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"Kamchatite" diamond aggregate from northern Kamchatka, Russia: New find of diamond formed by gas phase condensation or chemical vapor deposition

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Abstract

A series of polycrystalline diamond grains were found within the Valizhgen Peninsula in Koryakia, northern Kamchatka, Russia. A grain from the Aynyn River area is studied in detail with TEM. Diamond crystallites, 2–40 μm in size are twinned and have high dislocation density. They are cemented with tilleyite $Ca_5(Si_2O_7)(CO_3)_2$, SiC, Fe-Ni-Mn-Cr silicides, native silicon, graphite, calcite, and amorphous material. Among SiC grains, three polymorphs were discriminated: hexagonal 4H and 6H and cubic C3 (β-SiC). Silicides have variable stoichiometry with (Fe,Ni,Mn,Cr)/Si = 0.505–1.925. Native silicon is an open-framework allotrope of silicon S_{24}, which has been observed, to date, as a synthetic phase only; this is a new natural mineral phase. Three types of amorphous material were distinguished: a Ca-Si-C-O material, similar in composition to tilleyite; amorphous carbon in contact with diamond, which includes particles of crystalline graphite; and amorphous SiO_2. No regularity in the distribution of the amorphous material was observed. In the studied aggregate, diamond crystallites and moissanite are intensively twinned, which is characteristic for these minerals formed by gas phase condensation or chemical vapor deposition (CVD) processes. The synthetic analogs of all other cementing compounds (β-SiC, silicides, and native silicon) are typical products of CVD processes. This confirms the earlier suggested CVD mechanism for the formation of Avacha diamond aggregates. Both Avacha and Aynyn diamond aggregates are related not to "classic" diamond locations within stable cratons, but to areas of active and Holocene volcanic belts. The studied diamond aggregates from Aynyn and Avacha, by their mineralogical features and by their origin during the course of volcanic eruptions via a gas phase condensation or CVD mechanism, may be considered a new variety of polycrystalline diamond and may be called "kamchatite." Kamchatite extends the number of unusual diamond localities. It increases the potential sources of diamond and indicates the polygenetic character of diamond.

Keywords: Diamond, kamchatite, Kamchatka, SiC, tilleyite, silicide, native silicon, chemical vapor deposition