STATE OF ALASKA

William A. Egan - Governor

DEPARTMENT OF NATURAL RESOURCES

Phil R. Holdsworth - Commissioner

DIVISION OF MINES AND MINERALS

James A. Williams - Director

GEOLOGIC REPORT NO. 5

Geology of the Niblack Anchorage Area, Southeastern Alaska

By

Gordon Herreid

Juneau, Alaska

May 1964

GEOLOGY OF THE NIBLACK ANCHORAGE AREA

By

Gordon Herreid

INTRODUCTION

Two small copper deposits are known in the Niblack Anchorage area, 28 miles southwest of Ketchikan. The **Niblack** Mine, at the head of **Niblack** Anchorage, was one of the many small copper mines in the southern part of Prince of Wales Island which operated during the early part of the century. The **Dama** prospect, two miles southwest of the **Niblack** Mine, has long been known to contain disseminated pyrite over a considerable width. This area was chosen for investigation because it is the most accessible part of the southern Prince of Wales copper province and because it offered the possibility of finding a sulfide body between **Dama** prospect and the **Niblack** Mine. M.A. Kaufman, State Mining Geologist, and the author spent six days in the area mapping during May 1963.

PREVIOUS WORK

From 1904 until 1915, the U. S. Geological Survey reported briefly on mining developments around Niblack Anchorage every year or two. The report for the year 1905 (Wright and Wright, 1906) described the Niblack deposit as consisting of mineralized portions of quartz-sericite schist bands which occur in a complex of greenstone schist, with occasional beds of quartz-sericite schist and allied rock types: the irregular outlines of ore bodies were believed to be the result of intersecting fault planes. One ore body was noted to be 80 feet *long, 18* feet wide, and 20 feet high, plunging 45° northeast. No information concerning grade of ore was given in these reports. However, in 1905 the Niblack Mine had the greatest copper production in the district. By the time mining ceased in 1908, the shaft at the Niblack was down 320 feet and there were 5,500 feet of underground workings. The only other deposit in the map area on which significant work has been done is the Dama prospect, which has been explored with a 560-foot adit and a number of open cuts and trenches. This work was done in 1903-05. A zone of pyrite 125 feet wide in quartz sericite rock is exposed in the adit. During the period when the Niblack Mine operated, nothing was done on the Dama and apparently nothing has been done since. Twenhofel and others (1949) give a brief description of the Dama, including a map and a composite assay. Recently the U. S. Bureau of Mines sampled the deposits and conducted geophysical investigations around Niblack Anchorage. Although details of the work are not available, it is known that no significant discoveries of ore were made.

The old geologic reports, published and unpublished, supplemented and modified by aerial photo interpretation have been recently used by W. H. Condon (1961) to make a 1:250,000 scale geologic map of the southern part of Prince of Wales Island. This map and its accompanying report bring up to date the U. S. Geological Survey regional map in Bulletin 800 (Buddington and Chapin, 1929).

REGIONAL GEOLOGY

Prince of Wales Island is underlain by a lower Paleozoic eugeosynclinal assemblage consisting mainly of andesitic volcanics, graywacke, slate and limestone. These old rocks are exposed along a wide northwest-trending belt, the Prince of Wales geanticline of Payne (1955). The belt is bounded on its northeast side (and farther north, on the southwest side as well) by a thick section of Mesozoic graywacke, slate, and andesitic volcanics. The rocks of

the geanticline are strongly folded and much of the area is underlain by low grade metamorphic rocks. Mesozoic granitoid intrusives make up an estimated 5-10 percent of Prince of Wales Island. Typical contact metamorphic ore deposits occur near some of these intrusives. it seems evident that these intrusives intruded after, or late in the period of, Mesozoic uplift and deformation, and solidified at a fairly shallow depth. The regional structural geology is poorly understood because of complex structure, lack of recognizable marker horizons of known age, and poor exposures between high tide and timber line. In the map area the rocks have been isoclinally folded and the folds are overturned to the northeast and plunge moderately southeast. On a regional-scale geologic map the pattern of the rocks in southern Prince of Wales Island is consistent with the interpretation that the Niblack Anchorage area lies in the core of a great southeast-plunging syncline, with the older rocks to the north and west swinging around Cholmondeley Sound to Hetta Inlet. More mapping will be necessary before any well informed conclusions can be made concerning major structures in southern Prince of Wales Island.

