UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

ARGENTA TO BANNACK, BEAVERHEAD COUNTY, MONTANA

ROAD LOG AND FIELD TRIP GUIDE

for

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Montana Section

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by

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ROAD LOG

Mileage

0.0 Begin mileage at east end of Argenta (fig. 1). Drive southeast on Argenta Road across Argenta Flats, a gently sloping alluvial plain that was formed largely by deposition of glacial outwash from Rattlesnake Creek during the Pleistocene.

2.8 Take left fork of road.

3.5 A "strat test" hole was drilled near this point (NE1/4 NE1/4 Sec. 10, T7S, R10W). A well log indicates that the hole penetrated 150 ft of Quaternary gravel (some of it bouldery), sand, and minor clay. This alluvium is underlain by 520 ft of Tertiary(?) sediments that are predominantly clayey but also include less than 25 percent sand and gravel. At 670 ft, the hole penetrated volcanic rocks (basalt?) and continued in volcanics and minor interbedded gravel to T.D. 800 ft.

The white rock covering this and many other roads in the area is a zeolitic tuff extracted from a quarry adjacent to highway 278 a few miles to the southwest.

4.6 Turn right onto the old Big Hole Road; this is also part of the old "Dillon-Bannack Stage Road".

6.3 Cross Ermont Gulch and Ermont Road. As Ermont Gulch is approached, road descends from the level of Argenta Flats. Tertiary strata form the 300-ft-high mesa to south.

6.4 Turn right onto Highway 278.

6.6 Tertiary strata exposed in roadcut. Strata here are reddish-brown and sandy. Kay and others (1958) gave a Miocene age for these beds. Highway continues over Tertiary deposits for next 1.5 mi.

8.1 Base of Tertiary strata in low saddle on ridge. Depositional contact of Tertiary strata with underlying Cretaceous volcanics here dips easterly about 3 degrees. At some places in this area, the dip of the contact is considerably steeper, although it seems to be depositional everywhere. No faulting has been detected along this contact for several miles to the north and south. Elsewhere in the region, faults are common at the margins of Tertiary basins.

The Upper Cretaceous volcanic rocks, which are exposed intermittently for the next few miles, comprise two dissimilar volcanic units: the lower is light-colored silicic tuff (tuff of Grasshopper Creek) and the upper is somber-hued lavas, breccias, and minor pyroclastic deposits, volcanic conglomerate, and volcanic sandstone (volcanics of Cold Spring Creek) (Ivy and others, 1988). The tuff of Grasshopper Creek is exposed on the low hill 500 ft north of the highway; from the highway it appears as barely observable light-colored float among the sage brush. This exposure is on the east flank of a shallow syncline. The lavas in the volcanics of Cold Spring Creek are not exposed adjacent to the highway at this point. Both of these units are better exposed about 2.5 mi farther west on the west flank of the syncline.

8.4 A large hypabyssal intrusive sheet (McDowell Spring sill) is exposed in unspectacular roadcuts. The body is at least 400 ft thick (along Grasshopper Creek 8 mi to the south) and about 4 mi x 10 mi in extent. In the roadcut, the rock (porphyritic dacite) is massive, slightly altered, and greenish gray to brownish gray. At 74 Ma ($^{40}Ar/^{39}Ar$ determinations by L.W. Snee, oral commun., 1988), the McDowell Spring sill is the youngest rock known in the volcanics of Cold Spring Creek. The sill intrudes lavas in the volcanics of Cold Spring Creek along the highway and most other places, but about 0.8 mi north of the highway the sill intrudes and sends apophyses into the tuff of Grasshopper Creek, the oldest rock that it is in contact with. Occasional views to the south from the highway reveal distinctive steep-sided hills about 2 mi away that are the result of erosion into this sill.

9.1 Cross contact between McDowell Spring sill and overlying Tertiary strata, which form a gently east-dipping layer locally more than 100 ft thick above the Upper Cretaceous rocks. This erosional remnant, one of several along this portion of the piedmont, is more than 1 mi long adjacent to the highway and more than 0.5 mi wide north and south. Brown sandy deposits similar to those in the roadcut near Ermont Gulch are exposed on left.

