

happy occasion of his presidency over Section C at the Dundee meeting of the B.A., 1912, when he surprised and delighted all his friends. Peach was himself, too, whenever he handled a pencil, and will long be remembered for graphic sections across mountain chains, portraits of fossils, and maps, alike beautiful and true.

It is characteristic of his great boyish spirit that his thoughts never rested on achievement, but were ever concentrated on problems of the present and the future, some of them important, some trivial. He received the Wollaston Fund, Murchison Medal, and Wollaston Medal, as well as the 1892 Murchison Centenary Prize, from the Geological Society of London, and the Neill Medal from the Royal Society of Edinburgh. He was elected F.R.S. in 1892, and made LL.D. of Edinburgh University in 1903.

E. B. BAILEY.

CORRESPONDENCE.

THE SUDBURY NICKEL ORES.

SIR,—Professor Coleman's invaluable map and memoir of the Sudbury district have been of such great service to all students of that instructive mining field that his restatement of the hypothesis that its ores were formed by segregation in the molten norite—published in the last number of this Journal (1926, pp. 108–112) in criticism of my brief summary of the arguments against that view (“The Physical Chemistry of Igneous Rock Formation”, *Trans. Faraday Soc.*, No. 60, vol. xx, part 3, 1925, pp. 454–6)—will carry great weight. He supports the formation of the ores by igneous segregation on the following grounds.

(1) That those who have mapped the area unanimously adopt that theory. So far as I know the literature the hypothesis has been rejected in recent years by a great majority of those who have done extensive field work in the locality.

(2) The main support is now attached to the pyrrhotite in the norite which Professor Coleman claims can only be explained as a magmatic segregation. As evidence he instances the Frood Mine of which the petrography has been described by Dr. Howe (*Econ. Geol.*, vol. ix, 1914, pp. 508–14) and the structure by Miller and Knight in their Report to the Ontario Nickel Commission (1917, pp. 196–201 and 218). These and other accounts show that so far from the pyrrhotite there being a primary constituent of norite, it occurs as a secondary material in a belt of fractured rocks of various kinds. According to Howe the ore is partly mineralized diorite and partly mineralized gabbro; Miller and Knight add that it is partly also mineralized quartzite and gray-wacke. The country rock at the Frood Mine has been fractured and the sulphides act as a cement to the fragments, both in the gabbro and diorite, though in the latter the sulphides are also

present in blebs. The rock of the ore body has been crushed, brecciated, and sheared, and Miller and Knight state that this fractured zone was an ideal channel for the circulation of mineral-bearing solutions. They give a figure (op. cit., p. 199) of Frood ore to show that "the sulphides replace or impregnate the rock". So far from the ferro-magnesian minerals in the igneous rocks being unaltered, Howe figures Frood ore and shows the sulphides and quartz replacing hornblende, and I have seen many slides from other mines in which the sulphides replace biotite and hornblende and the hypersthene is much altered. The evidence from the Frood Mine, both from the field occurrence and the microscopic character of the materials, seems absolutely inconsistent with the formation of the ore as a magmatic segregation in an igneous rock. The facts indicate the ore-formation by mineral-bearing solutions impregnating a crushed zone of different types of rock. Professor Coleman quotes Dr. Howe in support of his own view; but Dr. Howe states (*Econ. Geol.*, vol. ix, 1914, p. 512) that the Frood rock has been dynamically metamorphosed, and (*ibid.*, p. 508) that "it offers serious objections to the confirmation of the view held in the field that the sulphides in the Frood rock were of magmatic origin". Dr. Howe, it is true, considers that the nickel may have been an original constituent in the rock; but he points out that even so its relations to the silicates have been so changed by the metamorphism that there is no conclusive evidence of its magmatic origin.

(3) In reference to Dr. Harker's rejection of the view that the "norite" and the overlying micropegmatite are derived from the same magma, the norite being due to gravitational segregation of the heavier constituents, Professor Coleman is sure that his specimens would convince Dr. Harker. I also feel sure that if Dr. Harker saw the material collected by Dr. Phemister, and had seen his field evidence that the most basic part of the "norite" is near the top and not far from its sharp contact with the micropegmatite, that Dr. Harker would be fully confirmed in his conclusion that the two rocks are not due to gravitational differentiation.

(4) Great importance is attached by Professor Coleman to blebs of ore which are completely surrounded by silicates in the igneous rocks. The blebs are said to be identical with the material in the ore veins, and therefore evidence that the veins are due to magmatic segregation. These blebs of ore, however, also occur in the quartzites, and in these rocks their origin by segregation is clearly impossible. The evidence that the veins and the ores cementing the fractured silicates are identical with the blebs may therefore be equally well cited as evidence that the blebs are not due to segregation. Sulphides completely isolated in rocks yet due to replacement are not uncommon.

(5) The greater importance attached to faults and fractures in association with the ore bodies is a welcome development. The

hydrothermalists have long called attention to the occurrence of the ore bodies in connexion with faults which explain their position.

(6) My statement that some of the nickel ores occur outside the norite is represented by Professor Coleman as founded on a statement by Mr. Knight. His statement was in my mind, with much other evidence, including the facts seen in a visit to the Victoria Mine in 1908, where the ore occurs in greenstones and not in the norite, with which there appears to be no connexion. Professor Coleman attributes the sulphide ores outside the "norite" to their injection as molten sulphide from the overlying igneous rocks; but that explanation would appear to me quite inapplicable to the ores in the "greenstones" of the Victoria Mine.

J. W. GREGORY.

GLASGOW.

March, 1926.

THE SUDBURY LACCOLITE.

STR,—Professor Coleman in his reference to me (p. 110) confuses together two questions which are, to my mind, quite distinct, viz. the relation of the norite to the underlying ore-bodies and its relation to the overlying granophyre. On the former question I am quite at one with him; but I cannot accept the "transition" from norite to granophyre as evidence that the two have been differentiated in place from one common magna under the influence of gravity.

The thick sheet of norite, like other large bodies of basic rocks, is variable, but I can see in it nothing resembling a vertical variation in accordance with density. The thick sheet of granophyre is less variable, and again without any appearance of order. Between the two comes a much smaller thickness of rocks of generally intermediate composition, not sharply divided from either norite or granophyre. These rocks vary irregularly, with a strong suggestion of heterogeneity, and closely resemble some familiar to me in the western isles of Scotland, where they are demonstrably hybrid products. The natural inference is that the granophyre was independently intruded after, but not long after, the sulphide-bearing norite, and that some commingling took place where the two came together. My own acquaintance with the Sudbury laccolite is limited to one brief visit and the study of a series of specimens collected, but all that I have since read (of observed fact as distinct from speculation) has gone to confirm the opinion then formed.

ALFRED HARKER.

CAMBRIDGE.

12th March, 1926.
