TEM/STEM nanoscale imaging of zircon and monazite sharpens geochronological interpretations

ANNE-MAGALI SEYDOUX-GUILLAUME[1], ANTONIN LAURENT[2], ALEXIS GRAND'HOMME[3], BERNARD BINGEN[4], EMILIE JANOTS[3], VALERIE BOSSE[1], STEPHANIE DUCHENE[2] AND DAMIEN GUILLAUME[1]

[1]LMV, UMR 6524 CNRS-UBP-UJM, Clermont-Ferrand & Saint-Etienne, France
[2]GET, UMR 5563 CNRS-UPS-IRD, Université de Toulouse, Toulouse, France
[3]ISTerre, Univ. Grenoble Alpes, Grenoble, France
[4]Geological Survey of Norway, Trondheim, Norway

Zircon and monazite are the most commonly used U-Pb geochronometers in a wide range of geological samples. However, and this is particularly true for very old rocks (Precambrian), their U-Th-Pb geochronological systems can be affected by redistribution of radiogenic Pb, or U and Th, during metamorphic or metasomatic events. Nanoscale imaging by TEM in old zircon already demonstrated that redistribution of Pb during UHT metamorphism may compromise high resolution *in situ* dating [1-3]. The same problem was also evidenced in monazite more than ten years ago [4]. Recently, STEM study of zircon crystals affected by radiation damage demonstrated that discordance of the U-Pb systems included a component of U-mobility due to the presence of UO_2 clusters, which precipitated inside nanoporosity of zircon crystals [5]. The objective of the present study is to highlight the need for nanoscale characterization of the minerals used for dating, in order to sharpen geochronological interpretations. To illustrate this demonstration we will draw on two monazite examples, one natural and one experimental, where TEM imaging was decisive for geochronological interpretations. In natural monazite from S-Norway the presence of sulfate nanodomains discriminates between different generations of monazite by correlating LA-ICP-MS U-Pb isotopic ages with their S-contents. For the experimental example TEM images revealed an incomplete replacement in monazite alteration rims. The consequences are the partial resetting of the U-Th-Pb systems due to nano-mixtures of primary and secondary monazite unavoidably analyzed together within the chemical and isotopic U-Th-Pb measurements.

[1] Utsunomiya *et al*. (2004) *GCA,* ***68***, 4679-4686.
[2] Kusiak *et al*. (2013) *Geology,* ***41***, 291-294.
[3] Kusiak *et al*. (2015) *PNAS,* ***112***, 4958-4963.
[4] Seydoux-Guillaume *et al*. (2003) *Geology,* ***31***, 973-976.
[5] Seydoux-Guillaume *et al*. (2015) *EPSL,* ***409***, 43-48.