Preliminary Report on the Comet Area, Jefferson City Quadrangle, Jefferson County, Montana

By
G. E. Becraft

Trace Elements Investigations Report 282

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PRELIMINARY REPORT ON THE COMET AREA, JEFFERSON CITY QUADRANGLE JEFFERSON COUNTY, MONTANA*

By

George E. Becraft

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Trace Elements Investigations Report 282

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JEFFERSON COUNTY, MONTANA

By George E. Becraft

ABSTRACT

Several radioactivity anomalies and a few specimens of sooty pitchblende and other uranium minerals have been found on the mine dumps of formerly productive base- and precious-metal mines along the Comet-Gray Eagle shear zone in the Comet area in southwestern Montana. The shear zone is from 50 to 200 feet wide and has been traced for at least 5 1/2 miles. It trends N. 80° W. across the northern part of the area and cuts the quartz monzonitic rocks of the Boulder batholith and younger silicic intrusive rocks, as well as the pre-batholitic volcanic rocks, and is in turn cut by dacite and andesite dikes.

The youngest period of mineralization is represented by chalcedonic vein zones comprising one or more discontinuous stringers and veins of cryptocrystalline silica in silicified quartz monzonite and in alaskite that has not been appreciably silicified. In some places these zones contain no distinct chalcedonic veins, but are represented only by silicified quartz monzonite. These zones locally contain uranium in association with very small amounts of the following minerals: pyrite, galena, ruby silver, argentite, native silver, molybdenite, chalcopyrite, arsenopyrite, and barite. At the Free Enterprise mine, uranium has been produced from a narrow chalcedonic vein that contains disseminated secondary uranium minerals and local small pods of pitchblende and from disseminated secondary uranium minerals in the adjacent quartz monzonite.

Undiscovered commercial deposits of uranium ore may occur spatially associated with the base- and precious-metal deposits along the Comet-Gray Eagle shear zone, and chalcedonic vein zones similar to the Free Enterprise.

INTRODUCTION

The Comet area is a few miles northwest of Boulder and about 20 miles southwest of Helena, Montana (fig. 1). U. S. Highway 91 between Butte and Helena crosses the southwestern corner of the area and a branch of the Great Northern Railroad crosses the southeastern and southwestern corners of the area. The area is drained southward by tributaries of the Boulder River. The maximum relief is about 3,300 feet, with most of the ridges about 1,000 feet above the principal valleys.

The geology of about 2 square miles in the southeastern corner of the area was mapped in September 1950 (Roberts and Gude, 1952); the remainder of the area was mapped in July-October 1951 by the writer, D. Y. Meschter, and E. B. Gross. Much of the petrographic work on which the rock descriptions are based was done by George J. Neuerburg and Gross. The mapping was under the supervision of M. R. Klepper and all work was carried out on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

With the exception of the detailed study in the vicinity of the Free Enterprise mine (Roberts and Gude, 1952), previous geologic work in this area has been of a reconnaissance nature in connection with studies of the mineral deposits in and near the Boulder batholith. The most complete are reports by Knopf (1913), Billingsley (1915), Billingsley and Grimes (1918), and Pardee and Schrader (1933).

GEOLOGY

General features

The Comet area is near the center of the Boulder batholith and is underlain principally by quartz monzonite. The rocks of the batholith have intruded a series of volcanic rocks, remnants of which are exposed near the northern margin of the map, and both the quartz monzonite and the volcanic rocks have been intruded by silicic rocks, including aplite, alaskite, alaskite porphyry, and pegmatite; these are designated alaskite on the map. The youngest consolidated rocks in the area are dacites and andesites that occur principally as steeply dipping dikes cutting the alaskite series and older rocks.

The major structural feature is the Comet-Gray Eagle shear zone, which trends N. 80° W. across the area near the northern margin of the mapped area. In the southeastern part of the area the quartz monzonite and alaskite have been sheared and brecciated and recurrently silicified along N. 60° E. trending, steeply

