STATE OF ALASKA

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DIVISION OF MINES AND MINERALS

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GEOLOGIC REPORT NO. 1

Preliminary Report on Geologic Mapping In The Coast Range Mineral Belt, Alaska

By

G. Herreid

Juneau, Alaska
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NOTE OF EXPLANATION:

This geologic report was originally published in the Annual Report of the Division of Mines and Minerals for the Year 1962. The Annual Reports cover the status and progress of the mineral industries in Alaska, activities of the Division, etc., in addition to various geologic and other reports by members of the Division.

The Annual Report for 1962 is now out of print, but the requests for Geologic Report No. 1 continue. To fill the demand, we have adopted the expedient of "lifting" it from the Annual Report for multilithing "as is" without retyping or redrafting except for changed page numbers. The following pages are the result.

Since it is of interest and in the same area, we include a geochemical report on Tracy and Endicott Arms by William H. Race, Mining Engineer of the Division. It was published in the same Annual Report.

James A. Williams
May 25, 1965

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PROPERTY AND AREAL REPORTS

Preliminary Report on Geologic Mapping in the Coast Range Mineral Belt

by Gordon Herreid, Mining Geologist

Introduction

Southeast Alaska is an area of great geological regularity because of the strong control by NW trending geosynclines of rock types, folds and ore deposits. This regularity is particularly well shown along the SW margin of the Coast Range batholith. Here, deformation and metamorphism of NW trending belts have taken place at great depths to produce an elongated belt of metamorphic rock whose style of structure shows little change along the belt, but regular changes across the belt. This marginal belt is the site of numerous ore showings and a few profitable mines. The elongation of the mineral province parallel to the structural features indicates a close relation between the regional geology and ore deposition. It seems probable that unexploited mineral deposits of economic grade remain to be found along this narrow belt, and that these deposits are related to the structural and other geologic features of the region. It is the object of the DM&M program in this area to study the deposits, the regional geology, and their interrelations.

The classical explanation for the close spatial relationship of the ore deposits of the Coast Range mineral belt (Juneau gold belt and extensions NW and SE) is that the ore is related in some way to the granitic intrusions in or along the Coast Range batholith. Recently, Forbes (1959) has shown that the Coast Range mineral belt at Juneau lies in a belt of progressive metamorphism and that the SW contact of the Coast Range batholith is gradational with these metamorphic rocks. Forbes has suggested (personal communication to the author) that the origin of the ore deposits in the area may be related to the development of the metamorphic belt itself. At the present time the low grade gold deposits mined formerly are no longer profitable and the main ore targets along the belt are base metal sulfide deposits which have long been known in the area.

Previous Investigations

The foundation, and still the most complete report on the geology of the Juneau gold belt, is A.C. Spencer's "The Juneau Gold Belt, Alaska," U.S.G.S. Bull. 287, published in 1906. Here, Spencer described with admirable simplicity the metamorphic and igneous rocks and the mineral deposits. His somewhat generalized geologic map of the Juneau area is the only one published to date. Spencer described the rock succession SW across the belt as diorite, a band of crystalline schist, and a band composed mainly of alternating slates and greenstones. He recognized that tilting and development of the schistosity took place before intrusion of the diorite. He noted that "wherever observed" diorite contacts, in both the main mass and outlying "dikes", are nearly always parallel to the "strike" of the enclosing rocks. He recognized no major folding, but suggested that it might be present. Concerning the ore deposits, he notes "the linear distribution of the mines of this part of southeastern Alaska has been recognized for many years." He subdivided the ore deposits into veins, sulfide disseminations ("impregnated masses of rock"), and gradations between the two. The disseminated deposits carry little gold, and Spencer devoted little attention to them for this reason. The veins "quartz, calcite, one or both", carry varying amounts of sulfides along with gold and silver, are discontinuous and in many areas are aggregated along certain lines "so that the combination of many veins, each unimportant in itself, is traceable with considerable distinctness for long distances". These he termed "stringer leads". The mines on Gold and Sheep Creeks in the Juneau area are on extensive vein complexes of this nature and similar complexes "may be observed.....in the Windham Bay and Sumdum districts".

Spencer believed that the amphibolite bodies and layers which occur in the slate in the Gold Creek area are intrusive "gabbros" which have been metamorphosed. These were termed 'metagabbros' by later writers. These metagabbros are an important ore control: "one finds typical stringer leads composed of numerous nearly parallel veinlets occupyingirregular openings in the slates adjacent to the contact" or "gash-like"stringer leads may form in the metagabbro near the contact. Spencer believed that the vein openings were probably due to later vertical movements during uplift long after the period of folding. Because diorite is the country rock of gold deposits at Berners Bay and at the Treadwell deposits, and because the fissure veins must have been emplaced in solid rocks, Spencer places the date of mineralization as long after emplacement of the diorite. He believed that the veins were deposited from hot aqueous solutions given off during crystallization of a buried body of magma.

Spencer's ideas on the regional geology and ore deposits have been accepted with slight modifications and additions by all later workers who published reports on the area until 1959 when Forbes' work appeared.

Buddington and Chapin (1929) mapped the regional geology of SE Alaska on a 1:500,000 scale and summed up much of the early work. These authors recognized that the rocks in the Juneau area and all along the SW margin of the Coast Range batholith have been isoclinally overturned to the SW. In general, they did not attempt to work out the details of the structure, but where they did, they reported that minor folds were "themselves acutely folded and in places pitch almost vertically". They also noted the increase in intensity of metamorphism from west to east as the batholith is approached.

Livingston Wernecke, consulting geologist for the Alaska Juneau Gold Mining Company, described (1932) some of the outstanding features of the north and south ore bodies and presented a geologic map of the north ore body. Mixed in with an account of the formation of the deposit is much descriptive information on the ore and wall rocks. He accepted Spencer's intrusive origin for the metagabbros which he believed are surrounded by contact metamorphic aureoles of spotted schist. He believed that the metamorphism has obliterated the evidence of folding in the wall rocks and that the ore was derived from a cooling magma at depth long after the period of metamorphism.

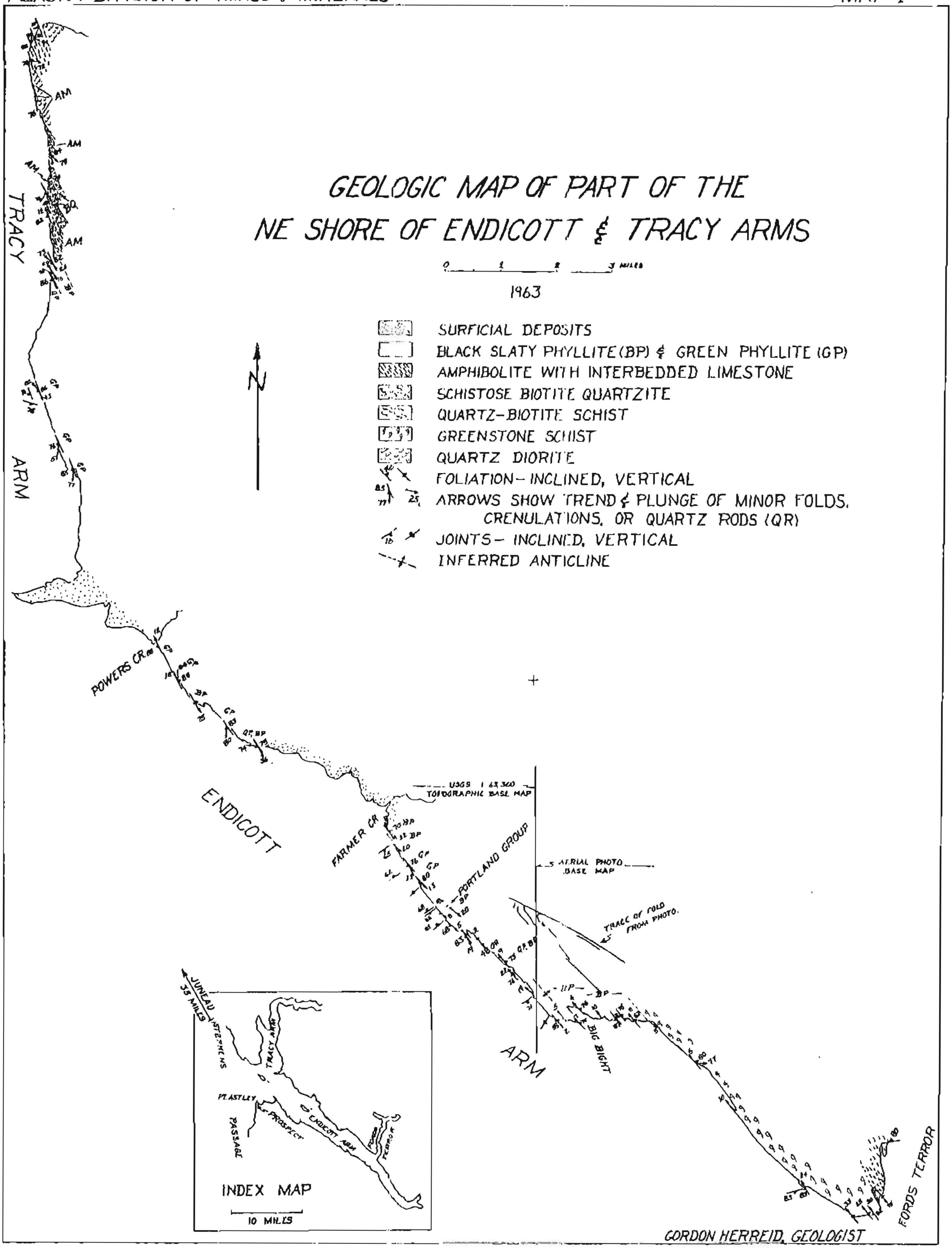
Recently, Wayland (1960) has published a paper on the Alaska Juneau mine based on thesis work done in 1937. This paper provides a good summary of the mineralogic and structural features of the deposit. Wayland mentions folding of the rocks and considered that "folding of some early quartz veins in phyllites is due to selective replacement by quartz of shear-folded beds". He notes that the "longer dimensions of a group of quartz stringers seems as a rule to follow the regional plunge of major structures (apparently metagabbro intrusives -GH) to the southeast". Wayland follows Wernecke in describing the metagabbro as intrusive because of its "occasional branching" but notes that the spots of the spotted schists are augen formed during shearing.

The Neglected Prize, a zinc-copper deposit, and the surrounding area along Tracy Arm, fifty miles SE of Juneau, are described by Gault and Fellows (1953). They present detailed maps of the deposit and the surrounding region and a short descriptive report.

