

Unconventional H₂O-CO₂ solubility and molecular structure of kimberlite melts

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Kimberlitic melts have the deepest origin of all terrestrial magmas. They are generated by low degree partial melting of carbonated mantle peridotite and are rich in volatiles (CO₂ + H₂O ~20-40 wt%). Their composition is thought to be intermediate between carbonatite and low-silica melts such as basanites. In these unconventional melts, the solubility laws of volatiles, and their effect on the molecular structure of the melt have never been resolved. Here, we report the results of mix CO₂-H₂O solubility experiment successfully producing quenched volatile-bearing and volatile-free synthetic analogues of kimberlitic glasses (SiO₂ content from 15 to 35 wt%; [1]). We further investigated these glasses by FTIR, Raman and NMR spectroscopy. Our results show that kimberlite melts display H₂O solubility similar to basalts but have very high CO₂-solubility, even at low pressure. As a consequence, kimberlites can retain extremely large quantities of volatiles during their ascent until the very last few kilometres: at 3 km, defined as the root zone of kimberlite diatremes, they can still dissolve 10-16 wt% CO₂ while their maximum H₂O content is at about 3-4 wt%. This unconventional solubility behaviour implies that >90% of kimberlite ascent-driven degassing occurs during the last 3 km below the surface and this can readily explain the peculiar morphology of kimberlite pipes and the depth of their root zone. Our spectroscopic investigations suggest that CO₂ has a strong effect on the melt degree of polymerisation, hinting to a major influence of CO₂ on the melt physical and transport properties, which certainly affect the dynamic of melt ascent and crystallization during the last minute degassing.

[1] Moussallam, Morizet, Massuyeau, Laumonier, Gaillard (2015) *Chem. Geo.* doi:10.1016/j.chemgeo.2014.11.017.