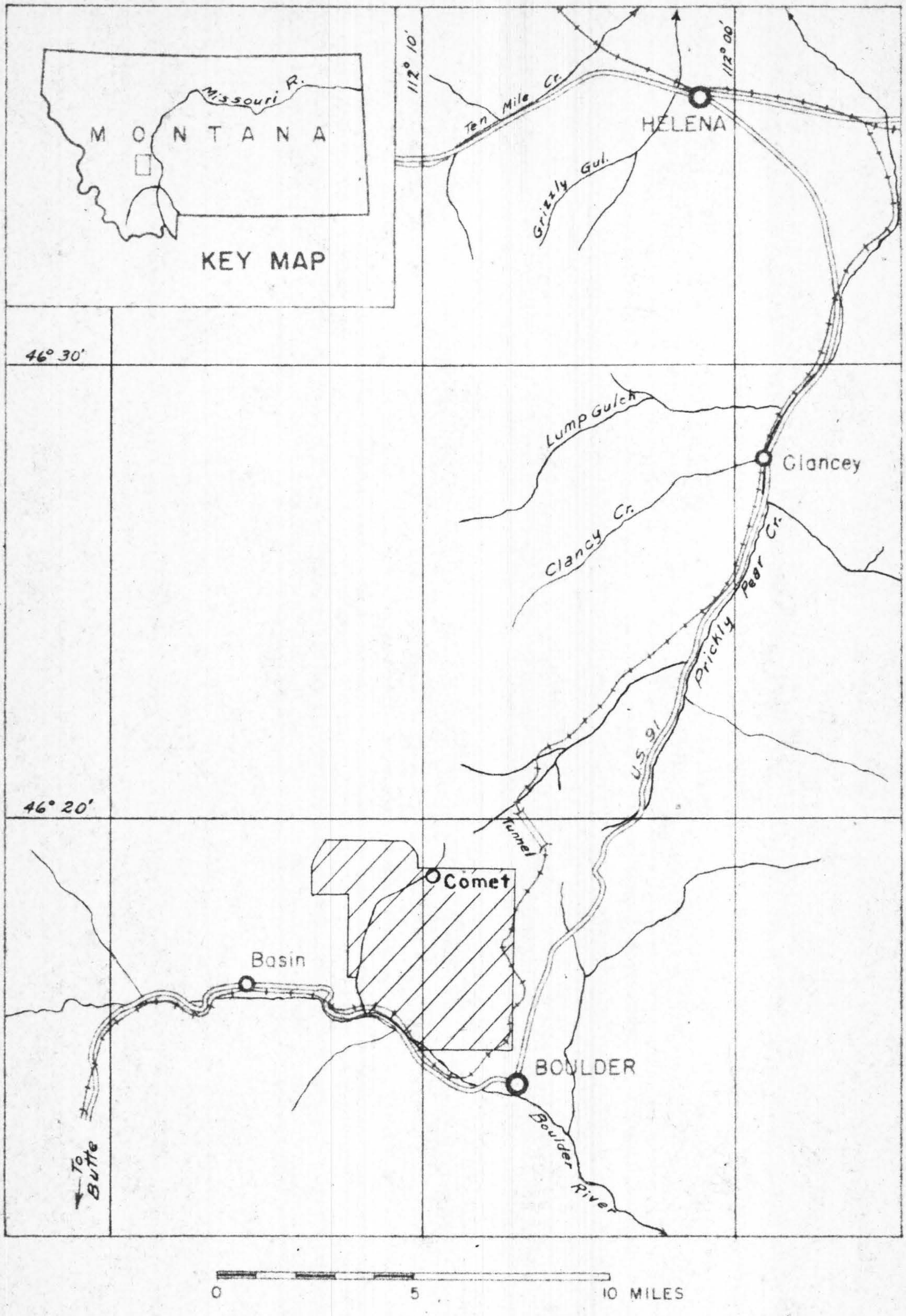

Figure 1. - Index map showing Comet Area, Jefferson City quadrangle, Jefferson County, Montana

dipping, chalcedonic vein zones that comprise one or more discontinuous stringers and veins of cryptocrystalline silica in silicified quartz monzonite and alaskite that has not been appreciably silicified. In some places the zones contain no distinct chalcedonic veins, but are represented only by silicified quartz monzonite. The trend of the chalcedonic vein zones gradually changes to east in the center of the mapped area. Faults are commonly observed in the mines in the area but, because of poor exposures, only a few could be traced on the surface.

The only sediments in the area are alluvial and colluvial material of Pleistocene (?) and Recent age. A veneer of hillwash and mantle covers much of the area.

Igneous rocks

Pre-batholith volcanic rocks

The pre-batholith volcanic rocks are part of a large roof remnant that extends northward beyond the limits of the area mapped. The part of the remnant within the area consists of two flows that have been mapped as a single unit. The contact between the volcanic rocks and the batholith is almost horizontal, although local irregularities exist. Field relations within these volcanic rocks were not studied in detail.

