

MINES, PROSPECTS, AND OCCURRENCES MAP OF THE SEWARD AND BLYING SOUND QUADRANGLES, ALASKA

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MAP SYMBOLS ----- Contact--Dashed where approximately located; dotted where concealed

----- High-angle fault--Dotted where concealed Thrust fault--Dotted where concealed. Sawteeth on upper plate

- SYMBOLS FOR MAIN COMMODITIES
- O Gold or silver ♦ Chromium, cobalt, and(or) nickel
- □ Copper △ Antimony
- Radioactive minerals (uranium and thorium) ∇ Nonmetal--Barite, haydite, limestone

Dot in symbol shows exact location

localities 251, 252, and 273 near basaltic intrusive rocks.

PRODUCTION DATA (based on gold @ \$130 per troy ounce, copper @ \$.60 per pound)

that the entire package of rocks plunges to the south (Tysdal and Case, in press), and gravity maps (Case and others, 1966; Case and others, in press) show that a gravity anomaly of +50 mgal over the mafic rocks of Knight Island continues southward, decreasing in value, beneath the more southerly islands. Thus rocks of Knight Island represent the lowermost exposed rocks of all five islands, whereas the rocks of Latouche, Elrington, Evans, and Bainbridge Islands represent a stratigraphically and structurally higher sequence of rocks. In other words, the sequence of rocks in the southern four islands should be representative of rocks that have been eroded from Knight Island.

The Latouche ore deposits lie on the flank of this major sequence of igneous and sedimentary rocks and are structurally high in the sequence. The few known mafic rocks on Latouche Island consist of sills near the northeastern and southeastern extremities of the island and an altered olivine-bearing dike (Bateman's, 1924, p. 346, "lamprophyre dike") at the Beatson mine (256). Pillow basalt crops out on Danger Island, a small island south of Latouche Island. meters west of locality 96) (700 ppm); on serpentinized dunite at locality 97 (200 ppm); and, at locality 68, 300 ppm on sheared rock of the Placer River fault. Background values for serpentinized dunite of the Resurrection Peninsula range To determine if a regional pattern exists in the distribution of sulfides, a tabulation was made of the most abundant Sulfide mineral present, when recorded in the literature, at each of the prospects, mines, and occurrences on Glacier, Knight, Latouche, Elrington, and Bainbridge Islands. The data presented in the following two paragraphs show only the distribution of reported chief sulfide minerals and do not reflect the possibility of more than one age of mineralization from 70 to 200 ppm cobalt. Background values for pillow basalts, sheeted dikes, gabbros, and mafic tuffs throughout the or remobilization of ores. The data do show, however, that the most abundant sulfide mineral at a locality is preferentially concentrated in a particular geologic unit or environment, whether or not the mineral was remobilized. Thus, in general, pyrite is the chief sulfide mineral in pillow basalts and in some sheeted basalt dikes near pillow basalts; pyrrhotite is the chief sulfide mineral in sheeted basalt dikes and is distributed throughout the width of the zone of sheeted dikes. Chalcopyrite is commonly the chief sulfide mineral in sedimentary rocks.

For the mafic igneous rocks of Knight and Glacier Islands, pyrite is the chief sulfide reported at ten localities (186, 187, 202, 207, 211, 215, 216, 217, 218, 233), including six in pillow basalts, three in sheeted basalt dikes near pillows, and one locality not near the contact. Pyrrhotite is the chief sulfide reported at six localities (191, 205, 206, 212, 214, 222), for the contact with pillow basalts, and one localities (191, 205, 206, 212, 214, 222). 209, 213, 214, 223), four in sheeted basalt dikes near the contact with pillow basalts, one (209) in dikes distant from the contact, and one (213), the Copper Bullion prospect, in pillow basalts. Chalcopyrite was the chief sulfide reported at seven localities (192, 210, 226, 230, 238, 244, 246), all in sheeted basalt dikes. For the rocks of Latouche, Elrington, and Bainbridge Islands and the sedimentary rocks of Knight Island, pyrrhotite was not reported as the chief sulfide at any locality. Pyrite was the chief sulfide reported at three localities (258, 275), all in sedimentary rocks with locality 275 adjacent to pillow basalt. Chalcopyrite was the chief sulfide reported at eleven localities (251, 252, 254, 255, 256, 264, 266, 267, 269, 270, 273), all in sedimentary rocks with

Chalcopyrite in the mafic igneous rocks of Knight and Glacier Islands preferentially occurs in the sheeted dikes.

