Geophysical Research Abstracts
Vol. 18, EGU2016-6364, 2016
EGU General Assembly 2016

Simulation of substrate erosion and sulphate assimilation by Martian low-viscosity lava flows: implications for the genesis of precious metal-rich sulphide mineralisation on Mars

Raphael Baumgartner (1), David Baratoux (2), Fabrice Gaillard (3), and Marco Fiorentini (1)

(1) Centre for Exploration Targeting, School of Earth and Environment, ARC Centre of Excellence for Core to Crust Fluid Systems, The University of Western Australia, Crawley, Western Australia (raphael.baumgartner@research.uwa.edu.au), (2) Géosciences Environnement Toulouse, CNRS, IRD and University of Toulouse, Toulouse, France (david.baratoux@gmail.com, (3) Institut des Sciences de la Terre d'Orléans, CNRS/INSU, Université d'Orléans, Orléans, France

On Earth, high temperature mafic to ultramafic lava flows, such as komatiites and ferropicrites of the Archean and Proterozic eons, can be hosts to Ni-Cu-PGE sulphide mineralisation. Mechanical/thermo-mechanical erosion and assimilation of sulphur-rich crustal rocks is ascribed as the principal mechanism that leads to sulphide supersaturation, batch segregation and subsequent accumulation of metal-enriched magmatic sulphides (e.g., Bekker et al., Science, 2009). In order to investigate the likelihood of the occurrence of similar sulphide mineralisation in extraterrestrial magmatic systems, we numerically modelled erosion and assimilation during the turbulent emplacement of Martian lavas, some of which display chemical and rheological analogies with terrestrial komatiites and ferropicrites, on a variety of consolidated sedimentary sulphate-rich substrates. The modelling approach relies on the integration of i) mathematical lava erosion models for turbulent flows (Williams et al., J. Geophys. Res., 1998), ii) thermodynamic volatile degassing models (Gaillard et al., Space Sci. Rev., 2013), and iii) formulations on the stability of sulphides (Fortin et al., Geochim. Cosmochim. Acta, 2015).
A series of scenarios are examined in which various Martian mafic to ultramafic mantle-derived melts emplace over, and assimilate consolidated sulphate-rich substrates, such as the sedimentary lithologies (i.e. conglomerates, sandstones and mudstones) recently discovered at the Gale Crater landing site. Our modellings show that lavas emplacing over consolidated sedimentary substrate rather than stiff basaltic crust, are governed by relatively high cooling and substrate erosion rates. The rapid assimilation of sulphate, which serves as a strongly oxidising agent, could result in dramatic sulphur loss due to increased volatile degassing rates at $fO_2 \gtrsim$QFM-1. This effect is further enhanced with increased temperature. Nevertheless, sulphide supersaturation in the way of sulphate assimilation can be achieved in relatively reduced (i.e. fO_2 <QFM-2) melts. We thus outline that reduced low-temperature melts of the Hesperian and Amazonian, such as those parental to the Adirondack-class basalts at Gusev Crater, rather than high-temperature melts of the Pre-Noachian and Noachian or those parental to some primitive Shergottite meteorites (Filiberto et al., J. Geophys. Res., 2015), are promising candidates for the presence of Ni-Cu-PGE sulphide mineralisation on Mars.