Smaller means more: UV laser ablation $^{40}Ar/^{39}Ar$ methods require detailed sample characterization

M.A. COSCA[1], D.GIORGIS[1], N. KRAMAR[1], A. MULCH[1] AND B. PUTLITZ[1]

[1] University of Lausanne, Institute of Mineralogy and Geochemistry, 1015 Lausanne, Switzerland

Combining high sensitivity mass spectrometers together with the high spatial resolution of ultraviolet (UV) lasers in $^{40}Ar/^{39}Ar$ geochronology has dramatically reduced the sample size required for *in situ* analyses of acceptable precision. Because of these technological advances there has been a rapidly growing demand to use such techniques to date the formation of specific stages of a metamorphic history and/or structural fabrics in a wide variety of rocks. Although these technological advances provide endless research opportunities for argon geochronologists, the accurate determination of when, for example, a specific foliation developed requires more than $^{40}Ar/^{39}Ar$ data. Because minerals are compositionally and structurally heterogeneous on a millimeter scale it is not surprising that $^{40}Ar/^{39}Ar$ age data acquired by *in situ* UV laser ablation are often heterogeneous. Close inspection of microchemical (electron microprobe, BSE, and SEM) and microstructural (optical microscopy and TEM) data within individual minerals often reveals variations that can be directly related to differences in $^{40}Ar/^{39}Ar$ ages and other isotopic data (e.g. stable isotopes).

One example in which a range of $^{40}Ar/^{39}Ar$ ages obtained by *in situ* UV laser ablation is reconciled by detailed sample characterization comes from the ultrahigh pressure (UHP) metamorphic rocks from the Sulu Terrain in China. In these rocks a striking correlation exists between the composition of white mica, apparent age, and their oxygen isotope values. Bulk step-heating $^{40}Ar/^{39}Ar$ analyses of these rocks are ambiguous. However, detailed sample characterization combined with *in situ* UV laser analyses demonstrate that argon was recycled from a Proterozoic protolith and trapped within the upper mantle UHP eclogitic assemblage during the Triassic. These results demonstrate the limited mobility of argon under fluid absent conditions at relatively high pressures. More generally, these conclusions highlight the need for complete sample characterization when interpreting otherwise complex $^{40}Ar/^{39}Ar$ data and underscore the potential of high spatial resolution *in situ* UV laser ablation $^{40}Ar/^{39}Ar$ geochronology for future research in metamorphic rocks.

References

Giorgis, D., Cosca, M., Li, S. (2000), *EPSL*, **181**, 605-615.

Giorgis, D., Cosca, M., Rumble, D., Liou, J.G., (2002) *Geochim. Cosmochim. Acta* (submitted).

Kramar, N., Cosca, M.A, Hunziker, J.C. (2001), *EPSL*, **192**, 377-388.

Mulch, A., Cosca, M.A., Handy, M.R. (2002), *Contrib. Mineral. Petrol.*, **142**, 738-752.

Experimental simulation of interactions between evolved hydrous liquids and gabbroic minerals at 200-400 MPa

FIDEL COSTA, BRUNO SCAILLET AND MICHEL PICHAVANT

ISTO-CNRS. 1A, Rue de la Ferollerie, 45071 Orléans, France. (costaf@cnrs-orleans.fr, bscaille@cnrs-orleans.fr, pichavan@cnrs-orleans.fr)

Numerous studies of mafic intrusions have proposed that interstitial liquids and fluids in cumulate piles migrate within crystal-frameworks, either by density-driven convection, compaction, or deformation (e.g., McBirney and Sonnenthal, 1990; Mathez, 1995; Boudreau, 1999). Specifically, migration of melts and fluids has been invoked to explain abrupt changes in the mineral proportions and compositions caused by reactions between 'dry' cumulus minerals and silica-, alkali- and water-rich liquids or fluids. Similar reaction-crystallization processes could happen during mafic-silicic magma interactions reported in studies of composite igneous complexes. However, despite detailed mineralogical and geochemical characterization of melt migration and reaction in gabbroic plutons, experiments dealing with such interactions at crustal pressures are lacking. Thus, we have started a series of experiments aimed at reproducing the phase assemblages and compositions resulting from such interactions. Experiments have been performed in IHPV at 200 and 400 MPa, 950-850 °C, fO_2 from NNO+1 to NNO+3, at H_2O saturated conditions, and using 1:1 mixtures of forsterite (Fo_{90}) and dacitic (65 wt% SiO_2, 2.7 wt% K_2O) glass powders. Run products consist of resorbed olivine (Ol) rimmed by hornblende (Hbl), orthopyroxene (Opx), phlogopite (Phl), and Fe-Ti oxides (Mt) set in a rhyolitic glass. Depending on the pressure (< 400 MPa) and temperature (< 900 °C) plagioclase is also stable. Compared to experiments with the 'pure' dacite end-member at the same P-T-fO_2-fH_2O, glasses of interaction experiments are higher in Al_2O_3 (~ 1.5-2 wt%) and Na_2O (~ 1-1.5 wt%), but lower in CaO (~ 1-1.5 wt%) and K_2O (~ 0.5-0.7 wt%), whereas the SiO_2 and MgO contents practically do not change. Mass balance calculations of the net stoichiometry of the reactions (wt%) yields: 40-50 liquid + 60-50 Ol = 70-55 Opx + 18-23 Hbl + 9-15 Phl + 1-8 Mt. Despite that the investigated system is rather simple (Ol + dacite) the mineral assemblages of the experiments are the same as those reported in mafic intrusions and xenoliths (e.g., Costa et al., 2002), and thus provide a first-order approach to melt migration and reaction processes in magma reservoirs at mid/upper crustal levels.

References

Boudreau A.E., (1999), *J. Petrol.*, **40**, 755-772.

Costa F., Dungan, M.A. and Singer B.S., (2002), *J. Petrol.* **43**, 219-241.

Mathez E.A., (1995), *Contrib. Mineral. Petrol.* **119**, 277-286.

McBirney A. and Sonnenthal E.L., (1990), *Chem. Geol*. **88**, 245-260.