Modelling clinopyroxene/melt partition coefficients for higher upper mantle pressures

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When partial melt occurs in the mantle, redistribution of trace elements between the solid mantle material and partial melt takes place. Partition coefficients play an important role when determining the amount of trace elements that get redistributed into the melt. Due to a lower density compared to surrounding solid rock, partial melt that was generated in the upper mantle will rise towards the surface, leaving the upper mantle depleted in incompatible trace elements and an enriched crust. Studies investigating trace element partitioning in the mantle typically rely on constant partition coefficients throughout the mantle, even though it is known that partition coefficients depend on pressure, temperature, and composition. Between the pressures of 0-15 GPa, partition coefficients vary by two orders of magnitude along both, solidus and liquidus. Since partition coefficients exhibit a parabolic relationship in an Onuma diagram, a similar variation is expected for all trace element partition coefficients that can be derived from the sodium partition coefficients.

In this study, we developed a thermodynamic model for sodium in clinopyroxene after Blundy et al. (1995). With the thermodynamic model results, we were able to deduce a P-T dependent equation for sodium partitioning that is applicable up to 12 GPa between the peridotite solidus and liquidus. Because sodium is an almost strain-free element in jadeite, it can be used as a reference to model partition coefficients for other elements, including heat producing elements like K, Th, and U. This gives us the opportunity to insert P-T dependent partition coefficient calculations of any trace element into mantle melting models, which will have a big impact on the accuracy of elemental redistribution calculations and therefore, if the partitioning of the heat producing elements is taken into account, also the evolution of the mantle and crust.


Schmidt, J.M. and Noack, L. (2021): Parameterizing a model of clinopyroxene/melt partition coefficients for sodium to higher upper mantle pressures (to be submitted)