10.5 Back into Upper Cretaceous volcanic rocks on west flank of syncline. Volcanics of Cold Spring Creek are exposed along highway for less than 100 ft. West of there, tuff of Grasshopper Creek is exposed.

10.8 Road metal quarry in tuff of Grasshopper Creek on left.

Saddle between quarry and timbered ridge of Quadrant Quartzite to west marks the approximate location of a fault that separates the Cretaceous volcanic rocks to the east from Paleozoic sedimentary rocks to the west. To the south as far as Grasshopper Creek (about 6 mi), this contact shows direct evidence of being a fault, although at some places the fault has been intruded and obliterated by fine-grained granodiorite. Locally the fault can be shown to dip west at a low angle or be nearly horizontal; it is interpreted as an east-directed thrust. To the north, however, the evidence for faulting is sparse but compelling. The only direct evidence is 1 mi to the north near a small area where conglomerate and sandstone (Upper Cretaceous Beaverhead Group) have been tilted to vertical and crop out about 200 ft down a gentle slope from massive outcrops of Mission Canyon Limestone (Mississippian). This fault was mapped by Lowell (1965) and named the Ermont thrust by Myers (1952) for supposed exposures near Ermont Gulch.

11.2 Roadcuts in west-dipping Pennsylvanian Quadrant Quartzite. Bedding in Quadrant is generally obscure.

11.7 Open treeless synclinal valley underlain by Permian Phosphoria Formation and in one small area in the synclinal trough by Triassic Dinwoody Formation. The valley is surrounded by timbered ridges held up by Quadrant Quartzite.

12.3 Quadrant Quartzite ridges to north and south of highway.

12.6 Badger Pass. Badger Pass is the high point on the highway over Badger Ridge, as it is known locally, which is held up predominantly by folded and faulted Paleozoic sedimentary rocks. The ridge is 2-3 mi wide and 8 mi long; it extends from Ermont Gulch on the north to beyond Grasshopper Creek on the south.

Low bare hill a few hundred feet south of highway is capped by thin gravel deposit that is probably late Tertiary. The gravel is underlain by Mississippian Mission Canyon Limestone. Other Tertiary beds lap onto the pre-Tertiary rocks locally along the west side of the ridge, but the straight contact at other places suggests that, at those places at least, the contact is a steep fault.

Permian Phosphoria Formation crops out north of the highway at Badger Ridge.

13.4 Approximate trace of east-trending Badger Pass fault that Ruppel (1982) interprets as a strike-slip fault.

13.8 Roadcuts in Conover Ranch Formation (Upper Mississippian or Lower Pennsylvanian) here about 100 ft thick with the base not exposed. The Conover Ranch grades into Quadrant Quartzite in upper 20 ft of exposure. Timbered hill southeast of highway is Mission Canyon Limestone. The relations suggest that a northeast-trending fault is in the valley adjacent to the highway because the normally intervening Kibbey Sandstone and Lombard Limestone seem to be absent.

West of the exposures of the Conover Ranch are Tertiary deposits that occupy most of upper Grasshopper Creek valley to great depth. Where exposed, the deposits are fluvial and lacustrine and are clay rich, presumably from the alteration of volcanic ash. Vertebrate fossils collected about 3 mi to the northwest indicate that these beds are probably late Oligocene or early Miocene (Fields and others, 1985).

The timbered ridge that forms the skyline about 10 mi to the west is Big Hole Divide. It is underlain by quartzitic strata of the Middle Proterozoic Missoula Group (Belt Supergroup). Structurally, these strata are part of the Grasshopper thrust plate (Ruppel and Lopez, 1984) that consists largely of Belt Supergroup rocks. The trace of the thrust fault that marks the eastern limit of the Grasshopper plate is buried by the Tertiary strata in Grasshopper Creek valley.

