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GEOLOGY of the PORTAGE CREEK-SUSITNA RIVER AREA

By

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INTRODUCTION

The Portage Creek-Susitna River area, about 10 miles east of Chulitna on the Alaska Railroad, first received attention as a promising mineral-rich area in 1922 following the discovery of a deposit of ruby silver (Mint Mine) on the west side of Portage Creek (Capps and Short, 1926). Exploration and development work at the Mint Mine continued sporadically up to about the beginning of World War II, but it was not until 1939 that reports of rich molybdenite deposits on the east side of Portage Creek (Smith, 1942) began to appear. Although since then a number of prospecting parties have been active in the area, no description of the molybdenite occurrences, or of the regional geology has appeared in the literature.

This report, based on 10 days field work during July 1963, describes the bedrock geology and mineralization in the Portage Creek-Susitna River area and attempts to evaluate its economic mineral potential. The mapped area, which covers approximately 12 square miles, extends from Devil Canyon, a steep-walled narrow gorge on the Susitna, north across a highland plateau to the valley of Portage Creek. The area is readily accessible only by air; two lakes in the central part of the area and sand bars along Portage Creek provide adequate landing facilities for light aircraft.

GEOLOGY

Setting

Based on the work of the U.S. Geological Survey (Capps, 1940; Miller, et al, 1959), the rocks in the mapped area belong to a group of undifferentiated Mesozoic sediments and intrusives in the Alaska Range geosyncline, a major tectonic element in south central Alaska. Post-Paleozoic deformation in the region probably began in Early to Middle Jurassic time and continued up to Early Cretaceous time, forming a number of arcuate geanticlinal and geosynclinal belts around the Gulf of Alaska. By comparison with rocks elsewhere in the Alaska Range geosyncline, the marine sediments exposed in the mapped area may be as young as Early Cretaceous. The intrusive igneous rocks in the area are apparently only slightly younger, their emplacement probably accompanying a major orogeny in Early Cretaceous time.

Lithology

The rocks in the Portage Creek-Susitna River area consist of graywacke and related sediments intruded by a quartz monzonite stock and minor rhyolite porphyry and diabase (?) dikes. Glacial deposits upwards to 100 feet thick or more mantle much of the area. Bedrock exposures are poor.

Dark gray green graywacke interbedded with black slate is the principal sedimentary rock type. Locally, dark gray pebble conglomerates with a graywacke matrix are abundant. Intercalated with these rocks are occasional strata of dark gray to dark purplish gray impure quartzite and thin lenses of dense light gray chert. With the exception of the more massive quartzites and conglomerates the rocks generally exhibit distinct bedding, in part graded, and cross-bedding. A band of black slate, approximately 800 feet thick, is shown on the accompanying geologic map as a separate unit. No extrusive volcanic rocks were identified within the sedimentary sequence and only one basic dike was observed cutting the sediments.

The quartz monzonite stock occupies most of the northern half of the mapped area. It is best exposed along Treasure Creek and at a few places northeast from locality 4 ; however, due to the thick glacial mantle, its extent and exact shape are largely inferred. The stock trends northeasterly, paralleling the regional structural grain of the country, and plunges gently to the southwest where it disappears under the sediments east of Portage Creek. Its maximum width, north of lake 2336, is approximately 1½ miles. The rock is very light colored with a coarse-grained granitic texture. Along its contact with the host sedimentary rocks a weak foliation has developed, but elsewhere the stock appears to be mineralogically and texturally homogeneous.

Elsewhere in the area, igneous rocks are scarce. Near locality 2 on Treasure Creek a 10-foot wide dike of rhyolite porphyry, striking N15°W and dipping 74°NE, was observed and at the east end of Devil Canyon on the Susitna a gray medium-grained basic dike trending approximately N30°W is exposed. On the high ridge west of lake 2375 a small outcrop of relatively soft, unaltered rhyolite flow or welded tuff appears to unconformably overlie the sedimentary rocks. Apparently this extrusive igneous rock represents an erosional remnant of a post-Mesozoic volcanic sheet.

