Scientific Report of STSM

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- **Purpose of the STSM:**

Peridotite massifs represent pieces of subcontinental mantle emplaced into continental crust. Through the combination of structural, petrological and geochemical investigation of these massifs exposed on surface, it is possible to put constrains on the composition and the processes occurring in the deep mantle lithosphere. The data obtained from peridotite massifs are complementary to the data provided by geophysical observations and indirect geochemical evidence, provided by extruded primitive volcanic rocks. The scope of my FLOWS STSM was to investigate the interaction between fluids and lithospheric mantle through the use of geochemical tracers in the Betic-Rif peridotite massifs (western Mediterranean region). These massifs constitutes the largest exposure of Subcontinental Lithospheric Mantle (SCLM) in the world, and hence offers unparalleled opportunity to unravel how fluids interact within the upper mantle, trigger melting and modify its rheological and seismic properties. Previous research (Reisberg and Zindler, 1986, Reisberg, 1988, Marchesi et al., 2012, Varas-Reus et al., 2014) has shown that the Betic-Rif lithospheric mantle interacted with large amount of fluids, likely of crustal origin, placed in a supra-subduction setting.

- **Description of the work carried out during the STSM:**

During the three months of my stay at the Géosciences Montpellier lab (Montpellier, France), I have performed the preparation and analysis of the radiogenic isotopes of Sr-Nd-Hf-Pb in a large scale sampling of the Betic-Rif peridotite massifs.

First of all, it was necessary to carry out a mineral separation in the selected samples to obtain pure separates of clinopyroxenes. The samples were crushed and sieved in the dependences of the Instituto Andaluz de Ciencias de la Tierra (IACT, Granada, Spain), recovering the mineral fraction 180-250 μm mesh, followed by magnetic separation. This separation was done using the Frantz isodynamic separator©, located also on the premises of the IACT. The necessary weight for each mineral fraction was determined by the concentrations of Sr, Nd, Pb and Hf in the clinopyroxene, and was approximately 100 to 200 ng. These concentrations were measured by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) in the Geósciences Montepellier Lab. The processing of the samples continued during my STSM in Montpellier, though a selection of ultra-pure mineral grains, in this case, clinopyroxenes, which are handpicked in alcohol under a binocular microscope. The grains of clinopyroxenes were then ultrasonically washed several times in alcohol and Milli-Q water. At this stage, mineral separates were very pure and only flawless minerals, free of cracks and visible inclusions. The last step consisted in crushing the minerals in an agate mortar. After this, samples were kept for isotopic analyses.

After powdering, samples were leached for 30 min at 110ºC with 6N HCL. Then the residues were rinsed two times with purified milli-Q H2O. Subsequent to leaching, samples were dissolved during 36-48 h on a hot plate with a mixture of HNO3, HF and HClO4. After evaporation to dryness, 2 cc of HNO3 13N was added to the residue and put in a hot plate for a second evaporation.

Chemical separation of Pb was conducted using the AG1X8 anion exchange resin, 200-400 mesh. After complete evaporation of the samples, 0.1 ml of 8N HBr was added to the samples and kept at 110˚C for another complete evaporation. Following evaporation, 1 cc of 0.5N HBr was added and loaded to the columns. Lead was then eluted in 6N HCl. Sr was separated using an extraction chromatographic method modified from (Pin et al., 1994). Nd isotopes were separated following Richard et al. (1976), including a first step of REE separation (using the AG50X8 cation exchange resin, 200-400 mesh). Hafnium chemical purification followed the method outlined by Blichert-Toft et al. (1997).

Average Nd, Sr and Pb concentrations in procedural blanks were less than 8, 36 and 60 pg respectively.

Nd, Pb and Hf isotopic compositions were measured by Multi-Collector Inductively Coupled Plasma Mass Spectrometry (MC-ICP-MS). Hf isotopes were measured by a Nu Plasma 1700 instrument, and Pb and Nd isotopes by a Nu Plasma 500 device, both MC-ICP-MS located at the Ecole Normale Supérieure de Lyon (France). Pb isotope compositions were analyzed using the Tl normalization method described by White et al. (2000).

Sr isotopic ratios have been measured by a ThermoFinnigan Triton T1 Themal Ionization Mass Spectrometer (TIMS) at the LABOGIS of the Centre Universitaire de Formation et de Recherche in Nimes (France). These analyzes will be completed by the personal in charge of the TIMS during the next weeks.

- **Description of the main results obtained:**

With all the obtained data, we will be able to understand the length scales and fluid-lithospheric interactions, and we will manage to put constrains in the fluid migration mechanism in the upper mantle. This study will allow, for the first time, to obtain a direct mapping of migration of crustal fluids in the Betic-Rif lithospheric mantle, and, in combination with the available structural and petrological data, to infer how this type of fluids can modify the structure, composition and seismic properties of the SCLM during subduction initiation.

- **Future collaboration with the host institution:**

Géosciences Montpellier is among the world's best reputed geochemical laboratories, equipped with cutting-edge analytical instruments, ultra-clean rooms and sample preparation facilities. This project has represented an invaluable opportunity to be trained in the use of a number of state-ofthe-art geochemical instruments and to develop isotope tracers for the characterization of mantle processes. Dra. Delphine Bosch (manager of the geochemical clean lab in Geosciences Montpellier) is co-director of this PhD thesis, so Géosciences Montpellier is among the world's best reputed geochemical laboratories, equipped with cutting-edge analytical instruments, ultra-clean rooms and sample preparation facilities. This project has represented an

invaluable opportunity for the PhD student to be trained in the use of a number of state-of the-art geochemical instruments and to develop isotope tracers for the characterization of mantle processes. . Dr. Delphine Bosch (manager of the geochemical clean lab in Geosciences Montpellier) is co-director of this PhD thesis, so her participation in the development and completion of this research is guaranteed. Collaborative work between the host institution and our scientific group in Spain will continue in the next years in this and other research projects.

- **Foreseen publications/articles resulting from the STSM :**

Once the data obtained during the STSM will be processed and interpreted, they will be published in several papers in highly internationally-reputed journals in Earth Sciences ((e.g., Journal of Petrology, Geology, Chemical Geology) and presented in international geological congresses (e.g., American Geophysical Union Fall Meeting, European Geosciences Union General Assembly, Goldschmidt Conference) .

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