Biosignatures in the Recrystallized Shock Melt Pocket of ALH-77005 Shergottite - Clues to Martian Life

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Introduction: The ALH-77005 Martian meteorite (lherzolitic type) was found at around the Allan Hills, in South Victoria Land on Antarctica in 1977-1978 [1]. Nyquist et al. [2] indicated lherzolitic texture of ALH-77005. Moreover, Ikeda [3] suggested this meteorite and its shergottite formation. The aim of this study is to investigate of biosignatures in the spinifex textured melt pockets.

Samples and Methods: The mineral assemblages and textures were characterized with a Nikon Eclipse LV100POL optical microscope. We used Bruker Hyperion 20000 FTIR-ATR microscope for the determination and distribution of micro-mineralogy and organic compounds.

Results: ***Petrography:*** The *ALH-77005* consists of pyroxene, olivine and feldspar. The ALH-77005 has coarse-granular texture with locally microgranular and poikilitic texture regions and melt pockets with recrystallized needle-like crystallites in glassy matrix. In the environment of melt pockets resorbtion rim can be observed with toast-like texture in some cases and infiltration of dark melt. The melt pockets are darker (dark-brown-black in plane polarized lights) than its environment (well-crystallized coarse crystals). In the vicinity and inside of melt pockets several textures can be observed. The needle-like crystals are feldspar and pyroxene in melt pockets. The lengths of needles are between 10-75 μm, and their width falls into 1-5 μm range. Near to melt pockets, isotropic lath-shaped plagioclase, maskelynite occur. But, according to presence of weak feldspar band Raman FTIR spectra, this alteration is transient, the shock pressure did not exceeded 30GPa. In the olivines, parallel to the fractures, kink-band system can be observed. The poikilitic fractured pyroxene grain contains olivine with thick one-set kink bands.

The recrystallized shock melt with spinifex texture contains **microbial features** as well, Mineralized microbially produced texture (MMPT) in the form of pearl necklace-like, with vermiform inner signatures, is embedded in needles (olivine, pyroxene, feldspar) in the rapidly cooled shock melt (Fig. 1/A). The MMPT consists of micrometer-sized microbial filamentous elements and clusters in their boundary region. The MMPT is very extensive, reaches 70-80 % of the shock melt pocket and is intimately woven in the full cross-section of the melted part. All of recrystallized melt pocket sections showed signs of Fe mobilization and oxidation (brown haloes around mineral grains, brown filaments, Fig. 1/B).

ATR-FTIR: The iron-oxidizing microbial structures have a mixed composition containing iron oxides (ferrihydrite, goethite) [4], and olivine [5]. Hydrocarbon compounds were also detected (long chain hydrocarbon, diene; [6-8], and C-H stretching of aliphatic hydrocarbons [7] (Fig. 2). The presence and appearance of ferrihydrite corresponds to bacterial originated remobilization of iron from olivine and troilite. IR vibrations of isoprenoids were also detected [8].

Conclusion: The presence of iron oxidizing bacteria in recrystallized shock melt could be proposed as Martian origin. In general, the terrestrial weathering is induced along fractures and rims, but this sample does not contain microbial alterations and weathering features outside of recrystallized melt pocket. Increasing microbially mediated activity helps to increase the amount of microbes, which first „eat" (consume) and then remineralize the mineral components in the matrix and in the glass regions [9,10], before the microbial alteration was stopped.

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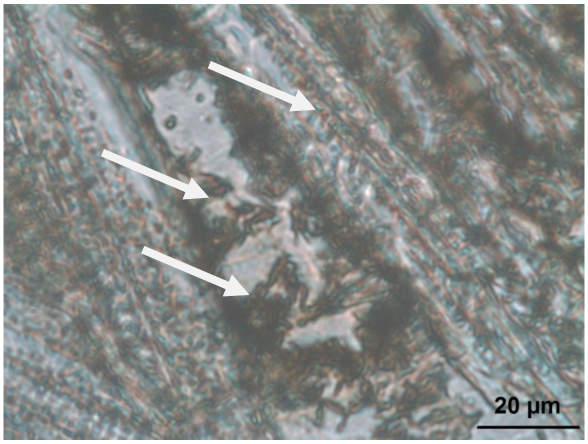
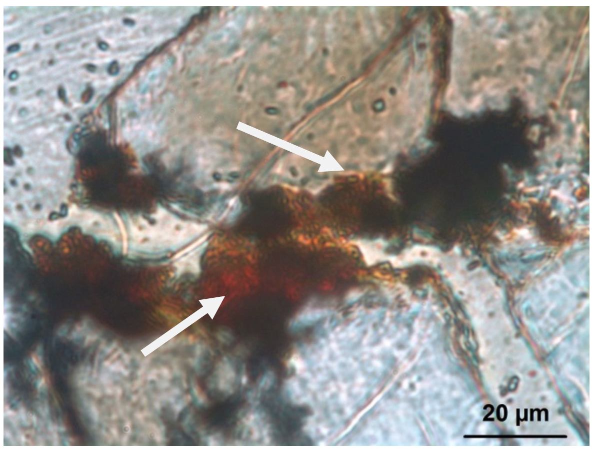
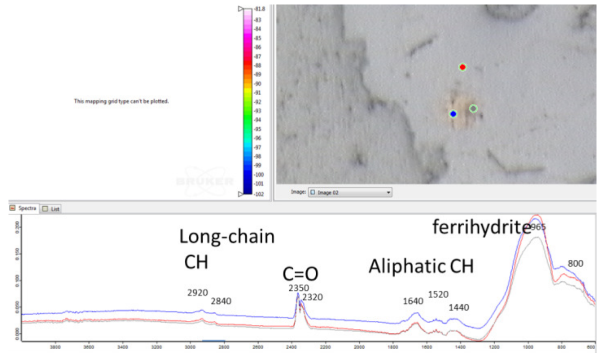


A



B

Fig. 1: (A) Filamentous pearl necklace-like inner textures (marked by arrows) in shock melt pocket, (B): Microbially mediated mobilization and mineralization of iron from opaque minerals and organic material.



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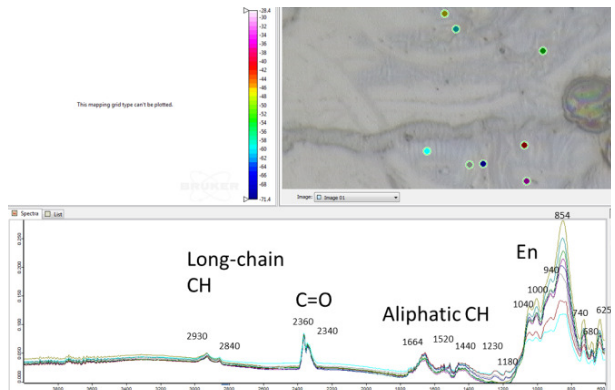

B

Fig. 2: IR spectra of area near troilite (degradation to ferrihydrite) and pyroxene with organinc compounds of biosignatures. Spectra were taken in shock melt pocket.