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*An inclusion of magnetite in diamond.*

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A MINUTE, black fragment of material, taken by Dr. J. R. Sutton from a cavity exposed on a cleavage-surface of a colourless diamond from Bultfontein mine, Kimberley, South Africa, was sent by him for determination. It is black with a sub-metallic lustre and in parts a bronzed tarnish; and is quite opaque even on the edges. The form is roughly that of a triangular chip, measuring  $1\frac{1}{2}$  by  $1\frac{1}{4}$  mm. with a greatest thickness of about  $\frac{1}{2}$  mm. The weight is about 1 milligram. The surface shows a small and uneven to granular fracture. On one portion there is a good crystal-face which reflects a sharp image; and on one part of this face there is a stepped growth with striae at  $60^\circ$ . On the goniometer the edges of the steps of one set gave an angle of  $70^\circ 31'$  with the main face, and from the other set an approximate measurement of  $70^\circ$  was obtained. No reflection was obtained from the striated area in the position of the rhombic dodecahedron. The form is therefore that of the regular octahedron. The face presents all the appearance of a true crystal-face,

rather than an impression of a negative crystal in the diamond. A striking feature of the fragment is its strong magnetic character with polarity: it is picked up by an unmagnetized knife-blade. The fragment sinks in methylene iodide (sp. gr. 3.33). These are the only tests that could be applied without damaging the fragment. They suggest magnetite, but are not decisive.

It was therefore decided to risk breaking off a small portion. The material proved to be hard and quite brittle. A portion of the detached fragment was crushed on a microscope slide with an ivory blade; it left a black mark (streak) on the ivory and a powder on the glass. Mounted in Canada balsam, this powder was seen to be black and quite opaque. The remainder of the detached fragment, when warmed in a drop of strong hydrochloric acid on a microscope slide, slowly dissolved without effervescence to a yellow solution. This gave a brown precipitate with ammonia, and with potassium ferrocyanide an intense blue colour. The suggestion that the material might be magnetite was thus confirmed; and the main portion of the specimen was returned to Dr. Sutton with this information.

Magnetite has not hitherto been recorded as an inclusion in diamond. As recently pointed out by Dr. Sutton,<sup>1</sup> inclusions of various kinds are not uncommon in diamond. Rarely, however, has it been possible to apply satisfactory determinative tests, owing to the minute quantities of material available. Black spots are of frequent occurrence in diamond. E. Cohen<sup>2</sup> suggested that they may be haematite, but he applied no special tests. C. Friedel<sup>3</sup> concluded that they consisted of carbonaceous material, since, when exposed on a cleavage-surface, they instantly disappear when touched with a blowpipe-flame. This has recently been supported by G. Friedel,<sup>4</sup> who regards the material to be graphite. He made special tests to prove the absence of iron, and he casts doubts on Cohen's haematite. Clearly, however, it is not necessary to assume that the black inclusions in diamond are always of the same kind of material. They might be haematite, ilmenite, chromite, picotite, magnetite, graphite, iron carbide (cohenite or cementite), or even metallic iron. In the isolated

<sup>1</sup> J. R. Sutton, Inclusions in diamond from South Africa. *Min. Mag.*, 1921, vol. 19, pp. 208-210.

<sup>2</sup> E. Cohen, Über Einschlüsse in südafrikanischen Diamanten. *Neues Jahrbuch Min.*, 1876, pp. 752-753.

<sup>3</sup> C. Friedel, *Bull. Soc. Chim. Paris*, 1884, vol. 41, p. 104.

<sup>4</sup> G. Friedel, Sur les inclusions noires contenues dans les diamants du Cap. *Compt. Rend. Acad. Sci. Paris*, 1923, vol. 177, pp. 1085-1087. [*Min. Abstr.*, vol. 2, p. 234.]

case now described there is given definite proof that the material is magnetite. Dr. Sutton states that this is the first time he has found an inclusion that is strongly magnetic ; so it would seem that magnetite is really exceptional as an inclusion in diamond.

Dr. Sutton remarks that the black inclusions in diamond are difficult to extract, and the material usually comes out in fragments. In the present case the diamond luckily cleaved in such a manner that the inclusion was got out without much damage. It was quite tight in the cavity. Loose inclusions, he remarks, are very rare.

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