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Foreword

From rifting to mountain building: The Pyrenean Belt

The Pyrenees are again under the spotlights! Today, an increasing number of research groups are focusing on this apparently simple double-verging orogeny. These recent (and ongoing) studies using a broad range of disciplinary approaches have greatly improved our understanding of the geological structure and tectonostratigraphic evolution of the Pyrenees and sometimes also challenged well-established models.

Over the years, the Pyrenees have generated numerous controversies due to their specific geological and geophysical characteristics and their occurrence in a highly debated plate kinematic framework. The uncertainties on the size of their crustal root, along with the occurrence of a HT–BP metamorphic belt and numerous bodies of mantle peridotites made the interpretation of the initiation and formation of this orogen particularly challenging. In spite of these shortcomings, the Pyrenees have been used as the main model for the studies of tectonic–sedimentation relationships, notably on their southern flank. As a consequence, the northern flank and the central region, the axial zone, have been little explored during the past 20 years.

Recent models proposing pre-orogenic mantle exhumation have contributed to the renewing interest within the geosciences community for the Pyrenean orogeny. Also, the recent discovery of ongoing extension of continental passive margins in remote deep-sea regions requires, today, to better understand their on-land analogues. This new research on the pre-orogenic evolution of the Pyrenees triggered a renewed interest in the processes of tectonic inversion and tectonic wedge development. For these reasons, the Pyrenees have become the focus of a series of national and international research projects (e.g., PYRTEC, PYROPE, PYRAMID, Orogen...).

In this thematic issue, we gather contributions from various approaches and methods focusing on a wide variety of topics, thus illustrating the renewed interest for all the facets of this orogen. This volume stems from a special session at the RST 2014 held in Pau (France), which brought together the scientific communities from both sides of the Pyrenees and where these new results were discussed and debated for the first time. The articles of this dossier dedicated to the Pyrenees are organized according to the geological time scale from Present to oldest periods.

Genti et al. (2016) use numerical modelling to evaluate the role of a set of geophysical and topographic parameters in the development of normal faults to the North of the Central–Western Pyrenees and investigate the mechanisms controlling seismicity in this area. They show that seismicity is strongly related to flexural rebound induced by surface processes.

The morphotectonic evolution of the Pyrenees during the Cenozoic is studied by Monod et al. (2016), based on the analysis of thick weathered horizons still preserved on flat, high-elevation surfaces. Mapping these horizons allows a 3D reconstruction of the ancient palaeosurface postdating the Eocene–Oligocene denudation, thus outlining its post-orogenic character.

These high-elevation surfaces are also studied by Bosch et al. (2016a), who test between two opposite interpretations regarding their evolution. The presence of a thick crustal root at the base of the surface remnants and the similar level of erosion in both the Central and Eastern Pyrenees favour an interpretation where the rise of the efficient base level of the chain induced the progressive inhibition of erosion and the smoothing of the relief before the Late Miocene.

Nivière et al. (2016) use the cosmogenic nuclide ^{10}Be to date an alluvial terrace in the foothills of the northwestern Pyrenees. This terrace was abandoned at 18 ± 2 kyr, more recently than previously thought, thus leading to a renewed interpretation of the geomorphological and climatic evolution of this region. In addition, dating suggests reactivation of a major thrust in this tectonically active area of the western Pyrenees.

Solo et al. (2016) measured magnetic fabric in apparently undeformed Lower to Middle Miocene sediments of the Ebro basin and show the presence of a subtle non-sedimentary magnetic fabric, which could be associated with a very weak north–south compressional deformation of the same age.

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New chrono- and lithostratigraphy for the central Aquitaine foreland basin combined with subsidence analyses are used by Rougier et al. (2016) to construct a sequentially restored, 120-km-long cross section through the North Pyrenean retrowedge. Two prograding cycles of basin fill are identified, controlled by very modest tectonic subsidence associated with gentle north-directed shortening in the Pyrenean retroforeland.

