European Mineralogical Conference
Vol. 1, EMC2012-593, 2012
European Mineralogical Conference 2012

Serpentine in kimberlite: an indicator of water-rich primary or externally-derived fluid?

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The origin of serpentine in kimberlite remains controversial. Mitchell (2008) favors the view that the serpentine in kimberlite is derived from magmatic fluids through deuteric alteration, which if true, would argue for dominantly hydrous primary kimberlitic fluids. Sparks et al. (2009) suggest that most serpentine growth in volcanoclastic kimberlite results from interaction with water-rich and at least locally silica-bearing external fluids that pervade the kimberlites following their emplacement. Evidence suggesting a secondary origin is reported by Stripp et al. (2006). They suggested that the emplacement of the pipe-filling deposit can lead to 20-30% porosity within which the matrix crystallizes. Given sufficient permeability, these pore spaces would rapidly fill with fluid that would facilitate hydration and reaction of the kimberlitic material to serpentine. Textural features like (i) iso-volumetric replacement of olivine grains by serpentine suggests at least local remobilization of Si4+ and Mg2+ and (ii) lack of primary groundmass phases resistant to alteration (e.g., perovskite and spinel) within serpentinite patches suggest void-filling instead of replacement of easily-altered primary kimberlitic material (e.g., interstitial ash, glass, or a late-stage kimberlite melt). To test the above views on serpentine formation, the phase relations for natural kimberlite and ideal kimberlite compositions were modelled assuming: (i) closed system behavior, (ii) systems open to fluid only, and (iii) systems open to fluid and SiO_2. Results of the initial modelling suggest that without an external source of fluid, the volume of serpentine would be less than 25%; whereas, with an external fluid source, serpentinization will begin at higher temperature, where the hydration reactions are more efficient, and produce up to 75% (volume) serpentine. If the external fluids carry small amounts of silica, more than 80% (volume) serpentine can form. This initial work implies that observed serpentinized, and volcanoclastic kimberlite occurrences are more consistent with the influx of some externally sourced fluid.
Mitchell (2008) Jour. Volc. Geotherm. Res. 174, 1–8; Sparks et al. (2009) Lithos, 112S, 429–438. Stripp et al. (2006) Jour. Metamorphic Geol. 24, 515–534.