These reports and a number of unpublished reports written during the same period provide a good picture of the distribution of the rocks and ore deposits along the Juneau gold belt and a fairly coherent mass of data and structure, mineralogy, and wall rock alteration in the ore deposits. The possibility of any genetic relation between the wall rock and the ore deposits has been considered and dismissed. No serious attention has been given to minor structures of the deformed rocks as a guide to their history. This is surprising, because one of the most striking features of the whole district, especially around the Alaska Juneau mine, is the presence of numerous folded quartz veins, quartz rods, boudined* quartz veins, and minor folds and crenulations in black phyllite. Around the Alaska Juneau these features are, with occasional exceptions, approximately parallel to one another, plunging SE 25 to 60 degrees. In addition, the outcrops of metagabbro, as mapped by Wernecke (1932 fig. 1) have a synclinal pattern except for isolated lenses and numerous interfingered contacts with black phyllite. This syncline, as exposed in mining operations, plunges about 41 degrees SE. The minor complexities of structure are typical of plastically deformed rocks mapped elsewhere in the world. The mine area is an excellent example of plastically deformed major folds with minor structures and ore paralleling the major folds.

In the extension of the Juneau Gold Belt north of Juneau in the Eagle River district, Knopf (1912) in describing the gneiss, which he considered to be a deformed igneous rock, states: "On the east side of Berners Bay, where the exposures are good and easily accessible, the gneiss encloses, for thousands of feet from the contact, vast numbers of rock fragments and detached masses of stratified sediments. It is worthy of note that all such detached masses of original country rock, wherever found in the gneiss, are oriented parallel to the prevailing structure, and that where they show crumpling, the crumpling is conformable to the wrinkled foliation of the enclosing gneiss". Just north of Juneau, Forbes (1959) has mapped a section across the Coast Range which shows progressively increasing grades of metamorphism eastward. Layers of gneiss occur in the medium grade schist and increase in amount eastward. Compositional layering and schistosity in the gneiss and enclosing schist are parallel, and contacts are gradational. Forbes believes that this gneiss is schist which has been tranformed as a result of introduction of Na, SiO_2 and minor K during late and post-kinematic time. Forbes found two directions of folding. The dominant folds trend NW or N, overturned to the SW and their plunge varies from NW to SE in different areas, indicating major culminations and depressions of the fold axes. Only minor folds were seen in the second set. These folds are open and upright with their axes trending NE to E down the dip of the major folds. Forbes correlates these folds with the major culminations and depressions of the NE fold axes and for this reason considers the NE folds to be the older of the two.

* boudin - a sausage shaped structure often present in quartz and other competent beds caused by stretching. In cross section, boudined bed resembles a string of lenticular beads.


GEOLOGIC MAP OF PART OF THE
NE SHORE OF ENDICOTT & TRACY ARMS
0 1 2 3 MILES
1963
SURFICIAL DEPOSITS
BLACK SLATY PHYLLITE (BP) & GREEN PHYLLITE (GP)
AMPHIBOLITE WITH INTERBEDDED LIMESTONE
SCHISTOSE BIOTITE QUARTZITE
QUARTZ-BIOTITE SCHIST
GREENSTONE SCHIST
QUARTZ DIORITE
FOLIATION- INCLINED, VERTICAL
ARROWS SHOW TREND & PLUNGE OF MINOR FOLDS, CRENULATIONS, OR QUARTZ RODS (QR)
JOINTS- INCLINED, VERTICAL
INFERRED ANTICLINE
N
TRACY
ARM
AM
BQ
POWERS CR.
ENDICOTT
ARM
FARMER CR.
PORTLAND GROUP
USGS 1:63,360 TOPOGRAPHIC BASE MAP
AERIAL PHOTO BASE MAP
TRACE OF FOLD FROM PHOTO.
BIG BIGHT
FORDS TERROR
JUNEAU 35 MILES
STEPHENS
TRACY ARM
PT. ASTLEY
PASSAGE
PROSPECT
ENDICOTT ARM
FORDS TERROR
INDEX MAP
10 MILES
GORDON HERREID, GEOLOGIST

Scope of This Report

Field work done during the summer of 1962 consisted of traverses along the shore line in three accessible areas which crosscut the Coast Range mineral belt: Tracy Arm, Endicott Arm, and the north shore of Taku Inlet. In addition, a traverse was mapped in less detail along the Gastineau Peak-Mt. Roberts ridge and several days were spent in the vicinity of the old Perseverance shaft at the head of Gold Creek. The object of these scattered traverses was to investigate and map the structure and metamorphism of the marginal belt as a background for mine and areal mapping. Two known but unmapped prospects in the Endicott Arm-Tracy Arm area were mapped and assayed. The somewhat scattered observations on the Alaska Juneau property were hampered by snow cover until late in the season and lack of an adequate base map, but some conclusions were drawn. This is a preliminary report, mainly on the structural aspects of the field mapping. A later report will incorporate the results of further compilation and microscope work.

Large fold structures can only occasionally be mapped in the area due to cover, lack of distinctive rock types, and shearing of the fold hinges. For this reason, minor folds assume a great importance when they parallel the major folds as they do in the Coast Range mineral belt. My emphasis in areal mapping has been on rock type and matamorphic grade, minor structures, the behavior of quartz veins, and assay or geochemical sampling for Au, Ag, Cu, Pb and Zn. The latter was mainly done by William Race, State Mining Engineer.

Endicott Arm-Tracy Arm Area

General Statement

Rocks exposed in the tidal zone were mapped along the NE shore in Endicott Arm and Tracy Arm. (Map 1 and fig. 2 and 3) The terrain crossed by this traverse is a belt of metamorphosed sediments whose metamorphism increases from phyllite on the SW to quartz biotite gneiss on the NE, in contact with the slightly foliated quartz diorite of the Coast Range batholith. This area contains two known copper-zinc sulfide ore bodies: the Neglected Prize, which was visited, and the Sumdum Chief, which was not visited. The Portland Group property was visited and mapped, but turned out to be devoid of economic metal values.

The rocks, at distances of about one and one-quarter miles SW of the quartz diorite, are all phyllitic except for limy amphibolite on Tracy Arm and scattered beds of recrystallized limestone. Unoriented (i.e. post-kinematic) plates of biotite are present in a restricted area west of the Big Bight but otherwise biotite occurs only as oriented (syn-kinematic) plates which increase irregularly in amount as the quartz diorite is approached. Similarly, banding of the rock gradually becomes more prominent due to the increase in quartz layering parallel to the foliation. With this increasing segregation of the minerals into dark, biotite-rich and light, quartz-rich bands, the phyllite grades, via quartz biotite schist, into quartz biotite gneiss. The foliation of the gneiss is parallel to that of the phyllite.

The phyllitic rocks contain cremulations and minor folds (L-1), with shallow to moderate plunges, which were formed during the major deformation in the region. In the biotite zone, particularly near the intrusives, these moderately plunging minor folds are missing, and steeply plunging, more highly contorted, minor folds (L-2) are present. No folded folds that would conclusively date one of the fold directions as earlier than the other were found. This steep L-2 fold direction usually shows up as crenulations or minor folds only, which may be present in the same outcrop with moderately plunging folds. The L-2 folds mainly occur in the gneissic areas, and increase in intensity near the gneiss-quartz diorite contacts. They are cut off sharply without deformation at the contact of the folded gneiss with the massive more-or-less directionless quartz diorite. L-2 folding must be pre-quartz diorite in age. I consider L-2 folds to have developed during the formation of the gneiss. They are older than the moderately plunging (L-1) folds which formed during the primary folding of the region. In the phyllite, particularly as the biotite zone is approached, both L-1 folds and L-2 crenulations may be present in the same outcrop.

Quartz veins are fairly common in the map area, particularly in the quartz-biotite schist and gneiss areas near the quartz diorite. Quartz veins occur sporadically in the phyllite, mainly parallel or nearly parallel to the foliation as lenses, folded veins, and rods, whose long axes are mostly parallel to L-1 folds and crenulations. However, in several areas, rather steep quartz rods occur. All of the rocks in the area are cut by nearly vertical NE striking cross joints, which in many places carry quartz veins up to a few 10's of feet long and a few inches wide. Sparse pyrite was associated with some of the quartz veins, but for the most part they appear quite barren of sulfides to the eye.

Rock Types

The metamorphic rocks in the area are of sedimentary origin except for a few pre-tectonic basic dikes. Most of the phyllite is black slaty, green chloritic, or banded limy fine grained rock with lustrous foliation surfaces, which, in many localities are crenulated. The limy phyllite commonly has intricate folds of a few inches amplitude. It is often associated with massive limestone layers which may be up to 50 feet wide, but due to deformation, have little continuity along the strike. On Tracy Arm, amphibolite associated with folded limestone layers appears to be a metamorphosed impure limy rock. Phyllitic quartzite is also interbedded with the phyllite and amphibolite.

The original sediments were aluminous, tuffaceous, and limy shale interbedded with limestone and argillaceous quartzite. No fossils were found, nor could they be expected in these deformed rocks. Buddington and Chapin (1929 pl.1) mapped the area as "probably Ordovician to Jurassic or later". Dutro and Paine (1957) show it as Triassic to Lower Cretaceous on the Geologic map of Alaska.

Quartz biotite schist and gneiss have formed by metamorphic segregation of the phyllite into quartzose and biotite layers up to ½ inch thick. Garnet is sporadically present in this rock, its first appearance corresponding roughly with that of biotite. Whether the formation of the gneiss was due to additions and subtractions of material on a significant scale from an original phyllite is unknown. Layering is more prominent and the grain size is larger in the gneiss along the borders of the massive quartz diorite, but the contacts between the two rocks are sharp with no deformation of minor structures in the gneiss. Lenticular inclusions and septa of metamorphic rock are common in the quartz diorite. Their orientations are parallel with the regional trend of foliation in the gneiss.

Fold Structures

The foliated metasediments which underlie the map area contain no extensive changes in strike and dip which would indicate clearly that large folds are present. In most of the map area, the foliation, which is due to the alignment of platy minerals, parallels the compositional layering which represents the bedding of the original sediments. The beds strike NW and dip steeply NE or SW. Sporadically throughout the area, isoclinal folds, with amplitudes from a few inches to a few feet, are present in the otherwise planar foliation. Small crenulations in phyllitic surfaces are more widespread. These folds on various scales are, for the most part, approximately parallel to one another, or can be subdivided into two mutually parallel groups. Over a distance of several miles the moderately plunging folds (L-1) gradually change their plunges. This is best illustrated in the area from Farmer Creek to Fords Terror. In the area on either side of Big Bight, the sense of minor folding is S-shaped on NE-dipping beds from the greenstone to just west of the Big Bight contact, and Z-shaped further west on SW-dipping beds indicating "up-east" and "up-west" movements. The area of change from Z to S contains beds much folded on a small scale, whose overall attitude is nearly flat with a slight NW dip. These relations indicate that these are "drag folds" on the flanks of an upright, appressed anticline. This is further confirmed by the presence of gray limestone on the NE limb in the Big Bight and on the SW limb on the point ½ mile to the west. At the Perseverance mine on the Alaska Juneau property, the large fold that is exposed is likewise a mass of small folds in the hinge area and quite planar on the flanks.

