THE GEOLOGICAL SURVEY OF WYOMING

HORACE D. THOMAS, State Geologist

PRELIMINARY REPORT NO. 3

The Keystone Gold-Copper Prospect Area Albany County, Wyoming

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UNIVERSITY OF WYOMING
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Cover. Keystone mine, 1905. Photo furnished by S. H. Knight

THE KEYSTONE GOLD-COPPER PROSPECT AREA, ALBANY COUNTY, WYOMING

by

Donald R. Currey*

INTRODUCTION

The Keystone area, which has been actively prospected for gold and copper for nearly a century, is located in westernmost Albany County, within the Medicine Bow Mountains of southeastern Wyoming. The area includes portions of T. 13 N., R. 78 W.; T. 13 N., R. 79 W.; T. 14 N., R. 78 W.; and T. 14 N., R. 79 W. (Fig. 1).

The area is traversed by graded roads and truck trails which are accessible from State Highways 230 and 130. Roads within the area are not maintained during the winter months. The nearest railheads are the settlements of Albany and Foxpark (Fig. 1), about ten miles east and southeast of the area respectively, which are served by the Coalmont Branch of the Union Pacific Railroad.

Geologic mapping was done during the summer of 1958 on vertical air photographs selected from U. S. Geological Survey flights CM 19 and CM 38, enlarged to scales of 1:12, 000 and 1:6, 300 respectively.

TOPOGRAPHY

The Keystone area is situated between 8, 500 and 10, 000 feet elevation on a high-level surface of low relief which has been partially dissected by the south-flowing drainage of Douglas Creek, a tributary of the North Platte River, and by an east-flowing fork of the Little Laramie River. Local relief ranges from less than 200 feet to over 500 feet.

The slopes and uplands support a rather dense conifer and aspen forest dominated by lodgepole pine. Timber-cutting is currently an important industry in the immediate region. Grassy park-like reaches along some of the streams are grazed by cattle in summer. Stream bottoms are largely grown with willows and other shrubs.

Although somewhat sparce on many of the more gentle upland slopes, rock outcrops are moderately abundant over most of the area.

GENERAL GEOLOGY

The rocks of the Keystone area (Pl. 1) are broadly divisible into two categories, those of Precambrian age and those of Cenozoic age. The earlier Precambrian rocks are metamorphic, consisting of schist and gneisses, into which later Precambrian bodies of moderately-foliated to massive igneous and igneous-like rocks were emplaced. Cenozoic rocks include Early Tertiary (?) dike-forming rhyolite, Late Tertiary (?) upland gravels, and Quaternary alluvium. The Precambrian rocks are more or less complexly foliated, jointed, and sheared.

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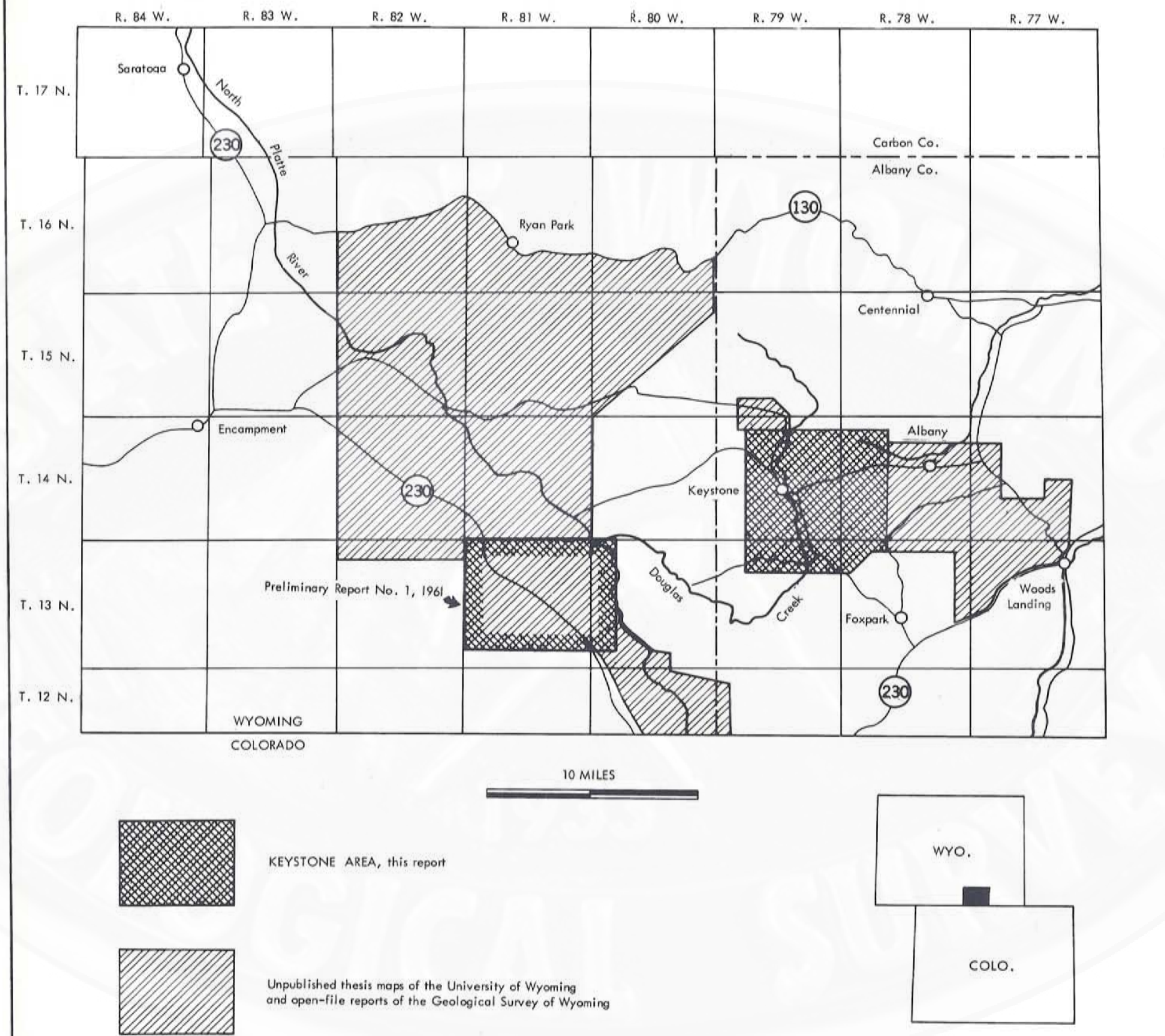

