

Coupled bedrock and detrital thermochronometry of a hyper-extended continental margin, Mauléon, Pyrenees

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Modern thermochronometric dating techniques have become increasingly powerful tools with a diverse range of applications in quantifying tectonic and sedimentary processes at rifted continental margins. While detrital zircon U-Pb is commonly used in detrital provenance studies, zircon (U-Th)/He (ZHe) dating has been shown to be a complimentary tool that not only constrains sediment provenance, but also the exhumation history of a sediment source region(s). In particular, analysis of ZHe lag time - time required for exhumation, erosion, and deposition in a sedimentary basin – is a powerful tool in elucidating the temporal and thermal evolution of tectonically active source areas. In hyper-extended margin basins, such as the Mauleon basin, inverted unroofing sequences with up-section variations in lag time can record changes in either sediment source(s) or exhumation rates during progressive continental break-up.

During progressive thinning and exhumation, different exhumed lithospheric levels will shed not only zircons but also lower-crustal rutile into syn-rift basins recording progressive crustal rifting and thinning. Zircon and rutile U-Pb-He double dating studies have shown the power of coupling these data with other geochemical characteristics or fingerprints (e.g., REE spectra, Hf isotopes, or trace-element thermometry) to further refine provenance signatures. Rutile double dating should be of particular use in hyper-extended margin settings, as rutile-bearing granulitic, lower-crustal rocks are exhumed during the thinning and exhumation phases. In summary, modern detrital U-Pb-He dating of accessory phases is ideally suited to reconstruct the complete tectonic evolution of hyper-extended continental margins, as syn-rift basins tend to archive a more complete record of evolution of the margin compared to bedrock thermal histories that are prone to thermal overprinting or loss to erosion.

The Mauléon Basin of the Western Pyrenees is an ideal hyper-extended basin for this study due to extreme crustal thinning during Cretaceous rifting followed by Pyrenean reactivation. Due to the fact that the Western Pyrenees experienced less reactivation and deformation, many of the pre-rift structure of the Western Pyrenees are preserved and can be analyzed and compared to the syn- and post-rift units and structures. This study is the first major chronologic study completed in the Mauléon Basin. The sample transect runs north-south and covers the length of the basin and intra-basin structures. By using the discussed techniques, this study will give new insights into the structure of the Mauléon Basin and the Western Pyrenees, rifting of the Pyrenees and also plate reconstructions and kinematics of the Iberian and European plates.

Keywords: Pyrenees, Zircon, Rutile, Thermochronology, Double-dating, U-Pb, (U-Th)/He, Extensional tectonics