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DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GEOLOGY OF TWO AREAS OF PEGMATITE DEPOSITS IN SOUTHEASTERN ALASKA

By

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This report is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey standards and nomenclature.

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PART I PEGMATITE DEPOSITS NEAR REDFISH BAY, BARANOF ISLAND

Abstract

A pegmatite deposit about 600 feet in diameter crops on a high bluff less than one-half mile east of a small unnamed cove between Redfish and Byron Bays, on the west coast of Baranof Island, southeastern Alaska.

The deposit which comprises several pegmatite bodies consists of quartz, albite-oligoclase, microcline and mica, listed in the order of their relative abundance. Feldspar and quartz crystals locally attain a length of more than 1 foot. Some muscovite mica up to 2 inches in diameter occurs, but the major part of the mica is contained in concentrations, containing mica flakes one-half inch across, that often are as large as 10 feet across. Ruby mica of strategic grade has been obtained from float from this deposit.

None of the rarer minerals such as beryl, columbite-tantalite or cassiterite that often occur in pegmatites were observed in the preliminary examination; and small-size concentrate samples obtained by panning stream sands from the area did not contain recognizable amounts of these rarer minerals. One sample contained a few grains identified as cassiterite. No radioactive anomalies were detected in the pegmatites, or in the stream concentrates.

The large tonnage of material available and the favorable location by a good anchorage on an ocean route are favorable factors that should contribute to the development of the deposits. Other deposits of comparable size probably occur in the area.

Introduction

The pegmatite deposits discussed herein occur near a small bay between Redfish and Byron Bays on the west coast of Baranof Island, southeastern Alaska. The deposits are about 60 miles by air southeasterly from Sitka, the nearest port of any size. Claims covering the deposits belong to Mr. William Hanlon, Sr., and Mr. Glenn Morgan of Sitka, who called the deposits to the attention of the writer in 1952.

The deposits were staked as possible gold lodes as early as 1906 by William Hanlon, Sr., and Charley Haley of Sitka, but no development of the lodes has been attempted since.

No reference to the deposits appears in the literature concerning the mineral resources of Alaska, and according to Mr. Hanlon, the deposits had not been examined by a geologist prior to the writer's visit. This paper is written to discuss the general geology of the deposits and of the adjacent area, concerning which little information is available at present.

The writer spent the period September 13-16, 1953, in the general area of Redfish Bay and west to the pegmatite deposits. Only a portion of the time was spent on the pegmatites. The pegmatites were revisited in August 1954, to obtain additional information on the internal structure of the pegmatites, and to examine the west face of the outcrops, which required climbing gear not available on the previous inspection.

The writer wishes to acknowledge the able field assistance of Mr. Glenn Morgan and to give special acknowledgment to Mr. Dick Pherson, a bush pilot in Sitka, who transported us to and from the area in a single-engine plane in weather so stormy that larger twin-engine planes would not make the trip.

Areal Geology

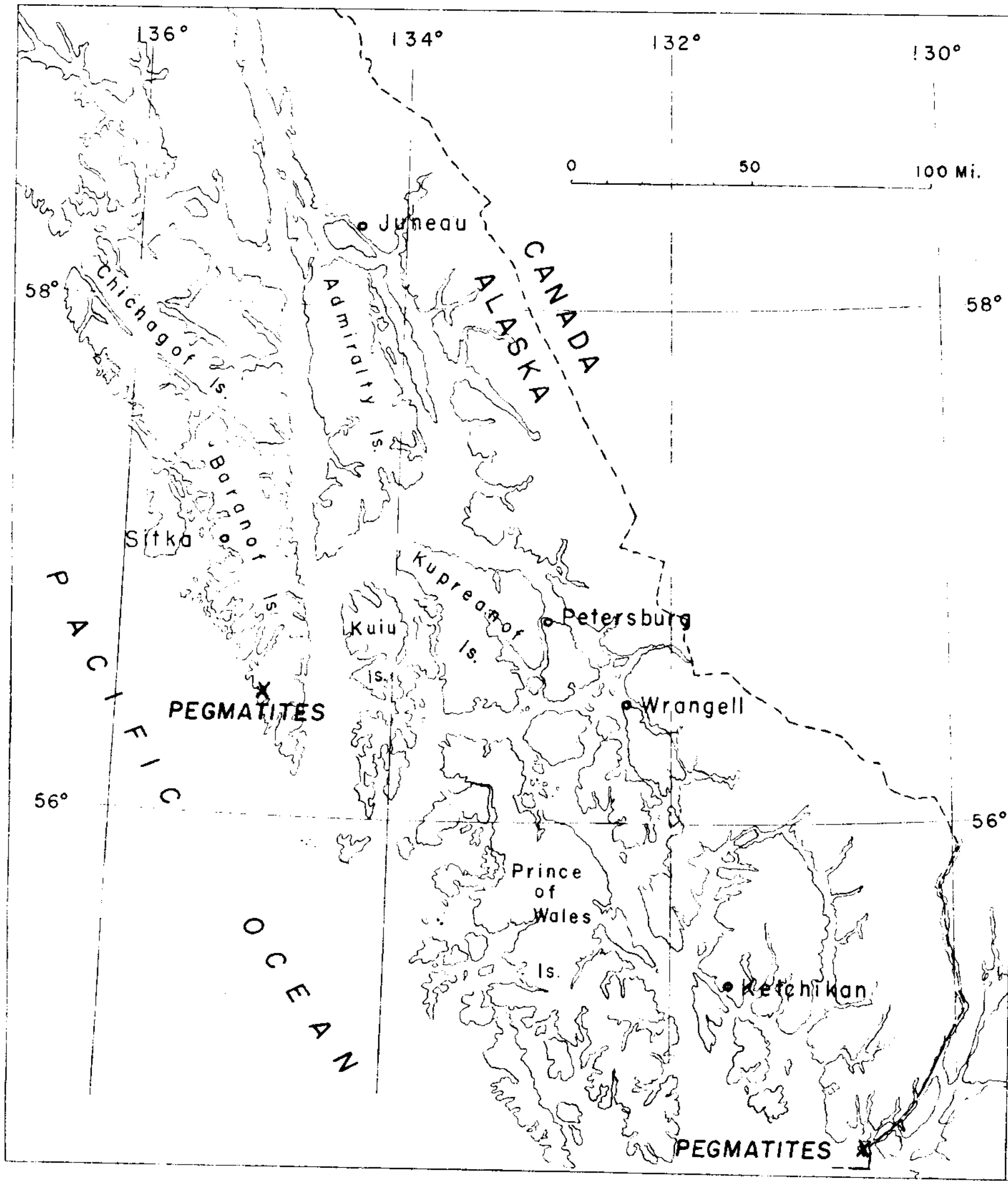
Only fragmentary geologic data pertaining to the regional geology of this part of Baranof Island are available. Knopf (1912) shows an intrusive batholith or stock in the general area of Big Branch Bay, and Buddington (1938) also shows a batholith that intrudes sedimentary and volcanic rocks of Paleozoic age in this region. Reed and Gates (1942) discuss a basic nickeliferous intrusive at Snipe Bay, about 20 miles north of Redfish Bay, and state:

