Visible – Near-Infrared Spectroscopy of Organics in Meteorites and Asteroids

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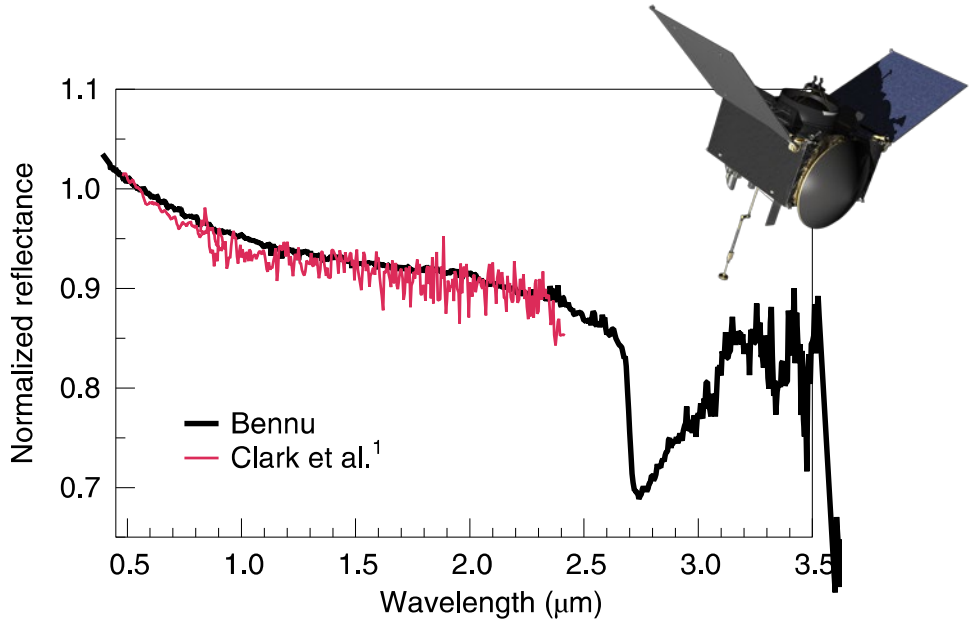
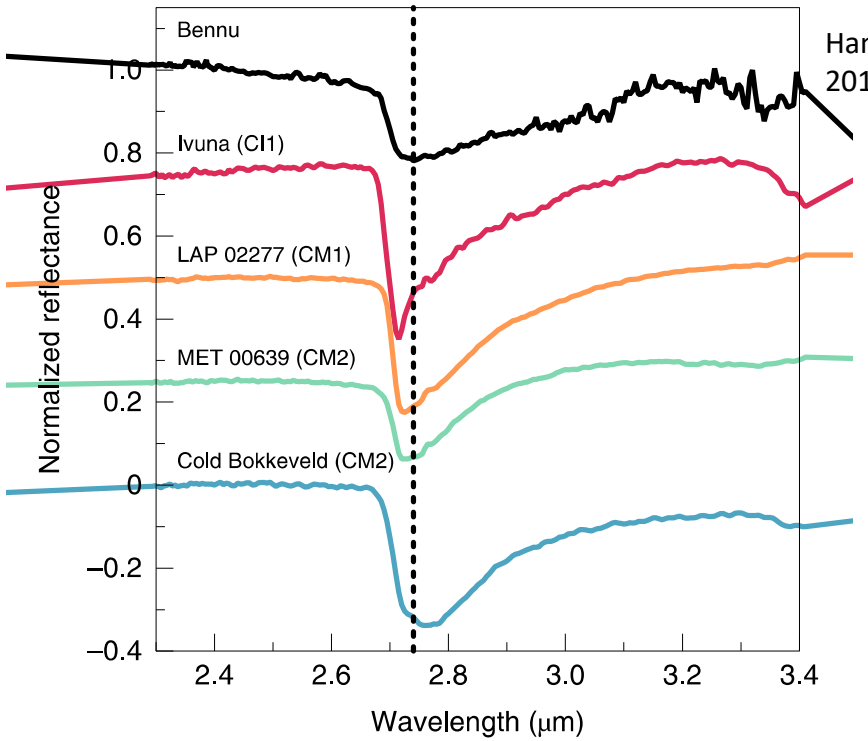
Motivation

- OSIRIS-REx: interpret VIS-NIR spectra from asteroid Bennu
  - Searching for primitive organics
  - Sample site selection
  - Global characterization
- General: Remotely quantify organic abundance on planetary surfaces and in field and laboratory samples with reflectance spectroscopy



