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Slab crustal dehydration, melting and dynamics through time

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Melting subducted mafic crust is commonly assumed to be the main process leading to silicic melts with an adakitic signature, which may form Archaean granitoids and generate early continental crust. Alternatively, melting of the overriding lower mafic crust and near-Moho depth fractional crystallisation of mantle melts can form differentiated magmas with an adakitic signature. Previous work shows how only very young slabs melt through dehydration melting, or depict melting of dry eclogites via water addition from deeper slab dehydration.
We quantify subduction dehydration and melting reactions in a warm subduction system using a thermo-mechanical subduction model with a thermodynamic database. We find that even young (hot) slabs dehydrate before reaching their solidus, which suppresses any slab dehydration melting and creates significant amounts of mantle wedge melting irrespective of slab age. Significant slab crust melting is only achieved in young slabs via water present melting if metamorphic fluids from the subducted mantle flux through the dry eclogites. These slab melts, however, are affected by massive mantle wedge melting and unlikely to participate in the overriding plate felsic magmatism, unlike the shallower, primitive mantle wedge melts. Understanding the overall flux of water carried by the descending slab mantle is therefore of prime importance. We thus inverstigated the deeper dehydration processes in subduction zones and implications for the water cycle throughout Earth's history. We estimate that presently $\sim$26% of the global influx water is recycled into the mantle, and that deep water recycling was also significant (although less efficient, 2-13% at 2.8 Ga) in early Earth conditions, which has important implications for mantle dynamics and tectonic processes in the Early Earth.
Alternatively, delamination and underplating of the mafic subducted crust would be a suitable mechanism to fit the geological record. We thus explore the conditions for which this may happen, and found that for a wide range of ages, the uppermost part of the subducted slab might delaminate to form compositionally buoyant plumes that rise through the mantle wedge. Thick crust on young slabs (as perhaps representative for a hotter, early Earth) may delaminate entirely and reside in the mantle wedge. Under such conditions, this ponded crust might melts subsequently, forming "adakitic" felsic melts contributing to a significant amount of the overriding plate crustal volumes.