Numerous topographic linears are present in Southeast Alaska as more or less straight valleys, scarps, and waterways. Many of these have been shown to be faults, and by inference the linear features of unknown origin on land and the linear waterways are assumed to be of fault origin also. The present topographic expression of linear elements is due mainly to stream and glacial erosion of the fault traces, although recent movements could be a factor in some places. Twenhofel and Sainsbury (1958) have reviewed the literature and the evidence for fault origin in linears and show a number of them on a map of Southeast Alaska. They give the age of movement of these faults as late Mesozoic to present. Because of the rarity of accurately mapped contacts of different rock types, little is known about the offset along these faults, It is likely that many of them are fractures belonging to a great northwest-striking, right lateral wrench fault system which has important members on either side of Prince of Wales Island on the northeast in Clarence Strait and on the southwest offshore. These faults were active during the post-magmatic period when ore deposits were formed, and it has been suggested (Twenhofel and Sainsbury, 1958, p. 1442) that they may be an important ore control.

GEOLOGY OF NIBLACK ANCHORAGE

The foliated rocks at Niblack Anchorage are greenstone volcanics interbedded with quartz-sericite rock and a little black slate

and limestone. These have been in-truded by a medium-grained quartz diorite body on the north side of the map area. At one place pillows were seen in the greenstone, and at another, massive layers interbedded with sheared greenstone sediments suggest interbedded flows and muds. The volcanics were evidently laid down under water. On the north end of the hook-shaped point south of Niblack Anchorage, gray limestone and black slate were found. Along the quartz diorite contact on the north side of the Anchorage phyllite occurs. Otherwise, the rock is mainly greenstone with interbedded quartz-sericite schist, which is shown somewhat diagramatically on the map, due to the poor exposures.

The greenstone is generally dark greenish gray and on weathered surfaces small plagioclase grains stand out from the aphanitic dark chloritic ground mass. Epidote veining is common and quartz veins are rare. Under the microscope a pillow greenstone flow on the point 3/8 mile west of the Dama edit is seen to contain about 15 percent twinned albite (An-5) phenocrysts up to 3 mm long along with finer-grained epidote, chlorite, and quartz. The groundmass grains are generally less than .05 mm long and consist of about equal parts of albite and green chlorite with scattered epidote and actinolite grains. The feldspar in the groundmass is saldom twinned and occurs both as individual grains and feathery rosettes. The chlorite follows a network of cracks and forms rims around most feldspar phenocrysts. Chlorite also occurs in irregular veinlets with epidote. There are no visible slip planer; and no parallel orientation of minerals, This greenstone represents the complete alteration of the original high temperature volcanic minerals to minerals stable under green schist metamorphic facies conditions. Ca, Fe, and Mg were mobile so that Ca was leached from the plagioclase, mafic minerals were broken down, and epidote and chlorite were deposited by solutions that permeated the rock. Greenstone west of the Niblack Mine at 1,100 feet elevation shows a similar nonoriented fabric in its metamorphic minerals despite the fact the folded bands of rock were present elsewhere in the outcrop. In both of these rocks slippage within the rock during folding was probably concentrated along tops of flows, which are seen to be foliated in places.

The quartz-sericite rock is a sligh-tly foliated, light cream-colored rock, locally containing megascopic quartz grains. It is generally limonite-stained on weathered surfaces as a result of oxidation of its disseminated pyrite. It tends to form prominent outcrops, often cliffs, and makes distinctive rust-stained creek float. Quartz-sericite rock layers appear to parallel composition banding in greenstone and the presence of greenish quartz-sericite rock in several areas suggests gradation with greens-tone. Above the Dama

adit, quartz-sericite rock forms folds a few feet across with tiny crenulations which parallel the fold axes on the foliation surfaces. Microscopic examination shows the foliation to be the result of a preferred orientation of sericite flakes less than .01 mm long which make up about 20 percent of the rock. The remaining 80 percent of the rock is almost entirely quartz, mainly as equant grains less than .1 mm in diameter, but also as quartz porphyroblasts up to 3 mm in diameter. In places where the proportion of quartz in the groundmass is smaller, the sericite shows microscopic crinkles, but for the most part the mica occurs as isolated short trains of oriented flakes in a sea of tiny anhedral quartz grains. Apparently the fine grained quartz has replaced much of a previously schistose groundmass. The quartz porphyroblasts are rounded to almost euhedral in places, have ragged borders with tongues of quartz projecting into the groundmass, and stand athwart the foliation without any deflection of the mica flakes. There is a striking lack of curvilinear flow lines of aligned mica grains and no lenticulnr quartz augen are present, No cross cutting quartz veins are present but in places replacement veins made up of anhedral quartz and pyrite grains (.3 mm in diameter) parallel the foliation. The rock appears to be a mica schist which has been silicified, and in places pyritized, after it was folded. The original rock was probably an acid tuff, or possibly a mudstone.

The quartz diorite intrusive north of Niblack Anchorage is a massive medium-grained rock containing many diabasc dikes and rounded basic inclusions. Under the microscope it is seen to be of subhedral-granular texture consisting mainly of a mosaic of medium-sized twinned oligoclasc (An-30) feldspar grains (up to 2 mm in diameter) with interstitial anhedral strained quartz. Prisms of unaltered green hornblende of about the same size as the feldspar are the only original mafic minerals in the rock. Patches of light yellowish epidote, green chlorite and leucoxene probably represent the alteration products of other mafic minerals. Much of the feldspar contains alteration patches of muscovite and epidote.

