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Amphibole-dehydration melting for Hadean protocrust

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Temperature is a fundamental issue in granitic magmas. Hf isotopic variations in magmatic zircons of granitoid rocks record Hf diffusion that is a temperature-dependent constant. Thus the variation can be used to evaluate the melt temperature of granitoid rocks. Our modeling based on Hf isotopic variation of zircons derived from the Jack Hills conglomerates, Western Australia, suggests a temperature of >770 ºC and possibly higher than 810 ºC for granitic melts generated in Hadean time, assuming a melt accumulation time of less than 1 million years (Figure 1). This is higher than the previous results by Ti-in-zircon thermometry and indicates an amphibole-dehydration melting, rather than a low-temperature water-saturated melting, for Earth's earliest crust. This may further suggest that free water or other complementary fluids may not have prevailed in the deep-seated melting zones of the earliest crust and that the earth's Hadean protocrust was dominantly of mafic in composition.

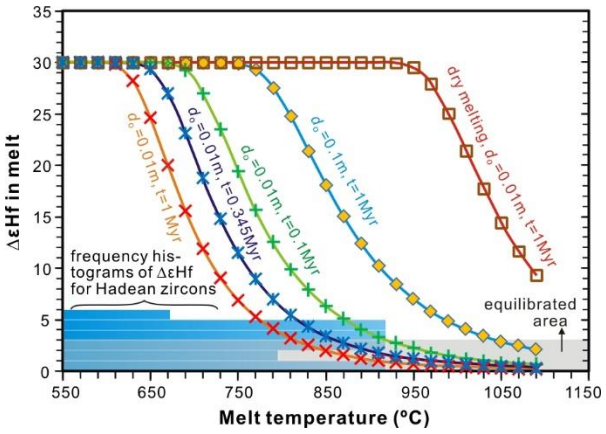

Figure 1: Modeling showing the relations of the variation of ΔεHf in granitic melt and the melt temperatures in Hadean time. Blue columns show the frequencies of ΔεHf for each 20 Ma interval of Jack Hills zircons. The samples with 0<ΔεHf<3 (i.e. the gray area) may have been equilibrated in Hf isotopes, and their Hf isotopic variation may be the result of analytical uncertainties. The D_0 and E_α for the uppermost dry melting line are 10–3.41 m^2/s and 354.88 kJ/mol, respectively, according to Mungall et al.[1].

References:

[1] Mungall J E, Dingwell D B and Chaussidon M (1999) Chemical diffusivities of 18 trace elements in granitoid melts. Geochim Cosmochim Acta 63: 2599-2610.