Geology of the Jarbidge Quadrangle, Nevada-Idaho

By ROBERT R. COATS

CONTRIBUTIONS TO GENERAL GEOLOGY

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GEOLOGY OF THE JARBIDGE QUADRANGLE, NEVADA-IDAHO

By Robert R. Coats

ABSTRACT

The Jarbidge quadrangle in Elko County, Nevada, and Owyhee County, Idaho, is an area of rugged mountains that reach an altitude of almost 11,000 feet and have almost a mile of total relief. The mountains are bounded on the north by a dissected tableland of young volcanic rocks and intercalated sediments. The extreme western part of the quadrangle is underlain by Precambrian(?) phyllite, quartzite, and schist and by probable Paleozoic limestone, quartzite, and phyllite. These rocks have been intruded by biotite quartz monzonite and hornblende-biotite quartz diorite of Cretaceous age and locally metamorphosed to andalusite- and biotite-cordierite-staurolite hornfels. Marginally, these rocks are overlain by thick lenticular accumulations of conglomerate and light-colored silicic tuffs and by an extensive blanket of intermediate to silicic tuff and lava. The older volcanic rocks and the basement on which they rest have been extensively faulted; the youngest lavas of this sequence are the host rocks for deposits of gold and silver and have been eroded to a surface of low relief. On this surface are several distinguishable sequences of silicic, mostly rhyolitic, pyroclastics and flows, which have been tilted gently northward and eroded. On this erosion surface rest gravel and basalt of Pliocene age. Erosion has been the dominant geomorphic process since eruption of the basalt, but locally much of the surface is mantled with stream, landslide, and glacial deposits.

The chief pre-Cretaceous structural feature is the Copper Mountain thrust, along which the Prospect Mountain(?) quartzite and Precambrian(?) rocks have been brought above undifferentiated Paleozoic(?) sedimentary rocks. The direction of movement on the thrust is not known, but it is thought that the hanging wall moved northwestward. The date of movement is not known but is apparently earlier than that of the Roberts Mountain thrust. A thrust fault believed to be the Roberts Mountain thrust is exposed just south of the southwestern part of the Jarbidge quadrangle. The Deer Creek thrust, on which Precambrian(?) rocks have been thrust over the Prospect Mountain(?) quartzite, is believed to be a steep subsidiary of the Copper Mountain thrust. Some steep northward-trending pre-Cretaceous faults in the southwestern part of the quadrangle are apparently downthrown on the west.

The presence of early Tertiary faults, probably of northeasterly trend, is suggested by the restricted distribution of the Dead Horse tuff and Meadow Fork formation. The Copper Creek fault, of considerable though not precisely known normal throw, trends N. 17° E., dips about 20° SE., and separates Paleozoic rocks from Tertiary rocks in the southwestern part of the quadrangle. The upper Miocene volcanic rocks are cut by numerous steeply dipping normal faults; the two predominant trends are north to N. 20° W., and east to N. 70° E.; the direction of throw is variable. The Jarbidge Mountains are roughly a nearly north-trending horst; north-flowing streams are thought to be consequent on the fault-block structure of late Miocene age. Pliocene rocks are cut by relatively few faults; one conspicuous fault, contemporaneous with the extrusion of the Pliocene basalt and trending about N. 75° E., with the north side downthrown, cuts the Banbury formation.

Mineral deposits, not described in detail in this report, include Tertiary epithermal gold-silver veins and scheelite-bearing tactite.

INTRODUCTION

The Jarbidge quadrangle embraces an area containing an unusually extensive and varied succession of volcanic rocks of rhyolitic to basaltic composition. Mapping was begun as part of a study on the distribution of trace elements in Cenozoic rhyolitic and dacitic volcanic rocks, with the idea of determining, if possible, the trends of differentiation as they affect the distribution of some of the rarer elements, especially uranium. The work was conducted on behalf of the Division of Raw Materials, U.S. Atomic Energy Commission.

Mapping of the quadrangle was begun in 1954 and continued through the field seasons of 1955 and 1956 by Robert R. Coats, assisted by D. C. Alverson in 1954 and B. F. Jones in 1956.

The Jarbidge quadrangle is in northeastern Nevada and southwestern Idaho; all but a small fraction of the area is in Elko County, Nevada; the remainder is in Owyhee County, Idaho. The region is accessible from Elko by State Highway 11 and gravel roads during the summer months and from Rogerson, Idaho, almost all year. The population fluctuates from about 6 during the winter to approximately 30 during the summer. The town of Jarbidge has the only post office, and one ranch house is the only permanent habitation in the quadrangle outside the town.

The chief topographic feature in the Jarbidge quadrangle is the ridge of the Jarbidge Mountains, a single crest that trends about N. 20° W. and maintains an altitude between 9,800 and 11,000 feet for about 7 miles. The Jarbidge River and its East Fork flow at altitudes ranging from 7,600 feet near their headwater forks to about 6,200 feet in the latitude of Jarbidge, giving a local relief of more than 4,000 feet. Both rivers leave the quadrangle at an altitude of about 5,300 feet in canyons excavated about 700 feet below the surrounding tableland that slopes gently northward to the Snake River plains.

GENERAL GEOLOGY

The Jarbidge quadrangle is underlain by sedimentary rocks of Precambrian(?) and probable Paleozoic age that have been intruded by intermediate granitic rocks and locally are hosts to small contact-metasomatic deposits of scheelite. These rocks were deformed in Eocene(?) time, with the resultant formation of local basins in which conglomerates and light-colored silicic tuffs accumulated. More widespread eruptions of intermediate to silicic tuff and lava followed. The Miocene and older rocks were extensively faulted; gold and silver were deposited in veins cutting the rhyolites; the Miocene rhyolites were eroded to low relief. On this surface, several distinguishable sequences of silicic pyroclastics and flows, with local intrusive phases, were successively deposited, slightly eroded, and succeeded by gravel and basalt. Erosion has been the dominant geomorphic process since the last eruption of basalt, but locally much of the surface is mantled with deposits of landslides, streams, and glaciers.

PRE-TERTIARY ROCKS

PRECAMBRIAN(?) ROCKS

Precambrian(?) schist, quartzite, and hornfels have been recognized only in the southwest corner of the Jarbidge quadrangle; they are more extensively exposed in the quadrangle to the south, in the Mount Velma quadrangle along the canyon of Copper Creek, and on the Copper Mountains ridge in the southeast corner of the Rowland quadrangle. K. O. Bushnell (written communication, 1955) described a unit of phyllite along lower Cottonwood Creek in the Rowland quadrangle. He said that the phyllite is everywhere in fault contact with a quartzite that correlates with the Prospect Mountain quartzite. The phyllite is generally similar to some parts of, but less metamorphosed than, the Precambrian(?) schist. Where thermally metamorphosed, the phyllite is converted to a chiastolite hornfels.

