Composition of the earliest hydrothermal fluids circulating along the South Range of the Sudbury Igneous Complex, Canada

DARREN LEFORT[1]*, JACOB HANLEY[1] AND JUNG HUN SEO[2]

[1]Dept. Geology, Saint Mary's University, Halifax, Canada (*correspondence: darrenlefort@gmail.com)
[2]ETH Zurich, Institute of Geochemistry and Petrology, CH-8092 Zürich, Switzerland

The Garson Ni-Cu-PGE deposit (Sudbury, Ontario, Canada) is hosted along the contact of the Sudbury Igneous Complex (SIC) and underlying Proterozoic-age metasediments and metavolcanic rocks. The deposit is strongly controlled by structural features and contains magmatic sulfides hosted in discrete shear zones. The main sulfides present are pyrrhotite, pentlandite and chalcopyrite with minor pyrite.

Massive sulfides overprint early quartz veins, forming sulfide-quartz stockworks. Fluid inclusions in the quartz are predominantly aqueous (30 vol% bubble) that contain a CO_2 vapor phase that homogenize upon heating between 2.8 and 29.0ºC, indicating a relatively low pressure of entrapment. A subordinate group of three phase (liquid-vapor-halite) inclusions are also present in the samples. Microthermometry showed the presence of clathrates in the primary inclusions. Clathrate destabilization temperatures yielded salinities between 12.1 to 14.4 wt% $NaCl_{equiv.}$. Some inclusions in which clathrates were not observed yielded a wide range salinities (from ice melting T) between 1 to 21 wt% $NaCl_{equiv.}$

LA-ICP-MS microanalysis of the primary aqueous inclusions show elevated concentrations of As, Pb, Zn and Sb, but very low concentrations of Cu, Fe and S, suggesting that these fluids did not equilibrate with typical magmatic sulfides or sulfide liquids, and were trapped prior to sulfide emplacement in the shear zones. Arsenic concentration in the fluids correlates to bulk salinity suggesting that the Cl complexation of As predominates at low T and low f_{O2}.

The circulation of early-stage CO_2-NaCl-H_2O fluids through metasedimentary wall rocks (and/or formation of these fluids from contact metamorphism of those wall rocks) may have been a factor in the local secondary enrichment of the Garson ores where As may be closely correlated to PGE distribution. Additionally, detection of As-rich fluid inclusions in quartz veins predating sulfide emplacement may serve as a discrimination tool for identifying areas along the South Range in which sulfide magmas may have been later contaminated through interaction with As-bearing country rocks.

Investigation of copper and zinc speciation in pig slurry by a multitechnique approach

S. LEGROS[1], E. DOELSCH[1,2], P. CHAURAND[2], J. ROSE[2], A. MASION[2], D. BORSCHNECK[2], O. PROUX[3], J.-L. HAZEMANN[4], V. BRIOIS[5], J.-H. FERRASSE[6], H. SAINT MACARY[1] AND J.-Y. BOTTERO[2]

[1]CIRAD, UPR Recyclage et risque, Montpellier, France
[2]CEREGE, Europôle Méditerranéen de l'Arbois, Aix-en-Provence, France
[3]CNRS, OSUG, St Martin d'Hères, France
[4]CNRS, Institut Néel, Grenoble, France
[5]Synchrotron SOLEIL, Gif-sur-Yvette, France
[6]MSNM-GP UMR 6181 CNRS Université Paul Cézanne, Aixen-Provence, France

The fate of pollutants associated with organic wastes is a key issue. For example, pig slurry presents high concentration of Copper (Cu) and Zinc (Zn) since they are used (at high concentration) as essential micronutrients in animal feeds. As a consequence, Cu and Zn accumulation was measured in soil surface layers that had been amended with pig slurry, inducing phytotoxicity as well as groundwater quality degradation. Better prediction of the mobility and bioavailability of Cu and Zn from pig slurry spreading can be achieved by determining the speciation of these elements.

The aim of this study is to investigate Cu and Zn speciation in pig slurry. A multitechnique approach was adopted including size fractionation, XRD, SEM-EDS, µXRF and XAS.

The present study demonstrated that only 0.2% of total Cu or Zn present in pig slurry was bound to particles smaller than 0.45 µm, while 75% of total Cu and Zn was bound to particles in the 0.45–20 µm size range. µXRF highlighted the colocalisation of Cu and sulfur. In addition, geochemical modelling demonstrated that physical chemical conditions within pig slurry lagoon are compatible with the precipitation of chalcocite (Cu_2S). Finally, XANES shows that Cu speciation in raw pig slurry and size fractions is described by Cu_2S and that its oxidation state is Cu (I). These Cu speciation in pig slurry may be the main reason for the observed Cu accumulation at the soil surface. Zn speciation revealed three patterns 49% Zn bound to organic matter, 37% amorphous Zn hydroxide, and 14% sphalerite (ZnS). The detected presence Zn sulphide, was unexpected and is reported for the first time. These three Zn forms seemed to be soluble in neutral or weakly acid soil systems, so the long-term impact of pig slurry spreading could lead to Zn leaching.