"The principal country rocks in the vicinity of Snipe Bay are biotitic quartzite and biotitic-quartz schist. These rocks are part of a graywacke formation, believed to be of Lower Cretaceous age, which is widespread on Chichagof and Baranof Islands. The graywacke formation, and the predominantly volcanic formations that underlie it, are cut by a variety of intrusive igneous rocks, which are thought to be mainly of Cretaceous but possibly in part of Tertiary age.

"The quartzite and quartz-schist strike northwestward and dip northeast."

FIGURE 1

INDEX MAP OF SOUTHEASTERN ALASKA SHOWING LOCATIONS OF TWO PEGMATITE AREAS



Guild and Balsley, Jr. (1942) discuss the geology of the chromite deposits at Red Bluff Bay, on the east coast of Baranof Island about 30 miles north of Redfish Bay. The schists of this region comprise folded and faulted phyllites and greenstone schists of Triassic(?) age. The schists strike northwesterly and dip northeasterly, and the beds are overturned. Fold axes trend about N. 30° W. and plunge 10° - 50° SE., and a prominent set of joints cuts the rocks approximately perpendicularly to the axes of folding. Shear zones are abundant in the ultramafic rocks, and follow two general directions, one striking about north, and the other striking northeasterly.

Geology of the Pegmatite-Bearing Rocks at Redfish Bay

Intrusive Rocks

Quartz diorite and related types.--The bedrock along the eastern shore of the small unnamed cove near the pegmatite deposits consists of a massive, unfoliated intrusive rock whose composition ranges from muscovite-granite through biotite-quartz monzonite to a biotite-quartz diorite (see plate 1), that contains locally xenoliths of paragneiss consisting of felsic minerals dominately. Locally the gneiss comprises as much as 30 - 40 percent of the bedrock, but these areas of gneissic rocks are restricted in areal extent, except near the borders of the intrusive mass.

At the west contact of the pegmatite body, the rock is a granite of the mineralogic composition shown on table 1.

TABLE 1 - Mineralogic composition of granite at pegmatite deposit at Redfish Bay 1/

Mineral	Volume Percent	Weight Percent
Quartz	21.9	22.0
Albite 2/	17.6	17.4
Oligoclase 2/	18.4	18.5
Microcline	34.0	32.0
Muscovite	2.5	2.6
Chlorite	4.6	4.7
Other 3/	1.1	1.8
Total	100.1	99.4

1/ Based on Rosiwal analysis of two thin sections.

2/ The relative proportions of albite and oligoclase may differ slightly from these figures, owing to the albite contained in perthitic intergrowth in the microcline.

3/ Includes garnet, apatite, sphene, ilmenite or magnetite.

The intrusive rock on the north tip of the small cove northwest of the pegmatite deposits is a granodiorite or quartz diorite containing abundant quartz, many zoned crystals of plagioclase, and some microcline, biotite and muscovite. Apatite, chlorite, bleached biotite, garnet, sphene and an opaque mineral (magnetite or ilmenite) are the minor constituents.

South and southeasterly from the pegmatite, in the area near the large lake at altitude 280 feet, the intrusive body is a massive quartz diorite containing approximately 20 to 25 percent of the mafic minerals biotite and hornblende. The remainder of the rock consists of about 50 percent of plagioclase, 25 percent of quartz, 1 percent of hornblende pleochroic to blue green, and minor accessory minerals comprising apatite, sphene, magnetite or ilmenite, and a few needles of sillimanite. The quartz is fractured and strained and contains abundant trains of inclusions; the biotite commonly is grouped about remnants of hornblende; and the opaque minerals are associated with the biotite or hornblende. The zoned plagioclase crystals have centers as calcic as 60 percent of anorthite, and rims containing 40 percent of anorthite. Apatite commonly is included in the calcic centers of the zoned plagioclases.

