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Magnetite (U-Th-Sm)/He dating: analytical challenges and application

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Magnetite (U-Th-Sm)/He dating method has a strong geodynamic significance, since it provides geochronological constraints on serpentinization episodes, which are associated to important geological processes such as ophiolite obductions, subduction zones, transform faults and fluid circulations. Although helium content that range from 0.1 pmol/g to 20 pmol/g can routinely be measured, the application of this dating technique however is still limited due to major analytical obstacles. The dissolution of a single magnetite crystal and the measurement of the U, Th and Sm present at the ppb level in the corresponding solution, remains highly challenging, especially because of the absence of magnetite standard. In order to overcome these analytical issues, two strategies have been followed, and tested on magnetite from high-pressure rocks from the Western Alps (Schwartz et al., 2020). Firstly, we purified U, Th and Sm (removing Fe and other major elements) using ion exchange columns in order to analyze samples, using smaller dilution. Secondly, we performed in-situ analyzes by laser-ablation-ICPMS. Since no solid magnetite certified standard is yet available, we synthetized our own by precipitating magnetite nanocrystals. The first quantitative results obtained by LA-ICP-MS using this synthetic material along with international glass standards, are promising. The laser-ablation technique overcomes the analytical difficulties related to sample dissolution and purification. It thus opens the path to the dating of magnetite (and also spinels) in various ultramafic rocks such as mantle xenoliths or serpentinized peridotites in ophiolites.

Schwartz S., Gautheron C., Ketcham R.A., Brunet F., Corre M., Agranier A., Pinna-Jamme R., Haurine F., Monvoin G., Riel N., 2020, Unraveling the exhumation history of high-press ure ophiolites using magnetite (U-Th-Sm)/He thermochronometry. Earth and Planetary Science Letters 543 (2020) 116359.