Mantle metasomatism as recorded in diamond dissolution features

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Roots of continental cratons keep a long record of multiple metasomatic events, but their trace is complicated due to the mixed signals left by these events in the composition of mantle silicate minerals. Simple composition helps diamonds to provide a more robust record of the latest metasomatic events which they witnessed. Growth and dissolution features on the diamond surface are sensitive to the composition of the reacting media. In this study we use mantle-derived resorption features on natural diamonds to examine the nature of metasomatic events in diamondiferous mantle lithologies. We use experiments at mantle conditions to examine how the composition of fluids and melts affect diamond resorption. We then compare these results to the features of natural diamonds to determine which of the tested compositions could have acted as metasomatic agents in Earth's cratonic roots.

Diamond dissolution experiments conducted at 6 GPa, 1200 – 1500ºC using synthetic MgO-CaO-SiO_2-CO_2-H_2O system examined the effect of CHO fluid, silica-saturated CHO fluid, aqueous and "dry" silica-carbonate and carbonate melts. Results show that the main control of diamond resorption morphology is the state of the reacting media: fluid vs. melt. We compared the experimental results to diamonds with mantle-derived resorption features from two kimberlites from the Orapa kimberlite cluster (Botswana). We identified twelve mantle-derived resorption types, none of which resembled the products of resorption in fluids. Most of the observed resorption types could be produced by dissolution in mantle melts with variable proportions of carbonate and silicate components and in the range of temperatures. The most abundant resorption type resembles the product of diamond dissolution in carbonate melts at temperatures above 1450ºC. Our results suggest that fluid-metasomatism is not destructive for diamonds while melt-metasomatism is. The lower hydrous carbonated solidus of lherzolite compared to harzburgite can result in the shift the process from diamond growth in fluids to diamond dissolution in melts due to metasomatic transformation of harzburgite into lherzolite.