UV Reflectance Spectroscopy for Inferring Composition of the Moon and Asteroids

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VORTICES

VOlatile Regolith Thermal Investigations Consortium for Exploration & Science

MHC

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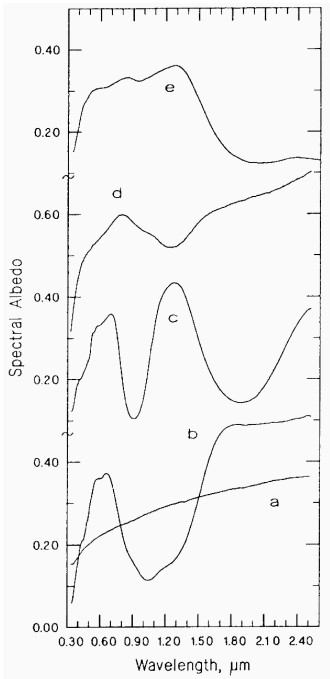
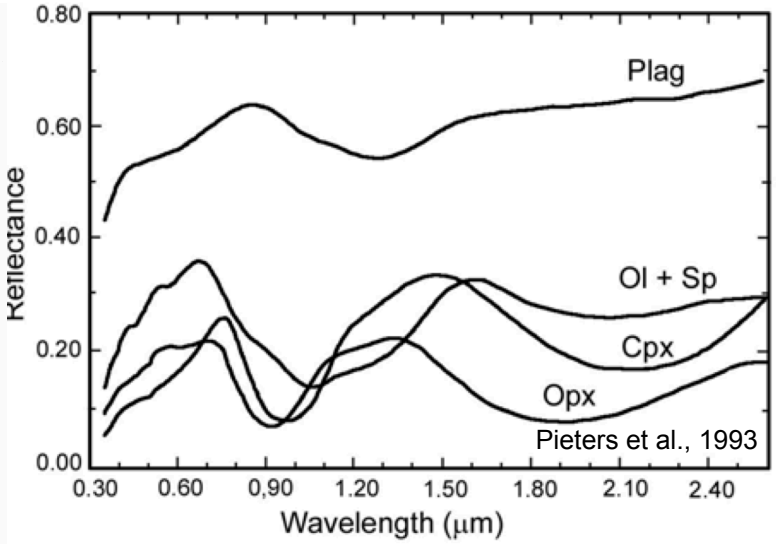
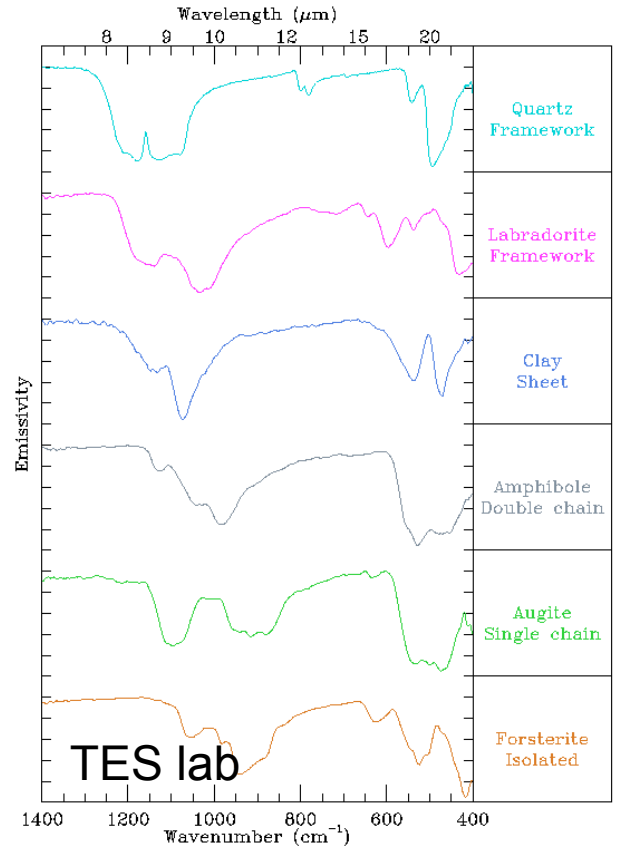
The ‘proven’ way…

Reflectance Spectroscopy



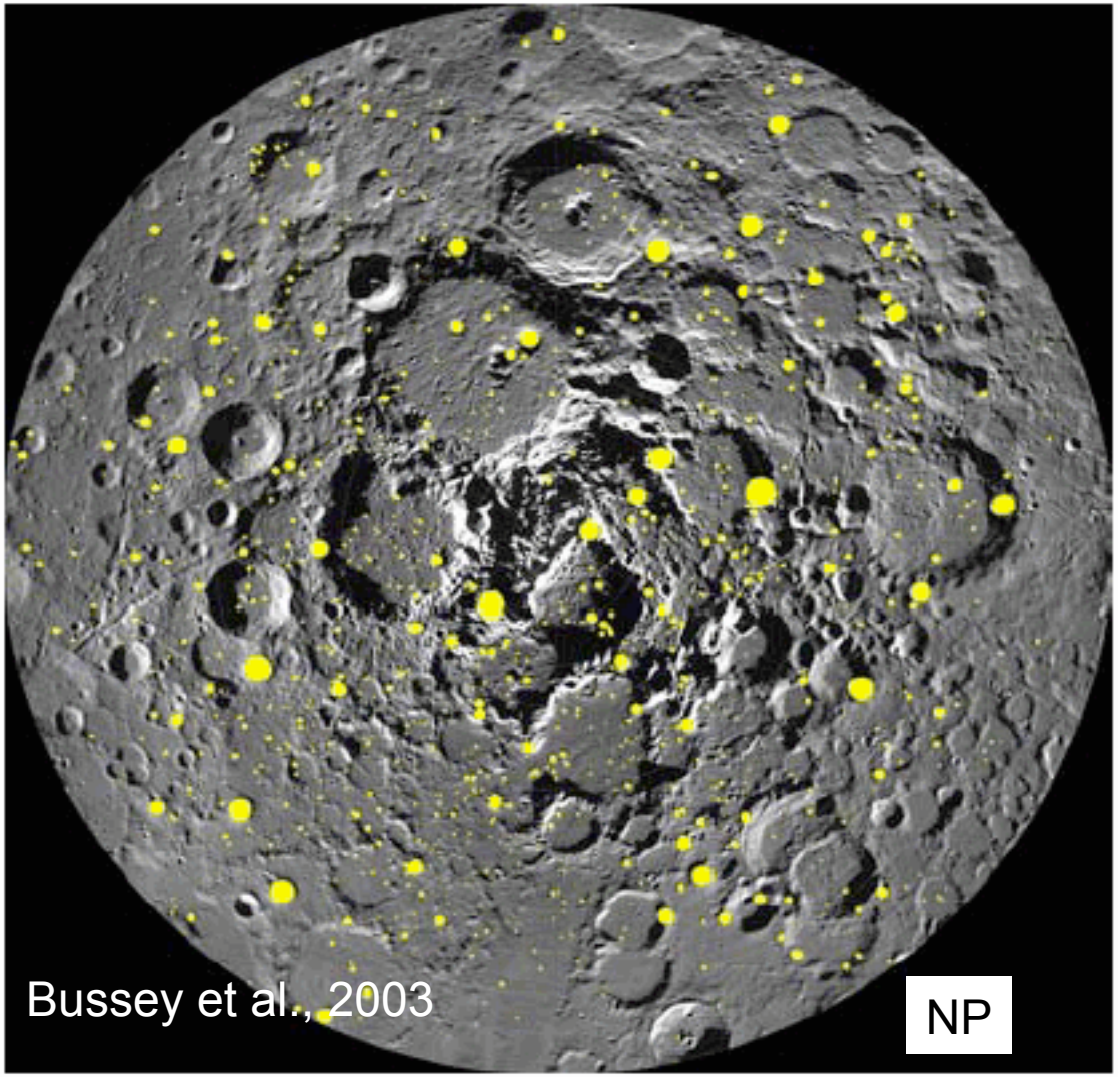


Thermal Emission Spectroscopy



But when the 'proven' way doesn't work….

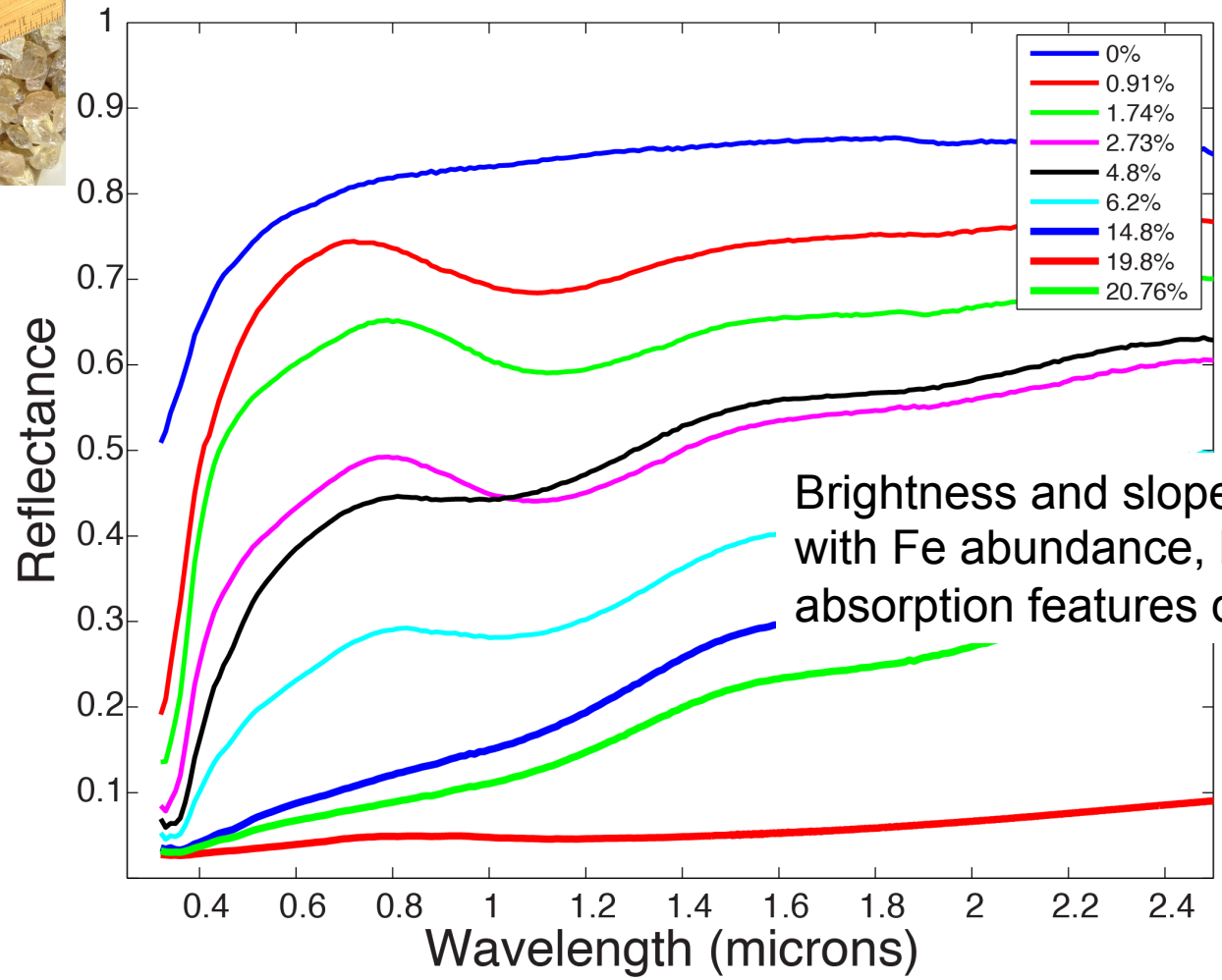
…such as due to poor illumination



(From Bussey *et al*, 2003, *GRL*, v. 30, Fig.4 .)