The principal lithologic types along Copper Creek canyon in the southwest corner of the Jarbidge quadrangle and in the Mount Velma quadrangle are thin-bedded quartzite and quartz-mica schist. One bed of feldspathic quartzite has blastophenocrysts of quartz and is apparently a metatuff. Muscovite and chlorite, the latter after green biotite, are common in the schist, and magnetite, green tourmaline, zircon, and apatite are also present. In the mica schist, the percentage of quartz is much less. Along Copper Creek, in the Western half of what would be sec. 25, T. 45 N., R. 57 E., were the subdividing carried out, the schist has been thermally metamorphosed, presumably by an unexposed intrusive body, to andalusite hornfels and biotite-cordierite-staurolite hornfels. In many places andalusite, cordierite, and staurolite have retrogressed to mica and chlorite. This part of the stratigraphic section is compositionally different from that in the Mount Velma quadrangle, described above.

The Precambrian(?) schist, quartzite, and hornfels rest on Prospect Mountain(?) quartzite in thrust contact. A possible depositional contact between Prospect Mountain(?) quartzite and Precambrian(?) rocks is exposed on the north side of the Copper Creek canyon, in the footwall of the Copper Creek fault; here, about 50 feet of white, tan-weathered quartzite that is pebbly at the base rests on the Precambrian(?) rocks. Bedding in the white quartzite is parallel to the bedding in the underlying schist and quartzite. On the southernmost ridge of the Copper Mountains in the Mount Velma quadrangle, the Precambrian(?) schist and quartzite lie in thrust contact on the Prospect Mountain(?) quartzite. Slices as much as 80 feet thick of the pure quartzite that resembles the typical Prospect Mountain(?) lie below greenish quartzite and schist of the Precambrian(?), close to the thrust contact. This is thought to be tectonic interlamination, but it could be due to change in the conditions of sedimentation.

Somewhat similar rocks have been mapped as Precambrian elsewhere in western Utah and eastern Nevada. Nolan (1935, p. 6) recognized about 2,000 feet of interbedded "slaty shales and rather thin-bedded dark quartzites" below the massive dominantly light-colored quartzite on the east side of the Deep Creek Mountains, just south of the Gold Hill district. Bick (1959, p. 1064–1065) proposed to restrict the term "Prospect Mountain quartzite" to the upper massive quartzite and to call the lower part of the formation the Goshute Canyon formation. Young (1960, p. 158–160) described a section 10,000 feet thick in the Schell Creek Range that he termed the Piermont group. It consists of tan, dark-brown, and gray to purplish-gray quartzite, much of it pebbly, and phyllitic shale and argillaceous siltstone. This sequence lies conformably beneath the Prospect Mountain quartzite; the lithologic change between the Piermont group and the Prospect Mountain is slight.

PROSPECT MOUNTAIN(?) QUARTZITE

The Prospect Mountain quartzite of Early Cambrian age was named by Hague (1883, p. 254) from exposures in the Eureka district, where he reported a thickness of about 1,500 feet. At Eureka, as elsewhere, the unit is unfossiliferous. The thick, massive formation, predominantly quartzite, that makes up most of the Copper Mountains ridge in the southwestern part of the quadrangle, is in this report correlated with the Prospect Mountain(?) quartzite. The formation also crops out in two small fault slices southeast of the town of Jarbidge.

The principal lithologic type is a massive white glassy tan-weathering quartzite with thin beds of mica schist. A minimum thickness of about 1,500 feet is present in the Jarbidge quadrangle. K. O. Bushnell (written communication, 1955) estimated that 2,000 to 3,000 feet of the unit was present in the Rowland quadrangle to the west.

In the absence of fossils, correlation of the formation can be based only on lithology. The Prospect Mountain is the only very thick, massive quartzite in the Paleozoic of this part of Nevada or Utah. The Prospect Mountain at Eureka, and other places where it is conformably overlain by known Lower Cambrian rocks, is generally relatively unmetamorphosed. In the Ruby Mountains, some rocks mapped by Sharp (1942, p. 651) as Prospect Mountain quartzite are notably more metamorphosed than the conformably overlying Middle Cambrian formation.

UNDIFFERENTIATED PALEOZOIC(?) SEDIMENTARY ROCKS

The pre-quartz monzonite sedimentary rocks are almost completely unfossiliferous, and they are not sufficiently distinctive in lithology to permit long-range correlation with well-dated rocks. Even short-range stratigraphic relations of many sequences are doubtful. The beds are found in small blocks bounded by faults or intrusive rocks and may be overlapped by much younger rocks. They are exposed in three principal areas; along the southwest edge of the quadrangle in Copper Basin, in the valley of Coon Creek and along the eastern slope of Copper Mountains just west of it, and in an area about 3 miles long and no more than 1 mile wide along the central part of the west border of the quadrangle. A fourth and smaller area is southwest of Marys River Peak in the center of the south edge of the quadrangle.

The rocks included in this unit are mostly calcareous. In Copper Basin and in the valley of Coon Creek, the principal rocks are thin-bedded and massive gray crystalline limestones rhythmically interbedded with thinner layers of yellowish-weathering silty limestone. There are also lesser amounts of pale-gray lustrous limy phyllite. Near the quartz monzonitic intrusives, these rocks are altered to tactite. In the area along the central part of the west boundary, the sedimentary rocks include a lower phyllitic member composed of pale-gray graphitic and limy phyllite and dark micaceous quartzite; an upper member is massive to well-bedded gray crystalline limestone. The limestone is altered to tactite near the quartz monzonitic intrusive. The Paleozoic(?) sedimentary rocks along the south-central part of the quadrangle boundary are composed of well-bedded gray to black chert consisting of sponge spicules and radiolaria; the cores of some of the spicules and later fractures in the rock are filled with apatite. E. R. Cressman (oral communication, 1959) suggested that the migration of apatite into the fractures may be a result of thermal metamorphism of unrecognized phosphatic rocks nearby. The thickness of the chert is not known, but it must exceed 600 feet.

The least metamorphosed limestone is relatively pure and contains only a small amount of chlorite and quartz, which are probably detrital. Thermal metamorphism produced phlogopitic mica and tremolite first, then diopside. Close to the contact with the intrusive rock, diopside, epidote, and grossularite are common. Locally, epidote is replaced by pink thulite; diopside, by green hornblende; and pyrite, pyrrhotite, molybdenite, and scheelite have been added in small amounts. More aluminous sediments, close to the intrusive contact, have given rise to microcline-bearing quartz-biotite schists that contain sparse crystals of sapphire as much as 1 mm in length. The irregular attitudes and lack of visible top or bottom permit only the crude estimate that several thousand feet of rock must be represented.

The only determinable fossil found in these rocks is a single poorly preserved trilobite, the age of which, according to A. R. Palmer (written communication, 1957), could be given with certainty only as "pre-Carboniferous Paleozoic * * * most likely Cambrian or early Ordovician * * *." This specimen came from thin-bedded limestone in Copper Basin, the coordinates of which are N. 2,559,500, E. 526,100.

