(c). The basic segregations are of two kinds. One (not found in place) is characterized by countless octahedra of a green transparent spinel, and a few grains of corundum. The other variety, which is found in the ore body, is made up largely of aggregates of sillimanite, and contains large numbers of spinel and sapphire crystals.

Besides these minor varieties, the proterobase contains inclusions of quartz and granite, the latter strongly altered.

Mineralogical Composition of the Ore.

Besides the magnetite and ilmenite mentioned as original components of the rock, the Sohland ore consists of pyrrhotite, chalcopyrite, and pyrite. The pyrrhotite is largely in excess of the others, and the mining activity is due to the nickel it contains, as the ore is too poor to work for copper alone.

The pyrrhotite is always massive, and two varieties can be distinguished. One is more or less granular and fine grained, the other more coarsely crystalline and platy. Chalcopyrite is always intimately intergrown with the pyrrhotite, especially the finer grained variety. The latter also contains many more inclusions of the proterobase, while the coarser is as a rule comparatively pure, and free from rock and copper.

Analyses of the Sohland pyrrhotite show an average of between 4 and 5 per cent. nickel, for nearly pure material. But in a number of cases I obtained as much as 7 per cent. Copper is generally rather subordinate, averaging between 0,5 and 1 per cent., but at times going as high as 2 to 3 per cent. Cobalt is present in very subordinate quantities, and traces of antimony and silver have been detected.

The Ore-Body.

The ore-bed proper lies in the proterobase at the granite contact. At the bottom of the shaft sunk where the discovery was made, it has a thickness of 6 to 8 feet, which, however, sinks to a foot or less. The granite itself at the contact is slightly impregnated with ore for a few inches. The pay ore ends rather abruptly and beyond is proterobase impregnated with diminishing quantities of sulphides.

The upper part of the vein (Fundschacht) is covered to a depth of about ten feet with clay and the alteration products of the proterobase. Below this, secondary oxidised copper ores appear, (malachite, bornite, chalcocite, etc.). The rock becomes gradually fresher and more strongly impregnated with sulphides, till at a depth of about 30 feet, massive ore is met.

Relations of Ore and Rock.

Examined more closely, the relations of the sulphides to one another, and to the rock minerals, present a number of interesting facts.

In the massive ore, the small amount of chalcopyrite, in part fills narrow clefts in the pyrrhotite, as though a later impregnation along planes of fracture. A bilateral arrangement of the sulphides is also characteristic, and is well illustrated by a number of polished sections in Prof. Beck's collection.

One section shows a narrow band of chalcopyrite, running through the proterobase, which is locally altered and somewhat talcose. On either side of this band, the proterobase is impregnated with chalcopyrite for 3 or 4 inches. Then follows a parallel band of pyrrhotite, which is marked off sharply on the inner side, and fades off gradually to barren proterobase on the outer side. Other sections show similar zonal structures, giving the ore a more or less vein-like appearance. At other times the sulphides are grouped regularly around elliptical or rounded rock masses, apparently along fracture planes. The inner zone is generally chalcopyrite, and is surrounded by pyrrhotite, which passes by a gradual transition to barren rock. The same phenomena have been noted in the Sudbury ore, and they afford one of the clearest proofs of the later introduction of the ore, especially when combined with the microscopic observations.

Microscopic Structure of the Ore.

From the examination of a large number of thin sections of ore, Prof. Beck draws the following conclusions.

(1). The sulphide ores fill a space originally occupied by primary rock constituents.

(2). The sulphides are principally associated with secondary, non-metallic minerals, viz. actinolite, and chlorite.

(3). The sulphides favor places where alteration is well advanced. They occur in all varieties of the rock, but especially in the predominant proterobase.

The general conclusions are supported by concrete examples, and an examination of the slides I have made, fully corroborates the observations of Prof. Beck.

Origin of the Ore.

Prof. Beck's work, as well as my own, then make a number of points clear.

(1). Except for a small proportion of sulphides, which may have been original constituents of the ore-bearing rock, the pyrrhotite, chalcopyrite, and pyrite, have been introduced *after* the complete cooling and differentiation of the rock magma.

(2). Not only so, but a partial alteration of the silicates has taken place, resulting in the formation of actinolite, chlorite, talc, etc., *before* the formation of the ore-bodies.

(3). These relations can only have been brought about by means of solutions.

(4). The peculiar intergrowth of secondary hornblende and ore seems to indicate a previous metamorphic action. The fresher silicates are simply corroded and etched, while a part has been further altered during the action of the solutions and the contemporaneous deposition of ore.

(5). The ore-bearing solutions in all probability, were of a thermal nature, from considerable depths. They circulated along the border of the proterobase, along passages formed by cooling and shearing, and were no doubt closely connected with the latter stages of the proterobase eruption.

The ore-body itself indicates the thermal nature of the solutions, and their origin from the depths of the basic magma. If the process had been a lateral secretion of descending waters, which concentrated the nickel and copper, originally disseminated through the proterobase, it is difficult to understand why the ore is confined to the proterobase along its contact with the granite.

COMPARISON WITH SUDBURY AND OTHER DEPOSITS.

A short comparison of various sulphide nickel-copper deposits, indicates their essential similarity, both of geological relations, and method of origin.

(1). Regarding their origin, no example of this class of ore-bodies, which I have studied, can be referred to as a direct magmatic segregation from an original rock magma. On the other hand, all the