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GEOLOGY AND STREAM SEDIMENT GEOCHEMISTRY OF ANTON LARSEN BAY AND VICINITY, KODIAK ISLAND, ALASKA

By

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During the spring of 1953 a few pieces of gravel containing the tungsten mineral scheelite were found on the lower part of Cornelius Creek (Jasper, 1955). Further prospecting disclosed a number of small low-grade pods containing scheelite in graywacke on Chalet Mountain near the head of Cornelius Creek. An area of about a half square mile around the occurrence was mapped by Seitz (1963) in 1956, and the prospect was examined by several mining companies.

The original purpose of the present study was to map the geology of a larger area around the prospect, and to collect stream sediments in hopes of finding additional tungsten occurrences and learning more about the geologic controls of the tungsten minerals. However, when the work was done in mid-May 1966, snow up to several feet deep covered nearly all exposures above about 500 feet elevation. As a result, the information in this report deals mainly with the geology along the coastline, and with stream sediments and panning concentrates from readily accessible streams, including those draining the scheelite occurrences. Six days were spent in the field.

GEOLOGY

The geology of Kodiak Island has been described by Capps (1937), who should be referred to for regional relations and generalized descriptions of the rock units.

Graywacke and slate

The dominant rock unit of the area, and the oldest exposed unit, is a rock sequence of graywacke, slate, argillite, and siltstone. The slate, argillite, and siltstone are predominantly dark gray to black, apparentlydue largely to carbonaceous material, and the graywacke is generally dark in color. Bedding varies from thick to thin, but some gross geographic units, based on this characteristic, appear possible. In Anton Larsen Bay the sediments between triangulation point LAR and the islands in the mouth of the bay are mostly thick-bedded to massive graywacke with relatively little slate and argillite. Along the coastline from the islandsaround into both sides of Sharatin Bay the sediments are mostly thin-bedded and contain a relatively large proportion of the finer-grained clastic rocks. In the head of Anton Larsen Bay and on Cornelius Creek, thin-bedded sediments including moderate amounts of slate, siltstone, and argillite are common. Slaty cleavage is present in much of the finer-grained sediments and in some poorly-sorted graywacke, but commonly is only poorly developed. Concretions occur in some graywacke, and irregular quartz veins are locally common.

These sediments are part of the thick section of similar rocks forming most of central Kodiak Island, and are probably correlative with slate and graywacke in the Kenai Peninsula and Chugach Mountains. Fossils of Jurassic or Cretaceous age have been found at a few localities in this group of rocks.

Granodiorite of Sharatin Bay

Medium to coarse-grained muscovite-biotite granodiorite crops out along the east shore of Sharatin Bay, and according to Capps (1937) forms a pluton about three miles long and a mile wide, as indicated on the map (figure 1). The composition of a typical specimen (sample KO-5) is shown in table 1. The biotite contains pleochroic halos around tiny inclusions of an unknown mineral.

Table 1. Composition of granitic rocks*

	KO-5	6E-15	6E-48	6E-57	6E-20	6E-47
Quartz	25	25	30	20	15	20
Plagioclase	51	58	48	64	60	55
% An	5-30	10-25	10-35	10-15	0-5	0-5
Orthoclase	15	10	15	10	10	15
Biotite	7	4	5	5		3
Muscovite	2	3	2	1	15	7
Magnetite				trace		
Apatite	trace		trace	trace		
Pyrite	trace	trace				

*Composition by estimates in thin sections.

KO-5 Sharatin Bay granodiorite, 1/3 mile east of triangulation point Dahl.

6E-15 Granodiorite of Anton Larsen Bay, west side of peninsula north of the end of the road.

6E-48 Granodiorite of Anton Larsen Bay, 1/4 mile north of triangulation point Anton on large island in Anton Larsen Bay.

6E-57 Granodiorite of Anton Larsen Bay, on west shore of Bay at the mouth.

6E-20 Fine-grained leuco-granodiorite dike from Sharatin Bay at three-pillar Point.

6E-47 Leuco-granodiorite dike, 0.6 mile northwest of triangulation point Anton on island in Anton Larsen Bay.

