## Surface features on diamonds and water content of olivine from kimberlite as indicators of fluid systems in kimberlite magma

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Volatiles in magmas play an important role in the eruption style and the geology of volcanic landforms, determine presence of fluid phase, the depths of volatile exsolution, and the rates of magma accent. In kimberlites the original proportions of the two main volatiles, $H_2O$ and $CO_2$, are obscured by complex origin of the groundmass minerals. Volatiles affect diamond preservation and determine the character of surface features produced on diamond faces during dissolution in kimberlites. Experiments demonstrated that oxidation of diamonds in magmas with $H_2O$- or $CO_2$-rich fluids and in the absence of fluid produce distinctively different types of surface features. In addition, water fugacity of kimberlitic magma can be estimated using water content in phenocrystic olivine measured by FTIR spectroscopy. We apply these two independent methods to several kimberlites in order to constrain the behavior of volatiles and their effect on diamond population and the geology of kimberlites.

The study uses diamond parcels, olivine concentrates, and kimberlite core from six EKATI Mine kimberlites, Northwest Territories, Canada. These kimberlites have similar emplacement ages, erosion level, and country rocks, but different geology, composition, and diamond populations. The surface features on diamonds studied under optical and scanning electron microscopes were compared to the diamond surfaces produced experimentally in the presence and absence of fluid. Concentration and occurrence of hydroxyl in kimberlitic olivine were measured using FTIR spectroscopy. We found that Leslie and Grizzly kimberlites filled with hypabyssal facies, with low grade and quality of diamonds, show very sharp dissolution forms on diamond surfaces. Such features indicate absence of a free fluid phase during the last stages of kimberlite emplacement. Panda, Beartooth, Misery, and Koala kimberlites filled with volcaniclastic kimberlite, with higher grade and quality of diamonds have diamond surfaces with well-developed trigon pits, rounded edges with striation, and hillocks. Such features suggest emplacement in an $H_2O$-fluid-rich environment. However, diamond populations of Panda and Beartooth are dominated by octahedral unresorbed stones and IR spectra of their olivines give higher concentration of water in olivines <600 ppm and the depth of fluid separation greater than 2GPa. On the contrary, Misery and Koala diamonds are mostly rounded with high degree of resorption. Their olivines contain <450 ppm of $H_2O$ and fluid separated at more shallow depths. Group 2 OH IR absorption bands are absent in FTIR spectra of olivine from kimberlites filled with hypabyssal facies and present in olivine from all volcaniclastic-filled kimberlites. This can provide a possible link to an early loss of magmatic fluid. The excellent agreement between the two independent datasets suggests that both are linked to the activity of water in the system. We further apply these results to explain the differences between the geology of these kimberlite pipes and their diamond populations.

 

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