The rock types listed above are considered to represent related facies of the quartz diorite, but it is not known whether the rock types are gradational or whether they are distinct intrusive bodies with sharp boundaries. The microscopic examination of thin sections of each rock type shows a distinctive progressive mineralogical change from quartz diorite to granite. These changes are: (1) a progressive increase of microcline and albite (2) a progressive bleaching of biotite and a conversion of all biotite to muscovite or chlorite (3) destruction of apatite (4) subtraction of calcium from the plagioclases, leading to the destruction of zoned crystals and the conversion of andesine to oligoclase or albite (5) removal of iron by the destruction of biotite, magnetite, or ilmenite, hornblende, and pyrite, although some iron probably was incorporated in the few very small red garnets.

The volume-percentage of free quartz in the microcline granite is no greater than the volume percentage in the quartz diorite. The solutions that converted large amounts of plagioclase to microcline or albite apparently were in equilibrium with respect to the free quartz in the quartz diorite. The changes outlined suggest a magmatic alteration, probably dueteric stage, rather than hydrothermal alteration.

Alaskite dikes.--Small alaskite dikes cut the major intrusive rocks and the schists and gneisses to the east. These dikes of coarse-grained pegmatites normally are less than two feet thick, and locally contain muscovite flakes up to 1 inch in diameter. The dikes appear to be more abundant in the quartz diorite south and southeast of the main pegmatite area than in the schists and gneisses east of the intrusive body, although this may be more apparent than real because the alaskite dikes are light in color and contrast more with the darker quartz diorite and gneisses. Many of the alaskite dikes were tested with the geiger counter, but none was noticeably radioactive. The alaskite pegmatites are not considered to be a promising environment for commercially valuable mica or feldspar, unless dikes much thicker than those observed can be found.

Granite dike.--One granite dike about 200 feet thick was observed where it intrudes hornblende-biotite gneiss at the head of Redfish Bay. In hand specimen it consists entirely of felsic minerals, including much muscovite, and appears identical with the granite near the pegmatite body. The dike has sharp boundaries and crosscuts the foliation of the enclosing gneisses at a small angle. This dike is important because it suggests that a magma chemically similar to that which produced the granite near the pegmatite body invaded the area.

Metamorphic rocks

Schists and paragneisses.--The metamorphic rocks immediately north and east of Redfish Bay (plate 1) comprise hornblende-biotite paragneiss, quartz-mica paragneiss, quartzites, slates and feldspathic graywackes. The paragneisses are most abundant in the small peninsula on the northwestern shore of Redfish Bay. The gneisses grade rapidly to the east into metamorphosed sedimentary rocks whose original composition is still readily discernable. The schists strike northwesterly (N. 10°-50° W.) and generally dip northeasterly at high angles, although reversals in dip are common.

Fold axes in the schist and gneiss generally plunge southeasterly from 10°-70° but again local variations are common.

Faults

The faults observed in the field are shown on Plate 1 as solid lines and those plotted from aerial photographs as dotted lines. In general, the faults belong to two systems - one striking northerly, and one striking northeasterly. This arrangement of faults apparently has controlled erosion in this part of Baranof Island because most of the larger bays, indentations and lakes trend either northeasterly or northerly.

One fault, too small to show on the map, cuts the north boundary of the massive pegmatite. The shattering of some of the larger, clear quartz crystals in the pegmatite possibly was contamporaneous with the faulting.

Pegmatite Deposits

The massive pegmatites crop out at an altitude of about 600 feet about one-half mile southeast of the eastern shore of the unnamed bay (see plate 1). They can be reached most easily from the northeast arm of the bay by the trail along the south bank of the small creek.

The outcrop of pegmatites is roughly circular, and is about 600 feet in diameter. It has been glaciated, as roches montonnees and glacial striations are preserved on the surface of the pegmatites. Weathering has affected the pegmatite only slightly. Complete lack of soil cover would allow easy prospecting of the bodies.

The surface of the pegmatites slopes northerly and/or easterly. They are bounded on the west by a perpendicular cliff at least 60 to 75 feet high, and on the north by a steep gulch eroded along a small fault.

Structure of the Pegmatites

The outcrop of pegmatite suggests a large, almost circular body, in which pegmatite minerals are distributed randomly. Exposures on the west cliff, however, reveal that the pegmatite is a compound body consisting of two or more dikelike pegmatites striking northerly and dipping easterly. The largest pegmatite is at least 30 to 40 feet thick and several smaller bodies lie above and below it. The largest pegmatite appears to pinch out near the center of the cliff, and another thick pegmatite with approximately the same attitude, but stratigraphically lower, appears to continue to the north. The major pegmatites are underlain by quartz monzonite containing a band of paragneiss about 20 feet thick and both rock types are cut by irregular patches and dikelets of granite and pegmatite. The paragneiss band strikes about N. 30° W. and dips 25° northeast.

