RADIOLYSIS OF MURCHISON SAMPLES – A PHOTOIONIZATION REFLECTRON TIME-OF-FLIGHT STUDY. S. Góbi[1,2], R. Frigge[1,2], M. J. Abplanalp[1,2], J. Gillis-Davis[3], R. I. Kaiser[1,2]
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Introduction. The carbonaceous chondrite Murchison is one of the most well studied meteorite belonging to the aqueously altered CM2 group. It is especially of great interest because of its relatively high water and organic material content, which has spurred a plethora of analytical works so far. Furthermore, radiolysis studies have also been done in order to better understand the space weathering taking place on bodies with astrophysical relevance. Nevertheless, there is still no comprehensive picture on these processes necessitating the conduction of further experiments in this topic.

Experimental details. Thin films of Murchison meteorite samples were prepared on silver wafers with an area of roughly 1.9 cm^2. These were mounted on a cold finger and cooled down to 5.5 ± 0.1 K or 150.0 ± 0.1 K in an ultrahigh vacuum chamber operated at a base pressure of roughly 10^{-10} torr using oil-free turbomolecular pumps backed by dry scroll pumps. The samples were then irradiated for 5 hours (i) with 5 keV electrons at a current of 10 μA, (ii) with CO_2 laser at the energy of approximately 8 W cm^{-2}, (iii) simultaneously with both radiation sources. During the irradiation, UV-VIS, FT-IR, and EI-QMS (with an ionization energy of 70 eV) spectra were taken on line and *in situ*. Blank experiments were also performed by conducting the identical experimental sequence, but without irradiating the sample. Then, the samples were kept isothermally for 1 additional hour before being heated to 300 K at a rate of 1.0 K min^{-1}, while monitoring the volatile products subliming into the gas phase (temperature programmed desorption or TPD phase). This was done via the EI-QMS and by the help of the state-of-the-art single-photon photoionization reflectron time-of-flight mass spectrometric (PI-ReTOF-MS) methods. The energy of the VUV photons used for photoionization were 10.49 eV. The samples were also analyzed by electron microscopy *ex situ* after the experiments.

Evaluation of results. No observable decrease can be identified in the FT-IR spectrum of the electron irradiated samples; neither a decrease in the silicate bands at 10 μm nor the appearance of a new absorption band in the examined MIR region. The former finding can be explained by the thickness of the sample, being approximately two orders of magnitude larger than the penetration depth of the electrons. The same holds true for the sample irradiated with the CO_2 laser and in the dual irradiation experiments except that a new O–H stretching band can be observed emerging at 3 μm in the latter experiment at 150 K. This implies the formation of H_2O by the destruction of the serpentinite content of the meteorite releasing the chemically bound water. The UV-VIS spectra showed darkening of the sample when irradiated with the CO_2 laser, which is in accordance with previous experimental results. In the EI-QMS spectra of the dual irradiated samples, signals at m/z values of 18 and at 44 can be detected during the TPD phase of the experiment showing the sublimation events of the H_2O and CO_2 molecules formed during the irradiation. The latter species originates from the destruction of the organic compounds that are abundant constituents of the Murchison meteorite. Being the PI-ReTOF-MS technique more sensitive than the other used methods makes it capable to detect molecules sublimed into the gas phase even in minor concentrations. This allowed for the detection of numerous signals that belong to smaller, volatile organic molecules that were produced during the radiolysis of the non-volatile organic content of the Murchison sample. It is also important to note that the EI-QMS and PI-ReTOF-MS results of the dual radiolysis experiments performed at 5.5 and 150 K differ from each other in their signal strengths only, i.e. in the concentration of the species produced. Namely, the observed formation rate of the products are higher at higher temperatures in general.

Conclusion, future goals. Radiolysis of Murchison samples were carried out using different radiation sources while monitored online and *in situ* by means of FT-IR, EI-QMS, and UV-VIS; whereas EI-QMS and PI-ReTOF-MS spectra were collected during the TPD phase. The results of the dual irradiated samples imply the production of H_2O originating from the release of chemically bound water. Besides, formation of CO_2 and small volatile organic compounds can also be observed caused by the destruction of the carbonaceous material indigenous to the Murchison sample. Moreover, the electron microscopy confirmed that the CO_2 laser heating causes the sample to melt and evaporate on its surface. Future studies investigating meteorite samples other than Murchison are required to be able to gain a comprehensive picture on the space weathering processes occurring on the surface of bodies with astrophysical relevance.

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