This consistency of minor structures on the "Big Bight" "Anticline" and the regional consistency of L-1 folds are the only evidence in the map area that minor folding mirrors major structures. The only direct evidence that major structures exist at all is the clear outline of a fold visible on the air photo 2 miles north of Big Bight. This has been traced on the map. (Map 1) The area has not been visited. Folds have been reported by Sainsbury (1957) and Forbes (1959) in the same belt in the Juneau area and, as mentioned above, a well-exposed fold is visible on the Alaska Juneau property, with well-exposed minor structures paralleling the large fold.

The minor folds in phyllitic rocks are commonly local "kinks" of a few inches amplitude in the beds. The micaceous surfaces of the phyllite are crenulated with small wrinkles of an amplitude of less than 1 mm. Thin (less than 1 mm. thick) white quartz layers, parallel to the foliation, are very often present in the folded beds and are folded along with them. The quartz is recrystallized to a granular aggregate and generally thickens in fold hinges. Cleavage usually does not cut through the hinges, indicating that folding is by bedding plane slip rather than differential shear along cleavage planes. The hinges of major folds are areas of much minor folding. The principal style of folding in the phyllite zone appears to be appressed folds accompanied by bedding plane slips which are upright or slightly overturned to the SW. However, in some areas the cleavage parallel to the axial planes of the L-1 folds does cut through the fold hinges, cutting the composition (bedding) layers into thin slices. It is possible that unrecognized shearing of fold hinges has obliterated many of the folds in the map area.

The steep (L-2) folding occurs most prominently on either side of the quartz diorite sill on Tracy Arm. The gneiss is made up of a mosaic of quartz grains with only scattered oriented platy minerals. Continuous layers of platy minerals are not present as in the phyllite and oriented trains of biotite take the place of crenulations as the chief linear element where minor folds are absent. This L-2 lineation is ubiquitous between the batholith and the quartz diorite sill on Tracy Arm. Cleavage has not played a role in the minor folding present in these rocks. The L-2 minor folds present in the gneiss on Tracy Arm and on Taku Inlet give the appearance of having formed under more plastic conditions than the L-1 folds in the phyllite. Entire areas are made up of a mass of tight steeply-plunging folds with no axial plane cleavage present.

The only L-2 folds found outside the gneiss occur in rather massive phyllitic quartzite on Tracy Arm. These folds plunge 79 degrees SE and have an amplitude of several 10's of feet. In another band of similar rock ¼ mile to the south, L-2 lineations occur. This quartzite occurs as layers in amphibolite, and it is quite possible that microscopic investigation will indicate that this area is of higher metamorphic grade than the phyllite. In other areas the L-2 folding occurs nearer the quartz diorite in rocks of higher metamorphic grade than the phyllite.

Quartz Veins

The quartz veins in all of the Endicott Arm-Tracy Arm area can be subdivided into three distinct classes: 1. Exsolution quartz veins: sugar quartz veinlets from a fraction of an inch to a few inches long and a fraction of an inch wide which are strictly parallel to the foliation and probably originated by exsolution from the adjacent country rock. 2. Tectonized veins of sugar quartz consisting of bunches of quartz lenses, rodded and boudined quartz, and folded quartz veins: most of these quartz bodies cut the foliation, often at only a slight angle. 3. Quartz veins occupying cross joints.

Exsolution Quartz Veins. Glassy crystalline quartz veinlets are common in the quartz-biotite gneiss area on Tracy Arm. These veins are lenticular, generally ½ inch or less wide and from a fraction of an inch to several feet long, and they invariably parallel the banding of the rock. They may occur in either the biotitic or the quartz-rich layers. It seems likely that the quartz in these veins has exsolved from the country rock into open spaces.

Tectonized Quartz Veins. Tabular quartz veins which crosscut the phyllite at high angles may contain a few or many simple folds. Often much-deformed quartz veins which occur as crests and troughs of fold hinges, with their limbs sheared out, are present in the rock, along with later less-folded crosscutting veins in the same horizon, indicating differential deformation of quartz veins of different ages. At one locality on Tracy Arm, an isolated quartz lens parallel to the foliation of the phyllite is on strike with a folded quartz vein, like a question mark with a lenticular period. In a nearby area, a quartz vein that parallels the foliation of the phyllite is pulled out into a series of lenses (boudins) like a string of beads. Most of the quartz veins in the Tracy Arm - Endicott Arm area are lenticular and parallel or nearly parallel to the foliation of the country rock. Often a series of such lenses are arranged en echelon, each parallel to the phyllite and slightly offset from the one beyond as if the group had originally been a single crosscutting vein which had been sheared into lenticular segments. Lenticular quartz and folded quartz veins are commonly surrounded by crenulations, and less commonly minor folds, in the adjacent phyllite, which often is planar and devoid of such structures at a distance from the quartz. These deformed quartz veins, where seen in three dimensions are elongated, with their long axes generally parallel to the associated fold structures in the phyllite. The deformed appearance of the quartz and its close association with minor fold structures in the phyllite is the result of post-quartz vein slip or stretching along the phyllite layers.

Another indication of the tectonic origin of deformed-looking quartz is given by its mode of occurrence in relatively unmineralized areas. Along the coast of Endicott Arm, south of Powers Creek, the phyllite mostly contains little visible quartz. At intervals of a few hundred feet, there are areas several feet across which contain veins, lenses, disconnected hinges and irregular crosscutting bodies of white quartz. This quartz does not occur rather evenly scattered in layers as in the gneiss zone, nor is it restricted to fold hinges, where it could be due to exsolution. The quartz appears to be due to the deformation of scattered quartz veins which were emplaced before or during folding of the phyllite. In many areas, particularly around the Alaska Juneau deposit, it was noted that quartz and deformation appear to be linked in origin. The vein quartz bearing areas have been deformed while others have not, as if the quartz acted as a lubricant. Possibly, deformation of the veins was facilitated by recrystallization into sugar quartz at the time of folding.

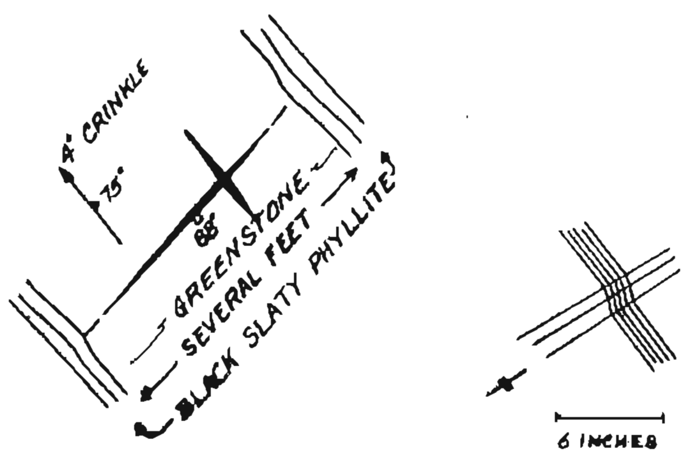
Often more-or-less tabular quartz veins are folded back on themselves so as to make a knot. Examples of different stages of this type of deformation show that the fold becomes compressed and the limbs sheared out to form an irregular lens, often containing swirls of phyllite. The long axes of these quartz rods are parallel to the original fold. It is not always possible to discriminate between these structures and the boudins, which are due to stretching, but they are both syntectonic structures with their long axes approximately parallel to the minor fold axes and crenulations in the enclosing rocks. Both structures indicate deformation after vein emplacement.

Study of these structures is hampered by the difficulty of determining the plunges of the folds and lenticular structures in the quartz veins. For the most part, the long axes of quartz structures are approximately parallel to L-1 folds, but in a few phyllite areas, steeply plunging quartz rods and lenses are present. These steep structures are intermediate in plunge between L-1 folding of the phyllite and L-2 folding of the gneiss.

There can be little doubt that sinusoidal folds in a tabular crosscutting vein are due to folding of pre-existing veins. In the more deformed quartz which occurs as boudins, rods, and complexly folded veins, selective replacement of early tectonic structures by later quartz has been suggested. Wayland (1960, p. 272) states that "The apparent folding of some early quartz veins in phyllites is due to selective replacement of shear folded beds." However, many of these folded beds lie in phyllite whose folding has been obliterated so that only axial plane cleavage remains. There has been nothing left to guide replacement into these complex fold forms. In addition, the axes of these folded quartz veins are commonly parallel to the crenulations in the enclosing phyllite and to the major and minor folds.

In any one deformed-looking quartz body replacement may be ruled out, but the general relations of folded, rodded and boudined quartz with folds and crenulations in adjacent quartz and wall rock indicates a tectonic origin.

Quartz Filled Cross Joints. The sketch shows a typical quartz filled cross joint. These veins are generally near vertical and strike NE, and typically crosscut a relatively competent bed. The slight "sucking in" of the bedding at the ends is very common and indicates a stretching of the country rock perpendicular to the vein. The joints usually extend beyond the ends of the quartz filling. Occasionally they change to kink bands beyond the end of the quartz. These quartz veins are post-tectonic and younger than the tectonized quartz lenses which they cut with sharp contacts. These crosscutting veins are invariably flat-lenticular in shape and range in length from less than an inch to 20 or 30 feet in strike length. In one exposure, quartz veinlets 3/4" long x 3/16" wide crosscut a 3" quartzite layer with streaked phyllite on either side. The quartz veins do not extend into the phyllite, and at their ends grade out into the quartzite. These veinlets appear to be exsolved from the quartzite. It seems likely that the larger crosscutting quartz veins have a similar origin.