Fig. 1. Index map showing the location of the Keystone gold-copper prospect area.

Precambrian Rocks

A fifteen-square-mile, roughly circular body of quartz diorite constitutes the core of, and is the oldest igneous rock unit in the area. The quartz diorite is flanked on the north and west by a belt of older quartz-biotite schist and on the south by older amphibole and quartz-andesine gneisses. Gabbro younger than the quartz diorite flanks the core on the east and occurs as elongate bodies within the quartz diorite. Quartz-feldspar gneiss younger than the gabbro occurs north of the schist belt, in a syncline in the schist belt, and as smaller scattered bodies within the schist, within the quartz diorite, and within the gabbro east of the core. Granite in the northeast corner is the youngest Precambrian rock unit in the area.

Quartz diorite. The quartz diorite, which comprises the central core of the area, is medium gray on fresh surfaces and light gray on weathered surfaces. Outcrops occur as prominent, rounded to spheroidal blocks bounded by widely spaced joints which have been markedly enlarged by weathering (Fig. 2). The rock is medium-grained, granitic textured, and susceptible to disintegration, thereby forming a gravelly soil. In order of decreasing abundance the principal constituent minerals are plagioclase (andesine), quartz, hornblende, biotite, and epidote. A leucocratic phase occurs near the eastern limit of the quartz diorite and on the interfluve in the fork between Muddy and Douglas Creeks; a melanocratic phase of the quartz diorite occurs at scattered localitites, particularly near the southern limit of the unit.

Foliation is faintly visible in most exposures of the quartz diorite, especially where the surface of the rock has been etched by weathering or where the foliation is delineated by small hornblende segregations and by larger incompletely assimilated inclusions of older metamorphic rocks. The inclusions occur both as elongate schlieren of partially assimilated schist and as ellipsoidal xenoliths of partially assimilated gneisses. Inclusions of the latter type are particularly conspicuous within a belt which extends in an approximately north-south direction through the central portion of the quartz diorite body.

The contact relationships between the quartz diorite and the adjacent pre-existing metamorphic rocks are invariably gradational through a narrow transition zone. A diminution in the grain size of the quartz diorite is characteristic as the contact zone is approached. Within the contact zone the quartz diorite lit-par-lit replaces, or injects into, the folia of the older units. The numerous inclusions, many of which are lithologically indistinguishable from the older metamorphic rocks with which the quartz diorite is now in contact, suggest that at least locally the emplacement of the quartz diorite was accomplised by means of a stoping mechanism.

Quartz-biotite schist. The quartz-biotite schist, which crops out in a bifurcate belt in the northern half and along the western margin of the area, is medium to dark gray on fresh surfaces, becoming brownish on weathered surfaces. Outcrops have an angular, blocky appearance because of close rectangular jointing (Fig. 3). The schist is predominately very fine-grained. A micaceous sheen is visible where the rock has been freshly parted along foliation. In order of decreasing abundance the principal constituent minerals are quartz, plagioclase, biotite, and muscovite. A spotted phase containing numerous hornblende porphyroblasts occurs as a discontinuous northeast striking band in the vicinity of the Keystone mine.

A section approximately 2,400 feet thick of the quartz-biotite schist is exposed along Douglas Creek in the vicinity of Keystone. The resemblance of the foliation to relict bedding and the similarity of the mineralogic composition to that of a sedimentary lithology such as a siltstone or an impure quartz sandstone suggest the possibility that the schist is of metasedimentary origin. In the headwaters of Smith North Creek the quartz-biotite schist is apparently gradational with the amphibole gneiss unit which occurs farther south.

