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REPORT

- -ON ORES OF - -

ALASKA NICKEL MINES KX114-11

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C O P Y

A REPORT OF A MINERALOGICAL EXAMINATION OF A SUITE OF NICKEL ORES FROM THE ALASKA NICKEL MINES, NEAR SITKA, ALASKA

THE ROCK

<u>General Description</u>: So far as can be determined from the material submitted, without a chemical analysis, the rock in which these Alaska nickel ores occur is a hornblende gabbro. Rocks of this general type are described by Knopf* as occurring in considerable quantity on Chichagof Island,

*Knopf, Adolph–The Sitka Mining District, Alaska, Bull. 504 U. S. Geological Survey page 15.

and other localities in the vicinity of Sitka.

A somewhat detailed microscopic examination of the rock indicates that it contains only the usual minerals, hornblende, pyroxene, and medium basic plagioclase, of a normal hornblende gabbro.

The pyroxene is in part altered to hornblende, and in some areas of the rock the fibrous, uralitic variety of hornblende predominates. Feldspars, labradorite to anorthite, the former predominating, are probably not as numerous in this rock as in the usual gabbro. The rock shows only a moderate amount of alteration, of a type characteristic of mineralization rather than weathering. That is, it appears that the silicate minerals of the rock were formed prior to the deposition of the ore minerals and that the alterations shown were probably produced by mineralizing solutions at the time the ores were deposited. The ore minerals as shown by Figure 1 occur as replacements of the silicate minerals, and appear to represent the most recent mineralogical change that has taken place in the rock.

THE ORES.

General Description: The ores are heavy sulphides, and so far as can be determined from the material submitted for examination, occur as replacement of the hornblende gabbro. They consist of the minerals, named in the order of formation, pyrrhotite, pentlandite and chalcopyrite, as far as could be determined, appear to be almost contemporaneous as regards time of deposition, and are both clearly later than the greater part, if no all of the pyrrhoitie, There really appears to be very little difference in the ages of all the sulphides and the relationships shown in some sections seem to indicate that they are all contemporaneous, but taken generally it appears that the pyrrhotite was the first to be deposited and that it was followed shortly by pentlandite and chalcopyrite. Throughout the main sulphides there occur numerous veinlets of the different minerals which probably represent a kind of re-arrangement of the respective minerals after the deposition of the main mass of the ore. These second veinlets of the different minerals make it difficult to determine definitely their age relations, and make it necessary when studying the question, to take into consideration the broader relationships between the different minerals rather than giving too much importance to minor features, such as the secondary veinlets just mentioned. (It should be explained in this connection that the word secondary is used wholly in a mineralogical sense and in no way refers to the source of the material in the secondary veinlets.) There is absolutely no evidence in the material submitted for study that the ores have been enriched by meteoric waters. On the other hand, it is clear that they have not, and that the secondary veinlets are the result of deep seated solutions or processes, and probably were formed during the latter part of the main period of ore deposition. The veinlet of pyrrhotite between large areas of pentlandite, shown in Figure 2, and the veinlets of pyrrhotite and chalcopyrite in a large area of pentlandite, shown in Figure 3, are good examples of the secondary or "rearrangement" veinlets. So far as my study of these and similar ores has extended, these secondary veinlets were formed very near the close of the period of mineralization, after the main body of the ore was already in place, and therefore, cannot be taken as criteria in determining the relative ages of the different component minerals of the ores. So far as can be shown by a photomicrograph the broader and true relations between the nickel bearing mineral and its host is illustrated in Figure 4 in which an area of pentlandite is seen lying between larege areas of pyrrhotite.

THE MINERALS

General Statement: As has been stated, the minerals making up this ore are pyrrhotite, chalcopyrite and pentlandite, with which also occur minute quantities of both magnetite and pyrite.

Pyrrhotite: The most abundant ore mineral is pyrrhotite, which probably has the composition $Fe_{11} S_{12}$. In the material submitted for examination, it appears that pyrrhotite makes up over 90% of the sulphide content of the ore. It has a kind of bronze color which is between a bronze-yellow and a copper-red, and tarnishes very readily, and is only weakly magnetic. It appears to have been the first of the ore minerals to form, and in a way might be regarded as the host for the others. As seen in polished section pyrrhotite occurs in irregular masses, in and between and around which are the pentlandite and chalcopyrite. When these areas are etched so as to develop their structure, they are seen to be made up of numerous, moderate sized, exceedingly irregular grains of random orientation between many of which are minute and line-like areas of pentlandite. Its relation to the silicate minerals, as shown in Figure 1 indicates clearly that it occurs as a replacement of the silicates and therefore that it was not deposited until after they were fully developed.

