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Serpentinization of the Ronda Massif (Spain): structural control and fluid origin, a framework for metal mobility

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1. Introduction

Serpentinization is a hydrothermal transformation of ultramafic rocks, such as the Sub-Continental Lithospheric Mantle (SCLM) which represents a reservoir of metals (e.g., Cu, Zn, Co, Ni, Cr, PGE, V, Ti, Au). During their exhumation, the mantle rocks are affected by various hydrothermal processes which can lead to economically viable metal deposits (e.g., seafloor massive sulfides; Patten *et al.*, 2022). Despite some works (Deschamps *et al.*, 2013; Lawley *et al.*, 2020), **the characteristics of metal mobilities during serpentinization still remain poorly constrained**, notably the related spatial scales. To address this issue, we have chosen a terrestrial example : the Ronda Massif (Spain). This massif is the largest remnant of SCLM in the world. It is partially serpentinized and is thus perfectly suitable to characterize metal mobilities at various scales (from the centimetre to the multi-kilometres scales). To date, **studies on the serpentinization of the Ronda peridotite remain scarce** (Pedrera *et al.*, 2016). Here we present the main serpentinization stages, then the structures along which serpentinization occurred and stable isotope data (*i.e.*, oxygen and hydrogen), as a pre-requisite to study metal mobilities.

2. Geological setting

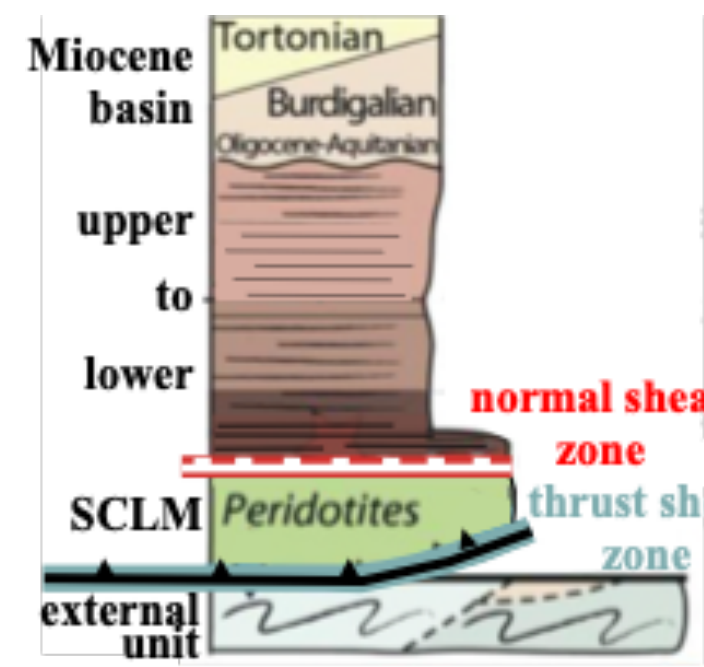
The Ronda Massif is located in the western Betic Cordilleras (Spain). This chain is the result of polyphase tectonics, starting from the oceanic openings during Mesozoic (Central Atlantic Ocean, Ligurian Tethys and Maghrebian Tethys), to Cenozoic convergence between Africa and Iberia plates.

The Ronda Massif is a paleolithosphere slice (*i.e.*, upper to lower crust with SCLM) exposed at the earth surface. However, the mechanisms and timing of this massif emplacement are still controversial.

To date, we retain 2 models :

- transpressionnal emplacement (Mazzoli *et al.*, 2011),
- back-arc rifting before thrusting (Frasca *et al.*, 2017).

The emplacement timing is approximated by dating differentiated felsic magmas that intruded the Ronda Massif between 19 and 22 Ma (U-Pb on zircon; Frasca *et al.*, 2017).



3. Three stages of serpentinization in the Ronda Massif

Stage 1: pervasive mesh texture serpentinization