Amphibole gneiss. The amphibole gneiss, which is poorly exposed along the southernmost margin of the area, is dark gray on fresh surfaces, but readily weathers to light greenish gray. Although bands of the gneiss are medium-grained, and even coarse grained, it is predominantly a fine grained unit. The gneiss is strongly foliated and is particularly characterized by bands, a few inches to several feet in thickness, of felsic and intermediate gneisses which alternate with and parallel the more dominant bands of amphibole gneiss. In order of decreasing abundance the principal constituent minerals of the amphibole gneiss are amphibole (hornblende), plagioclase (andesine-labradorite), quartz, epidote, and biotite.

The unit is lithologically similar to layered sequences which have been recognized elsewhere in the southern Medicine Bow Mountains (Houston, 1961, Pl. 1).

Quartz-andesine gneiss. The quartz-andesine gneiss, which occurs in the southeastern corner of the area, is light brownish gray on fresh surfaces, becoming cream-colored on weathered surfaces. The gneiss is fine-grained and highly foliated, almost schistose, with a brilliant sheen where freshly parted along foliation. The unit commonly weathers to form low, scattered, tombstone-like outcrops. In order of decreasing abundance the principal constituent minerals are plagioclase (andesine), quartz, biotite, epidote, and hornblende.

The western portion of the quartz-andesine gneiss is profoundly recrystallized and grades into fine-grained quartz diorite and thence into normal quartz diorite. Along its northeastern limit the gneiss is in abrupt contact with later intrusive gabbro. Along Lake Creek the gneiss is in poorly exposed contact with melanocratic quartz diorite and gabbro which accur to the south. The unit has been differentiated (Catanzaro, 1956, Pl. 1) eastward from the Keystone area as quartz-orthoclase-biotite schist.

Gabbro. Two varieties of gabbroic rocks occur in or marginal to the area. A normal gabbro occurs along the eastern margin, where it is in contact with, and younger than, the quartz diorite of the central core. This gabbro has been previously described in relation to the Lake Owens mafic complex (Catanzaro, 1956), which adjoins the Keystone area on the east (Fig. 1).

A second, less mafic, quartz-hornblende gabbro occurs within the Keystone area proper. In order of decreasing abundance minerals include hornblende, plagioclase (labradorite), and small amounts of quartz and epidote. Texturally the quartz-hornblende gabbro consists of two phases, a medium-grained phase which is in broad, elongate bodies and a fine-grained phase which occurs in minor dike-like bodies. Both phases are dark gray green on fresh surfaces and reddish brown on weathered surfaces. The medium-grained phase varies considerably in outcrop aspect, whereas the fine-grained phase weathers so readily that it generally exhibits negative topographic expression and is frequently concealed beneath a cover of soil and forest litter; the latter phase was not mapped.

Bodies of the medium-grained phase of the quartz-hornblende gabbro are distributed mainly along the inclusion-rich belt within the quartz diorite, although such bodies are also known to c cur within the quartz-biotite schist; gabbro of this variety is also in evidence on several of the mine dumps in the area. Both phases of the quartz-hornblende gabbro are massive and granitic-textured where unsheared and both are generally in intrusive contact with local country rock.

Quartz-feldspar gneiss. The quartz-feldspar gneiss is a highly variable lithologic unit of widespread occurrence in the area. The gneiss is in part probably metamorphic, in part apparently igneous, and at least in part younger than the gabbro. Two phases, one microcline-poor and the other microcline-rich, are evident. Both phases are predominately fine-grained, both vary from massive and granitic-textured to conspicuously foliated, and both phases are typically found in low mound-like outcrops. (Fig. 4).

The microcline-poor and rich phases occur north of the quartz-biotite schist, along the northern margin of the area. The microcline-poor phase is medium gray on fresh surfaces and light gray on weathered surfaces, and resembles the quartz diorite in outward appearance. In order of decreasing abundance the principal mineral constituents of the microcline-poor phase are quartz, plagioclase (oligoclase-andesine), biotite, muscovite, epidote, orthoclase, and microcline.

The microcline-rich phase occurs as a large body in the northwest portion of the area where it has been emplaced in the trough of a syncline within the quartz-biotite schist. It occurs as a number of smaller bodies within and southeast of the schist belt, and it is also in close association with the microcline-poor phase along the northern margin of the area. The microcline-rich phase is faintly-pinkish gray on fresh surfaces and a distinctive light pink on weathered surfaces. In order of decreasing abundance the principal constituent minerals in this phase are quartz, microcline, plagioclase (albite), orthoclase, biotite, musovite, and epidote.

The quartz-feldspar gneiss is a complex unit. Along its northern limit the quartz-biotite schist grades northward, through a zone of lit-par-lit replacement and injection, into the microcline-poor phase of the quartz-feldspar gneiss, which in turn grades into the microcline-rich phase of the gneiss. The latter phase is similar, if not identical, to quartz-orthoclase-microcline-mica gneiss described (Childers, 1957) from an area about 10 miles northwest of the Keystone area.

