MELTING MARS WITH IMPACTS: PROXIMAL MELT DEPOSITS AND THEIR COMPOSITIONS AS DETERMINED BY REMOTE SENSING. K. M. Cannon[1], J. F. Mustard[1], C. D. K. Herd[2], and J. Filiberto[3]. [1]Brown University, Department of Geological Sciences, Providence, RI, USA, kevin_cannon@brown.edu. [2]Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, Alberta, T6G 2E3, Canada. [3]Southern Illinois University, Department of Geology, Carbondale, IL 62901.

Introduction: Impact melting is a fundamental process on all terrestrial planets: it creates quenched glasses that may be easily transformed to clay minerals when water is available [1,2], or that if preserved can encapsulate complex organic matter, creating a potential biosignature trove on the martian surface [3,4]. However, martian impact melts have received little attention. They have not been studied with compositional remote sensing except to identify alteration minerals associated with the melt [e.g., 5,6]. Here we compare laboratory reflectance measurements of a true martian impact melt from the Tissint meteorite with orbital spectroscopic observations of several probable proximal melt deposits on the martian surface.

Laboratory measurements: Reflectance spectra from a glassy impact melt pocket [7] in the Tissint martian meteorite (Fig. 1) were obtained at the NASA/Keck Reflectance Experiment Laboratory (RELAB). These data, and unpublished spectra from impact glass in Elephant Moraine A79001, are currently the only natural samples for 'ground truthing' remotely sensed data of impact melt on Mars, although Apollo lunar impact melts and synthetic quenched glasses may also be useful material analogs [8]. Melting in meteorite veins and pockets is not an identical process to large-scale impact melting, but leads to the same result (crystals set in a glassy matrix) and so the two can be compared through spectroscopic analyses.

Remote sensing: Proximal impact melt units within and adjacent to craters were identified by morphologic characteristics (e.g., flow features, cooling cracks) with the CTX and HiRISE cameras on the Mars Reconnaissance Orbiter. Visible and near-infrared spectra were obtained for these units with hyperspectral data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instrument. CRISM spectra of the melt deposits were ratioed to spectrally bland or dusty regions within the same detector column in the same scene where possible, although the low albedo and weak spectral features of the melt units presented challenges in some cases. Spectra of well-crystalline pyroxene and/or olivine bedrock were extracted from the same scene in order to compare their spectral contrast with the melt units.

We also used global maps of olivine and pyroxene [9,10] from the Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité instrument to assess re-

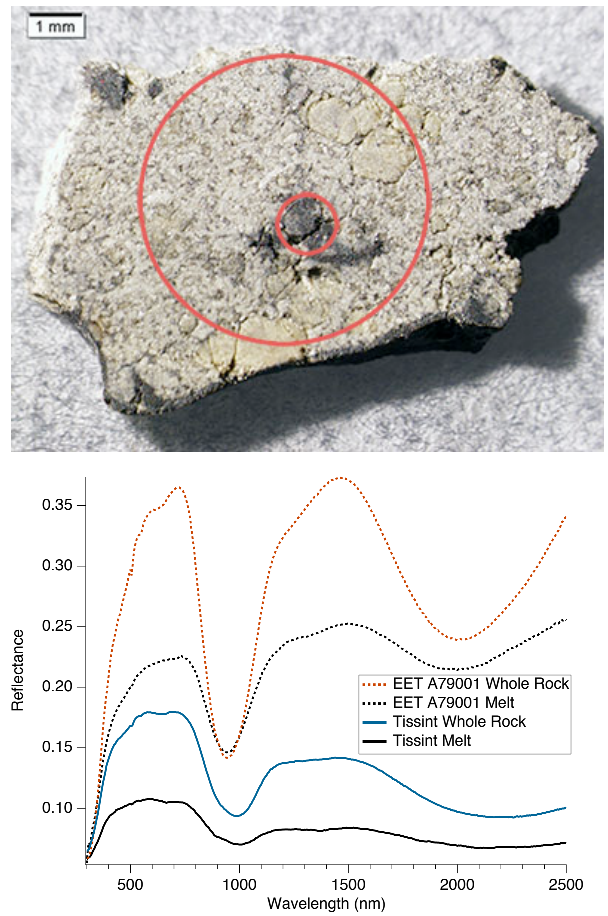

Figure 1. Top: Tissint martian meteorite specimen with glassy shock melt pocket (dark material) from the University of Alberta Meteorite Collection. Circles indicate footprints of spectral measurements. Bottom: Darkening and spectral contrast reduction seen in glassy melts (black spectra) compared to whole rock (colored spectra) for both Tissint and EET A79001.

gional mafic mineralogy around the melt deposits. By comparing these data to an updated spectral survey of martian meteorites we can roughly estimate target rock compositions and determine the first phases predicted to crystallize from cooling of hypothetical impact melts of these rocks using the MELTS program [11].

