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Raman characterization of minerals in the recently fallen Tissint shergottite

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Abstract

We use Raman spectroscopy to characterize the main minerals forming Tissint, especially the shock-induced minerals. This SNC meteorite belongs to the shergottites group. Our main goal is obtaining information on the physico-chemical processes that participated in its formation and delivery to Earth, but we are also interested in the presence of tiny shock veins throughout the rock that can provide information about shock processes. Moreover, some of these veins could contain components from the Martian atmosphere [1] which can be useful to sample Mars' atmospheric evolution [2].

1. Introduction

Tissint is the most recent Martian meteorite known to have landed on Earth. Many studies are performed on this meteorite, and its basic petrologic, elemental and isotopic characterization has been done. It shows olivine macrocrysts and microphenocrysts (to 1.5mm and to 0.4mm respectively) in a finer groundmass of patchily zoned pyroxene, plagioclase (maskelynite), Ti-poor chromite, ilmenite, pyrrhotite and minor merrillite [3]. We have selected several points in a thin section of Tissint in order to characterize the main minerals forming this meteorite, and particularly search for shocked minerals. It is usual to find evidences of shock in shergottites [4], like e.g. fractures and shock veins.

2. Experimental setup

We created a high-resolution reflectance mosaic of Tissint (Fig. 2) using a Carl Zeiss petrographic microscope that allowed us to select and characterize several areas (Fig. 1). Micro-Raman spectra were taken in backscattering geometry at room temperature using the 5145 Å line of an Argon-ion laser with a Jobin-Yvon T-64000 Raman spectrometer attached to an Olympus microscope and equipped with a liquid-nitrogen-cooled CCD detector. The lateral spatial resolution was ~ 1µm and the laser power onto the sample was kept below 1mW to avoid degradation due to overheating. The Raman spectrometer provided high-resolution spectra in working windows between 100 and 1,400 cm^{-1}.

3. Discussion

Olivine and pyroxene are the most common minerals in this meteorite as originally expected, also confirming the previous characterization of this meteorite as a Martian shergottite [5]. In any case, we also found tiny chromite inclusions (Figure 1, region b). The one we studied shows a brighter spot on its bottom composed of pyrite. The veins studied (Figure 1, region c) have a similar Raman spectrum, but the drift suggests that they are composed of a high pressure variation of pyrite [6]. The effects of shock events also imply the presence of secondary minerals that can provide information about hydrous activity and atmospheric processes on Mars [7].

4. Summary and Conclusions

We have characterized the main forming minerals of Tissint using Raman spectroscopy and identified the mineral within the small veins. Future studies include further characterization of these veins by other techniques and studying how the Raman drift in shocked pyrite can constrain the peak pressure.

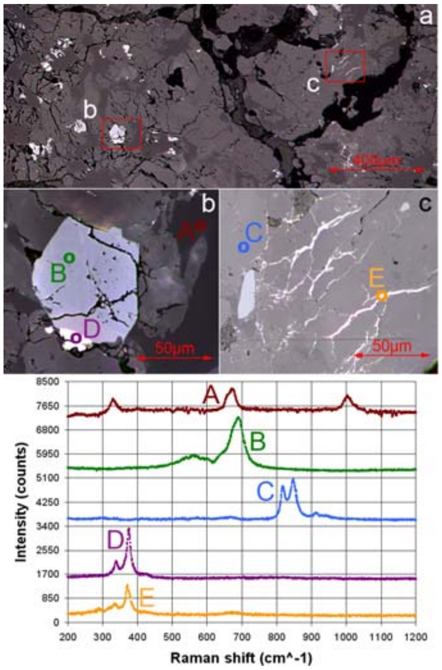

Figure 1: Optical bright field microscopy image of a small area of Tissint (region a) where Raman spectra has been collected. The Raman spectra of the selected points can also be seen at the bottom: A is pyroxene, B is chromite, C is olivine, D is pyrite and E is probably some high pressure variation of pyrite.

Acknowledgements

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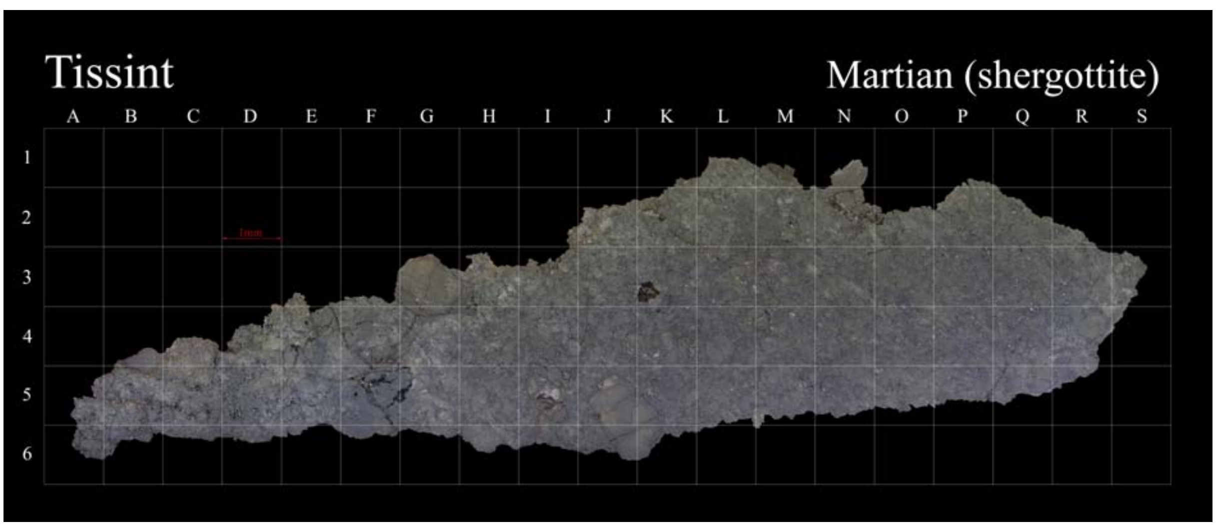

Figure 2: Mosaic of the thick section of Tissint obtained from reflected light images taken with a Zeiss Scope microscope. The studied area is in F5. The grid is 1mm wide.