THE OCCURRENCE OF NICKEL ORES*

Nickel is one of the metals that are of especial interest at the present time in connection with the manufacture of alloys, notably steel alloys. Nickel finds its chief use in the production of nickel steel, which is one of the most valuable of the special steels. Its use as an alloy with copper and zinc in imitation of silver, under various names, has long been known.

Nickel was discovered by Cronstedt in 1751 in a cobalt ore from Helsingland, Sweden. The element was found later by Cronstedt in the mineral niccolite (nickeline, nickelite or copper nickel), an arsenide of nickel, and it was presumably in the form of this mineral that nickel was present in the Swedish cobalt ore in which Cronstedt discovered the element. By German miners the mineral niccolite was known as kupfernickel (false or worthless copper), from its fancied resemblance to copper, and it was from this name that the name nickel was derived.

Formerly the amount of nickel ore required was small, and the supply was obtained from European deposits, notably those of Scandinavia, and from certain deposits in the United States.

The discovery of nickel ore in New Caledonia was made in 1865 by M. Jules Garnier, after whom garnierite, the chief nickel mineral found there, was named. Little mining was done in New Caledonia before 1875, however, though this locality soon after became the chief source of supply.

It was at a later date than this that the importance of the copper ores of Ontario came to be recognized as a source of nickel. Nickel was reported to occur in the Sudbury district of Ontario as early as 1856, but it was not until this region came to be opened up by the Canadian Pacific Railway in 1883 that important deposits were discovered. The copper ore originally mined at Copper Cliff, where mining commenced in 1886, was not suspected to contain nickel, and it was not until 1888 that the production of copper-nickel matte commenced. The Canadian output grew rapidly from that date, and Ontario soon took first place in the world's nickel production. This place it has since held, and its only serious competitor at present is New Caledonia.

Nickel Minerals.

The chief nickel minerals are nickeliferous pyrrhotite (iron sulphide), pentlandite (sulphide of iron and nickel), and garnierite (hydrated nickeliferous magnesium silicate). Other nickel minerals of some note include millerite and polydymite (nickel sulphides), niccolite and chloanthite (nickel arsenides), gersdorffite (sulpharsenide of nickel), and annabergite (hydrated arsenate of nickel).

Pyrrhotite, also known as magnetic pyrites, is a sulphide of iron approximating in composition to the protosulphide (FeS), but with a slight excess of sulphur over the amount required by this formula. The mineral frequently contains nickel, usually in the form of pentlandite. It is occasionally found in the form of tabular hexagonal crystals, but is usually massive. It is an opaque mineral, pale bronze-yellow to brown in color, with a metallic lustre, and is highly magnetic. Its hardness is about 4, and specific gravity 4.6.

Pentlandite is a sulphide of iron and nickel of variable composition, but usually corresponding to the formula (Fe,Ni)S. It occurs as inclusions in pyrrhotite, and is the chief nickel mineral of the Sudbury deposits. It crystallizes in the cubic system, and shows an octahedral cleavage. The mineral is opaque, pale bronze-yellow in color, with a metallic lustre. When free from pyrrhotite it is only weakly magnetic.

Garnierite, sometimes called noumeite or genthite, is, as already mentioned, the nickel mineral of the New Caledonia deposits. It is a hydrated silicate of magnesium, containing a variable amount of nickel, which ranges from 2 or 3 per cent. up to 30 per cent. or more. The mineral occurs as a compact earthy material in the form of veins traversing serpentine. It varies in color from pale green to dark green, whilst the hardness and specific gravity are also variable, the former ranging up to 3, and the latter from 2.27 to 2.87.

Niccolite, or kupfernickel, is an arsenide of nickel (NiAs), belonging to the hexagonal system, but is usually found massive. It is an opaque mineral, of pale copper-red color, with a metallic lustre. The hardness is about 5½, and specific gravity 7.5. Weathered specimens turn green owing to the formation of annabergite.

Millerite is a sulphide of nickel (NiS). It crystallizes in the rhombohedral system, but is usually found in the form of hair-like growths. It is opaque, brass-yellow in color, with a metallic lustre. The hardness is about 3½, and specific gravity 5.65.

Gersdorffite is a sulpharsenide of nickel (NiAsS) belonging to the cubic system. The mineral is opaque, white in color, often with a grey tarnish, and has a metallic lustre. Its hardness is about 5½ and its specific gravity varies from 5.8 to 6.2. As in the case of niccolite, weathered specimens turn green through the formation of annabergite.

Chloanthite is a nickel diarsenide ($NiAs_2$) usually with appreciable amounts of cobalt and iron replacing the nickel. It crystallizes in the cubic system. It is an opaque mineral, tin-white in color, with a metallic lustre. The hardness is about 6, and the specific gravity varies from 6.4 to 6.8. Weathered specimens of this mineral turn green owing to the formation of annabergite.

Annabergite is a hydrated arsenate of nickel ($Ni_3As_2O_8,8H_2O$). It usually occurs as an apple-green, earthy alteration product on weathered specimens of nickel arsenide minerals, and is of importance as an indicator of the presence of these minerals.

Nickel Ores in Europe.

United Kingdom.—Nickel minerals occur in veins of copper ore in Cornwall, and niccolite was formerly worked to some extent at the Pengelly mine, St. Ewe; whilst pentlandite is stated to have been found in some quantity at the Wheal Jane lead mine near Truro. Millerite is reported to occur in certain clay ironstones of the South Wales Coal Measures, notably those about Merthyr Tydvil.

According to the Home Office Mines and Quarries Report (Part III.), nickeliferous asbolan was formerly obtained in small amounts in Flintshire. The Report also states that nickel mining was started in Kirkcudbrightshire in 1897, and that 300 tons of ore, valued at £300, was raised.

Austria-Hungary.—At Schweidrich, near Schluckenau in Bohemia, there is an occurrence of nickeliferous pyrrhotite impregnating a basic dyke that tra-

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