

# **In situ quantification of CO<sub>2</sub> and H<sub>2</sub>O in apatite: The next step in studying volatiles in magmatic and hydrothermal systems**

JOHANNES HAMMERLI<sup>1</sup> AND JÖRG HERMANN<sup>2</sup>

<sup>1</sup>Washington State University

<sup>2</sup>University of Bern

Presenting Author: [johannes.haemmerli@wsu.edu](mailto:johannes.haemmerli@wsu.edu)

Volatiles, such as H<sub>2</sub>O, SO<sub>3</sub>, CO<sub>2</sub>, Cl, and F, play a key part in the genesis of ore deposits. However, the exact role volatiles play in different geodynamic settings and ore systems is challenging to study due to their fugitive behavior. In the absence of reliable fluid inclusions, different minerals incorporating H<sub>2</sub>O, SO<sub>3</sub>, CO<sub>2</sub>, Cl, and F have been used to study volatiles during magmatic, metamorphic, and hydrothermal processes [1]. Apatite group minerals may present a key new avenue to study volatiles, as apatite is relatively robust compared to other volatile-bearing minerals and occurs in most rock types, including ore-bearing rocks. Conveniently, apatite readily incorporates all of the above volatiles at elevated concentrations, often at wt.% levels. Routine EPMA measurements of S, Cl, and F contents in combination with stoichiometrically constrained H<sub>2</sub>O contents, helped to gain critical insights into their concentrations in ore systems [2]. However, one of the arguably key volatile components in ore systems, CO<sub>2</sub>, has remained a challenge to measure routinely, especially on a (sub-) mineral-scale. Here we present a new approach to measure in situ CO<sub>2</sub> and H<sub>2</sub>O contents in apatite on a micro-meter scale, applying Fourier-Transform Infrared Spectroscopy (FTIR) using a microscope equipped with a Germanium-tip objective. This set-up allows attenuated total reflectance measurements of apatites in polished thin sections, without the need for doubly polished samples [3]. Current limits of quantification are ~100 ppm and ~400 ppm for CO<sub>2</sub> and H<sub>2</sub>O, respectively. This new analytical approach allows for the systematic and combined study of all volatiles in a single mineral from a range of ore systems. Together with a few examples, we will present the new method and discuss the future work required to develop apatite and its volatile composition as a tool to characterize the volatile inventory of ore systems from source to mineralization.

[1] Zhu & Sverjensky (1992), *Geochimica et Cosmochimica Acta* 56, 3435–3467

[2] Chelle-Michou & Chiaradia (2017), *Contributions to Mineralogy and Petrology* 172:105

[3] Hammerli, Hermann, Tollan & Naab, *Contributions to Mineralogy and Petrology* 176:105