

**EVIDENCE FOR PRECURSOR SULFATES, CHROMATES AND VANADATES OF MARTIAN
REGOLITH LINEAGE IN IMPACT GLASSES IN SHERGOTTITES.**

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Introduction: On Earth, acidic fluid interactions in soils lead to the oxidation of sulfur as sulfate, chromium as chromate and vanadium as vanadate under oxidizing conditions [1]. As the Martian surface is oxidizing, similar reactions could occur in soils on Mars. As shergottites originate from the near-surface on Mars, it is likely that some of them might have incorporated surface materials in their voids/fractures. Here, we report evidence for sulfates, chromates and vanadates precursors in impact-melt glasses in some shergottites that display evidence for the presence of other Martian regolith components.

Sulfates, Sulfites and Sulfides: We analyzed impact-melt (IM) glasses containing Martian atmospheric gases in some shergottites including EET79001, Lith A and Lith B and Tissint to constrain the Martian regolith components entrained in host rock voids and presently contained in shock-melted glass. Sulfur abundances determined in some Lith B glasses are comparable to those found in Gusev and Meridiani soils. In Lith B shock glasses, a positive correlation between FeO and SO₃ indicates the occurrence of Fe-sulfates whereas similar correlation of SO₃ with CaO and Al₂O₃ in Lith A glasses suggest the presence of Ca- and Al- sulfates in their glass- precursors. As sulfur presently occurs as immiscible sulfide melts in these glasses, we determined the Fe/S (atomic) ratios in the shock- sulfides. The results indicate that these blebs are not related to igneous sulfides [2]. Also, S K-XANES spectra in EET79001 and Tissint glasses show that sulfur occurs as mixed sulfide and sulfite species that are produced by decomposition of secondary sulfates into sulfites during shock-melting and further reduction to sulfides by isentropic cooling [3]. The ⁸⁷Sr/⁸⁶Sr(I) results obtained in several EET79001, Lith A glasses indicate mixing of CaSO₄ of Martian regolith lineage with host rock material in the glass precursors [4]. The δ³⁴S values determined in EET79001, Lith A and B glasses suggest that the sulfide blebs likely originated from Mars global surface sulfate mixed into glass precursors indicating that extraneous sulfur components entrained into shergottite IM glasses [5].

Chromates: Chromate has analogous chemical behavior to sulfate and vanadate in acidic solutions on Mars [1]. Here, we draw attention to the results obtained by [6] on pristine platelets in a EET79001 Lith C glass (Fig.3d of [6]). During SEM studies on this sample, the authors detected a K_α peak at 2.305 – 2.310 keV which they attributed to Pb because lead produces M_α and M_β X- rays at 2.345 and 2.442 keV respectively. These grains were named “Phase X” and have a chemical composition of 82 % as PbO (wt %), 9 % as Cr₂O₃ and 4 % as SO₃, a composition similar to lead chromate PbCrO₄ with minor sulfur mixed into it.

Vanadates: We determined the V- valence states using micro XANES techniques in EET79001 in Lith C glasses, #506 (Lith A) and #507 (Lith B) [7]. The V- valence determined for #506 yields a mean value of 3.01±0.03 corresponding to a mean *f*O₂ value of IW -1.2±0.01 (based on methodology described in [3]) and indicate that the glassy regions in #506 are dominated by V³⁺ and contain only minor amounts of either V⁴⁺ or V²⁺ [7]. In the case of # 507 glass, we found a mean V- valence of IW +3.59±0.06 yielding a mean *f*O₂ of IW +1.4±0.2. Thus, #507 contains a mixture of V³⁺ and V⁴⁺. Here, the bleb-rich region (V- valence +3.76±0.10 corresponding to an *f*O₂ value of IW +2.1±0.3) indicates relatively higher proportion of V⁴⁺ than the bleb-free region (V of IW +3.43±0.1 corresponding to an *f*O₂ value of IW + 0.8±0.3). The *f*O₂ values determined in host rock Lith A and Lith B of EET79001 using Fe-Ti oxide and Eu oxybarometry techniques [8,9] are similar to one another, i.e., about IW +1.8±0.3. However, we find a distinctly higher V-valence value of +3.76 in Lith B #507 and a distinctly lower value of 3.01±0.03 in Lith A. Whereas *f*O₂ can be lowered by shock-reduction, high *f*O₂ values cannot be produced by shock reduction of host Lith B alone. The high *f*O₂ value requires an additional, more oxidized, V- component such as vanadate to be present in the glass-precursor materials of # 507. If vanadium occurred as vanadate (V⁵⁺) in the glass precursors, it could have been easily reduced to V⁴⁺ and/or V³⁺ during shock melting and isentropic cooling. The results are consistent with the proposition that vanadates and chromates could have been co-precipitated with sulfates near the Martian surface (but not *in-situ* in the host rock) and was later transported into host rock voids by aeolian activity.

References: [1] Bartlett R. and James B. 1978. *Journal of Environmental Quality*. 8, 31-35. [2] Ross D. K. et al. 2012. Abstract #1715. 46th Lunar & Planetary Science Conference. [3] Sutton S. R. et al. 2008. Abstract #1961. 39th Lunar & Planetary Science Conference. [4] Nyquist L. E. et al. 2012. *Meteoritics & Planetary Science* 32:A5262. [5] Rao M. N. et al. 2016. *Journal of Geophysical Research*. submitted. [6] Gooding J. L. and Meunow D. W. 1986. *Geochemica Cosmochemica Acta*. 50, 1049-1059. [7] Sutton S. R. et al. 2010. Abstract #1747. 41st Lunar & Planetary Science Conference. [8] Herd C. D. K. et al. 2001. *American Mineralogist* 86, 1015-1024. [9] McCanta M. C. et al. 2004. *Geochemica Cosmochemica Acta*. 68, 1943-1952.