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Raman analysis of volcanic basalt from Tenerife and its hydrothermal alteration: A volcanic terrestrial analogue

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Abstract

A complete Raman spectroscopic study of several samples from selected areas from Tenerife has been carried out, considering the volcanic eruption of the zone and fluid/rock interaction process type (weathering process, submarine and sub-aerial hydrothermal alteration). XRD and Attenuated total reflectance IR-Spectroscopy has been applied to confirm the Raman result.

1. Introduction

The geology of Tenerife has a special interest because it is a host spot island which it is generally seen as analogue for the geology of Mars. Along the geological history of Tenerife, the volcanoes have overimposed and enriched the geomorphology of the island. Some areas of the island have suffered different hydrothermal processes taking into account the period of the eruption and geological process followed [1, 2]. Thus, the systematic study of the compositional (mineralogical and geochemical) variations occurred on the selected zones can serve to compare and to understand the role of water in the geological history of Mars and also in the search for possible evidences of past or present life on the red planet. In order to obtain the chemical and mineralogical and structural identification of the mineral phases, the Raman technique and complementary analysis (XRD and ATR-FTIR) have been applied. The combination of these techniques is considered the next generation instruments for characterization of mineralogical and organic during the exploration on Mars [3].

1.1 "Las Cañadas" Caldera

"Las Cañadas" is one of the best calderas in the world with a controversial origin like multiple collapses or a giant sector collapse. But the zone shows 20 million years of volcanic formation with a singular geological, mineralogical and fluid-rock interactions caused by the volcanic and hydrothermal episodes [4].

Figure 1. The Cañadas Caldera outcrop

1.2 Los Azulejos

"Los azulejos" ubicated in "Las Cañadas Caldera", is a volcanic outcrop which exhibits a clearly hydrothermal alteration. Secondary mineral species, like analcime, smectite and illite, sulphates, manganese and iron oxides, can be found on the lithology. They show bluish, greenish and yellowish fumarolic structure which depends on the altered mineral species [4].

Figure 2. The Azulejos massif

1.3 Lavas Negras (Historical eruption)

Correspond to one of the last eruptions (1798) on the island in “Las Cañadas” edifice. The magma erupted by the volcano it corresponds to a pahohoe basaltic lava and the zones reflect the processes related to the primary volcanic paragenesis

Figure 3. Lavas Negras eruption outcrop

2. Experimental Setting

The mineralogical characterization of the sample was performed by micro Raman Spectroscopy, using a Nikon Eclipse E600 microscope coupled to a KOSI Holospec f/1.8i spectrometer illuminated by a REO LSRP-3501, He-Ne 632.8 nm laser. The detection was performed with an Andor DV420AOE- 130 CCD. Furthermore XRD (with Philips PW1710 XRD diffractometer), IR-spectroscopy (PerkinElmer Spectrum 100 FT-IR spectrometer) were used.

3. Result and summary

On table 1, a resume of the mineral species and phases on the chosen zones identified by Raman spectroscopy is compiled.

Table1. Summary of crystalline phases detected on the zones using Raman spectroscopy

Las Cañadas	Los Azulejos	Lavas Negras
Plagioclase	K-Feldspar	Plagioclase
Augite	Analcine	K-Feldspar
Forsterite	Kaolinite/Muscovite	Augite
Rutile	Rutile	Forsterite
Anatase	Anatase	Magnetite
Hematite	Hematite	Anatase
Goetite	Magnetite	*****
Magnetite	Quartz	*****
Quartz	Carbonate	*****
Calcite	Melanterite	*****
*****	Lepidocrocite	*****

The result encourages to use the Raman spectroscopy for the Mars exploration, given that the analysis shows that the technique has detected Bowen´s series reaction of the primary mineral phases following the temperature formation and the secondary mineralization. Thus, the Raman results are a potential indicator for the aqueous processes related to the different hydrothermal processes. Combining the technique with XRD and ATR-FTIR will provide us with comprehensive information about mineralogy taking into account different selection rules and particle sizes, vibrational and excitational information [3].

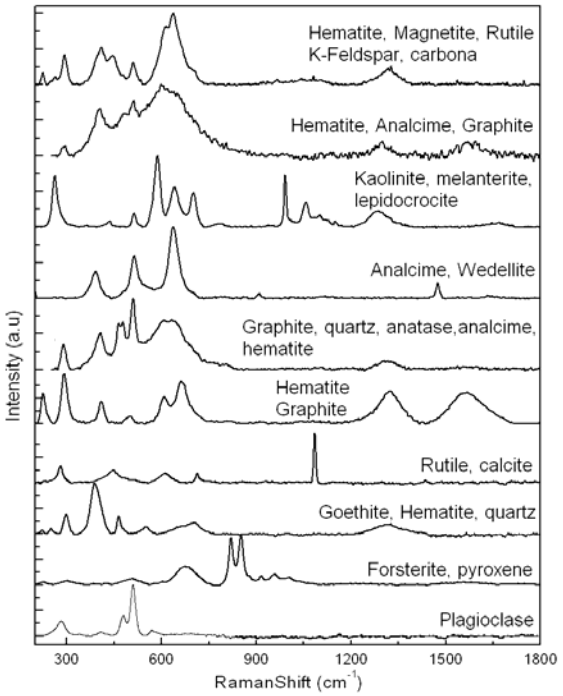

Figure 4. Raman spectra record of the mineral phases

4. References

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