Another pegmatite about 15 feet thick, not continuous with either pegmatite exposed in the west cliff, crops out in the steep bluff on the north side of the pegmatite area. It too strikes northerly, and dips about 30° to the east.

Zoning of the Pegmatites

Each of the pegmatites examined has marked zoning. In the large pegmatites the zones are distinct, but zones in the smaller pegmatites are less so. Each of the pegmatites contains a core of quartz, or of quartz and microcline. Succeeding zones are different in different pegmatites (see plate 2). The quartz core may be succeeded by a core margin zone that may consist of perthite, quartz, graphic granite, and granular mica; of pure microcline - perthite; or of perthite, granular mica, and quartz. Succeeding zones are not easily recognized, but the wall zone generally is quartz and graphic granite. No distinct border zone was recognized in any deposit.

The mineral of chief economic interest in the pegmatites is microcline-perthite that occurs in each of the larger pegmatites as a core-margin zone ranging from 4 feet to 10 feet thick. In two of the larger pegmatites the perthite is very pure, and in one it is admixed with minor amounts of granular mica and small pods of quartz. The most continuous zone of perthite is at least 120 feet long and averages 6 to 8 feet thick. Another zone of perthite containing only minor amounts of quartz and granular mica is at least 60 feet long and 8 to 10 feet thick. In a third pegmatite exposed across the strike, the pure microcline-perthite forms a solid zone from 4 to 6 feet thick.

Petrographic studies indicate that albite occurs along twin planes and cleavages in the perthitic microcline in such thin bands that coarse grinding in the mortar frees only a few fragments of albite. Thin sections show that the albite is segregated along cleavages, fractures and twin planes in the microcline, and may aggregate as much as 15 percent of the total volume. No chemical analyses of the microcline was made, but the writer is confident that the massive perthite zones can produce substantial tonnages of ceramic-grade potash feldspar.

Mica occurs in the deposits in two different varieties. In one small pegmatite (C in plate 2) the mica is rum mica, and occurs as wedge shaped books up to 2 inches in length that are intergrown in such manner as to suggest the three common faces of a tetrahedron. This mica occupies a distinct zone, possibly a core-margin zone, around a core of quartz and perthite. In mica-bearing zones of other pegmatites, the mica generally occurs as thin, rounded green flakes up to one-half inch in diameter, and locally the mica may aggregate 50 percent of the rock over a distance of several feet. No mica of sufficient size to furnish even the smallest punch mica was observed, although Mr. Hanlon obtained mica of strategic grade from float in this area that trimmed to sheets measuring 3 inches by 4 inches.

Large euhedral quartz crystals were observed at several places in the pegmatite. They usually were oriented with the c axis perpendicular to the dip of the pegmatites. The largest crystal measures 27 inches in length and occurs in the quartz core of the pegmatite exposed on the west cliff. Other crystals as much as 5 inches in diameter were observed. These crystals of quartz are remarkably clear, as is much of the quartz in some of the cores. Unfortunately, all this clear quartz is shattered, but fragments up to three-eighths inch thick may be obtained that are so clear that typed words easily may be seen through them. Some quartz of optical grade might be obtained during exploitation of the deposits for feldspar.

Minor Constituents

The only minor constituent of the pegmatites that can be identified in hand specimen is red garnet, which usually occurs in the quartz zones as small euhedral crystals that attain a maximum size of one-eighth inch.

Small amounts of heavy-mineral concentrates were obtained from a stream that heads in the pegmatite, from a stream that drains an area of quartz-monzonite, and from the outlet of the large lake southeast of the pegmatites. The results of studying these heavy-minerals are summarized on table 2.

TABLE 2 - Mineralogic and spectrographic examination of stream concentrates, Redfish Bay, Baranof Island

Microscopic Examination

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Sample No. 1/	Constituents
1	garnet, hornblende, quartz, tourmaline, zircon, muscovite, epidote, sphene, magnetite, cassiterite (?)
2	quartz, garnet, hornblende, ilmenite (?), tourmaline, hematite, zircon
3	limonite-stained garnet, hornblende, quartz, biotite, ilmenite

Spectroscopic Examination

J. J. Matzko

Sample No.	Greater than 5 percent	Less than 5 percent	Not detected
1	Fe, Ti, Al, Mn	Na, Mg	Sn, Pb, Cu, Ni, Co, Zn, F
2	Fe, Ti, Mg, Al, Na	Ca, Mn	Zn, Pb, Cu, Co, Ni, Sn
3	Fe, Mn, Mg, Al, Ca	Na, Ti	Cu, Zn, Pb, Sn

1/ Sample 1 from small creek flowing over pegmatite area.

Sample 2 from small stream flowing into the north arm of the cove.

Sample 3 from outlet of large lake southeasterly from pegmatite zone.

Locations are shown on plate 1.

Although these concentrates were obtained in relatively small amounts without digging deeply into the stream channels, the writer believes the results are diagnostic enough to indicate that few of the rarer constituents of pegmatite veins, such as cassiterite or columbite-tantalite occur in detectable quantities in the major pegmatite body.

The samples containing tourmaline and possibly cassiterite came from the areas of granite or altered quartz diorite relatively near the main pegmatite body.

No radioactive anomalies were noted in any of the samples.

Other Pegmatite areas

Two other areas that possibly contain pegmatite were selected by the interpretation of aerial photographs and are shown on plate 1.