CROSS JOINT   KINK BAND

FIGURE 1

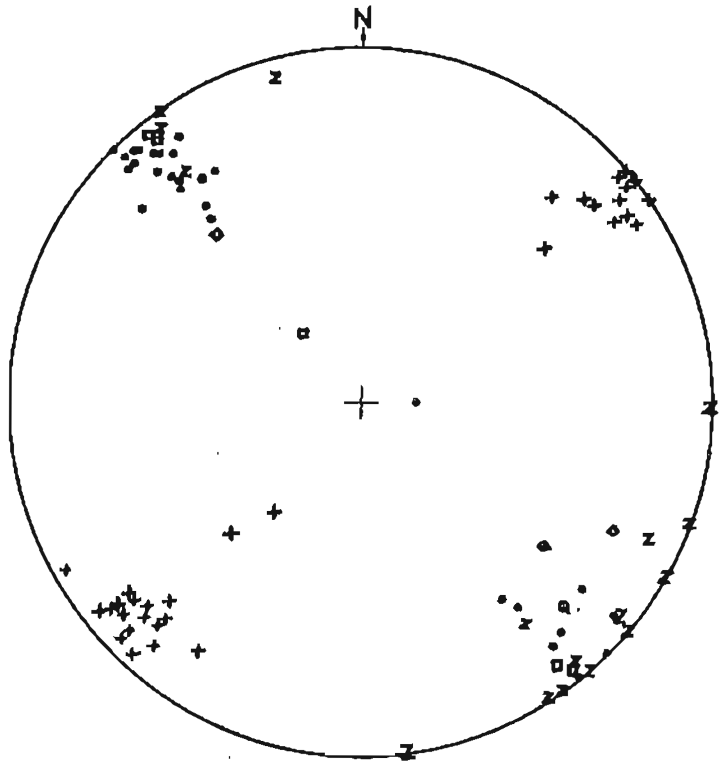


FIGURE 2

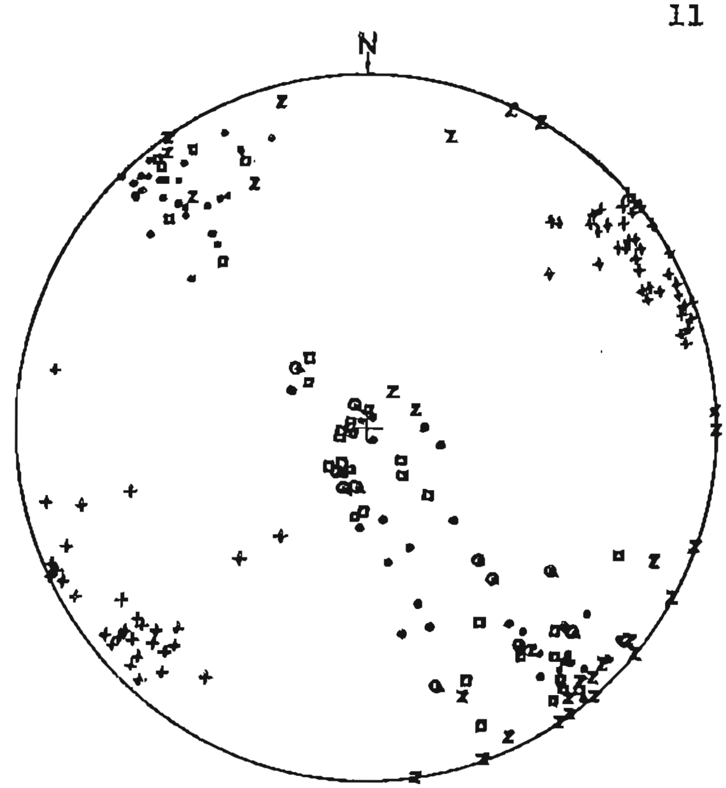


FIGURE 3

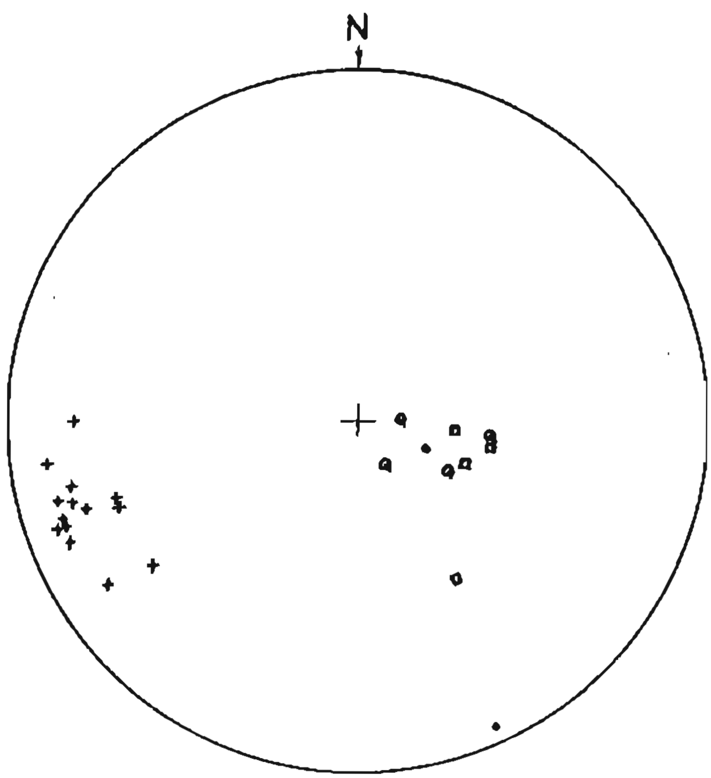


FIGURE 4

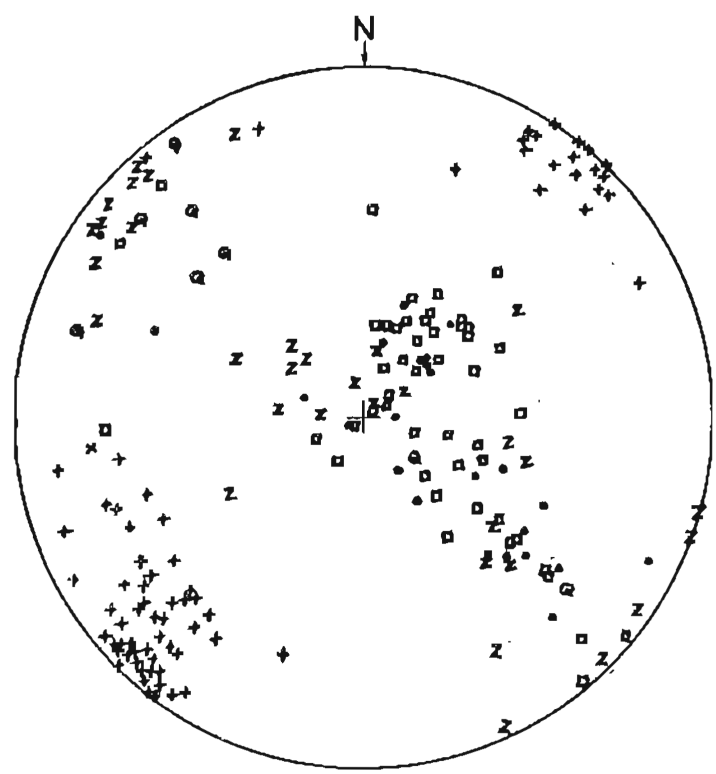


FIGURE 5

EQUAL AREA STEREOGRAPHIC PLOTS OF STRUCTURAL DATA

- • MINOR FOLD
- ◻ CRENULATION
- Q QUARTZ BOUDIN OR ROD
- + POLE OF FOLIATION OR BEDDING
- Z POLE OF JOINT

FIGURE 2 BIG BIGHT AREA OF ENDICOTT ARM
FIGURE 3 ENDICOTT-TRACY ARM MAP AREA
FIGURE 4 POINT ASTLEY PROSPECT AREA
FIGURE 5 TAKU INLET MAP AREA

Structural Synthesis

Evidence has been given to show that two general orientations of minor folds are present--early moderately plunging folds (L-1) which parallel the major folds and later steeply plunging folds (L-2). These relations can be graphically shown by plotting the structural data on a stereographic net. The plot of lineations and the poles of foliations mapped in the vicinity of Big Bight on Endicott Arm (Fig. 2) shows that fold and crenulation axes trend N40W with plunges averaging about horizontal. Foliation averages about N40W strike with vertical dip. The pattern of fold orientations on the geologic map (Map 1) suggests that the scatter of fold axes along their line of trend on the plot is due to culminations and depressions of the major fold axes along their strike. Because of the isoclinal nature of the folding most foliation attitudes in the map area are steep and the foliation poles are concentrated at the edges of the plot, with only slight scatter across the plot. The rare fold hinge areas where flat dips occur contain numerous minor folds which make meaningful foliation attitudes difficult to measure.

On Figure 3, all the structural data taken in the Endicott Arm-Tracy Arm area are plotted. This plot is much like Figure 2 except for the scattering of fold and crenulation axes across the center of the plot, due to the L-2 and intermediate axes. This pattern could be caused by folding of pre-existing NE-trending fold axes and quartz rods and boudins about a later NW-trending axis. Or the pattern could be the result of steep folding in the near vertical limbs of NW-trending folds. The second explanation is favored because the steep folding occurs mainly in rocks of higher metamorphic grade and not in the easily folded phyllite. Figure 3 indicates that the dominant joint orientation is N45E with a steep NW dip. This is in agreement with the finding of Gault and Fellows (1953, Fig. 2).

Tectonic Analysis

The NW trending folds are the dominant structure in the map area. This deformation was the result of a NE directed stress and was accompanied by metamorphism as shown by the preferred orientation, relative to the fold structure, of syn-kinematic biotite and other minerals. These NW folds are vertical, isoclinal, and are accompanied by minor drag folds with axes parallel to the major fold axes.

Along the NE side of the metamorphic belt, adjacent to the not yet intruded quartz diorite, the metamorphic grade was higher and gneiss formed and was folded on a small scale about steep axes. There is no sign of large steep folds and the minor folds and biotite lineations may be the result of a couple, sense unknown, acting in a horizontal direction (i.e. wrench movement) to produce a zone of shear movement when the rocks were plastic due to their high temperature. After the formation of these minor structures the quartz diorite was emplaced in some manner that produced sharp contacts without deformation of the lineation and lamination of the gneiss.

Subsequently, a dominant joint set formed, which is statistically approximately perpendicular to the NW fold axes but does not change with the oscillation of the minor folds, NW and SE. These joints represent planes of low pressure, as is shown by their quartz fillings, and according to the theory of the strain ellipsoid should be parallel to the direction of maximum stress. Thus, they may be a product of stress oriented in the same direction as that responsible for the NW folding. The change of structure from major folds to joints would be caused by the stiffening of the rocks due to steep folding and lowering of temperature. These joints are late, as they cut quartz diorite, gneiss, and phyllite, but the temperature was still high enough for quartz mobility and consequent vein formation.

