CHEMICAL AND MINERALOGIAL EXAMINATION OF ANTARCTIC MICROMETEORITES AND THEIR ORGANIC COMPOUNDS

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Introduction: Antarctic Micrometeorites (AMMs) are micron-sized dust particles collected in the Antarctica ices. Some of these micrometeorites could have formed in the outer solar system and brought to the inner solar system by comets [1]. Because of highly unequilibrated collections of anhydrous and hydrous minerals, former chemical analyses identified several micrometeorites to be very similar to rare CM and CR carbonaceous chondrites groups [1]. Three AMMs from the Concordia collection were analyzed by Raman spectroscopy to determine their mineralogical compositions and organic constituents. The AMMs have a porous morphology and are therefore expected to have suffered low thermal alteration during atmospheric entrance [1]. In this study, the alteration processes on their parent bodies as well as the possible alteration on Earth during atmospheric entrance are discussed.

Methods: The AMMs have typical sizes of 38µm x 67µm x 32 µm; 23µm x 20µm x 11µm and 23µm x 20µm x 29µm. They were placed on gold plates of 1cm x 1cm and analyzed by confocal Raman Spectroscopy using a Witec Alpha 3000 microscope. The samples were measured with x100 and x50 objectives using a 532nm laser and a power between 0.5-1.9mW to protect potential organic materials. 2D mappings with steps of 1µm x 1µm were acquired. A layer scan mode was also used to produce 3D mappings with steps between 0.25µm and 0.8 µm in the lateral dimension and 1µm in depth.

Results: The three AMMs are mainly composed of iron oxides like hematite and magnetite. Two of them furthermore show the presence of sulfate minerals. Olivine and pyroxene were found as very small inclusions in one of the three samples. Two grains also show the so-called D and G bands in the Raman spectra that are indicative for the presence of aromatic compounds [2].

Discussion: In order to determine the Fe and Mg contents of olivine and Fe, Mg, Ca contents of pyroxene, the exact peak positios were measured [3,4]. We estimated a chemical composition from $Fo_{37\pm19}$ to $Fo_{99\pm16}$ for the olivine inclusions and, for the pyroxene inclusion, a composition ranging from $En_{97.5}Fs_{2.5}$ to $En_{70}Fs_{30}$. The Raman properties of the D and G bands i.e. width, intensity and position were possibly affected by thermal alteration of the organic material in our samples [5,6]. We have therefore compared the measured values of these parameters with different groups of meteorites and Interplanetary Dust Particles (IDPs). The organic material in our AMMs has experienced similar degree of thermal alteration as IDPs, in particular as the Fe and oxide-rich IDP L2036 AE4 which shows similar mineralogical compositions than our AMMs [7]. The sulfate minerals were examined in terms of water and cation content in order to get a precise identification using their Raman band positions. [8,9]

Conclusion: Raman spectroscopy analyses of three AMMs have been performed to study alteration processes on their parent bodies. The AMMs contain oxide and sulfate phases and very few anhydrous minerals, which suggests that they could have undergone hydrothermal alteration on their parent bodies. However, one cannot exclude alteration on Earth during storage or during atmospheric entrance.

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