Results: Spectra from Tissint and EET A79001 impact glasses are darker than the rocks they are derived from, with attenuation and distortion of characteristic charge-transfer absorption bands (Fig. 1). Minute quantities of contaminating pyroxene and/or pyroxene crystallites within the glass itself are responsible for crystal field absorptions at 1 and 2 μm that overwhelm and mask absorptions from ferrous iron in glass observed in pure synthetic quenched glasses [8].

These same spectral characteristics are observed in every melt deposit on Mars included in this study (see Fig. 2 for examples). Melt units have low albedo and greatly reduced spectral contrast compared to well-crystalline bedrock in the same scenes. This suggests a large amount of glass in the melt deposits, but there are also mafic absorptions from olivine, pyroxene or both. We used HiRISE to carefully avoid obvious clast-rich melt and mobile dunes, so it is possible that this olivine and pyroxene represent early formed crystals before the remainder of the melt quenched to glass.

We are working to link the composition (olivine/spinel-rich vs. pyroxene-rich) of the melt to the first phase expected to form from batch melting and rapid cooling of the surrounding target material. For example, Alga Crater is hosted in olivine-free basaltic plains and the melt has a pyroxene rich composition, the first phase predicted by MELTS to crystallize from melting typical olivine-free martian basalt. Similarly, Ritchey Crater is emplaced in olivine-rich Hesperian ridged plains, and the melt contains olivine and dark glass. MELTS predicts spinel then olivine should form from melting then cooling an olivine-phyric type basalt, although the stability of spinel may be erroneously calculated by MELTS [12].

Conclusions: This first remote mineralogic analysis of martian impact melt shows: (1) Martian melt deposits appear to be a mixture of quenched glass and early-formed crystals (olivine or pyroxene or both). (2) The nature of these early-formed minerals can be predicted from regional studies of the target material and thermodynamic modeling with MELTS. (3) Studies of proximal melts/glasses with clear geomorphic features can inform future studies of glass in distal strewn fields where morphologic context is lacking.

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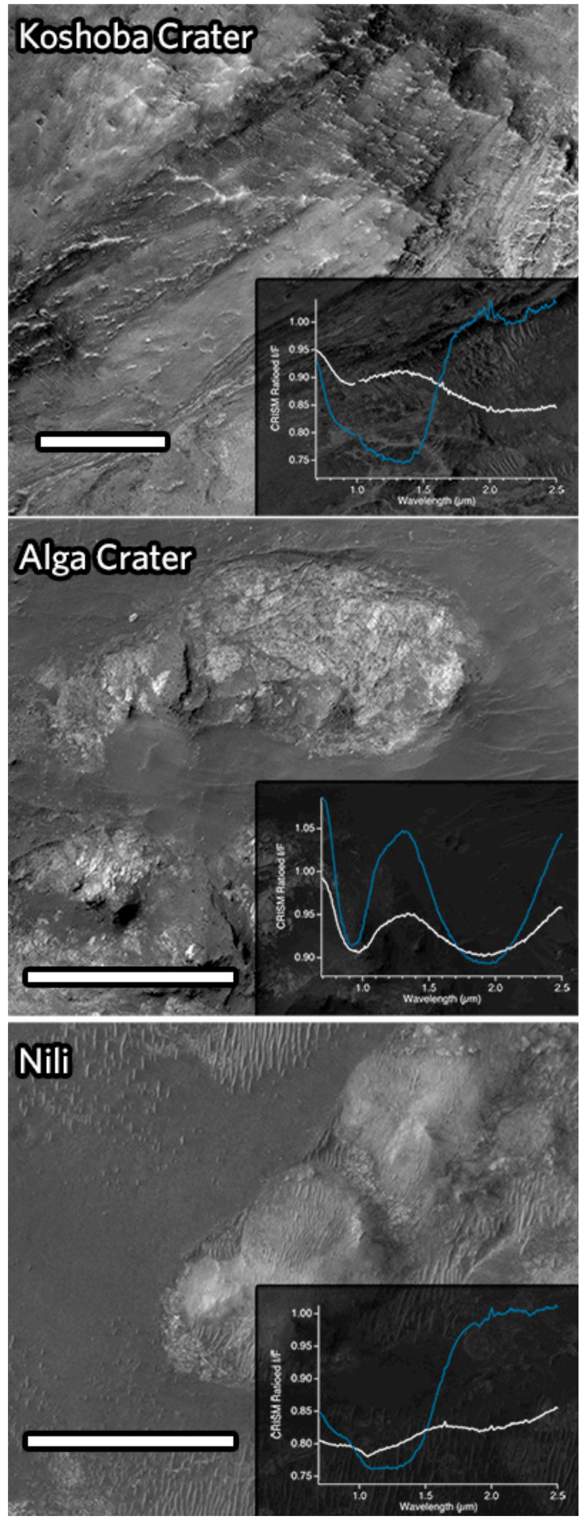

Figure 2. HiRISE images of probable melt deposits (dark material) in Koshoba Crater (ESP_16865_2035), Alga Crater (PSP_007573_1555) and near Nili Fossae (PSP_006923_1995) with CRISM spectra shown for melt (white) and pyroxene or olivine bedrock (blue) in the same scene for comparison. Scale bars = 200 m.