

verses granite. The deposit, however, is of no economic importance.

Nickeliferous cobalt ore was formerly worked at Dobschau in Hungary.

Germany.—Nickel mines were formerly worked at St. Blasien in the southern Black Forest. The ore here is nickeliferous pyrrhotite associated with pyrite and chalcopyrite, occurring in association with basic intrusive rocks of the gabbro type.

Nickeliferous copper ores containing on the average 12 to 15 per cent. of copper and about 3 per cent. of nickel were formerly worked at the Hulfe-Gottes mine, Nanzenbach.

Nickeliferous cobalt ores occur in the Harz and the Saxon Erzgebirge.

A notable German deposit of nickeliferous pyrrhotite is that of Sohland in Lausitz, Saxony. Here the occurrence resembles that already mentioned at Schweidrich in Bohemia. The ore occurs in a basic dyke, and as mined it contained from $5\frac{1}{2}$ to 6 per cent. of nickel, together with some copper. The ore occurs at the margin of the dyke in contact with the enclosing granite.

Nickel ores have been worked at mines situated to the north of Frankenstein in Silesia. The ore occurs as a fissure-filling in serpentine and usually contains from 0.5 to 3 per cent. of nickel. Less commonly, ore containing from 4 to 18 per cent. has been obtained.

Greece.—A deposit of nickel ore of some importance is stated to occur on the Greek island of Locris, east of Athens. The mine commenced operations as one of iron-ore. Below the iron ore a deposit of nickel ore, consisting of earthy brown material, with patches resembling garnierite, was obtained. A sample of the ore was found to contain 7.22 per cent. of nickel. The nature of the deposit suggests that it has probably been formed by the weathering of nickeliferous serpentine. Material from this deposit has been smelted at Evje in Norway.

Italy.—At Varallo in Piedmont a basic intrusion consisting partly of norite contains nickeliferous pyrrhotite. Mines were formerly worked at this locality.

Norway.—Nickeliferous pyrrhotite deposits similar in character and mode of origin to those at Sudbury in Canada occur in various parts of Norway. The pyrrhotite occurs as a segregation product in norites that are intrusive in gneisses and schists. A notable occurrence is that of the Flaad mine (Evje mine) near Evje, where a large amount of nickel ore has been mined. The ore deposit here occurs partly within and partly at the margin of an intrusive mass of gabbro and norite. The ore contains a high percentage of pyrrhotite associated with chalcopyrite. Selected ore contains 4.6 per cent. of nickel and 1.5 per cent. of copper; but the average values are stated to be 2.3 per cent. of nickel and 1.2 per cent. of copper. Another notable productive deposit of pyrrhotite in norite is that of the Erteli mine, near Ringerike.

The ore from the Flaad mine is smelted to a matte at Evje, and that from Erteli mine at the Ringerike nickel works. The matte is refined at Christiansand by a special electrolytic process known as the Hybinette process, from its inventor, N. V. Hybinette.

In this process the matte is first roasted and converted into oxides. It is then leached with weak sulphuric acid to extract copper sulphate, after which the residue is heated with sulphuric acid to a temperature at which hydrous sulphates do not exist. It is then again leached with weak sulphuric acid to extract copper sulphate. Afterwards it is heated with hydrochloric acid to a temperature sufficiently high to cause

partial decomposition of the anhydrous chlorides, and again leached with weak acid, the heating being repeated if necessary. The ultimate residue thus obtained contains nickel oxide which can be refined by ordinary means.

According to the Diplomatic and Consular Report on Norway for 1913, the output of ore at the Flaad mine for that year was 28,000 tons. A small amount of ore was obtained also from the Faeo mine near Haugesund. A quantity of ore, amounting to 19,000 tons, from the Erteli mine was smelted at the Ringerike nickel works, which are now leased by the Christiansand nickel refining company. The amount of imported ore smelted at Evje and Ringerike during 1913 was 3,000 tons. The Hybinette refining process at Christiansand produced 600 tons of nickel and 350 tons of copper during 1913, as compared with 400 tons of nickel and 200 tons of copper in 1912. Some platinum, palladium, gold and silver were obtained as by-products.

Russia.—A deposit of nickel ore of the garnierite type occurs at Rewdinsk in the Urals, south-west of Ekaterinburg. It occurs in an almost vertical quartz vein, about 6 ft. thick, which traverses serpentine rocks. The ore contains from 4.8 to 19.2 per cent. of nickel oxide, but the deposit is small. Several attempts have been made to work the deposit.

In the Verkhne-Ufalei district to the south-east of Rewdinsk, H. W. Turner reports the occurrence of nickeliferous pyrite in the Nijni-Kardadinsk mine (Bull. Amer. Inst. Min. Eng., 1914, p. 191), in a black carbonaceous deposit. This carbonaceous material contained 14.85 per cent. of fixed carbon, 26.55 of volatile matter, 35.65 of moisture, and 1.69 of nickel and cobalt. The ash obtained by burning the carbonaceous matter constituted 22.9 per cent. of the sample and contained 7.2 per cent. of nickel.

The orebodies at this and other mines in the district are iron ore consisting of a mixture of chalybite and limonite and are associated with deposits of nickeliferous serpentine. Nickeliferous pyrite occurs in the limonite-chalybite deposit. The deposit has been tested by boring and an average sample of the iron ore, representing about 40,000 tons of ore, was found to contain 0.75 per cent. of nickel. A sample of pyrite obtained by concentrating the crushed ore was found to contain 6.28 per cent. of nickel.

Spain.—Nicolite associated with chromite occurs in a mass of serpentinized peridotite at Los Jarales, 35 km. northwest of Malaga. At and near the surface the ore is altered to garnierite. The deposits are stated to be small in extent.

Sweden.—At various localities in Sweden, notably at Klefva in Smaland, nickel ores occur, and were formerly worked to a small extent. These Swedish occurrences resemble those of Norway.

Switzerland.—Nickel ore occurs in the Gollyre and Grand Praz mines, near Ayer, in the Val d'Anniviers. An ore averaging 3 to 4 per cent. nickel, 7 to 8 per cent. cobalt, and 2 to 3 per cent. bismuth is stated to occur at Kaltenberg in Turtmanntal.

Nickel Ores in Africa.

Union of South Africa.—A promising deposit of nickeliferous pyrrhotite, closely similar to that at Sudbury in Canada, occurs at Insizwa, Cape Province. Here, as at Sudbury, there is a basin-shaped mass of intrusive norite, from 2,000 to 3,000 ft. thick, lying in the shales and sandstones of the Beaufort series of the Karroo system.

The ore when fresh consists chiefly of pyrrhotite, pentlandite and chalcopyrite. There are two different