Granodiorite of Anton Larsen Bay

An elongate curving pluton of muscovite-biotite granodiorite is exposed across the mouth of Anton Larsen Bay. This pluton varies appreciably in composition and texture within the map area. In the vicinity of sample 15 the rock is relatively homogeneous biotite granodiorite with minor muscovite, grain size 3-5 mm. The southern end of the body varies from coarse to fine-grained and contains moderate to abundant muscovite. Pegmatites, aplites, quartz-muscovite veins, pyrite, and mafic inclusions are common, especially in the contact zone. The composition of three typical specimens is indicated in table 1.

Leucocratic granodiorite dike

A persistent dike of altered leucocratic porphyritic granodiorite or soda granite extends from Sharatin Bay at least to the pluton in Anton Larsen Bay. The southwestern end of the dike and the margins near the north end have a fine-grained groundmass and show considerable silicification and sericitization. The central part of the dike at the northern end is even-grained and contains several percent muscovite. The porphyritic texture suggests that the dike is a later and shallower intrusive than the granite, but the area of intersection was not visited. The dike appears to be offset a few hundred feet at one locality, and smaller offsets may exist elsewhere. The dike cuts across the bedding at several localities and generally has a steeper dip.

Glacial deposits and volcanic ash

Glaciers covered all but the highest peaks of Kodiak Island during the Pleistocene and glacial till and outwash commonly cover the bedrock in flat areas and valley bottoms. In addition, the eruption of Mt. Katmai in 1912 spread a layer of volcanic ash up to several feet thick over the area. The ash has since been compacted and eroded, but the material forms much of the present stream sediment and thus has an important effect on the stream sediment geochemistry.

Structure

As indicated on the geologic map (figure 1), the prevailing strike of the beds is N.35-60E. with a northwest dip. Superficially the sequence appears monoclinal, but the presence of small isoclinal folds, crumpling, slaty cleavage and occasional overturned graded bedding indicates that major isoclinal folding is probably present. Axes of minor folds parallel the regional strike and have shallow plunges. Repetition of the section by faults paralleling the regional strike is also likely, although as mentioned under the description of graywacke and slate, major units within the map area do not seem repeated.

Bedding near the two plutons commonly departs from the regional trend to a more nearly east-west direction, probably reflecting forcible intrusion or pre-intrusive structures that localized the intrusives.

ECONOMIC GEOLOGY

Two types of mineral occurrences are known in the map area. Scheelite occurrences are known on Chalet and Sharatin Mountains, and gold-quartz veins have been prospected in the granodiorite of Anton Larsen Bay. The individual occurrences are discussed below. Locality numbers refer to mineralized locations shown on the geologic map (figure 1).

Tungsten occurrences

Locality 1

At the time of the field work of this report, the scheelite occurrences were inaccessible because of snow, so the following information is based on descriptions by Jasper (1955) and Seitz (1963). Rocks in the prospect area are graywacke and slate. Scheelite occurs as finely disseminated grains and fine veinlets in quartzitic zones in the graywacke, and as thin coatings on quartz veins and fractures. Scheelite was detected in 16 places by Seitz (1963) within a zone about 300 feet wide and 1,600 feet long parallel to the regional strike of the sediments. Jasper (1955 and personal communication) records four additional occurrences extending the zone an additional 2,000 feet southwest along the bedding. Scheelite-bearing graywacke is reported as light-colored ("light blue-gray") in both references, and Jasper suggests that the host rock may be a silicified limy bed or group of beds. The disseminated scheelite is generally confined to pod-shaped bodies with thicknesses up to several feet. Most bodies are only a few feet long, but one area of disseminated scheelite shown by Seitz is about 100 feet in length. Arsenopyrite, chalcopyrite, and pyrite accompany the scheelite in small to trace quantities. No gold or silver has been detected in samples from the area. Quartz veins, some of which have scheelite-coated surfaces, are relatively abundant near the scheelite-bearing graywacke, and tend to strike perpendicular to the bedding.

The presence in the map area of granitic rocks containing abundant biotite and some muscovite suggests that the tungsten may be related to granitic intrusives, either the bodies shown on the geologic map or, more likely, unexposed intrusives at depth below or down dip from the scheelite occurrences.

