# Analyzing nitrogen in cordierites and other phases by SIMS

RICHARD L. HERVIG[1], CRYSTYL FUDGE[1] AND ALEXANDRA NAVROTSKY[2]

[1]School of Earth & Space Exploration, Arizona State University, Tempe, AZ 85287-1404, hervig@asu.edu; cfudge@asu.edu

[2]UC Davis, Davis, CA 95616, anavrotsky@ucdavis.edu

A variety of phases preserve a record of volatile elements present during the evolution of a rock that may otherwise be lost during eruption or exhumation. Examples include trapped melt inclusions in volcanic materials, their nominally anhydrous hosts (at trace levels), and hydrous minerals such as apatite, amphibole, and mica. The crystal structure of cordierite includes channels that are known to contain high (relative to nominally anhydrous minerals) concentrations of $H_2O$, $CO_2$, and $N_2$ (as well as noble gasses and sodium). We explored select samples, finding a large range in the H, C, and N signals by secondary ion mass spectrometry (SIMS). These signals were quantified via samples characterized by FTIR [1] and synthetic SiAlON glasses. Lake Co. $An_{62}$ served as a blank.

SIMS analyses used a primary beam of $O^-$ (10nA; impact energy of 21.5 keV) focused to ~20 $\mu$m in diameter. Positive secondary ions were accelerated to 9000V. High mass resolution was used to remove all interferences on $^{14}N^+$. E-probe analyses used routine techniques.

The results show a range in Mg/(Mg+Fe) from 0.62 to 0.95. Most cordierites were low in $Na_2O$ (<0.4 wt.%) except for one high sodium sample containing nearly 2 wt.%. The $H_2O$ contents ranged from 0.9 to 2 wt. % and the $CO_2$ concentrations varied from 0.07 to >2 wt. %. All measurements for nitrogen (as elemental N, ppm) were greater than the background as defined by Lake Co. plagioclase, and ranged from tens of ppm to nearly 200 ppm.

Nitrogen is bimodal in cordierites. We observe either a few tens of ppm or >100 ppm N. Given the limited sample suite, nitrogen is apparently positively correlated with $CO_2$ (except for one sample from a sapphirine-bearing, meta-anorthosite rock from Fiskenaessat, Greenland), and negatively correlated with $H_2O$. Bulk analyses of cordierite also show ~bimodal behavior: <10 or 100-350 ppm N [2].

Our measurements of natural silicate glasses (rhyolite obsidian & basaltic glass) show undetectable N (<30ppm). Experimental glasses (containing some trapped air in the capsule?) contain N well above background. We suggest that most experimental samples contain nitrogen, but cannot comment on the role of this element in high P, T experiments.

[1] Am Min 75 (1990) 71 [2] *Chem Geol* **281** (2011) 211