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A DISCUSSION ON "ORIENTED OLIVINE INCLUSIONS IN DIAMOND"

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Recently Mitchell and Giardini (1953) reported on oriented inclusions of olivine in diamond flats. The orientation was such that (010) of olivine was parallel to (111) of the diamond and that the zone [101] of olivine was parallel to [101] of the diamond. The inclusions were elongated parallel to the [101] direction which was common to both the olivine and diamond. This is a very peculiar habit for olivine crystals as they are commonly elongated parallel to the *c*-axis. However, this habit can be understood on the basis of a newly developed theory of crystal morphology (Hartman and Perdok, 1952). According to this theory the habit of a crystal is governed by a set of chains of strong bonds running through the structure. Such a periodic bond-chain is represented by a periodic bond chain vector (P.B.C. vector) with a length equal to the period of the attachment energy of the chains.

Oriented inclusions are always connected with the pseudo-equality of parameters. In the present case the pseudo-equality concerns the direction [101] in both crystals. For the diamond the cube edge length is 3.56 Å. (Wyckoff, Chap. II, table p. 11). The parameters for olivine are:  $a = 4.77$  Å,  $b = 10.28$  Å, and  $c = 6.00$  Å (*Strunz, Min. Tabellen*, p. 169). The axes chosen here are the morphological ones. From these data [101] for the diamond is 5.03 Å and [101] for olivine is 7.66 Å, that is nearly  $3/2 \times 5.03$  (mistake 1.5%). This is a good agreement. In the diamond the direction [110] makes with [101] an angle of 60°. In olivine the direction [102] makes with 101 an angle of 60° and its length is 12.91 Å, that is approximately  $5/2$  times 5.03. The mistake is here 2.5%. According to Neuhaus (1943) oriented inclusions should have pseudo-equality of parameters in three dimensions. In this case it is found that the *b*-axis of olivine is exactly equal to  $5 \times d_{111}$  of the diamond.

Now it can be concluded from an inspection of the structure of olivine that there are P.B.C. vectors connected with *a.o.* [001] and [101]. The

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zone [102] is not a P.B.C. vector. Hence it follows that if a very small crystal of olivine is oriented on (111) of the diamond as described by Mitchell and Giardini, it can easily grow in the direction [101], but not in other directions. The zones [001] and  $[\bar{1}01]$  do not fit well on the substrata and although these directions are represented by P.B.C. vectors, the growth velocity in these directions is relatively small. Therefore, the crystals are elongated only parallel to the zone [101]. As the olivine crystals are included in the diamond, this process has occurred during the growth of the diamond. It is not possible that the olivine crystal settled down in full-grown state on the diamond, because in that case the direction of elongation would presumably have been [001], certainly not [101]. (Conclusion that the diamond grew at a temp. < melting point of olivine?)

Similar deviations from the normal habit have been reported in the literature. Frondel and Ashby (1937) mention hematite crystals that have grown as needles on muscovite. Recently Watanabe and Ueda (1953) showed an electron micrograph of octahedral antimony oxide formed on a cleavage surface of stibnite, in which the senarmontite is elongated parallel to the zone [110].

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