Europlanet TNA Report

PROJECT LEADER

Name: Francois Holtz
Address: Institute of Mineralogy, Leibniz University of Hannover, Callinstraße 3, 30167 Hannover, Germany **E-mail:** f.holtz(at)mineralogie.uni-hannover.de

COLLABORATORS

Name:	**Affiliation:**
Tatiana Shishkina	Same as project leader
Roman Botcharnikov	Same as project leader
Renat Almeev	Same as project leader
Date of TNA visit:	5-9 (6-8) December 2010
Host laboratory:	The Cameca 1270 Ion Microprobe Centre de Recherches pétrographiques et Géochimiques (CRPG) Vandoeuvre-les-Nancy, France

Project Title – **Quantitative determination of CO_2 concentrations in basaltic glass inclusions in olivine**

- Report on the outcomes of the TNA visit (approx 1 page)

The Cameca 1270 Ion Microprobe was used to analyse carbon and water concentrations in basaltic glass inclusions in olivine crystals from Mutnovsky volcano, Kamchatka. Several samples from two other volcanoes were also analysed.

The concentrations of CO_2 and H_2O in glass inclusions, trapped in crystallizing minerals at depth, provide unique information on natural magmas and fluids. Coupled with experimental determination CO_2 and H_2O solubilities in silicate melts at high pressure, the measured CO_2 and H_2O contents in glass inclusions allow quantitative evaluation of magmatic pressures/depths and magma evolution history of volcanoes (degassing, evolution of activities of volatile components).

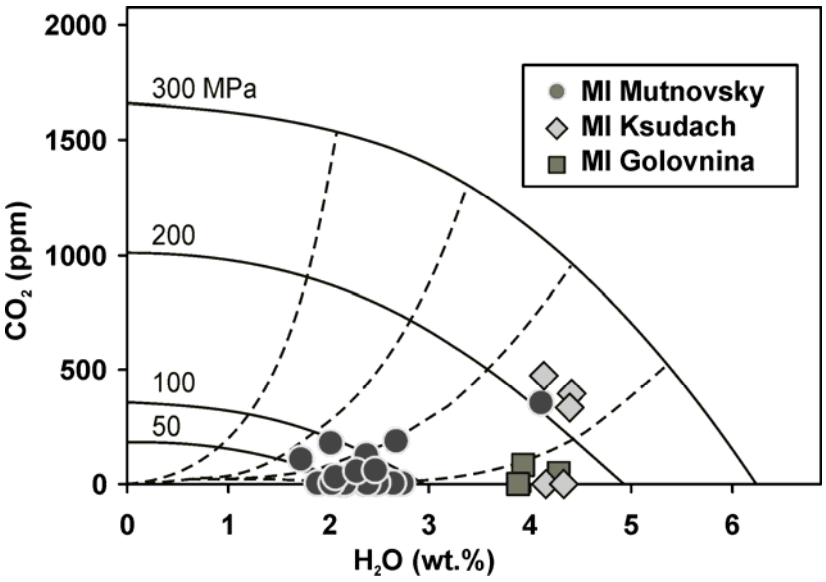
Glass inclusions were homogenized at 1150°C and exposed to the surface of the olivine crystals by polishing. Olivine grains with the melt inclusions and pieces of basaltic glasses with known H_2O and CO_2 concentrations were mounted into an inch-size Al-ring using special epoxy (mixture of Araldite D and hardener HY956) and coated with Au. Prior to measurements on the Cameca 1270 Ion Microprobe, samples and standards were held in a vacuum gas chamber for degassing and the analyses were started when the vacuum on the level of 10^{-8} to 10^{-9} Torr was achieved. Cs^+ beam was used to produce negatively charged secondary ions: C, OH and O. The glasses were sputtered with a 10 kV Cs^+ primary beam of the 10-15 nA intensity with a size of approximately 20x30 µm. The duration of a single measurement with 16 cycles was about 15 minutes.

Before and after each analytical session a series of representative standards were measured for calibration of carbon and water concentrations (from 0.77 to 5.7 wt.% H_2O and from 0.0114 to 0.3277 wt.% CO_2; Shishkina et al., 2010). After session, we provided eight

glasses with different H_2O and CO_2 contents as standards for the Cameca 1270 Ion Microprobe Lab in CRPG (Nancy).