Pentlandite: So far as could be determined the nickel in this ore occurs wholly in the mineral pentlandite, a nickel-iron sulphide, (Fe,Ni) S, which, according to Dana, is in part 2 Fe S. Ni S. In color pentlandite is cream-white to pale yellow-bronze, which in some instances may be confused with that of freshly polished pyrrhotite. It takes high polish and shows by its relief in the polished section that it is somewhat harder than chalcopyrite, but not quite so hard as pyrrhotite. It is rather brittle and possesses a distinct octahedral cleavage which causes the larger masses of the mineral to present a shattered appearance when seen in the polished section.

In this ore the pentlandite is clearly younger than pyrrhotite, and is found in irregular areas and veinlets in and around the masses of the iron sulphide, and as minute dots and narrow line-like inclusions in their interior. Many of these last mentioned areas of pentlandite are exceedingly small, some of them less than .005 mm in diameter, so minute indeed that a clean separation of the two minerals by mechanical means is probably impossible.

In the polished section under the microscope the larger areas of pentlandite are readily recognized by their light yellowish or creamy bronze color, and by numerous and prominent fractures, some of which clearly correspond in the direction to the somewhat distinct octahedral cleavage characteristic of the mineral. These, and other characteristics of the mineral are fairly well shown in Figures 2, 3, and 4.

Chalcopyrite: So far as could be determined, the copper content of this ore occurs wholly in the mineral chalcopyrite, (Cu Fe S_2), sometimes called "copper pyrites" or "yellow copper". It presents only its usual and characteristic properties and therefore does not call for a detailed description.

So far as could be determined, chalcopyrite in this ore is probably somewhat younger than pentlandite. However there appears to be very little difference in point of age between the two, and one is probably not far wrong when he regards them of contemporaneous deposition. Figures 2 and 3 are photomicrographs of polished specimens of the ore and show chalcopyrite in typical relations with the other sulphides.

Pyrite and Magnetite: Pyrite and magnetite occur so sparingly in the material submitted for examination that from a metallurgical point of view they are wholly negligible.

COMPARISON WITH OTHER NICKEL DEPOSITS.

General Statement: From the few samples of associated rock submitted for study it is impossible to form a reliable basis for comparison of the rocks of the Alaska deposits with those associated with other described nickel ores. It is however, a type of rock not widely different from some of the rocks associated with the Sudbury deposits, and not at all uncommon with nickel ores.

As regards the ore minerals, the sulphides, the case is different and direct and reasonably accurate comparisons can be made. As a general statement it can be said that the ore minerals of the Alaska Nickel Mines are in the main made up of the same minerals that occur in many of the best known nickel deposits in the world.

Sudbury: Tolman and Rogers° state that there are three

° A study of the magmatic sulphide ores, Tolman, C.F. and Rogers, Austin F., Stanford University Publications, 1916, p 29.

fairly distinct types of rocks are associated with the Sudbury ores. (1) quartz Norite, almost free from ores, (2) a pyrrhotite-bearing norite. (3) a hornblende-bearing granitic rock with abundant sulphides. The difference between gabbro and norite is slight, only a matter of the kind of pyroxene present; if the predominant pyroxene be augite or diallage the rock is called gabbro, but if the pyroxene be hypersthene or any of the ortherhombic group it is known as norite.

In the Sudbury ores it has been noted that as the ores become richer in nickel and copper, the amount or hornblende present greatly increases. Hornblende is the predominant silicate mineral in the specimens of the Alaska nickel ores studied. The ore minerals in the two deposits are the same, namely pyrrhotite, pentlandite and chalcopyrite, and, so far as has been determined, bear the same age relation to each other.

ALEXO MINE, ONTARIO: Descriptions of the rock and ore from the Alexo Mine statethat the rock is peridotite. (Closely related to, but somewhat more basic than a gabbro), and that the ores consist of the same minerals as the Alaska nickel ores-pyrrhotite, pentlandite and chalcopyrite.

Insizwa Range, Griqualand, So. Africa: Du Toit° states that the nickel ores of the Insizwa Range consist of the minerals pyrrhotite, pentlandite, and chlcopyrite, with small amounts of pyrite, niccolite, and a platinum mineral, probably sperrylite in an olivine bearing gabbro. They are, therefore, similar in all important respects to the Alaska Nickel ores.

°A report on the copper-nickel deposits of the Insizwa, Mount Ayliff, East Griqualand, Cape of Good Hope. Du Toit, A. L.Dept. of Mines, 15th Ann. Sept. Geol. Com. 1910 pp 111-142.

Norway: There are about 50 known deposits of nickel ores in Norway that consist in the main of minerals pyrrhotite, pentlandite, and chalcopyrite in various types of gabbro. These deposits are described by Vogt° in his classic work magmatic ores.

°Bildung von Erzlagerstaetten durch Differentistions process in basichen Eruptivmagma, Vogt, J.H.L. Zeit. F. prakt. Geol. Jahr. 1893

From the descriptions it is evident that in the main these deposits are all similar to the Alaska nickel ore.