Several large pegmatite (?) dikes were seen from the air along the beach cliffs between Redfish Bay and Byron Bay. This area was not traversed on foot by the writer, and the size, extent and mineralogy of these dikes is unknown. The writer recommends detailed prospecting of the entire outcrop area of the quartz diorite stock and the contacting schists and gneisses.

Economic Considerations

Several favorable factors combine to suggest that the main pegmatites constitute a commercially valuable body of feldspar, and possibly of mica and optical quartz.

(1) Large tonnages of pegmatite are available and could be mined by open-pit methods, or perthite zones could be mined by shallow underground openings sloping easterly at about 25 to 30°.

(2) The deposit is situated less than one-half mile from tidewater in a relatively sheltered cove whose entrance is protected by several small, rocky islands. An aerial tram could be built at low cost and loading facilities for large barges easily could be established. It should be pointed out, however, that in stormy weather the exposed coastline of Baranof Island is battered by very large waves and entrance to the small cove is impossible.

(3) The deposit is near the regularly traveled sea lanes; the pegmatite could be barged to markets in the continental United States at low freight rates.

(4) Abundant timber is available on the wooded slopes of the cove for all mine and mill use. Waterpower from the large lake southeast of the main deposit could be developed with a tunnel less than 200 feet in length, or from streams that drain the lakes to the north of the cove. The streams heading near the pegmatite area are too small to provide substantial power.

(5) The deposits, although they probably contain few of the rarer and more valuable minerals that may occur in pegmatites, are free from the deleterious constituents, such as iron, high calcic plagioclase and manganese. The finer mica easily could be tabled or floated out of a ground mill-feed.

PART II - PEGMATITE DEPOSITS NEAR SITKLAN PASSAGE, SOUTHEASTERN ALASKA

Abstract

Pegmatite bodies that locally contain large books of mica occur in a belt of intensely feldspathized granulites and gneisses along the western margin of intrusive rocks of the Coast Range complex in the vicinity of Sitklan Passage near the mouth of Portland Canal in southeastern Alaska.

The deposits occur along two distinct belts in which sill-like bodies of gneissic pegmatitic rock several hundred feet wide can be traced along the regional strike for several miles. Locally, smaller dikes of pegmatite crosscut the structure of the granulites. The deposits consist almost entirely of albite-oligoclase feldspar, granular quartz, and subordinate mica. Structural characteristics of the deposits indicate the pegmatites probably are in part synkinematic with the late stages of the Coast Range orogeny as related to the Ketchikan area.

Mica of strategic size and grade has been obtained from several pegmatites and two prospect pits in a large pegmatite on Sitklan Island have disclosed relatively large books of mica. Preliminary examination did not disclose radioactive anomalies in the pegmatites, and none of the common minor constituents of pegmatites, such as beryl, cassiterite or columbite-tantalite were observed.

Although the tectonic history of many of the pegmatites indicates they were emplaced under a stressed environment and probably will not contain mica of strategic grade, the abundance and the large areal distribution of pegmatites are such that detailed prospecting of the area is warranted. Special attention should be given to pegmatites discordant with the structure of the enclosing gneisses and granulites, because these pegmatites are the best mica prospects of the area.

Introduction

The field work for this report was done May 28-31, 1953, and September 1-3, 1954. During the first examination the writer, accompanied by R. L. Thorne of the U. S. Bureau of Mines completed a rapid areal reconnaissance of portions of Sitklan Island, Kanagunut Island, and the mainland north of Sitklan Passage. During this period the prospects near Sitklan Passage were mapped by the writer. In September 1954, the writer was accompanied by Fred Barker and R. S. Velikanje of the U. S. Geological Survey; the newest workings on the pegmatites were examined and mapped, and the southern end of Sitklan Island was examined. During the second examination Mr. B. W. W. McDougall, consulting engineer and geologist for a Canadian mining concern, was on the ground and accompanied us while on Sitklan Island. The geologic data and conclusions expressed herein are based entirely upon the writer's observations, and may not necessarily reflect the opinions of Mr. Thorne.

At the time of field work in 1953 the prospects discussed were being actively explored by a partnership consisting of Messrs. Frank Blasher, Paul J. Ater, Louis Pearson and J. H. O'Leary, all of Seattle, Washington or vicinity. All partners except Mr. Ater were on the property during the time of examination; they were accompanied by Mr. Robert O'Connor of Seattle.

During late 1953 or early 1954, the claims held by the above-mentioned partners were sold to a Canadian company, and much additional prospecting of some pegmatites had been accomplished by the time of the writer's visit in September 1954. Mr. R. Coty, agent for B. C. Mica Mines, Ltd., was on the property during the second examination. The writer wishes to acknowledge the assistance of all these men, and to express his appreciation for the many favors extended by them.

Geology

Bedded Rocks

The bedded rocks of Sitklan Island, Kanagunut Island, and the adjacent mainland to the north comprise high-rank metamorphic rocks, provisionally of Mesozoic and Paleozoic age or older, derived from a sequence of predominantly clastic beds possibly of marine origin. A marine origin is favored because of the thin, continuous units, the lack of conglomeratic beds, and the few thin but persistent limestone beds in the sequence.

The beds have been tilted steeply eastward, and regionally metamorphosed to garnet-biotite-hornblende-quartz-plagioclase granulites. Red garnet up to one inch across is very conspicuous in a wide belt of garnetiferous schists and granulites on the western portion of Kanagunut Island and Port Tongass (see plate 3). The garnets commonly are euhedral, but fractured.

