Geophysical Research Abstracts
Vol. 18, EGU2016-17704, 2016
EGU General Assembly 2016

Role of fluid in the mechanism of formation of volcaniclastic and coherent kimberlite facies: a diamond perspective

Yana Fedortchouk (1) and Ingrid Chinn (2)

(1) Dalhousie University, Earth Sciences, Halifax, Canada (yana@dal.ca), (2) De Beers Group Exploration, Johannesburg, South Africa (Ingrid.Chinn@debeersgroup.com)

Dissolution features on diamonds recovered from kimberlites vary depending on the dissolution conditions and can be used as a reliable proxy for volatiles and their role in kimberlite emplacement. Volatiles determine the mechanism of magma emplacement; variation in volatile content and CO_2/CO_2+H_2O ratio may affect the geology of kimberlite bodies and formation of coherent vs. volcaniclastic kimberlite facies. Here we examine the evolution of a kimberlite system during ascent using the resorption morphology of its diamond population. We use 655 macro-diamonds from a complex kimberlite pipe in the Orapa kimberlite field (Botswana) to examine the role of volatiles in the formation of the three facies comprising this pipe: two coherent kimberlite facies (CKA and CKB) and one massive volcaniclastic facies (MVK). The diamonds come from three drillholes through each of the studied kimberlite facies. Separate diamond samples derived from 2 – 13 m intervals were combined into 40 m depth intervals for statistical purposes. Four independent morphological methods allowed us to reliably discriminate products of resorption in kimberlite magma from resorption in the mantle, and use the former in our study. We found that the proportion of diamonds with kimberlitic resorption is the lowest in CKA – 22%, medium in MVK – 50%, and highest in CKB – 73%, and it increases with depth in each of the drillholes. Each kimberlite facies shows its own style of kimberlite-induced resorption on rounded tetrahexahedron (THH) diamonds: glossy surfaces in MVK, rough corroded surfaces in CKB, and combination of glossy surfaces with chains of circular pits in CKA, where these pits represent the initial stages of development of corrosive features observed on CKB diamonds. Based on the results of our previous experimental studies we propose that resorption of MVK diamonds is a product of interaction with COH fluid, resorption of CKB diamonds is a product of interaction with a volatile-undersaturated melt (possibly carbonatitic), and CKA diamonds show an overprint of melt-controlled resorption over a fluid-controlled resorption. We propose an early separation of the fluid phase during the ascent of this kimberlite magma, segregation of this fluid and rise towards the top of the magma column. Over-pressurisation caused by the expansion of this fluid worked as a driving force for the magma ascent acceleration. The magma column has separated into two parts: (1) the bubble-rich magma towards the top, explosive emplacement of which formed the MVK facies, followed by the "tailing" bubble-poor magma quietly arriving to form the CKA facies, and (2) magma that lost volatiles to the upwardly escaping bubbles, in which a slower ascent caused more intensive diamond resorption and delayed emplacement, forming the CKB facie. It is possible that formation, buoyancy, and growth of fluid bubbles controls the ascent of the kimberlite magma, where emplacement of bubble-rich magma forms volcaniclastic kimberlite facies, while fast rise of the bubbles through the magma column separates the fluid-rich phase that moves up preparing the conduit in the surrounding rocks and forms an explosive pipe at the surface, from a volatile-depleted magma, which slowly rises and fills the pipe with CK kimberlite facies.