PROBLEMS ASSOCIATED WITH THE EXISTENCE OF CARBONADO.

H.J.Milledge[1], D.Shelkov[2], C.T.Pillinger[2], A. Verchovsky[2] and R. Hutchison[3]

(1) Dept. of Geological Sciences, University College London, Gower St, London WC1E 6BT, U.K.
(2) Planetary Sciences Unit, Dept. of Earth Sciences, The Open University, Milton Keynes MK7 6AA , U.K.
(3) Dept. of Mineralogy, Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Carbonado is a form of polycrystalline diamond found together with appreciable quantities of alluvial diamonds in a number of localities, notably in Ubangi in the Central African Republic and in Brazil, where primary sources have not yet been identified. Individual specimens can be very large (~3000 carats, equivalent to the Cullinan, the largest known monocrystalline diamond, which came from the Premier Mine), and is valued as an abrasive on account of its exceptional hardness and resistance to brittle fracture, as it has no cleavage planes. Kimberlite pipes do contain polycrystalline diamond, which frequently incorporates significant quantities of impurities, sometimes making the specimen magnetic, known as stewartite (Williams 1932). However, no specimen considered to be carbonado has ever been found in volcanic rocks such as kimberlite, with the possible exception of microcarbonados recently found in Kamchatka (F.V. Kaminski, private communication).

This situation raises a number of questions of interest to kimberlite geologists. Because carbonado contains a significant quantity of impurities, these can be analysed by microprobe techniques in order to provide evidence of paragenesis (e.g. Meyer, 1987), or to indicate formation or emplacement ages (e.g. Richardson et al. 1990). It is also possible to make carbon isotope analyses, which usually give $d^{13}C$ values of ~ -28‰ (Vinagradov et al. 1966), indicating crustal rather than mantle carbon reservoirs. Such analyses led to the suggestion (Smith and Dawson, 1985) that carbonado might be associated with meteorite impacts, since the high pressure/high temperature conditions deemed necessary for diamond formation could not be achieved under the crustal conditions which were indicated by the inclusion geochemistry. However, the high porosity of carbonado makes the value of geochemical results debatable.

Although an association with meteorite impacts had been envisaged, no suitable crater had been identified until a possible candidate of enormous size (800 km in diameter), probably Precambrian, was located in Ubangi (Girdler et al. 1992). If indeed Precambrian, this crater could account for Brazilian as well as Central African carbonado, so that the possibility of a meteorite-related origin, which had waned in view of RRE determinations on carbonado (H. Kagi et al. 1994), needs to be reassessed (Shelkov et al. 1994).

Four approaches to this problem have been pursued.

(1) Many unbroken carbonados exhibit ablated surfaces strongly reminiscent of tektites (Shelkov et al., loc. cit.), so that if impacts are not involved, not only must some process capable of explaining these surface textures be identified, but its relation to the diamonds found together with carbonados must be explained. Shock origin of fine-grained polycrystalline diamond is certainly possible (e.g. De Carli, 1979), but the question at issue is whether the surface was produced at the same time as the carbonado itself, or by some later event. Some estimates of P/T parameters involving plastic deformation in the

shock-synthesis of diamond composites have been given by Novikov et al. (1993) and plastic deformation of diamond is thought to be possible at temperatures as low as 900C; some Australian diamonds show surface markings which resemble scratches made in a plastic rather than in a brittle material, and the morphologies of some diamonds from the same localities as carbonado will be discussed.

(2) The magnetic properties of carbonados as compared with those of polycrystalline diamond aggregates found in kimberlite pipes can give evidence of the strength of the magnetic field in which the specimens cooled. Such investigations have been made for a number of specimens. (D.W.Collinson, personal communication).

(3) Comparison of infrared, Raman and cathodoluminescence spectra and X-ray diffraction data for carbonado with results for diamond known to have been formed by impact in meteorite craters (Walter et. al. 1990, Milledge et al. 1994) can be used to assess the probability that carbonado has an impact-related origin.

(4) New measurements of carbon and nitrogen isotopic composition have been made for a number of these specimens (Shelkov et al. 1995).

Large scale meteorite impacts have a number of possible consequences for structural geology (Overbeck et al. 1993), and one purpose of this review of current knowledge is to invite exploration geologists to consider whether any of these are relevant to any phenomena which they may encounter.

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