SPECTRAL IDENTIFICATION OF IMPACT GLASSES VIA NIR REFLECTANCE SPECTROSCOPY.

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Introduction: Impact cratering is one of the most important geological planetary surface processes. The identification of impactites (i.e., rocks affected and/or produced by impact events) typically requires significant field research and laboratory analysis on Earth. When considering a probable impact, site investigators look for macroscopic metamorphic evidence such as breccias, melt rocks, shatter cones and the like, and if found, samples are returned to the lab and investigators look further for microscopic metamorphism such as planar deformation, diaplectic glasses, high pressure mineral phases and lechatelierite [1]. What if there were a simpler method, that could be employed remotely and required no sample preparation? Here we report on an NIR spectral feature that appears to be unique to impact-melt and diaplectic glasses which may allow for the remote identification of impactites through NIR spectroscopy alone.

Experimental Procedure: A suite of impactites from the Haughton structure, Devon Island, Canada, as well as several from other impact sites have been investigated. Samples have been characterized via UV-Vis-NIR and IR reflectance/absorbance spectroscopy, XRD, XRF and NMR and XPS investigations are ongoing. UV-Vis-NIR and XPS spectra of the bulk rocks were also collected.

UV-Vis-NIR absolute reflectance spectra were collected with the Analytical Spectral Devices (ASD) FieldSpec Pro HR spectrometer at the University of Winnipeg Planetary Spectroscopy Facility (PSF), from 0.35–2.5 µm at phase angles of i30º and e0º using a PSF 50 watt QTH collimated light source. Spectra were acquired relative to Spectralon® and corrected for minor irregularities in Spectralon's absolute reflectance. Spectral calibration was monitored via periodic measurement of a Holmium Oxide reflectance standard. The ASD instrument has a spectral resolution between 2 – 7 nm and each spectrum shown is the sum of 1000 spectra to increase the SNR.

IR spectra were collected in absorbance mode using the PSF Bruker Vertex 70 FTIR from 5000 to 400 cm^{-1}, at a resolution of 2 cm^{-1} using the internal mid-IR source and RT-DLaTGS detector; 128 scans were averaged to increase the SNR. For spectral collection <45 µm powders were mixed with KBr and pressed into pellets. Wavelength calibration was assured via periodic measurement of a polystyrene standard and background correction was accomplished via subtraction of the spectrum of a blank KBr pellet.

Results: The results are presented in the following three figures for three samples representative of the larger suite, **HMP99-052**, **HMP00-263B** and **HMP99-071C** and three other naturally occurring glasses, a **Dakhleh Glass**, a **Fulgurite** and a **Tektite** for comparison.

Discussion: Figures 1 and 2 are UV-Vis-NIR and IR spectra of three phyllosilicate-free impact glasses from Haughton, both focused on our area of spectral interest. The NIR spectra of the three samples all contain a spectral feature centred at ~ 2210 nm which we are attributing to overtones of the fundamental vibrational modes the Si-O/Si-O-Si bridging oxygen bonds in each glass [2,3]. The three Si-O/Si-O-Si vibrational modes can be seen in Figure 2, centred at ~ 480, 800 and 1100 cm^{-1} [4]. Also in Figure 2, one can see the possibly complicating influence of Si-OH and its dominant stretching mode at ~ 900 cm^{-1} [5]. Si-OH expresses itself in the NIR as a doublet overtone at ~2250 nm which is clearly illustrated in Figure 1 from [6]. Of the possible minor contaminants that could alter the spectra of the Haughton glasses, all but those resulting from the glass itself and Si-OH have been ruled out [2]. In Figure 1, the ~ 2250 nm overtone of Si-OH can is observed as a distinct shoulder on the ~ 2210 nm feature in the **HMP00-263B** spectra and the two are sufficiently separated in wavelength such that they can be distinguished as two distinct absorption bands.

Conclusion: The ~ 2210 nm absorption band may be indicative of impact glasses. The mechanism responsible is under investigation but it may reflect their unique formation environment with cooling rates slower than those in other naturally occurring glasses (e.g., Fig. 3). The slower cooling, and/or constraining pressure unique to the impact metamorphism can produce a glass with more polymerization, leading to more Si-O-Si bonds and the appearance of a spectral feature at ~2210 nm indicative of impact.

References: [1] French B. M. (1998) *LPI, No. 954*. [2] Craig M. A. et al. (2010) *LPS XLI*, Abstract #2110. [3] Šimon L. and McMahon H. O. (1953) *J. Chem. Phys., 21, 1*, 23-30. [4] Bell R. J. and Dean P. (1970) *Dis. Faraday Soc., 50,* 55-61. [5] Yamaguchi Y. et al. (1996) *J. Chem. Phys. 105*, 5. [6] Rice M. et al. (2010) *LPS XLI*, Abstract #2576.

