Paleo-Mohometry: Assessing the Crust Thickness of Ancient Arcs Using Integrated Geochemical Data

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Deciphering the evolution of continental crust requires quantitative constraints on how its thickness changed over time. An essential reference in this respect is the thickness of magmatic arcs developed along subduction zones, given that primary crust generated in this tectonic setting represents the most important juvenile contribution to continental mass. Because igneous rocks building up the arcs commonly bear geochemical fingerprints of the depths at which sub-arc mantle melts and pressures at which magmas differentiate within the crust, the composition of these rocks offers indirect clues about the thickness of the hosting crust. The fact that element concentrations and ratios in arc magmas correlate with Moho depths has long been recognized [1,2] but scarcely exploited to estimating crust thicknesses. Today vast, publicly available geochemical databases open unprecedented opportunities in the statistical analysis of geochemical data at regional and global scales. Correlating these data with Moho depths obtained from the latest geophysical models allows the formulation of "mohometers", i.e. geochemical proxies for arc crust thicknesses [3,4].

Using a wide range of crust thickness–composition correlations identified in active arcs, in this contribution new mohometers with improved uncertainties are devised and then tested against modern arcs excluded from the calibrations and against well preserved and documented paleo-arcs. A combination of new (and refined existing) calibrations, chiefly relying on commonly reported major and trace elements covering nearly the entire igneous differentiation spectrum, are used here in order to constrain the thickness of less-preserved (fragmented, deformed, or eroded) ancient arcs. Combined with geochronologic data, such estimates allow tracking modifications in the crust thickness of long evolving arcs and help the better understanding of the relative contribution of continental and oceanic arcs to the formation of continents.

[1] Coulon & Thorpe, 1981, Tectonophysics 77/79; [2] Plank & Langmuir, 1988, EPSL 90/349; [3] Chapman et al., 2015, Geol. 43/919; [4] Profeta et al., 2015, Sci. Rep. 5: 17786.