A dark red-to-black garnet of smaller size is associated with the red garnet. Locally these garnet beds are estimated to contain as much as 30 to 40 percent of garnet. The garnet sands along the west coast of Kanagunut Island are beach placers derived from the garnet schists. Thin, persistent beds of coarsely crystalline and very pure limestone or marble occur in the garnet granulites on Kanagunut Island and a few beds of quartzite are found opposite Tongass Island.

To the east, and overlying the garnet granulites, is a belt of hornblende-biotite-garnet granulites in which green hornblende is much more conspicuous and garnet much smaller and less conspicuous than in the underlying rocks. These rocks appear to be generally less schistose than the underlying rocks.

The hornblende-biotite-garnet granulites grade eastward into a belt of rocks that were mapped as a "zone of feldspathization" that appears to be a greatly feldspathized facies of granulites and paragneisses containing rocks that originally were similar to the underlying hornblende-biotite-garnet granulites. The feldspathization probably is in part caused by higher rank metamorphism that locally produced a gneissic texture and in part caused by the introduction of soda feldspar. The true pegmatitic bodies without exception are confined to this belt of feldspathized rocks. The various claims staked on Sitklan Island, on the mainland north of Sitklan Island, and on Nakat Bay, are in this zone of pegmatite-bearing, feldspathized rock. This is considered to be a significant fact in considering the genesis of the pegmatitic bodies. The feldspathized rocks locally contain recrystallized limestone beds up to 20 feet thick.

Many pegmatites were seen in the field that apparently represent replaced gneisses or schists. Such pegmatites exhibit relict planar structures of similar thickness as the contacting granulites or gneisses, they are concordant, and they consist of albite or albite-oligoclase intergrown with granular vitreous quartz and minor amounts of muscovite mica in small flakes. Particularly good exposures can be seen on the north shore of Sitklan Passage, and on the southeastern part of Sitklan Island.

Other coarser-grained, rudely foliated, pegmatites of similar mineralogy, and containing larger muscovite flakes up to 1 - 1½ inches in diameter possibly are the next stage in the development of replacement pegmatites. Such pegmatites are common, and they too are roughly concordant with the contacting schists, gneisses or granulites. None of these pegmatites were proved to be formed by replacement, however, and the proof of their origin must await additional detailed mapping.

Folding of the Bedded Rocks

No major folds were seen in the metamorphic rocks, although the beds range in strike from N. 5° W. to N. 60° W. An abrupt change in strike from N. 30° W. to N. 5° W. occurs near, and probably was caused by, the east-trending fault on the east side of Sitklan Island.

Dragfolds are most abundant in the limestones and commonly plunge steeply down the dip of the beds. These dragfolds are not as abundant or conspicuous as those observed along the front of the batholith near Juneau and Wrangell.

Intrusive Rocks

Pegmatites

Intrusive pegmatitic bodies as much as several tens of feet thick, and from a few feet up to several hundred feet in length, occur in two distinct belts in the zone of feldspathization on Sitklan Island, and on the mainland to the north (see plate 3). Aerial reconnaissance showed that pegmatitic bodies east of Nakat Harbor were a continuation of one or more of these belts. Exposures in the mountains north of Sitklan Passage show two distinct zones of pegmatitic rocks that possibly are continuations of those exposed on Sitklan Passage and Sitklan Island.

The intrusive bodies of pegmatite are composed essentially of pearly-white albite or oligoclase intergrown with vitreous massive quartz or granular vitreous quartz. Locally, muscovite mica forms books as large as 6 to 8 inches in diameter, but most of the pegmatites contain little or no mica. Minor amounts of biotite, chlorite, and muddy-green epidote crystals, attaining a maximum size of several inches long, occur in some of the pegmatites. These crystals have reaction rims composed of muscovite, chlorite and a little magnetite. A rusty fracture in one sample of pegmatite contained specks of free gold.

The pegmatites classed as intrusive bodies generally are discordant; they tend, however, to be elongate in the direction of the foliation of the enclosing rocks. No zoning was observed in any of the pegmatites. Twenty samples of feldspar selected at random from the pegmatites were examined in the laboratory by crushing and immersion in oil. In 19 samples the indices of refraction were bracketed by oils of index 1.53 to 1.545, indicating all the feldspar was albite-oligoclase. Each sample contained intergrown glassy quartz. One sample consisted of microcline.

None of the rarer minerals commonly associated with pegmatites were found. The pegmatites have no anomalous radioactivity detectable by the geiger counter.

Basalt Dikes

Basaltic dikes intrude the metamorphic rocks and the pegmatitic bodies. They were injected generally along the best developed joint system, which strikes about N. 30° to 50° E. The basalt dikes have chilled borders and have baked the enclosing rocks. In one exposure basalt dikelets filled fractures in a large pegmatite body. Flow lineation and displaced pegmatite xenoliths in this dike suggests that magma possibly had flowed from west to east. Some of the basalt dikes have phenocrysts of plagioclase feldspar as large as 1 cm. in length, and one dike contains smaller phenocrysts of basaltic hornblende. Pyrite, magnetite and pyrrhotite are common accessory minerals. The dikes are not metamorphosed or deformed, thus indicating igneous activity after regional deformation. The relations also establish that the pegmatitic bodies are older than the basalt dikes.

