

Trace element distribution in pelitic garnet: Implications for petrogenesis, PT modeling, and geochronology

A.M. CRUZ-URIBE¹ AND T.D. HOISCH²

¹Pennsylvania State University, University Park, PA 16802, USA (amc472@psu.edu)

²Northern Arizona University, Flagstaff, Arizona 86011, USA (thomas.hoisch@nau.edu)

Trace element zonation patterns were determined for garnet from the schist of Mahogany Peaks in the Raft River and Albion Ranges of Utah and Idaho, USA. Variations in HREE and Y that cannot be explained by Rayleigh fractionation can be linked to previously interpreted garnet growth reactions determined from major element analyses used for pressure-temperature (PT) path modeling. Near-rim spikes in HREE and Y occur in garnet analysed from two samples from the Albion Range and one sample from the Raft River Range and are up to an order of magnitude higher in concentration than surrounding concentrations. The near-rim spike present in one garnet from the Albion Range corresponds to a previously interpreted hiatus in garnet growth, after which garnet grew by the reaction $pg + st + qtz = gt + ms + ky + ilm + H_2O$. The subtle major element and petrographic evidence of the growth hiatus is supported by the much more obvious spikes in the HREE and Y profiles; in addition, the presence of a sharp decrease in Ti at the hiatus supports the proposed garnet- and ilmenite-producing reaction. A second garnet from a nearby outcrop in the Albion Range exhibits a near-identical rim increase in HREE and Y and a sharp decrease in Ti, suggesting the presence of a growth hiatus at this point; this interpretation provides an explanation for the lack of fit to a portion of the simulated major element profile produced from PT-path modeling, which assumed no hiatus [1]. The near-rim spike in HREE and Y in one garnet from the Raft River Range corresponds to an interpreted hiatus followed by a garnet-producing reaction that consumed paragonite. This interpretation is supported by a spike in Na concentration at the hiatus.

HREE zoning in metamorphic garnet also has implications for geochronology, in particular for the Lu-Hf system. Lu zoning in garnet provides insight into the tectonic interpretation of garnet Lu-Hf ages determined for the rocks studied here [2]. Near-rim spikes in Lu suggest that garnet ages are biased toward garnet rims, and thus represent the later stages of garnet growth and modeled PT paths.

[1] Harris *et al.* (2007) *J. Metamorphic Geol.* **25**, 915-934.

[2] Cruz-Urube *et al.* (2008) *Eos Trans. AGU* **89**, (53).

Raman spectroscopic detection of urea, a possible biomarker, in calcite and gypsum mineral matrices

A. CULKA AND J. JEHLICKA*

IGMMR, Faculty of Science, Charles University in Prague, Prague, Czech Republic

(*correspondence: jehlicka@natur.cuni.cz)

Urea (NH₂)₂CO is created in the biochemical urea cycle (also called the ornithine cycle). This metabolic pathway serves to dispose of ammonia, a waste product of metabolism of chemical substances containing nitrogen. Nitrogen containing organic materials can form minerals in the geological environment (urea) or can transform into newly created secondary minerals (struvite, phosphammite, boussingaultite). The urea cycle, to a certain extent, is present in all animals and even in fungi and a few bacteria. Since urea is a biomarker on Earth, it is important to search for it on other Earth-like planets.

Raman spectroscopy has often proven to be a very suitable detection method for studies in geology, organic geochemistry and exobiology. This concerns above all the possibility of nondestructive detection of both organic and inorganic parts of rocks, including minerals, biomolecules as well as micrometric inclusions. Raman spectroscopy is also one of the instruments to be employed during the ESA Exomars mission to Mars.

Raman spectroscopic detection (514 nm laser) of urea has been tested in experimentally prepared powdered mineral matrices to ascertain the detection limit of this method. Other biomarkers such as β-carotene [1] and usnic acid [2] have been previously tested for detection in similar experimental conditions. The detection limits of urea in both calcite and gypsum mineral matrices have been determined as 1wt% using Raman spectroscopy. These results are important because of the planned Exomars mission and consequent evaluation of the collected data.

[1] Vitek *et al.* (2009, in press) *PSS*, doi:10.1016/j.pss.2008.06.001. [2] Osterrothova *et al.* (2009, in press) *SAA*, doi:10.1016/j.saa.2008.09.005.