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Diamond morphology as a key to understanding metasomatic processes in subcratonic mantle

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Metasomatism in the subcratonic mantle is responsible for growth as well as dissolution of diamond. The morphology of resorption features developed on diamond during its residence in the mantle provides an important record of the nature of the metasomatic media and conditions of diamond destructive metasomatic events, while the diversity of these features indicates different metasomatic processes occurring in the mantle. The objective of this study was to shed more light on the nature of metasomatic processes in the subcratonic mantle by examining the conditions of mantle-derived diamond resorption. Towards this end, we conducted a study of 800 diamonds from two kimberlite pipes in the Orapa kimberlite field, Botswana, and examined the relationship between the conditions of diamond growth, as recorded in their nitrogen defects, and subsequent dissolution recorded in their resorption features. Using a set of morphological criteria we identified preservation of mantle-derived resorption features on 55% of diamonds from one pipe and 25-75% of diamonds from the second pipe. We identified at least twelve distinct morphological types developed during mantle residence of the diamond, and examined the possible effect of diamond internal features vs. the effect of the conditions of the mantle metasomatism. The mantle resorption types are the same for diamonds from both of the Orapa kimberlites studied, and compare well to the types previously described on diamonds from Ekati Mine (Canada), implying similarity of metasomatic history beneath the Slave and Zimbabwe cratons. A comparison of the mantle-derived diamond morphologies to the products of diamond dissolution experiments allows assessment of the importance of metasomatism caused by carbonatitic melts vs. aqueous silicate melts in the mantle underlying the kimberlites. The nitrogen content and nitrogen aggregation state of the diamonds from the different morphological groups provides insights into the relationship between the diamond-growth and diamond-dissolution environments in the subcratonic mantle, as well as the stability of certain xenolith groups during kimberlite ascent, affecting preservation of the mantle-derived morphology on their enclosed diamonds.