But when the 'proven' way doesn't work….

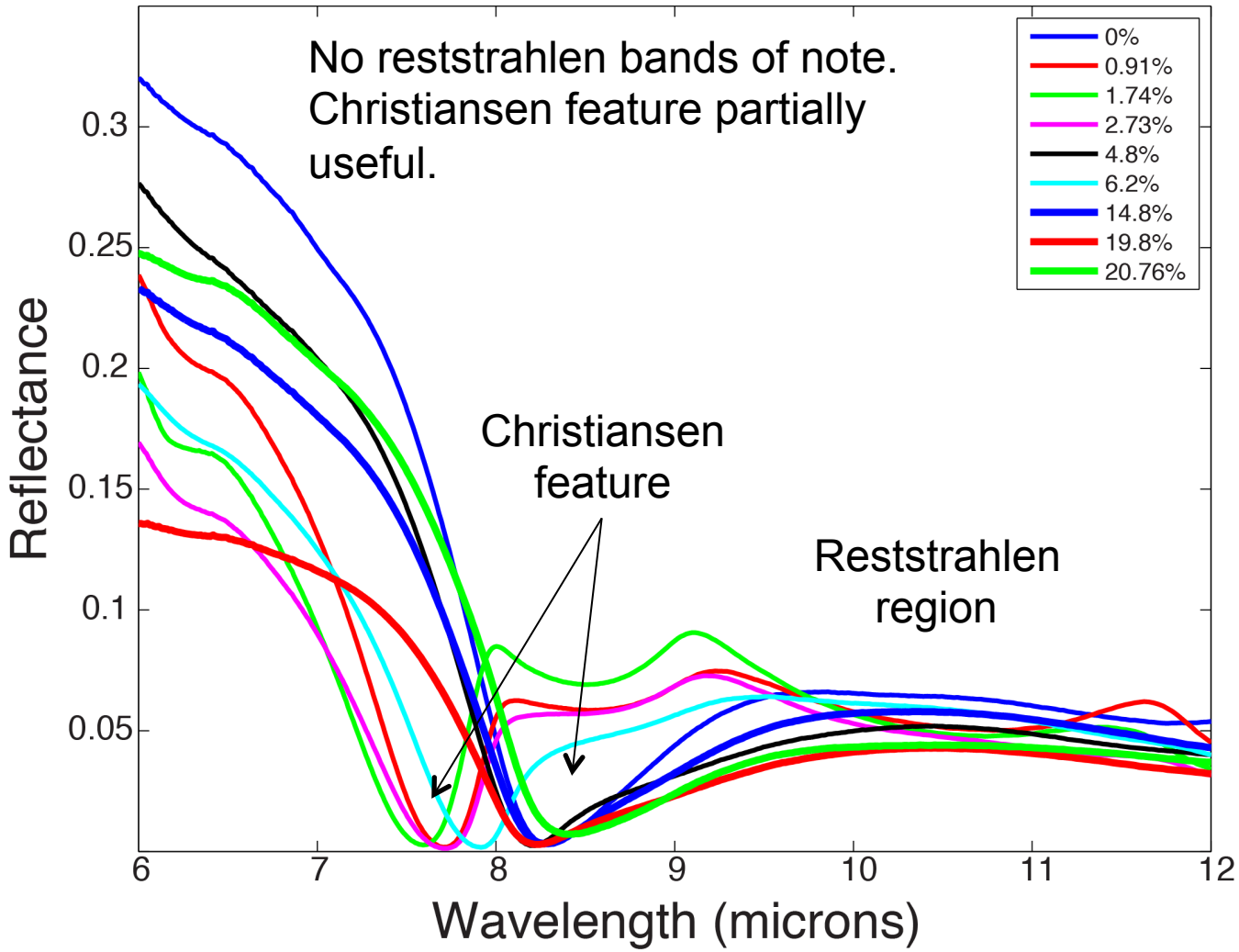
… synthetic analog lunar glasses



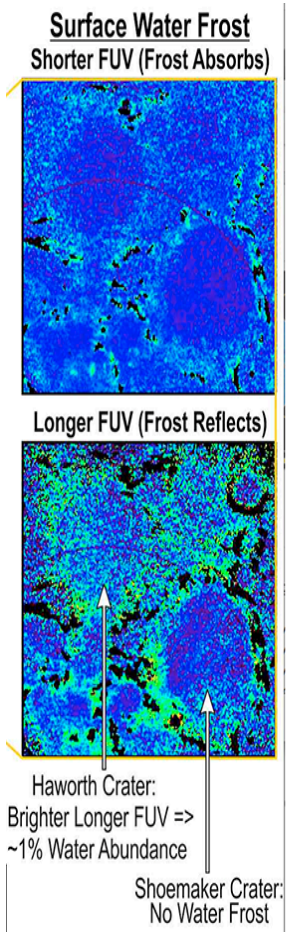
Brightness and slope correlate with Fe abundance, but absorption features do not…

But when the 'proven' way doesn't work….

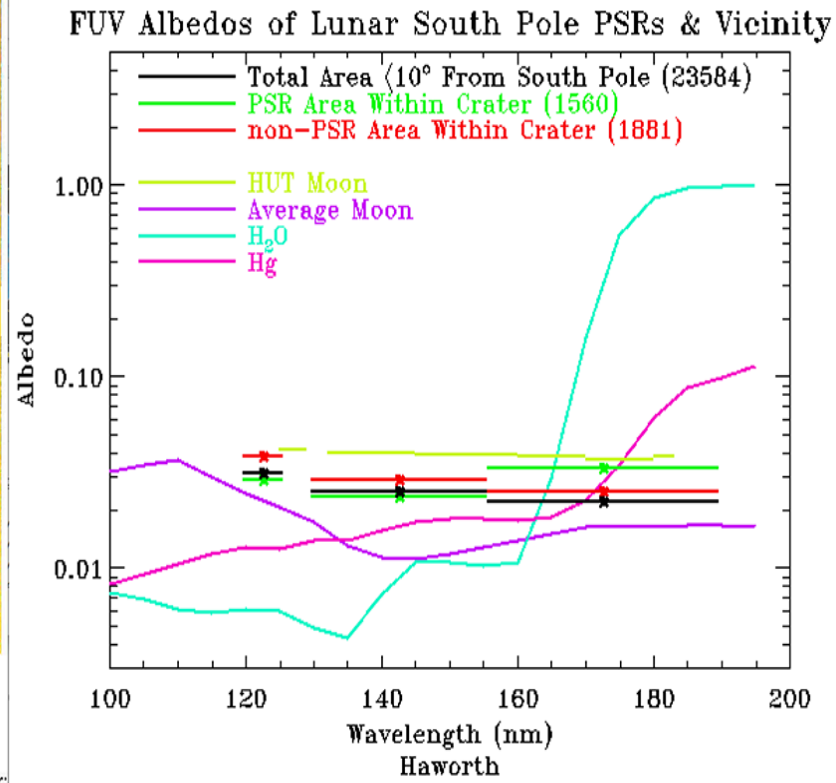
… synthetic analog lunar glasses



Or new questions are being asked that the UV could be better suited to addressing…

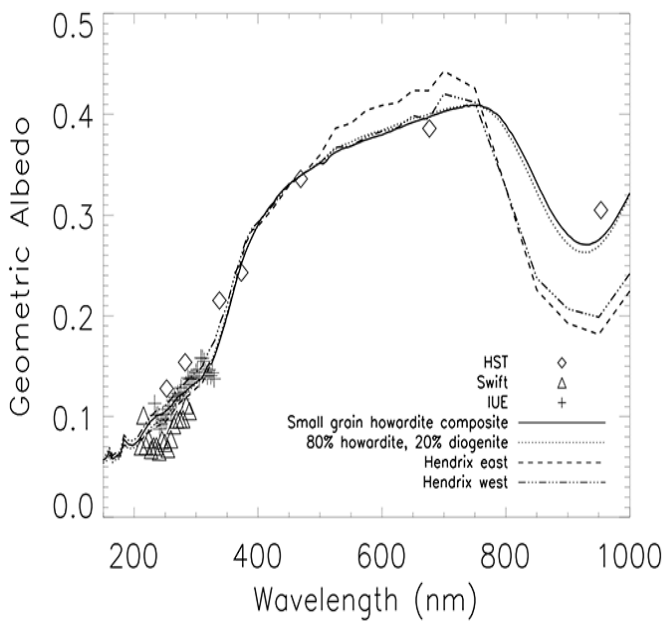


Moon



Gladstone et al., 2012)

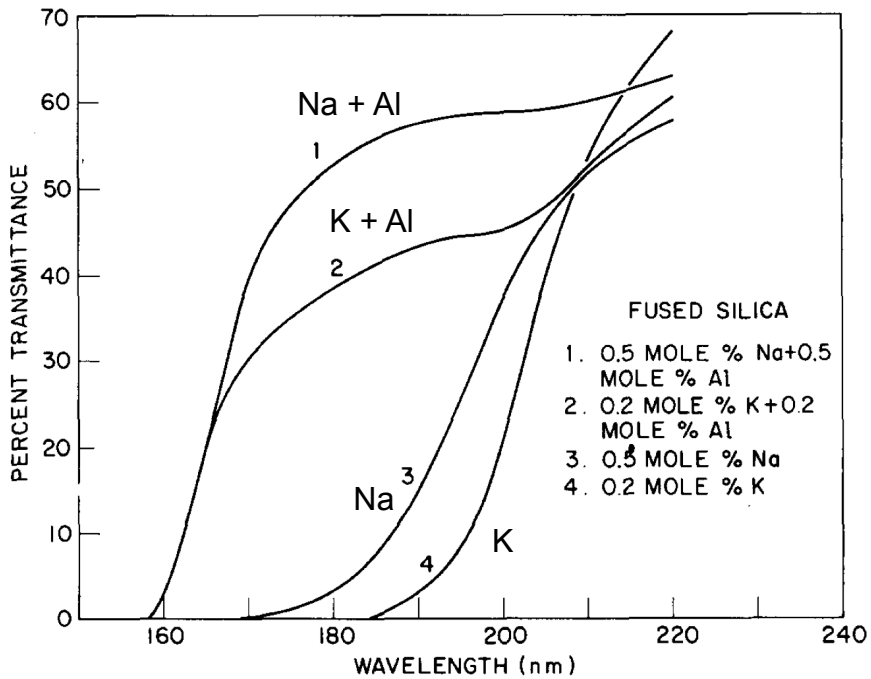
Vesta

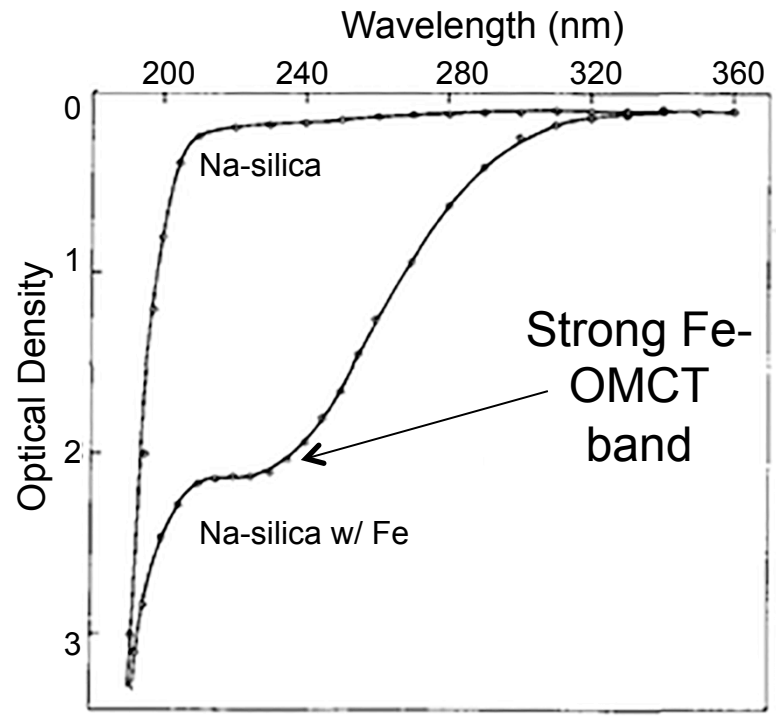


Hendrix et al., 2003

Using the UV for composition…Not a new idea..

