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Evolution of Earth Mantle since Eoarchean detected by in-situ study of melt inclusions in komatiite olivine phenocrysts

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We report evolution of the deep mantle composition based on the results of study of melt inclusions in high-Mg olivine phenocrysts of komatiites and related picrites of ages between 3.3 and 0.09 Ga. Melt inclusions were quenched from 1250-1400 ^{o}C and studied by EPMA, SIMS, RAMAN and LA-ICP-MS.

Crystallization temperatures were up to 1490^{o}C for Phanerozoic komatiites and up to 1550^{o}C for Archean ones which correspond to potential temperatures of ca. 1620^{o}C and over 1700^{o}C correspondingly.

All melts are highly depleted in incompatible elements and contain a significant excess of H_2O over elements of similar partition behavior between solid and melt: H_2O/K_2O (up to 40 over normal 1 for OIB and MORB) and H_2O/Ce (up to 7000 over normal 200), while H_2O content is in the range of 0.2- 0.9 wt.%. D/H ratios of the melt inclusions less affected by H diffusion loss, indicate mantle source severely depleted in deuterium (δD is typically in the range between -100 and -230 ‰).

First data on $^{87}Sr/^{86}Sr$ ratio in komatiite melt inclusions reveal two components in each suit: depleted and slightly enriched compare to BSE mantle of the same age. Depleted component suggests model age of the komatiite source at least 0.5 Ga and up to 1 Ga older than emplacement age.

All studied primitive komatiite melts are depleted by Pb relative to BSE. The Ce/Pb ratio gradually increased since 3.3 Ga and stays nearly constant after 2.7 Ga.

The high potential temperatures of all studied komatiites amply their mantle plume origin and partial melting of these plumes when crossing the mantle transition zone. We propose that the mantle plumes that generate komatiites entrain H_2O by interstitial melt during their passage through the hydrated mantle transition zone. We further suggest that the source of H_2O depleted in deuterium in the mantle transition zone were subducted partially dehydrated slabs of oceanic lithosphere, which is supported by the temporal evolution of Ce/Pb ratio of komatiites. The sources of komatiites were depleted by previous melting events 0.5-1 Ga before their origin. All these imply an active subduction process since the Eoarchean.