Within and south of the schist belt the only quartz-feldspar gneiss of consequence is the microcline-rich phase. In the synclinal trough this phase is in contact with the surrounding quartz-biotite schist through a transitional lit-par-lit zone. Various smaller bodies exhibit both gradational and sharp contact relations with local country rock. At least one body seems to be localized along sizeable aplite dikes and at least one body occurs within the gabbro along the eastern margin of the area. A relatively large body in the northeast portion of the area may be truly gradational with the adjacent granite unit.

Fig. 2. Large outcrop of quartz diorite, showing characteristic enlarged joints; east side of Douglas Creek, about one mile north of Muddy Creek.

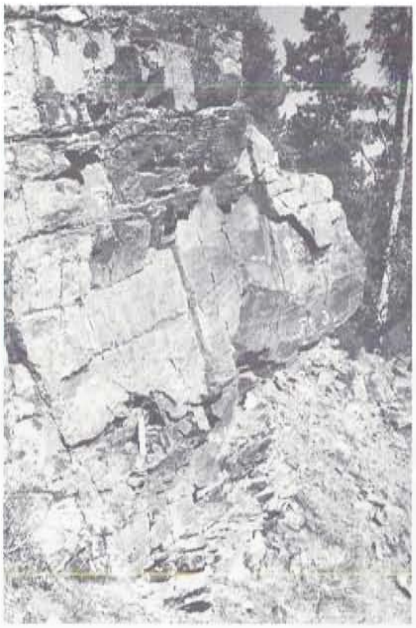

Fig. 3. Typical outcrop of quartz-biotite schist, showing close rectangular jointing (6-inch rule); west side of Douglas Creek, four-tenths of a mile north of Gold Run.

Fig. 4. Typical low, scattered, rounded to angular-fractured exposures of quartz-feldspar gneiss (microcline-rich phase); near confluence of Horse and Douglas Creeks.

Granite. Massive granite is well exposed in the northeastern corner of the area. The granite is medium- to coarse-grained, granitic-textured, and pink-colored on both fresh and weathered surfaces, and is highly susceptible to disintegration by weathering. Outcrops are frequently toadstool-shaped and are characteristically surrounded by pink-colored gravelly detritus. In order of decreasing abundance the principal constituent minerals are microcline, quartz, plagioclase (albite), biotite, orthoclase, and hornblende.

Along the southwestern limit of its occurrence the granite is in sharp contact with the quartz-biotite schist and with the gabbro. In the northern part of the area, the granite may be in gradational contact with a microcline-rich body of the quartz-feldspar gneiss and it may be responsible for the local felsic enrichment of the originally microcline-poor gneiss. The granite is probably correlative with the Pikes Peak type granite of other areas (Houston, 1961, p. 11) in the Southern Rocky Mountains.

Cenozoic Rocks

The Cenozoic rocks of the Keystone area include a dike-forming rhyolite of Early Tertiary (?) age, upland gravel of Late Tertiary (?) age, and alluvium of Quaternary age.

Early Tertiary (?) rhyolite. The rhyolite occurs as a nearly vertically dipping 50-foot-wide dike which is expressed topographically as a low ridge. The dike is discontinuously exposed for a distance of over five miles in a northwest-southeast direction across the eastern half of the area. The rhyolite is massive and microporphyritic-textured with fine-grained phenocrysts of biotite and orthoclase in a microscopic-grained groundmass of quartz, feldspar, and muscovite. Fresh surfaces of the rock are pinkish gray and weather an orange brown color.

Late Tertiary (?) upland gravel. The uplands on either side of Muddy Creek are largely blanketed by remnants of a poorly consolidated gravel unit. The unit is nowhere well exposed. Cobbles are subangular to rounded and vary from less than one inch to more than one foot in diameter. Little matrix or cement is evident. In order of decreasing frequency the cobbles consist of mafic igneous rocks and mafic gneisses, granite and felsic gneisses, schist of various varieties, and remarkably little quartzite. Quartz diorite cobbles are absent.

The gravel may occupy broad ancient channels which, in part, now show reversal of topography. Within the Keystone area the gravel ranges in elevation from 9,200 to 8,900 feet and was originally graded or was subsequently tilted in a manner such that the elevation of the gravel gradually diminished to the south. Maximum thickness of the gravel may approach 200 feet.

Quaternary alluvium. Alluvium, in places significantly auriferous, occurs throughout the area in modern stream channels, in low terraces along streams, and in relatively unincised park-like bottoms. The undisturbed alluvial deposits, which overly Precambrian bedrock are overlain by several inches of soil, range up to 1,000 feet in width and up to perhaps 15 feet in thickness. For the most part the alluvium is unconsolidated and is composed of clastic particles ranging from sand to small-boulder size. The alluvium contains cobbles of quartz diorite and a markedly higher proportion of cobbles lithologically indistinguishable from the Medicine Peak metaquartzite, which crops out in the central portion of the Medicine Bow Mountains to the north of the Keystone area, than does the late Tertiary (?) upland gravel.

