

## The volatile contents of the Apollo 15 lunar volcanic glasses

A.E. SAAL<sup>1</sup>, E.H. HAURI<sup>2</sup>, J.A. VAN ORMAN<sup>3</sup>  
AND M.J. RUTHERFORD<sup>1</sup>

<sup>1</sup>Brown University, Providence, RI 02192

(\*correspondence: asaal@brown.edu)

(Malcolm\_Rutherford@brown.edu)

<sup>2</sup>DTM, Carnegie Institution of Washington, DC 20015

(hauri@dtm.ciw.edu)

<sup>3</sup>Case Western Reserve University, Cleveland, OH 44106

(james.vanorman@case.edu)

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 the new report showing evidences of indigenous water in lunar volcanic glasses<sup>1</sup>. Because these glasses are the most primitive melts erupted on the surface of the satellite, this result represents the best evidence for the presence of a deep source within the Moon relatively rich in volatile. Here we report new volatile data (C, H<sub>2</sub>O, F, S, Cl) for over 200 individual Apollo 15 lunar glasses with composition ranging from very-low to high Ti contents (sample 15427,41; 15426,138; 15426,32). Our new SIMS detection limits (~0.15 ppm C; ~0.4 ppm H<sub>2</sub>O, ~0.05 ppm F, ~0.21 ppm S, ~ 0.04 ppm Cl by weight determined by the repeated analysis of synthetic forsterite located on each sample mount), represent at least 2 orders of magnitude improvement over previous analytical techniques. After background correction the volatile contents have the following ranges: C 0-0.14± 0.13 ppm is within background; 0-70 ± 0.4 ppm for H<sub>2</sub>O; 1.6-60 ± 0.1 ppm for F; 58-885 ± 1.3 ppm for S; and 0-3 ± 0.02 ppm for Cl. Our new values represent an increase in the volatile concentrations by a factor of 2 from previously reported data<sup>1</sup>. Two outstanding features of the data are the significant correlation among H<sub>2</sub>O, Cl, F and S contents, and the clear relationship between the volatile and the major element contents of the glasses. The data support the hypothesis that there were significant differences in the initial volatile content, and/or the mechanism of degassing and eruption among these glasses was different. Most importantly, the data suggest that the measured H<sub>2</sub>O is indigenous to the Moon. Our results suggest that, contrary to the prevailing ideas, the bulk Moon is not uniformly depleted in highly volatile elements, and the presence of water, in particular, must be included to constrain models for the thermal and chemical evolution of the Moon's interior.

[1] Saal *et al.* (2008) *Nature* **454**, 192-195.

## Experimental study of the system U(VI) – organic compounds – H<sub>2</sub>O as a function of pH at 25°C, 0.1 MPa

C. SABATER<sup>1</sup>, C. NGUYEN-TRUNG<sup>2</sup>, M. GRIVÉ<sup>1</sup>,  
E. POURTIER<sup>2</sup>, A. KIPROP<sup>2</sup>, L. RICHARD<sup>2</sup> AND L. DURO<sup>1</sup>

<sup>1</sup>Amphos21, Valldoreix, Spain

(carolina.sabater@amphos21.com)

<sup>2</sup>Nancy-Université, G2R, 54506 Vandoeuvre-lès-Nancy cedex, France

There is an increasing interest in evaluating the influence of the hydrophilic fraction of sedimentary organic matter on the migration of radionuclides around nuclear waste geological storage sites. In that respect, phenol, benzoic acid, and salicylic acid may be considered as reference compounds for type-III, higher-plant-derived organic matter. Their interactions with U(VI) and Th(IV) ions have been the subject of several experimental studies. However, reliable data for U(VI) and Th(IV) complexes with phenol, benzoic acid and salicylic acid remain scarce.

The present work is a systematic experimental study of U(VI) – Organic compounds – H<sub>2</sub>O ternary systems as a function of pH and the concentrations of uranyl (VI) and organic ligand at 25°C and 0.1 MPa using a combination of three techniques: UV-visible spectroscopy, ATR-FTIR, and ESI-MS. The present study was undertaken (1) to detect the presence of possible uranyl(VI)-organic complexes, and (2) to determine their number and their stability domain.

A uranyl (VI) nitrate stock solution was prepared from recrystallized schoepite by dissolution in HNO<sub>3</sub> solution. The resulting concentration was 0.506 M uranyl(VI). A phenol solution was prepared by dissolution of a determined amount of phenol in H<sub>2</sub>O. All solutions were prepared and handled in closed containers to prevent the dissolution of CO<sub>2</sub>. The pH of each sample was adjusted using either HNO<sub>3</sub> or NaOH solution. The pH was measured using a Ross combination glass/reference electrode standardized against buffer pH 4, 7, and 10. UV-visible and ATR-FTIR spectroscopic measurements were made at various uranium (10<sup>-4</sup> – 10<sup>-1</sup> m) and phenol (10<sup>-4</sup> – 10<sup>-1</sup> m) concentrations to form various phenol/uranyl(VI) molal ratios in the range 0 – 10<sup>3</sup> over a pH range of 2 – 12.

UV-visible absorption measurements of 10<sup>-3</sup> M U(VI) solutions with phenol/uranyl(VI) molal ratio ranging from 0 to 10<sup>2</sup> at pH = 4 have revealed the presence of a uranyl(VI)-phenolate aqueous complex. Its individual UV-visible spectrum shows an absorption maximum around 417 nm.