Assays of samples from the better showings are listed in table 2, after Jasper (1955) and Seitz (1963). Jasper lists eight other assays of material from localities where traces of scheelite could be found, but WO_3 values were nil to 0.03%.

Numerous claims in the area havebeen staked by Kodiak Exploration Co., a local group including George Cornelius, Emil Knudson, and others.

Locality 2

Scheelite-bearing float was also found by Cornelius and associates in tributaries from the northwest side of Cornelius Creek. Observation by Jasper of light-colored graywacke beds near the crest of Sharatin Mountain led to the discovery of scheelite at approximately the locality shown on the map. A sample across 27 inches submitted by the Kodiak group contained 3.45% WO_3.

Other occurrences

According to Jasper (1955 and personal communication), scheelite was also found a mile or two northeast of Locality 1, about 20 miles to the southwest, and in a cliff exposure along the northwest coast of Kodiak Island.

Gold quartz veins

Locality 3

Several quartz veins cut the granodiorite at this locality in a small bay. The largest vein is about 3 feet wide and includes several inches of massive pyrrhotite with minor chalcopyrite. Additional pyrrhotite is disseminated through the quartz. A sample across the vein is listed in table 3 as sample 6E-15. Parts of the quartz vein are vuggy, and other parts contain considerable muscovite. The vein strikes N.60W. and dips 82SW. The locality is within a few hundred feet of the contact of the granodiorite. A few small pits have been dug on the exposures.

Locality 4

Several quartz veins are exposed on the shore here. The largest of these has been prospected by a 7-foot adit which exposes several small quartz-pyrrhotite veins with a sheared limonite-rich zone along one side. Traces of chalcopyrite and some muscovite are locally present. The veins are in the contact zone between the granodiorite and a large graywacke inclusion. This locality is apparently the one mentioned by Capps (1937, top of page 181), who states that arsenopyrite accompanies the sulfides and that a small open cut was dug at an elevation about 150 feet above sea level several hundred feet south.

Table 2. Assays of disseminated scheelite deposits

No.	Width	WO_3	Description
36-V	35"	1.75%	Red Cloud claim, iron-stained siliceous sediment (Jasper, 1955)
48-V	42"	0.28%	Blue Hill claim, in siliceous sediment with arsenopyrite, chalcopyrite and pyrite (Jasper, 1955)
320A	2'	0.56%	Exploratory pit on disseminated scheelite (Seitz, 1963)
320B	2'	0.16%	Exploratory pit on disseminated scheelite (Seitz, 1963)
320C	2'	0.05%	Exploratory pit on disseminated scheelite (Seitz, 1963)
320D	2'	0.06%	Exploratory pit on disseminated scheelite (Seitz, 1963)

Table 3. Assays of gold-quartz veins

Sample No.	Locality	Au	Ag	Cu	As	Sn
6E-15	3	tr	0.40	0.1	tr	N.D.
6E-52	5	0.16	1.00	tr	5.5	N.D.
6E-51	6	0.10	1.10	0.15	tr	N.D.
6E-48	7	0.28	3.50	tr	14	N.D.
KO-8	8	0.10	tr	tr	N.D.	N.D.

Locality 5 (Anton Larson prospect)

An adit 33 feet long explores a quartz-pyrite-pyrrhotite-arsenopyrite vein striking approximately north-south and dipping 80° west at this locality. The vein is 3 to 5 feet wide and contains traces of chalcopyrite. Minor phrrhotite is disseminated in the silicified granodiorite within a foot or two of the vein. Numerous inclusions of graywacke are also present within the granodiorite, and smaller quartz veins are common in the vicinity. A sample of sulfide-rich material from the dump contained minor gold and silver and considerable arsenic (sample 6E-52, table 3).

This prospect is also discussed by Capps (1937, p. 180) as part of the Kizhuyak lode. He obtained an assay similar to that reported here, and states that an open cut on the hill about 500 feet northeast of the adit showed some rusty quartz cutting diorite.

Locality 6

Granodiorite on the beach at this point is cut by numerous quartz veins striking N.15W. and containing local lenses of pyrrhotite. A sample of one of the veins is listed as 6E-51 in table 3. A few hundred feet south, an area of graywacke inclusions in the granodiorite is cut by abundant quartz veins with minor pyrrhotite and traces of chalcopyrite.

