Detecting Glass on the Krafla Lava Flow Field, Iceland

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introduction

- As molten lava contacts water, ice, steam, or dense atmospheres, the cooling rates of the lava surface increases [e.g., 1, 2] according to the quenching agent.
- Rapid cooling of lava produces increases glass abundance on the lava flow surface, and it may be expected that environments which cool lava quicker will produce more glass on the lava surface.
- When measured *in-situ,* increased glass abundance will darken VNIR spectra, lowering the profile of a spectral signature as total reflectance in addition to specific absorptions [3, Fig. 1].
- We use morphological and spectral maps of Krafla, Iceland, to delineate and sample areas where lava cooling rates may have accelerated and may show greater glass abundance.

<u>Can lava flow glass be quantified using remote total reflectance, similar to *in-situ* data, to highlight rapidly cooled lavas or water-rich environments?</u>

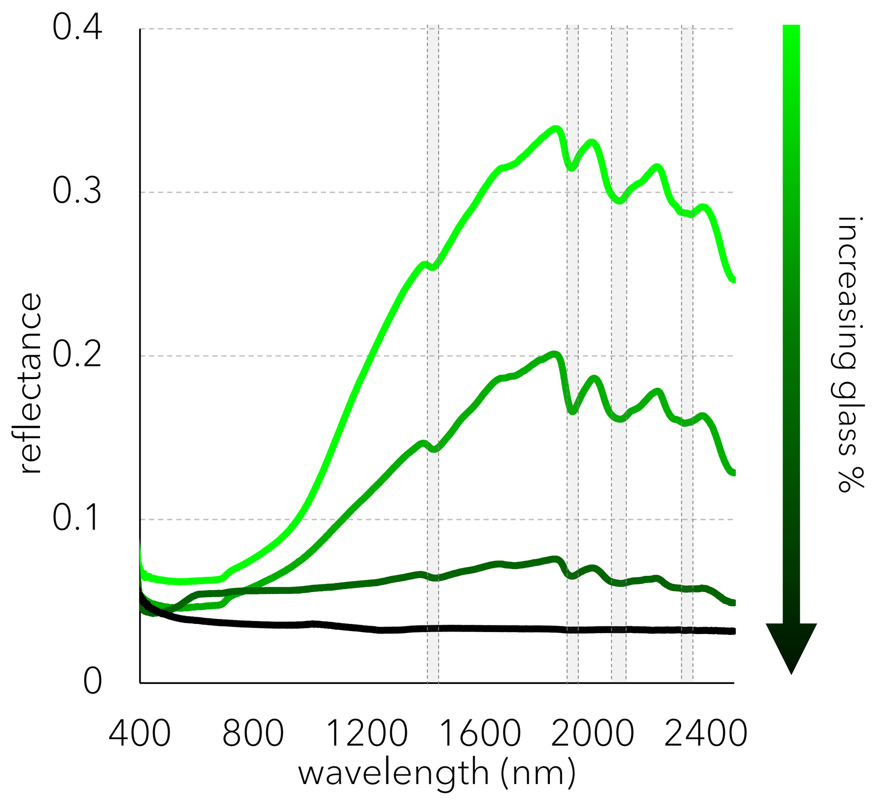

figure 1: Unshifted *in-situ* VNIR spectra of basalt. Glass abundance is inversely associated with reflectance at > 1000 nm. In higher wavelengths, prominent absorptions remain consistent, but show decreased amplitude with increased glass abundance.

Krafla survey

- To create baseline data of glass distribution under air-quenched conditions, we survey Krafla first with WorldView3 (WV3) image data to delineate regions by total (average) VNIR reflectance, strength of the 670 nm absorption, increased proportions of ferrous silicates [4], and the inflection relationship of glass and olivine [5] absorptions at ~1050 nm.
- We then validate WV3 data by gathering *in-situ* ASD measurements at the intersection of total reflectance anomalies, predominant endmembers from the parameter maps, and areas of relatively homogeneous morphology and roughness.
- For areas of known changes in roughness and morphology (simplified here as pahoehoe and a'a), total reflectance anomalies are considered *within* each morphology to account for the fractal scattering of the surface.

results

- Within WV3 data, the lowest reflectance units correspond to rough a'a surfaces [Fig. 2]. The lowest reflectance units measured *in-situ* correspond to smooth pahoehoes near central flows and the margins, distant from morphological boundaries [Fig. 3, 4].
- Effects of scattering are problematic when considering total reflectance alone, however, when considering the distribution of total reflectance *per* each morphology has allowed for WV3 total reflectance to be more strongly correlated to *in-situ* total reflectance [Fig. 3, 4].
- Negative slopes near the 1050 nm concavity in WV3 data show lower total reflectance *in-situ* and positive slopes show higher total reflectance *in-situ* [Fig. 4].
- Total reflectance anomalies linearly shift from rough (a'a) versus smooth (pahoehoe) flow surfaces, but in-situ measures do not show similar shifting due to roughness [Fig. 4].
- Final spectra may then be validated to absolute glass abundance measured petrologically in the future.