Structure

Several structural trends are evident within the foliated rocks of the area. The quartz-biotite schist belt assumes the appearance of a down-folded septum bounding the quartz diorite on the north and northwest; the microcline-rich quartz-feldspar gneiss northwest of Keystone lies in the trough of the fold and widens to the west, in the direction of plunge. Faint foliation within the eastern portion of the quartz diorite core is concentrically disposed with respect to the plan outline of the gabbro farther east, suggesting forceful, perhaps penecontemporaneous, emplacement of the gabbro with resulting accommodation by the quartz diorite. More conspicuous foliation near the southern limit of the quartz diorite is largely secondary, imparted by shearing distributed through broad zones. Foliation in the quartz-feldspar gneiss along the northern margin of the area tends to be locally continuous and independent of lithologic phase.

Although joint systems appear in any one place to be largely influenced by the attitude of local foliation, one joint set is persistent throughout the area. This set, which strikes generally north 30 degrees east and dips nearly vertically, has been an important factor in localizing the emplacement of minor intrusive bodies. Elongate bodies of medium-grained gabbro, smaller dike-like bodies of fine-grained gabbro, dikes and veins of pegmatite and aplite, some quartz veins, and the prominent rhyolite dike all deviate little from this trend, indicating repeated tensional stresses normal to the joint set.

Two important sets of shears occur in the area: broad east-west-striking shear zones which roughly parallel the southern limit of the quartz diorite in the vicinity of Lake and Smith North Creeks, and narrow northwest-trending shears in the northern half of the area. The shearing in the southern portion of the area is distributed through broad zones, at least five in number, which together constitute a belt of shearing about one mile in width. Individual shear zones within this belt are separated by relatively unsheared horses. The intensity of shearing varies from thoroughly sheared mylonite seams to scarcely perceptible secondary foliation in the form of a planar alignment of tectonic augen. The mylonite seams and secondary foliation strike between north 80 degrees east and south 80 degrees east and dip from 70 degrees north to nearly vertical. Felsic veinlets occur among and parallel to some of the planes of shearing, an indication that the shearing may in part antedate the emplacement of granite in the area. The felsic veinlets are themselves somewhat sheared, indicating subsequent repetition or continuation of the shearing.

The shears in the northern portion of the area vary from a few inches to several feet in width and evidence only slight relative displacement. This set generally strikes north 60 degrees west and dips steeply to the southwest. With few exceptions the shears belonging to this set are noteworthy as loci of gold-copper mineralization rather than as structural features. Mineralized shears, or trends as they might be more properly regarded, are poorly exposed except in surface workings at the Florence, Keystone, Gold Crater, and Cuprite mines. Other mines and prospects in the area are without doubt situated on structurally cognate, but more poorly exposed, mineralized trends.

ECONOMIC GEOLOGY

Mineral deposits of immediate economic interest in the Keystone area include primary gold-copper deposits and gold-bearing placer deposits. Other deposits of potential interest in or adjacent to the area include pegmatites and a vermiculite occurrence.

Primary Gold-Copper Deposits

In the northern portion of the area the primary gold-copper deposits are for the most part aligned along the narrow northwest-trending shears. Because along strike shearing is scarcely perceptible in most exposures and surface expression is generally discontinuous, these features are best termed mineralized trends. The east-west alignment of the "Monarch" trend at the Independence mine is an exception to the predominant orientation. In the southern portion of the area the primary gold-copper deposits are disposed along planes of shearing which are in turn dispersed in a parallel or sub-parallel fashion within the broad east-west striking shear zones that constitute the structural grain in that vicinity. In both the northern and southern portions of the area the deposits are accompanied by silicification in the form of small, irregular quartz veinlets. In many instances wallrock is altered to a reddish color and enriched in epidote. The mineralized trends in the northern portion of the area, in particular, cut several small, poorly exposed mafic bodies which seem to have been emplaced earlier along the same trends.

The primary deposits of the area generally contain values in both gold and copper. The deposits have a tendency to be zoned through a comparatively narrow vertical range. The vertical dimension of the zonation has undoubtly been restricted by the presence of a high water table. Hypogene minerals, characteristic of the zone perpetually beneath fluctuations of the water table, in the Keystone area include chalcopyrite, bornite, pyrite, pyrrhotite, and native gold. Supergene minerals, deposited in a zone near the water table, include chalcocite and covellite. The oxidized zone, extending from the top of supergene zone to the surface, contains hematite, malachite, azurite, cuprite, native cooper, and native gold. The better grade copper ores of the area have been taken from the deeper portions of the oxidized zone and, especially, from the supergene zone. The better gold ores have been taken from the oxidized zone, where hypogene gold-bearing sulfides have been weathered to a free-milling state.