SiO_2 glasses, with…

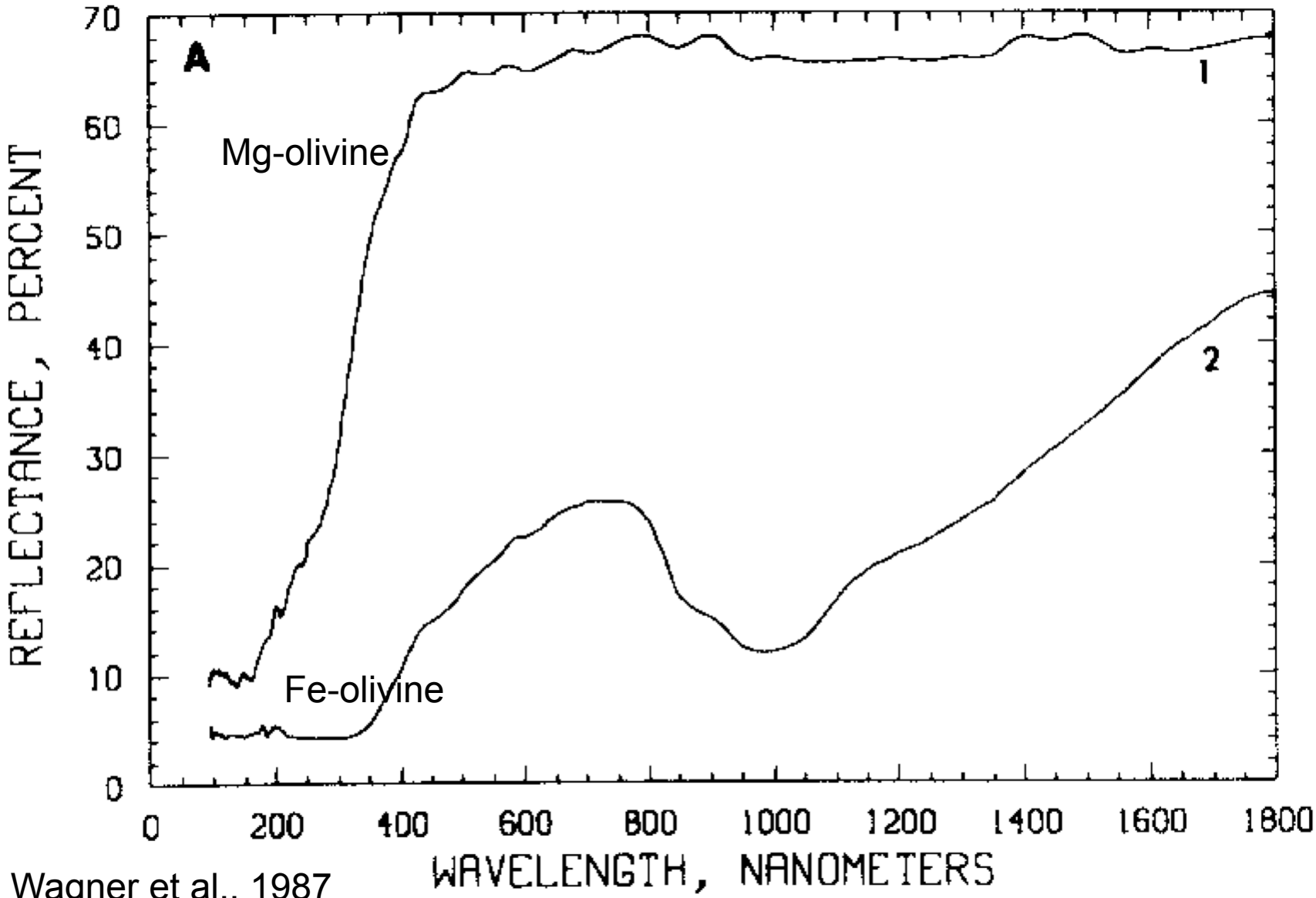




Transmission spectra from Sigel et al., 1974

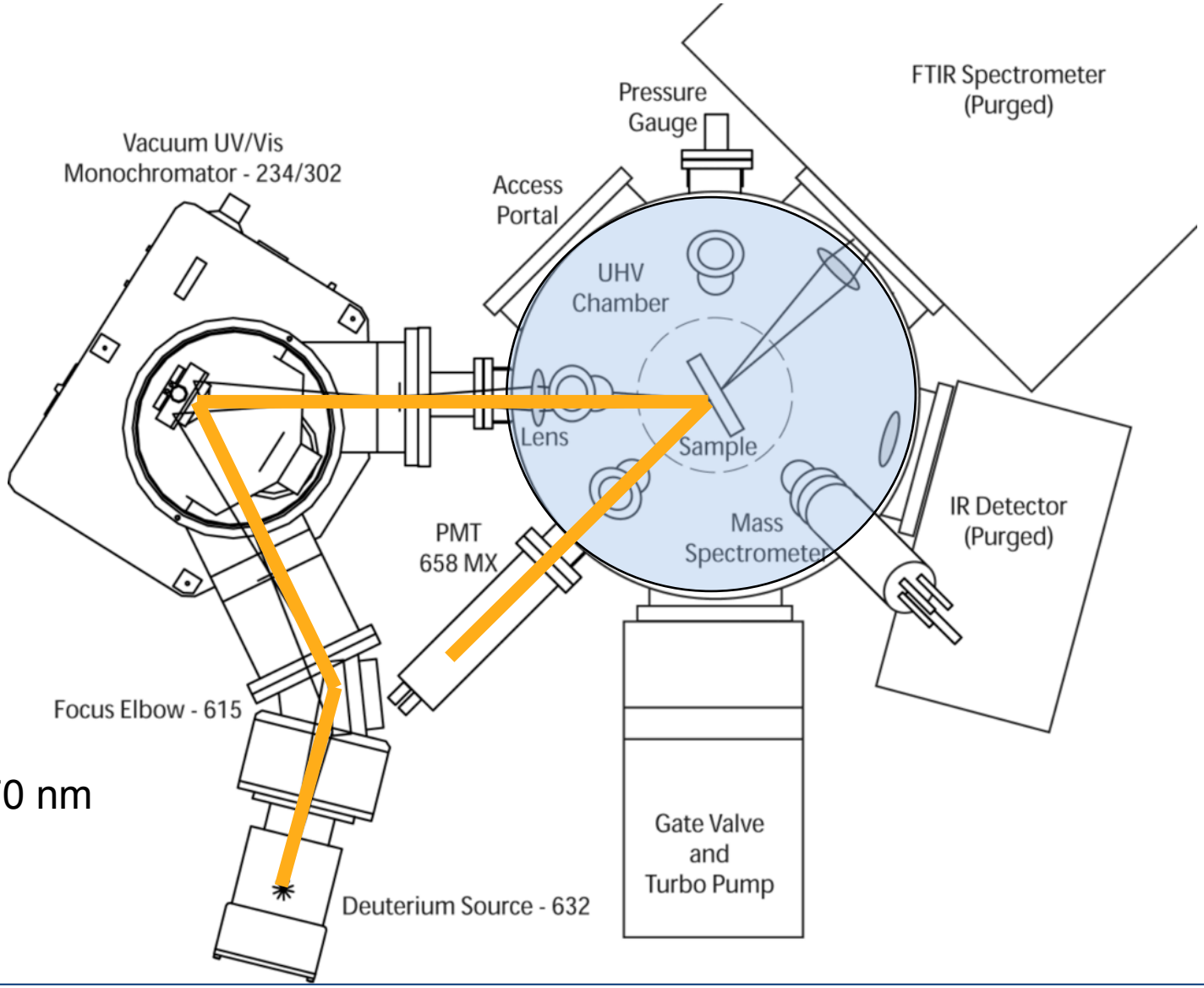
But these are not reflectance spectra…

Using the UV for composition…Not a new idea..