QUARTZ MONZONITE

Quartz monzonite intrudes all the pre-Tertiary rocks in the western part of the quadrangle; it occurs as one large stock, most of which is in the Rowland quadrangle to the west, and a few small satellitic bodies. The dominant rock is a medium- to fine-grained biotite quartz monzonite (adamellite); biotite granodiorite is less common. Minor contact phases include hornblende-biotite quartz diorite and aplitic dikes of syenitic or granitic composition.

The intrusive contacts are not well exposed but are apparently highly irregular. Directional textures are not conspicuous; evidence of granitization is very scarce, except locally in some aplitic rocks along the contact.

The plutonic rocks in this part of Nevada have generally been regarded as outliers of the Idaho batholith of Cretaceous age (Larsen and Schmidt, 1958, p. 19). This age assignment is accepted here.

TERTIARY AND QUATERNARY ROCKS

DEAD HORSE TUFF

The formation here named the Dead Horse Tuff is the oldest Tertiary formation in the Jarbidge quadrangle. It is named for Dead Horse Creek in Copper Basin, part of the type locality. It crops out in Copper Basin, in the area south of Copper Basin outside the quadrangle, and in the area of Seventy Six Creek, to the east of Copper Basin. It is chiefly a crystal-vitric tuff, ranging in grain size from very fine to coarse, and, where coarse-grained, pumiceous tuff; small amounts of volcanic sandstone are included. The color ranges from pale gray or pale chocolate brown to creamy white, rarely green. In composition the unit ranges from biotite-hornblende dacite through biotite-hornblende quartz latite to biotite rhyolite tuff. South of the quadrangle the proportion of massive devitrified welded tuff is large, and the structures are obscure; most of the formation in the Jarbidge quadrangle is well bedded. The more calcic members have plagioclase as calcic as An_{52}, green hornblende, hypersthene, and brown biotite, with accessory apatite, zircon, and magnetite; the rhyolitic members have crystals of quartz, sanidine, brown biotite, plagioclase as calcic as An_{29}, magnetite, apatite, zircon, garnet, and allanite(?).

The total thickness, measured by compass and rangefinder from the depositional contact with the Paleozoic rocks south of the quadrangle to a point in a gulch about 2,000 feet west of BM 8092, is about 5,200 feet. The lower half of the formation is exposed outside the quadrangle. The attitude in the quadrangle is homoclinal with an average strike of about N. 50° E. and a dip to the northwest of about 35°. The unit is overlain conformably by the Meadow Fork formation.

Dr. D. I. Axelrod has kindly allowed me to quote determinations made for him, using the potassium-argon method, on biotite from the Dead Horse tuff. These were reported to him on March 5, 1962, by Geochron Laboratories, Inc., of Cambridge, Mass. The sample gave an age of 39.9 million years. This age would be well within the late Eocene (Evernden, J. F., Curtiss, G. S., Savage, D. E., and James, G. F., written communication, 1962).

MEADOW FORK FORMATION

The Meadow Fork formation is here named for the Meadow Fork of Copper Creek, along which the unit is best exposed, and which is included in the type locality. The formation here rests conformably on the Dead Horse tuff and is overlain unconformably by the Danger Point tuff and younger rocks. It is also exposed in the bed of Bonanza Gulch, 2 miles south-southeast of the town of Jarbidge, and in the cirque basins northeast, northwest, and southwest of Marys River Peak.

A section measured along Meadow Fork totaled about 1,300 feet, of which about 800 feet were covered. Of the visible part, something less than 100 feet is tuff or tuffaceous shale, and the rest is poorly sorted and poorly bedded tuffaceous conglomerate; the principal rock types represented in the boulders, which may be as much as 5 feet in diameter, are granite and pinkish granitized quartzite; there are smaller fragments of phyllite, tactite, and mica schist. The tuffs contain crystals of quartz, plagioclase, sanidine (locally adularized), orthoclase, sphene, chloritized biotite, hornblende, muscovite, clinozoisite, and augite. Glass fragments in the tuff are largely replaced by zeolites and clay, both montmorillonite and nontronite.

In Bonanza Gulch, about 150 feet of Meadow Fork formation is exposed, of which about one-third is conglomerate; the remainder is arkosic and tuffaceous sandstone. The fragments are chiefly granitic rock and contact-metamorphosed limy sediments. Secondary minerals include nontronite(?), quartz, adularia, and fluorite.

Northeast of Marys River Peak, the section is more than 1,000 feet thick even though the base is not exposed. It is largely conglomerate and tuffaceous arkose in which the fragments are rhyolitic, granitic, or metamorphic rocks (schist and quartzite). Calcite fragments are common, and many are replaced by fluorite. Secondary calcite, montmorillonite, and sericite are also common. Some of the granitic boulders in the conglomerate are as much as 5 feet across, but no outcrops of granitic rock are known in the vicinity.

In Copper Basin the lower part of the Meadow Fork dips northwestward; higher in the section the attitudes are variable, in part because of the direction of primary dip in the coarser beds and in part because of subsequent deformation. In the vicinity of Marys River Peak, the formation thickens northward and has generally a gentle northward dip that is probably primary. The age of the Meadow Fork formation is indeterminate, as no fossils have been found in it, but the gradational contact with the Dead Horse tuff and the coarseness of the conglomerate suggest that deposition required only a short interval of time immediately following deposition of the Dead Horse tuff; it is therefore regarded as probably late Eocene in age.[1]

SEVENTY SIX BASALT

The basaltic rock, here named the Seventy Six basalt from its occurrence in the valley of Seventy Six Creek in the southern part of the

[1] The age of the Meadow Fork formation is indicated as Miocene(?) in the explanation of plate 1, but an Eocene date seems preferable on the basis of the potassium-argon date of the Dead Horse tuff.

Jarbidge quadrangle, is generally intrusive in the exposures mapped, but it may also be in part extrusive. In addition to its occurrence in Seventy Six Creek valley, its type locality, and best and most accessible exposure, the basalt also crops out in the cirque basins northwest and southwest of Marys River Peak and northeast and southeast of Cougar Peak.

The basalt is generally a black to dark-gray medium- to fine-grained porphyritic rock. Phenocrysts of plagioclase make up a maximum of 33 percent of the rock, and a minimum of less than 1 percent; in any large exposure, some plagioclase phenocrysts ranging in size from ½ inch to 6 inches can be found. The most strikingly porphyritic phase of the rock is well exposed in a roadcut on the Elko-Jarbidge road just north of the south quadrangle boundary. The composition of the phenocrysts has been determined as An_{68} by index of refraction. Groundmass plagioclase is probably slightly more sodic. The texture is subophitic; irregular plates of purplish titanaugite include grains of olivine, labradorite, magnetite, ilmenite, and apatite. Patches of mesostasis are made up of biotite and orthoclase. Elsewhere, the groundmass is glassy, and the clinopyroxene is in rude sheafs and clusters of fibers, with chains of magnetite crystals. Olivine is altered to chlorite, serpentine, antigorite, and nontronite.