Modal Analysis of Quartz Diorite

Plagioclase feldspar (An-30)	44%
Quartz	28
Epidotc	12
Muscovite	10
Chlorite	2.5
Hornblende	1.4
Leucoxene	1.5
Opaques (black)	0.6
Sphene	0.2
Carbonate	0.2

Age of Rocks

Large areas in southern Prince of Wales Island including that around Niblack Anchorage have been mapped as Middle Devonian, possibly in part Silurian or older (Condon, 1961). No evidence relating to the age of bedrock in the map area was found in the present investigation.

Structure

The rocks around Niblack Anchorage dip southwest with occasional "aberrant" southeast dipping beds and widespread southeast plunging crinkles. The southeast dips occur on the noses of folds of medium size which plunge southeast, more or less parallel to the southeast plunging crinkles. These folds and crinkles in otherwise monoclinal beds indicate that the actual structure in the area consists of isoclinal folds plunging southeast and overturned to the northeast. Any major folds in the area should conform to this orientation. It should be possible to trace out the thick layer of quartz-sericite rock at the Dama if it is actually a horizon in the greenstone and if it has not been disrupted into a scattered series of pods. Concentrations of pyrite are associated with medium-sized southeast plunging hinges, and any ore shoots in the area would be likely to have the same orientation over any considerable distance.

Without extending the mapping to the west, it is not possible to explain several attitudes west of the Niblack Mine which could not be the result of folding horizontal beds around southeast plunging axes.

Geochemical Sampling

Stream sediment samples were taken above high tide level on all of the creeks flowing into Niblack Anchorage. These were analyzed in the field for heavy metals by the University of Alaska method (Mukherjee and Mark Anthony, 1957). The only anomalously high readings were taken at the Dama adit, at the Niblack Mine, from the creek west of the Dama adit, and from a seepage near the Red Stack east of the Niblack Mine. In all of these areas the high readings were associated with pyrite-bearing quartz-sericite rock.

Ore Deposits

1. Niblack Mine -- Only the dump, water-filled inclined shaft, and scattered remains of equipment and buildings are left at the Niblack Mine. The only mineralized rock seen in place is a prominent limonite stained outcrop that lies between the dump and the beach. A chip sample across this zone (7 feet wide) ran Au-.02 oz.; Ag-.3 oz.; Cu-1.97%; Pb-nil; Zn-1.50%. This ore is a pyrite-chalcopyrite replacement of

greenstone schist on the nose of a medium-sized fold which plunges 30° southeast. On the dump magnetite is common with the richest copper ore being magnetite-jasperoid rock cut by chalcopyrite and calcite veinlets. Country rock on the dump is mainly greenstone, but some quartz-sericite rock is present. The inclined shaft is flooded to within 30 feet of the collar.

2. Between the Niblack Mine and the prominent Red Stack, 3/8 miles to the southeast, large iron-stained quartz sericite boulders are scattered along the beach. These carry disseminated pyrite, but no copper minerals or stains were seen. Bedrock does not crop out between the mine and the Red Stack, either along the beach or in the lowland back from the beach. The Red Stack and nearby outcrops are probably in place and are the same pyritized quartz-sericite rock. The cliffs immediately southwest of the Red Stack are unmineralized greenstone and farther west they appear to be greenstone, but were not visited.

3. Dama adit (el. about 780') -- The adit was not remapped as Twenhofel and others (1949, p. 7-9) have mapped and sampled it. They report 0.11 percent Cu in a zone of pyritized schist 125 feet wide. The quartz sericite rock contains an estimated maximum 50 percent pyrite, whereas the interbedded greenstone has little pyrite. Between the adit and the top of the hill at 1,140 feet pyritized quartz-sericite rock is exposed at a number of surface workings and outcrops, but no copper minerals or stain were seen. A number of southeast plunging folds occur with pyrite, but the pyrite is not noticeably concentrated along fold hinges. Composition banding between greenstone and quartz-sericite rock parallels the foliation of the schist.

4. Creek west of Dama adit -- A geochemical anomaly of 5x background (25 ml dye) was obtained from creek sediments above the high tide level. A geochemical traverse up the creek with frequent sediment sampling showed the anomaly to lead to a zone of pyritized pale green quartz-eye quartz-sericite rock about 200 feet wide. Geochemical readings on stream sediments above this zone were approximately background (4 to 6 ml of dye). No copper minerals or stain were found in the pyrite zone. On the left limit of the creek, on a knob of quartz-sericite rock, at about 910 feet elevation, a 38 foot adit has been driven (shown on map). The wall rock contains up to an estimated 10. percent pyrite in places but the only copper mineral seen was a minute patch of stain in the face of the adit. The area on either side of the creek is mostly covered except where cliffs occur. A prominent cliff at about 1,300 feet elevation on the left limit is iron-stained and is probably quartz-sericite rock. A geochemical sample a few hundred feet below the cliff was not above background (6 ml. dye).