Roigé et al. (2016) study the Eocene clastic systems of the Jaca foreland basin (southern Pyrenees). They outline changes in sediment composition during the tectonostratigraphic evolution of the basin and show that the shift from Middle Lutetian deep-marine conditions to a Priabonian alluvial system records a main reorganization in the active Pyrenean pro-wedge.

Bosch et al. (2016b) provide new apatite (U–Th)/He (AHe), apatite fission track (AFT) and zircon (U–Th)/He (ZHe) data to unravel the timing of exhumation and thrusting in the western Axial Zone of the Pyrenees and the adjacent North Pyrenean Zone including the Chaînons Béarnais, thus providing insights into the tectonic and relief evolution of the chain. These data better constrain the timing of motions along the main thrusts of the Axial Zone.

Teixell et al. (2016) present a new crustal section of the Pyrenees through the Jaca basin, the western Axial Zone and the Chaînons Béarnais. They consider feedbacks between the mid-Cretaceous hyperextension postulated recently and the Pyrenean inversion. Their reconstruction allows identifying the ancient continental margins of the Iberian and European plates and a suture domain where mantle rocks have been exhumed at the foot of both passive margins.

Saint Blanquat, (de) et al. (2016) provide new constraints on the modes of mantle exhumation in the pre-orogenic Pyrenees by studying the peridotites located east of the Lherz body. They reveal the petrographic variability and the heterogeneity in the serpentinization degree of the exposed mantle rocks. These results imply a mode of exhumation, which favoured merging mantle fragments from different structural levels. As in the Lherz area, these bodies are indisputable witnesses of a hyper-extended Cretaceous passive margin.

The mechanisms of mantle exhumation in the distal portion of the palaeomargins are also investigated by Corre et al. (2016) in the western North Pyrenean Zone. New mapping shows that mantle rocks have been exhumed during Albian–Cenomanian times and that extreme crustal thinning and mantle exhumation occurred along a detachment associated with the boudinage of both the mantle rocks and the ductile continental basement.

Based on structural analysis and Crystal Preferred Orientations (CPO) measured in marbles of the Lherz region, Lagabrielle et al. (2016) show that the prerift sediments of the North Pyrenean Zone display an evolution from ductile to brittle deformation under a very high thermal gradient. They describe exhumation processes ending with the sedimentary reworking of both the deformed Mesozoic metasediments and the exhumed ultramafic rocks.

The oxygen and carbon isotopic compositions of quartz–calcite veins in the Boucheville basin are investigated by Boulvais (2016) and show that the fluids that circulated throughout the Boucheville Basin were generated within the basin itself. Therefore, these fluids are the consequence, not the cause, of the Pyrenean HT–LP Cretaceous metamorphism.

New sedimentological and structural data of the Boucheville basin were collected by Chelalou et al. (2016) and are used to produce synthetic stratigraphic columns of different portions of the basin and to restore selected cross-sections. They show the asymmetrical geometry of the basin. Raman spectroscopy on carbonaceous material (RSCM) reveals homogeneity in the temperatures between 500 °C and 600 °C.

Munoz et al. (2016) present the first detailed study of the base-metal vein-type mineralizations exposed within the Axial Zone metasediments. The Pb–Zn deposits are located in Devonian terranes south of the Mesozoic Aulus basin and are interpreted to have been emplaced under an extensional setting by low-temperature $NaCl–CaCl_2$ brines. Isotopic $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ ratios acquired on galena suggest an emplacement during the Middle–Late Triassic and the Late Jurassic.

The post-Variscan evolution of the Anayet Basin is investigated by Rodriguez-Méndez et al. (2016). This evolution is characterized by a trans-tensional regime, which began at least in Stephanian times and lasted until the Late Permian. During Middle Eocene times, the Alpine Orogeny inverted and deformed the Anayet Basin.

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