Poster

Nanoscale investigation of extraterrestrial ureilitic carbon

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Ureilites are achondritic meteorites mainly composed of olivine, pigeonite, carbon phases (graphite and diamond) and Fe-Ni compounds. All the ureilitic samples are believed to come from the same parent body, the Ureilitic Parent Body (UPB), which was catastrophically disrupted by impact event(s) [1]. Nowadays, the shock origin of diamonds in ureilites is the most supported and reliable process of formation [2-7]. The different recorded ureilitic fragments present different levels of shock recorded by silicates [8].

To attempt to confirm the shock event as the formation process for carbon phases, a series of shock carbon-bearing ureilitic meteorites will be investigated by a combined approach applying Transmission Electron Microscopy (TEM), micro-X-Ray Diffraction (μ-XRD) and micro-Raman Spectroscopy (MRS). In this contribution, I will present the project plan, funded by the Alexander Von Humboldt Foundation, aimed at developing a new approach that will allow the detailed and quantitative investigation of the defects in extra-terrestrial ureilitic diamonds and graphite. This multimethodological approach would to restrict the real shock range experienced by the samples, to improve the shock classification of this meteorite group and possibly extending this approach to other carbon-bearing meteorites.

The first samples on which we collected the first preliminary results for this project are 5 ureilitic samples from Frountier Mountain Antarctica (FRO 95028, FRO 01089, FRO 97013, FRO 01088 and FRO 01012). The petrographic description of these samples is reported in [6]. These selected ureilites were studied by Optical Microscopy (OP) and Scanning Electron Microscopy (SEM) [by JEOL JSM-6490] while the carbon phases extracted from these fragments were investigated by micro X-ray diffraction (μ-XRD) [using Rigaku-Oxford Diffraction Supernova kappa-geometry goniometer], micro-Raman Spectroscopy (MRS) [by WiTEC Alpha R 300] and Transmission Electron Microscopy (TEM) [using Talos 200kV].

The μ-XRD, MRS and TEM results on carbon of the selected ureilites with a wide range of different levels of shock (from U-S2 to U- S6) will allow to i) evaluate the presence of "compressed graphite" structure; ii) detect and characterize the stacking disorder in extra- terrestrial ureilitic diamonds for both nanometric and micrometric crystals; iii) define a correlation between the carbon features (stacking disorder [9] in diamond, compressed graphite, and various nanostructures) and the degree of shock recorded by silicates in each ureilitic sample selected for this study; iv) constrain the pressure range at which individual features (like lonsdaleite lamellae, twins, etc.) appear. This evaluation will help to improve the shock classification adopted so far in literature based on stacking disorder and other microstructural features.

The combined investigation of carbon features together with the shock recorded by silicates will help us to better understand the energy released by dynamic impact process(es) that involved a differentiated body as the UPB and also will allow us to improve the shock classification of ureilitic meteorites. The result of this project will very likely add a "missing piece" in reconstructing the puzzle of the UPB and its asteroidal daughter bodies' history.

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