Locality 7

The granodiorite along the beach for several hundred feet on the north side of Larson Island is cut by quartz veins and considerably iron-stained. Pyrite and pyrrhotite are locally abundant. The quartz veins, which are locally vuggy, average N.75W. in strike. A sample of a quartz vein including considerable sulfide contained moderate amounts of gold and silver, and much arsenic (sample 6E-48, table 3).

Locality 8

A zone of quartz veins accompanied by pyrite and pyrrhotite cuts the granodiorite on the beach here. The zone is about 10 feet wide. An assay of the quartz veins is shown as sample KO-8 in table 3.

Locality 9 (Womens Bay lode)

At approximately this location, Capps (1937, p. 178-179) reports a quartz vein up to 14 feet wide containing arsenopyrite, pyrite, chalcopyrite, sphalerite, galena, and \$3-10 per ton in gold. The vein is said to have been traced for 1,800 feet along strike, and was developed by a short adit and shaft. The locality was not visited in the present project, but is included here because it lies approximately on the northerly trend of the other gold-quartz veins, and seems to be of similar character.

Summary of gold-quartz veins

The quartz veins lie along a zone about a quarter mile wide and two miles long, trending about N.20E. The host rock is granodiorite, but the veins are concentrated in areas near the contact or near graywacke inclusions. Pyrrhotite, pyrite, arsenopyrite, and traces of chalcopyrite are the metallic minerals recognized. Considerable muscovite occurs in some veins, and is also an alteration product of nearby granodiorite. Samples collected in this project and previous samples collected by Capps (1937) generally contain a maximum of a few tenths of an ounce of gold, but higher grade shoots could exist along the zone, because exposures are rare away from the beach. Geochemical soil sampling for arsenic might be an effective means of detecting such shoots, although the layer of volcanic ash is undoubtedly a complicating factor. The mineralogy and geology of the veins also suggest the possibility of tin or tungsten, but none of these metals were detected in any samples from the gold-quartz veins.

GEOCHEMISTRY

A total of 43 stream sediment samples were collected during the course of the investigation. Most of these samples were collected at the mouths of streams draining into Sharatin and Anton Larsen Bays; two (nos. 40 and 41, table 4) however,came from streams draining, and within one mile of, the scheelite occurrences on Sharatin Mountain. Sediments from the larger streams and those draining the scheelite-bearing area were also panned and the panned concentrates saved for laboratory examination. Cold heavy metal tests using the method described by Hawkes (1963) were run on most of the stream sediments in the field. All the samples were dried and seived to -80 mesh in the laboratory and analyzed for total copper, zinc, lead, and molybdenum by the Rocky Mountain Geochemical Laboratories in Salt Lake City, Utah. Semi-quantitative emission spectrographic analyses were also performed on a number of the samples for beryllium, mercury, tungsten, and tin by the U.S. Geological Survey.

The results of the field tests and total copper, zinc, lead, and molybdenum content of the stream sediments are given in table 4. With the exception of only one sample (no. 39) no anomalous metal content was detected. Copper values are all below 70 parts per million, zinc below 150 ppm, lead below 15 ppm, and molybdenum below 5 ppm. Sample number 39, the exception, contains 85 ppm copper and 195 ppm zinc. This stream drains graywacke and slate in the area between Sharatin Mountain and the Kodiak-Anton Larsen Bay road.

Poor correlation was observed between the field tests and total metal analyses performed in the laboratories. Most of the positive field tests (more than 5 ml of dye) were on samples with less than average metal content (nos. 1, 15, 16, 26, and 29), whereas the samples with greater than average metal content generally resulted in a low field test (nos. 17, 19, 20, 21, 23, and 27).

Examination of the panned concentrates of the stream sediments for scheelite proved discouraging. The only scheelite observed was in sample 40, which contained 4 grains, and in sample 37, which contained 2 grains. Both of these samples are from the stream draining the known scheelite occurrences on Sharatin Mountain. Moreover, tungsten was not detected in any of the stream sediments, including samples 37 and 40, analyzed by the U.S. Geological Survey by emission spectroscopy. However, the lower limit of detection for tungsten by the Survey's method is only 30 ppm.