Faults

Dotted lines in plate 3 indicate faults as inferred from aerial photographs. Only one major fault was seen in the field. Smaller faults occur near the pegmatites at the Hyder Mica No. 1 prospects on Sitklan Island. Pyrite and pyrrhotite were introduced into the enclosing rocks along the faults. One fault contact between pegmatite and massive hornblendite or hornblende-granulite was observed, indicating that some faulting post-dates the emplacement of the pegmatites. It is not known if the basalt dikes are faulted.

Individual Prospects

The term "Prospect" as used here applies only to mica-bearing pegmatites that have been trenched or drilled and that show mica in some quantity.

Last Chance Prospect

The Last Chance Prospect is on the mainland approximately 1,500 feet from the beach camp in a north-northwesterly direction (see plate 3). The prospect consists of a small trench about four feet long on a pegmatitic body about two three feet thick. The pegmatite contains some silvery mica in thin books as much as 1½ inches in diameter that are bent around albite crystals. The mica books have a crude foliation, and the resemblance to many such exposures elsewhere leads the writer to infer that the mica will not be of strategic grade or large enough to recover any but the smallest of punch mica. Furthermore, the estimated mica content of the pegmatite is less than 10 percent; the mica is randomly distributed, and the pegmatite is so thin that it probably could not be mined economically. The enclosing country rock is a quartz-biotite paragneiss.

A Territorial Department of Mines engineer collected good grade mica from a pegmatite in this area, but the collection has not been duplicated since, and the location of the pegmatite is unknown.

Hyder Mica No. 1 Prospect

This prospect is on the northeast corner of Sitklan Island about 300 feet from the beach at an altitude of about 140 feet (see plate 4). Open cuts about 30 to 40 feet long were made on two massive pegmatite bodies that intrude massive hornblende rock. Four of the five larger trenches expose mica-bearing pegmatite in which mica plates up to 8 inches are developed. Small pits on other outcrops of pegmatite disclose no mica.

Broken and bent books of mica predominate over those from which sheets could be cut, although Mr. Blasher has cut many perfect sheets measuring 3 by $4\frac{1}{2}$ inches from some of the better books. Most of the deformed books are ruled. In many places an intersecting cleavage forms "A" mica. The mica is dark grey-green to muddy-green, and some samples from this prospect submitted by the Territorial Department of Mines and by Mr. Blasher to the General Services Administration were classed as "strategic grade muscovite mica". Other samples of the mica tested partially by the General Services Administration, by the Varlacoid Chemical Company of New York, and by Associated Laboratories of Portland, Oregon, have been described respectively as "surface samples not suitable for grading", as "mine-run ruby muscovite mica", and as "muscovite mica, non-ruby, stained A quality, A.S.T.M. size grade $5\frac{1}{2}$ and 6, heating loss 0.17 percent". All of the characteristics of the mica from this deposit have not been determined.

Other pegmatites crop out in the area near the prospect pits. Many outcrops were examined, and a few smaller mica books were found, but the mica content is generally very small. At places mica forms a crude foliation. The pegmatites are similar to those exposed on the beach and consist of albite or albite-oligoclase and quartz, with minor muscovite and epidote, except near contacts where some pegmatites contained hornblende xenoliths altered to biotite. These contacts were observed in detail because of a previous report by J. C. Roehm of the Territorial Department of Mines (Roehm, J. C., 1945, unpublished) which ascribed the formation and localization of mica to amphibolite-pegmatite contacts where amphibolite had been ingested. This genesis is not accepted by the writer for several reasons: (1) Mica was not observed near any of the contacts examined, nor was it found especially abundant near any of the hornblende xenoliths. (2) a chemical reaction between iron-bearing hornblende and pegmatite to produce iron-free muscovite mica, without evidence of associated alteration minerals, appears remote. (3) mica occurs sporadically in many of the pegmatites with no close relation to hornblende rock-pegmatite contacts. Consequently, it seems most likely that the mica is merely a local segregation such as is common in all mica-bearing pegmatites.

Prospect pits that expose pegmatite have been dug at scattered intervals in a line striking southwesterly from the larger trenches. The present owners of the property believe these pits are located on one continuous pegmatite several thousand feet long striking southeasterly (oral communication from Mr. Coty). The writer found many outcrops of hornblende rock and hornblende granulite in the creek bed that parallels the line of pits, and concludes that the pits are located upon outcrops of many different pegmatites rather than upon a continuous one. The dense cover of timber, brush and rotting vegetation prohibits the tracing of contacts, and great caution is urged in extrapolating individual pegmatites without close bedrock control. Extreme caution is urged in computing mica reserves in such pegmatites until sufficient pitting and trenching has been done.

Two faults, both of which strike northeasterly and are hydrothermally altered, were mapped near the open pits. Pyrite was introduced into the wall rocks near the faults, and some of the massive hornblende rock was altered to a mass of biotite or vermiculite. Hydrothermal solutions from one of these faults or from the pegmatites probably formed the biotite or vermiculite in the massive hornblende rock on the footwall of the pegmatite body exposed near the northwestern open cut. One probable fault contact between pegmatite and hornblende rock was observed near the intersection of the faults (see plate 4).

