THE MINERLAOGY OF METEOR CRATER FROM MICRO-INFRARED AND REMOTE HYPERSPECTRAL IMAGING. J.R. Michalski and S.P. Wright, Division of Earth and Planetary Science, University of Hong Kong, Hong Kong, China; jmichal@hku.hk

Introduction: Meteor Crater in Arizona, USA is one of the most comprehensively studied impact structures and planetary analogs on the planet. Since 1960, comprehensive geological studies by Shoemaker [1], various other authors have investigated the structure, erosion, and mineralogy, and remote sensing of Meteor Crater (summarized by Kring [2]). Building on previous works [3-4], we have analyzed multispectral and hyperspectral remote sensing data, hyperspectral data of hand samples, laboratory spectra of samples and powders, and hyperspectral infrared imaging of thin sections. The goal is to better understand how the mineralogy of the crater from microscopic to macroscopic is related to impact facies and to remote sensing perspectives.

Methods: Datasets used in this work include: a) ASTER visible/near-infrared (VNIR), shortwave infrared (SWIR), and thermal-infrared data (TIR); b) AVIRIS hyperspectral SWIR, c) HyTES hyperspectral TIR; d) WorldView 3 multispectral VNIR and SWIR; e) lidar; f) laboratory VNIR, SWIR and TIR reflectance data (collected on a Nicolet iS50); g) HySpex VNIR and SWIR hyperspectral reflectance of hand samples; h) TIR hyperspectral reflectance of thin sections; i) optical petrography and j) x-ray diffraction (XRD) data. All lab analyses were carried out at the Planetary Spectroscopy and Mineralogy Laboratory at HKU.

Results: Multispectral images clearly show mineralogical heterogeneity associated with the crater (Figure 1), as has been demonstrated previously through analysis of ASTER and TIMS data [2,3]. Hyperspectral airborne data reveal significantly more detail related to multiple target rock units as well as breccias, shattered rocks and ejecta mapped by Shoemaker. The dominant compositional units are those dominated by 1) carbonate (Mg-bearing, based on position of C-O overtones); 2) kaolinite (based on AlOH overtones at 2.16 and 2.21 μm); Fe-oxides (based on 0.55 μm electronic absorptions); and quartz (based on emissivity features from 8-10 μm) (Figure 2). In fact, multiple types of quartz features are observed, mostly related to particle size and surface roughness. Microcrystalline quartz and quartz with micro-scale fractures and roughness exhibit different reststrahlen features than smooth, plutonic quartz or large grains polished by eolian activity [5].

HySpex analysis of hand samples shows the same trends with strong absorptions attributable to Mg/Ca-carbonate and kaolinite group minerals. Hand specimens of lechatelierite [6-7] exhibit clear absorptions related to amorphous silica in the HySpex data. But so far, these features have not been identified in AVIRIS data. Despite the high spatial resolution of AVIRIS data at this site (3.2 m/pix), the abundance of lechatelierite in ~10 m^2 pixels is not sufficiently high to detect remotely at this point. Micro-TIR spectral mapping of thin sections however, does show a diversity of minerals including evidence for amorphous silica and potentially coesite.

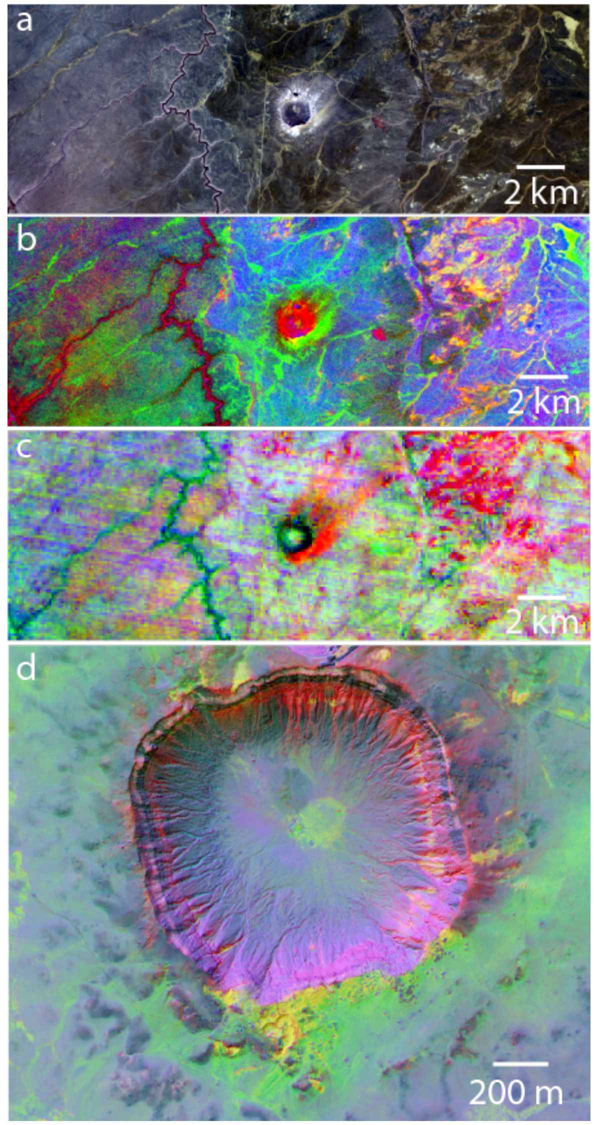

Figure 1: ASTER VNIR reflectance (a), ASTER SWIR principal component image (PCA) (b); ASTER TIR decorrelation stretch (14/12/10 RGB) (c); and AVIRIS PCA overlaid on lidar hillshade (d). Note the multiple lithologies observable in the AVIRIS data.