Structure

The regional trend of the sedimentary rocks is east northeast. Where not locally disturbed by the quartz monzonite intrusion and related folding, the strike of the bedding ranges between N50°E and N80°E and dips vary from 50° SE to almost vertical.

Around the periphery of the stock the sedimentary rocks have been warped and folded by the forceful intrusion of the quartz monzonite. At the west nose of the stock the folds tend to be symmetric with gently dipping limbs; south of the stock, however, the folds become asymmetric, relatively tight and locally overturned. All of the folds plunge at low angles to the west and southwest parallel to the trend of the quartz monzonite stock.

Only one fault has been recognized in the area. This structure of apparently small magnitude forms the contact between the quartz monzonite and black slate unit east of the mouth of Treasure Creek. The fault strikes approximately N70°E and dips 30° NW; movement has been normal dip slip, dropping the black slate relative to the quartz monzonite. The fault zone, marked by clay gouge, limonite stain, fragments of slickensides and occasional sulfides, is exposed over a length of 700 feet in a small ravine on the south side of Treasure Creek valley. On the north side of Treasure Creek alteration is much less intense and the mapped trace of the fault plane is only approximate. Above the valley, glacial deposits render useless any attempt to trace the fault to the east or west.

Where observed the direction and plunge of minor structures (crinkles and small drag folds) in the semi-schistose graywacke near the contact of the stock are conformable with the trends of the major folds. Hence all major and minor folds and the known fault exposed on Treasure Creek, appear to be the direct result of the quartz monzonite intrusion.

The prominent joints in the area strike between N and N30°W and dip steeply to vertical. This dip joint pattern is similar throughout both the igneous and sedimentary rocks and it does not appear to be controlled by the emplacement of the quartz monzonite stock. Although the joints trend approximately normal to the local fold axes, they are also normal to the homoclinally folded country rock and presumably reflect tensional release in the larger regional structure.

Igneous Petrography

The main bulk of the quartz monzonite is a very light colored (Color Index=3%) coarse-grained (up to 3 mm. in diameter) rock with a subhedral-granular texture. The essential minerals are quartz, orthoclase and plagioclase; minor accessory minerals are biotite, which has been partly altered to chlorite; fluorite; zircon and apatite. A modal analysis is given in Table I (sample P-10). The quartz occurs as large anhedral grains, generally strained and containing numerous inclusions. Smaller, clear and unstrained anhedral grains with an interstitial habit possibly represent a second generation of quartz mineralization. The feldspar occurs as large subhedral crystals of coarse perthite consisting of calcic oligoclase and orthoclase. No individual crystals of plagioclase or orthoclase were observed. The minor biotite, locally altered to a fine-grained mesh of chlorite, tends to be largely interstitial. Anhedral masses of strongly cleaved fluorite, as much as 1 mm. in diameter, are generally associated with the biotite. Minute needles of apatite and small corroded prisms of zircon are scattered throughout the rock.

A body of quartz monzonite exposed over a width of 60 feet on upper Treasure Creek is interpreted as an apophysis off the main stock. A modal analysis is given in Table I (sample P-9). The rock is very similar in composition to the bulk of the quartz monzonite but is somewhat finer-grained and differs greatly in the form and habit of the feldspars and content of the minor accessories. Large subhedral crystals of feldspar, as much as 2 mm. in diameter, consist generally of orthoclase cores and sodic oligoclase rims, resembling the typical Rapakivi texture. However, the orthoclase cores are not always clear, but often contain irregular patches of oligoclase as in a very coarse perthite. Smaller euhedral crystals of oligoclase, as much as 1 mm. in diameter and showing no evidence of a perthitic texture, are also common throughout the rock. The modal orthoclase:plagioclase ratio is approximately constant for both the stock and apophysis. These features suggest that in the apophysis exsolution of the two feldspars has advanced beyond the perthite stage, with the plagioclase phase concentrating at the margin of the original host crystal and to a limited extent forming individual crystals seemingly without a genetic tie to the original host.

