



Late-Variscan and Pyrenean low-T metamorphism recorded in the basement and sedimentary cover of the southern Axial zone (Bielsa massif, central Pyrenees)

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The Pyrenean mountain belt experienced a polyphased history from the Variscan to the Alpine orogeny. Deciphering the different phases of metamorphism and deformation in the present structure of the belt is difficult, and particularly challenging in the Axial zone (central Pyrenees), where peak metamorphic conditions remained below 450 °C. This is however crucial to understand the evolution of the Pyrenean belt after pluton emplacement at c. 310-320 Ma. In this study* we characterize the age and conditions of different stages of greenschist-facies metamorphism in the Bielsa Variscan basement massif (below the Gavarnie unit, in the southern Axial Zone) and its Permo-Triassic sedimentary cover. At its northern and southern borders, the massif is extensively metasomatized throughout a vertical section of at least 2000 m depth. Similar alteration features have been observed eastward in the Pyrenees and are therefore probably significant at the scale of the central Axial zone. Field observations near Lake of Urdiceto, in the northern part of the massif, show that the sedimentary cover and its basement are tightly and harmonically folded. Close to the lithological contacts between the basement and the sedimentary cover, mylonitic bands extend ~E-W. Further away from the contact, zones of brittle deformation alternate with undeformed granite and mylonites. In all samples, at microscopic scale, the magmatic mineral assemblage is replaced by greenschist-facies metamorphic minerals, including chlorite, white mica, rutile and titanite. Chlorite-white mica thermobarometry and LA-ICP-MS in-situ U-Pb rutile and titanite dating indicate that the alteration occurred at ~300-350°C, ~2 kbar and 310-280 Ma. In samples with higher strain, secondary chlorite, white mica, monazite and rutile overprint earlier metasomatic events. P-T-t conditions for this event are estimated at ~200-250°C, 3-4 kbar and c. 40 Ma. Mylonitic bands preserve both metamorphic stages. Sediments exhibit two generations of veins (extensional and transtensional) filled with two generations of chlorite and rutile partially reset at Triassic and Eocene times. These results suggest that (1) the sedimentary cover and the basement experienced a similar history since sediment deposition, (2) the Bielsa massif was heterogeneously altered and deformed prior to the Pyrenean orogeny (late-Variscan) without recording the Cretaceous rifting phase preserved in the eastern Pyrenees, (3) Alpine metamorphism is preserved and localized in the most deformed areas of the massif. The spatial distribution of the deformation and metamorphism have been likely controlled by the first late-Variscan alteration, in Bielsa as in the other massifs of the Axial zone: the crust must have been significantly weakened prior to the Pyrenean shortening.

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