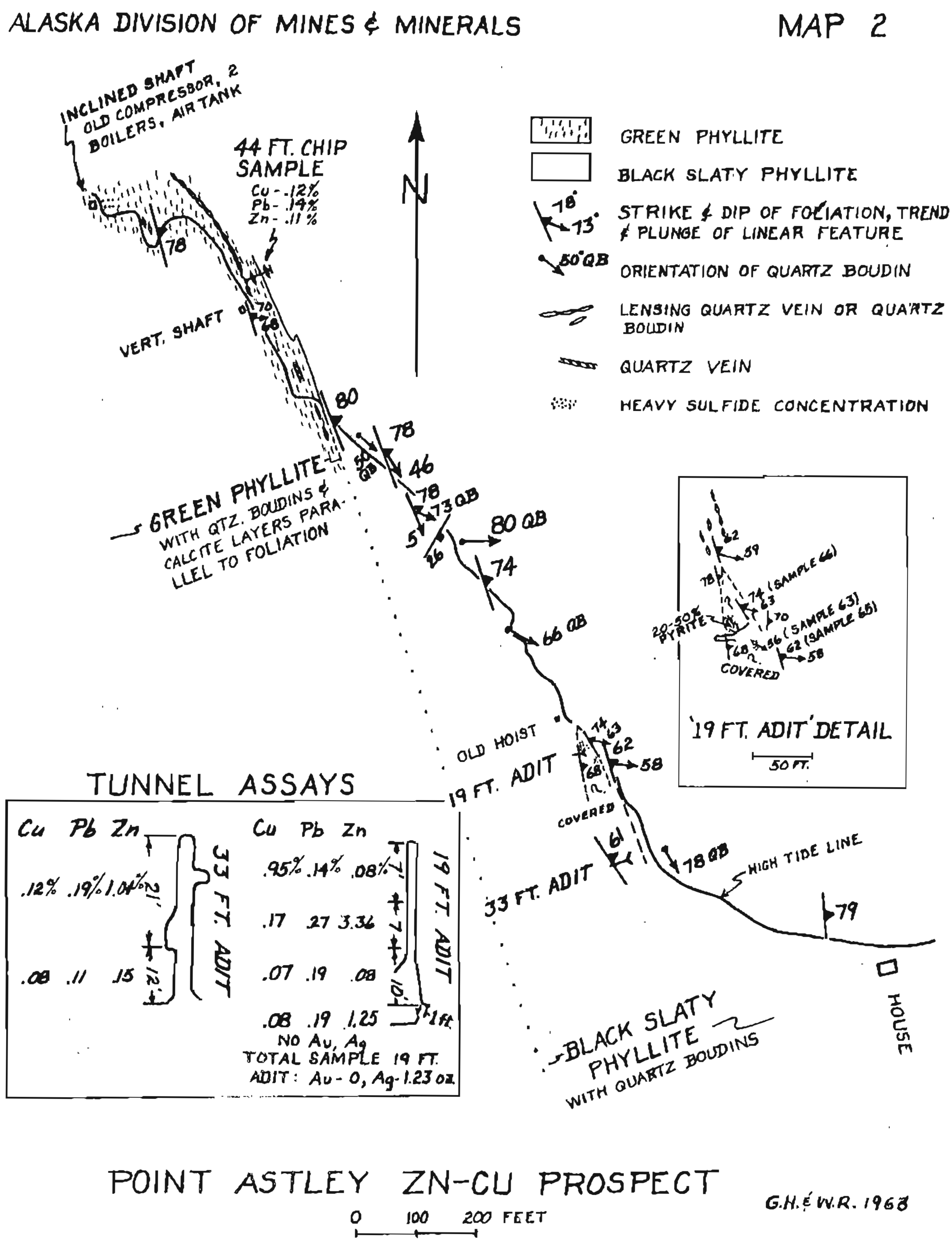
The steep plunging (L-2) minor folds formed after the main period of folding and before formation of the cross joints. They may represent the response of the steep dipping plastic gneiss to the same SW-directed stress that formed the major folds. Once the folded beds of the metamorphic belt beds were nearly perpendicular to the deforming stress, they would resist further folding. If the direction of deforming stress were not exactly perpendicular to the near vertical hot plastic zone in the interior of the metamorphic belt, a couple might result which could fold the rocks of the plastic zone about steep axes. Other linear zones of weakness along the Coast Range belt could behave in the same manner. Point Astley may represent such a zone.

Copper Zinc Prospect at Point Astley

This property is the same as described by Spencer (1906, p. 45) as the Oceanic Group of claims. The prospect is shown on the U.S.G.S. Sumdum C-5 1:63,360 quadrangle map on the beach one mile SE of Point Astley. (See also index map on Map 1.) Two adits, two flooded shafts, some old mining machinery, and a habitable building remain from the early work. Concerning the geology, Spencer states that "irregularly distributed along the schistosity of this country rock there has been an introduction of sulfides,accompanied by quartz and calcite, with no apparent channels to which the metalliferous solutions were confined. This sort of filling has produced a mineral belt a few hundred feet in width and several hundred feet in length, within which occasional seams rich in silver and copper are encountered."

The mineralized zone was mapped and sampled in two adits and along the tidal zone where it is well exposed. (Map 2 & Fig. 4) William Race, State Mining Engineer, did the assay sampling and took geochemical samples in the area. (See following report) The deposits occur in the vicinity of a contact between green chloritic phyllite and black slaty phyllite. The chloritic phyllite contains quartz and carbonate boudins and rods. It is strongly lineated by this rodding and by crenulations on the phyllitic surface. The black slaty phyllite contains faint, moderately plunging, crenulations and numerous rodded and boudined quartz veins. All or almost all of the quartz veining is pre-tectonic, as shown by lenticular outcrops. Where exposures allow a look at the third dimension, this quartz proved to be elongated into rods and boudins whose long axes are parallel to one another and to many of the crenulations in the wall rocks. The sulfides appear to take part in these structures and, therefore, are probably pre-tectonic also. Pyrite and ore minerals are concentrated in two localities. The northern-most lies in the hangingwall of a 2 foot wide zone consisting of about 70% irregular masses and lenses of quartz in greenstone schist. Fibrous amphibole subparallel with the lineation of the wall rock is disseminated along this zone. A chip sample taken over the entire width (44 feet) of the disseminated pyrite zone in the hangingwall of the quartz assayed 0.37% total Cu, Pb, Zn. This is the most mineralized zone in the northern area.

The southern-most ore zone is exposed on the shore and in two short adits. This area was strongly lineated with an average easterly plunge of 59°. Lineations consist mainly of prominent crenulations, but one irregular fold, made up of quartz and sulfide, plunges SE 56°. There are no crosscutting sulfide or quartz veins. The whole sulfide-quartz zone (outlined on the map) has the appearance of a large tectonic lens. It seems likely that this lens is actually a tectonic prism that plunges steeply eastward, parallel to its minor structures.


ALASKA DIVISION OF MINES & MINERALS
MAP 2
GREEN PHYLLITE
BLACK SLATY PHYLLITE
STRIKE & DIP OF FOLIATION, TREND & PLUNGE OF LINEAR FEATURE
ORIENTATION OF QUARTZ BOUDIN
LENSING QUARTZ VEIN OR QUARTZ BOUDIN
QUARTZ VEIN
HEAVY SULFIDE CONCENTRATION
INCLINED SHAFT OLD COMPRESSOR, 2 BOILERS, AIR TANK
44 FT. CHIP SAMPLE
Cu - .12%
Pb - .14%
Zn - .11%
N
VERT. SHAFT
GREEN PHYLLITE WITH QTZ. BOUDINS & CALCITE LAYERS PARALLEL TO FOLIATION
80 QB
66 QB
20-50% PYRITE
COVERED
(SAMPLE 66)
(SAMPLE 63)
(SAMPLE 65)
19 FT. ADIT DETAIL
50 FT.
OLD HOIST
19 FT. ADIT
COVERED
33 FT. ADIT
78 QB
HIGH TIDE LINE
HOUSE
TUNNEL ASSAYS
Cu Pb Zn
.12% .19% 1.04% 21'
.08 .11 .15 12'
33 FT. ADIT
Cu Pb Zn
.95% .14% .08% 7'
.17 .27 3.36 7'
.07 .19 .08 10'
.08 .19 1.25 1 ft.
NO Au, Ag
TOTAL SAMPLE 19 FT. ADIT: Au - 0, Ag - 1.23 oz.
19 FT. ADIT
BLACK SLATY PHYLLITE WITH QUARTZ BOUDINS
POINT ASTLEY ZN-CU PROSPECT
0 100 200 FEET
G.H. & W.R. 1968

A large amount of deformed quartz is visible in the country rock exposed along the shore just east of the old building, but little sulfide is present. With this exception, the area mapped contains the only observed significant amount of quartz and indications of mineralization between Point Astley (proper) and the next point, about a mile to the east. At V.A. Bench Mark "Holk" shown on the quadrangle map ½ mile east of Point Astley, a sheared conglomerate with ellipsoidal clasts occurs. The long dimensions of the ellipsoids plunge steeply.

The following statement is made by Buddington and Chapin (1929 p. 291): "A highly mashed overthrust fault zone is indicated by the cataclastic texture of the rocks in a belt on the mainland adjacent to Stephens Passage from Point Houghton north to Point Astley and to the northwest.....". The authors may be referring to this conglomerate or to the Point Astley prospect.

It seems likely that the structure at the Point Astley prospect may be the result of sub-horizontal shear movements similar to those that formed the steep lineation along the edge of the batholith in the Tracy Arm-Endicott Arm area. The extensions of this zone along the strike may be a structure favorable for ore deposits.

Portland Group Prospect

Early work on the Portland Group is briefly mentioned by Spencer (1906, p.45) as follows:

"Close to the shore on the north side of Endicott Arm opposite Sumdum, numerous claims have been located upon a wide belt of mineralized rock belonging to the schist belt which lies adjacent to the Coast Range diorite. The ore bodies consist of siliceous schists carrying disseminated sulfides and stringers of quartz and calcite which fill openings along the schistosity. The zone of mineralization follows the strike of the schists and with an average width of nearly 1,000 feet is traceable for a mile or more along their outcrop. The ores are gold-bearing pyrite, galena, and sphalerite and are reported to assay from $0.50 to $3 per ton. A crosscut tunnel 180 feet in length and a few open cuts expose the mineralized rock, but how much of this will eventually prove to be minable can be determined only by more development work and careful sampling."

Two adits of the Portland Group were mapped (Map 3) and chip samples were taken for the full length of the workings by William Race, State Mining Engineer. The results of this examination are shown on the accompanying map. The bedrock in the adits consisted of dark slaty phyllite with numerous lenticular quartz veins and light colored quartzose phyllite with quartz layers. No crosscutting quartz veins are present and visible mineralization is restricted to sporadic cubes and a few seams of pyrite. All of the quartz is pre-tectonic and it seems likely that this area has little more mineralization than the average bedrock in the region. The assays give a useful sample of the trace metal content of unweathered country rock.