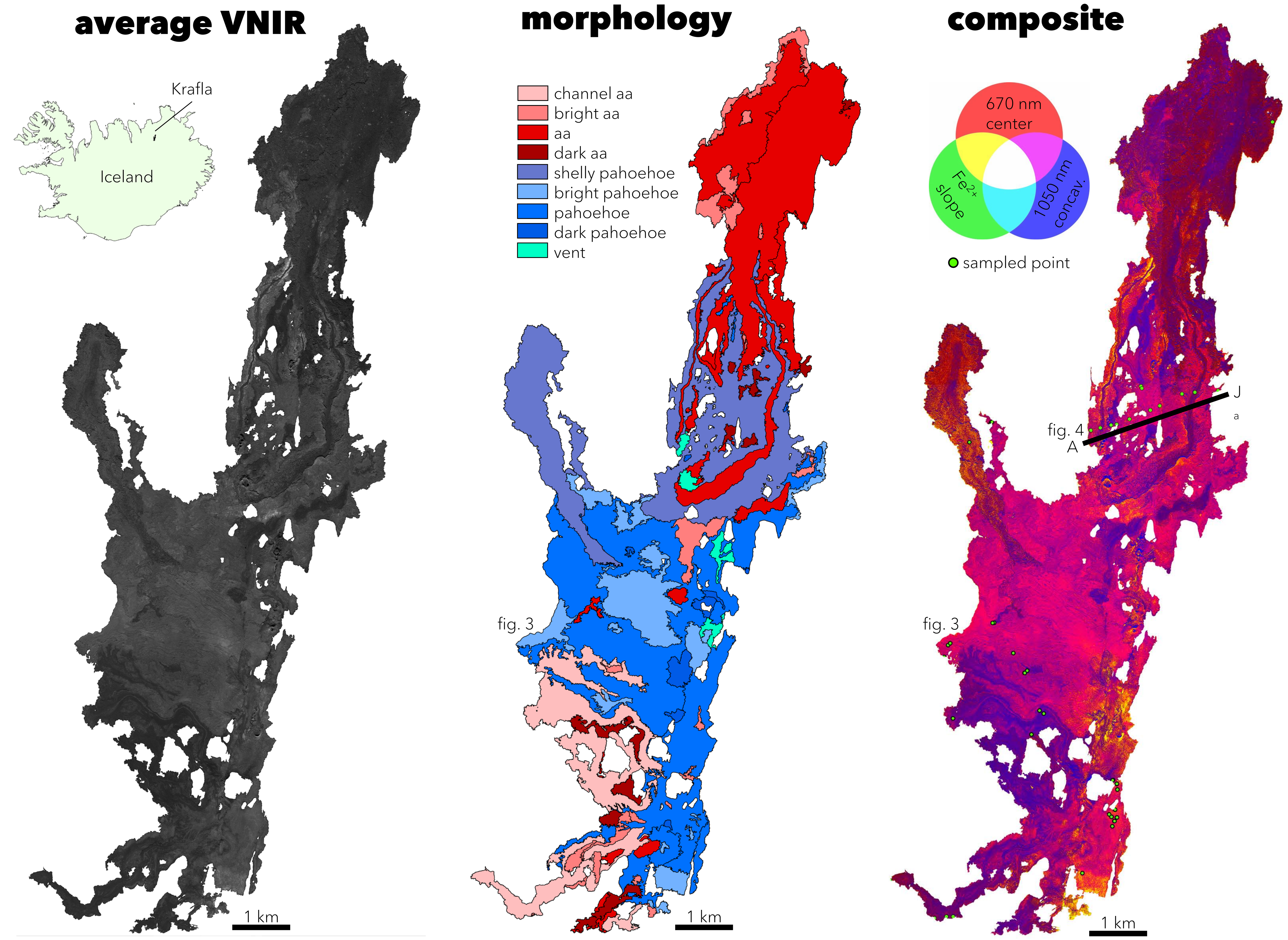

figure 2: WV3 maps of Krafla as (**left**) averaged VNIR reflectance (bands 1 – 8), (**center**) 1 and 2σ deviations of morphology [3], and (**right**) composited parameter map.

