Europlanet TA Scientific Report

PROJECT LEADER

Project number: 21-EPN-FT1-006
Name: *Melting phase relations of subduction zone minerals and their nitrogen budget*
Home Institution: Bayerisches Geoinstitut (BGI), University of Bayreuth, Bayreuth, Germany
TA Facility visited: Research Center Petrographiques et Geochimiques (CRPG), Nancy France

Project Title:

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

In this study the phase relations of hydrous aluminosilicate minerals (e.g. montmorillonite, phlogopite, phengite and serpentinite) that are present in sedimentary layers or form during early prograde metamorphism of the oceanic lithosphere are investigated at sub-arc conditions. The investigated minerals are potential hosts for nitrogen at different P-T conditions along the subducting slab, depending on their phase stabilities and the N partitioning upon partial melting of these phases. In the present analytical session, several minerals in equilibrium with melt (quenched glass) have been analysed by means of SIMS.

The measurements in this report were performed using the CAMECA 1280 HR2 Ion Probe at CRPG, France. All the experimental capsules planned for the session were analysed and additional secondary standards were investigated.

The experimental samples showed consistent and reproducible N content on the different measured spots both on the mineral and the melt phase. More challenging was the measurements of the standards that confirmed the existing concern on the possible matrix effect during SIMS measurements of mineral phases. The different behaviour of the light elements analysed in a glass or crystalline matrix appears to have a strong effect on the measured nitrogen ion yield.

The work performed during this analytical session at the SIMS, allowed the acquisition of the N data for the calculation of the partition coefficients between mineral and melt while providing additional evidence for the need of further investigation of the matrix effect for this technique.

Full Scientific Report on the outcome of your TNA visit

We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.

The analyses performed during the TNA visit were carried out using the CAMECA 1280 HR2 Ion Probe at CRPG, France in collaboration with Dr. Evelyn Füri. The spot analyses of $^{14}N^{16}O^-$ and $^{15}N^{16}O^-$ secondary molecular ions were carried out using a 10 keV Cs^+ primary ion beam with a ~10nA current. Nominal mass resolution during acquisition is of ~13,000 (see Füri et al.2018 for details). Finally, nitrogen concentrations were obtained from the relationship between the secondary ion intensity ratios $^{14}N^{16}O^-/^{16}O_2^-$ and $^{14}N^{16}O^-/^{30}Si$ and the known N content of nine synthetic basaltic glasses with N concentration varying from <1 to 3906 ppm.

All the experimental samples planned for this visit, as well as the secondary standards (Buddingtonite, Hyalophane and Phlogopite) were measured during the collection days. The experimental capsules showed consistent and reproducible N content on the different measured spots. The collected values will be used to calculate the partition coefficient of N between mineral and melt in order to evaluate N flux along the subduction zone.

Interestingly, N analyses of secondary standards were more challenging than expected. Firstly, it was not possible to perform measurements on the buddingtonite sample due to the absence of an emission signal. We believe this to be due to the small-grain sized nature of the crystals and the difficult polishing of the last that possibly affected the quality of the collection. When measuring hyalophane, we observed a similar behaviour as in Mosenfelder et al.2019, with the mineral showing very low N values (~200 ppm) relative to the expected value of 1100ppm. This is possibly due to a strong matrix effect as well as the presence of BaO in the structure as discussed in the work from Mosenfelder and co-authors. Finally, the phlogopite sample presented an irregular pattern for $^{14}N^{16}O^-$ (Figure 1) during the measurement cycles. The N content in this mineral varies by about 3 orders of magnitude (orange diamonds) at approximately mid acquisition. Given that the signal of both ^{30}Si (blue circles) and $^{16}O_2$ (grey circles) is stable, we believe this pattern to be caused by the layered nature of the mica mineral. It is possible that with the increasing depth of the measurements , a different sheet having a different N content was hit. Maybe such behaviour would not be observed during other analytical techniques due to the different depths reached during acquisition but the behaviour is remarkable and interesting to consider with respect to the matrix effect problem.

The collected data were processed by comparing the $^{14}N^{16}O^-$ ion yield of the measured sample to the one from the calibration provided by the standards (Figure 2). By comparing the $^{14}N^{16}O^-$ ion yield to the N concentration value in the calibration, both the $^{14}N^{16}O^-/^{16}O_2^-$ and $^{14}N^{16}O^-/^{30}Si$ could be precisely obtained taking into account the analytical precision and reproducibility.

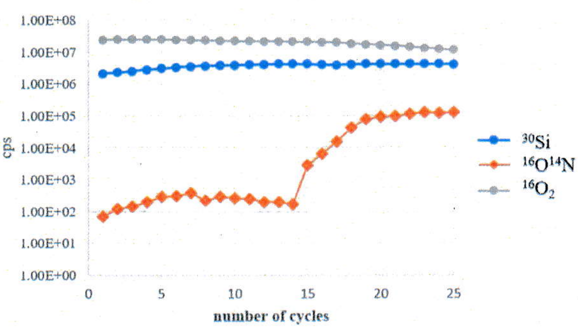

Fig.1: Evolution of the secondary ion intensities (^{30}Si,$^{16}O^{14}N$ and $^{16}O_2$) during a 25 cycle measurement of phlogopite.

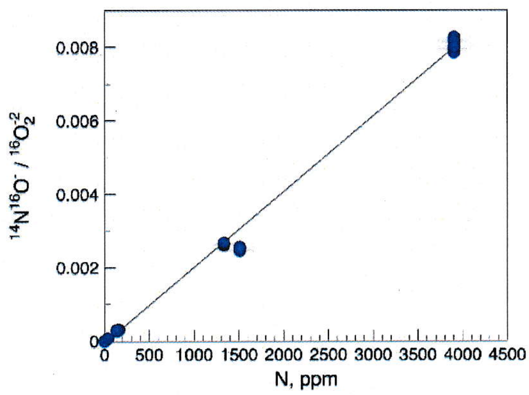

Fig.2 : Calibration line obtained from fitting of the $^{14}N^{16}O^-/^{16}O_2^-$ ratio for the standards measured every night during the 5-day TNA visit.

References : Füri, E.; Deloule, E. and Dalou, C. (2018) Nitrogen abundance and isotope analysis of silicate glasses by secondary ionization mass spectrometry. *Chem Geol.*, 493, 327-337. **Mosenfelder, J.L.**; von Der Handt, A.; Füri, E.; Dalou, C.; Herving, R.L.;Rossman, G.R. and Hirchmann, M.(2019) Nitrogen incorporation in silicates and metals :results from SIMS,EMPA,FTIR and laser-extraction mass spectrometry. *Am.Min.*, 104, 31-46.

- Give details of any publications arising/planned (include conference abstracts etc)

The results will be published in a high-impact peer-reviewed journal, e.g. Earth and Planetary Science Letters, Chemical Geology. Open access to the content of the publication will always be guaranteed.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: **28-08-2022** Arrived: **28-08-2022**	**29-08-2022**	**[1] but no financial compensation requested by facility**	5	**[1] but no financial compensation requested by facility**	**02-09-2022**	Departed: **03-09-2022** Arrived: **03-09-2022**

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	CRPG Nancy, IPF facility
Host Signature	**Evelyn Füri, scientific host** E. Füri **Laurie Reisberg, CRPG Europlanet coordinator** Laurie Reisberg
Date	

- Project Leader confirmation

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Project Leader Name	Caterina Melai
Project Leader Signature	Caterina Melai
Date	03-09-2022