The rocks are light- to dark-gray andesite, generally fine-grained, with small phenocrysts of plagioclase and hornblende. Flow banding, observed in a few isolated localities, is uncommon.

The few thin sections examined show porphyritic texture, in part seriate. Corroded plagioclase phenocrysts comprise from 25 to 30 percent of the rock and are normally zoned from An_{40} to An_{20}. Phenocrysts of hornblende, which may comprise as much as 2 percent of the rock, are commonly altered in part to biotite, in part to groundmass material, and in some specimens to ilmenite, penninite, and tourmaline. The mosaic groundmass consists principally of very fine-grained albite and quartz with accessory amounts of biotite, apatite, zircon, magnetite, and tourmaline.

Knopf (1913, p. 28) concluded that these rocks are of late Cretaceous age; recent studies near the eastern margin of the batholith support this conclusion (M. R. Klepper, R. A. Weeks, and E. T. Ruppel, oral communication).

Quartz monzonite

The Comet area is underlain principally by the Boulder batholith, which has been divided on the basis of textural and minor compositional differences into five distinctive, mappable units; all five are within the quartz monzonite range. The relative ages and structural relations of the several map units are not known, but the similarities in composition and to some extent in texture suggest a common source and probably a close age relationship.

The most common unit, designated "qm" on figure 2, is dominantly medium-grained biotite-hornblende quartz monzonite. The texture is hypautomorphic, locally modified by large irregular grains of potash feldspar. The rock comprises 30 to 35 percent plagioclase, 25 to 35 percent potash feldspar, 20 to 30 percent quartz, 2 to 7 percent biotite, 1 to 5 percent hornblende, and 1 percent or less of magnetite, sphene, apatite, rutile (?), and zircon.

The plagioclase ranges from thick tabular crystals to small irregular grains and is commonly zoned from An_{45} to An_{20}. The large crystals are euhedral against quartz and irregular against potash feldspar. Slight sericitization of the plagioclase is common and some crystals have zones that are almost completely replaced by sericite.

Orthoclase appears to be more common than microcline; however, some potash feldspar, in which grid twinning cannot be detected, has faintly uneven extinction which may indicate a triclinic structure. Microperthite is common, and many large irregular grains have inclusions of quartz and corroded plagioclase crystals, suggesting that microperthite has replaced part of the plagioclase. Slight kaolinization gives a faint cloudiness to all the potash feldspar. All of the quartz is anhedral, some contains many liquid inclusions, and some has a faintly detectable grid structure. Strain shadows are common.

Biotite is generally more abundant than hornblende and ranges from small flakes to thick tabular grains; its pleochroic colors are: X, light yellow to yellowish-green; Y and Z, brown to brownish-green. Many biotite crystals are altered to penninite, only part of which exhibits the characteristic anomalous blue interference color, clinozoisite, sphene, and magnetite. Hornblende typically forms subhedral crystals, but corroded euhedral crystals are not uncommon. The pleochroic colors are: X, yellow green, Y and Z, dark green. The alteration products are commonly epidote, penninite, and rarely clinozoisite.

In the northwestern part of the mapped area, a distinctive rock type, designated "qm_1", lies between "qm" and the pre-batholithic volcanic rocks and extends in both directions beyond the limits of the area mapped. The significance of this spatial relationship is not known. The "qm_1" differs significantly from "qm" in composition, containing less quartz and more potash feldspar. The approximate composition of "qm_1" is 20 percent quartz, 45 percent potash feldspar, 30 percent plagioclase, and 4 percent biotite and hornblende. The texture is hypautomorphic, almost xenomorphic. Plagioclase crystals, commonly zoned from An_{45} to An_{30}, have ragged edges. Some crystals are cut by small irregular stringers of calcite which appear to be of replacement origin. Large irregular orthoclase crystals, commonly clouded by kaolin, appear to have replaced plagioclase in part. Microperthite is common. Quartz occurs interstitially. Hornblende is present as subhedral crystals, in part replaced by penninite, epidote, calcite, and magnetite. Biotite, in irregular grains, is pleochroic; X, pale yellow; Y and Z, dark brown. Sparse accessory minerals include apatite, sphene, zircon, and very rare bluish-gray tourmaline.

A type of quartz monzonite designated "qm_2" was found in only one small area, on the northwestern slope of Mt. Thompson, where it is apparently in contact with alaskite, "qm_1", and pre-batholith volcanic rocks although the contacts are not exposed. The texture is xenomorphic. The composition of the rock is 21 percent quartz, 25 percent plagioclase, 42 percent orthoclase, 6 percent biotite, 3 percent augite, 1 percent hornblende, and less than 1 percent magnetite, apatite and zircon.