Ore Deposits -- Summary.

The only ore seen in the map area was near the abandoned Niblack Mine. This was magnetite-chalcopyrite in greenstone, associated with quartz-sericite rock, One or more bands of quartz-sericite rock which is pyritized in places, occurs along the southwest side of Niblack Anchorage, at an elevation of 700-1500 feet. The pyritized zones carry a small percentage of copper, probably about 0.1 percent. The Dama adit has been driven in this rock and the same (?) pyritized rock layer crops out over a width of about 200 feet at about 900 feet elevation in the creek west of the Dama adit. No copper minerals were seen along this creek. The same rock type is probably present in the bold cliffs along the upper part of 2230 foot mountain south of the Niblack Mine and may continue northwest, It is unlikely that economic copper deposits went unnoticed in the quartz-sericite rock along these cliffs during the period of active prospecting.

ORIGIN OF ORE

The massive and disseminated pyrite-chalcopyrite deposits occur in quartz-sericite layers which are conformable to the layering in greenstone volcanic rocks. The sulfide and quartz replacement of the quartz-sericite rock took place after it was folded and metamorphosed. Deposits similar to this are found in many places throughout the world. Ivanov (1962) has recently summarized the characteristics of such deposits. According to him the great majority of large pyritic deposits in geosynclinal areas are closely associated with quartz-sericite rocks, originally rhyolitic flows or pyroclastics, that are usually interbedded with greenstone flows. These ore deposits are concordant with the bedding and are not primarily controlled by faults or associated with granite bodies. The restriction of economic deposits to small anticlinal structures in some greenstone-rhyolite regions indicates a structural control and therefore a deep source for hydrothermal ore solutions. Silicification and sericitization in and around ore deposits seems to confirm a hydrothermal origin.

Kinkle (1962) stresses the strong stratigraphic control of the ore in the Huelva district, Spain. Here a horizon of rhyolite flow rocks overlain by pyroclastic rhyolite contains isolated pods of massive pyrite of a uniform character (including the Rio Tinto deposit) over a distance of 100 km. Kinkle believes that the ore was deposited as sulfide precipitates on the sea floor or as replacements of unconsolidated tuff around ancient submarine volcanoes. He also believes that the common association of massive pyritic deposits with acid volcanic layers in greenstone or eugeosynclinal type sediments is the result of a

similar origin

These descriptions of the close spatial relationship of pyritic deposits to quartz-sericite layers are in accord with what is known of the Niblack deposits and indicate the possible importance of such layers as a guide to ore on southern Prince of Wales Island. Unknown deposits similar to the Niblack deposit may be present northwest of Niblack Anchorage.

RECOMMENDATIONS

It is considered unlikely that undiscovered copper deposits exist in the map area, because of the relatively good exposures and the amount of early work done. Northwest beyond the limits of the map, particularly in areas more remote from the beach, the quartz-sericite layers in the rock provide a favorable ore target for exploration in conjunction with geochemical prospecting.

REFERENCES CITED

Buddington, A.F., and T. Chapin.
1929. Geology and Mineral Deposits of Southeastern Alaska; U. S. Geol. Survey Bull. 800, 398 p.

Condor,, W.H.,
1961 Geology of the Craig Quadrangle; U.S. Geol. Survey Bull. 1108-B, 43 p.

Ivanov, S.N.,
1962 Some Basic Problems of the Distribution of Sulfide Mineralization in Pyrite Provinces; Translated from the Russian in International Geology Review, V. 4, p. 151-160

Kinkle, A.R.
1962 Observations on the Pyrite Deposits in the Huelva District, Spain, and their Relation to Volcanism; Econ. Geol. Bull. V. 57, p. 1071-1080

Mukherjee, N.R., and L. Mark Anthony.
1957 Geochemical Prospecting; Univ. of Alaska, 81 p.

Payne, T.G.,
1955 Mesozoic and Cenozoic Tectonic Elements in Alaska; U. S. Geol. Survey Map 1-84

Twenhofel, W.S., J. C. Reed, and G.O. Gates.
1949 Some Mineral Investigations in Southeast Alaska, U.S. Geol. Survey Bull. 963, p. i-iv, 1-45

Twenhofel, W.S., and C.L. Sainsbury.
1958 Fault Patterns in Southeastern Alaska; Geol Soc. American Bull., V.69, p. 1431-1442

Wright, F.E., and C.W. Wright.
1906 Lode Mining in Southeastern Alaska; U.S. Geol. Survey Bull. 284, p. 18-29