

Chemical mohometry? A petrological modelling interrogation

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Crustal thickness is a crucial driver of petrological and tectonic processes that have operated throughout Earth's history. In the absence of geophysical data, crustal thickness has been approximated using various geochemical proxies in igneous rocks (e.g. Sr/Y ratios in granitoids) and accessory minerals (e.g. Europium anomalies in zircon). These proxies are inferred to be robust indicators of paleo-Moho depths and the results linked to secular changes in Earth's tectonic processes and to evaluate crustal growth and reworking over time. Applying these proxies assumes that they are versatile measures of the thickness of the crust. Here, we use petrological modelling of various rock compositions to test the veracity of some commonly used chemical mohometers. Although many proposed geochemical mohometers are pressure sensitive—and can be somewhat linked to depth—they are also sensitive to temperature, bulk rock compositions, and the influence of open-system petrological processes. For example, zircon with Europium anomalies of 0.6 could be produced from partial melting or fractionation of hydrated mafic rocks with variable redox states at depths of 10 to 55 km. I-type granites derived from partial melting of a hydrated mafic source with variable Mg/Fe ratios at 30 km depth yield Sr/Y values equivalent to 25–60 km using mohometry. We demonstrate that the confluence of factors that lead to the final composition of an igneous rock or an accessory mineral limits the use of mohometers as proxies for crustal thickness. However, petrological modelling does open new avenues to explore the various factors that control the trace element compositions of granitoids and accessory minerals to understand high-temperature igneous and metamorphic processes that operate in the deep continental crust.