Wagner et al., 1987

Experiments at APL



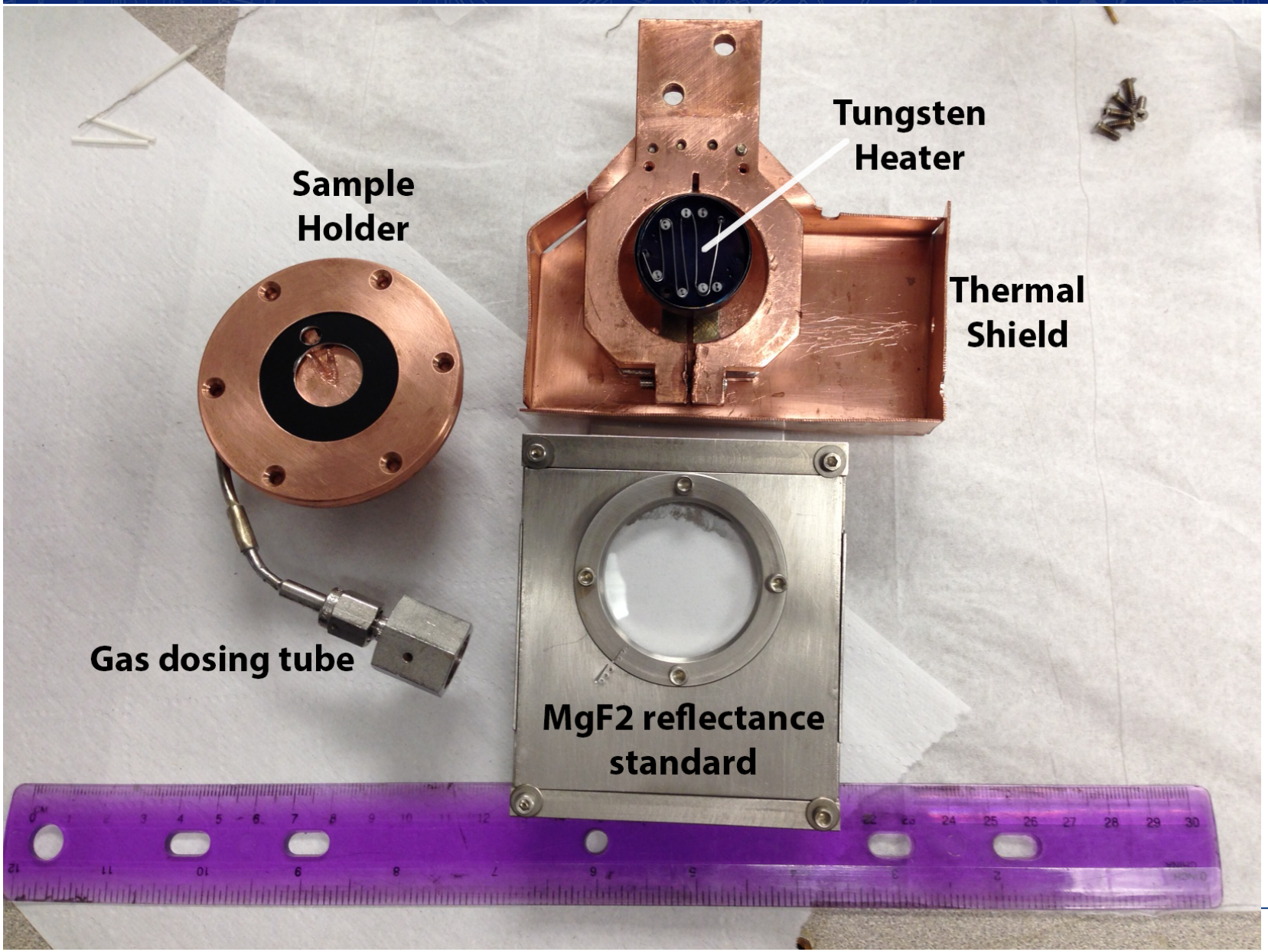
130 – 570 nm

$\alpha = 45^o$

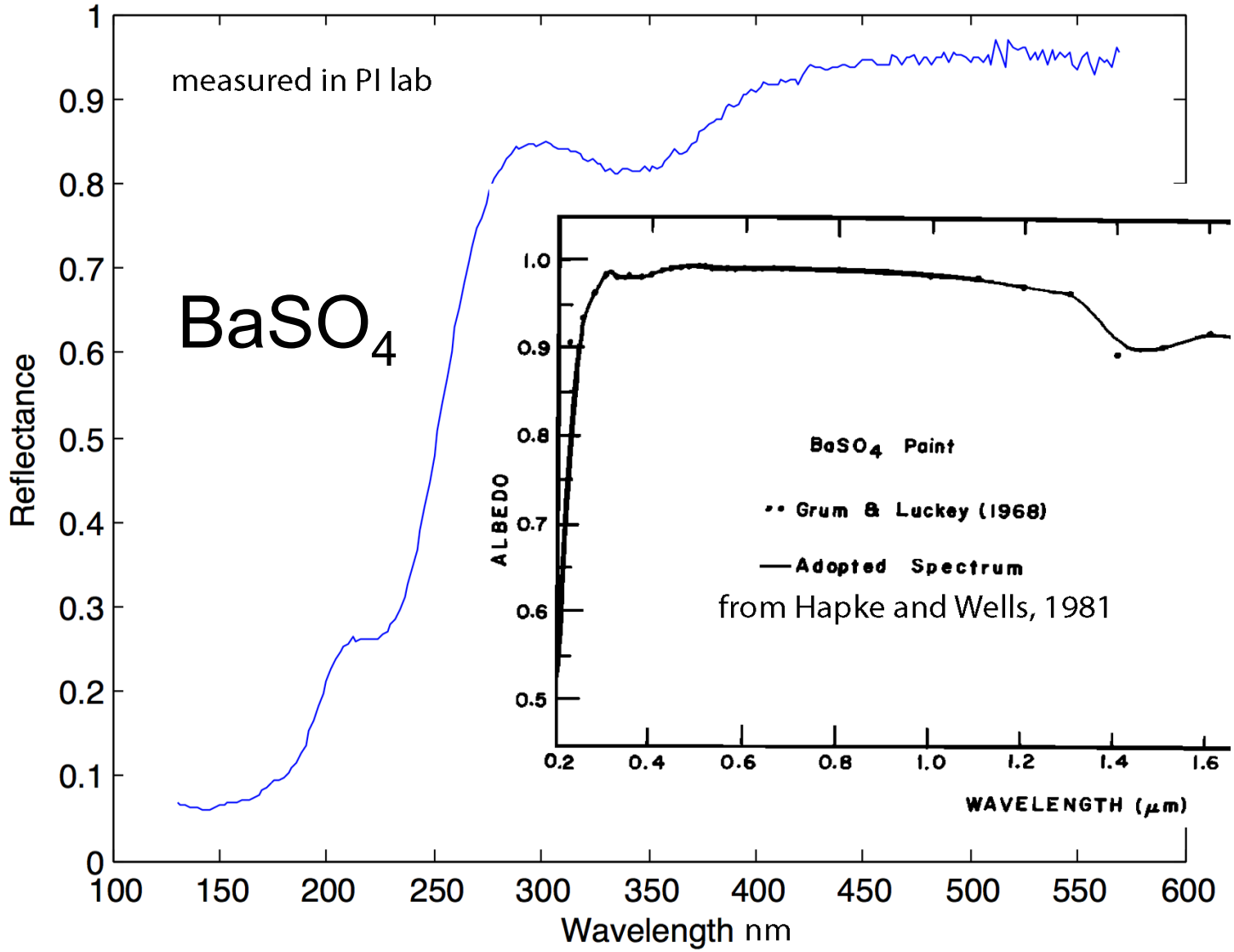
$i = 5^o$

$e = 40^o$

Sample Holder

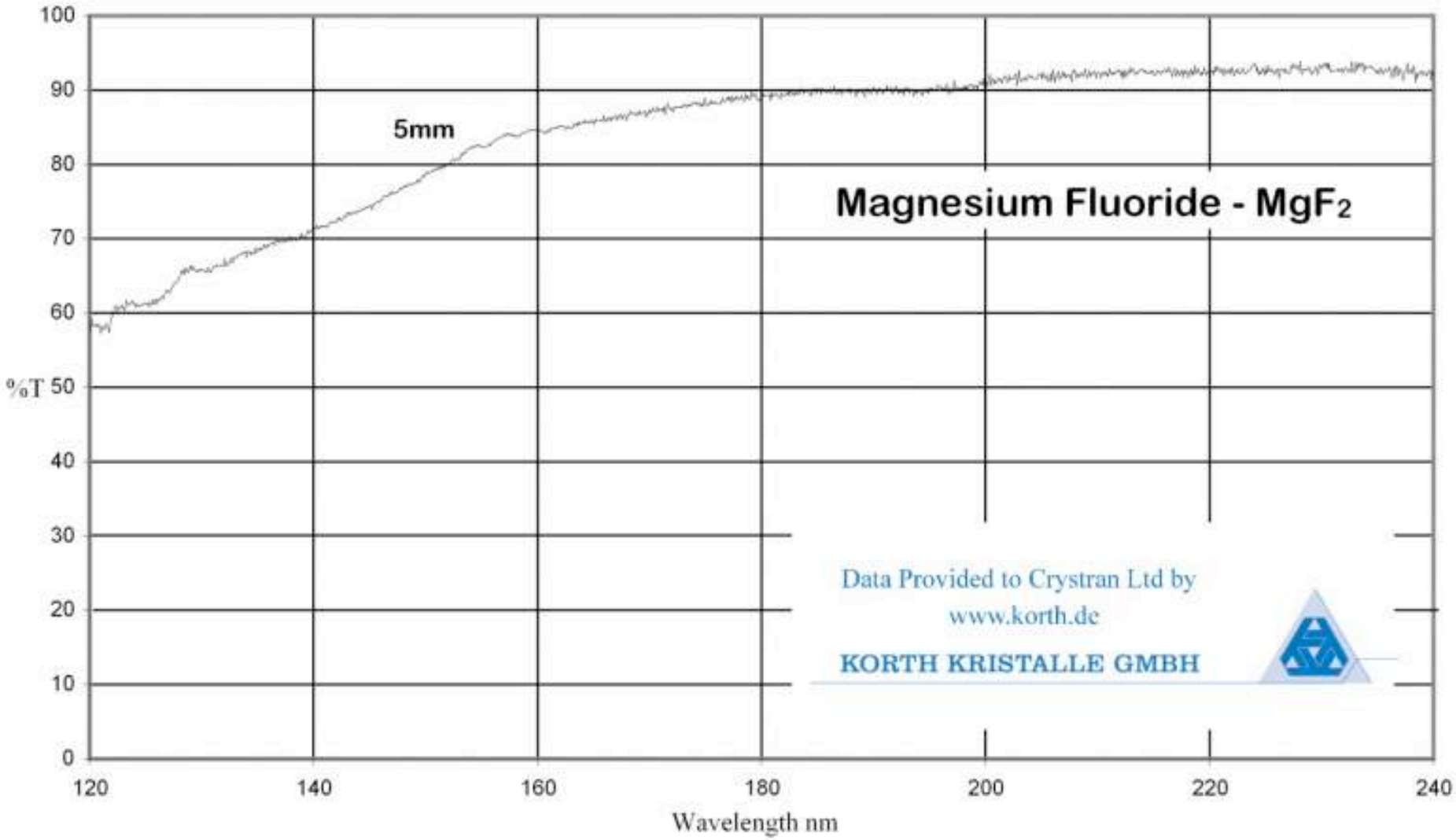


The 'standard' Reflectance Standard – $BaSO_4$

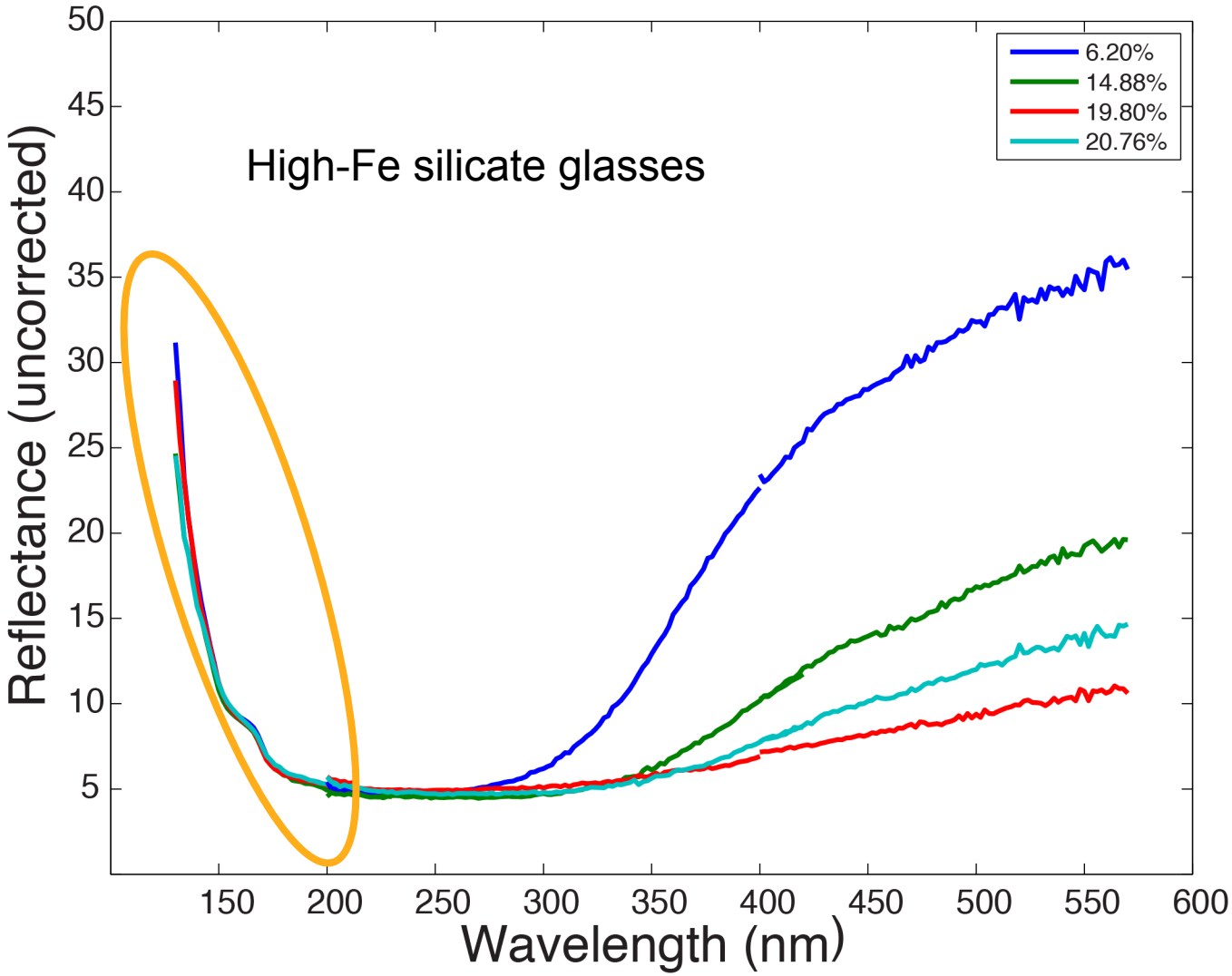


What to use as a standard?