Plagioclase crystals, corroded and embayed by orthoclase and quartz, are normally zoned from An_{40} to An_{25}. Orthoclase is slightly kaolinized and shows no evidence of triclinic structure. Microperthite is common in irregular grains and contains many inclusions of quartz, plagioclase and biotite. The relative abundance of orthoclase and microperthite ranges widely within the specimens examined. Quartz occurs interstitially and as small spherical inclusions in feldspars. Ragged anhedral to subhedral biotite grains are pleochroic, with X light yellow, and Y and Z greenish brown to dark yellow-brown. Some biotite is altered to brown penninite. Anhedral crystals of augite, pleochroic from light green to very pale yellow, have a maximum extinction angle of 45 degrees. Light green weakly pleochroic uralitic hornblende is present as thin, discontinuous rims and as irregular replacements of the augite.

A fresh-appearing quartz monzonite on the west slope of Mt. Thompson is designated "qm_3". This rock has a hypautomorphic-granular texture and is composed of 42 percent plagioclase, 25 percent potash feldspar, 19 percent quartz, 5 percent biotite, 4 percent augite, 3 percent hornblende, and accessory amounts of magnetite, apatite, zircon, and sphene. Unzoned plagioclase crystals are An_{35}; some crystals are normally zoned from An_{40} to An_{25}. Sparse sericite has penetrated along fractures in most of the crystals. Orthoclase grains are anhedral and some have very slight wavy extinction. Microperthite has irregular boundaries with plagioclase, and appears to have partially replaced it. The relative abundance of microperthite and orthoclase ranges widely within the specimens examined. The potash feldspar is in part kaolinized. Quartz is present as anhedral grains. Biotite, also typically in anhedral grains, is slightly altered to penninite and clinozoisite. Ragged, subhedral prisms of weakly pleochroic, light-green augite, with a maximum extinction angle of 40 degrees, are partly replaced by uralitic hornblende.

On the eastern and southern slopes of Mt. Thompson a textural variation, "qm_4", occurs along the border of the batholith between the "qm" and the volcanic rocks, and grades into the "qm". Near the contact with the volcanics it is fine-grained xenomorphic and slightly porphyritic. The grain size increases gradually with distance from the contact, grading into the common medium-grained quartz monzonite. The composition of "qm_4" does not differ significantly from "qm" even within a few feet of the volcanic contact. It is composed of about 25 to 30 percent plagioclase, 35 to 40 percent potash feldspar, 25 to 30 percent quartz, 4 percent biotite, 2 percent hornblende, and sparse apatite, magnetite and zircon.

Alaskite

A complex group of quartz-rich rocks comprising aplite, alaskite, alaskite porphyry, and pegmatite intrudes the pre-batholith volcanic rocks and the quartz monzonite. The rocks occur principally as dikes; however, a few large bodies of irregular shape have been recognized. All of the above quartz-rich rock types may be present in a single body, but more commonly only one or two are present. In the Comet area aplite predominates, alaskite is common, and alaskite porphyry and pegmatite are relatively rare. The coarser-grained rocks, where present, are not necessarily restricted to the center of dikes and intrusive bodies, but appear to be sporadically and irregularly distributed. Similarly, selvages of finer-grained rock are not characteristic of the margins of dikes and other intrusive bodies.

In the area mapped, there is a concentration of alaskite near the southeastern corner. Because of few exposures, it could not be determined whether the alaskite is in a few large bodies, as shown on the map in this vicinity, or in many small dikes separated by quartz monzonite wall rock.

The texture of the rock is xenomorphic, in places modified by phenocrysts of quartz and potash feldspar. Microperthite and granophyre are common. The rocks are composed of potash feldspar, 40 to 60 percent; quartz, 25 to 40 percent; plagioclase An_5 to An_{15}, 5 to 30 percent; biotite, 1 to 3 percent; and small amounts of apatite, tourmaline, zircon, magnetite, and rutile. Tourmaline also occurs as a later replacement along joints and fractures.

A detailed study of the alaskite is now in progress to determine, if possible, whether there is a genetic relationship between the alaskite and some of the mineral deposits in the area, as suggested by the spatial relationship of the alaskite to areas of intense alteration and abundant siliceous reefs in the southeastern corner of the map, and by the common presence of tourmaline in the alaskite and also in the altered quartz monzonite surrounding base metal veins.

