Examination of surface features on kimberlitic iron-titanium oxide minerals

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Fe-Ti oxides, chromite and ilmenite, are minerals common in kimberlite diamond deposits. They are brought to the surface during the eruption of a kimberlitic magma from the upper mantle. Previous studies have shown that, similarly to diamonds, partial dissolution and interaction of Fe-Ti oxides with kimberlite magma results in complex reaction rims and dissolution patterns. The nature of this interaction reflects the chemical composition of the magma and fluid phases. The goal of this study is to investigate a connection between the morphology of surface features and the composition of reaction products occurring on kimberlite oxide minerals to geological features of the kimberlite body.

This study uses chromite and ilmenite grains from two kimberlites with different geological features. Kimberlite A is a small pipe, filled with coherent kimberlite facies. Kimberlite B is larger and has two lobes filled with two different types of coherent kimberlite facies; the pipe also contains massive volcaniclastic and resedimented volcaniclastic facies. 75 grains were selected for examination of dissolution features under Scanning Electron Microscope: from Kimberlite A, 20 chromites and 21 ilmenites; from Kimberlite B, 10 chromites and 24 ilmenites. After the grains were imaged, they were mounted and polished to investigate reaction zoning and phases using Back Scatter Electron imaging, X-ray mapping and Wavelength Dispersive Spectroscopy methods. Most of the examined chromite samples are rounded ovoid grains with oriented euhedral octahedral nodules. Very few of the imaged ilmenite grains display dissolution features, and most are covered with reaction phases (perovskite and titanite). The results of the WDS analysis and BSE images show that chromites from Kimberlite A are slightly zoned with chromium and titanium enriched rims. Chromites from Kimberlite B are less zoned, with only a thin rim of titanium enrichment and some visible pitting in BSE images. Ilmenites from Kimberlite A show visible zonation in BSE images as well as in X-ray maps. The grains have Mg-enriched, Fe- depleted rims with some reaction products (both perovskite and titanite) on the grain surface. Kimberlite B ilmenite grains are not visibly zoned; however, WDS analyses show depletion in Ti around the rim of the ilmenite grains. Kimberlite B ilmenites also have large volumes of reaction products on the surface of the grains, both perovskite and titanite. In both kimberlites the concentration of Niobium appears to decrease towards the rim of the ilmenite grains. The data and compositional information obtained from this study will be used to infer the composition of fluids present in the melt, as well as composition and evolution of the primary kimberlite magma.

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