16.2 Turn left on road to Bannack. Road continues over Tertiary and Quaternary deposits as far as Bannack.

19.1 Junction with road south to Grant in Horse Prairie (Fig. 1). Continue straight ahead. Note placer tailings across Grasshopper Creek to south. These placer workings are above the level of Holocene gravels along Grasshopper Creek and are partly or entirely within the Tertiary strata in Grasshopper Creek basin.

19.7 Turn right to campground. Cross Grasshopper Creek to picnic area for lunch.

After lunch, continue driving east on gravel road that by-passes Bannack on the south side of Grasshopper Creek. The road passes the Hendricks millsite, which is fenced and posted with signs warning of contamination. The danger is presumably from either mercury or cyanide. Mercury would seem the most likely, as an amalgamation plant was installed in 1918, and mercury is relatively immobile in the mill tailings. Cyanide processing of the ore was added in 1919, but it is unlikely that a hazzard from that source would remain for the several decades since mining ceased in 1941, for cyanide breaks down in the surface environment.

20.4 Park in open flat area after recrossing Grasshopper Creek to the north side. Walk (or drive if the road is accessible and permission can be obtained) downstream (east) to observe Mississippian limestone that forms the host rock for ore, the main lode-mining area of the Bannack district, and the current placer-mining operation.

BANNACK MINING DISTRICT

History

Bannack holds a unique position in the mining and political history of Montana, chiefly because it was the first discovery that led to the development of a major mining district and because it was the first capital of the Territory of Montana. In recognition of this and because of its picturesque appearance, its preservation as Bannack State Park is richly deserved.

The first white men to visit the area were the members of the Lewis and Clark expedition who made their way up the Beaverhead River in August, 1805. They went through the site of Dillon, passed the mouth of Grasshopper Creek, which they named Willard's Creek, and continued on to the south and west over the mountains through Lemhi Pass. On their return the following year, William Clark and 19 others came south through Big Hole valley, crossed over Big Hole Divide (probably where the present highway 278 crosses), and went down Grasshopper Creek on their way to a cache on Horse Prairie Creek to the south. Thus, they were within sight of Bannack, undoubtedly without giving gold or mining a passing thought.

In 1862, a group of prospectors, who had come into east-central Idaho from the south, crossed the Beaverhead Mountains, probably at Big Hole Pass east of Gibbonsville, Idaho, and discovered gold about July 10 in the streams at the head of Ruby Creek, which is about 10 miles southwest of the present town of Wisdom, Mont. In order to bring supplies by wagon from Idaho to the new diggings, the miners followed the Indian trail over Lemhi Pass, went down Horse Prairie Creek, then turned north into upper Grasshopper Creek valley. Other prospectors soon followed this route from the Salmon River country, and on July 28, 1862, members of a party that included John White and William Eads, panned the gravels where they crossed a creek and found colors. Not aware that Lewis and Clark had named the creek Willard's Creek, they named it Grasshopper Creek, which name has survived.

News of the discovery spread rapidly. Wagon trains and parties of various size throughout the region were diverted from their original destination by the reports of gold and headed for Grasshopper Creek. That first year about 400 persons wintered at Bannack, as the miners named the new camp, and by September, 1863, the population had grown to 3,000 or 4,000. Bannack became the first capital of Montana Territory after it was established in May, 1864.

The richest placer ground available for working with primitive hand methods was soon depleted, and a lack of sufficient water prevented efficient mining. Discovery of the Alder Gulch placers near Virginia City in 1863 also resulted in a major exodus from Bannack. The water problem was partially solved when ditches were completed, beginning in 1863 but particularly after 1866, and as a result, placer mining was revived. The ditch water also assisted in working bench gravels as much as 100 ft above creek level. A further impetus was provided in the 1890's with the introduction of dredges that continued to operate until 1902. Placer mining by various techniques has persisted off and on until the present time. The creek has now been placered for 7 mi below Bannack.