Dacite-andesite

The youngest rocks in the area are dacite and andesite. Because of the sporadic distribution of quartz, both dacite and andesite may occur in a single outcrop. They comprise a group of steeply dipping dikes with a general northeasterly trend. The dikes are restricted to a relatively narrow area that also trends northeasterly through the center of the mapped area. Many of the dikes exhibit a platy jointing of diverse trend but invariably steep dip. Commonly, small biotite flakes are oriented parallel to the joints.

The rock is gray to white fine-grained porphyritic dacite and andesite. Glassy euhedral plagioclase and biotite phenocrysts are common; euhedral quartz crystals are common in some hand specimens and entirely lacking in others from the same outcrop.

The rock contains from 12 percent to 40 percent phenocrysts that consist of plagioclase, normally ranging from 55 to 75 percent and rarely as low as 10 percent of total phenocrysts; quartz, normally ranging from 12 to 25 percent, but in some specimens completely absent and in a few comprising as much as 70 to 90 percent; and biotite, ranging from 10 to 25 percent.

The plagioclase crystals are subhedral to euhedral and are commonly embayed by and contain inclusions of the groundmass. Most crystals are unzoned; the composition in different specimens ranges from An_{45} to to An_{25}. Some crystals are partly to completely replaced by fine-grained sericite and others by kaolin.

Biotite occurs as thin, platy crystals with pleochroism X, light yellow, Y and Z, dark brown to dark greenish brown. Quartz occurs commonly as euhedral prisms, some of which are rounded, and embayed by the groundmass. The groundmass is generally a very fine-grained aggregate of plagioclase, biotite, possibly quartz, and glass. Some streaming of the groundmass around phenocrysts is evident from orientation of the biotite flakes and feldspar laths.

North of Sugarloaf Mountain, a black glassy dike-like body of andesite about 2 feet wide and 25 feet long lies between normal dacite-andesite and quartz monzonite. This is believed to be a selvage of the larger normal dike, but the contact was completely covered and could not be observed.

The glassy andesite is porphyritic and typically contains about 20 percent of plagioclase as phenocrysts and as much as 5 percent of biotite as phenocrysts. The groundmass comprises crystallites of sodic plagioclase, biotite, and interstitial glass.

The plagioclase phenocrysts are clear, tabular euhedrons; wormy intergrowths of groundmass occur in the central parts of some. Two types of zoning are present; normal zoning from An_{30} to An_{20}, and reverse zoning. The reverse-zoned crystals have sharply defined rounded An_{15} cores and An_{25} rims.

Near the junction of High Ore Creek and the Boulder River is an intensely brecciated pipe-like body consisting of angular fragments, ranging in size from less than one tenth of an inch to several inches, of normal porphyritic dacite and extremely fine-grained banded dacite. The pipe is about 400 feet long and 50 to 80 feet wide, and stands about 10 to 50 feet above the surrounding quartz monzonite. The only contact observed was a sharp vertical contact between the breccia and a small alaskite dike at the northern margin of the pipe. Within a few inches of this contact, the average size of the fragments is much smaller than the average size of the fragments throughout the remainder of the pipe. The alaskite is not brecciated or altered at the contact; however, several rounded disintegrated fragments of quartz monzonite were found in the pipe within several feet of the contact.

Most of the fragments are composed of moderately to intensely altered dacite or andesite. Some fragments are altered entirely to kaolin, limonite, and quartz. In others, the quartz and biotite are essentially unaltered but laths of plagioclase have been replaced entirely by chalcedony. A few fragments contain large irregular grains of calcite. More than one period of brecciation is indicated by several of the included large angular fragments which are composed of smaller angular fragments.

The fragments are cemented by very fine-grained, flow-banded dacite. The cementing material is essentially unaltered and consists of irregular grains of quartz, plagioclase, subhedral flakes of biotite, and glass. The banding is apparently the result of a slightly greater amount of glass in some bands which imparts a darker shade of gray.

Structural features

The most conspicuous structural features in the Comet area are the Comet-Gray Eagle shear zone in the northern part and the many steep-dipping chalcedonic vein zones in the southeastern part. The vein zones have been offset by northwest- and northeast-trending faults. Numerous faults of diverse trends were observed underground but only a few of the most obvious could be traced on the surface because of the lack of key units for correlation.

