H_2 through low-temperature serpentinization at active faults. Ronda peridotite, Betics-Rif

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INTRODUCTION

In recent years, serpentinization has become an object of study due to its role in geologic hydrogen production (Osselin et al., 2022) and the increasing interest that this gas is arousing, because of the advantages that it presents as a possible energy source (Gaucher et al., 2023).
It is proven that hydrogen production occurs as a consequence of iron oxidation during serpentinization (McCollom et al., 2016). At high temperatures (~320 ºC) and high Fe-rich olivine contents, magnetite is the prominent mineral to host the recently formed ferric iron (McCollom and Bach, 2009; Klein et al., 2013). Nevertheless, serpentinization can also occur at lower temperatures (below 200 ºC) and other minerals, like brucite, would host the ferric iron (Klein et al., 2014). Thus, hydrogen production can occur under a wide temperature range, which may have strong implications in case of search for accumulations.
This low-temperature serpentinization has been observed in orogenic peridotites within Iberia (Klein et al., 2014), characterized by a Mg-rich olivine (Forsterite) and a low temperature geologic setting. The Ronda peridotites are emplaced in the Betics-Rif and, with 300 km^2 of extension, represent the biggest massif of subcontinental lithospheric mantle in the world (Gervilla et al., 2019). Several springs occur in the Ronda peridotite massifs located along fault traces (Ojeda et al., 2023). Among these springs they are hyperalkaline ones, characterized by the precipitation of travertine and crystalline crusts (Giampouras et al., 2019) and with H^+ concentrations as high as 1.2 mg/l (Etiope et al., 2016). An example of these hyperalkaline springs is the Baños del Puerto spring, where we can observe several precipitation processes. When in contact with the atmosphere, the CO_2-driven uptake of the hyperalkaline fluids produces calcite-dominated precipitation. In addition, the interaction of the waters from this spring and the river ones results in the precipitation of aragonite, and the sporadic flooding of river waters and their subsequent evaporation lead to the precipitation of dolomite that takes place during the lithification of travertine. It is possible that the elevated contents of hydrogen of these hyperalkaline springs is related to serpentinization at low temperatures that could take place in a deep aquifer isolated from the atmosphere and connected to the springs through active faults (Giampouras et al., 2019).

METHODOLOGY AND OBJECTIVES

In order to characterize the low-temperature serpentinization associated to hyperalkaline springs, the first step in our study is to determine whether or not there is a relation between the tectonic activity of the area and the emplacement of the hydrogen seeps. In order to do so, we carried out a morphotectonic study, calculating the k_{sn} index and χ values, as well as hypsometric curves and integral of the basins. The aim of this study is to clarify if there is a link between active faulting and low-temperature serpentinization within the Ronda peridotites, as our preliminary results suggest, since the hyperalkaline springs are located in basins that have been recently rejuvenated by tectonic activity (Fig. 1).
As a work in progress, it will be followed by a detailed petrological study of the serpentinites found in the hyperalkaline springs. This petrological analysis will consist of the study of fluid inclusions (through RAMAN and micro-FTIR analysis), phase identification through compositional maps using SEM-BSE and EDX and the identification of serpentinite polymorphs. This cross-sectional approach, will allow us to better understand the effects of active faulting on the low-temperature alteration of ultramafic rocks and to characterize the alternative reactions of serpentinization that do not involve the formation of magnetite.

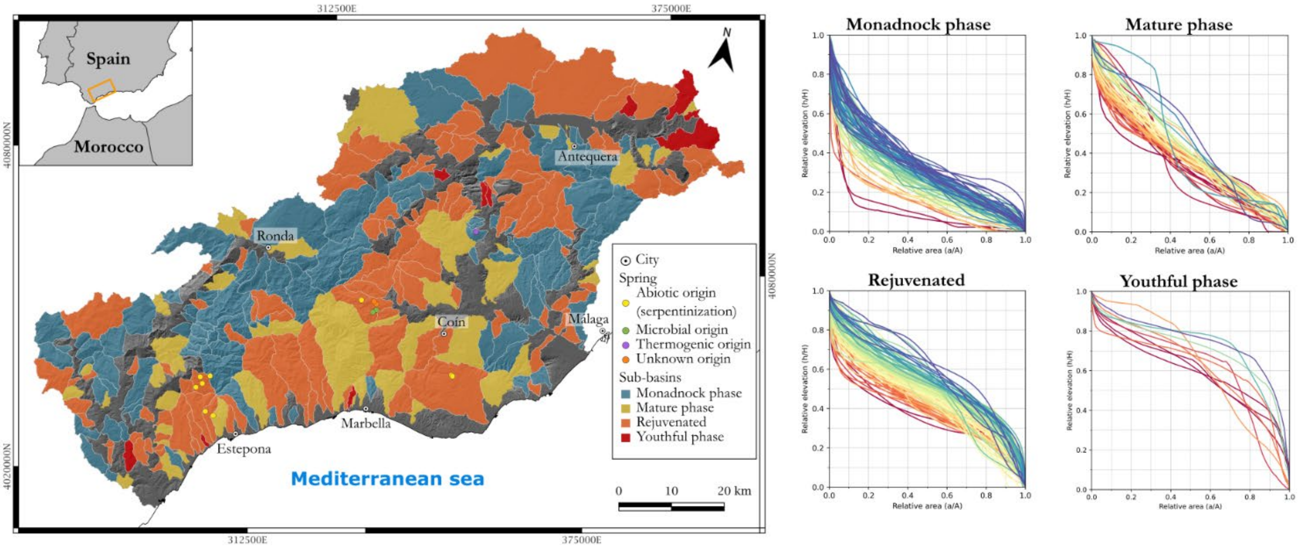

***Fig 1**. Basin clasification based on the hypsometric curves of the studied area. Note how the springs whith a possible serpentinization origin are located on rejuvenated basins.*

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