The quantification of C and H concentrations was based on calibration curves that show linear correlation between known H_2O and CO_2 contents and OH/O and C/O ratios, respectively, for the whole range of analyzed concentrations in the standard glasses. It must be noted, however that the analytical technique was not completely successful, because the intensity for both OH/O and C/O showed continuous drift of the obtained signal even after 16 cycles of the analysis. The reason for that might be a contamination of the surface with organic material or continuous evaporation of epoxy in the sample chamber. Another indication for such contamination is the relatively high detection limit for both H and C, as evidenced by the intersection of the calibration curve with the concentration axis (at about 0.7 wt.% for H_2O and 195 ppm for CO_2). These observations indicate that improved analytical approaches should be used in future, e.g., organic-free matrix and "pre-cleaning" of the surface with large beam and long exposure time with consequent analysis using smaller beam size.

Despite the analytical problems, 3 days of measurements on Cameca 1270 Ion Microprobe resulted in ~40 successful analyses of melt inclusions. The majority of the inclusions from Mutnovsky volcano contain 1.7 to 2.7 wt.% H_2O. This is in a very good agreement with previous analyses of melt inclusions from the same samples performed by SIMS (Cameca ims4f) at the Institute of Microelectronics (Yaroslavl', Russia). In most of the samples no CO_2 was detected, probably due to incomplete dissolution of the shrinkage bubbles inside the melt inclusions or CO2 loss. Only 7 inclusions provided measurable amounts of CO_2 from 20 to 180 ppm. Although these values are below or very close to the detection limit, they point to quite low vapour saturation pressures of magmas at Mutnovsky, i.e., approximately below 110 MPa. Only one inclusion from Mutnovsky contains rather high amounts of volatiles: 4 wt.% H_2O and 353 ppm CO_2 that corresponds to the saturation pressure of approximately 200 MPa (see Fig.1). This implies that olivine crystals from basaltic tephra of Mutnovsky volcano trapped melt inclusions from already significantly degassed magma at a relatively shallow depths (less then 3 km). Therefore we can expect a magma chamber beneath Mutnovsky volcano at the depth of 1 to 3 km.



The samples from Ksudach and Golovnina volcanoes showed typically higher concentrations of both H_2O and CO_2, indicating that magmas were stored at deeper levels than that of Mutnovsky.

The obtained results show a high potential of the applied analytical techniques, but they also indicate that further improvements of analytical approaches are required for precise and accurate quantitative determination of both H_2O and CO_2 concentrations in silicate glasses.

- Publications arising/planned (include conference abstracts etc)

- Shishkina, T., Botcharnikov, R.E., Holtz, F., Almeev, R.R., and Portnyagin, M. (2010): Solubility of H_2O and CO_2-bearing fluids in tholeiitic basalts at pressures up to 500 MPa Chemical Geology 277, 115-125

- Shishkina, T.A., Almeev, R.R., Botcharnikov, R.E. and Holtz, F. (2011) Magma storage conditions and degassing processes of low-K and high-Al island-arc tholeiites: Experimental constraints for Mutnovsky volcano, Kamchatka. IODP/ICDP Kolloquium, Muenster, Germany.

- Shishkina, T.A., Almeev, R.R., Botcharnikov, R.E. and Holtz, F. Magma storage conditions and degassing processes of low-K and high-Al island-arc tholeiites: Experimental constraints for Mutnovsky volcano, Kamchatka. (paper in preparation, 2011)

- Host approval

The host is required to approve the report agreeing it is an accurate account of the research performed.
Host : Etienne Deloule, DR-CNRS-CRPG

As presented above, this TNA visit was planed to analyse carbon and water concentrations in basaltic glass inclusions in olivine crystals from Mutnovsky volcano, Kamchatka in using the Cameca 1270 Ion Microprobe. The Hannover team provided the requested reference materials for these measurements, and gave them to the ion probe laboratory for futur works. As mentioned, the back ground level observed during this session may be related to the sample préparation, and this should be corrected in the futur. An additional point is that following this session, in using the Hannover reference materials, we also improve our analytical procedure in adding Si in the measures masses. Therefore the quantification of C and H concentrations can be calculated as a fonction of the OH/Si and C/Si measured ratios, providing better calibration curves than the OH/O and C/O.

The proposed report is an accurate account of the research performed in the ion probe laboratory.