The Seventy Six basalt intrudes the Dead Horse tuff in masses along the divide between Copper Basin and Seventy Six Creek and cuts the Meadow Fork formation in the cirques southwest, northwest, and northeast of Marys River Peak. These intrusions are sills that are locally transgressive and as little as 6 feet thick, but locally they expand to laccolithic masses 200 feet thick, as on the northeast shoulder of Cougar Peak. The mass exposed along the road just north of the south quadrangle boundary is vesicular in its upper part and seems to have a roughly synclinal structure. The masses, possibly connected, are distributed over almost 1 square mile in this vicinity and do not follow the bedding of the Dead Horse tuff but are preferentially found very near the projected position of the lower surface of the Danger Point tuff. It seems likely that part of the Seventy Six basalt may have been extruded on the erosion surface cut across the Dead Horse tuff and Meadow Fork formation prior to the eruption of the Danger Point tuff. The basalt nowhere intrudes the Danger Point tuff or the Jarbidge rhyolite, although thin sills of it come within a few feet of the upper surface of the Meadow Fork formation in the cirque on the east face of Cougar Peak. The age of the Seventy Six basalt is probably late Miocene(?).

DANGER POINT TUFF

The Danger Point tuff is here named for Danger Point, a prominent ridge on the east side of Coon Creek valley, the type locality. It is found only on the east sides of Coon Creek valley and Copper Basin, directly below the Jarbidge rhyolite. It rests unconformably on Paleozoic(?) metamorphic rocks, Dead Horse tuff, and Meadow Fork formation. The tuff is essentially glassy volcanic debris of andesitic to rhyolitic composition; the glass is largely altered to montmorillonite, and the swelling of the montmorillonite on hydration causes rapid slumping of exposed surfaces and many landslides on the east sides of Copper Basin and Coon Creek. The total thickness is probably no more than 400 feet, of which less than half is exposed in scattered sections representing different parts. Much of the tuff occurs in internally structureless beds 6 inches to 7 feet thick.

Some of the exposed lower beds contain intermediate plagioclase, quartz, brown distorted biotite flakes, augite, hypersthene, and brown hornblende. Higher in the section, biotite and hornblende appear to be the only ferromagnesian minerals; and in the highest beds, directly beneath the Jarbidge rhyolite, quartz, sanidine, sodic plagioclase, and zircon are the only phenocryst minerals. In an exposure on a landslide scar approximately at the quarter corner between secs. 29 and 30, T. 45 N., R. 58 E., boulders of quartzite as much as 8 inches in diameter are sparsely distributed in a restricted zone about 66 feet below the upper surface. Smaller fragments, not only of quartzite, but also of chert, schist, and hornfels, are widely distributed in the formation. The formation is almost flat lying but has been deformed by faulting and by landslides.

The age of the Danger Point tuff is not known, but the close lithologic resemblance and the apparently conformable relationship between the uppermost part of the tuff and the overlying Jarbidge rhyolite suggest that they are of approximately the same age, late Miocene(?).

JARBIDGE RHYOLITE

The Jarbidge rhyolite is here named for the Jarbidge River valley, the type locality. It is equivalent to the "older rhyolite" of Schrader (1923, p. 17). The rhyolite includes flows, tuffs, and welded tuffs of rhyolitic composition. Small amounts of coaly material are locally interbedded. A few dikes and some small necks of vitrophyre have not generally been separately mapped. Because of pervasive recrystallization and hydrothermal alteration, it is not possible over much of the area to differentiate ash-fall tuffs, welded tuffs, and flows. Judging solely from their relative frequency in the thin sections examined, the products of cold ash-falls are commoner than welded tuffs. Well-bedded fine-grained tuffs are rare.

The rhyolite ranges from pale bluish gray to yellowish gray and oxidizes to shades of brown and red; greenish and purplish tints are local. Fresh glassy rocks are black to dark gray. The rocks are characterized by a large proportion of quartz phenocrysts as much as 5 mm in diameter that are mostly rounded or corroded but are in part euhedral; by sanidine crystals, which are slightly smaller and less numerous; and by somewhat rarer phenocrysts of oligoclase-andesine. The rarely recognizable clinopyroxene is pigeonitic. Bastite pseudomorphs after pyroxene(?) are common. Biotite and hornblende or recognizable pseudomorphs after them are extremely rare. Accessories include zircon, apatite, ilmenite, magnetite, and pale-pink garnet. Topaz, apparently secondary, was found in a single section.

Locally, a propylitic type of alteration, characterized by the development of epidote and chlorite, has given a dull luster and a greenish-gray color to the rocks. More commonly, the groundmass and plagioclase and sanidine phenocrysts have been replaced by adularia and, locally, by clay minerals.

The thickness of the Jarbidge rhyolite has not been precisely determined, because it is sliced by numerous high-angle faults, and easily mappable marker beds have not been found. It is certainly in excess of 2,000 feet, but probably not much more than that figure. Reliable attitudes can be obtained only by mapping depositional contacts or by measuring attitudes of interbedded tuffs. These show that the dips are very low, generally less than 15°.

The age of the Jarbidge rhyolite is not known. The upper limit is set by the age of the Dead Horse tuff, which is late Eocene. The rhyolite is overlain unconformably by the Cougar Point welded tuff, which is Miocene and Pliocene, according to D. I. Axelrod (written communication, 1959). Axelrod considers the Jarbidge rhyolite most probably late Miocene.[2]

GODS POCKET DACITE

The Gods Pocket dacite is here named for a sequence of flows and minor tuffs on Gods Pocket Peak, the type locality, in the southeastern part of the Jarbidge quadrangle. Most of the dacite is a pale-gray dense stony textured aphanitic rock, locally with black vitrophyric phases. It has relatively large phenocrysts of andesine and smaller amounts of sanidine; quartz and pigeonite phenocrysts

[2] Dr. D. I. Axelrod has kindly permitted the publication here of a date determined for and reported to him by Geochron, Inc., on sanidine from the Jarbidge rhyolite, collected on Meadow Creek, in the Rowland quadrangle. The sanidine gave an age of 16.8 (±0.5) m.y. This would fall in the late Miocene (Evernden, J. F., Curtiss, G. H., Savage, D. E., and James, G. F., written communication, 1962).

are smaller and sparser; augite and hypersthene, quite rare. Accessory minerals include magnetite, apatite, and zircon. The unit locally includes 30 to 50 feet of pale-gray vitric unconsolidated tuff at the base. The source of the dacite is unknown. A concentration of vitrophyric dikes near the top of the peak suggests that the vent from which these flows were extruded may lie beneath Gods Pocket Peak. The total thickness remaining is about 930 feet, but the original top of the unit is not preserved. The age of the sequence is unknown, but because it unconformably overlies the Jarbidge rhyolite, it is considered Pliocene(?). D. I. Axelrod (written communication, 1959) regards it as Miocene or Miocene and Pliocene.

