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Elusive zircon record of water-fluxed orthogneiss melting in the Velay dome (Massif Central, France)

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Zircon U–Pb geochronology is routinely performed to decipher the timing and duration of melting events within the continental crust. A comprehensive understanding of the zircon behavior during anatexis is thus of critical importance to accurately assess the impact of crustal melting on orogenic processes. We investigated an anatectic system from the southern part of the Velay dome (Variscan French Massif Central) comprising late Carboniferous migmatites developed at the expense of peraluminous augen gneisses and associated with (leuco)granite bodies intrusive at higher structural levels. Our zircon U-Pb geochronological survey (494 analyzed grains) evidences a very limited record of the Variscan anatectic event. Indeed, oscillatory-zoned melt-precipitated zircon grains extracted from metatexites, leucosomes and (leuco)granites almost systematically yielded the late Neoproterozoic crystallization age of the orthogneiss protolith/source. Field and petrographic observations, whole-rock geochemical signatures, phase equilibrium and thermodynamically-constrained trace element modelling collectively indicate that partial melting of the orthogneisses took place at T~700°C and was fluxed by ingress of external water, most likely originating from H_2O-rich dioritic or granitic magmas. The lack of new Variscan zircon growth observed in our dataset is intimately tied to the low melting temperature which is shown to restrict the amount of Zr being possibly dissolved in the melt phase (in terms of Zr melt solubility; Zr dissolution kinetics; and physical occlusion of zircon in restitic biotite). Peraluminous orthogneisses, yet highly fusible due to their “eutectic” subsolidus mineral assemblage, exhibit a very limited zircon record of low temperature water-fluxed melting meaning that zircon has little potential to provide reliable chronological constraints on water-fluxed melting episodes affecting such lithologies.

Mots-Clés : zircon geochronology, water-fluxed melting, anatexis, Variscan orogeny, Velay dome

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