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ORIGINAL PAPER

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Long-term thermo-tectonic evolution of the Montes de Toledo area (Central Hercynian Belt, Spain): constraints from apatite fission-track analysis

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Abstract In the Montes de Toledo area, located in the axial part of the Central Hercynian zone, a long-term thermo-tectonic evolution can be deduced from apatite fission-track (AFT) data in conjunction with tight geological constraints derived from the knowledge of regional geology and other independent chronometers. The area is composed of two different blocks separated by the Toledo Shear Zone (TSZ). The northern block is a granulite facies anatectic terrane. The southern block is composed of greenschist facies Paleozoic sediments intruded by a late Hercynian granitic pluton. A total of 13 samples have been recovered for AFT analysis. AFT ages in both blocks cluster around 189–221 Ma, with mean confined track lengths between 11.4 μm and 12.4 μm. Modeling of the AFT data indicates that the thermal history is broadly similar in both blocks, which constrains the main movement of the TSZ, as essentially before the Upper Permian. AFT ages in the TSZ cluster around 124–164 Ma, and the track lengths vary between 11.4 μm and 12.4 μm. These data reveal that the fault must have been affected by a later thermal overprint as AFT ages are significantly younger than those of the footwall and hangingwall blocks. This differential thermal resetting is likely related to the advection of localized hydrothermal fluids that are responsible for the widespread Pb–Zn mineralization along the TSZ. These results give an example of resetting AFT data by hydrothermal events. The long-term evolution suggests a lack of important Alpine tectonism in the Montes de Toledo block, in clear contrast to other nearby Hercynian areas such as the Sierra de Guadarrama, where the important effect of Alpine tectonism has almost totally erased the previous thermal signal in the AFT system.

Keywords Spanish Central Hercynian Zone · Apatite fission-track dating · Resetting related to fluids · Mesozoic and Cenozoic thermal history

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Introduction

The Montes de Toledo and the Sierra de Guadarrama belong to an intraplate range (Central Iberian Zone) that originated from the stress migration toward the inner part of the Iberian microplate during two different Alpine collisional events (Fig. 1). The convergence between the Eurasia and Iberia plates during the Paleogene and Early Miocene led to the formation of the Pyrenees–Cantabrian mountain range; and the convergence between the African and Iberian microplate from the Miocene to the present created the Betic Cordillera (Zoback 1992; Anderweg et al. 1999). Both collisional events affected the basement of the central part of the Hercynian Iberian Belt.

The Sierra de Guadarrama is the main relief in Central Spain reaching maximum altitudes of about 2,600 m. The range trends parallel to the Betic Cordilleras, which suggests a possible tectonic control of the latter in the formation of the Sierra de Guadarrama (De Brujne 2001; de Bruijne and Andriessen 2000; De Bruijne and Andriessen 2002). The AFT-dating technique was used to quantify the far-field effects of the Alpine orogeny on the exhumation of the Sierra de Guadarrama (de Brujne and Andriessen 2002). In contrast, the northern part of the Montes de Toledo area, located 70 km to the south of the Guardarrama range, is