The origin of the primary gold-copper deposits in the Keystone area is not altogether understood. The genetic relationships exhibited by similar deposits in neighboring districts are of interest in this respect. Primary copper sulfides in the Encampment (Fig. 1) mining district, about thirty miles west of the Keystone area, are believed (Spencer, 1904, p. 53-60) to be indigenous to, or derived from, mafic rocks. That belief was founded mainly on the strength of analyses which showed significant traces of copper sulfides in mafic intrusive rocks in that district. The principal metallic mineralization in the French Creek area, about ten miles northwest (Fig. 1) of the Keystone area, consists of a silicified zone containing pyrrhotite, pyrite, and chalcopyrite. The zone occurs within schistose amphibolite and the source of the sulfides is believed (Childers, 1957, p. 49) to have been the mafic magma from which the amphibolite was derived. The Rambler copper mine, noteable for its supergene concentration of platinum-bearing covellite ore, is situated in an area (Fig. 1) adjacent to the northwest corner of the Keystone area. Primary mineralization in the Rambler mine is believed (Kemp, 1904) to be indigenous to mafic dike-rock encountered there.

Although the primary gold-copper mineralization in the Keystone area may be partly attributable to mafic sources, it is distinctly possible that some primary mineralization occurred during late stages in the regional emplacement of granite, when residual liquids seem to have resulted in minor pegmatite and aplite dikes, barren quartz veins, and the felsic metasomatism of fine-grained gneiss. There occur in the area mafic dikes containing quartz and aplite veinlets. The association of aplite with the quartz suggest that the quartz is of granitic rather than mafic origin. In places the broad, locally mineralized shear zones in the southern portion of the area, in addition to being enriched in silica and evidencing what appears to be hydrothermal alteration, are visibly enriched in potash. A sample of sheared quartz diorite collected from a locality near Lake Creek shows a nearly four-fold enrichment in potash over a sample of quartz diorite from a nearby unsheared locality.

Unsheared quartz diorite	Sheared quartz diorite
(NRRI sample No. 12490)	(NRRI sample No. 12491)
K_2O--0.73 percent	K_2O--2.80 percent

A vein specimen from the dump of the White Swan mine contains comb-structured quartz having a crustification of pink feldspar on the terminated ends of the quartz prisms. The potash enrichment of the mineralized shear zones and the occurrence of potash feldspar in vein material is tentatively regarded as indicating that mineralization was at least partly related to late stage phenomena of the Pikes Peak type granite, the most likely source of potash in the region. Quartz and copper sulfide mineralization actually occurs within some of the granite pegmatites of the Big Creek pegmatite area, about ten miles west-southwest of the Keystone area, where it is thought (Houston, 1961, p. 10) that such occurrences probably represent a late stage of granitic mineralization.

Subsurface geology is inaccessible in most of the mines (Pl. 1) in the Keystone area because of flooding or caving. Little or no data is available regarding a few of the mines. Brief summary descriptions, taken from previously compiled (Currey, 1959, p. 51-59) historical data, of some of the more important mines are given in the following paragraphs.

Albany mine. A 360-foot shaft had been sunk by 1903 at the Albany mine and drifts thereupon run on the Albany-Cuprite mineralized trend. A large body containing covellite was reportedly encountered at a depth of 150 feet.

Cuprite mine. The Cuprite mine, discovered in 1900, is situated on the Albany-Cuprite trend about seven-tenths of a mile southeast of the Albany mine. The Cuprite mine was opened by a 954-foot drift driven on the mineralized trend and by a 65-foot shaft sunk on the apex of the trend. The mineralized zone, which was of a width slightly less than the breast of the drift, contained native copper, cuprite, pyrite, chalcopyrite, chalcocite, and values in gold and silver. Assays reportedly ranged: copper, 3 to 28 percent; gold, a trace to 2.56 fine ounces per ton; and silver, a trace to 2.00 fine ounces per ton. Chromium and cobalt were also reported from the mine.

Douglas mine. The Douglas mine, the first lode mine in the area, was originally located in 1870. Development by 1903 consisted of a 150-foot inclined shaft with 80 feet of drifts and crosscuts. An ore body seven feet wide was encountered at the 35-foot level and three smaller ore bodies were found at deeper levels. The ore was gold-bearing and in addition contained native copper, copper carbonates, chalcopyrite, and chalcocite. Cobaltite in considerable quantity was also reported. Almost all traces of the mine were obliterated when the present road was constructed along the west bank of upper Douglas Creek.

Independence mine. An 80-foot shaft with 100 feet of crosscuts has been sunk by the early 1900's at the Independence mine, near the intersection of the east-west "Monarch" trend, a sizeable quartz vein, and the northwest-striking "Mammoth" trend, a shear containing auriferous pyrite and chalcopyrite. A 125-foot drift was driven eastward on the Monarch trend from a point one-quarter of a mile west of the shaft. At the 80-foot level the shaft was still in the oxidized zone. Chalcanthite-bearing ore reportedly averaged 13.5 percent copper and one analysis reported 0.97 percent bismuth.

