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Mg-K mafic magmatism and catastrophic melting of the Variscan crust in the southern part of the Velay complex (Massif Central, France)

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The Late Carboniferous Velay complex is a large migmatite dome extending over the central-eastern part of the French Massif Central. Two stages of migmatization were recognized in the southern edge of the complex : (1) “Pre-Velay” anatexis under biotite stable and water saturated conditions. (2) “Velay” water-absent melting synchronous with emplacement of the peraluminous S-type Velay granite cutting across the Early Carboniferous nappe stack.

Field study of the southern part of the dome shows that Mg-K-rich micaceous diorites of mantle origin, locally called vaugnerites, outcrop as intrusive bodies in three main settings : (1) Meter-sized stocks are intimately associated with several granite plutons, the comagmatic ascent and crystallization of mafic and felsic melts being evidenced by lobate contacts and intricate shapes. (2) Decameter-sized medium to coarse-grained massifs and sills emplaced in unmolten to metatexitic paragneisses. (3) Fine-grained decimeter-sized concordant lenses are found as clusters in metatexitic to diatexitic orthogneisses.

Seven vaugnerites were dated either directly or indirectly through their co-magmatic host granite. In situ (LA-ICP-MS) zircon and monazite U-Pb ages are indistinguishable within analytical uncertainties, spanning from 303.7 $\pm$ 3.1 to 307.4 $\pm$ 1.8 Ma except for one slightly younger (294.4 $\pm$ 3.9 Ma) sample . Granites and vaugnerites of the study area emplaced mainly during a short period of time at ca. 305 Ma. Assuming vaugnerite intrusions are coeval implies that their varied shapes are a consequence of contrasting behavior of the mafic magma depending on the host.

Granites from the southern Velay are exactly of the same age, ca. 305 Ma, although several generations can be clearly identified based on field relationships. They display complex zircon inheritance patterns involving Proterozoic to Cambro-Ordovician components; in details, the inheritance pattern varies between (or even within) plutons, pointing to the involvement of a range of crustal sources. This large 305 Ma granite production event is related to melting of varied portions of the Variscan crust and is synchronous with intrusion of Mg-K mafic mantle-derived melts in the middle crust. This close temporal association support a key-role played by Mg-K magmatism in the last stages of the Variscan orogeny with mass and heat flux from the mantle enhancing crustal melting and subsequent collapse of the belt.