Experimental study of development of positive trigons on diamond: conditions of near-surface diamond resorption with application to crystallization conditions of Snap Lake kimberlite, Canada

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Diamond is one of the most well recognized native elements and is in high demand worldwide. Kimberlites are volatile-rich, ultrabasic igneous rocks, which are a primary source rock of diamonds. During ascent of the kimberlite magma to the Earth's surface, as well as after crystallization, its diamonds undergo resorption as a result of oxidation within the kimberlite magma. Diamond resorption near the surface produces surface features on diamond crystal faces (resorption morphology) particularly; trigonal etch pits also known as trigons, and the orientation of these trigons is positive as opposed to negative. The orientation of the trigons is controlled by the temperature and oxygen fugacity in the kimberlite magma. Many studies have been conducted on kimberlite magma composition and crystallization conditions; however, there is a lack of direct near-surface composition constraints and an uncertainty in the first order controlling factors and limits of near-surface diamond resorption. Kimberlitic diamond resorption morphology can be used as a proxy for constraining nearsurface crystallization conditions of the host-kimberlite as well as for the controls on the diamond crystal quality. To investigate the diamond-bearing kimberlite nearsurface crystallization conditions, this study uses a recent approach of examining the parameters of positive trigons experimentally developed on diamond crystal faces using an atomic force microscope (AFM). Diamond resorption experiments were conducted in the presence of Na_2CO_3-NaCl melts at 0.1 MPa (atmospheric pressure) and 700–800°C (relatively low temperatures to reflect near-surface conditions). The experimentally produced positive trigons were measured using the AFM. This study confirms the individual effect of relatively low temperature and melt composition (halogens in the carbonate) on diamond resorption kinetics and morphology, and also shows that the relationship between the diameter and depth of the experimentally produced positive trigons is an important indicator of the volatile composition and temperature in the kimberlite magma interacting with the diamond,surface. Application of these results will be used explain the crystallization conditions during emplacement of the Snap Lake kimberlite dyke which shows predominantly positive trigons on its diamonds.

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