POLE CREEK DACITE

The name Pole Creek dacite is here given to a number of small domical protrusions of medium-gray to black vitrophyre found near the east border of the quadrangle, around the headwaters of Pole Creek, especially in sec. 13, T. 46 N., R. 58 E., the type locality. Most of these are probably of dacitic composition. The rocks are characterized by numerous oligoclase xenocrysts, each of which has a spongy, more calcic rim due to reaction between xenocryst and magma. Sparse quartz and pigeonite phenocrysts are also present. Accessories include magnetite, ilmenite, apatite, and zircon. A common peculiarity is the presence of vesicle linings of tridymite and small spherules of goethite. The maximum thickness is about 900 feet, and the maximum lateral extent of any one mass is about a mile and a half, but parts of the masses are concealed by later gravels. There is little evidence of the unit's age, except that it was apparently erupted more or less contemporaneously with the deposition of the Slide Creek gravel.

SLIDE CREEK GRAVEL

The Slide Creek gravel is the name here applied to the deposit that underlies the flat near the headwaters of the northern headwater tributary to Slide Creek. It is exposed also at the type locality of the west side of the ridge to the east of the Slide Creek canyon, near the east edge of the quadrangle. The Slide Creek gravel rests unconformably in Jarbidge rhyolite and apparently interfingers locally with the Pole Creek dacite. It is poorly sorted and unconsolidated, with boulders as much as 4 feet across, some of which are rounded, some subangular. The boulders include pieces of Jarbidge rhyolite and Pole Creek dacite. The gravel is not deformed, except by faulting, and seems to be overlain unconformably by the Jenny Creek tuff. The discordance may not reflect a great age difference. Its age cannot be accurately fixed, but its relationship to the older rocks and to the overlying tuff suggest that it is Pliocene. D. I. Axelrod (written communication, 1959) regards it as Miocene or Miocene and Pliocene.

JENNY CREEK TUFF

The Jenny Creek tuff is here named for exposures at the type locality which is just below the mouth of Jenny Creek on Jack Creek. The tuff is patchily distributed across the full width of the quadrangle and rests everywhere with depositional contact on the Jarbidge rhyolite, the Pole Creek dacite, or the Slide Creek gravel. It is locally intruded by the Robinson Creek dacite and is overlain by the Cougar Point welded tuff. The Jenny Creek tuff is partly massive vitric tuff that ranges from buff to pale gray and contains angular fragments and spherulites derived from the underlying rocks, and partly well-bedded poorly consolidated tuff. Although the maximum thickness is about 330 feet, there are few places where as much as 60 feet is exposed. The type section includes one layer, about 3 feet thick, of dark-gray rhyolite welded tuff with crystals of quartz, sanidine, andesine, magnetite, apatite, and zircon. The composition resembles that of the overlying Cougar Point welded tuff, and it is probable that the Jenny Creek tuff grades into the Cougar Point by increase of welded tuffs and decrease of ash-fall tuffs and sedimentary tuffs.

The ease with which the tuff is deformed, especially when water saturated, has favored landslides, and the geologic map (pl. 1) shows that they commonly obscure the boundary between the Jarbidge rhyolite and the Cougar Point welded tuff; the presence of Jenny Creek tuff concealed by the landslides is inferred. The attitude of the Jenny Creek tuff, where measurable, suggests that the unit conformably underlies Cougar Point welded tuff; dips are generally low and in a northerly to northwesterly direction.

Two determinations of the age of material from the Jenny Creek tuff are available. A diatomite from a small exposure (USGS diatom loc. 4586) near the road saddle about 0.8 mile SSE. of the junction of Robinson Creek and the East Fork of the Jarbidge River was dated by Kenneth Lohman (written communication, 1958) as "early Pliocene or possibly late Miocene, with a preference for early Pliocene." Two species of fossil leaves found in disintegrated material (55 NC128) 4 miles south of the same junction were called late Miocene by R. W. Brown. The formation is here regarded as Pliocene.

COUGAR POINT WELDED TUFF

The thickest section of the Cougar Point welded tuff, here named, exposed in this quadrangle is that below Cougar Point on the East Fork of the Jarbidge River. This exposure is regarded as the type locality. Although the welded tuff occupies most of the northern third of the Jarbidge quadrangle its areal extent is far greater. It is exposed on the margins of the Snake River plain at many places from the Goose Creek area in Cassia County, Idaho, to western Owyhee County, Idaho, and on the north side of Snake River in the southern slopes of Mount Bennett near Mountain Home, Idaho. H. E. Maldé and Howard Powers (1962, p. 1200–1201) have applied the name Idavada volcanics to a unit that includes the Cougar Point welded tuff and the Jenny Creek tuff and possibly also other rocks not represented in the Jarbidge quadrangle.

The Cougar Point welded tuff, which corresponds closely to the "younger rhyolite" of Schrader (1923, p. 20), is reddish- or yellowish-brown to brownish gray where holocrystalline, but black or gray to orange-red, depending on the degree of oxidation where glassy. The sequence is made up of a number of units, the more massive and resistant ones being generally cryptocrystalline and forming crudely columnar cliffs as much as 150 feet high; such cliffs may be made up of several units. The glassier phases are more closely fractured, often perlitic, and commonly obscured by slope wash. Many units have vitrophyric basal phases that grade upward into dense rocks of stony texture. Much of the welded tuff is vesicular; the ellipsoidal vesicles may be nearly equidimensional, flattened and slightly elongated, or much elongated but only slightly flattened. The flattening is generally in the plane of the textural layering, and elongate vesicles display a marked parallelism. In some places the thicker welded tuffs show signs of primary deformation, subsequent to extrusion, in the form of sharp anticlinal folds which commonly trend northeastward. The next younger bed generally passes undisturbed above the crest of these folds, and, in some places, folds may be seen to die out downwards within the thickness of a single flow. The anticlinal folds are not bordered by synclinal flexures of corresponding shape.

In the rhyolite welded tuff, phenocrysts most commonly make up less than 2 percent of the rock but may range to as much as 10 percent. The phenocrysts include quartz, sanidine, plagioclase, and pigeonite, and accessory zircon, magnetite, and apatite. Hornblende phenocrysts have been found in less than 10 percent of the rocks sectioned, and biotite in about 1 percent. The relative proportions and compositions of the various primary minerals vary from unit to unit. Plagioclase ranges from An_{25} to An_{80}, with frequency maxima at about An_{27} and An_{45}. Pyroxene is almost uniformly pigeonitic, with 2V ranging from 0° to 35°. Augite was identified in about 2 percent of the sections, and hypersthene in 1 percent. In the thicker flows, recrystallization of the glassy phase to sanidine and tridymite is complete. Small vesicles may be filled with tridymite, which indicates probable gas-phase transport.