The steep-dipping Comet-Gray Eagle shear zone trends in general N. 80° W., is as much as 200 feet wide, and extends from beyond the eastern margin of the map almost to the western margin, a distance of 5 1/2 miles. It transects the older volcanic rocks, the quartz monzonite, and the alaskitic rocks, all of which are intensely sheared and brecciated in the zone, and it in turn is transected by the younger dacite and andesite. Two northeast-trending shear zones join the main zone about 2,000 feet east of the Comet, and in the vicinity of the Bismark mine, movement along the easternmost split from the main shear zone has offset the contact of the older volcanic rocks and the quartz monzonite. This is the only place along a shear zone where displacement can be demonstrated.

The general trend of the chalcedonic vein zones changes from N. 60° E. in the southeastern corner of the mapped area to east near the center. Brecciation has occurred in many of the vein zones, and gouge or microbreccia is common at the margin and within some vein zones.

MINERAL DEPOSITS

General statement

The area mapped contains a number of base- and precious-metal deposits that have been exploited by several mines and numerous prospects. The most important deposits occur along the Comet-Gray Eagle shear zone. Different deposits contain gold, silver, lead, zinc, and copper in different ratios. These are the oldest deposits in the area, and some at least may be assigned to the tourmalinic silver-lead group of Knopf (1913, p. 46).

A younger and distinctly different type of deposit comprises the chalcedonic vein zones that locally contain a little silver and gold but no important concentrations of base metals. Deposits of this type are common near Boulder and particularly near Clancey, north of the area mapped (Knopf, 1913, p. 54).

A third type of deposit that has some characteristics of both of the above types contains abundant lead, silver, and zinc in a gangue that is predominatly cryptocrystalline silica; no tourmaline occurs in these veins or in the altered quartz monzonite wall rock adjacent to them. These deposits may have been formed either in an intermediate period of mineralization or may be the result of mineralization in both of the periods previously described.

Uranium minerals and high radioactivity anomalies (fig. 3) have been found in deposits of both the older and younger groups. Uranium may have been deposited during both periods of mineralization or only during the later period, when some of the older veins may have been reopened and reinvaded by ore-bearing solutions.

The general features of the mineral deposits in this area and some of the principal deposits have been described by Knopf (1913, pp. 114-122), Billingsley and Grimes (1918, pp. 306-315), and Pardee and Schrader (1933, pp. 285-299). In this report only the deposits with abnormal radioactivity are described.

Older deposits

Comet mine

The Comet mine is in the Comet-Gray Eagle shear zone in quartz monzonite near the roof of the Boulder batholith. In the mine the shear zone is cut by two dacite dikes. Along the shear zone, are a number of other base- and precious-metal deposits. The Comet deposit is the largest and the value of lead, silver, zinc, gold, and copper produced from the Comet mine is reported by company records and unpublished reports to exceed 20 million dollars. During the latest period of activity, from 1934 to 1941, the production was about 3 million dollars from ore that averaged about 7 to 10 dollars per ton in combined lead, zinc, silver, gold, and copper. The company officials considered the mine to be worked out when operations were terminated in 1941.

All workings are inaccessible, but old maps indicate that the mine was developed to a depth of 960 feet and for a strike length of 2,200 feet by a vertical shaft and eight principal levels. No ore was mined below the 700-level, and most of the production came from above the 500-level.

Three principal veins follow the trend of the shear zone and dip steeply to the south, and several splits of these veins were explored (fig. 2). The major portion of the stoping was done on these veins within 500 feet east and west of the shaft. Company stope maps suggest that the bulk of the ore occurred in shoots in the three main veins and the several minor splits of these veins, in a roughly defined block that was longest on the 300-level and pinched out at about the 700-level. Below the 700-level the veins contained abundant pyrite, but only very small amounts of other sulfides, in a quartz gangue.

The wall rock is dominantly altered quartz monzonite with subordinate altered alaskite. Alteration is of three types - silicification, sericitization, and kaolinization. A detailed study now in progress may yield more information on the relationship between the different types of alteration and the deposition of ore minerals.

Ore minerals identified from dump samples are galena, sphalerite containing exsolved chalcopyrite, pyrite, chalcopyrite, and arsenopyrite. The gangue is chiefly altered wall rock and quartz, part of which is a clear crystalline variety and part a dark bluish-gray fine-grained variety.

Several samples of radioactive material were collected by Survey personnel from the Comet dump. John Giulio, present lessee of the property, reports that these samples probably came from the east drift on the 200-level. Moderate to high radioactivity anomalies were found at only two places on the dump, but higher than average radioactivity was detected at a few other places.

