

Arsenic and tungsten in groundwaters of West Bengal, India

T. JADE HAUG¹, ANDREW NEAL², NINGFANG YANG¹,
KATHERINE TELFEYAN¹, SAUGATA DATTA² AND
KAREN H. JOHANNESSON¹

¹Department of Earth and Environmental Sciences, Tulane University, New Orleans, LA 70118, (thaug@tulane.edu, kjohanne@tulane.edu)

²Department of Geology, Kansas State University, Manhattan, KS 66506, (sdatta@k-state.edu)

Arsenic (As) concentrations and speciation were measured along with tungsten (W) in groundwaters from Murshidabad, West Bengal, India ($6.91 \leq \text{pH} \leq 7.54$). Total dissolved As concentrations (As_T) range from < 1 to $4622 \mu\text{g kg}^{-1}$, and As(III) predominates in solution accounting for between 54% to $>98\%$ of As_T . W concentrations range from 0.15 to $1.1 \mu\text{g kg}^{-1}$. The W concentrations are low compared to alkaline groundwaters ($\text{pH} > 8$) from Nevada, USA, where W concentrations range from 0.27 to $742 \mu\text{g kg}^{-1}$ [1, 2]. Although W correlates with As in the Nevada groundwaters ($r^2 = 0.63$, $p < 0.05$ [1]), W is not correlated with As_T or As(III) in Murshidabad groundwaters ($r^2 = 0.075$, $p > 0.2$ and $r^2 = 0.085$, $p > 0.2$, respectively). These relationships suggest that As and W biogeochemistry differ as a function of pH and redox conditions. Both W and As are strongly desorbed from mineral surface sites at high pH and under oxidizing conditions [3], which explains, in part, the relationship between these two elements in groundwaters from Nevada. Under reducing conditions and neutral pH that characterizes Murshidabad aquifers, As(III), which occurs as the uncharged H_3AsO_3^0 species, is more mobile than the tungstate oxyanion, WO_4^{2-} . We hypothesize that both As(III) and W are mobilized by reductive dissolution of Fe(III) oxides/oxyhydroxides, but that WO_4^{2-} is strongly re-sorbed, whereas As(III) is relatively more mobile as the uncharged, H_3AsO_3^0 in Murshidabad.

[1] Seiler *et al.* (2005) *Appl. Geochem.* **20**, 423. [2] Johannesson *et al.* (2000) *Aquatic Geochem.* **6**, 19. [3] Johannesson and Tang (2009) *J. Hydrol.* **378**, 13.

The volatile content of primitive Lunar volcanic glasses

E.H. HAURI¹, A.E. SAAL², M.J. RUTHERFORD² AND
J.A. VAN ORMAN³

¹DTM, Carnegie Institution of Washington, (ehauri@ciw.edu)

²Dept Geological Sciences, Brown University

³Dept Geological Sciences, Case Western Reserve University

The general consensus is that the Moon formed and evolved through a single or series of catastrophic heating events in which most of the highly volatile elements, especially hydrogen, were evaporated away. That notion has changed with new reports showing evidence of indigenous water in lunar volcanic glasses [1] and in lunar apatites from mare basalts [2, 3, 4]. These results represent the best evidence for the presence of a deep source within the Moon relatively rich in volatiles. We compiled volatile data (C, H₂O, F, S, Cl) for more than 360 individual Apollo 14, 15 and 17 lunar glasses with composition ranging from very-low to high-Ti contents. The glassy volcanic spherules range in size from $\sim 100 \mu\text{m}$ to $\sim 1 \text{mm}$. We measure the volatile content by SIMS using a Cameca IMS 6F and NanoSIMS at DTM, CIW. Our new SIMS detection limits ($\sim 0.13 \text{ppm C}$; $\sim 0.4 \text{ppm H}_2\text{O}$, $\sim 0.05 \text{ppm F}$, $\sim 0.21 \text{ppm S}$, $\sim 0.04 \text{ppm Cl}$) represent at least 2 orders of magnitude improvement over previous analytical techniques.

Our data support the hypothesis that there were significant differences in the initial volatile content of lunar magmas, and/or the mechanism of eruptive de-gassing was different for different eruptions. Interestingly, a general correlation was found between the volatile enrichment and the incompatible trace elements. This suggests that eruptive degassing, although extensive, did not completely erase initial differences in volatile contents between the distinct compositional groups of volcanic glasses. Our results suggest not only a much wetter Moon's interior than previously thought [1], but also suggest that the KREEP component, either through shallow assimilation by the melt or deep hybridization of the LMO cumulate, may influence the volatile composition of erupted lunar magmas.

[1] Saal, A. E. *et al.* (2008) *Nature* **454**, 192. [2] McCubbin, F.M. *et al.* (2010) *PNAS*, **107** (25), 11223. [3] Boyce, J. W. *et al.* (2010) *Nature* **466**, 466. [4] Greenwood, J. P. *et al.* (2010) *Proc. 41th LPSC* Abs 2439. [5] Hauri, E. H. *et al.* (2006) *EPSL* **248**, 715. [6] Spangler, R. *et al.* (1984), *J. Geophys. Res.* **89**, 487. *Proc. 40th LPSC* Abs 2374