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Bulk crustal composition and modulations by magmatic additions

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Estimates of the bulk chemical composition of Earth's continental crust are highly variable. In particular, no consensus exists with respect to the composition of the lower crust. While it is appropriate in some places to distinguish an upper, middle, and lower crust, more recent studies advocate that, in some places, middle and lower crust cannot readily be distinguished based on seismic wave velocities, geochemical compositions, and heat flow constraints. We provide a new estimate of the bulk composition of the Ivrea – Verbano crustal section in the Alps in order to address this issue. The Ivrea – Verbano zone is unique by exposing an almost complete section of crustal rocks from close to the crust-mantle transition to the volcanics at surface. The Ivrea zone represents a Paleozoic continental crust section that is affected by Permian transcrustal magmatism. The Ivrea – Verbano zone is thus a unique example where the chemical evolution of the continental crust over time can be studied. We compiled more than 1300 bulk rock major and trace element compositions and analyzed them to identify major changes in the chemical composition induced by the addition of voluminous magmatic bodies in the Permian.
An evaluation of major element chemical trajectories of pre-Permian Ivrea crust and the Permian magmatic additions indicates that the metasedimentary crust is dominated by (mechanical) mixing trends, while the magmatic addition closely follows trends controlled by mineral phase equilibra. Despite widespread evidence for partial melting and assimilation processes during Permian transcrustal magmatic activity in the Ivrea – Verbano zone, cumulate lines of descent from experimental studies on lower crustal differentiation are comparable to the magmatic evolution. This indicates that global datasets from metamorphic terrains can be evaluated for their igneous versus metasedimentary contribution to the bulk continental crust.