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Komatiite melts detect deep hydrous reservoirs in the mantle transition zone implying active subduction since Eoarchean time

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The ERC Synergy project: **M**onitoring **E**arth **E**volution Through **T**ime (MEET) started in November 2020. Here we report results of study of melt inclusions and host high-Mg olivine phenocrysts of komatiites and related picrites from Phanerozoic localities: Gorgona, Colombia (0.09 Ga), Song Da, Vietnam (0.26 Ga), and Archean localities: Belingwe belt, Zimbabwe (2.67 Ga), Abitibi belt, Canada (2.70 Ga) and Barberton belt, S. Africa (3.3 Ga). Melt inclusions were remelted at 1250-1400 ºC and 1 bar pressure, quenched and studied by EPMA for major elements, K and Cl, by SIMS for H_2O contents and D/H ratios, and by LA-ICP-MS for trace elements. Host olivines were studied for major and minor elements by EPMA and trace elements by LA-ICP-MS.

Results:

1.Crystallization temperatures using Al-in olivine-spinel and Sc/Y olivine-melt geothermometers were up to 1490ºC for Phanerozoic komatiites and up to 1550ºC for Archean ones. These correspond to potential temperatures of ca. 1620ºC and over 1700ºC correspondingly.

2. Studied inclusions in the most Mg-rich olivines of each suite contain a significant excess of H_2O over elements of similar partition behavior between solid and melt: K and Ce. This leads to exceptionally high ratios of 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.% in parental melts.
3. 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 ‰).

Interpretation:

1. Potential temperature of all studied komatiites exceeds 1600ºC and thus implies their mantle plume origin. Moreover, these potential temperatures are high enough to ensure partial melting of these plumes when crossing the mantle transition zone.
2. We propose that the mantle plumes that generate komatiites entrain H_2O by interstitial melt during their passage through the hydrated mantle transition zone.
3. 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 implies an active subduction process since the Eoarchean.