METEORITE ATMOSPHERIC ENTRY REPRODUCED IN PLASMATRON.

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Introduction: Atmospheric entry of meteoroids is a complex process that involves melting, evaporation, and oxidation of the original material. Meteorites recovered on the ground are used for constraining the composition and the history of the parent bodies, but atmospheric entry can induce significant changes in microstructures and chemistry that may bias our interpretation. Ablation and heating effects are generally investigated by numerical modeling (e.g., [1]) or by heating experiments, which are however far from reaching the conditions experienced by meteoroids (e.g., [2,3]). Here we present the preliminary results of experiments in the VKI Plasmatron, a facility that creates a steady state plasma flow up to 22 mbar pressure, over 10 000 K temperature, with a potential heat flux of 16 MW/m^2. This instrument is commonly used for testing spacecraft heat shields and, therefore, represents a good approximation of the conditions encountered by any material during the atmospheric entry. Preliminary tests on basalt, chosen as a terrestrial analogue for meteorites, show the importance of vaporization effects.

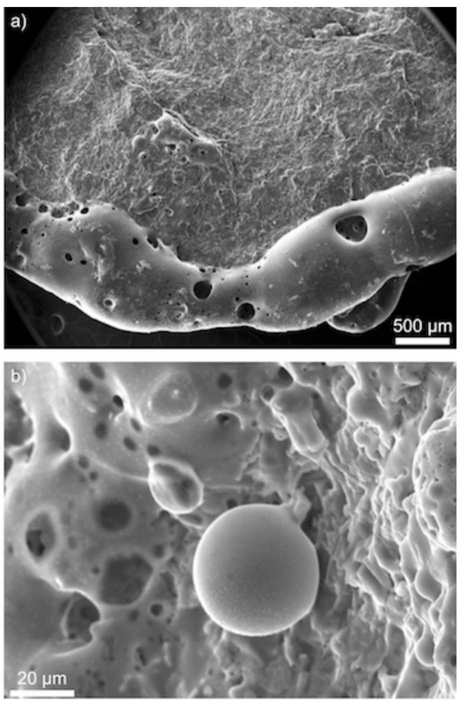

__Fig. 1__ Secondary electron-SEM images of basalt sample in cork after plasmatron experiment.

Methods: Cylinders of ca. 1 cm diameter and 2 cm length were drilled from a specimen of alkali basalt. Samples were jacketed in cork or graphite for two series of experiments. Several experimental conditions have tested at the VKI: at 15 mbar and 3MW/m^2, 40 s exposure time, cork, at 15 mbar 3MW/m^2, 21 s exposure time, graphite, and at 220 mbar 3MW/m^2, 51 s exposure time, cork. After the experiment, droplets of melt flowing over the sample holder and the sample itself (cut in two halves, normal to the flow) were analyzed with µ-XRF and SEM, equipped with EDS detector, at the VUB.

Results: The molten portion of the sample clearly shows a change in the bulk chemical composition, with respect to the original material. The most obvious change is the strong depletion in alkali and generally highly volatile elements, corresponding to an apparent enrichment of the melt in refractory elements. The sample holder has a strong influence in the behavior of the basalt during the experiment. Cork has thermal insulation effect and, therefore, the inner part of the samples is barely heated. Thermal fracturing causes the ejection of unmelted fragments, which are only coated with a thin film of melt (Fig. 1a). Graphite, on the contrary, is a good thermal conductor and, therefore, the sample is more extensively molten, with only the very inner part preserved from melting. Ejection of material is less obvious, but droplets of melt were observed to flow radially on the surface of the sample holder. At the transition between the melt coating and the unaffected portion of the sample, melt spherules have formed (Fig. 1b). These melt spherules are the experimental analogue of ablation spherules formed from meteoroids. The melt exhibits *schlieren* and flow fabric. Tiny vesicles seem to be coated by iron oxides.

Conclusions: Melting experiments with plasmatron offers a broad range of application in planetary science, from investigation of meteorite fusion crust and micrometeorite formation to the evolution of impact ejecta. In these preliminary experiments, the change in bulk composition in the melt supports the hypothesis of alkali vaporization during atmospheric entry, based on studies of cosmic spherules (e.g., [4,5]). Further experiments are planned in the next months, testing highly equilibrated ordinary chondrites, iron meteorites, as well as impact melt at different experimental conditions (e.g., experiment duration, temperature, and pressure).

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