Neglected Prize Prospect

A U.S. Geological Survey report on this property by Gault and Fellows (1953) gives detailed and regional geologic maps and assays. These authors estimate the reserves to be 400 tons per vertical foot for a vein 4.8 feet wide and 830 feet long carrying 3.2% Zn, 1.5% Cu, 0.013 oz. Au and 0.75 oz. Ag. Other lower grade veins are reported in the vicinity. The deposit was visited for one day, but not

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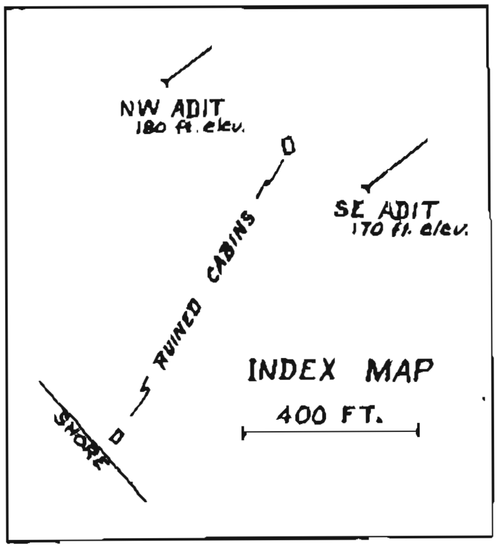
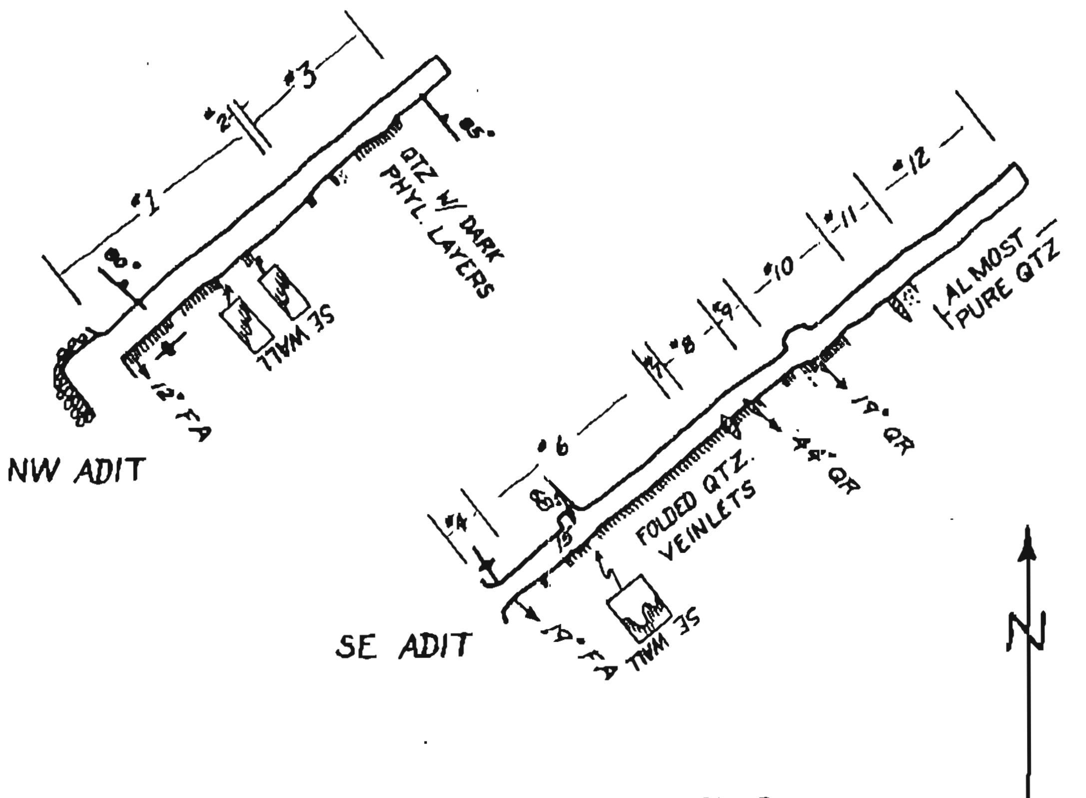
MAP 3



ASSAYS

	Au	Ag	Cu	Pb	Zn
#1	T	0	.22%	.15%	.17%
#2	0	0	T	.18	.10
#3	T	T	0	.11	.13
#4	T	0	0	.23	.16
#6	T	0	0	.21	.14
#7	T	0	.07	.19	.09
#8	T	0	.09	.21	.15
#9	T	0	T	.17	.22
#10	T	0	.12	.16	.52
#11	T	0	.37	.16	.23
#12	T	0	.40	.18	.23



PORTLAND GROUP

50 FT.

G.H. & W.R. 1963

- DARK PHYLLITE WITH QUARTZ LAYERS
- QUARTZOSE PHYLLITE
- PYRITE
- FOLIATION
- PLUNGE OF FOLD AXIS (FA) OR QUARTZ ROD (QR)

remapped. It is evident from the maps and from outcrops along the vein that steep lineations predominate in this area, just as they do along the shoreline on strike to the NW. The deposit appears to have formed during the period of L-2 folding and shearing of the gneiss, as the sulfides appear to conform to the rock structures. It seems likely that the long axes of this deposit is steep, parallel to the minor structures.

Taku Inlet

A section across the metamorphic belt was mapped along the north shore of Taku Inlet (Map 4 & Fig. 5). This work will be described only briefly as the main features of the geology are similar to those in the Endicott Arm-Tracy Arm area. The rocks at Point Bishop are andesitic volcanics with amygdaloidal flow tops facing NE. These are interbedded with the overlying dark phyllites of the Perseverance slate. No large structures have been detected in this slate, but moderately plunging L-1 minor folds and crenulations are common. These are more erratic than in the Endicott-Tracy Arm area, but mainly plunge SE. In some rocks, minor structures plunge both SE and NW in the same outcrop. As the quartz diorite is approached across the phyllite, first biotite and then red garnet occurs, indicating an increase in the metamorphic grade. Some of these garnets have been rolled, indicating that folding with consequent bedding plane slip has continued after the formation of the garnet. The biotite is oriented parallel to the foliation of the schist and is therefore syn-tectonic also.

Toward the NE, the biotite schist grades into gneiss with the gradual increase in metamorphic differentiation of the rocks into quartz and biotite rich layers. Steep plunging (L-2) minor folds predominate in the gneiss, but are also found locally in the biotite schist. The quartz diorite contains quartz hinges, basic inclusions and lineations formed of trains of biotite crystals that parallel the structures of the metamorphic rocks. In some areas in the quartz diorite, lenticular quartz augen contains red garnets.

Folded, boudined, and rodded quartz veins similar to those described in the Endicott-Tracy Arm area occur in the phyllite, schist, gneiss and locally as relict structures in the quartz diorite. In addition two quartz stringer zones, about 150 feet apart, occur in the phyllite; these veins are surrounded by biotite hornfels. At one of the localities, the zone is about 20 feet wide; the main stringers strike about parallel to the foliation of the phyllite but dip 60° SE, across it; between the main stringers, the hornfels is cut by numerous irregular quartz veinlets, many of which are bordered by biotite. A chip sample across the zone gave nil Au and Ag. Crenulations in the wall rocks plunge moderately SE. Typical steep NE striking joints cut the veins and do not contain quartz. The stringer zones represent quartz emplaced after folding and before formation of joints.

Three conspicuously rusty stained zones, totaling over ½ mile in width occur at and on either side of Cooper Point. The bedrock in these areas is pyrrhotite-bearing quartzose schist. One-fifth of a mile north of Cooper Point, the schist is cut by parallel and crosscutting quartz veins with greater than average amounts of disseminated pyrrhotite in the adjacent country rock. A sample of the sulfide-bearing rock ran 0.02 oz. Au, nil Ag, per ton. This rock appears to be a metamorphosed impure quartz sandstone, similar in original rock type to the quartz-biotite rock 1½ miles SW of Cooper Point and to the phyllitic quartzite in the core of the fold near the old Perseverance shaft at the Alaska Juneau mine. The rock between these quartzose areas is derived from black slate.

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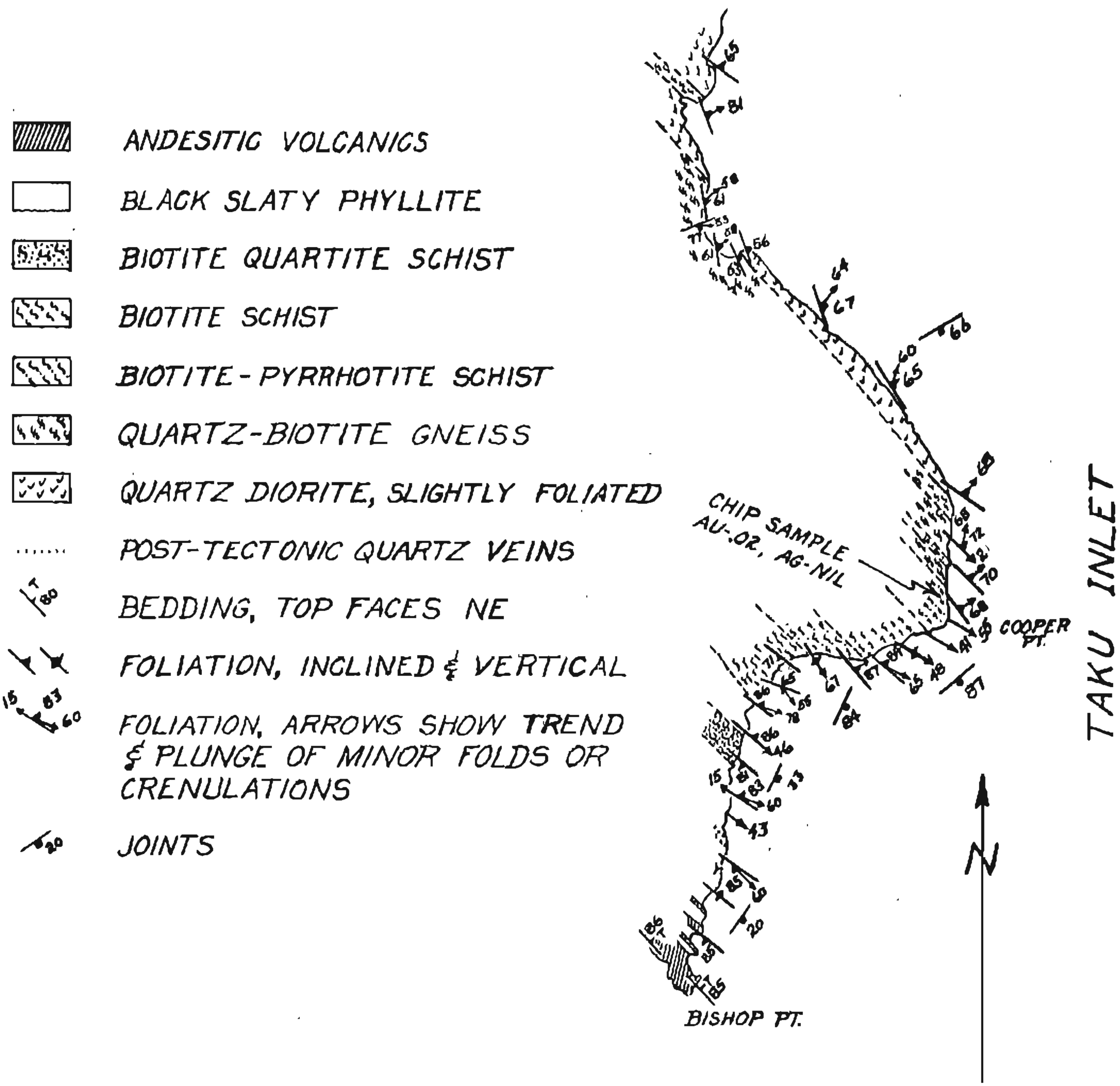
MAP 4



GEOLOGIC MAP OF PART OF NORTWEST SHORE OF TAKU INLET

1 MILE

G.H. 1965

Alaska Juneau Mine

The Alaska Juneau mine offers the most favorable opportunity to study the relation between mineralization and the geology of the Coast Range region. The surface area of the old Perseverance Mine is well exposed, fairly accessible, and contains what is by Alaska Juneau standards, fairly good ore. This ground is now part of the Alaska Juneau property. About 10 days was spent in the area in mapping and reconnaissance. Because of the short time spent in the area, the complexity of the geology, and lack of a satisfactory base map, no map is included in this preliminary report. Possibly for similar reasons, no comprehensive report has ever been published on the mine.