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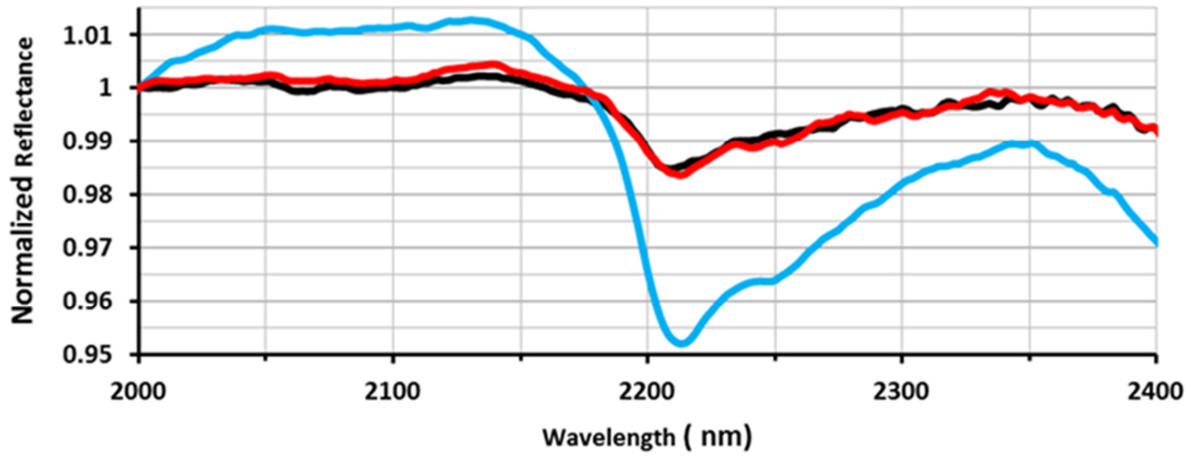

Figure 1:

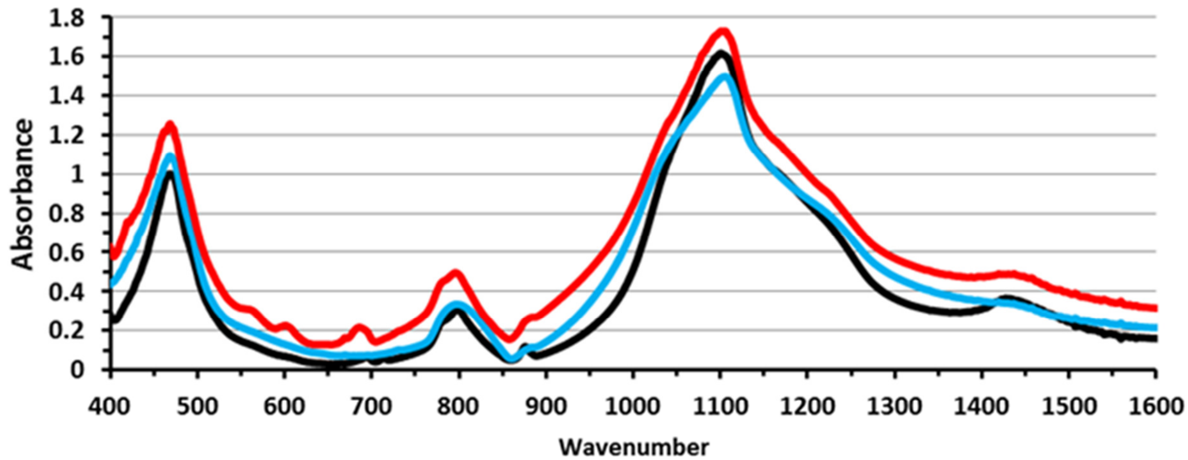

Figure 2:

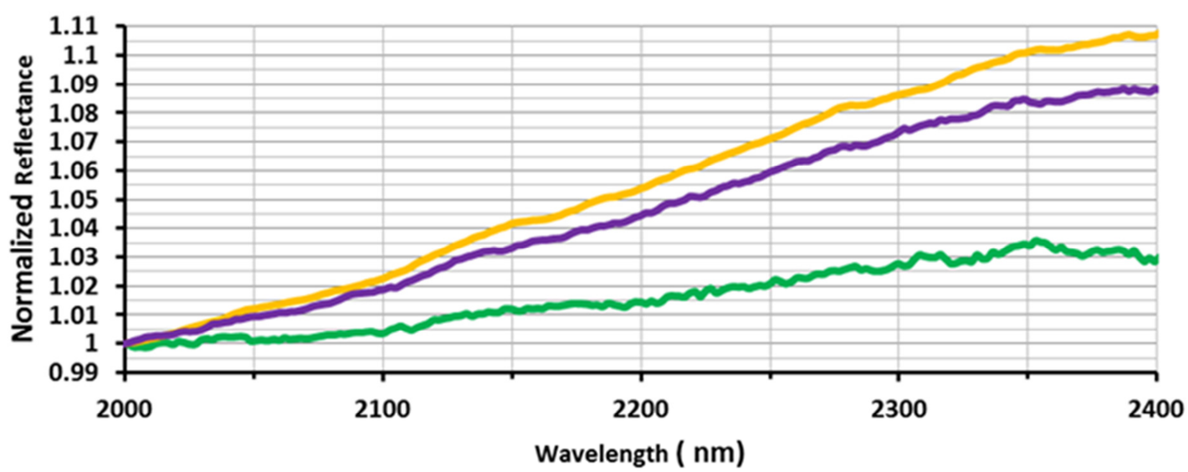

Figure 3: