FOLLOW THE GLASS: PRESERVATION AND COLONIZATION POTENTIAL OF MARTIAN GLASS-BEARING IMPACTITES. K. M. Cannon[1] and J. F. Mustard[1], [1]Brown University, Department of Earth, Environmental and Planetary Sciences, Providence RI, USA, kevin_cannon@brown.edu

Introduction: Rapidly quenched impact glass can both preserve complex biosignatures [1,2] and serve as a substrate for microbial life [3,4]. These features of glass-rich impactites are intruiging for martian exobiology because Mars is the only planetary body in our system that may have hosted life *at/near its currently accessible surface*. Here, we detect and spatially map proximal impact glass on Mars, and discuss factors affecting the preservation and colonization potentials of this glass.

Methods: We analyzed martian craters with orbital reflectance spectroscopy data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) onboard the Mars Reconnaissance Orbiter. CRISM image cubes were processed using standard methods [5], then converted to single-scattering albedo using the Hapke model [6]. We then unmixed each pixel in the cube using a set of pre-defined endmembers, including basaltic glass. Using a neutral in-scene endmember precludes determining endmember abundances quantitatively, but this is mostly impossible anyway because of uncertainties in particle sizes. We have demonstrated experimentally that these methods are robust in identifying relative amounts of glass in complex mixtures, without false positives [7].

Results: To date we have identified 34 craters that show evidence for spatially coherent deposits of basaltic glass-bearing materials (Fig. 1), almost all associated with crater central uplifts. These spectral signatures often have remarkably sharp outlines and correspond to distinct geological units that in HiRISE imagery show evidence for flow features and entrained breccia clasts. We interpret these units as impact melt breccias and/or impact melts, similar to other studies of some of the same craters [8-10]; however, this is the first time quenched glass has been reported and mapped spectroscopically as a constituent of these units. These glassy impactite deposits do not resemble typical melt ponds and flows on the Moon, or exceptional martian examples like Pangboche Crater [11]. This discrepancy is likely caused by volatiles present in the target [12], but our results suggest that impact melts on Mars are not totally destroyed by interacting with volatiles.

Secondary alteration minerals are present at most of the craters investigated, but there is no convincing genetic link between the impact glass and these phases. Fe/Mg-smectites are nearly always associated with olivine bedrock: where glass and alteration minerals appear to be spatially colocated in CRISM images,

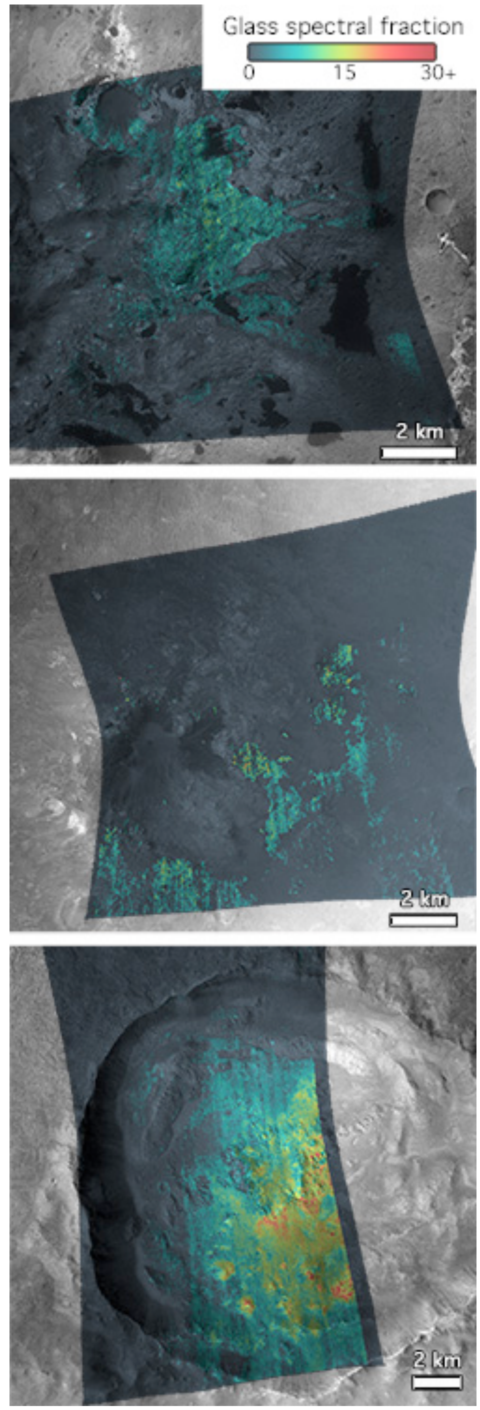

Figure 1. Maps of relative basaltic glass fraction overlain on CTX imagery at (top) Ritchey Crater, (middle) Toro Crater, and (bottom) Taytay Crater. All show coherent units of preserved proximal impact glass.

closer investigation at HiRISE scales shows that they occur in separate geologic units (Fig. 2). Mild alteration of olivine and intact metastable glass suggests against significant – if any – post-impact alteration at these relatively small craters (mean D ≈ 30 km).

