Geodynamics and lithospheric differentiation: a G3 approach applied to the Variscan belt of Western Europe

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Résumé

In this contribution, we explore the concept of lithospheric differentiation through a comparison of geological, geochemical and geophysical data from the Variscan belt of Western Europe. The Variscan belt consists of metamorphic nappes emplaced from 380 to 340 Ma, overlying a migmatitic middle crust exhumed around 320–300 Ma. Migmatites developed to the expense of paragneiss and orthogneiss but also contain enclaves of Mg-K-rich diorite, which represent mantle-derived magmas influenced by subduction. The lower crust granulites record PT of _˜1.0 GPa and _˜1000 ∘C at 320–280 Ma. Mantle xenoliths reveal distinct mantle domains with (i) spinel-harzburgites in the BM and northern FMC, interpreted as a fossil Variscan depleted mantle wedge accreted during orogenesis, and (ii) spinel-lherzolites in the southern FMC, reflecting refertilization by melts from upwelled asthenosphere. This lithospheric mantle has been variably overprinted by Cenozoic carbonated alkali basalt melts.
The lithospheric-mantle to crust ratio (lm/c) reconstructed from gravity and seismic data shows (i) a high lm/c for Baltica, Laurussia, Avalonia and Armorica, which reflects their thick lithospheric mantle and dense crust, (ii) a low lm/c for the internal zone of the Variscan belt and reworked Gondwana margin owing to a thin lithospheric mantle (
Based on these data, we propose that the Western European lithosphere was largely shaped during the Variscan orogeny. We propose that slab retreat during convergence caused thinning of the mantle lithosphere of the upper plate and triggered lateral flow of the partially molten Variscan orogenic root and gravitational collapse of the belt. In Bohemia, this collapse was limited, as evidenced by the preserved 40 km-thick crust, but was more pronounced in France and Iberia, enhanced by southward slab retreat from 340 to 290 Ma. Partial melting of the orogenic crustal root started at the orogenic climax and was further boosted by emplacement of mantle-derived magmas generated by decompression melting caused by thinning of the lithospheric mantle of the upper plate. Transfer of these magmas during orogenic evolution led to lithospheric differentiation.

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