A Pyrenean-like model for the Variscan belt in NW Africa: insights from thermometry-based Raman spectroscopy study in the Khenifra Basin

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The Variscan belt in NW Africa is an intracontinental belt, resulting from far-field compressional stress during the closure of the Rheic Ocean between the Late Carboniferous and the Early Permian. In the classical view, this orogen building was preceded by a pre-orogenic stage, namely the Eo-variscan stage, suggested to have occurred at the Late Devonian-Early Carboniferous transition.

This view is now questioned, for multiple reasons. A first structural reason aims at re-interpreting the so-called Eovariscan features as extensional ones. Indeed, although many structures have been described, their integration into a compressional setting is not straightforward. A second reason is geodynamical, since this peculiar stage is bracketed between two general extensional phases recorded at the scale of NW Africa, and this leaves a very short time interval to proceed to a compressional phase that is geodynamically not integrated until today. At last, a third reason stems from early findings from metamorphic works in the Western Meseta that demonstrated the occurrences of previously unnoticed high geothermal gradients inside numerous Early Carboniferous basins (Chopin et al., 2014; Wernert et al., 2016; Delchini et al., 2018; Lahfid et al., 2019).

In this work, we sampled the Khenifra Basin within the easternmost part of the Western Meseta, where the Eovariscan deformation was defined (Allary et al., 1972). We carried on structural observations into the basement and sampled both the Ordovician basement and the Middle?-Late Visean series of the basin, which is thought to be extensional. Maximum temperatures reached by the 77 sampled rocks were obtained from the analysis of organic matter with the use of the Raman spectroscopy. The examination of this new dataset demonstrates that the Ordovician series acquired temperatures through a single event, consistently with their common record of the Eovariscan deformation. Instead, the unconformable Visean series on top
of the basement show a pronounced basinal asymmetry, from low temperatures (< 160°C) to temperatures equivalent to the Ordovician ones (> 250°C). The Visean series do not record the Eovariscan deformation, and their thermal structure was acquired before the Variscan event, regarding their repartition within the basin. The examination of the different hypotheses for the timing of the maximal temperature acquisition (Variscan, compressional Eovariscan and extensional Eovariscan) leads to a single option only compatible with an extensional Eovariscan context.

The renewal on the knowledge about the early stages of the Variscan orogeny in NW Africa allows us to consider a Pyrenean-like model for the formation of this intraplate belt, resulting from the inversion of hot Early Carboniferous rifted basins.