Synthesis of pure polycrystalline diamond by direct conversion of graphite at high pressure

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We synthesised optically transparent diamond by direct conversion of graphite rod at pressures between 12 and 25 GPa and at temperatures 2000-2500°C, using a multianvil apparatus. Micro-focus X-ray diffraction and Raman spectroscopic measurements demonstrated that these samples were made of pure cubic diamond, although only a very minor and broad Raman peak near 1332 cm^{-1} was observed in the latter measurement. TEM observations revealed that thus synthesized samples were consisted of minute diamond crystals of typically 10 to 20 nanometers. An indentation test showed that such diamonds possess Knoop hardness of up to 140 GPa, which is equivalent to or even harder than natural single crystal diamonds (~60-120 GPa). Moreover, they are nearly twice as hard as those of commercially available synthetic polycrystalline diamonds containing binders. We propose a new scenario for the origin of natural polycrystalline diamonds based on the present experiments, suggesting that they were formed by the slab-plume interaction in the mantle transition region.

Hydrothermal interaction with volcaniclastic sediment beneath the Suiyo Seamount submarine caldera, Izu-Bonin Arc

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Hydrothermal fluid circulation system develops within volcaniclastic sediment beneath the caldera floor of Suiyo Seamount (28°34'N, 140°30'E, depth 1360m), Izu-Bonin Arc. In order to study influence of magma-hydrothermal activities on sub-vent biosphere in the island arc setting, the Archaean Park Project conducted shallow drillings up to 12m within the active hydrothermal field, using tethered Benthic Multicoring System (BMS), in 2001 and 2002. For geochemical and microbiological studies, several fluid samples were also collected from active vents and the drilled holes during the dive programs using ROV Hakuyo2000 and DSRV SHINKAI2000, in 2001 and 2002.

Chemical composition of the obtained fluid samples were well explained by simple mixing between a unique hydrothermal endmember and ambient seawater, in spite of wide range of sampling sites and fluid temperature (5 to 300°C). This result suggests a single hydrothermal reservoir extends within sediment beneath the caldera floor. Since some drilled holes intersected the reservoir, we believe it extends at a few meters below the seafloor, at least in some portion. The evaluated temperature based on oxygen isotopic ratios of the clay minerals of the BMS core samples supports high temperature fluid-mineral interactions within the reservoir.

Silica concentration of the endmember hydrothermal fluid was close to saturation with quartz around 300°C. It is reasonable to consider chemical equilibrium during the fluid interactions with volcaniclastic sediment, because coarse and unconsolidated volcanic sands and pumice fragments would enhance hydrothermal interactions. Significant high calcium enrichment in the Suiyo hydrothermal fluid would be explained by fluid interactions with low-K series dacite and clay minerals such as mica, chlorite/montmorillonite, which were identified in the BMS core samples. Fluid chemistry is strongly controlled by the interaction with volcaniclastic sediment beneath the Suiyo Seamount submarine caldera, which represents water-rock interaction within a hydrothermal system in the island arc setting.