, rugose and tabulate corals, crinoids, bryozoa, and gastropods.

The lower half of the Woodhurst Member is characterized by repetition of cyclical pairs of limestone/shale units that are 3 to 27 in. (7 to 70 cm) thick. Each cyclical unit is comprised of olive-gray bioclastic wackestone and packstone grading upward to skeletal lime-mudstone capped by friable calcareous shale. The lower contact of a bioclastic limestone of one cyclical unit with the underlying calcareous shale of the previous unit is sharp but conformable. The contact of the Woodhurst Member with the underlying Paine Member is placed at the base of the first bioclastic, commonly crinoidal, wackestone, packstone, or grainstone bed above dominantly lime-mudstone and shale beds of the Paine.

The Paine Member is brownish-gray to light-olive-gray, ribboned rock of thin lime-mudstone beds and thin interbeds and laminations of calcareous shale. The shale interbeds are thicker near the base and the top of the member. The lime-mudstones are commonly pelletal, laminated, and have small amounts of comminuted bioclastic debris and small (1 in. (3 cm) long) rugose coralla. Zoophycos trace-fossil impressions on bedding planes and fine (1-5 mm thick) anastomosing burrows are common; low-angle pelletal cross-laminations and asphalt-filled vugs on fresh surfaces are rare. The lower contact of the Paine Member is everywhere concealed and is mapped above the stratigraphically highest float of the reddish-colored Lower Mississippian and Upper Devonian Three Forks Formation.

The thickness of the Lodgepole Limestone varies from 750 ft (229 m) to over 1,000 ft (305 m) thick, due to facies changes and to intraformational bedding plane decollement zones as much as 65 ft (20 m) thick

MDt Three Forks Formation (Lower Mississippian and Upper Devonian)—This formation contains three regionally recognized members which, in descending order, are the Sappington, Trident, and Logan Gulch Members (Sandberg, 1962, 1965). All members are very poorly exposed in the Blacktail Mountains, but conspicuous multicolored soil float of the formation is easily traced, even in densely forested parts of the map area.

The Sappington Member forms benches of variegated bright-purple to light-gray brachiopod limestone and evaporite-solution-breccia with calcareous sandy siltstone and medium-gray silty limestone. The Trident Member crops out locally as pale-olive-gray fissile clay shale. The Logan Gulch Member crops out locally as yellowish-brown to medium-gray dolostone of minor evaporite-solution-breccia. The regionally conformable contact of the Three Forks formation with the underlying Upper Devonian Jefferson Formation is concealed everywhere in the study area, but was mapped at the stratigraphically highest float of dolostone free from the birdseye fabric of the Jefferson

Dj Jefferson Formation (Upper Devonian)—The Jefferson is divided into the Birdseye Member at the top and an unnamed lower member (Sandberg, 1962, 1965). The Birdseye Member is olive-gray to light-gray, intraclastic, vuggy, grainstone-to-rudstone, grain-supported, crystalline dolostone with clay filling intergranular spaces. The lower member is comprised of cyclical repetitions of three lithologies: (1) dark-gray to dark-yellowish-brown, thick-bedded, locally vuggy, crystalline dolostone, which is sour-smelling (H$_2$S) on fresh surfaces; (2) medium-gray to yellowish-gray, medium- to thick-bedded, crystalline dolostone; (3) light-gray to yellowish-brown, thin-bedded and finely laminated, calcareous clay mudstone, lime-mudstone, and shaly dolostone. The contact of the Jefferson with the underlying Upper Cambrian Pilgrim Dolomite is unconformable

Cpi Pilgrim Dolomite (Upper Cambrian)—The Pilgrim is grayish-pink to pale-yellowish-brown, fine- to medium-grained dolostone that is medium- to thick-bedded and contains local faint intraclastic mottles on fresh surfaces. Weathered surfaces are characteristically pitted, coarse grained, and abrasive. Uppermost beds are commonly greenish-gray and aphanitic with thin wavy laminations. The contact with the underlying Middle Cambrian Park Shale everywhere is concealed and is mapped at a break in slope that occurs at the stratigraphically highest float or outcrop of greenish-shale. An abrupt change in float at the contact, local edgewise pebble conglomerate, and a marked lateral change in thickness of the Park Shale, from 100 to 230 ft (30 to 70 m) suggest that a disaster could exist at the Park-Pilgrim contact in the study area