Gold Crater mine. The Gold Crater mine, situated on the Mammoth trend about half a mile southeast of the Independence mine, was opened first by an adit and later by a shaft and an additional adit. Several small quartz veins within the trend reportedly carried free gold and a 10- to 20-inch seam of sheared wallrock carried clusters and spots of pyrite and chalcopyrite. The average tenor (of Gold Crater ores) was calculated in 1905 to be the equivalent of one foot of 20-dollar ore. The mine is one of the most recently active lode mines in the area, 50 feet of drift having been driven in 1937.

Keystone mine. Astride the Keystone-Florence trend, the Keystone mine was the premier mining operation in the area in 1890 (cover photograph): 6, 000 tons of ore were reported on the dump ready for stamping and 100, 000 tons were believed in sight underground. In that year a 40-ton mill with 20 stamps, powered by an 85 horsepower water turbine, and four concentrators were placed in operation. When full-scale operations ceased in 1893, the mine had been opened by a 365-foot shaft with nearly one mile of drifts and stopes. Clean-up operations were conducted at the mine in 1916 and in 1939. The mine plant was dismantled and the shaft sealed in the 1950's.

The Keystone-Florence trend strikes north 60° west and dips 80° southwest in surface workings at the Keystone mine. At depth, quartz along the trend varied from 2 to 6 feet in width and averaged approximately 1. 2 fine ounces of gold per ton; about 55 percent of the contained gold was described as free-milling. Values were carried as free gold in the quartz and as gold in combination with pyrite and pyrrhotite, the latter in a mylonite selvage adjacent to the quartz.

Florence mine. Situated on the Keystone-Florence trend about seven-tenths of a mile southeast of the Keystone mine, the Florence mine was discovered shortly after the Keystone mine and was closed in 1889, when the machinery was moved to the Keystone. The Florence mine was opened by a 160-foot shaft with 120 feet of drifts on the 30-foot level and shorter drifts on the 100-foot level. A large amount of ore was reportedly stoped from the 30-foot level. Irregular up to 18-inch-wide kidneys of auriferous pyrrhotite were exceedingly rich, reportedly ranging from 155 to 1, 000 dollars in gold per ton (1890 prices), but were quite discontinuous. Only a small proportion of the ore was free-milling; since the gold was extremely finely divided it was lost in the slimes. Instead of being a concentrating ore, the mineralization was regarded as being well suited to treatment by chlorination or cyanide.

Lake Creek mines. A great deal of prospecting for gold and copper was conducted in the late 1890's and early 1900's near the junctions of Muddy and Lake Creeks with Douglas Creek. Gold-copper mineralization occurs in silicified mylonite seams within the broad east-west-striking zones of shearing and alteration which traverse that portion of the area. Underground workings in the Lake Creek vicinity included a 75-foot shaft with 715 feet of crosscuts and drifts and an adit 335 feet in length. Contemporary assays from the Lake Creek mines reported combined values in gold, silver, and copper ranging from 4 to 140 dollars per ton.

Placer Deposits

Quaternary alluvium in and along Douglas Creek and its tributaries, from above Rush Creek to below Lake Creek (Pl. 1), has been repeatedly placered for gold since 1868 when Iram Moore discovered placer gold in Moore's Gulch (Fig. 5). By 1896 an elaborate system of hydraulic ditches had been constructed, and placer operations in the area had been expanded to such a scale that the four largest placer holdings embraced a total of 220 claims. Placer operations have been conducted intermittently since that time. Operations utilizing gasoline-powered draglines and rotary washing plants were conducted by the Medicine Bow Mining Corporation along a stretch of Douglas Creek south of Keystone in 1936 and in 1946, and by the Moe Brothers at a locality on Douglas Creek about one and one-half miles north of Keystone in 1958 (Fig. 6).

Except for a thin cover of soil and vegetation in relatively undisturbed places, the alluvium is clean and easily washed; boulders large enough to seriously interfere with bulk handling are uncommon. Sufficient water to operate placers is generally available in Douglas Creek during the summer months. The Creek slackens from a flow of the order of 150 second-feet in the spring to a flow of somewhat less than 40 second-feet in the autumn.

Placer gold recovered from the area has ranged from 0. 890 to 0. 960 fine, with up to 10 percent alloyed silver and occasional traces of platinum. Small amounts of metallic platinum and paladium have been found in black sands recovered during placer clean-ups. As a rule the gold is bright and easily amalgamated. Up to 25 percent of the gold which has been recovered has been coarse and jagged, sometimes with considerable quartz attached; the balance has been in the form of flower or fine flakes. A nugget weighing 3. 4 ounces, probably the largest ever recovered in the area, was taken from the Home placer, a short distance south of Keystone on Douglas Creek. Gravel values ranging from 0. 35 to 1. 75 dollars per cubic yard have been reported (Beeler, 1906) from various localities in the area. The higher values have generally occured at or very near bedrock. Single pannings from near bedrock in Moore's Gulch reportedly yielded gold in amounts ranging from fifty cents to two and one-half dollars per pan (1906 prices).

Fig. 5. View northwest across Moore's Gulch, site of 1868 gold discovery; dump of Albany mine in background.

Fig. 6. Moe Brothers 1958 placer operation on upper Douglas Creek, near Gold Run, showing dragline and floating washing plant.