Thanks are due to Mr. Gene Nelson, Juneau manager of the Alaska Juneau Gold Mining Company, for furnishing maps, reports and survey data and some of the flavor of the old AJ.

The ore bodies of the Alaska Juneau mine are merely the richest portions of a larger area described by Wernecke (1932) as 1-2,000 feet wide and 3½ miles long. In this area, vein quartz occurs in abundance greater than average for the region. Most of this vein quartz occurs in folded, boudined and rodded veins, usually a fraction of an inch in width which, because they carry little or no gold, have been given little study. These veins are similar in structure to the deformed quartz veins elsewhere in the Coast Range mineral belt. They were deformed along with the enclosing wall rocks. The evidence for the pre- or syn-tectonic age of these deformed quartz veins is similar to that given earlier in the description of structures in the Endicott-Tracy Arm area. In addition, there are many veins of several inches to a few feet in width which crosscut the foliation of the country rock, usually at small angles. These are the ore-bearing veins. These are not of great strike length, are irregular in cross section, occasionally boudined, often end bluntly with the foliation wrapped around the end of the vein, and may hook around at the end as though folded. See Figure by Wernecke (1932, Fig. 7). This is also shown by Bateman (1950, Fig. 12-6). No great amount of slip has occurred on the foliation surfaces of the enclosing phyllite since these veins were emplaced, but their irregularities seem to be indicative of some post-vein deformation. I would tentatively place them as late tectonic. This is contrary to the opinion of earlier workers, all who have considered them to be much later than the period of folding.

Earlier workers have regarded the amphibolites as intrusive. I found that the contacts between amphibolite and quartzose phyllite are gradational, and it appears that the amphibolite represents tuff layers in the original sediments. It seems likely that crosscutting relationships which have led to the conclusion of an intrusive relationship were due to mistaking axial plane cleavage in black slate for bedding where it strikes into fold hinges of amphibolite. This same relationship is present on a small scale in many of the quartz veinlets where folded veins crosscut the cleavage of the enclosing slate.

Whatever their origin, the amphibolites were emplaced before folding and metamorphism, apparently parallel to the bedding of the sediments. They have an important role in the formation of the ore structures as the openings are localized along contacts of amphibolite with black phyllite. The deformed condition of some, or possibly all, of the veins indicates that at least some of these openings were formed and filled with quartz before the end of folding. Mining has shown that the late veins, which carry the ore, are closely controlled by these folds and plunge about 40° SE, parallel to the major amphibolite fold hinges.

Wernecke (1932, p. 495) states that the ore-bearing quartz stringers occur "in more or less continuous pipe-tine groups along fracture ridges or tongues of brown gabbro". These ridges and tongues are irregular folds in the hinge areas of altered amphibolite (brown gabbro). The ore zones occur mainly along the axial plane zone of the major fold, localized along favorable contacts.

Thus, the analysis of minor and major structures shows that the early quartz veinlets were emplaced and deformed before the end of the period of folding, and that the location of the later, ore-bearing quartz veins was closely controlled by the fold structures. The vein structures indicate that these are not simple, undeformed fissure veins. This ore control may be the result of more brittle behavior of the rocks near the end of folding.

The Alaska Juneau deposit occurs approximately a mile SW of the biotite zone of metamorphism, but brown biotite is closely associated with the ore zone and commonly occurs along the margins of the amphibolite bodies in the area. Elsewhere along the Coast Range mineral belt, isolated areas of biotite bearing phyllite have been found SW of the main biotite zone.

The amphibolite bodies were deposited or emplaced before folding and metamorphism and have been folded with the enclosing phyllite into major folds. Minor folds parallel these major folds. Minor quartz veins were emplaced before or during metamorphism and folding, and have been much deformed. Larger, ore-bearing, quartz veins were emplaced later, apparently near the end of the period of folding. The ore shoots, made up of large numbers of these quartz veins, occur near black slate-amphibolite contacts along the axial plane zone of the major fold. Openings formed during folding along the contacts localized the ore. Localization of mineralization along the hinges of folds plunging downward at 40° provided access to deeper levels. The ore was deposited during the period of metamorphism about a mile outside the biotite zone.

It is suggested that water and other volatiles boiled off from the metamorphic zone below the deposit and traveled up the plunging structures bringing in quartz, ore minerals and the heat necessary to raise the ore zone to biotite grade temperature. The formation of the deposit was a function of structure, metamorphism, trace element content of the rock and timing--all elements that can be mapped.

General Summary

Geologic mapping was done in selected cross sections of the metamorphic belt SW of the margin of the Coast Range batholith, over a width of up to 4 miles in the Endicott-Tracy Arm and Juneau-Taku Inlet areas.

The rock types, metamorphism, and structure in the two areas are similar. The metamorphic rocks consist of phyllite on the SW side, grading into biotite schist and then quartz biotite gneiss as a result of the appearance and growth of biotite and the increasing differentiation of the rocks into biotite-rich and quartz-rich layers as the metamorphic grade increases with the approach to the batholith. The contact of the quartz diorite of the batholith with the gneiss is gradational to sharp, and oriented inclusions of metamorphic rocks are present in the quartz diorite. The quartz diorite post-dates the formation of gneiss and appears to be of replacement origin.

NW trending folds dominate the structure of the region. These folds are best preserved in the phyllites as swarms of parallel NW-trending minor folds plunging moderately NW and SE. In favorable localities, large NW-trending folds are detectable parallel to the NW-trending minor folds. The major folds are isoclinal, bedding plane slip folds which are either vertical or overturned slightly to the SW.

Along the NE side of the metamorphic belt, mainly in the gneiss, minor folds and lineations plunge steeply down the near vertical beds. This second direction of folding is later than the first, and is thought to represent horizontal (wrench) movements along a plastic heated zone pre-dating the quartz diorite, which appears to be restricted to the same zone.

Later NE-striking, near-vertical cross joints cut phyllite, gneiss and quartz diorite.

Quartz veins in the map area can be categorized as: 1. Veinlets parallel to the foliation which exsolved from the country rock; 2. Pre- or syn-tectonic quartz veins which have been deformed by later slip along foliations of the enclosing rock and, 3. Tabular veins in cross joints which post date folding. The quartz veins at the Alaska Juneau mine are thought to be pre- or syn-tectonic in age.

The NW-trending folds and NE-striking cross joints resulted from a SW directed stress. Possibly the steep folds, which are intermediate between the two in age, represent a response under different conditions to stress from the same direction.

Mineral deposits in the area are controlled by openings associated with NW-trending folds and with NW-striking zones of wrench movement. The deposits appear to date from the time of deformation and metamorphism and may be related to metamorphic temperature gradients.

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Preliminary Geochemical Investigation
Tracy and Endicott Arm Area
by William H. Race, Mining Engineer

Introduction

The Tracy and Endicott Arm area was chosen for geological and geochemical investigation because it is a continuation of the famous Juneau gold belt, contains several base metal prospects, and is readily accessible to ocean transportation. It therefore appeared to be a good area to investigate the regional geology of the Coast Range mineral belt.

The old known prospects and mines in the area were investigated as time permitted. The stream sediments and water-shed soils were sampled in the course of the investigation.

Mines and Prospects in the Area

The Jingle-Jangle, or old Neglected Prize deposit on Tracy Arm has been prospected by trenching and a shaft 16 feet deep. The U. S. Geological Survey Bulletin 998-A estimates 40,000 tons of ore present for every 100 feet of depth. Assays taken by various engineers average 3.2 percent zinc, 1.5 percent copper, 0.013 ounces of gold, and 0.75 ounces of silver per ton.

The Sumdum Deposit on Endicott Arm has been drilled and mapped by one of the large mining companies. Their report is still confidential but it is understood that this deposit is similar to the Jingle-Jangle but somewhat larger and of lower grade.

The Portland Group on Endicott Arm was evidently an old gold prospect.

The Sumdum Chief mine produced about $500,000 worth of gold before the deposit was exhausted.

The Pt. Astley deposit has been prospected for gold, lead, and zinc by two tunnels and two shafts. The deposit is at high tide level so the shafts are flooded. The extent of underground development is unknown.

Physical Features

The mountains of Tracy and Endicott Arms rise abruptly from sea level in most places. Timberline attains an altitude of about 2500 feet and glaciers occupy most of the valleys above 4500 feet. The valleys and streams are fed by melting snow, glaciers, or rain. The stream flow fluctuates widely with variances of rainfall and temperatures that affect the rate of melt.

The overburden consists of sand or sandy clay on bedrock, very little gravel, sandy soil, and top soil. It was found that the soil cover in Endicott Arm was thicker than that in Tracy Arm where in places it was difficult to find a sample adjacent to a stream.

Method

Geochemical samples were dug by shovel, placed in marked plastic freezer bags and sent to Mr. Denny, Assayer at the Division of Mines and Minerals office in Ketchikan. Mr. Denny determined the amount of metal by two methods. He used the cold extraction method developed by the University of Alaska and the fusion method perfected by the Geological Survey of Canada. The results compared favorably, though the fusion method seemed to show wider variations. However, either method would detect the presence of an anomaly.

U.S.G.S. Bulletin 1000-F designates the sequence of soil horizons as follows:

"A" - the uppermost horizon or topsoil containing the humus.
"B" - the middle layer or subsoil containing no humus.
"C" - the lower layer composed of residual weathered bedrock.

The "B" zone was used in this investigation because in some places there were only the "A" and "B" zones available, so it was concluded that the samples would be more consistent by taking them all from the same horizon.

Samples were taken of the sandy "B" zone adjacent to streams. In some instances samples were dug from a depth of 3 or more feet in order to reach the "B" zone underlying muskeg. Some stream sediment samples were dug adjacent to "B" zone samples and compared.

Because of the large fluctuation in stream flow, no attempt was made to determine the metal content of water samples.

The results of the assays were plotted on an overlay of aerial photos of the area that were pinpointed at the time of sampling. In this manner, all sample points could be returned to for further investigation.

A total of 139 soil samples were taken and analyzed. These are presented in the Appendix with sample maps of the area investigated.

Observations

1. The Jingle-Jangle and Sumdum deposits were not discernible from samples taken near sea level.

2. The Sumdum deposit was not discernible from samples taken a mile from the beach.

3. The Jingle-Jangle deposit was discernible when sampled within a few hundred feet of the outcrop.

4. The highest zinc values, other than on the Jingle-Jangle, were found on the west side of Tracy Arm opposite the Jingle-Jangle; on the west side of Endicott Arm near the Sumdum Chief; and near Pt. Astley.

