Differentiation and dehydration of alkaline basaltic magma recorded by clinopyroxene megacrysts

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Clinopyroxene (Cpx) megacrysts commonly observed in intraplate continental alkaline basalts convey important information about magma evolution. We analysed major and trace element compositions alongside water contents of Cpx megacrysts in alkaline basalt from Abaga volcanic field in central Inner Mongolia of eastern China. The anhydrous composition within each single crystal is homogeneous, but comparison between the Cpx megacrysts shows systematic variation: with the decrease of Mg# (from 82 to 70), the contents of compatible elements such as Ni and Cr decrease, while those of incompatible elements such as Na, Sr and REE increase. However, water content at the core generally decreases, from 400 to 40 ppm, with decreasing Mg#. These observations indicate that these Cpx megacrysts crystallized from genetically associated melts that represent different stages of evolution from a common primitive magma. Thermobarometer calculations yield decreasing temperature and pressure toward decreasing Mg#, with the most magnesian Cpx megacryst gives 23±2.3 kbar. We suggest that the parental melts of Cpx were stored at lithospheric depths of 40-70 km, with the most differentiated being the most water-depleted by losing water to the surrounding mantle.

We also observe a decrease of water content from the core to the rim in a few Cpx megacrysts. We interpret this to be due to water loss from Cpx to erupting (and degassing) magma during magma ascent. Quantitave modeling of the dehydration profiles indicate that magma ascent took about a few to several hours, which is consistent with typical ascent rate of basaltic magma.