ESRF	**Experiment title:** Cu local environment in hydrothermal systems: insights in major Au Cu-rich ore deposits build-up	**Experiment number**: 30-02-751
Beamline: BM30B	**Date of experiment**: from: 9 November 2006 to: 11 December 2006	**Date of report**: 25 July 2007
Shifts: 24	**Local contact(s)**: Dr. Olivier PROUX	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Jean CAUZID[a*], Jean-Louis HAZEMANN[b*], Vivian NASSIF[c], Herve PALANCHER[c], Pascal PHILIPPOT[d], Gleb S. POKROVSKI[e], Olivier PROUX[f*], Karen RICKERS[g*]

[a]ID22 ESRF; [b]Institut Néel, CNRS, 38042, Grenoble, France; [c]CEA, Cadarache, France; [d]Géobiosphère Actuelle et Primitive, IPGP, Paris, France; [e]LMTG, Toulouse, France; [f]LGIT, UMR CNRS Université Joseph Fourier, Saint-Martin-d'Heres, France; [g]HASYLAB, DESY, Hamburg, 22603 Germany

Report:

Chosen sample: fluid inclusions

Fluid inclusions are small quantities of fluids trapped in minerals. A single inclusion traps a few cubic micrometers of fluid, which migrates in km^3 volumes through the Earth's crust. Smoothing out natural variability in fluid inclusion concentrations is fulfilled through analysis of statistically relevant series of fluid inclusions. Quantifying series of fluid inclusions using Synchrotron Radiation –induced X-Ray Fluorescence (SR-XRF) was the aim of other experiments (ME401, ME824), which led to a series of publications (Cauzid et al., 2006; Cauzid et al., submitted). In some specific cases, fluid inclusion generations are well constrained and no systematics are required on them, but some unknowns remain on the chemical speciation in the fluid, which can be accessed directly through spectroscopy (this experiments and ME824, 30-02-748, 30-02-812). Going forward in the in-situ X-ray absorption spectroscopy analysis of fluid inclusion was the aim of this experiment.

Experimental method

Doubly polished quartz crystals hosting liquid and vapour fluid inclusions were held in Linkam THMSG600 heating-freezing stage installed vertically on the new microfocus end-station on BM30B (see experiment 30-02-748). Temperature increments of 100°C at the beginning to 25°C when getting closer to fluid inclusion homogenisation temperature were chosen. At each temperature step, Cu speciation in target fluid inclusions was measured to check speciation changes in the included fluid.

Results

Selected inclusions were extracted from two locations: the Yankee Lode of the Mole Granite, a S-rich system and Torres de la Paine, a S-depleted system. Both samples recorded low- and high-density phase separation as co-existing liquid and vapour inclusions. In both cases previous experiments conducted at the ESRF (ME824, CH1936) and HASYLAB showed that Cu is enriched in the vapour. XAS analysis was undertaken to have insights into the Cu complexes allowing such preferential partitioning of Cu into the vapour. The experiment

provided data on the evolution of Cu speciation in single fluid inclusions from room T to 500°C. This evolution is similar in vapour from both locations from room-T to ~400°C with a change from a hydrated Cu^{2+} at room T to chlorinated Cu^{1+} species at 400°C (Figure 1). Above this temperature, speciations changes in fluids from both location to new Cu^{1+} species, but on the contrary to lower temperatures speciations are not similar in both samples. These results were included in two communications on synchrotron radiation and fluid inclusion analysis (Cauzid et al, 2007; Rickers et al., 2007).

This experiment has also shown that microfocalisation of the X-ray beam at BM30B can be done down to a 10*10 μm^2 spot size (vertical*horizontal) while keeping the sample in specific thermal conditions.

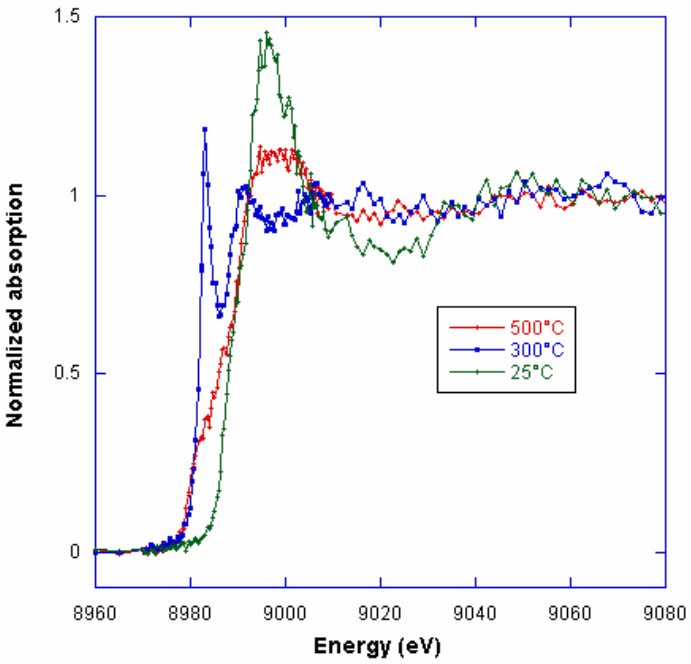

Figure 1: speciation in the included fluid evolves during heating from a Cu^{2+} hydrated species to Cu^{1+} chlorinated species to an unknown Cu^{1+} species at 500°C. This last spectrum, although of unknown geometry yet, is probably another chlorinated species as Cl is the only potential ligand in the fluid.

The experiment was shorten by a detector failure and Be contamination on the beamline.

References resulting from this experiment

Cauzid, J., Bleuet, P., Martinez-Criado, G., James-Smith, J., Hazemann, J.-L., Testemale, D., Proux, O., Brugger, J., Liu, W., Rickers, K. and Philippot, P. 2007. Fluid inclusion analysis using synchrotron radiation. European Current Research on Fluid Inclusions (ECROFI-XIX). University of Bern, Switzerland, 17–20 July, 2007. Abstract Volume, p. 180.

Rickers, K., Bleuet, P., Cauzid, J. and Lüders, V. 2007. Elemental partitioning during sub-critical phase separation: evidence from SR XRF, fluotomography and X-ray absorption techniques of liquid-vapour fluid inclusion assemblages from the granitic Torres del Paine Complex, Patagonia. European Current Research on Fluid Inclusions (ECROFI-XIX). University of Bern, Switzerland, 17–20 July, 2007. Abstract Volume, p. 61.

Related references from experiment performed at the ESRF

Cauzid, J., Philippot, P., Somogyi, A., Ménez, B., Simionovici, A. et Bleuet, P., 2006. Standardless quantification of single fluid inclusions using synchrotron radiation induced X-ray fluorescence. Chemical Geology, 227: 165-183.

Cauzid, J., Philippot, P., Martinez-Criado, G., Ménez, B., Labouré, S. Contrasting Cu-complexing behaviour in vapour and liquid fluid inclusions from the Yankee Lode deposit, Mole Granite, Australia. Submitted to Chemical Geology