

Mechanisms of diamond oxidation and their bearing on the fluid composition in kimberlite magmas

YANA FEDORTCHOUK,¹ DANTE CANIL,^{1,*} AND ELENA SEMENETS²

¹School of Earth and Ocean Sciences, University of Victoria, Victoria, B.C., V8W 3P6, Canada

²Gemological Research Inc., Vancouver, B.C., Canada

ABSTRACT

Diamond oxidation experiments were undertaken in a piston-cylinder apparatus at 1150 to 1500 °C and 1 GPa to understand the mechanism of diamond oxidation in kimberlite melts and to determine the main rate-controlling parameters for this process. Only surface graphitization, and no diamond resorption, occurs in melts that are fluid undersaturated (synthetic kimberlite, carbonate melt, alkaline basalt, CaO-MgO-SiO₂-H₂O-CO₂ melts). In contrast, fluid oversaturated conditions (as evidenced by the presence of bubbles) produce resorption features commonly seen in natural diamonds recovered from kimberlites. The diamond oxidation rate is the same in the melts with a free fluid phase, in a pure H₂O or CO₂ fluid, suggesting that the process of diamond oxidation is its reaction with the fluid and not with the melt. Both CO₂ and H₂O oxidize diamonds at a similar rate, but produce very different surface features. Therefore, the surface features of natural kimberlite-hosted diamonds may provide information on the relative proportion of H₂O and CO₂ in the kimberlitic fluid. The common diamond morphologies imply significant amount of H₂O. The absence of diamonds with surface graphitization and the abundance of resorbed diamonds in kimberlites suggest the presence of a free fluid phase in kimberlite magmas for hours or days. We found no correlation between the rate and character of diamond oxidation and the physical properties of diamonds (nitrogen content, color).

Keywords: Diamond oxidation, resorption features, experiments, kinetics, fluid phase, kimberlite magmas, nitrogen content