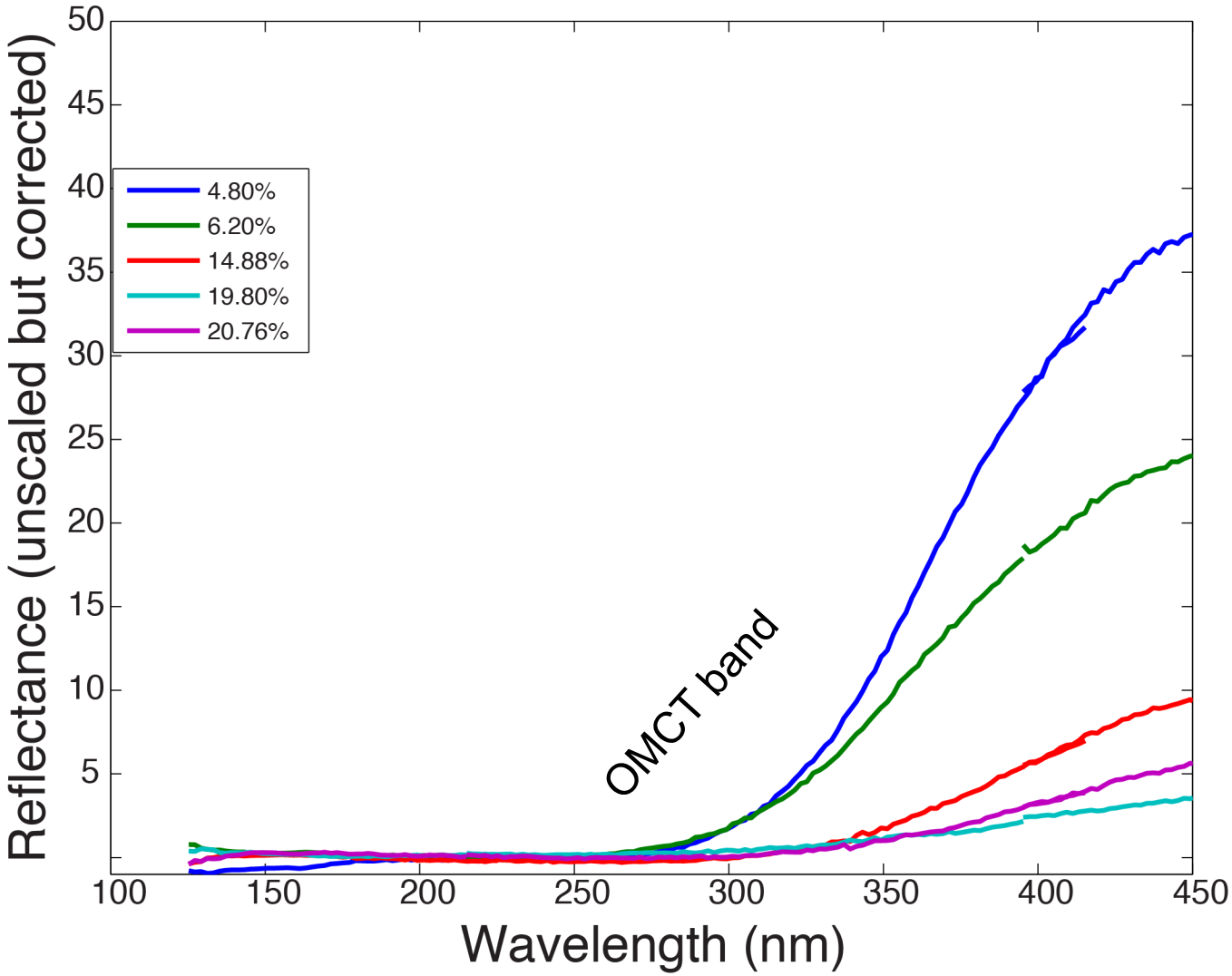
- **Transmission of 5mm thick MgF_2 window**