The first lode mine of consequence in Montana was the Dakota, claimed in November, 1862, only a few months after the original placer discovery. Rich gold ore was mined from near the surface on several of the 12 Dakota claims, which under regulations then extant were only 100 ft long. Those claims and workings are now covered by the patented Gold Bug and Blue Grass claims located about 1,500 ft northeast of Grasshopper Creek. Most of the lode mines, however, were developed on the southwest side of the creek. A group of claims in the central part of the district was consolidated into the Golden Leaf Mining Company in 1890. It and its successors and lessees mined from the Golden Leaf group intermittently through 1955.

Most of the metal production from the Bannack district, which was almost entirely gold, was obtained prior to consistent record keeping that began in 1902. Various estimates of production have been made based on company records, hearsay, interviews, and newspaper accounts. These estimates range to as much as 500,000 oz gold. Considering the volume of placer gravel worked, the number and size of lode mines, and the fact that the richest gravels and ores were mined in the earliest years by a large number of individuals, this figure may not be far from the truth. Placer production probably has exceeded lode production by a factor of about three to four.

Geology

The lode mines of the Bannack district (fig. 2) are along the sides of the narrow gorge of Grasshopper Creek where it flows southeast through a north-trending ridge (Badger Ridge) of folded and thrust-faulted strata of Mesozoic and Paleozoic age. The bulk of the rocks exposed in the ridge are Mississippian through Triassic age. They have been thrust over Upper Cretaceous detrital sedimentary and volcanic rocks exposed along the east flank of the ridge. Most of the mines are localized in limestone on the periphyry of a granodiorite stock that is exposed on the south side of the valley about 1 mi downstream from the town of Bannack.

The chief sedimentary rocks in the district are cliff-forming beds of the Mississippian Lodgepole Limestone and Mission Canyon Limestone, which constitute the Madison Group. For more than 2 mi north of the district, the ridge is capped by these two units. Within the district, however, contact metamorphism has caused recrystallization of the normally light to dark gray limestone to produce fine- to coarse-grained white to light-gray marble to such an extent that the identification of the formations at many places is at present in doubt. Locally, calc-silicate skarn is present at the contact of the marble and the granodiorite.

Also exposed are the Upper Mississippian Lombard Limestone and Kibbey Sandstone on the east and south sides of the district, and the Pennsylvanian Quadrant Quartzite on the west side of the district. All of the Paleozoic formations are in complex fault relations with one another.

On the northeast side of Grasshopper Creek east of the district, a thrust plate consisting of the Mississippian limestones lies on an Upper Cretaceous sequence, consisting of Beaverhead Group, tuff of Grasshopper Creek, and volcanics of Cold Spring Creek. These units have been tilted to vertical beneath the thrust, but in less than a mile farther to the east the dip has flattened to a gentle southeast dip, and deformation of the rocks seems to be insignificant. Within the Beaverhead, which is chiefly red-weathering limestone-pebble conglomerate with a quartz-sand matrix, are elongate masses of Mississippian limestone as much as 1 mi long (south of the area of fig. 2) that are interpreted as exotic blocks similar to those described in the Beaverhead Group in the Tendoy Range to the south (Perry and Sando, 1982). Near Bannack, these blocks have previously been interpreted as klippe (Lowell, 1965). East of Bannack, well exposed contacts of these blocks with sandstone and conglomerate of the Beaverhead show clearly that they are not tectonic contacts. The masses are tentatively interpreted as blocks broken off of the overlying thrust plate after it broke through to the surface and became an erosion thrust. If this is true, the thrust probably did not continue eastward much farther than its present eastern trace.

The igneous rocks in the district consist of medium-gray fine-grained granodiorite that forms a stock about 1 mi long and 0.5 mi wide, a smaller stock about 0.25 mi in diameter, and numerous dikes and small irregular bodies. The lode mines are associated spatially with both of the stocks, which are 0.2 mi apart and hence probably apophyses of a single, large body at depth. The two stocks intrude Mississippian limestone, but the dikes and other small bodies are especially abundant in the Cretaceous volcanic rocks. In general, the intrusive rocks are slightly altered and do not crop out well. Although the age of these intrusive rocks has not been determined directly, they are probably Late Cretaceous (about 75 Ma) on the basis of K/Ar and $^{40}Ar/^{39}Ar$ determinations on similar rocks a few miles to the east and north (oral commun., L.W. Snee, 1988). The age of the intrusive rocks with respect to thrusting has likewise not been determined directly. The evidence is conflicting and can be interpreted to indicate two ages of faulting, two ages of intrusion, or both; however, most thrusting was probably over before intrusion began.