References: [1] Shoemaker (1963) *The Moon, Meteorites, and Comets,* 301-336. [2] Kring, D. (2017), LPI Contribution 2040. [3] Ramsey (2002) *JGR-Planets*, doi: 10.1029/2001JE001827 [4] Wright and Ramsey (2006) *JGR-Planets*, doi: 10.1029/2005JE002472. [5] Michalski, J. R. (2005), PhD Thesis, Arizona State Univ, 215 p. [6] Hörz, F. et al. (2002), MAPS 37, 501-531.[7] Osinski, G. R. et al. (2015), EPSL 432, 283-292.

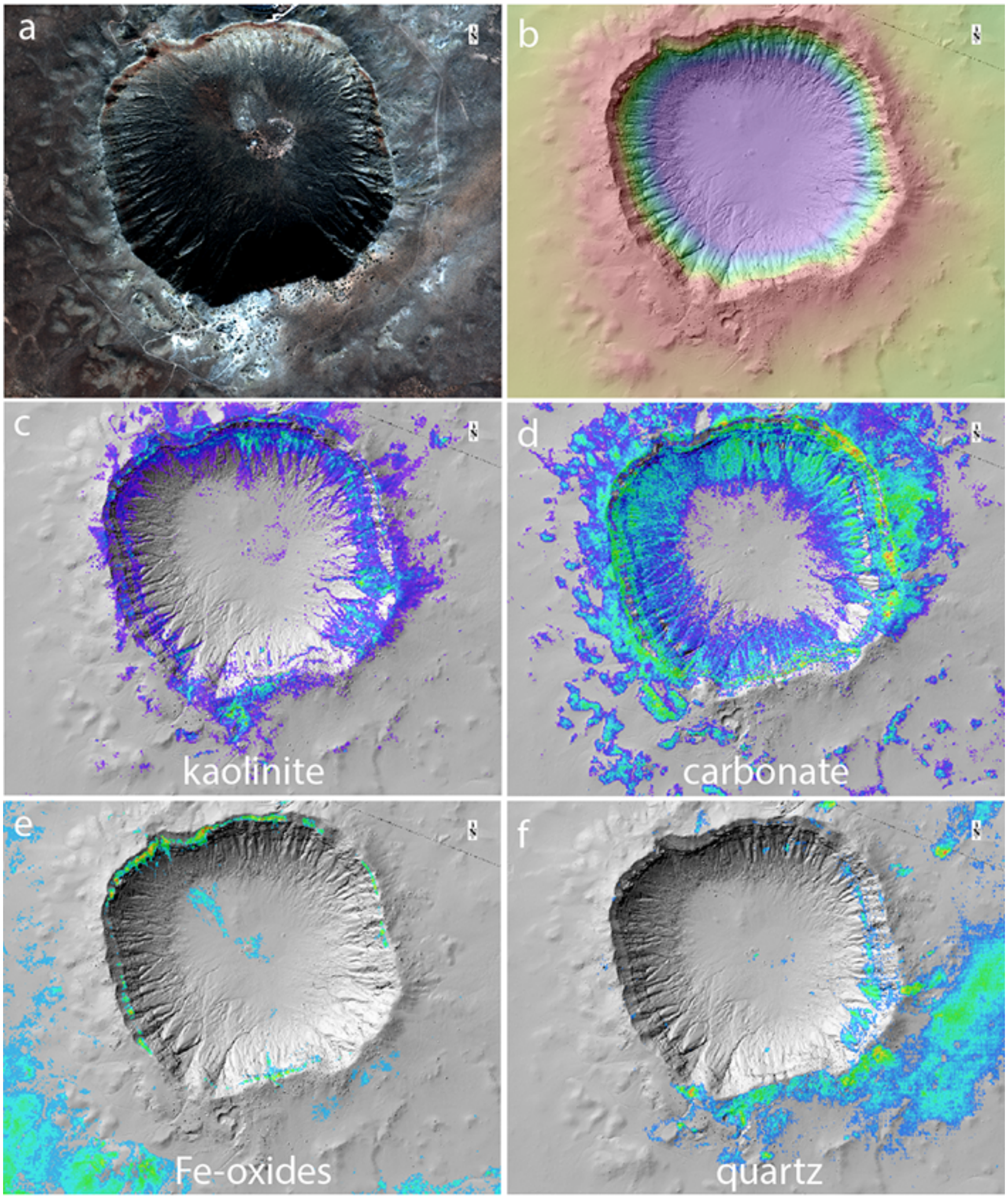

Figure 2: Remote sensing data and spectral index maps of Meteor Crater. Worldview 3 multispectral true color data (a); lidar elevation draped onto lidar hillshade data (b); kaolinite 2.21 µm spectral index (c); carbonate 2.32 µm spectral index (d); Fe-oxides 0.55 µm spectral index; and quartz (8.21 and 9.04 µm spectral index (f).