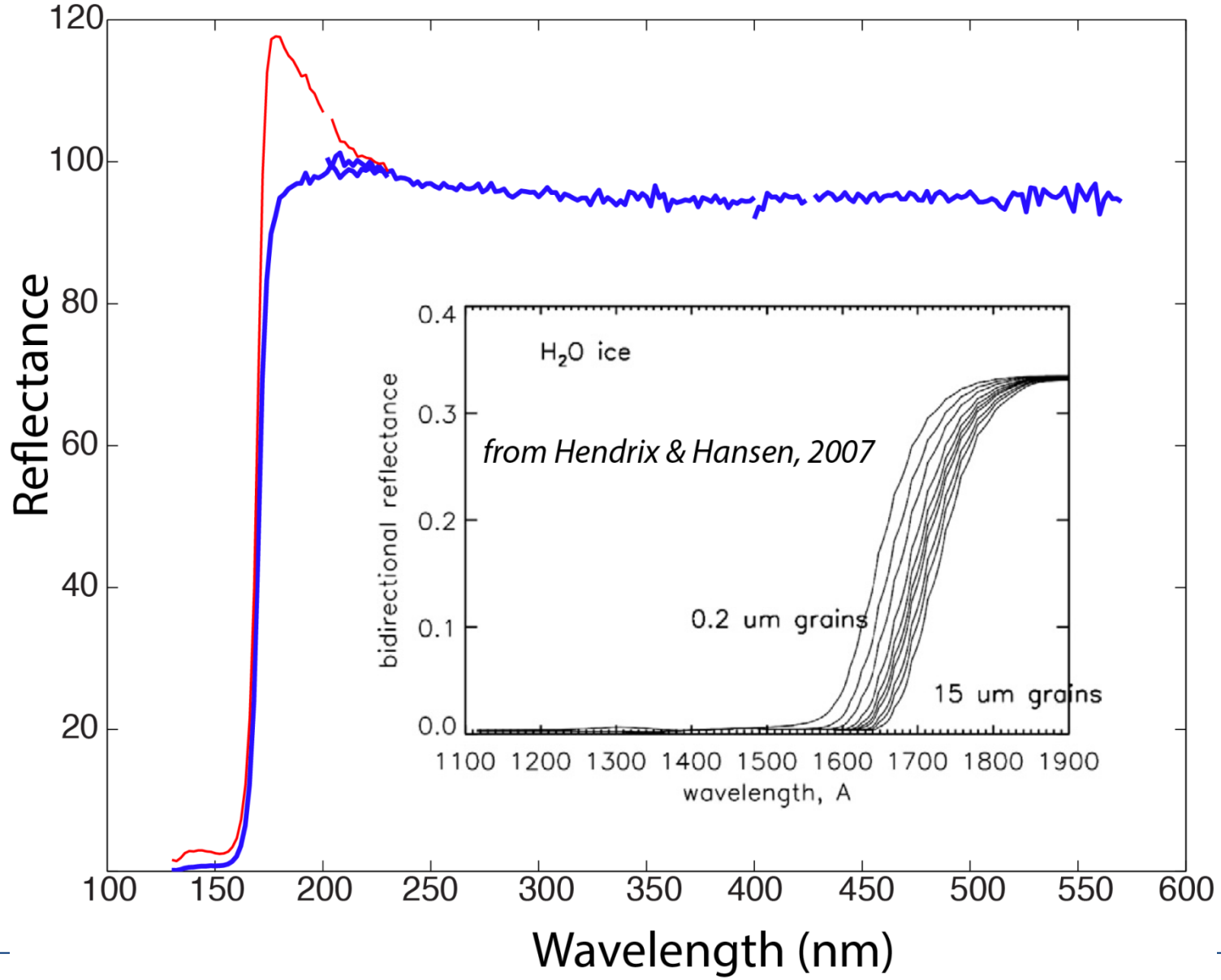
Uncorrected reflectance spectra



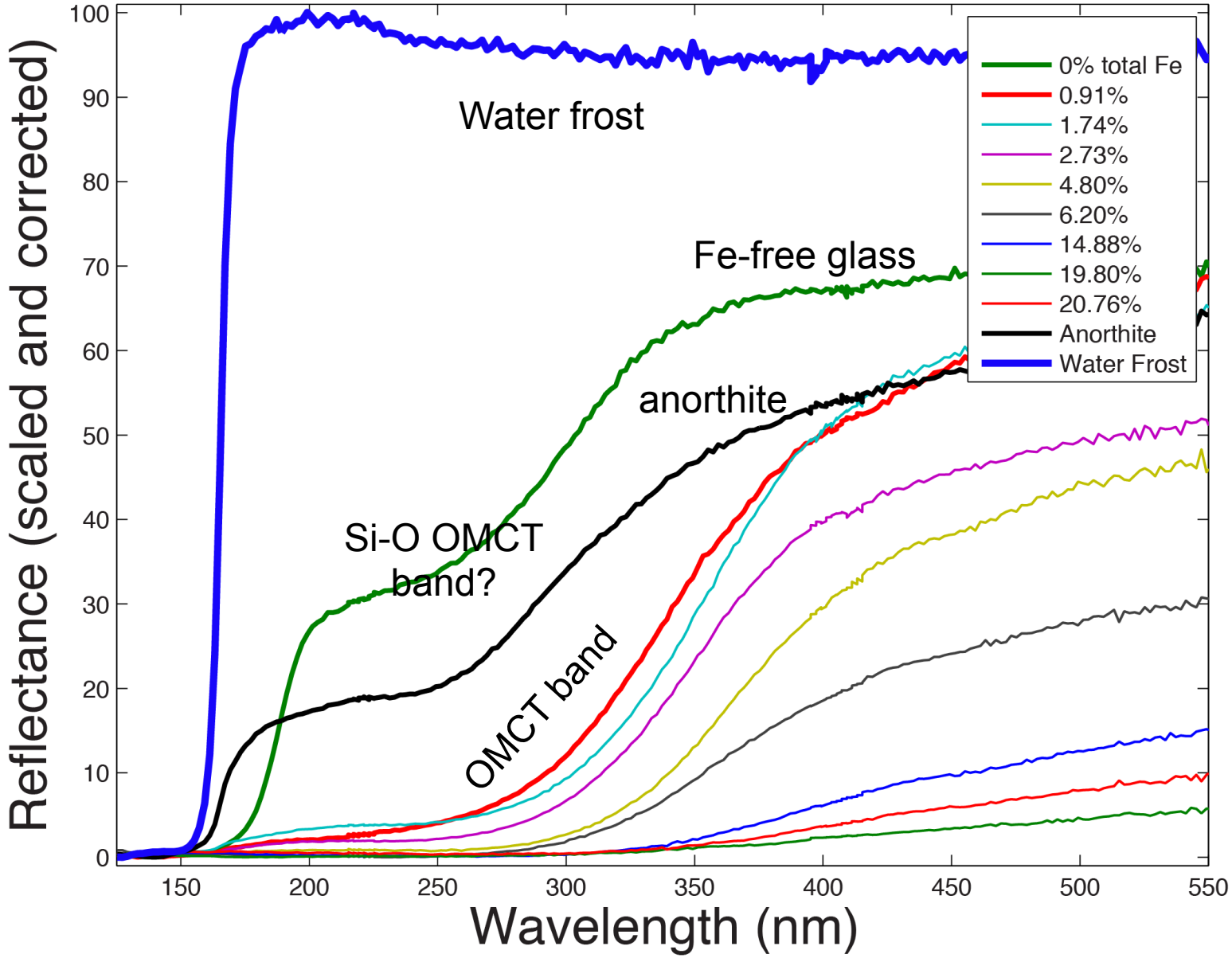
Corrected High-iron glasses



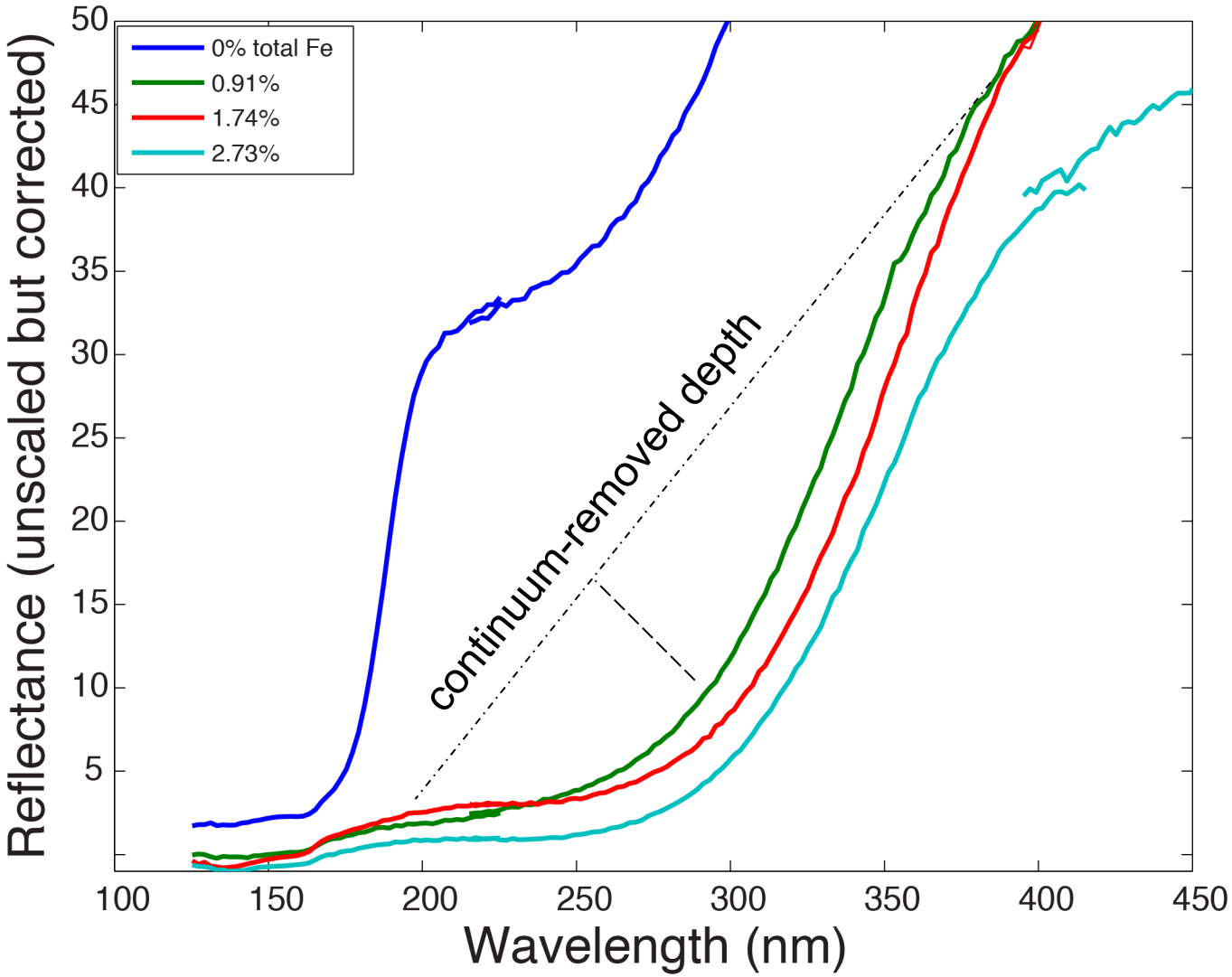
Validating with water frost



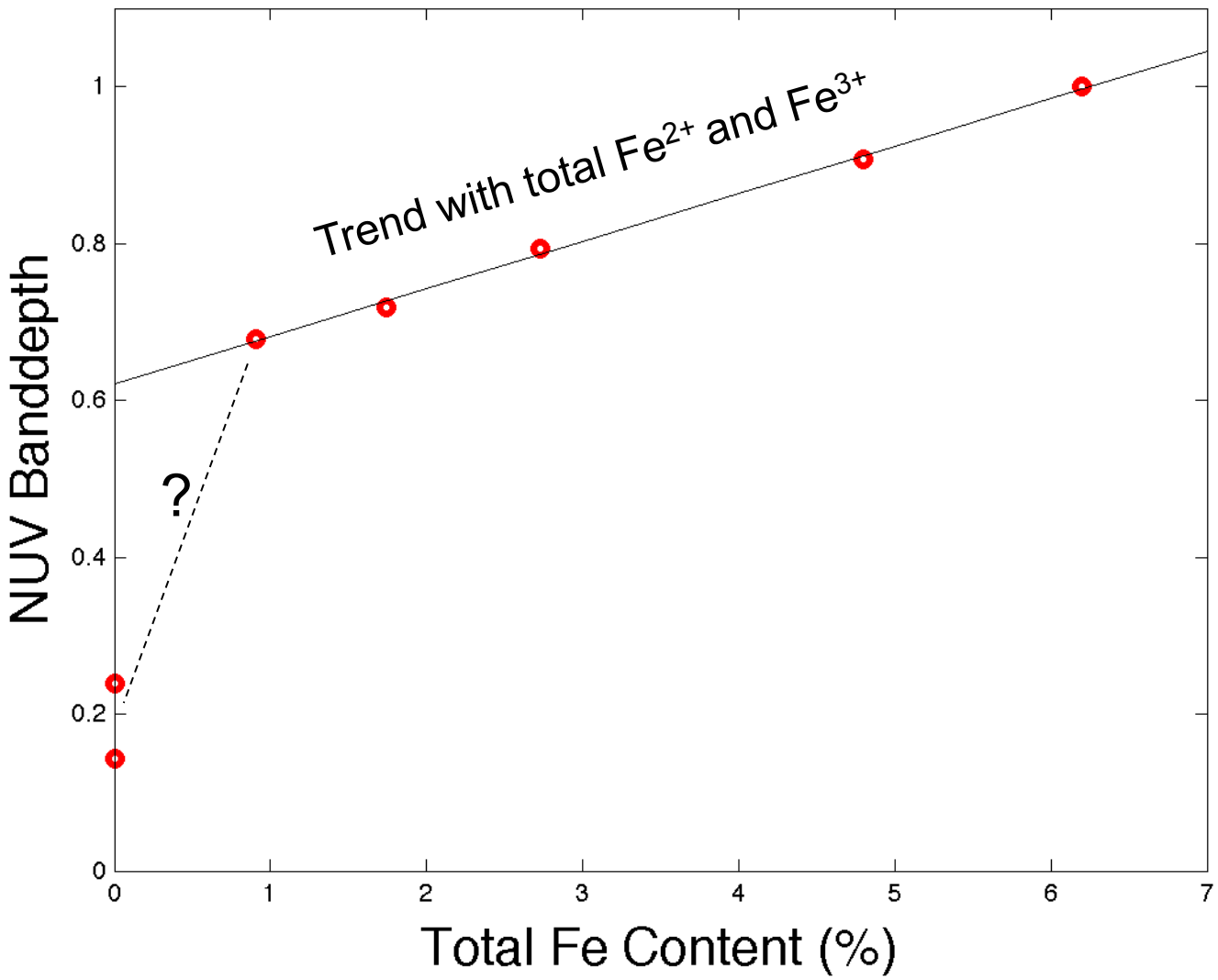
Silicates & Water Frost



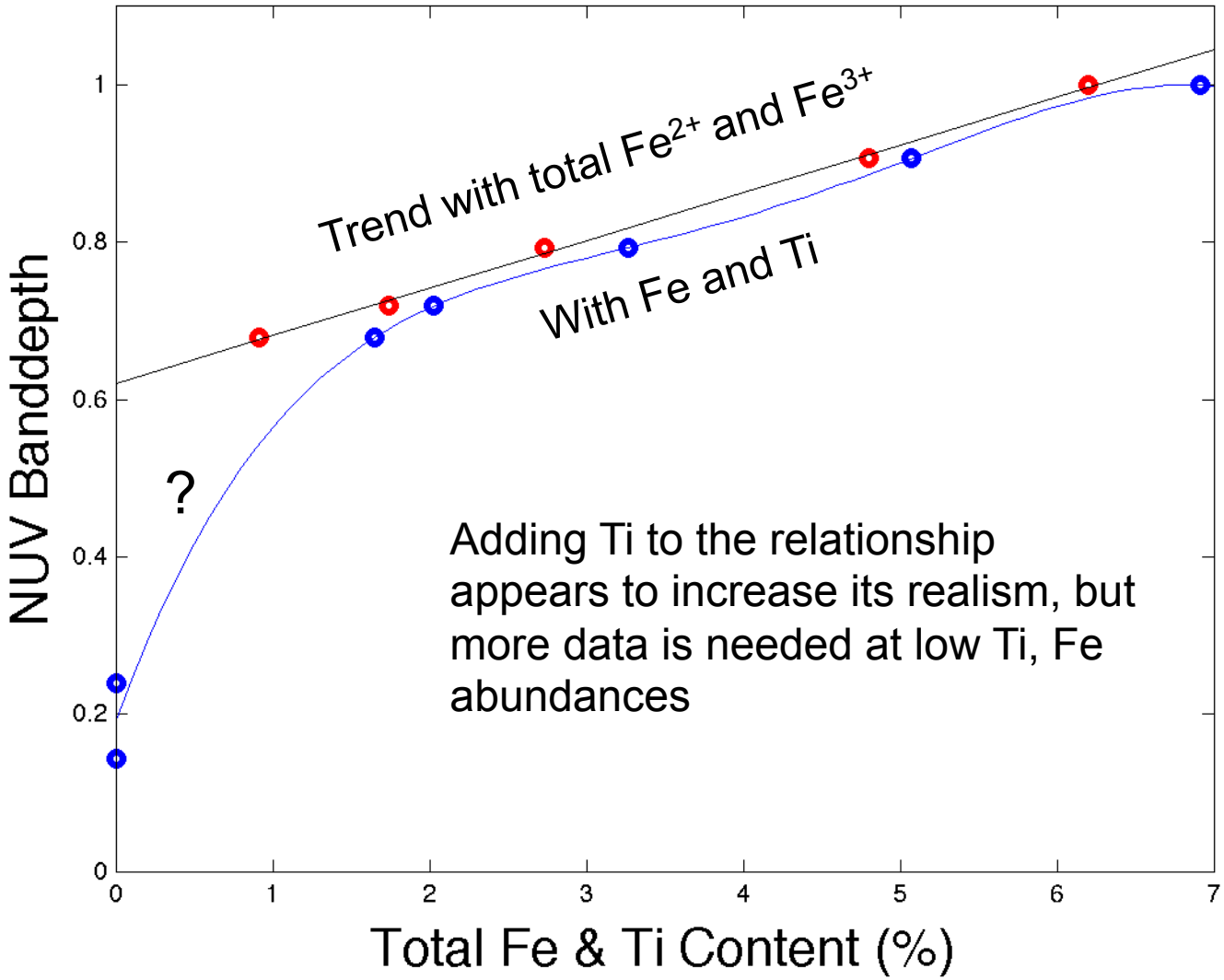