The maximum thickness of the Cougar Point welded tuff exposed in the Jarbidge quadrangle is about 1,250 feet in the canyon of the East Fork of the Jarbidge River, just west of Cougar Point. The Jarbidge River canyon near the mouth of Deer Creek exposes about 800 feet. According to Maldé and Powers (written communication, 1959), the thickness of this formation elsewhere may exceed 1,500 feet. The maximum dip, except in areas of local disturbance, is about 8° to the northwest. The individual beds are of considerable extent, but none has been separately mapped.

Maldé and Powers (1962, p. 1201) said that their Idavada volcanics in the western Snake River Plain are early Pliocene but that similar rocks in the eastern Snake River Plain are partly of middle Pliocene age. Diatomaceous volcanic ash interbedded with welded tuff in a roadcut 1,800 feet south of the Idaho State line in the Jarbidge River canyon (USGS diatom loc. 4247) was reported by Kenneth Lohman (written communication, 1958) as yielding a diatom assemblage made up of species ranging from middle Miocene to Recent in age. D. I. Axelrod (written communication, 1959) pointed out that rocks equivalent to the Cougar Point welded tuff are underlain by upper Miocene beds along Trapper Creek in the Goose Creek basin and unconformably underlie the Humboldt formation south of Contact, "* * * where it [the Humboldt] has yielded a lower Pliocene mammalian fauna." The Cougar Point is here regarded as Pliocene.

ROBINSON CREEK DACITE

The name Robinson Creek dacite is here applied to a rock unit that includes one dike and a number of small intrusive domes of gray vitrophyric perlite, probably of dacitic composition. These are exposed at a number of places along Jack Creek and Robinson Creek, which can be considered to be the type locality, and seem to intrude the Jenny Creek tuff, which is locally opalized near the contact. The rocks are characterized by phenocrysts of labradorite or andesine, hypersthene, pigeonite, magnetite, and apatite. Zircon, quartz, and sanidine are present in some of the bodies. One thin dike intrudes the lowermost part of the Cougar Point welded tuff. The greatest exposed thickness is about 200 feet, and the maximum length of individual bodies is three-quarters of a mile; generally the bases are not visible, and original outer surfaces have been removed.

The intrusive relation of the Robinson Creek dacite to the Jenny Creek tuff and the lower part of the Cougar Point welded tuff suggests that the dacite is slightly younger than the lower part of the

Cougar Point welded tuff. The restricted distribution suggests that the points of extrusion were structurally determined and that the same structures may have determined the places where the Jenny Creek tuff accumulated in greater thickness.

BANBURY FORMATION

The name Banbury volcanics was applied by Stearns (1936, p. 435) to "* * * massive dark-brown weathered basalt flows and coarse and fine tuff beds * * *" exposed "* * * near Banbury Hot Springs, Twin Falls County, Idaho." Maldé and Powers (written communication, 1959) considered the Banbury volcanics as forming a basalt plateau "* * * which continues southward to the foothills of the Jarbidge Mountains." The term used here is Banbury formation rather than Banbury volcanics because of the large quantity of interbedded sediments. In the Jarbidge quadrangle, the sediments are predominantly gravel, with small amounts of rhyolitic tuff (less than 20 feet) immediately below the basalt. Basalt thus forms a lens which thickens gradually northward; the gravel beneath the basalt thickens rapidly northward because of the downwarping of the underlying Cougar Point welded tuff; the gravel above the basalt is thickest near the southern margin of the basalt flows. The occurence of both gravel and basalt together is confined to the area along the west half of the north quadrangle margin. The basalt itself, as already indicated, extends far to the west, east, and north, but the gravel seems to be thicker in this area than elsewhere in the vicinity. The Cougar Point welded tuff, which underlies the lower gravel, was slightly eroded before burial, and scattered boulders indicate that the gravel once extended several miles farther south.

Fragments in the gravel range from pebble to boulder size, reaching a maximum diameter of 1½ feet. Boulders of Cougar Point welded tuff are coarser and more angular than boulders of Jarbidge rhyolite. A few of the boulders are slightly weathered. Where the gravel lies on the basalt, it contains boulders of basalt.

The basalt is a pale-gray olivine basalt, with subophitic texture. It is locally slightly reddened where magnetite and ferromagnesian minerals are oxidized.

The maximum thickness of the basalt in the quadrangle is about 105 feet; it thins southward by overlap to as little as 4 feet. The underlying gravel is as much as 200 feet thick, but it thickens rapidly northward to more than 600 feet a few miles north of the quadrangle boundary. The upper surface of the basalt has a regional slope to the northwest of about 40 to 50 feet per mile; the lower surface at one place dips about 4° northward. The inclination of pipe vesicles indicates that the basalt in this quadrangle generally came from the northwest, and hence advanced upslope, although the upper surface must have declined in the direction of flow.

No evidence as to the age of the Banbury formation was found in this area. Stearns (1936, p. 435) considered it to be late Pliocene; Maldé and Powers (1962, p. 1204–1205) regard it as middle Pliocene on the basis of shell and mammal remains collected from sediments between the two basaltic sequences of the Banbury volcanics, and on the fact that basalt in the Banbury south of Bruneau is overlain by their middle Pliocene Chalk Hills formation. The basaltic flows and intertonguing gravel in this marginal area will be considered middle Pliocene, but they may represent only the upper, less altered part of the Banbury volcanics of Maldé and Powers.

TERRACE GRAVEL AND GLACIAL OUTWASH

The terrace gravel includes all alluvial deposits that are obviously related to modern streams but are now found some distance above them. Distribution does not appear systematic, but rather the result of accidental preservation of small bodies in a few places. Material exposed at the surface is commonly coarse with some boulders a foot in diameter; locally, in stream and roadcuts, finer material is exposed. A roadcut in the Jarbidge River canyon near the quadrangle boundary exposes a 3-inch layer of pale-gray volcanic ash. Two and a half miles south of the Idaho State line, roadcuts reveal artifacts, shells, and bones in a soil layer rich in ash. The vertebrates, determined by G. E. Lewis, L. G. Tanner, C. B. Schultz, and T. M. Stout (written communication, 1956), all have a range from late Pleistocene to Recent. The shells were determined by D. W. Taylor (written communication, March 6, 1958) as *Gonidea angulata*, which ranges from middle Pleistocene to Recent but was not found living in the Jarbidge River. Most of the deposits are relatively thin, but the small deposit on the East Fork of the Jarbidge River, just below the mouth of Slide Creek, is about 200 feet thick.

Glacial outwash in most places cannot be distinguished from the terrace gravel. In Copper Basin, however, the areal distribution of a number of small patches of gravel, which are immediately downstream from areas of glacial moraine and well above any present stream competent to carry the material, suggests glaciation. Residual cobbles on the surface of bodies mapped as outwash are much smaller than the largest boulders in the glacial moraines, and sorting is considerably better. Because of the better sorting, some of the bodies of outwash are aquifers and furnish small seep supplies of water.

