Goldschmidt2017 Abstract

Post-collisional magmas: Isotopically camouflaged contributors to crustal growth

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The continental crust is assumed to have been extracted from a single complementary mantle reservoir, initially chondritic, that became progressively depleted over time: the Depleted Mantle (DM). Recently, the combination of U–Pb–Hf–O isotope analyses in global zircon databases has been used to constrain the timing and rates of continental crust growth. The crust-forming events are identified based on the premise that zircons from juvenile materials display Hf–O isotope systematics similar to that of the DM. Such grains are typically abundant in magmas generated in modern-day subduction zones which have been retained as the loci of continental crust growth. In contrast, this work suggests that magmas emplaced shortly after continental collision represent a non-negligible contribution to crustal growth, despite having zircons with "crust-like" isotopic characteristics. We address this paradox and its implications for crustal evolution based on a case study from the Variscan French Massif Central. Mafic magmas rich in both compatible and incompatible elements are systematically emplaced at the end of orogenic episodes. Their dual signature is best explained by melting of phlogopite– and/or amphibole–bearing peridotite, formed by contamination of the mantle by limited amounts (10–20%) of crustal materials during continental subduction. Mass balance constraints show that 62–85% of their bulk mass is provided by the mantle component, whereas incompatible trace elements are dominantly crustal in origin. Thereby, they represent significant additions to the crust, whilst their zircons have "crustal" isotope signatures. Because post–collisional mafic magmas are (i) ubiquitous since the late Archean; (ii) the parental magmas of voluminous granitoid suites; (iii) selectively preserved in the geological record, zircons crystallized from such magmas bias the crustal growth record of global zircon Hf–O isotopic datasets towards ancient crust formation and, specifically, may lead to an under-estimation of crustal growth rates since the late Archean.