Standard Spectral Analysis



Fe-abundance vs. OMCT band depth

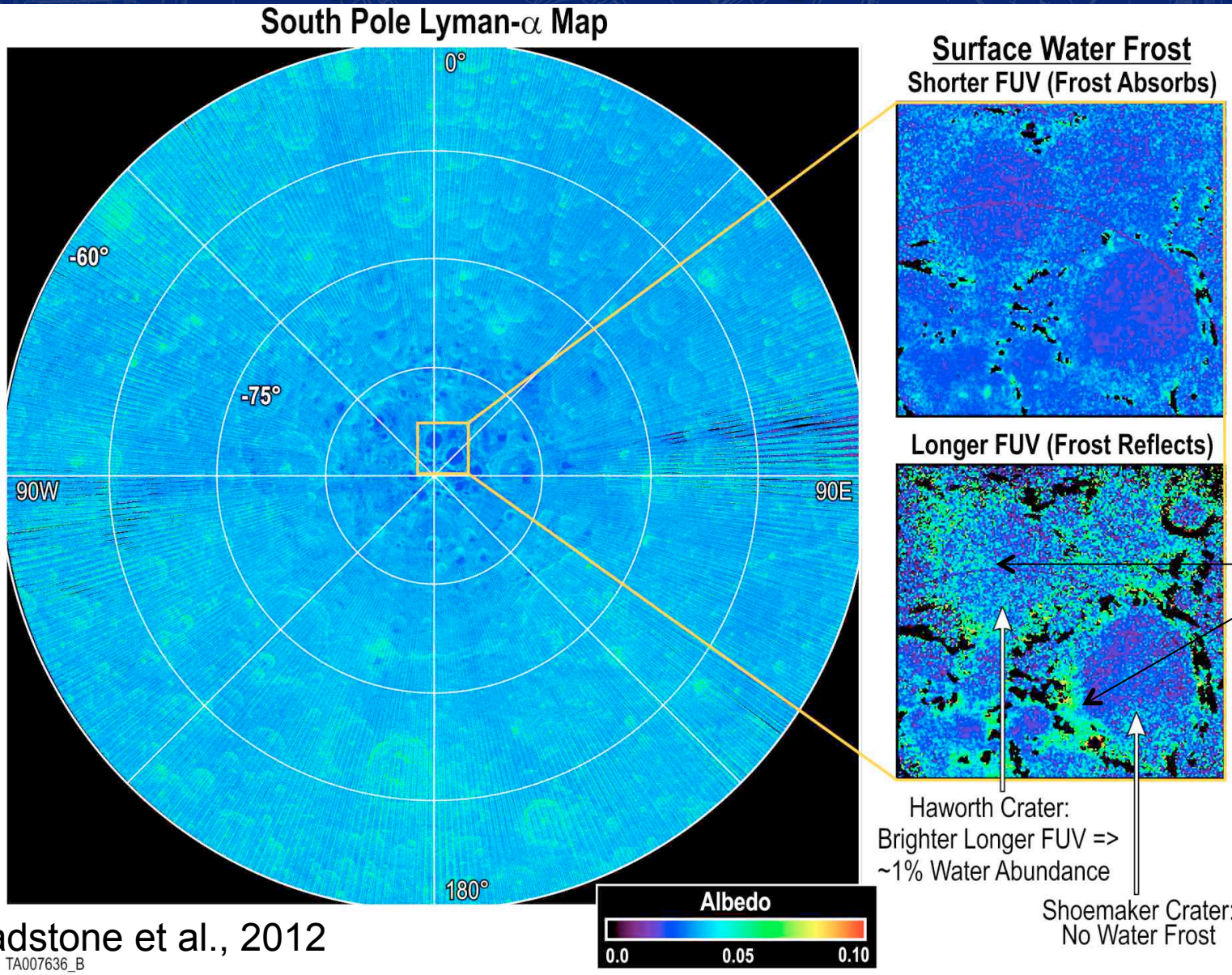


Fe & Ti -abundance vs. OMCT band DEPTH



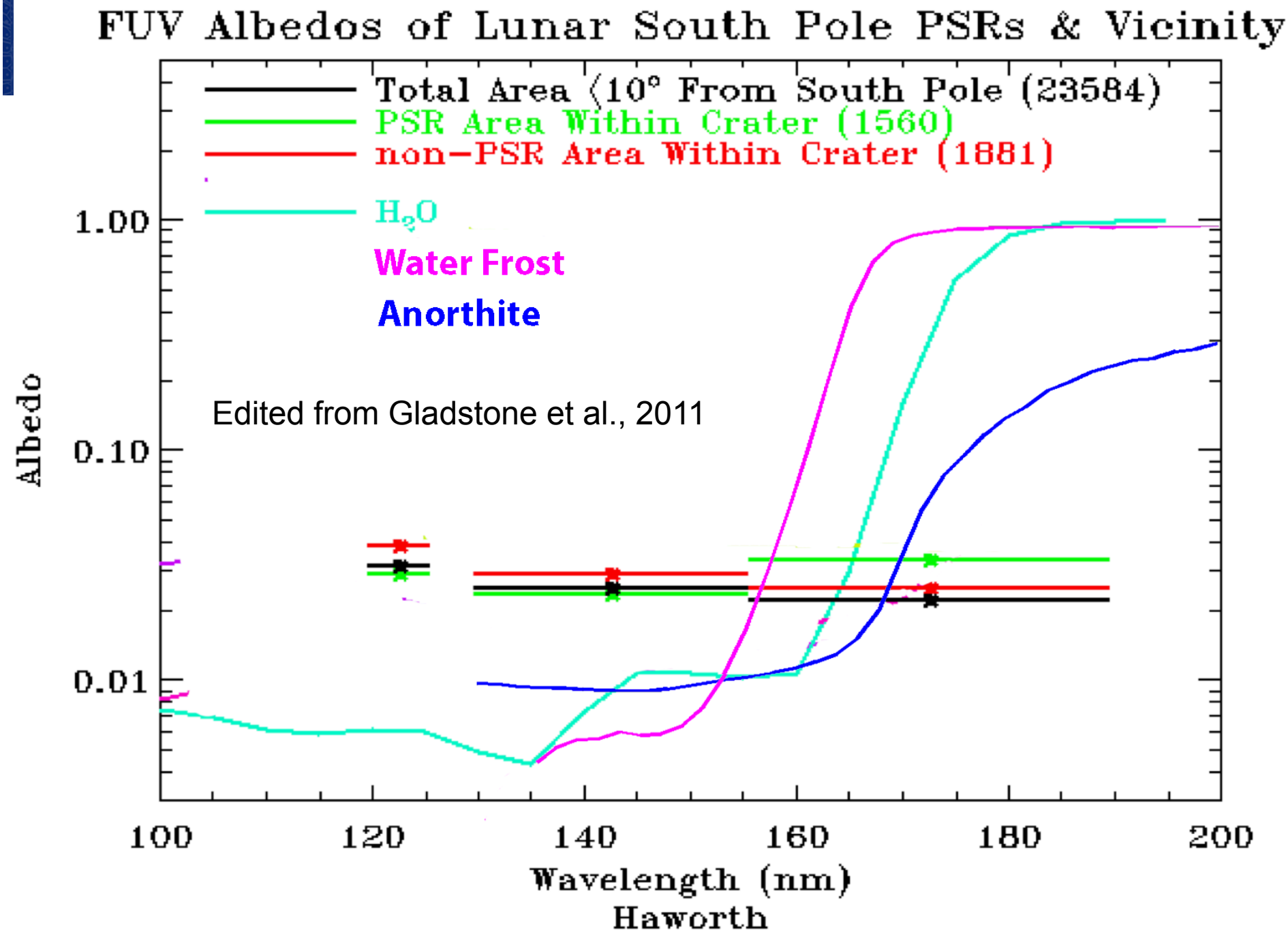
Adding Ti to the relationship appears to increase its realism, but more data is needed at low Ti, Fe abundances

