

Fluid-mobile element symmetry in arc magmatism – Slab *and* surface

MICHAEL A. DUNGAN¹, C. BOUVET DE MAISONNEUVE¹,
O. REUBI² AND C.H. LANGMUIR³

- ¹Section of Earth Sciences, University of Geneva, 13 rue des
Maraîchers 1205 Geneva, Switzerland
(Michael.Dungan@unige.ch, Caroline.Bouvet@unige.ch)
²Earth Sciences, Isotope Geology, ETH-Zürich, 8092 Zürich,
Switzerland (Olivier.Reubi@erdw.ethz.ch)
³Earth and Planetary Sciences., Harvard University,
Cambridge MA, 02138, USA (langmuir@eps.harvard.edu)

A cornerstone of theories concerning the origin of subduction-related magmas is the differential fluid-solubility of elements liberated by dehydration reactions in subducted oceanic lithosphere. Diverse data verify the water- and sulfur-rich nature of arc magmas. Among these is the excess gas emitted by active arc volcanoes relative to the amount which could be dissolved in erupted magmas; i.e. much of the magma arriving at shallow levels in the crust stalls as intrusions and undergoes decompression crystallization and degassing. *Does low-P exsolution of H₂O-rich vapor preferentially transport fluid-mobile elements (B, Li, Cs, Rb, Ba) relative to fluid-immobile HFSE?* Compositional trends within some late Holocene (<2 ka) eruptions of crystal-rich (30-50 vol%) mafic magmas (51-56 wt% SiO₂) at Volcán Llaima (38.7° S: Andean Southern Volcanic Zone) imply that magma heterogeneity, due in part to migration of fluid-mobile elements in vapor (e.g. variable Rb/Zr & Rb/SiO₂ at nearly constant Mg#), may develop in conjunction with fluid-induced remobilization of residual crystal mush bodies (gas sparging) from previous eruptive/intrusive episodes. If this inference is correct, these inhomogeneities reflect variable mass contributions from new magma, preferentially mobilized interstitial melt from mush bodies plus variable fractions of entrained solids, and the consequences of elemental mobility in percolating vapor. These components sum to a hybrid compositional signal that is relatively minor compared to the high LILE/HFSE related to the primary slab-fluid signature, but it is robust and distinct from the fractional crystallization trend. This process will be manifested primarily at 'hyperactive' volcanoes where replenishment maintains composite crystal mush bodies above the solidus for years to decades without engendering significant eruptions (frequent, small magma injections), as well as triggering remobilization of crystal mush and the occasional eruption of pahoehoe lava (rare, but large replenishment events). This phenomenon may be applicable to relating magma replenishment to eruptive behavior and frequency.

The effects of bacterial cell walls on precipitation of uranyl phosphates

S.M. DUNHAM-CHEATHAM¹, X. RUI², B.A. BUNKER²,
R. HELLMAN³, N. MENGUY⁴ AND J.B. FEIN¹

- ¹Department of Civil Engineering and Geological Sciences,
University of Notre Dame, Notre Dame, Indiana 46556
(sdunhamc@nd.edu, fein@nd.edu)
²Department of Physics, University of Notre Dame, Notre
Dame, Indiana 46556
³Environmental Geochemistry Group, LGIT, OSUG,
Université J. Fourier, 38041 Grenoble Cedex 9, France
⁴Laboratoire IMPMC, Institut de Physique du Globe de Paris

Addition of dissolved polyphosphate to induce uranyl-phosphate mineralization represents a promising remediation strategy for oxidized U-contaminated groundwaters. However, the effects of microorganisms on the extent of precipitation and on precipitation mechanisms are unknown, and these effects can control the mobility and fate of U in the subsurface. We conducted 2 sets of precipitation experiments, with and without bacteria under otherwise identical conditions: 1) with a fixed initial log molality of dissolved U(VI) of -4.20, and P log molalities from -5.79 to -3.49; and 2) with a fixed initial log molality of total P of -3.62, and U log molalities from -5.08 to -3.90. We used non-metabolizing *Bacillus subtilis* cells, a gram-positive aerobic soil bacterial species. The samples were allowed to react for 2 hours, then were centrifuged to separate the solid and aqueous phases. The extent of precipitation was determined by analyzing the supernatant for remaining aqueous U and P. The solid phases were characterized by TEM, XANES, and EXAFS.

The results indicate that bacteria exert a large effect on the extent, the mineralogy and the morphology of the precipitates. The abiotic systems precipitated two distinct micron-scale uranyl phosphate phases with similar crystal sizes under all conditions studied. Conversely, the biotic systems exhibited less U removal than the abiotic controls, and precipitated only one dominant uranyl phosphate phase. Under low P concentrations, there was no evidence of a direct impact of cell walls with precipitation. However, with increasing P concentration, precipitation became located within the cell wall, and nanocrystals of the uranyl phosphate were formed. This study offers the first evidence of a direct influence of the cell wall on non-metabolic precipitation, a mechanism that likely results from interaction between aqueous uranyl cations and cell wall phosphate sites. The formation of nanoparticulate uranyl phosphates could greatly affect the mobility and fate of U in contaminated systems subject to polyphosphate remediation.