Biotite showing no evidence of replacement by chlorite occurs in slightly greater amounts in the apophysis than in the coarser-grained stock. Two generations of biotite may be present; an early anhedral biotite characterized by numerous pleochroic haloes, and a later inclusion-free biotite that mantles the early biotite and tends to give the composite biotite crystal an euhedral outline. Topaz (?) occurring as colorless anhedral grains up to ½ mm. in diameter is the second most abundant accessory mineral in the apophysis. It exhibits parallel extinction, has low birefringence and moderate relief and is optically positive with large 2V. Needles of apatite are present, but fluorite and zircon are apparently absent.

TABLE I

Modal Analyses of Quartz Monzonite

from the Portage Creek-Susitna River Area

	P-10 coarse-grained phase	P-9 medium-grained apophysis	P-7 contact rock
quartz	41	29	42
orthoclase	30	36	28
plagioclase	25 (An_{25-30})	29 (An_{12-20})	21 (An_{20})
biotite	2	5	3
chlorite	1	--	--
sericite	--	--	6
fluorite	1	--	--
zircon	tr	--	tr
apatite	tr	tr	tr
topaz (?)	--	1	--
magnetite	--	--	tr
Color Index	3	5	3

Sample Locations:
P-10 - near locality 4
P- 9 - upper Treasure Creek
P- 7 - north of lake 2336

Sample P-7 (Table I) of the quartz monzonite stock collected within a few feet of the graywacke contact is texturally quite different from the two samples described above. Phenocrysts of perthitic feldspar, as much as 4 mm. long, occur in a fine-to-medium-grained anhedral-granular groundmass of quartz and cuneiform intergrowths of quartz and orthoclase. Both the perthitic and groundmass orthoclase are partially altered to sericite, the alteration being more intense in the phenocrysts. Biotite, zircon, apatite, and magnetite occur as minor accessory minerals; neither topaz (?) nor fluorite were observed.

The unusually high modal quartz of samples P-10 and P-7 appears to be due to post or late magmatic silicification as both samples were collected in areas where silica has been introduced.

The rhyolite porphyry dike exposed in Treasure Creek near locality 2 may also be genetically related to the quartz monzonite. Megascopically, it is a pale olive aphanitic rock containing phenocrysts of smoky quartz and white orthoclase. No mafic minerals nor strong alteration was observed.

Metamorphism

The bulk of the rocks in the mapped area exhibit the effects of only mild low grade regional metamorphism. The fine-grained argillaceous sediments have been metamorphosed to weakly fissile black slate, but the coarser-grained graywacke and more siliceous sediments, other than containing abundant quartz-epidote veinlets, are virtually unchanged. In the southern part of the area the sediments are partly chloritized and semi-schistose, but whether this indicates an increase in the regional metamorphic grade to the south or is local and due to the effect of a buried intrusive is not known.

Thermal metamorphism around the periphery of the stock, on the other hand, has greatly changed some of the host sedimentary rocks. At locality 1 the black slate has been metamorphosed to a dark gray andalusite hornfels, with the andalusite occurring as light pink transparent porphyroblasts as much as 15 mm. long. As seen in thin section the matrix is a crumbled, fine-grained biotite-quartz-graphite schist; the andalusite is the variety chiastolite, containing abundant oriented graphitic inclusions. The graywacke and other coarser sediments that have been intruded by the stock are altered to dense silicic hornfels with a characteristic purplish to reddish gray color. Locally, near the contact, anastomozing quartz veinlets and an occasional quartz-carbonate vein, as much as 6 inches wide, are common.

MINERAL DEPOSITS

Molybdenite, MoS_2, is the principal ore mineral present in the area. It is known to occur, with other sulfides, in at least 3 localities, each with a different habitat, but all apparently genetically related to the quartz monzonite.

