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Melt inclusions from Permian-Triassic komatiites, northern Vietnam, reveal evidence for a deep hydrous mantle reservoir

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Studies of melt inclusions in Phanerozoic komatiites are crucial for understanding the evolution of the mantle composition, as well as the rates of crustal production and recycling through time. The Permian (~260) Ma Song Da komatiites in Vietnam are among the few known occurrences of well-preserved Phanerozoic komatiites. Hanski et al. (CMP 2004) proposed that the Song Da lavas derived from komatiitic magmas based on their bulk-rock composition and the assumption that the estimated water content in these rocks is less than 0.03 wt.%. Despite continuous efforts to uncover their primary melt composition, concentrations of the volatile and mobile elements in the primary Song Da melt are still poorly constrained due to seawater alteration and low-grade metamorphism.

This study reports high precision EPMA, SIMS, and LA-ICP-MS melt inclusion data presenting evidence that the primary melt of these Phanerozoic komatiites contained up to 0.9 wt.% water. Their original δD values were lower than −66‰, and the H_2O/K_2O ratio was ~37. Despite the elevated water content, we provide evidence that these rocks were indeed derived from a komatiitic melt. The crystallization temperature of olivine from the Song Da komatiites calculated using the Al-in-olivine-spinel geothermometer was ~1490°C. The MgO content of the primary melt was ~22.8 wt.%, and the potential temperature of the mantle source was estimated at 1630 ± 42°C. The observed negative correlation between δD and the inclusion size and a positive correlation between the water content and the inclusion size suggest diffusive loss of H from melt inclusions rather than its gain. The high H_2O/K_2O ratio indicates a vast excess of water in these melts' source compared to the primitive mantle (BSE). We conclude that the Song Da komatiites' parental melt was derived from the mantle plume, which passed through the mantle transition zone (410-660 km), being partially molten. This plume has entrained H_2O from the hydrated transition zone likely through the interstitial melt. In turn, the H_2O in the transition zone has been accumulated from subducted and partly dehydrated oceanic lithosphere. This explains the high-water content and depletion in deuterium recorded in the melt inclusions.