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► To cite this version:

Elo se Bessi re, Laurent Jolivet, Romain Augier, St phane Scaillet, Jacques Pr cigout, et al.. Lateral variations of pressure-temperature evolution in non-cylindrical orogens and 3-D subduction dynamics: the Betic-Rif Cordillera example. EGU General Assembly 2021 (online), Apr 2021, Online, France. 10.5194/egusphere-egu21-7837 . hal-03554562

HAL Id: hal-03554562

<https://hal.science/hal-03554562v1>

Submitted on 3 Feb 2022

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EGU21-7837, updated on 03 Feb 2022

<https://doi.org/10.5194/egusphere-egu21-7837>

EGU General Assembly 2021

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Lateral variations of pressure-temperature evolution in non-cylindrical orogens and 3-D subduction dynamics: the Betic-Rif Cordillera example

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Orogens closely linked to 3-D subduction dynamics are frequently non-cylindrical and the Mediterranean region is a perfect natural laboratory to observe several of them, as well as their interactions. Through the succession of extension, subduction and sometimes collision events, the kinematic reconstructions of such orogens can be difficult and the subject of active debates. The internal zones are often non-consensual, especially when their long-term Pressure-Temperature-time-deformation (P-T-t-d) evolutions are studied. This complexity is mostly due to pre-orogenic inheritance or complex interactions between the subducting lithosphere, the overriding plate and the asthenosphere. All these elements are described and documented in Mediterranean orogens, i.e., a complex shape of the Eurasian and African margins in pre-orogenic times and a complex slab retreat and tearing dynamics. Their 3-D geometry results in strongly arcuate belts, such as the Betic-Rif Cordillera, located in the westernmost part of the Mediterranean region.

Focused on the Internal Zones of the Betic-Rif Cordillera and based on recent findings (Orogen Project framework), a synthesis of the tectono-metamorphic evolution shows the relations in space and time between tectonic and P-T evolutions. The reinterpretation of the contact between peridotite massifs and Mesozoic sediments as an extensional detachment leads to a discussion of the geodynamic setting and timing of mantle exhumation. Based on new ⁴⁰Ar/³⁹Ar ages in the Alpujarride Complex (metamorphic formations of the Betic Internal Zones) and a discussion of published ages in the Nevado-Filabride Complex (metamorphic formations of the Betic Internal Zones), we conclude that the age of the HP-LT metamorphism is Eocene in all the Internal Zones. A first-order observation is the contrast between the well-preserved Eocene HP-LT blueschists-facies rocks of the Eastern Alpujarride-Sebtide Complex and the younger HT-LP conditions reaching partial melting recorded in the Western Alpujarride. We propose a model where the large longitudinal variations in the P-T evolution are mainly due to (i) differences in the timing of subduction and exhumation, (ii) the nature of the subducting lithosphere and (iii) a major change in subduction dynamics at ~20 Ma associated with a slab-tearing event.