The massive hornblende rock could be a facies of the normal hornblende granulite recrystallized under the influence of heat from the pegmatites, and not an altered intrusive body, for the following reasons: (1) the contacts of the pegmatites and the hornblende rock often strike and dip parallel or approximately parallel to the regional bedding, thus maintaining the sill-like attitude of the pegmatites; (2) gradations from the massive rock showing decussate structure into a foliated hornblende-garnet granulite were observed; (3) a similar massive hornblende rock at one other locality was found to be a contact phase between hornblende-garnet granulite and pegmatite.

On the other hand, a small outcrop of pyroxenite on the north shore of Sitklan Passage clearly has an intrusive form, thus confirming the occurrence of ultrabasic intrusive rocks in the area. Possibly the hornblende rock observed near the main prospects is a facies of the pyroxenite, but the final determination of the origin must await further field mapping.

Zoning of the Pegmatites

No zoned pegmatites were found in the area examined. Because of the economic implications of zoning, special attention was given to this problem during the second field examination. If the pegmatites are zoned, the mineralogical and physical variations between zones are so slight as to be undetectable in the field. The mica exposed in the prospect pits bears no particular relation to its position in the pegmatite, and the pegmatite does not vary perceptibly in composition.

The feldspar of the pegmatites is almost entirely albite-oligoclase with only very minor amounts of microcline. Granular, vitreous quartz is intergrown with all feldspars observed, and no concentrations of quartz were found that suggested quartz cores. The texture may vary between pegmatites and within the same pegmatite; such variations, however, are not consistent and are not accompanied by mineralogical changes.

Although none of the pegmatites is completely exposed, enough exposures were examined to establish firmly that the pegmatites generally are not zoned.

Genesis of Pegmatites

Pertinent observations bearing on the genesis of the pegmatites are summarized below.

(1) The pegmatites are generally sill-like bodies lying in the plane of the bedding of the metamorphic granulites along a zone of feldspathisation. No pegmatites were seen outside of this zone. Some pegmatites have crosscutting contacts, some have gradational contacts, but they always have their long axis parallel or subparallel to the regional strike of the rocks.

(2) The pegmatites contact-metamorphosed some of the host rocks.

(3) The pegmatites contain only quartz, feldspar, mica approaching muscovite in composition, and epidote.

(4) At many places the flakes of muscovite create a foliation approximately parallel to that of the enclosing rocks. The mica is "bent around" augen-like albite crystals.

(5) The quartz of the pegmatites is broken and fractured to such an extent that it breaks down upon weathering or under the pick to a mass of fine grains.

(6) The pegmatite is intruded by basalt dikes injected in a northeasterly direction along a well-developed joint system.

(7) Most of the larger mica observed was cleaved and ruled. Some fairly large unruled sheets can be obtained although they make up a very small total of the mica observed at any of the pits. Some mica of strategic size and grade can be obtained.

A consideration of the above relations suggests that the pegmatites were intruded as heated bodies or soda-rich fluids into the enclosing rocks during the late stages of the Coast Range orogeny. The pegmatites probably were derived, in part at least, from "syngenetic fluids" created from the rocks in the zone of feldspathisation under the influence of the heat of regional metamorphism at depths well below the present position of the pegmatites. No genetic relation to exposed intrusive rocks of granitoid composition is demonstrable.

The pegmatites were injected prior to the formation of the strong northeast-trending joints when the bedding or foliation of the granulites was the easiest direction of entrance. Widespread feldspathization probably was partially contemporaneous with the formation of the pegmatites so that some gradational contacts were developed.

The foliation of the pegmatites and the granulation of the quartz indicate that the pegmatitic bodies were subjected to some dynamic metamorphism after their formation. No effects of deformation after the injection of the basalt dikes and the later faulting were found.

Conclusions

From the preliminary field work it is concluded that pegmatites and intensely feldspathized metamorphic rocks are common throughout a zone at least one mile wide that occupies the east part of Sitklan Island and continues to the north on the mainland for several miles. The pegmatites locally contain mica books of strategic size and grade, but the events of the tectonic history of the rocks caused many of the pegmatites to be crushed or become foliated. The writer does not believe the geologic environment is favorable for the occurrence of the large, slowly-cooled, unstressed pegmatite bodies that are the usual hosts of minable deposits of strategic grade mica.

Not enough prospecting has been done to determine the content of rarer constituents in the pegmatites.

The pegmatites consist predominantly of albite or albite-oligoclase and quartz in fine intergrowths. Although a large tonnage of material is available, the separation of quartz and feldspar would require special beneficiation and the resulting feldspar would not be usable in many industries that consume potassic feldspars.

The deposits are located near tidewater on or near regular sea lanes so that relatively cheap transportation to market could be had.

Recommendations

Additional field work is recommended, especially on Sitklan Island where the larger, discordant pegmatites appear to be most abundant. Prospecting to the north among the feldspathic and pegmatitic rocks in the zone of feldspathization should be directed toward outlining unfoliated, mica-bearing pegmatities. A few surface trenches on these pegmatites should demonstrate the type, grade and amount of mica present.

The pegmatites in which mica is oriented so as to give a crude foliation are not considered to be a favorable host rock for mica of strategic size and grade, and do not warrant extensive exploration for strategic mica.

Some prospecting for economic deposits of vermiculite along the contacts between pegmatite and hornblendite or pyroxenite is recommended.

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