

The effects of oxygen fugacity on mineral stabilities in kimberlite

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Kimberlite is one of the most important diamondiferous volcanic rocks on the earth. However, many questions around kimberlite are still debated such as the primitive composition of kimberlite magma, the kimberlite source, parameters that controlling kimberlite magma generation and ascent [1, 2], etc. Here we carried out experiments to identify the role of oxygen fugacity on the mineral stabilities in kimberlite. We performed high pressure experiments in a piston cylinder apparatus at 3 GPa, and temperatures between 1000 and 1200 °C, using graphite-saturated conditions. The kimberlite composition is based on the average composition of near primary group I kimberlites from South Africa [3, 4], but with higher CO₂ (11 wt.%) and lower H₂O (5 wt.%). In our experiments, olivine, clinopyroxene and dolomite are present in all runs as major residual phases. The stability of carbonate shrinks as temperature increases. Phlogopite and calcite are only stable below 1200 °C. At 1200 °C, the dominant mineral phases are olivine and orthopyroxene. Hence, we find that addition of graphite does not change much of the mineral assemblages of kimberlite, and dolomite in kimberlitic melts could be stable in a carbon-saturated condition at the lithospheric mantle depth. Carbon-saturation can impose a lower oxygen fugacity in the source of kimberlite compared to the case of carbonated peridotite condition [5, 6]. Our data, therefore, indicate that the possible contribution of graphite or diamond in the source of kimberlite can be overlooked by interpreting kimberlite source based on the bulk kimberlite composition, or by partial melting of carbonated peridotite. Further studies on the possible effect of carbon in the source of kimberlite are required.

References:

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