Mineral deposits

The principal lode deposits are replacement bodies in limestone or marble near the two stocks, but some are in skarn. The most favorable location is where the recrystallized limestone (or skarn, if present) changes outward to unrecrystallized limestone. The reason for this localization is uncertain, but perhaps the marmorization caused volume changes that resulted in increased permeability for ore-forming fluids in this zone. The ore bodies are tabular, pipelike, or irregular, and some are veinlike, though short and not confined to recognizable fractures.

The primary ore consists of gold-bearing quartz and pyrite. Minor amounts of chalcopyrite are widespread, and galena and sphalerite are sporadic in occurrence. The early-mined ore was oxidized and enriched in gold in the near surface invironment compared to the unoxidized ore. This oxidized ore commonly consisted of aggregates of earthy iron oxides and quartz; locally manganese oxides, carbonate minerals, and secondary copper minerals were present. These ores were particularly desirable as they could be treated merely by crushing followed by amalgamation or cyanidation. The primary sulfide ore required more complex treatment by milling equipment not readily available in the early days.

In terms of production, the chief lode mines of the district are the Golden Leaf (or Sleeping Princess) group, Excelsior, and the Hendricks, all on the southwest side of Grasshopper Creek, and the Gold Bug, which includes the original Dakota claims, on the northeast side. Several other mines produced smaller amounts. The Golden Leaf group was by far the largest lode mine in the district; it produced between about 75,000 and 125,000 oz of gold between the 1860's and 1955.

BLUE WING MINING DISTRICT

About half way between the Bannack district and Highway 278 is the Blue Wing district (fig. 2). It will not be visited on this excursion and, hence, will be described only briefly. Additional information is available in Shenon (1931) and Geach (1972).

The Blue Wing district was discovered in 1864, and the first mine developed, the Kent, became the first silver mine in Montana. In contrast to the Bannack district, the Blue Wing district is chiefly a silver district, and its total production is much smaller but probably in excess of $2,000,000.

The geology of the Blue Wing district is strikingly similar to the Bannack district. The main ore bodies are replacement deposits and short veins in Mississippian limestone near the contact with fine-grained granodiorite. In addition, a few veins in granodiorite have been mined. The intrusive body is more than 1.5 mi wide and 2 mi long but is probably relatively thin, as it seems to have been intruded along a flat or low west-dipping thrust fault (the same thrust exposed on the east side of the Bannack district). If this intrusive body has a root or feeder pipe beneath it, as seems likely, its location is unknown. The largest mine in the district is the New Departure that was developed in a klippe of Mississippian rocks. In part, the klippe, which is about 0.5 mi wide and 1 mi long, rests in fault contact with Cretaceous volcanic rocks and in part is underlain by the intrusive body that is inferred to have intruded along the thrust contact. The ore bodies are in limestone near the intrusive.

Much of the richer ore mined was oxidized to a brown to black aggregate of iron and manganese oxides. Primary ore minerals include sphalerite, galena, chalcopyrite, pyrite, polybasite, tetrahedrite, and pyrargyrite in a gangue of quartz, calcite, and rhodochrosite.

SOURCES OF INFORMATION

Much of the information in the preceding paragraphs was obtained from a few sources. The historical data is mainly from a master's thesis by Oren Sassman, a native of Dillon. Most of the geologic and mineral deposit information is from a geologic map by W.R. Lowell, a report on mining districts in Beaverhead County by R.D. Geach, reports on regional geology by E.T. Ruppel and associates, and unpublished work by R.C. Pearson. References to these and other selected reports appear below.