The fineness and silver-platinum content of the placer gold agree closely with that of gold from local primary deposits. This, together with the fact that much of the coarser placer gold is but slightly rounded, sometimes with quartz still attached, suggests that the placer gold is locally derived.

Other Deposits

Numerous small pegmatite bodies, from a few inches to a few feet in width, occur in every Precambrian unit in the area and appear to be a pegmatitic phase of the Pikes Peak type granite. Prospect pits have been sunk on pegmatite at several localities, but no production is known. An allanite-bearing pegmatite has been reported (Osterwald, et. al., 1959, p. 201) in the granite, a short distance northeast of the Keystone area; a number of niobium-bearing pegmatites have been reported (Houston, 1961, p. 6 and 7) several miles southeast and southwest of the area. A small deposit of poor grade vermiculite has been prospected by a shallow pit in the W½, sec. 7, T. 13 N., R. 78 W. where amphibole gneiss has been partially altered to vermiculite. A remnant, less than one acre in area and perhaps ten feet thick, of middle or late Tertiary siliceous freshwater limestone has been prospected by shallow pits in the NW¼, sec. 5, T. 13 N., R. 78 W.

Mineral Production

Reserves of oxidized and supergene gold-copper mineralization within the Keystone area have historically proven to be highly problematical from the standpoint of sustaining profitable underground mining operations. Hypogene mineral deposits of economic grade are uncommon in the area. In the earlier years some of the placers may have been worked at a profit, but more recent placer operations for which data are available (U. S. Bureau of Mines, 1947, p. 1560) have apparently operated at a loss. An estimate of gold production from the Keystone area since 1868, drawn from a number of incomplete accounts from that period, is: Keystone mine, approximately five thousand fine ounces; Florence mine, approximately twenty-five hundred fine ounces; other lode mines, on the order of one thousand fine ounces; placer mines, on the order of four thousand fine ounces. Total gold production from the Keystone area, therefore, probably approximates twelve thousand five hundred fine ounces. No satisfactory records of copper production are available. Production of silver and other metals in addition to gold and copper has been negligible.

SUGGESTIONS FOR PROSPECTING

Primary gold-copper mineralization in the more productive northern half of the Keystone area seems to be mainly aligned along trends which strike northwest. These trends should be explored along currently delimited strike and along projected strike. Because the mineralized trends are poorly exposed, exploration might be expedited by the use of geochemical and geophysical prospecting methods. Electrical methods, such as the self-potential and equipotential methods, might prove effective due to the considerable sulfide mineralization. It is possible that magnetic or electromagnetic methods might prove sensitive to the presence of pyrrhotite. The small, poorly exposed bodies of mafic rock which are often associated with the mineralized trends also might respond to suitable magnetic methods as local paramagnetic anomalies. It is reasonable to expect that mineralized trends discovered in the future will, in general, parallel . the alignment of known mineralized trends. Traverses in a northeast or southwest direction, that is, at right angles to the strike of known trends, therefore, stand to be most efficient in terms of exploration for new trends. Surface exploration might be effectively augmented by diamond drilling, particularly to verify geophysical anomalies and to ascertain the extent and grade of oxidized and supergene mineralization, including those of currently known trends.

The zone of contact between the quartz diorite and the quartz-biotite schist may in some manner constitute a locus of mineralization. The White Swan, Keystone, and Gold Crater mines are in close proximity to this contact. A skarn-like zone composed principally of epidote, garnet, and quartz occurs about two-tenths of a mile north of the Gold Crater mine and may be related to the contact.

Primary gold-copper mineralization in the southern portion of the area, rather than being confined to relatively narrow trends, is somewhat diffuse within the broad east-west-striking zones of shearing in that vicinity. The shear zones, however, can be fairly easily traced on the ground, especially if reference is made to appropriate vertical air photographs.

Quaternary alluvium in the area has been sampled time and again for placer gold. Because the alluvium is seldom more than fifteen feet thick it is relatively easily tested by shallow, inexpensive excavations. Strata fine-grained enough to arrest the downward sifting of gold are only infrequently interbedded in the alluvium, hence, both sampling and recovery operations should be particularly directed toward the alluvium nearest bedrock. It is not known whether the upland gravels of the area have ever been tested for placer gold; gravels which may be stratigraphically correlative have been tested with unknown results at Cinnabar Park, about one and one-half miles north of the Keystone area.

Although no pegmatites of commercial grade have been discovered within the Keystone area, several such deposits are known in the region. The southern Medicine Bow Mountains are known to constitute a province favorable to their occurrence. Pegmatites related to the Pikes Peak type granite, some of which occurs in and adjacent to the northeast corner of the area, are known in other areas for their content of rare earth minerals. Units similar to the amphibole gneiss which crops out along the southern margin of the Keystone area are regarded (Houstone, 1961, p. 11) as preferred hosts for pegmatite mineralization in the region. Commercial deposits of vermiculite located about ten miles southwest of the Keystone area are also known to occur in a similar amphibole gneiss sequence.

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