Fe AND O EELS STUDIES OF ION IRRADIATED MURCHISON CM2 CARBONACEOUS CHONDRITE MATRIX. L. P. Keller[1], R. Christoffersen[2], C. A. Dukes[3], R. A. Baragiola[3], and Z. Rahman[2]. [1]ARES, Code XI3, NASA/JSC, Houston, TX 77058 (Lindsay.P.Keller@nasa.gov). [2]Jacobs, NASA/JSC, Code XI, Houston, TX, 77058. [3]Laboratory for Atomic and Surface Physics, University of Virginia, Charlottesville, VA 22904.

Introduction: The physical and chemical response of hydrated carbonaceous chondrite materials to space weathering processes is poorly understood. Improving this understanding is a key part of establishing how regoliths on primitive carbonaceous asteroids respond to space weathering processes, knowledge that supports future sample return missions (Hayabusa 2 and OSIRIS-REx) that are targeting objects of this type. We previously reported on He^+ irradiation of Murchison matrix and showed that the irradiation resulted in amorphization of the matrix phyllosilicates, loss of OH, and surface vesiculation [1]. Here, we report electron energy-loss spectroscopy (EELS) measurements of the irradiated material with emphasis on the Fe and O speciation.

Sample and Methods: A polished thin section of the Murchison CM2 carbonaceous chondrite was irradiated with 4 kV He^+ (normal incidence) to a total dose of $1x10^{18}$ He^+/cm^2. We extracted thin sections from both irradiated and unirradiated regions in matrix using focused ion beam (FIB) techniques with electron beam deposition for the protective carbon strap to minimize surface damage artifacts from the FIB milling. The FIB sections were analyzed using a JEOL 2500SE scanning and transmission electron microscope (STEM) equipped with a Gatan Tridiem imaging filter. EELS spectra were collected from 50 nm diameter regions with an energy resolution of 0.7 eV FWHM at the zero loss. EELS spectra were collected at low electron doses to minimize possible artifacts from electron-beam irradiation damage [2, 3].

Results and Discussion: Fe $L_{2,3}$ EELS spectra from matrix phyllosilicates in CM chondrites show mixed Fe^{2+}/Fe^{3+} oxidation states with $Fe^{3+}/\Sigma Fe$ ~0.5 [4]. Fe $L_{2,3}$ spectra from the irradiated/amorphized matrix phyllosilicates show higher Fe^{2+}/Fe^{3+} ratios compared to spectra obtained from pristine material at depths beyond the implantation/amorphization layer. We also obtained O *K* spectra from phyllosilicates in both regions of the sample. The O *K* spectra show a pre-edge feature at ~530.5 eV that is related to O 2*p* states hybridized with Fe 3*d* states [3]. The intensity ratio of the O *K* pre-edge peak relative to the main part of the O *K* edge (that results from transitions of O 1*s* to 2*p* states) is lower in the irradiated layer compared to the pristine material and may reflect the loss of O (as OH) as was observed by IR spectroscopy [1].

Conclusions: In addition to amorphization and OH loss [1], EELS spectra of He^+ irradiated matrix phyllosilicates in Murchison show that some of the Fe^{3+} is reduced to Fe^{2+}. Spectral deconvolution is underway to extract quantitative ratios from the EELS spectra.

References: [1] Keller, L. P. *et al*. (2015) *LPS* 46, #1913. [2] Garvie, L. A. *et al*. (2004) *Am. Min*. 89, 1610. [3] Garvie, L. A. (2010) *Am. Min*. 95, 92. [4] Zega, T. J. *et al*. (2003) *Am. Min*. 88, 1169.