5. The highest copper values were found on the west side of Tracy Arm.

6. The highest lead values were found south of the Portland Group.

Conclusions

1. The Jingle-Jangle deposit likely extends several hundred feet further south than is indicated by trenching.

2. It is apparant that orebodies cannot be detected at any great distance by geochemical sampling in this particular area. An interval of more than 800 feet is unreliable for systematic prospecting in this area.

3. Stream sediment samples did not vary greatly from "B" zone samples taken adjacent to streams.

Explanation of Appendix

The list of samples is presented for those readers who may wish to compare them with other geochemical samples. Sample numbers prefixed with C1, C2, and C3 were taken in the Endicott Arm area. C4 prefixed samples were from Pt. Astley, C5 and C6 from Tracy Arm and the Jingle-Jangle deposit. C7 samples were taken in the Sanford Cove area.

Sample Number C2-28 was taken near the Portland Group and assumed to be contaminated since rock samples did not indicate the presence of a great deal of mineralization.

Sample C5-5 was taken about three hundred feet below the outcrop of the Jingle-Jangle and is indicative of results obtainable near a deposit of this type. It is interesting to note that Sample 10 is quantitatively nearly the same as Sample 9 which was taken from on top of the deposit, and both are higher in ppm than Sample 12 which was also taken on top of the deposit.

Sample C6-11 may have been contaminated but more sampling should be done in the immediate vicinity.

The background mineral content apparently varied from 0 to 50 parts per million for copper, 0 to 20 ppm for lead, and 10 to 90 ppm for zinc. Background determined by Chapman and Shacklette, U.S.G.S. Professional Paper 400-B, varied from 20 to 100 ppm for copper, 20 to 50 ppm for lead, and 20 to 50 ppm for zinc on samples taken of the "C" horizon at Mahoney Creek and Yakobi Island. That background is easily discernible from an anomaly as apparent from sample C5-5, i.e., 150 ppm copper, 40 ppm lead, and 1300 ppm zinc.

Map I indicates graphically the approximate amounts (ppm) of copper, lead, and zinc found during the course of this investigation. Not all the samples are shown because of lack of space.

Map II is a copy of a U.S. Geological Survey map of the Jingle-Jangle deposit on which some of the geochemical samples are shown. Samples prefixed with a 6 are C6 samples and those without prefixes are C5 samples. Many more samples would be necessary to delineate the orebody. This investigation was primarily done to determine what could be accomplished aerially by geochemical samples and no attempt was made to delineate the orebody.

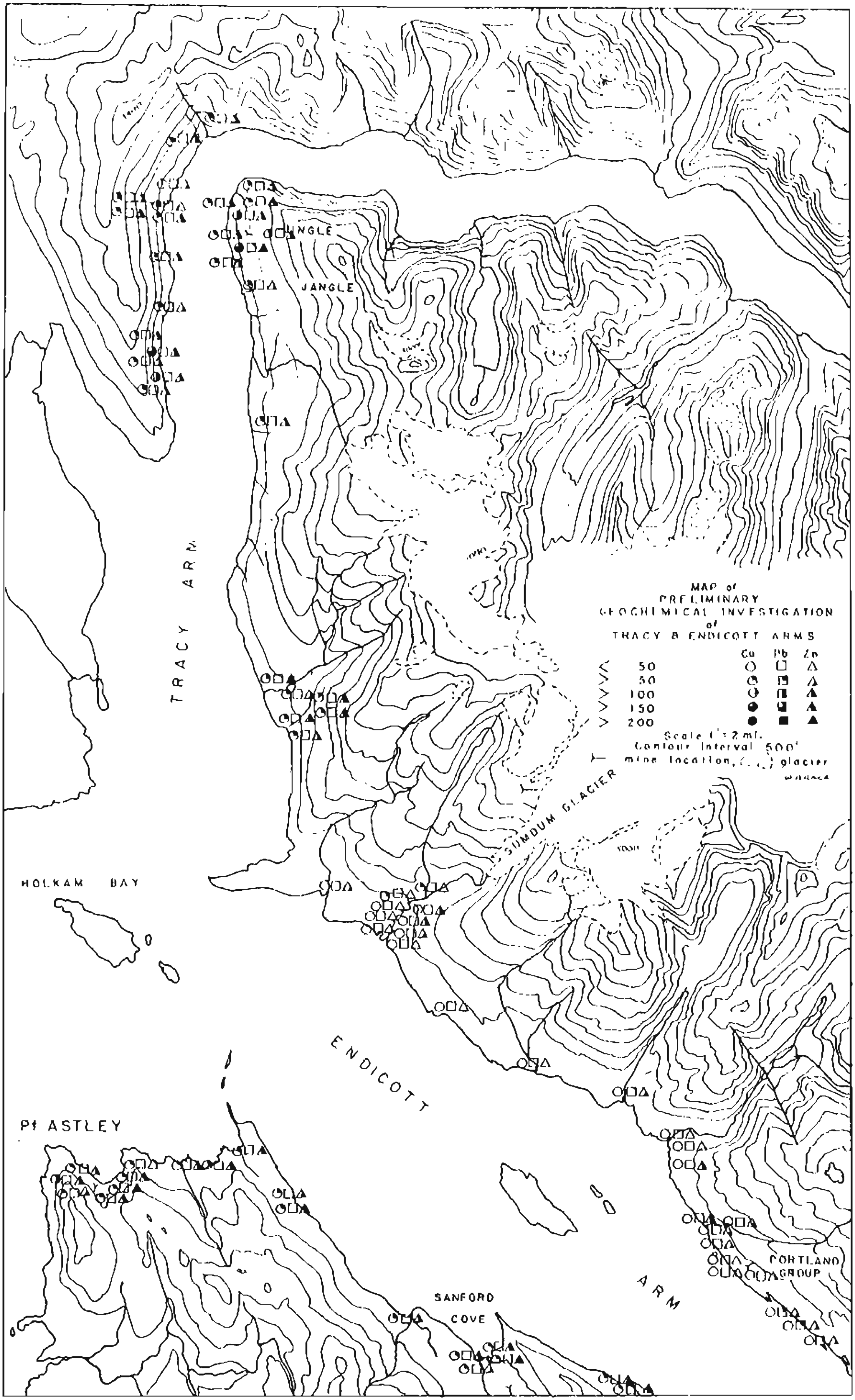
Soil Samples

	PPM		
	Cu	Pb	Zn
C1-1	3	1	100
C1-2	27	nil	50
C1-3	7	1	85
C1-4	nil	nil	65
C1-5	5	3	70
C2-1	nil	3	30
C2-2	nil	nil	10
C2-3	nil	64	150
C2-4	3	2	40
C2-5	nil	nil	30
C2-6	nil	1	25
C2-7	nil	1	25
C2-8	2	47	150
C2-9	nil	nil	50
C2-10	2	2	40
C2-11	nil	nil	25
C2-12	1	nil	50
C2-13	1	1	35
C2-14	2	nil	40
C2-15	2	nil	25
C2-16	1	2	35
C2-18	nil	1	40
C2-19	2	5	25
C2-20	nil	2	40
C2-21	nil	24	110
C2-22	nil	6	35
C2-23	2	27	75
C2-24	2	62	80
C2-25	1	58	50
C2-26	nil	11	35
C2-27	nil	14	25
C2-28	3	185	3000
C2-29	2	nil	100
C2-30	nil	2	40
C2-31	1	5	40
C2-32	nil	9	60
C2-33	2	3	50
C2-34	1	2	35
C2-35	16	1	45
C3-1	15	2	50
C3-2	5	nil	115
C3-3	25	2	125
C3-4	8	1	50
C3-5	2	nil	25
C3-6	nil	nil	40
C3-7	nil	6	25
C3-8	3	1	60
C4-1	42	8	33
C4-2	20	6	42

	PPM		
	Cu	Pb	Zn
C4-3	55	5	40
C4-4	65	10	27
C4-5	50	11	30
C4-6	90	3	21
C4-7	13	13	11
C4-8	45	7	38
C4-9	87	6	37
C4-10	75	3	134
C4-11	45	15	47
C4-12	75	6	250
C4-13	72	nil	150
C4-14	52	5	80
C4-15	47	3	72
C4-16	100	17	100
C4-17	40	14	62
C4-18	57	13	48
C4-27	91	nil	57
C5-1	60	10	145
C5-2	51	12	130
C5-3	95	9	87
C5-4	97	12	250
C5-5	150	40	1300
C5-6	89	10	52
C5-7	100	17	70
C5-8	43	13	38
C5-9	97	21	72
C5-10	92	22	30
C5-11	55	15	48
C5-12	73	13	42
C5-13	43	16	35
C5-14	40	21	40
C5-15	21	18	32
C5-16	55	12	125
C5-17	60	13	125
C5-18	40	1	78
C5-19	83	nil	35
C5-20	93	nil	118
C5-21	52	2	50
C5-22	92	nil	100
C5-23	57	nil	95
C5-24	180	nil	138
C5-25	94	nil	142
C5-26	50	nil	58
C5-30	33	nil	20
C5-31	55	nil	38
C5-32	88	nil	140
C5-33	97	6	100
C5-34	88	nil	122

	PPM		
	Cu	Pb	Zn
C5-35	57	nil	118
C5-37	38	nil	52
C5-38	90	nil	50
C5-39	85	2	45
C5-40	60	40	50
C6-1	100	16	125
C6-2	85	nil	60
C6-3	50	nil	65
C6-4	55	nil	55
C6-5	50	nil	75
C6-6	55	nil	75
C6-7	60	nil	70
C6-8	55	nil	100
C6-9	90	nil	95
C6-10	85	nil	80
C6-11	55	nil	5200
C6-12	50	1	100

	PPM		
	Cu	Pb	Zn
C6-13	55	4	125
C6-14	75	4	85
C6-15	55	nil	75
C7-1	80	nil	45
C7-2	90	nil	50
C7-3	75	8	105
C7-4	57	14	150
C7-5	50	1	35
C7-6	67	4	40
C7-7	45	40	55
C7-8	62	20	95
C7-9	55	20	80
C7-10	55	6	65
C7-11	57	8	75
C7-12	55	8	20
C7-13	62	12	35
C7-14	57	4	125
C7-15	60	6	80


MAP of
PRELIMINARY
GEOCHEMICAL INVESTIGATION
of
TRACY & ENDICOTT ARMS
Cu Pb Zn
< 50
> 50
> 100
> 150
> 200
Scale 1" = 2 mi.
Contour Interval 500'
mine location, glacier
TRACY ARM
JANGLE
SUMDUM GLACIER
HOLKAM BAY
ENDICOTT ARM
Pt ASTLEY
SANFORD COVE
CORTLAND GROUP

Map 6

COPY OF U.S. GEOLOGICAL SURVEY, GEOLOGIC MAP OF JINGLE-JANGLE DEPOSIT