Mantle hydration and the role of water in the generation of large igneous provinces

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The genesis of large igneous provinces (LIP) is controlled by multiple factors including anomalous mantle temperatures, the presence of fusible fertile components and volatiles in the mantle source, and the extent of decompression[1]. The lack of a comprehensive examination of all these factors in one specific LIP makes the genesis model debatable.

Here, we report estimates of the water content in picrites from the Dali picrites that represents the initial stage of the Emeishan LIP in southwestern China. The water contents of the primary magma were estimated based on the water content of clinopyroxene phenocrysts and a chemical-composition-dependent water partition coefficients. The major and trace element analyses of melt inclusions in olivine phenocrysts and major and minor element (Ca, Mn, Ni, Al) compositions of the host mineral phases were used to constrain the source lithology and the crystallisation temperature of olivine. Although these picrites display high water content up to 3.4 wt.%, the trace element characteristics do not support a subduction zone setting but point to a hydrous reservoir in the deep mantle. The recovered mantle potential temperture is around ~1500^{o} C, and primary magma would contain ~50% by weight of pyroxenite-derived melts. These results indicate that both high temperature, volatiles and pyroxenite play significant role in the genesis of Emeishan LIP.Combining with previous studies, we propose that hydrous and hot plumes occasionally appeared in the Phanerozoic era to produce continental LIPs (e.g., Tarim, Siberian Trap, Karoo). The wide sampling of hydrous reservoirs in the deep mantle by mantle plumes thus indicates that the Earth's interior is largely hydrated.

[1]Campbell, I. H. & Griffihs, R. W. Implications of mantle plume structure for the evolution of flood basalts. Earth Planet. Sci. Lett. 99, 79–93 (1990).