Two samples of dump material were submitted for chemical analysis and mineral identification to the Geochemistry and Petrology Branch of the U. S. Geological Survey in Washington, D. C. The results are summarized below. One sample of weathered soft black vein material, selected as the most radioactive sample found, contained 0.52 percent uranium. An X-ray powder pattern of the sooty black material, ignited, matched the standard patterns of quartz and hematite. A spectroscopic analysis of the X-ray spindle showed major silicon, minor iron, and traces of calcium, magnesium, sodium, potassium, and manganese. The second sample submitted was a soft yellow mineral spatially associated with the sooty black mineral of the first sample. It contained 0.015 percent uranium, and the X-ray powder pattern matched the standard patterns of quartz, possibly gypsum, and possibly clay. Spectroscopic analysis showed major aluminum, iron, and silicon, minor calcium and potassium, and a trace of magnesium and manganese. Although no uranium minerals were identified, the amount of uranium in the samples is significant. The dump material has been exposed to weathering for at least ten years and possibly for 35 years or more; therefore, the uranium minerals originally present in the ore were probably destroyed by weathering with the removal by surface waters of some of the uranium. Because the radioactivity is localized in a few small areas in the dump, there is a strong possibility that the uranium minerals came either from a single vein that was not extensively mined or from scattered pods in one or more veins that were extensively mined. Although the available data do not allow an estimate of reserves of uranium to be made for the Comet mine, the moderately high-grade samples and the strength and persistence of the Comet shear zone suggest that a commercial deposit of uranium may occur.

Gray Eagle mine

The Gray Eagle mine, in sec. 35, T. 7 N., R. 5 W., is about 1 1/2 miles west of the Comet mine along the Comet-Gray Eagle shear zone. It was last operated in 1937 but is now inaccessible. It has been described by Knopf (1913, p. 121) and Pardee and Schrader (1933, pp. 287-289). Sulfide minerals identified from dump samples are galena, sphalerite with exsolved chalcopyrite, pyrite, chalcopyrite, and arsenopyrite. Tetrahedrite is reported from the mine but none was identified in the present survey. The value of gold, silver, lead, zinc, and copper produced is estimated to have been about 1 million dollars.

Radioactivity in dump samples was first reported by geologists of the Atomic Energy Commission on June 4, 1951 (AEC PRR M-81). Subsequently the part of the dump that had appreciable radioactivity was shipped to the East Helena smelter for the silver content, and only slight radioactivity was detected during the present survey. However, Mr. Giulio, who shipped this ore, collected several strongly radioactive samples from this part of the dump. One of these, a piece of weathered vein material that contained pyrite, a sooty black mineral, and a spatially associated soft yellow mineral, was submitted to the Geological Survey laboratory for chemical analysis and mineralogic study. The results of the examinations are summarized below. The sample assayed 2.2 percent uranium. An X-ray powder picture of the sooty black mineral showed a very poor, possibly cubic pattern. An X-ray powder pattern of the same mineral, ignited, matched the U_3O_8 standard pattern which indicates the mineral is possibly metamict pitchblende. Spectroscopic analysis of an impure sample of the yellow mineral showed major iron and silicon, and minor uranium, vanadium, calcium, magnesium, aluminum, and manganese, and a trace of zirconium. This mineral is unquestionably a secondary uranium mineral but could not be specifically identified.

The part of the dump from which these samples were collected was reported by a man who had worked in the mine to have come from a subsidiary vein about 100 feet south of the main productive vein on the 600-level, which is 200 feet below the main adit level. Mine maps show that this subsidiary vein was followed for only about 300 feet, which may account for the localization of radioactive material in one small part of the dump.

Additional strongly radioactive samples were found by Mr. Frank Rowe, part owner of the mine, in May 1952 in excavations on the dump. A sample tested in the Geological Survey office in Spokane contained about 2 percent equivalent uranium. A black sooty mineral intimately intermixed with pyrite was separated from gray crystalline quartz in a second sample and contained about 40 percent equivalent uranium. This mineral was identified as uraninite by the Geochemistry and Petrology Branch of the Geological Survey.

Although there is no basis for making any estimate of reserves of uranium ore, the high uranium content and the presence of uraninite in the samples indicate that a commercial deposit may be present. In May 1952 the owners began to reopen the mine in order to obtain more information on the distribution and grade of uranium in the mine.

Silver Hill mine

The Silver Hill mine adjoins the Comet mine on the west. It is developed by a shaft 165 feet deep from which several levels have been driven. The mine is inaccessible, but available mine maps indicate that the north crosscut on the 65-level intersects the three main veins that were mined in the Comet; where they were intersected, the veins contained no significant sulfide mineralization.

