

Cuboctahedral diamonds from volcanic rocks of Kamchatka: Contamination or growth in unusual environments?

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Enigmatic appearance of cuboctahedral diamonds with morphology and infrared characteristics similar with synthetic diamonds grown from typical metal solvent, in natural ophiolitic and volcanic rocks (e.g., Howarth et al., 2015) requires more attention.

We studied several diamond crystals from Tolbachik volcano lava flow (Karpov et al., 2014) and from Ozerovskoe gold deposits, which is located not far away of Tolbachik, using transmission electron microscopy and synchrotron X-ray fluorescence. In the TEM films prepared using FIB technique we find only one metallic inclusions in Tolbachik diamonds. It contains Mn and Ni with minor Si. Ozerovskoe diamonds contain many inclusions. Their compositions correspond to Mn-Ni metals and Si-Ca-Mn oxides. X-ray fluorescence spectra, measured in the range of transitional metals with incident X-ray of 10 keV, confirm these compositions and also indicate presence of Fe-Ni and Fe-Ni-Mn inclusions with Cr, Ti, Cu, and Zn impurities. Bulk diamonds contain significant amounts of Mn, Ni and Fe in the range of 5-40 ppm. These values are much lower than those determined by LA-ICP-MS (Howell et al., 2015) for similar diamonds from Tibet ophiolites. FTIR spectra of Tolbachik diamonds indicate presence of minor carbonate and silicate inclusions.

Ozerovskoe diamonds are embedded to hydrothermally altered WC beads. This may clearly indicate contamination of rocks by drilling instruments. However, they are also extremely interesting for study as we can get an example of rapid alteration of WC during hydrothermal or weathering activity for short period of 30-40 years. Since we had only two crystals at present we cannot exclude natural origin for Ozerovskoe diamonds, because undoubtedly natural WC even with Co impurities (the composition, which is exactly as in industrial tools) was observed in hydrothermal deposits from Tolbachik eruption in 1975 and earlier (e.g., Glavatskih, 1990).

Mn-Ni (+Fe) solvent was used to produce industrial synthetic diamonds in USSR, thus the immediate conclusions is that Kamchatka cuboctahedral diamonds are contamination from drilling tools or other hard instruments. However, in case of Tolbachik this hypothesis is hardly possible, because diamonds were recovered from fresh lava flow of 2012-2013 eruption. Wide occurrence of similar diamonds in other rocks, including ophiolite and garnet peridotite may require their natural origin. One of the possible hypotheses is rapid growth in cavitation bubbles, where huge overpressure compared to detonation process is generated along with ultrahigh temperatures. However, detailed characterization of cavitation diamonds is yet to be reported. The study should be continued on larger amount of samples from different localities.

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References

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