American Mineralogist, Volume 99, pages 1537–1543, 2014

Chemistry and Mineralogy of Earth's Mantle

Evidence for multiple diamondite-forming events in the mantle†

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Abstract

A collection of 35 diamondite samples (polycrystalline diamond aggregates, sometimes referred to as framesites), assumed to be from southern Africa, have been studied to investigate their infrared (IR) spectroscopic characteristics. Due to the abundance of sub-micrometer, interlocking diamonds (polycrystalline) with mineral and fluid inclusions within the diamond material affecting their transparency, only fragments from 10 of the samples provided high-quality data. The IR spectra showed a wide range of generally high-nitrogen concentrations (386–2677 ppm), with a full range of nitrogen aggregation states, from pure IaA to pure IaB. Platelet characteristics were interpreted as being regular (i.e., not having been affected by deformation and/or heating events), meaning the nitrogen aggregation data could be interpreted with confidence. Surprisingly, the platelet data showed a positive correlation between their intensity (integrated area) and peak position. The primary hydrogen band (at 3107 cm^{-1}) and secondary band (at 1405 cm^{-1}) are both often present in the samples' spectra, but show no correlation with any other characteristic. There is also no correlation between the samples' paragenesis (as defined by their garnet chemistry) and any of the IR characteristics. While we have no independent determination of the samples mantle residence age, nor the temperature they resided at, we infer that diamondite formation has occurred episodically over a large time frame in single and distinct growth events (as opposed to over a short time frame but over a large depth/temperature range). This idea is more in keeping with the theory that C-O-H diamond- (and diamondite-) forming fluids are the result of localized small volume processes. Interestingly, one sample contained fluid inclusions that exhibited a water:carbonate molar ratio (~0.8), similar to the saline and silicic end-members of the monocrystalline diamond-forming fluid chemical spectrum.

Keywords: Polycrystalline diamond, framesite, infrared spectroscopy, nitrogen aggregation, C-O-H mantle fluids