Moderate radioactivity was detected on the dump. The radioactive material, which occurs along joints and fractures in the vein material, could not be identified.

A Defense Minerals Exploration Administration loan for lead-zinc has been recommended to permit unwatering the shaft to the 65-level, extending this level to intersect the north split of the north vein of the Comet mine, and drifting a maximum of 300 feet along this vein.

Hope-Bullion

The Hope-Bullion prospect, which adjoins the Comet mine on the east, is approximately at the junction of the main Comet-Gray Eagle shear zone and two northeasterly splits of this shear zone (fig. 2). A few bulldozer trenches on this property expose intensely altered quartz monzonite that contains sparse cerussite, galena, pyrite, and sphalerite.

Geologists of the Atomic Energy Commission reported weak radioactivity in the trenches, but none was detected in the present survey. The owner is sinking a 100-foot shaft and will drift 200 feet on the vein as part of a Defense Minerals Exploration Administration project.

Boulder Chief mine

The Boulder Chief mine, in sec. 27, T. 7 N., R. 5 W., is developed by a shaft and an adit, both of which are now inaccessible. These workings apparently explore a small east-trending vein. A small amount of lead, silver, and copper was produced between 1913 and 1917. The shaft is collared in pre-batholith volcanic rocks, but most of the rock on the dump is intensely altered alaskite or quartz monzonite. Sulfide minerals identified from dump samples are galena, sphalerite, pyrite, and arsenopyrite. No radioactivity was detected on the large dump from the shaft; several small pits upslope east of the shaft showed weak radioactivity. A sample of the most radioactive material that could be found consisted mostly of brown limonite and contained 0.016 percent equivalent uranium and 0.010 percent uranium.

Intermediate deposits

No abnormal radioactivity was detected in deposits of this type, therefore descriptions of these deposits are not included in this preliminary report.

Younger deposits

Free Enterprise mine

The area around the Free Enterprise mine was mapped by Roberts and Gude (1952) in 1950, and no additional work was done in the present study. At the Free Enterprise mine, uranium has been produced from a narrow chalcedonic vein that contains disseminated secondary uranium minerals and local small pods of pitchblende and from disseminated secondary uranium minerals in the adjacent quartz monzonite. Associated with the uranium are very small amounts of pyrite, galena, ruby silver, argentite, native silver, molybdenite, chalcopyrite, arsenopyrite, and barite.

A Defense Minerals Exploration Administration loan for uranium was granted in September 1951; under this contract 345 feet of drifting was done and several holes were drilled to intersect the vein below the present workings. The exploration was completed in April 1952. No commercial ore was developed.

High Ore (Montana Consolidated) mine

The High Ore mine, patented as the Montana Consolidated claim, is in sec. 2, T. 6 N., R. 5 W. No record of production is available. The mine consists of an 1,800-foot crosscut with a 200-foot drift, two stopes, and a winze on a vein near the face. There is no air circulation in the mine beyond about 700 feet from the portal. The crosscut intersects several siliceous veins, some of which contain sparse pyrite, galena, and chalcopyrite. The veins consist of silicified quartz monzonite with stringers of white to bluish gray quartz commonly a few inches wide. About 200 feet from the face, the crosscut intersects a vein, at least 10 feet wide, of dark-blue quartz with white quartz stringers containing sparse pyrite and galena. The vein, which strikes approximately N. 60° E. and dips 65° to 70° SE., is probably the downward extension of the large siliceous structure on the top of the ridge west of the mine portal. The drift follows the vein about 200 feet to the southwest. On the surface the vein is intensely silicified fine-grained quartz monzonite cut by many light gray chalcedonic stringers from 0.1 inch to 12 inches wide; some of the stringers contain a little milky quartz, and a few are cut by small brown-weathering carbonate stringers. The rock in the vein zone is intensely brecciated and faulted, most of the fragments are blocky and less than a foot in largest dimension.

Radioactivity in the mine was discovered during the present survey in October 1951. No abnormal radioactivity was found on the dump or along the outcrop of the vein. Radiometric traversing of the tunnel, however, disclosed a gradual increase in radioactivity from normal background at the portal to ten times normal background a few tens of feet from the face; beyond this point the increase is more rapid: at the face the reading is 30 times background. This radioactivity is probably due to radon gas, but the source of the gas could not be determined nor could any samples of radioactive rock be found.

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