All workers who have studied the ore deposits of the copper belt have concluded that the copper ores are genetically related to the mafic igneous rocks. Johnson (Capps and Johnson, 1915), in his early studies, attributed the sulfides to granitic magma but later concluded that mafic igneous magma was the source of the ore fluids (Johnson, 1918b, p. 202). Theories for the origin of the deposits in the map area generally have centered on Knight Island where ore deposits and mafic rocks are closely associated. A direct correlation of the Latouche deposits with a mafic magmatic source is not possible because the deposits are isolated in slate and sandstone. Nevertheless, the ore deposits at Latouche are part of a similar group of ore deposits that characterize the copper belt of Prince William Sound, and all of the investigators who have studied the Prince William Sound deposits concluded that the Latouche deposits must be related to the mafic

All of the known massive sulfide deposits are reported to occur in shear zones. Johnson (1918b) believed that the shear zones in the mafic rocks probably formed during the succession of intrusions and extrusions that built up Knight Island, providing channels for mineralizing solutions. Richter (1965) concluded that deposition of the massive sulfides of Knight Island probably occurred more or less contemporaneously with metamorphism, shearing, and folding of the mafic rocks. Deposition of massive sulfides apparently was controlled by secondary structures that formed local areas of reduced pressure within the major shear zones during metamorphism (Richter, 1965, p. 15-16). Where relations are interpretable, Richter found massive sulfides of the shear zones (1) in areas of subtle changes in direction of schistosity, 2) in warped schist at the contact of large bodies of competent rock (competent rock is static), and (3) in strongly warped schist at the apices of small lenses or boudins of competent rock (competent rock has been rotated). Wiltse (1973), on the other hand, favored a volcanogenic origin for the ores of Knight Island. His observations showed an asymmetrical distribution of zinc values within lensoid ore bodies, confinement of ore to subaqueous tuff

units, depletion of metals adjacent to spatially related shear zones, and a lack of hydrothermal wallrock alteration. McGlasson (1976) also concluded that sulfide mineralization on Knight Island is premetamorphic in origin, indicated by (1) grains of chalcopyrite that have foliation oriented parallel to foliation of tuffaceous host rock; (2) grains of alcopyrite that have been deformed between and around quartz grains in schist; (3) primary sedimentary structures preserved in sulfides (Wiltse, in McGlasson, 1976), and (4) snowball textures of quartz intermingled with chalcopyrite, with galena and sphalerite recrystallized in the pressure shadows (Wiltse, in McGlasson, 1976). Near the Ellamar mine in northeastern Prince William Sound (Cordova quadrangle) in a geologic setting similar to that at Latouche Island, G. R. Winkler (oral commun., 1976) observed sulfide minerals concentrated in the troughs of ripple marks. This observation also supports a synsedimentary origin for the sulfide mineral grains. Stefansson and Moxham (1946) cited the occurrence of several faults that juxtapose quartz diorite against mineralized rock at the Copper Bullion prospect. (213) and concluded that mineralization preceded faulting. The sedimentary structure-sulfide mineral relationships cited by McGlasson and Winkler are good arguments for mineralization during deposition of sediments. Arguments 1, 2, and 4 cited by McGlasson are similar to the arguments

of Richter (1965) who reached the opposite conclusion. These three arguments are not definitive because the mineralizing fluids could have been remobilized, thus supporting McGlasson's viewpoint, or they could have been primary fluids that migrated along a channelway (the shear zone), were deposited, then subsequently resheared, thus supporting Richter's

Sheet tot

SCHIST--Sandstone, siltstone, and some tuffs metamorphosed to biotite grade of greenschist facies

McHUGH COMPLEX--Weakly metamorphosed clastic and volcanic rocks; in large part is a melange

PILLOW BASALT--Submarine extrusive basalt

TUFF--Aquagene tuff interbedded with flysch

McHUGH COMPLEX (Cretaceous and(or) Jurassic)

SHEETED BASALT DIKES--Sequence composed almost wholly of dikes

GABBRO--Large pluton that intrudes sheeted dikes and flysch

ULTRAMAFIC ROCKS--Small tabular bodies of serpentinized dunite

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Some of the mafic igneous rocks were emplaced during or after deformation of the sedimentary rocks and after mineralization. Mafic rocks intrude and crosscut nearly vertical sedimentary rocks on Knight Island (Johnson, 1918b) and small gabbro bodies intrude both dikes and sedimentary rocks. Sills intrude vertical sedimentary beds on the islands south of Knight Island. Dikes intrude ore bodies at several places: (1) at the Copper Bullion prospect (213), mapping by Stefansson and Moxham (1947) shows dikes that cut massive and disseminated sulfides; (2) at the Jonesy mine (222) a narrow mafic dike intruded one of the larger shear zones, but itself is not sheared (Johnson, 1918b; Richter, 1965); (3) at the Knights Island Alaska Copper Co. mine (225) several mafic dikes 2 to 30 m thick and irregular masses of mafic rock cut and intruded the mineralized shear zone (Johnson, 1918b; Richter, 1965); and (4) at the Beatson mine (256) on Latouche Island the ore body is intruded by an unshattered, altered, olivine-bearing "lamprophyre" dike (Bateman, 1924) It is apparent that deposition of sediments, intrusion of mafic rocks, mineralization, deformation, and perhaps metamorphism were processes ongoing all at the same time, creating complex relationships.

