ETCHING OF DIAMONDS IN SILICATE MELTS IN CONTACT WITH ATMOSPHERIC MEDIUM

V.M.Sonin
Institute of Mineralogy and Petrography SB RAS, Novosibirsk

Herald DGGGMS RAS № 5 (15)'2000 v.2
URL: *http://www.scgis.ru/russian/cp1251/h_dgggms/5-2000/magm29.eng*

The formation of diamonds, connected genetically with the mantle peridotites and eclogites, occurred at the high P-T parameters, corresponding the fields of their thermodynamic stability. Most authors agree, that the evacuation of diamonds to the surface had to happen quickly enough, in order to provide their safety in the fluid-saturated kimberlitic magma. Diamond interaction with silicate melts, for a first approach, can be modeled at the atmospheric pressure, though, naturally, the diamond-containing kimberlite magma existed at higher pressures.

Within the frames of the work, we have studied the etching peculiarities of diamond crystals in the fusible silicate melts: Na_2O (30 wt. %) - SiO_2 (70) (No 1), Na_2O (20) - B_2O_3 (40) - SiO_2 (40) (No 2), as well as in natural alkaline basalt. The necessity of such study was caused by the fragmentary character of such investigations and, correspondingly, rather contradictory data on the subject. The experiments were held at the device, constructed on the base of a tubular electric heater of the SUOL type, in platinum ampoules at 1000-1200°C in the atmospheric medium. Yet, only the experiments, in which diamond was not in the direct contact with the air, were taken into account. For etching, the powdered natural crystals of the fraction 0.6/0.8 mm, and single natural diamond crystals of octahedral habit, weighing 4.4-15.1 mg, were used. The portion of diamond "powder" amounted to 7±0.2 mg (35±1 grains) per one experiment.

The provided investigation allowed to establish, that (1) at 1000°C the silicate melt residues the rate of diamond etching, relative to the atmospheric air (some 2.5-1.5 orders in the row of compositions № 1, № 2 and the mixture of № 2 and basalt (1:1 by weight); (2) in the silicate melt, contacting with the air, diamonds are oxidated by the dissolved oxygen; (3) the rate of the process and the morphology of the etched crystals probably depend on the transport characteristics of the melt.

During the microscopic study of the samples it was established, that in the process of such etching of diamonds in silicate melt, the gaseous bubbles, i.e. the products of diamond oxidation, generate on the crystal surfaces. The morphological changes were studied in the experiments with single crystals. In the melt No1, the irregularly developed dull spots occurred on the faces, along with the blackening of the surfaces. The elements of such dull spots - crystallografically disoriented geometrically irregular etch pits - serve as indicators of the corrosion sculptures, occurring during the surface graphitization of diamonds. The presence of non-diamond carbon on the crystals was confirmed by the IR-spectroscopy of the samples. At some parts of the faces, the minute (up to first mkm in size) reversely oriented triangular etch pits were found, as a rule, with distorted outlines. In the melt № 2, against the growth of etching rate, numerous disc sculptures 20-260 mkm in size, consisting of minute irregular etch pits, were found on crystal surface. Such disc sculptures represent the imprints of gas bubbles - the products of oxidation. In the course of diamond crystal etching in the melt, consisting of the synthetic composition No2 and basalt mixture (1:1 by weigh), the triangular pits, oriented accordingly to the face outlines, were formed. All the etch figures are known for natural diamonds.

In the experiments with basalt melt, conducted at 1130-1200°C, it was established that: (1) due to the high rate of diamond oxidation and low solubility of the gaseous products of the reaction between the diamonds and the etching melt, the "foam-like" layer of bubbles forms, rising the crystals to the surface, so that diamond etching occurs in the surface layer of the melt; (2) in contrast to the oxidation in gaseous medium, diamond etching in the basalt melt proceeds selectively, with the formation of flat-bottomed steep-walled triangular, with truncated apexes, and hexahedral pits, along with the caverns with more complicated outlines. As a result of the etching, diamond grains are deeply corroded and obtain irregular forms, with greater specific surface. The character of etching of singular monocrystals is essentially similar: selective etching with the formation of deep caverns, usually flat-bottomed, with one or a number of smaller gently sloping triangular etch pits, directly oriented relative to the faces. The etch figures, obtained in the basalt melt, are morphologically similar to the faceted caverns on the natural diamonds from lamproites, while the surface, consisting of numerous caverns of various sizes, reminds the so-called cell-comb sculptures on the impact diamonds.

So, under practically similar outer conditions, varying only chemical composition of the melt, we obtained a very wide spectrum of morphological peculiarities, previously fixed only in sharply oxidizing (directly oriented triangular etch pits), or reductive conditions (corrosion sculptures due to surface graphitization). The mostly wide-spread type of partially dissolved natural diamonds is characterized by the presence of reversely oriented triangular etch pits on the {111} faces, which form under the conditions if intermediate values of the oxygen partial pressure. That means, that the crystal morphogenesis and etching rate in an opened system are determined by the composition of silicate melt, as the medium, in which the migration of fluid (reagents and the products of diamond oxidation) takes place. The latter conclusion can be of great importance for the determination of natural diamonds' stability (conservation) during the formation of original diamond deposits.