GLACIAL MORAINE

Glacial moraines of at least three distinct stages can be recognized in the Jarbidge quadrangle. The youngest two of these can also be related to present topographic features; two earlier glacial deposits, now much eroded, may represent more than one glacial stage. One of these two occurrences is under the power line about 3,100 feet east of the Mahoney Ranger Station. The other consists of two formless heaps of material trending across Buck Creek valley about 22,000 feet N. 51° W. of Jarbidge.

The material east of Mahoney Ranger Station is completely unsorted conglomerate composed entirely of Jarbidge rhyolite in which the boulders are rounded to subangular and as much as 4 feet in diameter. A few scattered boulders of Jarbidge rhyolite rest on Cougar Point tuff where the power line crosses the saddle between Johnny Creek and the Jarbidge River. It is highly probable that both these scattered boulders, and possibly the tillite described above, were derived from the Jenny Creek glacier, though not necessarily during the same stage.

The material in Buck Creek valley, of which 6 to 8 feet is exposed near the floor of the valley, is also unsorted and lithologically heterogeneous and has angular to subrounded fragments ranging in size from 1.5 feet down to fine silt. The larger fragments consist of Jarbidge rhyolite, granite, pegmatite, metachert, and slate. Similar rocks are found in a smaller patch to the northwest. At the head of Buck Creek, the granitic rocks no longer crop out north of the divide; a substantial northward shift of the divide between the vigorously down-cutting Rattlesnake Creek and Buck Creek must have taken place since these glacial boulders were quarried.

Deposits of the next younger stage of glaciation lie in valleys whose heads have lost the typical cirque form and are now mantled with talus. Examples are on the west slope of the Jarbidge Mountains in Snowslide Gulch, Bonanza Gulch, and Dry Gulch; on the northeast and southeast side of Coon Peak; and on the north side of Deer Mountain. Many such deposits rest on surfaces above stream level. The northernmost moraines in the Jarbidge River valley are about a mile south of the mouth of Jack Creek; in the valley of East Fork they are due west of Gods Pocket Peak. In the Copper Creek basin, deep postglacial valleys separate terminal parts of moraines from their source areas.

The youngest moraines are in glacially modified valleys. Terminal moraines still retain their original form, and postglacial erosion of bedrock is slight. The cirque form is preserved at the heads of many of these valleys; for example, those of Jack Creek, Fall Creek, Cougar

Creek, the East Fork of the Jarbidge River, and West Marys River. Most of the youngest glaciers came from cirques incised into rhyolite or quartzite, and therefore boulders of these rock types are the commonest glacial material. Both rock types are resistant to weathering, and it was not feasible to use the degree of weathering of the boulders as a basis for discriminating between glacial deposits of different ages. Commonly, even in the gravels of the Banbury formation, the boulders of Jarbidge rhyolite are firm. Some glacial deposits of the second stage are tinted red by weathering pyritic rhyolite boulders, but this character is inconstant and depends more on source area than on age.

In length of glacier and degree of dissection of deposits, the two later stages, whose moraines have been described, are comparable with the earlier Lamoille and later Angel Lake stages described by Blackwelder (1931, p. 918).

LANDSLIDE DEPOSITS

Landslides are widespread in the Jarbidge quadrangle. Most of them are facilitated by the presence of resistant jointed formations, such as the Jarbidge rhyolite or the Cougar Point welded tuff, overlying weak and commonly clayey volcanic ash, such as the Danger Point tuff and the Jenny Creek tuff. A few appear to be facilitated by glacially oversteepened slopes in locally weakened argillized zones in the Jarbidge rhyolite. Most of the landslides occur in Coon Creek valley, Copper Basin, the valleys of Jack Creek and the Jarbidge River, near their junction, and the valleys of East Fork and Robinson Creek, near their junction. In several places it has been possible to distinguish two ages of landslides; the younger has a rougher topography, retains more undrained depressions, and is often closely confined to present valleys. The older is more dissected, retains fewer undrained depressions, and often caps ridges where the underlying rock is easily eroded. Recognition of two distinct ages of slides points to two distinct periods of formation separated by a period of relatively little landsliding. In at least one place, glacial till rests upon older landslide deposits, suggesting that slides were more prevalent during the period of high rainfall coincident with the glaciation.

ROCK GLACIERS

In the Jarbidge Mountains, cirques at the heads of Jenny, Jack, and Fall Creeks, and the north and south forks of Cougar Creek contain rock glaciers, some of which are now active. All these, except one are of the lobate type, as defined by Wahrhaftig and Cox (1959, p. 389), and range in width from 1,500 to 8,000 feet and in length from 200 to 500 feet. The only tongue-shaped rock glacier lies in a cirque on the northeast side of Cougar Peak and is 1,500 feet long and 700 feet in maximum width. Some lobate rock glaciers northeast of the Matterhorn have coalesced to form an incipient tongue-shaped rock glacier. All the rock glaciers in the Jarbidge Mountains are made up largely of coarse debris that contains angular blocks as much as 4 feet across. An adit in the Altitude mine, at an altitude of 9,900 feet in the north-facing cirque at the head of Jack Creek, fills with ice to a point a few feet from the portal within a year or two after being cleaned out. The 40-foot-high front of the rock glacier just north of the mine contained interstitial ice on August 15, 1956. This glacier is apparently not active, because a path leading across it is undisturbed, even though apparently little work has been done for more than 30 years.

Water from the small rock glacier in the cirque southeast of Jarbidge Peak drains into a pond which has the milky discoloration characteristic of streams draining active glaciers. Some lobate rock glaciers at lower altitudes and on south-facing cliff walls support vegetation. In a few places, near the lower limit of rock-glacier growth, inactive rock glaciers have collapsed, leaving basins between talus slopes and the outer ridge of the rock glaciers. Some landforms thus resulting are indistinguishable from protalus ramparts.

ALLUVIUM

Most of the alluvium in this quadrangle is confined to relatively thin bodies of coarse poorly sorted unconsolidated gravel and sand along the present streams and no more than 6 to 8 feet above normal high water. Schrader (1923, p. 15) reported that the alluvium just below Jarbidge is 14 feet deep. Both here and on the East Fork of the Jarbidge River, some of the wider bodies of alluvium result from the obstruction of the stream by landslides. A few small bodies of alluvium were deposited along some of the minor streams at higher altitudes, where they lose part of their gradient on passing from the Cougar Point welded tuff to the basalt of the Banbury formation.

TALUS AND ALLUVIAL CONES

Alluvial cones, found at the mouths of many steep gulches, have been combined in mapping with the talus that mantles the steeper cliff faces, because they grade into one another on the steepest slopes. The talus cones might more logically be mapped with the alluvium deposited by the permanent streams, but their composition and topographic form seem to relate them more intimately with the cliff-face talus.