Spectral Mixing: Discriminating ice from feldspar

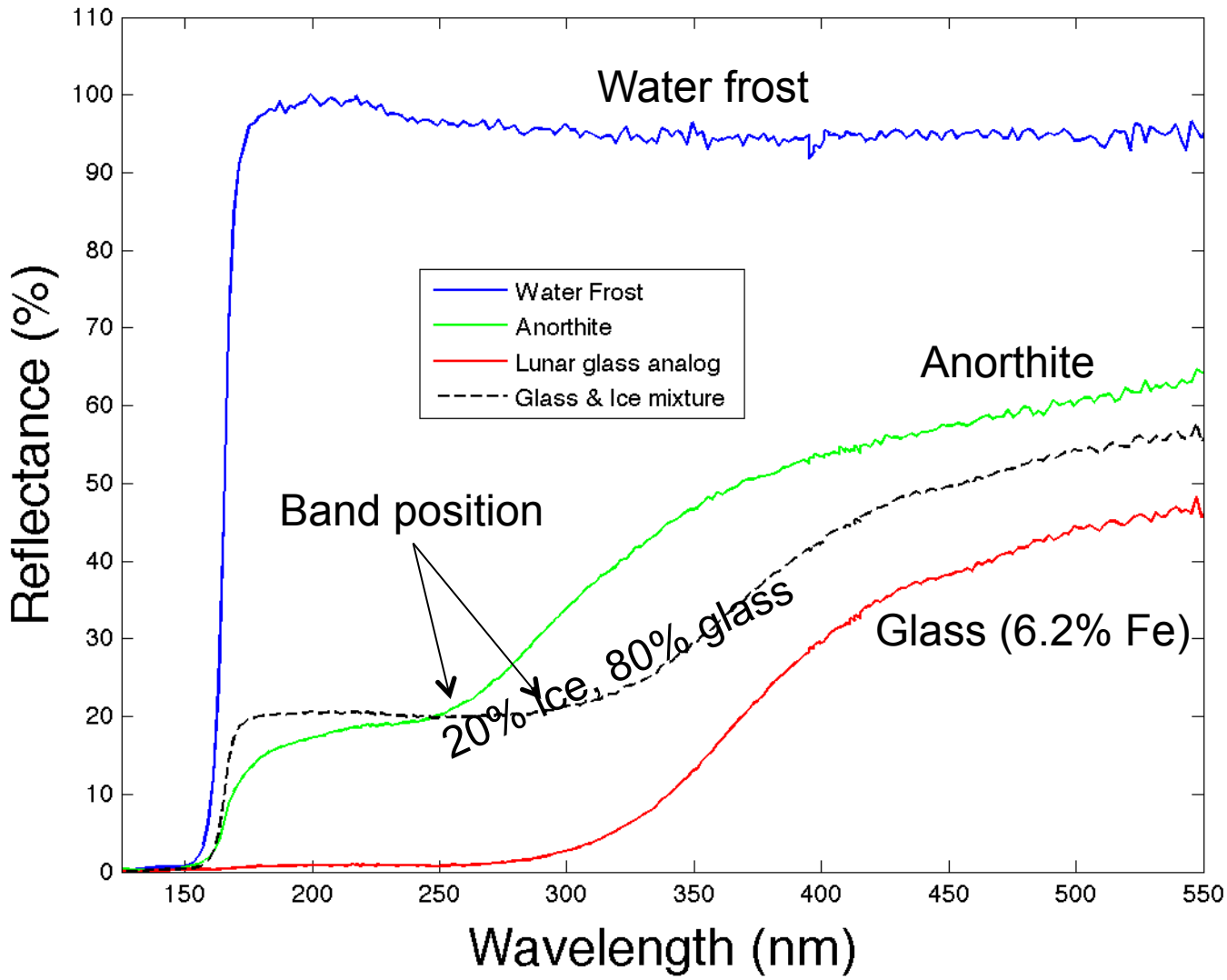


Gladstone et al., 2012

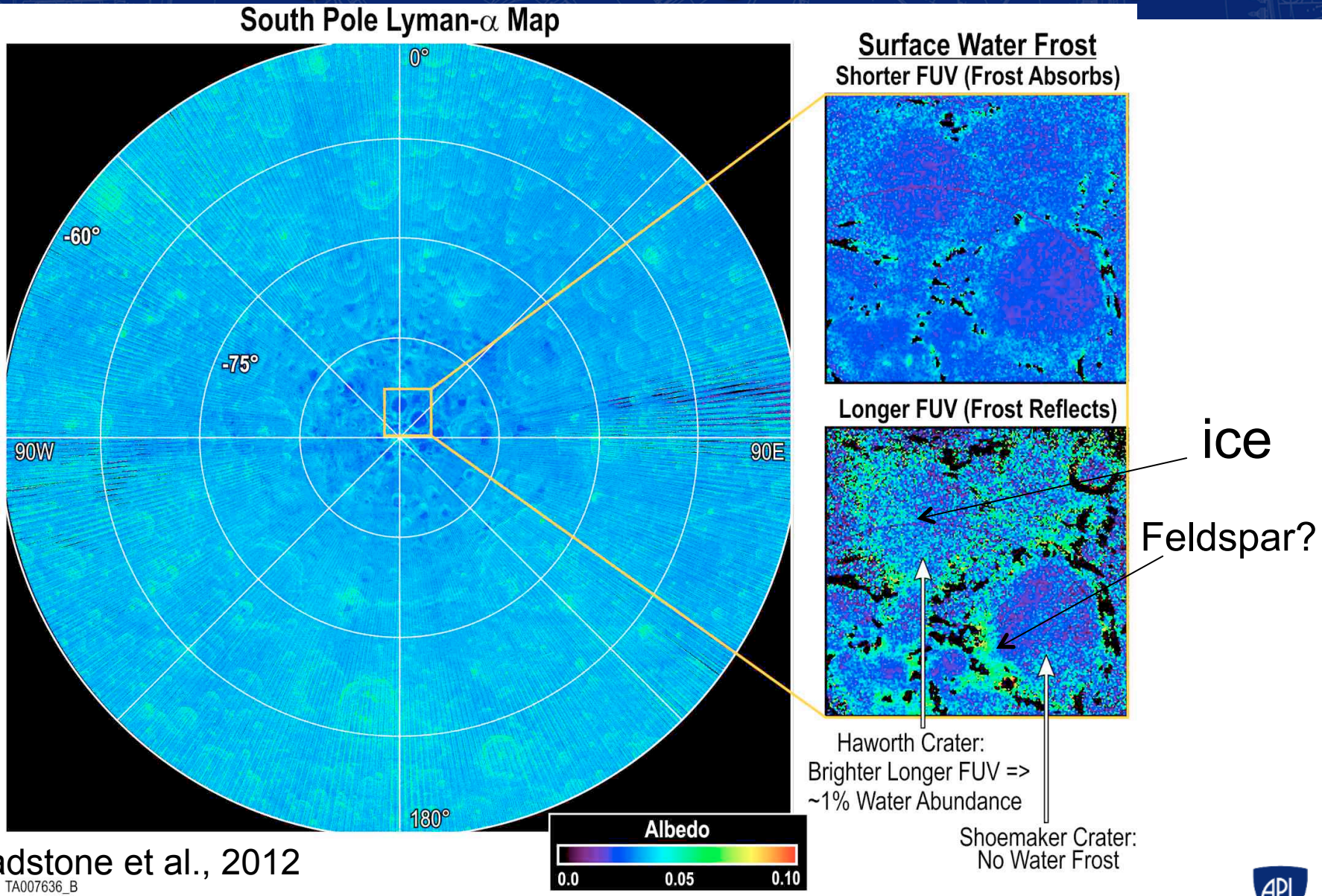
TA007636_B


FUV Albedos of Lunar South Pole PSRs & Vicinity
Total Area (10° From South Pole (23584)
PSR Area Within Crater (1560)
non-PSR Area Within Crater (1881)
H_2O
Water Frost
Anorthite
Edited from Gladstone et al., 2011
Albedo
1.00
0.10
0.01
100
120
140
160
180
200
Wavelength (nm)
Haworth

Spectral Mixing: Discriminating ice from feldspar



Spectral Mixing: Discriminating ice from feldspar



Gladstone et al., 2012

TA007636_B

Conclusion

UV spectroscopy to determine surface composition

- Keys on very strong OMCT absorptions from 130 to 400 nm.
- Sensitive to silicates with and without transition elements (plagioclase and basalts), and waterice

Laboratory measurements

- More are needed to better develop compositional relationships
- Carefully done (scattered light, limited choice of reflectance standards)

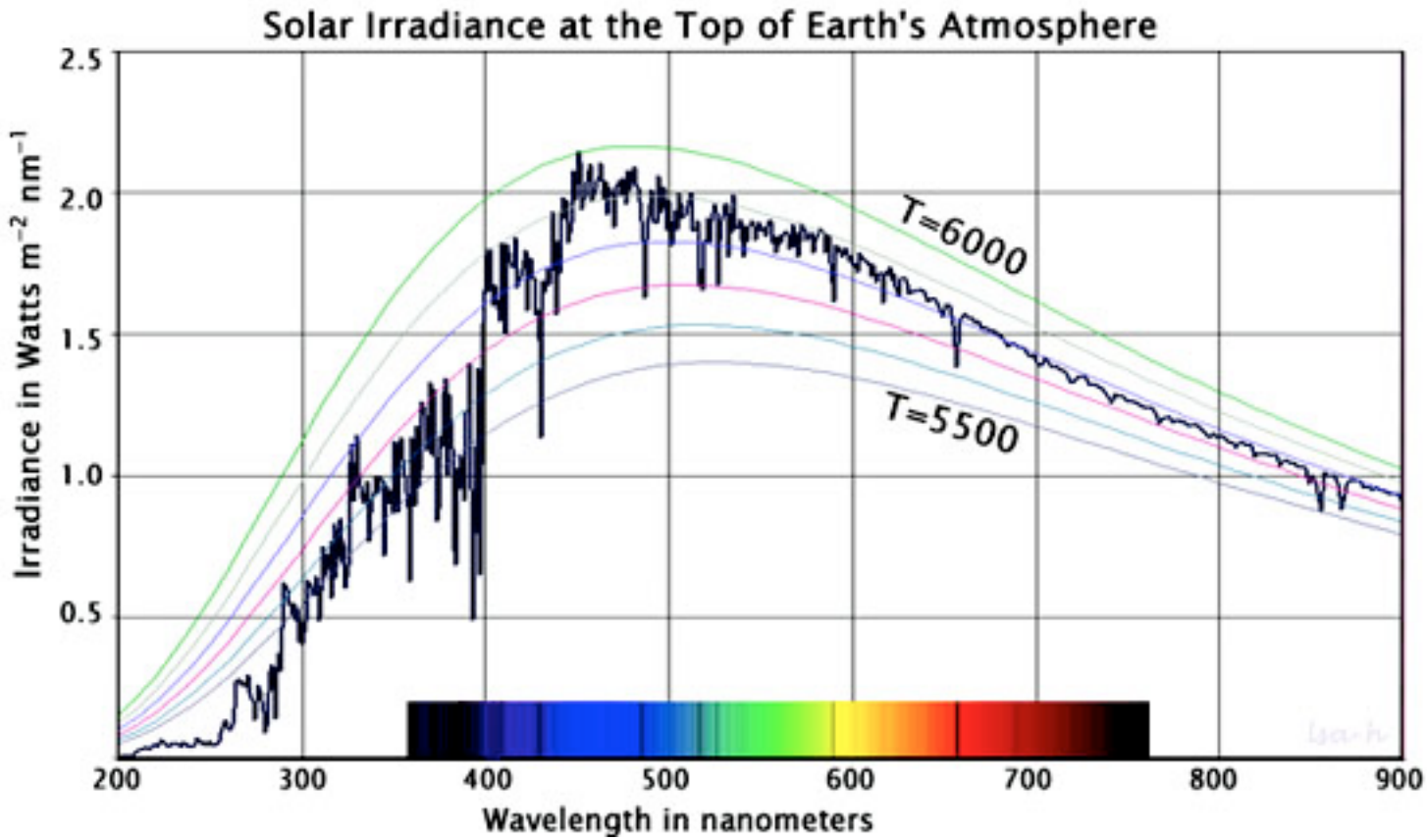
Relevant to airless bodies such as Moon and asteroids

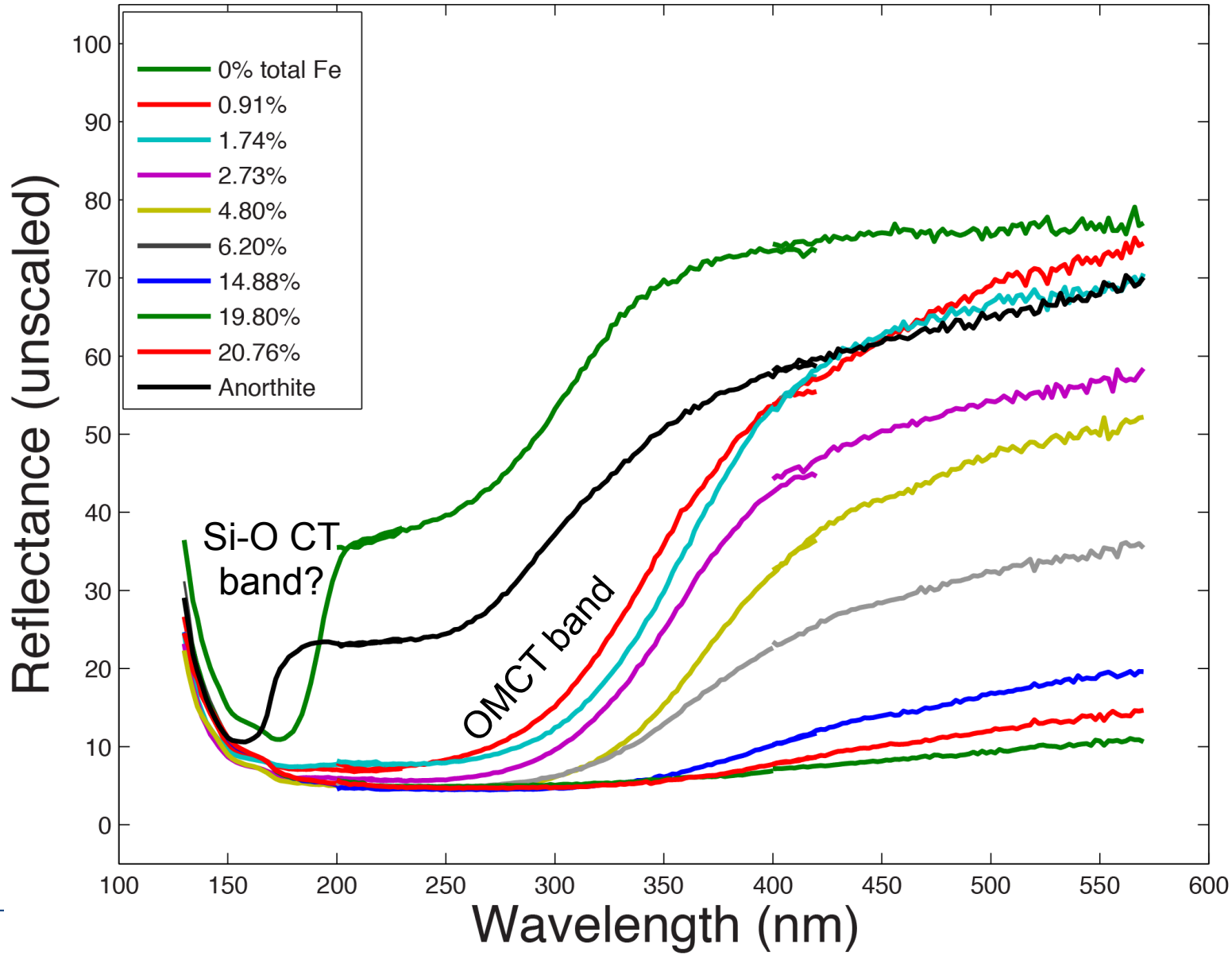
- Can work where traditional choices don't such as in poorly illuminated conditions (shadows, cold regions) or where surface structure/composition make other techniques less effective
- However, photon starved measurements require long integration times for high SNR.

Back Up Slides

Challenge to the UV

- **Rely upon galactic background from 'hot' stars as ours is too cold**



Data from The 1985 Wehrli Standard Extraterrestrial Solar Irradiance Spectrum at http://rredc.nrel.gov/solar/standards/am0/

Silicates - Raw Spectra