The U.S. Geological Survey's spectrographic analyses for other selected elements in the stream sediments failed to reveal anything of significance. A very light beryllium line (less than 1 part per million) was detected in samples 4, 5, 8, 9, 11, 13, 15, 16, 22, 23, 29, 32, and 39. Approximately 15 ppm tin was detected in sample 25. In the remaining samples the tin content is less than 3 ppm, the lower limit of detection. Mercury was not detected in any of the samples; however, the lower limit of detection for mercury is only 0.3 percent.

Sample 25 is from the large stream flowing into the head of Anton Larsen Bay. As no tin was detected in any of the tributaries to this stream, it is very possible that the relatively high tin in sample 25 has been derived from refuse dumped into the stream by the ranches on the alluvial flats south of the head of the bay.

Table 4. Copper, zinc, lead, and molybdenum content of stream sediments

		Concentration (ppm)				Field Test
Map No.	Field No.	Cu	Zn	Pb	Mo	(ml of dye)
1	6E-34	30	85	5	2	5
2	6E-33	10	50	5	2	3
3	6E-32	15	60	-5	2	3
4	6E-29	25	65	5	2	3
5	6D-6	40	90	10	3	2
6	6E-28	15	50	-5	2	0
7	6E-27	15	45	-5	4	3
8	6E-22	10	35	-5	3	3
9	6D-5	40	85	5	4	3
10	6E-21	15	65	5	3	2
11	6E-19	20	75	5	3	3
12	6E-42	20	80	5	4	2
13	6E-39	15	55	10	3	4?
14	6D-10	15	30	5	3	3
15	6E-56	20	70	5	3	7

Map No.	Field No.	Cu	Zn	Pb	Mo	Field Test (ml of dye)
		Concentration (ppm)				
16	6D-7	20	60	5	4	7
17	6E-59	65	115	10	4	2
18	6E-13	25	85	5	3	1
19	6E-12	30	110	10	3	2
20	6E-10	40	130	15	2	3
21	6E-11	25	110	5	4	3
22	6D-1	10	65	5	4	3
23	6D-2	25	120	5	3	4
24	6D-3	20	90	5	3	3
25	6E-9	15	60	5	3	1
26	6D-4	15	60	5	3	6
27	6D-9	35	150	10	5	2
28	6E-3	30	70	5	2	2
29	6D-8	40	95	10	4	6
30	6E-2	35	85	10	3	3
31	6E-1	25	95	10	2	1
32	6D-12	30	85	10	3	
33	6D-11	25	85	5	3	
34	6E-61	35	80	10	3	
35	6E-62	25	55	10	3	
36	6E-63	70	135	15	4	
37	6E-64	50	120	10	3	
38	6E-65	50	95	10	3	
39	6E-67	85	195	10	3	
40	6E-68	50	115	10	4	
41	6E-69	25	85	10	3	
42	6E-70	40	95	10	2	
43	6E-71	45	105	15	3	

All analyses by Rocky Mountain Geochemical Laboratories, Salt Lake City, Utah

SUMMARY AND CONCLUSIONS

The Anton Larsen Bay area and vicinity is underlain principally by interbedded graywacke and slate of Mesozoic age. The rocks strike northeast, generally dip northwest, and appear to be isoclinally folded. Small stocks and one persistent dike of granodiorite intrude the sedimentary rocks.

Disseminated scheelite in graywacke occurs in a number of localities on Sharatin Mountain, and gold-quartz veins are fairly common in the granodiorite body on Anton Larsen Bay.

Geochemical stream sediment sampling in the area has not revealed any significant anomalous concentrations of metals (copper, zinc, lead, molybdenum, tungsten, tin, and beryllium) and further suggests that the surface scheelite occurrences on Sharatin Mountain are small and local.

The quartz veins in the granodiorite of Anton Larsen Bay, on the other hand, may represent a potential source of gold. In general, the veins assay $3-10 per ton in gold. Furthermore, as exposures in the area are poor, the possibility of higher grade ore or more extensive mineralized zones should not be overlooked.

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