STRUCTURE

The structural history of the Jarbidge quadrangle is moderately complicated. The intrusion of the quartz monzonitic rocks, although not itself precisely dated, furnishes a convenient time datum for the discussion of the structural history. The discussion of the structure of the pre-quartz monzonite rocks is handicapped especially by lack of stratigraphic data, but it seems reasonably certain that the Prospect Mountain(?) quartzite is at least somewhat older than the other pre-Cretaceous sedimentary rocks that are distinguished only on a lithologic basis. Knowledge of the deformation of the Jarbidge rhyolite is limited by the hydrothermal alteration and lack of suitable key horizons. Sufficient evidence for a reliable decipherment of the tectonic history may never be found in this area.

PRE-CRETACEOUS DEFORMATION

The chief structural feature of the pre-Cretaceous deformation is the Copper Mountain thrust, here named for exposures on the east flank of Copper Mountains, west of Coon Creek. The Copper Mountain thrust brings Prospect Mountain(?) quartzite and Precambrian(?) rocks above undifferentiated Paleozoic(?) sedimentary rocks. It is exposed for about a mile south along both sides of Coon Creek from about the latitude of Bear Creek Summit, and then again below the Jarbidge-Charleston road just south of Coon Creek Summit. Other contacts between Prospect Mountain (?) quartzite and the undifferentiated Paleozoic rocks seem to be steeply dipping fault contacts. Some may be normal faults that have brought the undifferentiated Paleozoic rocks down into juxtaposition with the Prospect Mountain(?) quartzite from beds deposited on it or thrust above it. They may also represent normal faults that have brought the undifferentiated Paleozoic rocks up from the lower plate, beneath the Copper Mountain thrust. A third possibility is that they may represent thrust slices associated with the Copper Mountain thrust. A fault, here called the Deer Creek fault, that separates the Precambrian(?) rocks from the Prospect Mountain(?) quartzite is considered to be a minor thrust related to the Copper Mountain thrust.

It is known, however, that some of these steep faults, which trend from north to about N. 15° E., are cut off by the granitic intrusion in the valley of Coon Creek. The steep faults along Copper Creek, in the Copper Basin, appear to be downthrown on the west side, so that the thrust lies below the level of the stream west of Copper Creek.

POST-CRETACEOUS DEFORMATION

The earliest post-Cretaceous structures have not been directly observed, but their existence can be inferred from the distribution and character of the Meadow Fork formation. This formation, which rests upon the Dead Horse tuff in the southern part of Copper Basin, forms a monoclinal sequence at least 1,300 feet thick and is found resting unconformably on phyllite at a point about 400 feet west of the "k" in "Meadow Fork" on plate 1; so far as can be determined, it is not present at all north of this point. The large size of the boulders in the Meadow Fork formation and the abrupt changes in thickness suggest accumulation in a narrow trough with steep walls. The northeastward trend of some of the faults cutting the undifferentiated Paleozoic sedimentary rocks between Meadow Fork and Copper Creek suggests that the basin may have been bounded by faults of similar trend. Abrupt lensing out and a change in lithology of the Meadow Fork are apparent between the north and south sides of Marys River Peak where the thickness of the Meadow Fork changes from more than 1,000 feet to less than 150 feet in a distance of little more than 1 mile.

One of the best-exposed post-Cretaceous structures is the normal fault that extends out of the quadrangle near the southwest corner. This fault, here called the Copper Creek fault, has a strike of N. 17° E. and a dip of 20° SE. Faint striations on the polished surface of the quartzite suggest that the movement was dip-slip. The hanging wall of the fault in this quadrangle is Dead Horse tuff and Meadow Fork formation; south of the quadrangle, rocks found on the hanging wall side include late Paleozoic limestones of the eastern assemblage, rocks resembling the Valmy formation of the western assemblage, and rocks of the overlap assemblage (Roberts and others, 1958, p. 2815–2821). The rocks of the western assemblage appear to lie in thrust contact on the rocks of the eastern assemblage; the fault may be the Roberts Mountains thrust, which must have passed above the Prospect Mountain(?) and later been displaced by the Copper Creek fault, if movement on the latter fault has always been normal. The Copper Creek fault is concealed on the north by talus on the east slope of Copper Mountains and reappears in the unnamed gully between Copper Creek and Meadow Fork, where it separates the conglomerate of the Meadow Fork from undifferentiated Paleozoic sediments; only a short distance farther northwest it disappears under landslide material. It almost certainly antedates the Jarbidge rhyolite, which shows no corresponding displacement anywhere along the projected strike of the fault.

The Tertiary volcanic rocks are cut by numerous faults, nearly all of which are very steeply dipping. For those that displace contacts, some idea of the direction and amount of displacement can be obtained; but many are marked only by lineaments, visible on aerial photographs by reason of the topographic expression, and on the ground by associated rock alteration and occasional lithologic contrast. The two principal trends of the high-angle faults that cut the Jarbidge rhyolite and the Gods Pocket dacite range from north to N. 20° W. and from east to N. 70° E. All of the known faults that cut these formations are normal; the downthrown side may be on either east or west. The Jarbidge Mountains and adjacent areas are a series of fault blocks whose relative displacement seems to follow no systematic rule. The Jarbidge Mountains are roughly a horst, and the block that nearly follows the crest is not only topographically but structurally high; the Jarbidge River roughly follows a graben, and the same is probably true of the East Fork. As most of these nearly north-trending faults do not displace the Cougar Point welded tuff, they are probably late Miocene(?) in age. The present major north-flowing streams probably follow courses inherited from consequent streams that flowed in graben valleys. Most of the mineralized faults of the Jarbidge mining district trend from N. 10° W. to N. 60° W.

Few faults cut rocks younger than the Gods Pocket dacite, and the displacement is relatively small. Some may be rejuvenated faults of the sets described in the paragraph above, but the number mapped is too small for any firm conclusions.

The Banbury formation in this area is cut by a single fault, which has a trend of about N. 75° E., but which is made up of some segments striking N. 10° E. and others striking from east to N. 80° E. On the west side of the Jarbidge River, the net throw is about 90 feet; but the block between the two main branches of the fault dropped about 35 feet below the block on the north side. The fault can be traced northeastward beyond the limits of the map to the canyon of the East Fork of the Jarbidge River. On the east side of the Jarbidge River, it is evident that the fault was contemporaneous with the extrusion of the basalt, because basalt from the upper part of the flow has entered an opening caused by irregularities in the fault surface where it cuts the already solid lower part. It may be conjectured that there is a cause and effect relation between the extrusion of the basalt and the relative depression of the Snake River plain to the north.

MINERAL DEPOSITS

The Jarbidge quadrangle contains two types of mineral deposits of economic value: (1) Tertiary epithermal gold-silver veins in the Jarbidge rhyolite, which yielded about $10 million in gold and silver, essentially all before 1942 (Granger and others, 1957, p. 85); and (2) scheelite-bearing tactite deposits along the contact between the granitic rocks, here mostly quartz monzonites, and the undifferentiated Paleozoic sediments, which are estimated to have yielded a few hundred units of WO_3 in molybdenian scheelite between 1942 and 1956. There has been no production since 1956. The status of the gold mines in 1922 was described by Schrader (1923, p. 36–77). Most of the workings were inaccessible in 1954–56.

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