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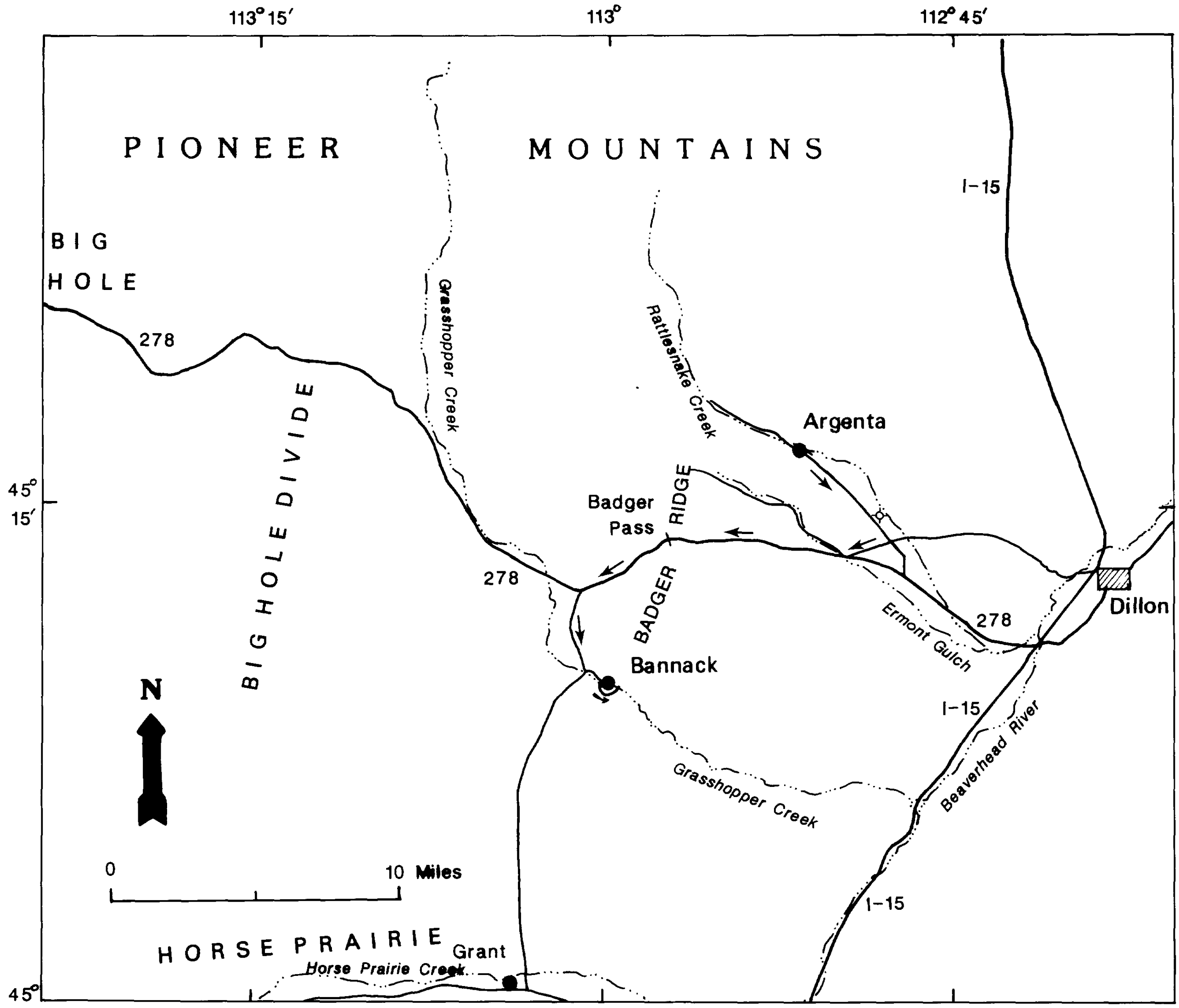
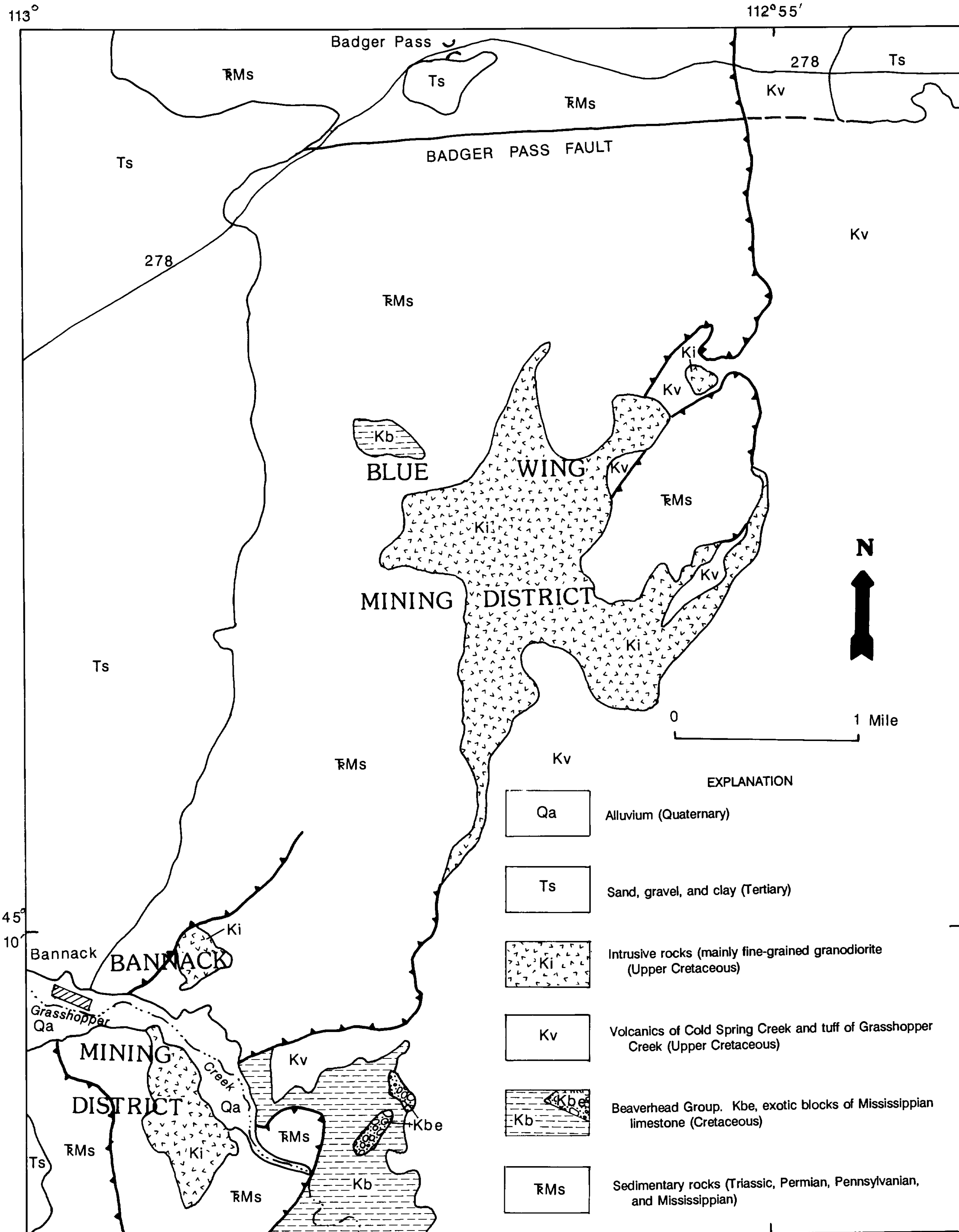


Fig. 1 -- Index map of the Argenta-Bannack area, Beaverhead County, Montana. Arrows show field-trip route from Argenta to Bannack.



Geology from Lowell (1965); modified by R.C. Pearson, 1988

Fig. 2 -- Generalized geologic map of the Bannack and Blue Wing mining districts, Beaverhead County, Montana.