Acid alteration of igneous volcanic material from Martian analog: Implication to Mars

/ ANTONIO SANSANO*(1), EMMANUEL LALLA (1), JESÚS MEDINA (1,2), FERNANDO RULL (1,2)

(1) Unidad Asociada UVA-CSIC al Centro de Astrobiología INTA-CSIC, Edificio Inditi. Av. Francisco Valles, 8 P. Tecnológico Boecillo 47151-Boecillo (Valladolid)
(2) Dpto. Física de la Materia Condensada, Cristalografía y Mineralogía, Universidad de Valladolid

INTRODUCTION

The acid alteration has received considerable attention for the formation of secondary material from the Martian volcanic material. Experimental simulations are necessary in order to have a better comprehension of the geological process that have created and modified Mars, and the past-present geology of Mars related with the secondary alteration material. Thus, the results obtained can help us to know how future instrumentation will be used to address these questions [1, 2].
The Raman Laser Spectrometer (RLS) is one of the selected instruments included in the Analytical Laboratory Drawer (ALD) of the Rover engine, as Raman spectroscopy is considered a key technique by ESA due to its ability to perform a combination of petrological, mineralogical and geochemical determinations at the same spot [3].
Bearing in mind these ideas, a simulation has been done considering the possibility of past acid water on the surface of Mars. The result could complement the models proposed and provide information onthe formation ofindividual secondary material or the martial soil as whole [4]. The analytical instrumentation used is fundamentally Raman in order to compare with the results to be collected by Exomars RLS, complemented with XRD and ATR-IR.
On the other hand, the material used in thesimulation is basaltic coming from selected outcrop in theTenerifeIsland (Canary Archipelago). The samples were chosen on the basis of available information on volcanic activity and episodes, fluid-rock interactions caused by the weathering processes, submarine and sub-aerial hydrothermal alterations and the geomorphological features of the selected areas [5].

Outcrops selected
Las Cañadas Caldera: records 20 million years of volcanic activity with erosive processes, hydrothermal active sub-aerial processes and diffusive emission of gas.
Los Azulejos: This outcrop shows a variety of alteration processes with development of analcime, clays and illite group minerals. Also the rock/fluid interaction shows mushroom textures and fluid circulation processes involvingsulphate, manganese and iron oxides.
Historical eruptions: The magma have been erupted in the last 500 years and it correspond to a basaltic lava which reflects primary volcanic paragenesis as well as meteoric alteration processes

METHODS AND EXPERIMENTAL SET-UP

Samples selection
Seven samples were selected covering different origins and composition. The original mineralogy was analyzed by Raman and XRD:

- Sample 1 (SMP1) Los Azulejos: feldspar, analcime, muscovite, quartz, rutile, diopside.
- Sample 2 (SMP2) Las Cañadas: hematite, magnetite, apatite, weathered pyroxene, oligoclase, forsterite, pyroxene.
- Sample 3 (SMP3) Las Cañadas: labradorite, actinollite, oxides, orthoclase, amorphous feldspars, albite.
- Sample 4 (SMP4) Los Azulejos: quartz, anatase, feldspars, weddellite.
- Sample 5 (SMP5) Las Arenas: forsterite, pyroxenes (diopside, augite), iron oxides (hematite, magnetite), calcite, apatite.
- Sample 6 (SMP6) Lavas Negras: pyroxenes, plagioclase, forsterite.
- Sample 7 (SMP7) Las Cañadas (sampleTNFC04): anorthoclase, hematite, carbon, quartz, anatase, calcite, rutile, clays, zeolites.

Simulation experimentset-up
For the simulation experiment a thermostatic controlled bath was used to keep the reaction temperature at60ºC. Seven1g-weight samples were treated in 100ml of sulphuric acid solution. The pH of the solution was adjusted at 2. The flasks were sealed to avoid evaporation and were continuously stirred by magnets.
The experiment was carried on during a month and checked by pH sampling.


Fig. 1. Experimental Set-up

Analytical instrumentation
Mineralogical characterization of the samples (in bulk mode) was performed by micro-Raman spectroscopy using a Nikon Eclipse E600microscope coupled to a spectrometer KOSI Holospec f/1.8i illuminated by aHe-Ne 632.8 nm laser REO LSRP-3501. The detection was donewith a CCD Andor DV420AOE- 130. Acquisition parameters forthe micro-Raman systemwere: 30 s integration time, 10 accumulations and laser power varying depending on the sample. In addition, X-ray diffraction was performed on the samples (with XRD diffractometer Philips PW1710). The infrared spectroscopy was obtained by a Fourier Transform Infrared spectrometer in an attenuated total reflectance (FTIR-ATR). The ATR-FTIR Perkin Elmer Spectra 100 spectrometer system was equipped with a diamond ATR universal system and the spectral range applied was from 650

*palabras clave:*Tenerife, Marte, Alteración ácida, Raman | *key words: Tenerife, Mars, Acidic Alteration, Raman*

* corresponding author:asansano@fmc.uva.es

to 4000 cm^{-1} with 2 cm^{-1} spectral resolution.

PRELIMINARY RESULTS

After a month of treatment, the experiment was stopped. We have observed that the solid materials were completed disaggregated and only a small amount of powder was on the bottom of the flasks. Also in several samples there were small flakes floating on the surface, maybe clays.

The first results obtained are for the pH evolution. Thus, starting from a pH 2, the different samples react with the media roughlyincreasing the pH in the same amount of their reaction with the acid. A careful tracking of the pH evolution allowed us to observe that the fastest reaction were for samples SMP2 and SMP5, decreasing to the samples SMP3, SMP4 and SMP6. The least reactive samples were SMP1 and SMP7.

During the treatment, a small portion of each solution was picked and let it dry to crystalize the solutes. Several sulphates were detected by micro-Raman spectroscopy. These samples wereanalyzed by micro-XRD and the results are being processed. Likewise, following the filtering and evaporation of the solutions, the remaining phases are now in the process of study and identification, and the results will be presented elsewhere.

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