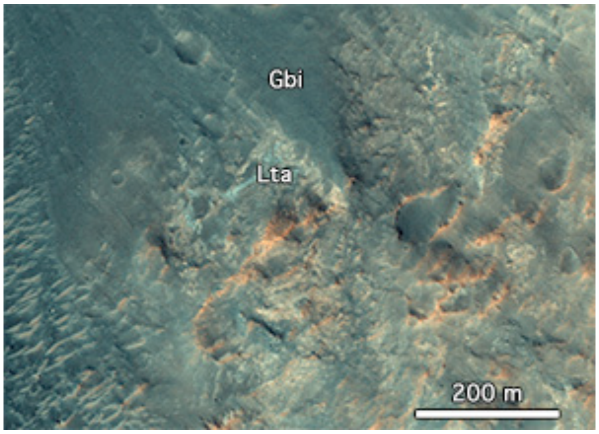

Figure 2. Part of HiRISE ESP_012939_1875 inside Taytay Crater showing dark-toned glass-bearing impactite (Gbi) that is distinct from the light-toned altered (Lta) material it overlies.

Discussion: Basaltic glass is metastable and alters quickly in warm, wet conditions. This glass had to have been protected from the elements in order to serve as a preservation mechanism or as a useful biological substrate. Some of the craters where we find preserved glass have fluvial erosion features, demonstrating that proximal impact glass has remained intact on at least billion-year timescales. However, the martian surface and *shallow* subsurface became inhospitable after the death of the dynamo at 4.1-4.0 Ga [13,14], so only truly ancient (>4 Ga) impact glass may host traces of past biochemistry.

Glass-rich substrates could have been inhabited by subaerial/subaqueous communities akin to terrestrial microbial mats. Again, the decline of the dynamo rendered this habitat unsuitable, restricting possible trace fossils like tubules [3,4] to >4.0 Ga glass deposits. In either case, burying and later exhuming impact glass offers a way to preserve signs of extinct life on the accessible surface today (Fig. 3); a periodically [15] (as opposed to perpetually) warm and wet early climate would also aid preservation.

Conclusions: We identified probable impact glass hosted in melt (breccia) deposits in 34 well-preserved martian craters. These spectral signatures are coherent and mappable from orbit, and could be used to locate regions where records of past exobiological activity are accessible on Mars' surface today. Future work will focus on older/exhumed craters which formed after major aqueous alteration that would have destroyed impact glass, but when the surface was still hospitable.

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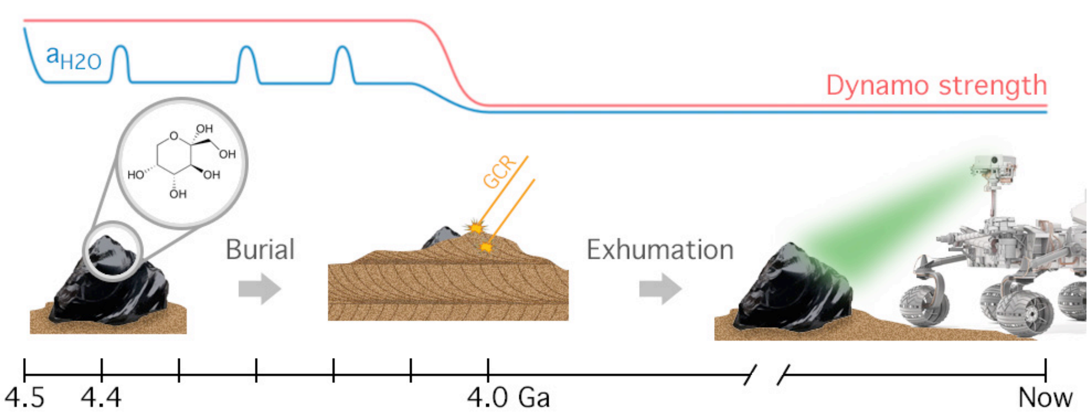

Figure 3. Schematic representation of a scenario in which ancient glass encapsulates complex organic molecules and is buried deeply, then recently exhumed on the present-day surface.