Lode gold deposits are present in the Port Wells district and in the Moose Pass-Hope district. Gold production from the Seward quadrangle is known to be more than 153,000 troy ounces; about 46,000 troy ounces are from lodes, the remainder from placers. The placer deposits are described in a companion report (Tysdal, 1978). Gold also occurs in the copper ore of Prince William Sound, ranging from a trace to as much as 0.02 troy ounces per ton (Stejer, 1956; Johnson, 1918b).

Port Wells district Gold lodes of the Port Wells district are in quartz or quartz-calcite veins that commonly range in width from a few centimeters to 1 or 2 m and extend a few tens of hundreds of meters in traceable length. Some veins are wider, the vein at the Granite mine (120) having a maximum width of about 5 m. The veins pinch and swell, and form irregular bunches, stringers, and tiny veinlets between breccia fragments. The quartz veins occupy fault and shear zones. Rocks between

the walls of the shear zones were brecciated, subsequently cemented by mineralized quartz, and underwent at least local minor post-mineralization movement that is indicated by gouge along the vein walls and by cross-fracturing (Johnson, 1914a). The breccia fragments are of the same lithology as the country rock. In the Granite mine (120), where a shear zone cuts both sandstone and granite, the breccia is of the same lithology as the immediately adjacent country rock. Chromium in amounts of 1,000 ppm or greater was detected in a few gabbroic rocks, but it is present chiefly in serpentinized dunite. A value of 1,000 ppm was obtained for sheared greenstone (219) of Chenega Island and from gabbro (104) on the Resurrection Peninsula. All other anomalous values, ranging from 1,000 to more than 5,000 ppm, were from

small bodies of serpentinized dunite (101, 103) associated with the pillow basalt, sheeted dike, and gabbro complex of the Resurrection Peninsula (Tysdal and others, 1977). Background values for pillow basalts, sheeted dikes, gabbro, and mafic tuffs throughout the Seward and Blying Sound quadrangles commonly range between 10 and 200 ppm chromium with a few values in the 300 to 500 ppm range.

No cobalt minerals were observed. Anomalous cobalt values were detected on a small serpentine pod (a few hundred

map area ranged between 5 and 70 ppm. quartz vein. Galena is a minor accessory mineral in many of the gold lodes. Lead in excess of 1,000 ppm was detected from several mines in the Hope district (P. R. Mitchell, unpub. data, 1977).

The highest manganese value, greater than 5,000 ppm, was obtained from siltstone cut by a small, north-trending shear zone on the ridge between Palmer and Resurrection Creeks (lat 60<sup>0</sup>47'18" N., long 149<sup>0</sup>35'09" W.). Several channel samples from the Hirshey and Carlson mine (22), a gold lode, yielded 3,000 to 5,000 ppm manganese. These high values correspond to low values of iron from the same samples; conversely, high values for iron correspond to manganese values of 700 to ,500 ppm, suggesting that manganese and iron substitute for each other at these localities.

Many rocks from the quartz lode mines in the Hope area were analyzed for mercury, which was detected in nearly every sample. Values generally were less than 1 ppm, but a few rocks gave values in the range of 1 to 3 ppm, and three samples yielded values of 10 ppm (P. R. Mitchell, unpub. data, 1977). An increased mercury content corresponded to an increased value of gold obtained from the same sample. Analyses of free gold panned from the dump of the Nearhouse and Smith mine (12) shows mercury to be chemically combined with gold (R. B. Tripp, oral commun., 1976). Minute grains of cinnabar were reported in pan concentrate stream-sediment samples from the mouth of Bertha Creek and from a tributary of Cooper Creek The largest concentration of it is at the Copper Bullion prospect (213), which may be in a zone of transition from sheeted dikes into pillow basalts. Chalcopyrite commonly was reported in the literature as the most abundant sulfide in sedimentary rocks, although lenses of massive pyrite and pyrrhotite are present.

(Jasper, 1967, p. 35, 45). However, no cinnabar was observed in the Seward or Blying Sound quadrangles in any of the several hundred pan concentrate stream-sediment samples analyzed by the U.S. Geological Survey. A similar appearing red dish mineral, minium (Pb<sub>3</sub>0<sub>4</sub>), which could be confused with cinnabar, was observed in several samples and confirmed by Xseveral hundred pan concentrate stream-sediment samples analyzed by the U.S. Geological Survey. A similar appearing red-dish mineral, minium (Pb<sub>3</sub>0<sub>4</sub>), which could be confused with cinnabar, was observed in several samples and confirmed by X-ray analysis (R. B. Tripp, oral commun., 1977).

