Melting experiments of an alkali basalt from Kuanhsi area, Taiwan, at pressures up to 1 GPa

T.C. LIU[1]*, J.S. CHIU[1] AND Y. IIZUKA[2]

[1]Department of Earth Science, National Taiwan Normal Univ., Taipei, Taiwan (*correspondence: liutc@ntnu.edu.tw) (chioujs@yahoo.com.tw)
[2]Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan (yiizuka@earth.sinica.edu.tw)

An alkali basalt of Kuanhsi area, Hsinchu county, Taiwan, was studied with a quenching furnace and a piston-cylinder apparatus. The late Miocene basalt occurred as a dike in the Tertiary sedimentary strata. The liquidus and solidus temperatures of the basaltic melt at atmospheric pressure are measured at 1316°C and lower than 1050°C, respectively. The crystallization sequence of the basaltic melt is determined as: iron-titanium oxides (1316°C), olivine (1258°C), clinopyroxene (1166°C), and plagioclase (1092°C). The liquidus mineral at 1 GPa is garnet. The following phases are iron-titanium oxides (1330°C), olivine (1280°C), clinopyroxene (1220°C), and plagioclase (1110°C). As temperature decreases, the residual melts become enriched in silicon and calcium; but depleted in magnesium, iron, sodium, and potassium. The differentiated melts of the basaltic melt became olivine-normative and quartz-normative through fractional crystallization. The basalts in this area can be modeled as the fracional crystallization products of the basaltic melt at pressure between atmospheric pressure and 1 GPa.

An XAS study of CuCl solubility and copper speciation in low-density water near the critical isochore

WEIHUA LIU[1]*, JOËL BRUGGER[2],
BARBARA ETSCHMANN[1], DENIS TESTEMALE[3]
AND JEAN-LOUIS HAZEMANN[3]

[1]CSIRO Exploration & Mining, Australia (*correspondence: weihua.liu@csiro.au)
[2]South Australian Museum and The University of Adelaide, Australia
[3]Institut Néel, Département MCMF, France

There is a lack of experimental data and theoretical models for metal speciation and solubility in low-density supercritical fluids near the critical isochore, where fluid density is between typical vapour and dense solutions, and where small changes in pressure result in relatively large changes in fluid density. Such conditions are important for example for seafloor hydrothermal systems, where supercritical fluids experience rapid pressure changes as pressure changes from lithostatic to hydrostatic.

In this study the solubility of nantokite ($CuCl_{(s)}$) and the structure of the predominant copper species in supercritical water (290-400 bar at 420°C; 350-450°C at 290 bar; 500°C and 350 bar; density = 0.14 – 0.64 g/cm^3) were measured concurrently using synchrotron XAS techniques. XANES and EXAFS analyses show that the predominant species in the solutions studied is a slightly distorted linear Cl-Cu-H_2O complex. The solubility of $CuCl_{(s)}$ decreases exponentially with decreasing water density (i.e., decreasing pressure), in a manner similar to the solubility behaviour of salts such as NaCl in water vapour. Based on this similarity, an apparent equilibrium constant for the dissolution reaction of 0.54 was regressed from the data at 420°C, and it was determined that each Cu atom is solvated by average 2.71 water molecules. This indicates that under these conditions, copper solubility is controlled mainly by the structure of the second-shell hydration, which is essentially invisible to the XAS techniques used in this study.

These results suggest that decreasing pressure from a supercritical low-density fluid may initiate precipitation of copper from the fluid before boiling or phase separation, but the low density fluid can still carry significant amounts of copper (~2000 ppm at 420 °C and 290 bar). Such low-density fluids could have contributed to copper transport under similar conditions such as seafloor hydrothermal vent fluids.