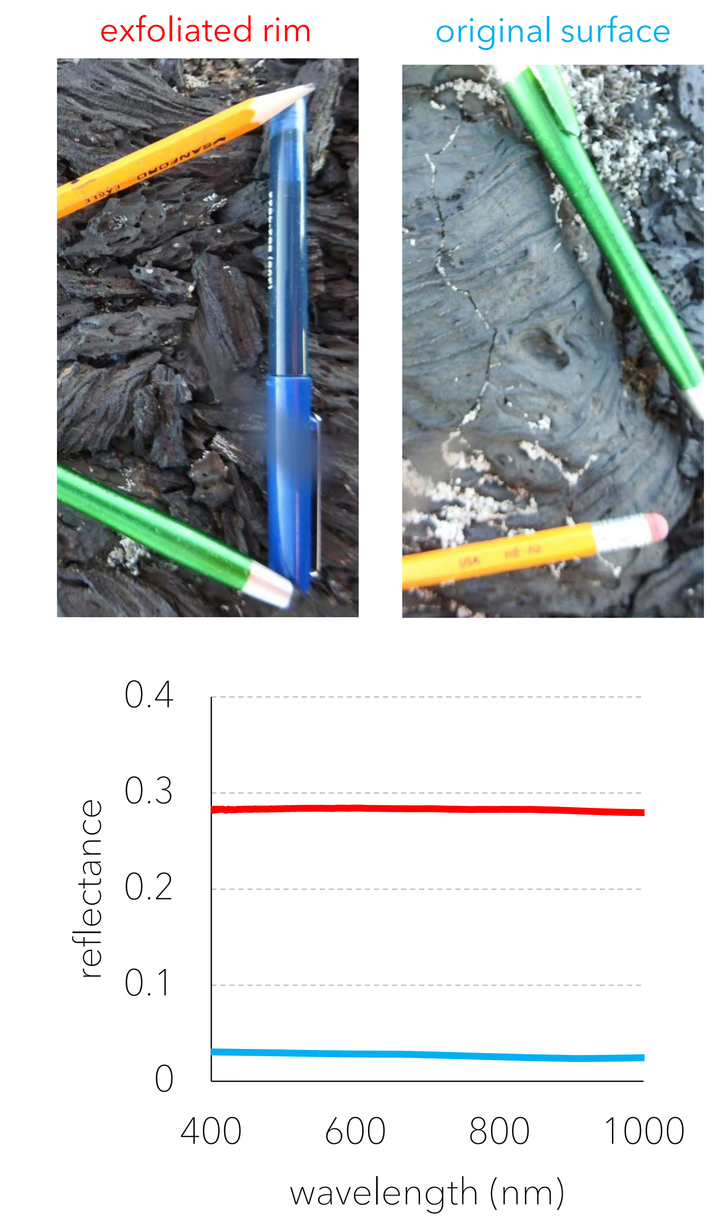

figure 3: example of sampled point near the central margin of Krafla showing exfoliated glass-right chips (left, **red**) and the original glass-rich surface (**right**, **blue**)

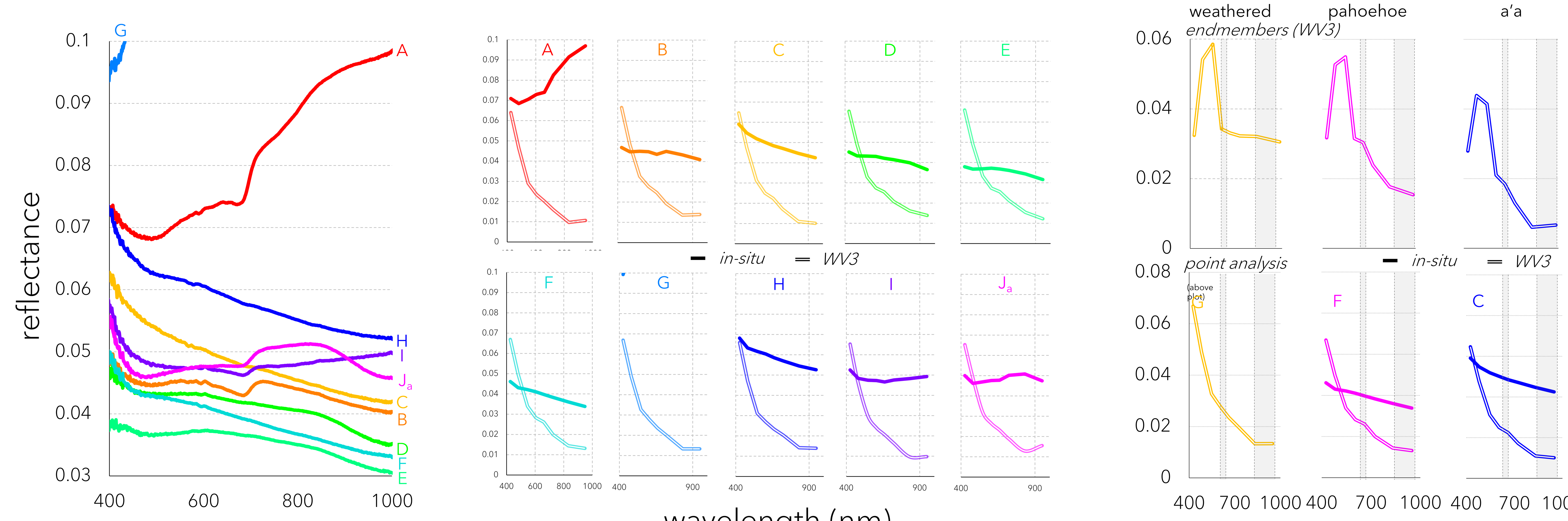

figure 4: *In-situ* VNIR spectra of major transect across Krafla. Colors and letters correspond to transect from west to east (left and center). Final endmember spectra derived from composite map are shown as point analysis (right). Pahoehoe lobes show lower total reflectance, stronger absorptions near 670 nm, and negative slopes near the 1050 nm center.

Acknowledgements and References

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