> Molybdenum Molybdenum was detected in only one sample, yielding a value of 10 ppm. The sample was from an iron-stained zone along the Hope road, about midway between Sunrise and the junction of the Hope road with the Seward highway. Molybdenite was reported from the Alaska Oracle mine (51) (Tuck, 1933, p. 509; Smith, 1942, p. 186), and Tuck (p. 491) stated that it has been reported from several other localities. Martin, Johnson, and Grant (1915, p. 137) reported molybdenite in quartz veins near the head of the Chickaloon River (T. 6-7 N., R. 4 W.), but no confirmed occurrences of molybdenite are known in the Seward and Blying Sound quadrangles. On Crow Creek, about 6 km north of Girdwood and in the Anchorage quadrangle, Martin, Johnson, and Grant (1915, p. 137) and Park (1933, p. 409) observed molybdenite in several vuggy quartz veins on

> Nickel in anomalous amounts was detected only in serpentinized dunite (97, 101) of the Resurrection Peninsula, giving amounts has been reported (Lincoln, 1909, p. 209) from the Beatson mine (256) and from the Duchess mine (258) (Stejer, . On Knight Island, "nickel-bearing lodes" were reported in the pyrrhotite ores of Mummy and Drier Bays (Johnson, 1919, p. 145; Martin, 1919, p. 22, 23, 31), but the nickel probably was a minor element. Platinum group elements

Seven samples from the Resurrection Peninsula were analyzed for platinum group elements: platinum, palladium, rhodium, rubidium, iridium, and germanium. The samples were one basalt dike, five serpentinized dunite rocks, and one beach sand from near the dunite. The greatest values obtained from serpentinized dunite (97) were 0.005 ppm platinum, 0.01 ppm palladium, and 15 ppm germanium. The beach sand yielded 0.005 ppm palladium and 3 ppm germanium. No platinum group elements were detected in the basalt dikes.

antimony, and gold (Mines Handbook, 1927, p. 158). Thus undetected telluride minerals may exist in the Port Wells

district of the Seward quadrangle.

No significant occurrence of tellurium is known in the Seward or Blying Sound quadrangles. Analyses of tellurium were made on 22 samples from the Nearhouse and Smith mine (12), and tellurium was present in all samples, yielding values that ranged from less than 0.02 ppm to 0.16 ppm (P. R. Mitchell, unpub. data, 1977). In the Port Wells district but in the Anchorage quadrangle, gold-bearing quartz veins of the Homestake mine contain nagyagite, a sulfotelluride of lead,

Tin was detected in only one sample (171), a sheared sandstone from near King's Bay that contained 50 ppm.

No important concentrations of titanium were found; titanium constituted 1 percent or less of rocks analyzed geochemically. Titanium minerals identified include ilmenite, titaniferous magnetite, leucoxene, and sphene, all of which are accessory minerals found chiefly in the mafic igneous rocks.

smaller amounts than in the mafic rocks. Only one occurrence (95) is considered anomalous, 2,000 ppm vanadium, detected from an iron-stained zone of gabbro on the Resurrection Peninsula.

FOLIO OF THE SEWARD AND BLYING SOUND QUADRANGLES, ALASKA MAP MF -880 A

SHEET 1 OF 2 Tysdal-Mines, prospects, and occurrences

Sphalerite (ZnS) is a fairly common accessory mineral in the gold lodes where it generally is associated with galena (PbS). Although sphalerite is a common accessory mineral in the copper lodes of Prince William Sound and Blying Sound, galena rarely was reported in association with it in this environment. Only trace amounts of lead were detected in the mafic rocks, except in shear zones. Sphalerite also occurs in sheared granite at Wells Bay (184). NONMETALLIC COMMODITIES

Large resources of sand, gravel, and rock suitable for industrial and construction use are common in the Seward and Blying Sound quadrangles. These commodities are distant from any major urban area, and transportation costs limit their use mainly to road building and local construction projects. Other nonmetallic commodities are minor and uneconomic, except perhaps for local use of limestone (tufa) near Seward.

Asbestos was reported (Grant and Higgins, 1910b, p. 79) in irregular veins mixed with quartz in a prospect (262?) on the southeast side of Elrington Island. Some of the veins are 8 cm wide, with the asbestos fibers formed perpendicular to the vein walls. This is the only reported occurrence of asbestos in the Seward and Blying Sound quadrangles, and its

existence was not verified in our study.

Barium was detected in amounts of 5,000 ppm or greater at locality 247 where it is disseminated in iron-stained green-stone near a shear zone. No barite was observed in the outcrop. Barite prospects are reported (U.S. Bureau of Mines, 1973b, and KARDEX, 1976b) along Puget Bay (176, 177, 178, 179), localities not visited by the writer.

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