Cpa Park Shale (Middle Cambrian)—The Park is chiefly greenish-gray to dusky-yellow-green, flaky calcareous and waxy, fissile clay shale. Thin- to medium-bedded grayish-orange to moderate-reddish-brown dolostone and lime-mudstone oolitic limestone crop out locally in the middle third of the formation. Hematitic pisolites are common in these carbonate beds and locally dolostone conglomerates form interbedded claststone. The contact of the Park Shale with the underlying Middle Cambrian Meagher Limestone is conformable and is mapped at the base of the stratigraphically lowest bed of greenish shale that is thicker than the beds of reddish carbonates and shales of the Meagher

Cm Meagher Limestone (Middle Cambrian)—The Meagher is composed of grayish-red-purple to pale-red dolostone and limestone layers that are thin- to thick-bedded, but appear massive and form cliffs; these beds are commonly mottled light-gray and contain abundant fine (1-3 mm thick) anastomosing burrows or algal traces. The top third of the formation is pale-reddish-brown to light-olive gray, thin- to medium-bedded dolostone and limestone, and contains several shale interbeds. Thin graded beds and laminations of the carbonates are composed of fining-upward pelletal and oolitic grains. Glauconite grains are most common near the top of the member. The middle third of the formation is pale-red to light-olive-gray, mostly thick-bedded, burrowed, finely crystalline dolostone and limestone. It contains abundant intraclasts, pellets, oncolites, and oolites. Track-and-trail markings are common on bedding planes. The lower third of the formation is commonly covered by talus, is sparry dolostone with pale-red laminations, or pale-red shale. Some beds of the basal third of the member are locally filled small fractures in gently folded limestone and dolostone. The contact of the Meagher with underlying Middle Cambrian Wolsey Shale is everywhere concealed, but regionally is conformable; it is mapped at a break in slope directly above the uppermost exposures of greenish-gray shale typical of the Wolsey

Cw Wolsey Shale (Middle Cambrian)—The Wolsey is olive-green, locally variegated, fissile, calcareous, and micaceous clay shale. Track-and-trail markings (Cruziana zone) are common on bedding planes. The basal 10 ft (3 m) of light-gray, thin-bedded, fine- to medium-grained, glauconitic quartz arenite crop out in the lower half of the formation. The conformable contact of the Wolsey Shale with the underlying Middle Cambrian Flathead Sandstone is gradational and is placed at the base of the stratigraphically lowest bed of sandstone that is thicker than the sandstone beds

Cf Flathead Sandstone (Middle Cambrian)—The Flathead is light-brown to grayish-red, fine- to coarse-grained subarkose, arkose, and quartz arenite. Quartz- and feldspar-pebble conglomerate lenses and conglomerate-bed- and cobble-size beds fining upward to quartz arenites are the dominant lithologies of the unit in northern and central Idaho; in the southern part of the map area, the fine-grained, thin to thick beds of clean-grained (pegmatitic) quartz conglomerate clasts are the dominant lithologies in the southern part of the map area. Some sandstone beds display herringbone cross-stratification commonly with thick, up to 1 ft (1 m), shale drapes over the sandstone foresets. The contact of the Flathead with the underlying Archean gneiss is an angular unconformity

Wg Granite gneiss (Archean)—This unit is dominantly quartzo-feldspathic gneiss with subordinate hornblende gneiss, garnet gneiss, pegmatite, aplite, and mica schist

CORRELATION OF MAP UNITS

Qal$_2$		HOLOCENE	QUATERNARY
Qal$_1$		HOLOCENE AND PLEISTOCENE	
Qrs	Qs		
Qgv	Qgt	PLEISTOCENE	
UNCONFORMITY			
Tc		UPPER TERTIARY	CENOZOIC
Tbb	Tbbl	LOWER MIOCENE	TERTIARY
Tcr		MIDDLE OLIGOCENE	
UNCONFORMITY			
Tru		EOCENE	
UNCONFORMITY			
Kb$_3$		BEAVERHEAD GROUP	UPPER CRETACEOUS
Kb$_2$			
Kb$_1$			
UNCONFORMITY			
KJu		LOWER CRETACEOUS AND UPPER JURASSIC	MESOZOIC
UNCONFORMITY			
Rd		LOWER TRIASSIC	
UNCONFORMITY			
Pp		PERMIAN	
UNCONFORMITY			
MPq		UPPER MISSISSIPPIAN AND PENNSYLVANIAN	
Mcr		SNOWCREST RANGE GROUP	
Mlb		UPPER MISSISSIPPIAN	
Mk			
UNCONFORMITY			
Mmc		MADISON GROUP	PALEOZOIC
Mlp		LOWER MISSISSIPPIAN	
MDt			
Dj		UPPER DEVONIAN	
UNCONFORMITY			
€pi		UPPER CAMBRIAN	
€pa			
€m		MIDDLE CAMBRIAN	
€w			
€f			
UNCONFORMITY			
Wg		ARCHEAN	PRECAMBRIAN

EXPLANATION

Contact—Dashed where approximately located

Fault—Dashed where approximately located; dotted where concealed. U, upthrown side; D, downthrown side. Arrows show direction of strike-slip movement

Thrust fault—Dashed where approximately located; dotted where concealed. Sawteeth on upper plate. Arrows show direction of tearing at margin of thrust plate

Anticline—Showing trace of axial plane and direction of plunge

Overturned anticline—Showing trace of axial plane and direction of plunge

Syncline—Showing trace of axial plane and direction of plunge. Dotted where concealed

Strike and dip of beds

Inclined

Overturned

Strike and dip of foliation

Inclined

Prospect

EXPLANATION OF CROSS SECTION SYMBOLS

Thin-bedded limestone

Medium-bedded limestone

Thick-bedded limestone. Small hachures at top represent evaporite-solution breccia, or salt at basal decolement

Dolomite

Clastic rocks

Metamorphic rocks

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This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

Base from U.S. Geological Survey
Ashbough Canyon, 1961
Gallagher Mountain, 1963
Beech Creek and Monument Hill, 1965

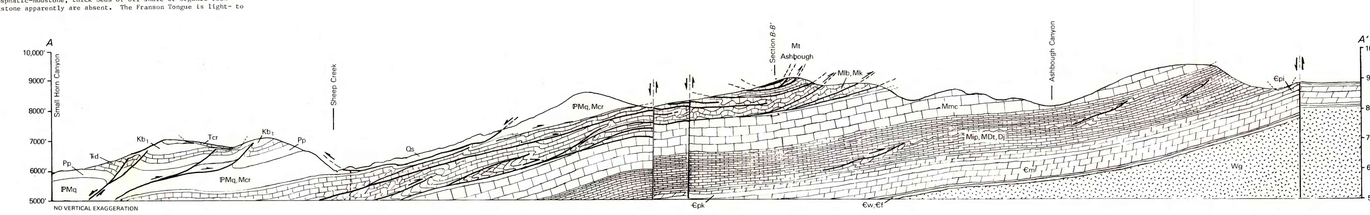
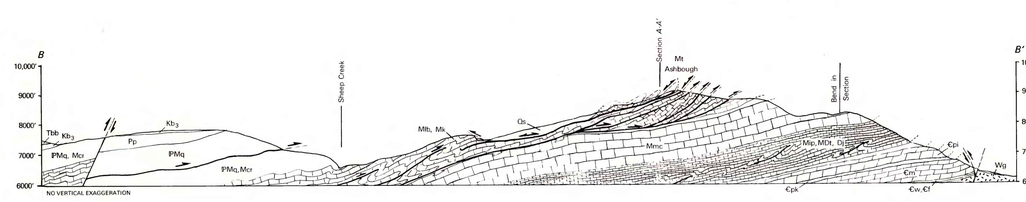
SCALE 1:24 000

1 0 1 MILE
1 0 1 KILOMETER

CONTOUR INTERVAL 20 AND 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

APPROXIMATE MEAN DECLINATION, 1979

MONTANA

GALLAGHER MOUNTAIN | ASHBOUGH CANYON | MONUMENT HILL | BEECH CREEK

MAP AREA (SHADED) AND QUADRANGLE BOUNDARIES