



Perspective

Orthogneisses in the deepest levels of the Variscan belt are not a Precambrian basement but Ordovician granites: tectonic consequences

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Augengneisses are known in the deepest levels of the European Variscan Belt, and particularly well represented in the French Massif Central where they were first interpreted as resulting from metamorphism and metasomatism ('embréchites ocellées' of Jung and Roques) [10]. Another origin was proposed by Autran and Guitard [2], who considered that the orthogneisses of the Canigou dome (eastern Pyrenees) were Precambrian granites unconformably overlain by Cambrian sediments and involved in large (20 km) southward recumbent folds of Penninic alpine style. This interpretation was accepted by Demange [8] for the granitic orthogneisses of the Montagne Noire axial dome, that were considered as well as a Precambrian granitic basement involved in large Penninic folds, but here curiously recumbent to the north, a vergence opposite to the well-known southward recumbent folds that deform the sedimentary cover of the southern Montagne Noire [1].

The dating of the granitic orthogneisses of the Montagne Noire by Roger et al. [15] as Ordovician (450–460 Ma) is a crucial result that gets new insights into the tectonic interpretations and the geodynamic evolution of the European Variscides.

The augengneisses of the Montagne Noire are not a Precambrian basement, but Ordovician granites in-

truding a Lower Palaeozoic or Proterozoic sedimentary series. That was already proposed 15 years ago by Bard [4] on the basis of a petrologic and structural study. Similar ages were found in the eastern Pyrenees by Delaperrière [6] and Deloule et al. [7] for the gneisses of the Canigou dome. The consequences for the Variscan belt are very important.

- The first one is a direct structural consequence: the hypothesis of large recumbent folds with a gneissic core and inverted limb may be ruled out even if the gneisses are intensely sheared and involved in southward facing nappes in both areas [16].
- The second one is, the question of the location of the old Precambrian crystalline basement in the Variscan Belt: only very small gneissic outcrops around 2 Ga exist in northern Brittany and the Channel islands. Apart that, everywhere the rocks found beneath the Cambrian rarely exceed 650 Ma. Other remnants of the old basement around 2 Ga are found by dredging west of Iberia in the Galicia bank [9], which is the probable continuation of the northern Brittany on the southern branch of the Ibero-Armorican Virgation. Other remnants of same age are found by dredging offshore north of Iberia as pebbles in a Cretaceous breccia. These rocks (BP granulites), which were uplifted by the Pyrenean tectonics, could represent

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the deepest basement beneath the Upper Proterozoic sediments in the autochthonous substratum of the Cantabrian nappes.

Why the deep crystalline Precambrian basement (2 Ga) outcrops so rarely in the Variscides? Probably because it was reworked and buried beneath thousands of metres of Proterozoic (Panafrican orogeny) and Lower Palaeozoic sediments (passive margin) before the Variscan tectonics.

What is the geodynamic meaning of the Ordovician granitic magmatism? Convergence or extension? Rift or arc? Both hypotheses have been proposed. In some places where the Ordovician (480 Ma) granitoids are typically peralkaline, as in southern Portugal [11], the rift origin is clear. For other calc-alkaline granites similar to those of the Montagne Noire and the Pyrenees, as the Central Iberian Ordovician volcanism and magmatism [13], an arc origin was pointed out [16]. Nevertheless, if we take into account the general geodynamic setting during Ordovician times, we favour more extension than convergence. Firstly, the Ordovician period corresponds to the opening of oceanic basins, particularly in the Massif Central [12] where remnants of oceanic crust are dated at 480 Ma [14]. Secondly in other continental parts of the belt, like the Montagne Noire, the thick Ordovician sediments are typical of extensive passive margins. Finally, structural evidences of normal faulting during Ordovician, leading to block tilting and angular unconformities, were described in various parts of the Variscides, as in central Brittany [3] or northwestern Iberia [5] and eastern Pyrenees.

What are the perspectives resulting of this new work?

- Firstly it is evident that geochronology (if possible multi-method) is necessary for a better understanding of the deep structures of the Variscides. Especially in the Massif Central, it is crucial to distinguish among the various orthogneisses Ordovician and possibly older ones. Very few are dated and not by modern methods.
- A second point is to better understand the Lower Palaeozoic granitic magmatism, particularly its geodynamic meaning. For that, geochemical studies are necessary and especially ϵ_{Nd} values.
- Careful mapping would be useful to better understand the emplacement mechanisms. Why these orthogneisses are so concordant with the bedding/ foliation plane as in Montagne Noire? Because they are laccolites? Or only because they are flattened and sheared by the Variscan tectonics? Did they develop contact metamorphism before the Variscan regional metamorphism?

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