Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09749, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09749
EGU General Assembly 2008


# Volatiles in kimberlite: Volume relationships and implications for conduit and eruption dynamics

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The eruption of kimberlite magma must be governed by the same physical and chemical principles controlling eruption of basaltic to rhyolitic magmas. However, this does not mean that kimberlite behavior can be understood by simple linear extrapolation of ideas developed for other volcanoes. The most unique aspect of kimberlite magmas is their potential for having high dissolved contents of primary volatiles (e.g., $H_2O$ + $CO_2$ $>$ 15 wt. %) coupled to a high ascent rate. The high ascent rates ensures that higher volatile contents are maintained to the point of eruption. Here, we use recent results in experimental and theoretical petrology [1, 2] to explore and amplify concepts that have been advanced for the emplacement and eruption of kimberlite [3, 4, 5, 6]. Specifically, recently published thermodynamic models for $H_2O$-$CO_2$-silicate melt equilibria [1, 2] are used to simulate melt-solid-fluid equilibria during emplacement and eruption of kimberlite. These new thermodynamic models forecast volatile solubilities as a function of T, P and melt composition and can track energetics (e.g., enthalpy, heat capacity) and volume relationships. Heat contents are critical for evaluating the extent to which these systems are able to cool during eruption relative to their characteristic glass transition temperatures [7, 8, 9]. Efficient cooling can promote glass formation. More importantly, these calculations can explore the volume relationships between melt, fluid and solid [4, 7, 10, 11]. These relationships have direct consequences for the style and duration of volcanic eruption, the size and stability of the volcanic plume, depths of magmatic fragmentation, and conduit evolution. We use these calculations to test the premise that the geometries of the Diavik kimberlite pipes (Diameter: 120-140 m; Depth: 350-400 m) are ultimately a reflection of eruption

intensity (e.g., diameter $\alpha$ volume flux) and duration (depth $\alpha$ time).

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