The conspicuous altered-mineralized zone along the fault on the south side of Treasure Creek probably received the first attention of prospectors within the area. Unfortunately, the nature of the mineralization can only be inferred from talus fragments and an old adit dump, as bedrock exposure is extremely poor and the workings are caved and covered by soft,clay-rich material from the fault zone. At locality 1 near the site of a caved adit that apparently crosscut the fault, a number of boulders were found that consist of massive arsenopyrite with minor sphalerite, chalcopyrite, molybdenite, fluorite and epidote. An assay and x-ray spectrographic analysis 1/ of a hand picked sample of this sulfide-rich material ran: 0.18 oz. Au , nil Ag, 2-3% Zn, 0.1-0.5% Cu, and 0.1-0.5% Mo, with trace amounts of Pb, Cd, Sb , and Bi. The strong argillic alteration and limonite staining along the fault extends irregularly eastward 200 to 300 feet into the quartz monzonite stock. Beyond that, the stock is relatively fresh with scattered patches of locally altered rock. Near the fault the original quartz monzonite rock has been altered to a soft, brown incoherent mass of clay and quartz grains containing an occasional band of massive, but friable, quartz. Although no disseminated sulfides were observed in the altered zone, six channel samples (ranging in length from 1 to 5 feet) were cut along a line extending northeast from the fault into the unaltered quartz monzonite (see detail map for location of samples). With the exception of sample 1, which contained 0.1% Mo, no anomalous metal concentration was detected.

At locality 2 molybdenite, together with chalcopyrite, occurs as scattered flakes and grains on fracture surfaces in a brownish gray silicic hornfels. The sulfides are found both in barren fractures and fractures filled with quartz; however, only a very small percent of the fractures appear to be mineralized. Extent of the mineralized area is not known.

Locality 4 , near the west nose of the quartz monzonite stock, includes the richest molybdenite mineralization observed in the area. A cut bench about 75 feet long and a short adit, on the east side of a small swampy valley, exposes altered quartz monzonite containing a number of silicified shear (?) zones. The shear (?) zones parallel foliation in the host quartz monzonite which strikes between N43°W and N81°W and dips between 71° and 85° N. Spotty, but locally rich lenses, vugs, and masses of large molybdenite crystals with sphalerite and minor chalcopyrite and pyrite were observed in 3 of the quartz-rich zones. Channel samples across the widest (2½ feet) and richest of these zones, however, did not assay more than 0.1% Mo or Zn.

Locality 3 refers to the Mint Mine. The mine was not examined during this investigation, but is included on the geologic map to show its location relative to the molybdenite occurrences.

The molybdenite deposits in and around the quartz monzonite stock may be somewhat analogous to the deposits at Questa, New Mexico, where a stock of soda granite intrudes a series of weakly metamorphosed greenstones. High grade molybdenite veins with pyrite, quartz, and fluorite occur within the stock and a tremendous volume of low grade ore occurs in the greenstone aureole. The low grade ore consists of minute flakes of molybdenite coating joint and fracture surfaces in the brittle and broken greenstone. The molybdenite is believed to have been deposited from fluorine-rich acid solutions emanating from within the soda granite. Similarly the molybdenite in the Portage Creek-Susitna River area appears to have originated from the fluoride-bearing quartz monzonite, but whether ore grade material is present remains to be seen.

SUGGESTIONS FOR PROSPECTING

On the basis of our present meager knowledge of the geology and mineralogy of the molybdenite deposits in the area, it appears that further prospecting and exploration is certainly justified. Unfortunately, most of the area is not amenable to ordinary pick and shovel prospecting or geochemical testing, due to thick glacial cover and paucity of streams. Trenching and diamond-drilling the known but poorly exposed mineralized zones appears to be the most practical means of prospecting the area. The following suggestions for future exploration are offered:

1. At locality 2 both sides of Treasure Creek valley should be thoroughly prospected and sampled to determine extent of weak molybdenite mineralization in fractured hornfels.
2. The contact of the quartz monzonite stock with the sediments, from south of locality 4 , west around the nose of the stock and north to locality 1 should be explored by bulldozer trenches. A tractor route from Chulitna appears to be practical.
3. The silicified shear (?) zones at locality 4 should be traced laterally by trenching. A light-weight portable diamond drill would be desirable to test the deposit at least to depths of 100 feet.

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1/ All assays by Irwin W. Mitchell, Assayer, Division of Mines and Minerals