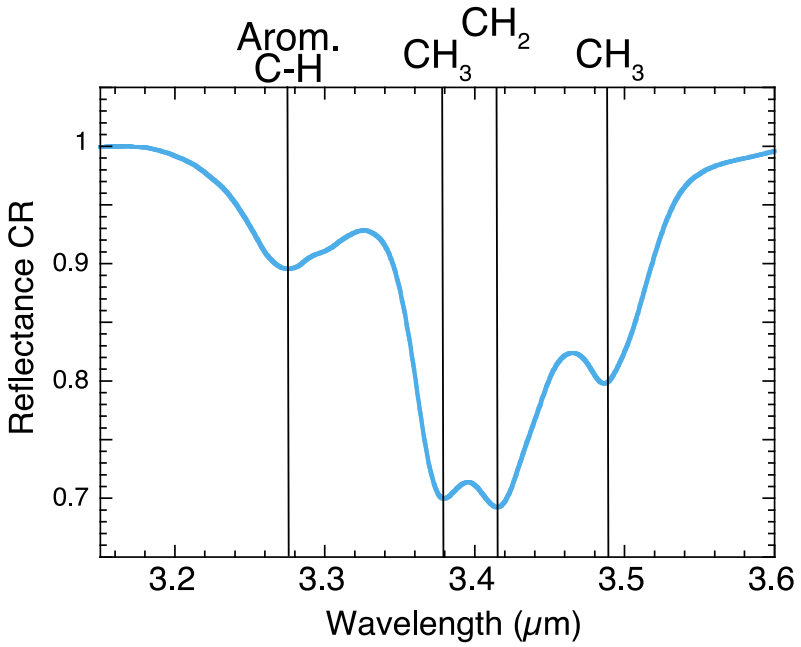


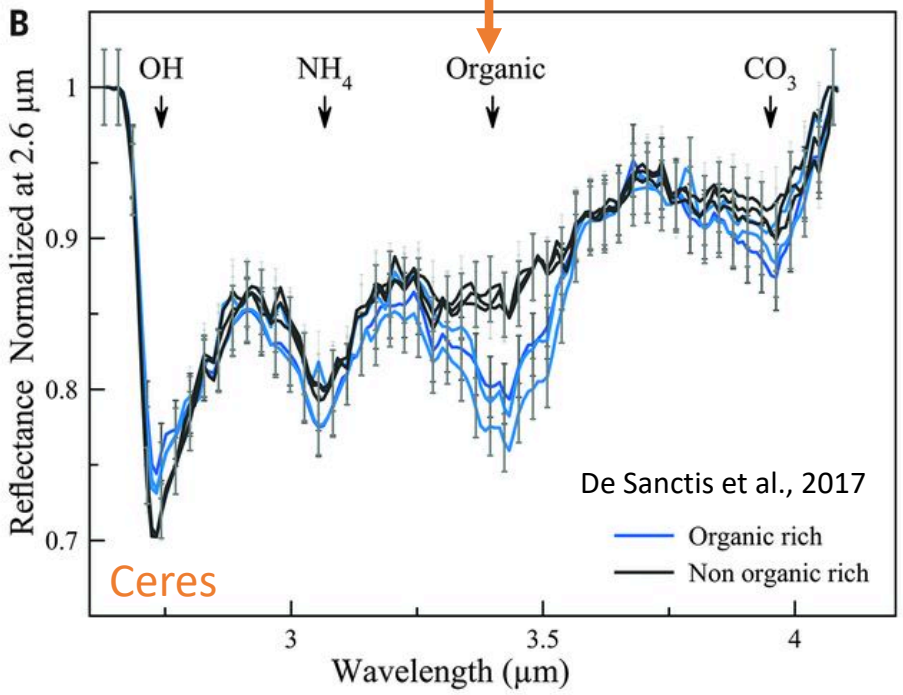
Hamilton et al., 2019

Background

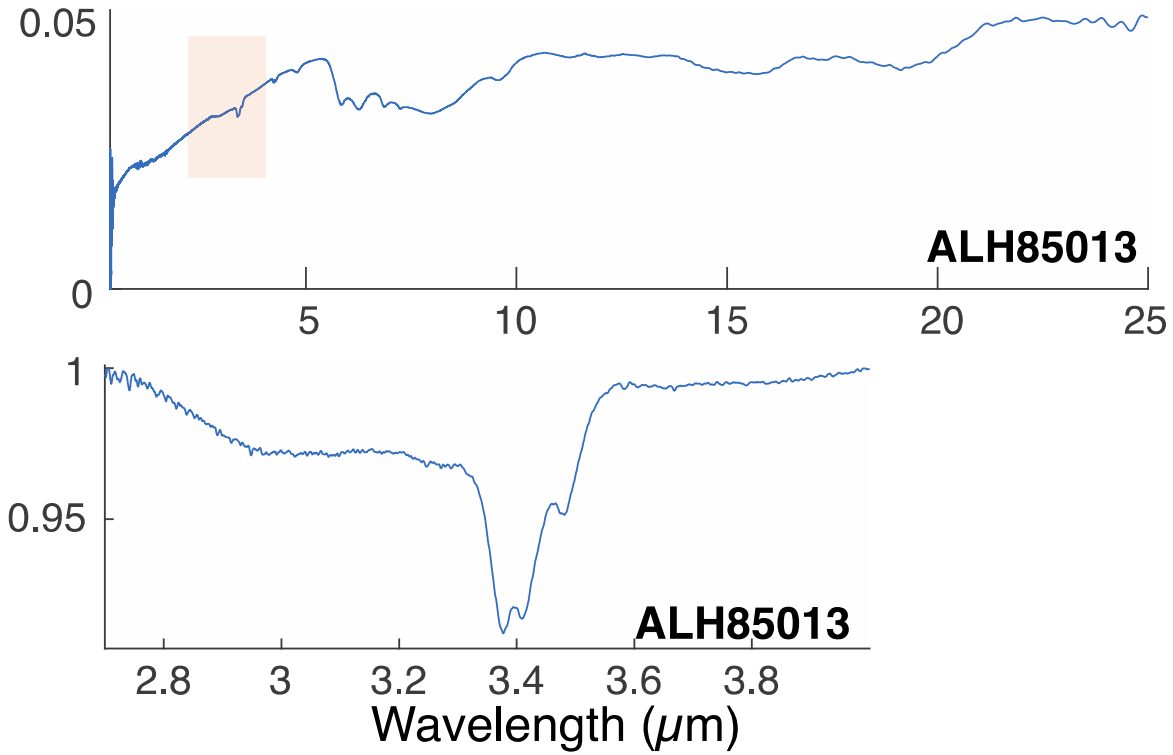
Reflectance spectra of organic-bearing rocks capture: (1) inorganic composition *and* abundance, (2) organic composition *and* abundance, (3) particle size, (4) albedo

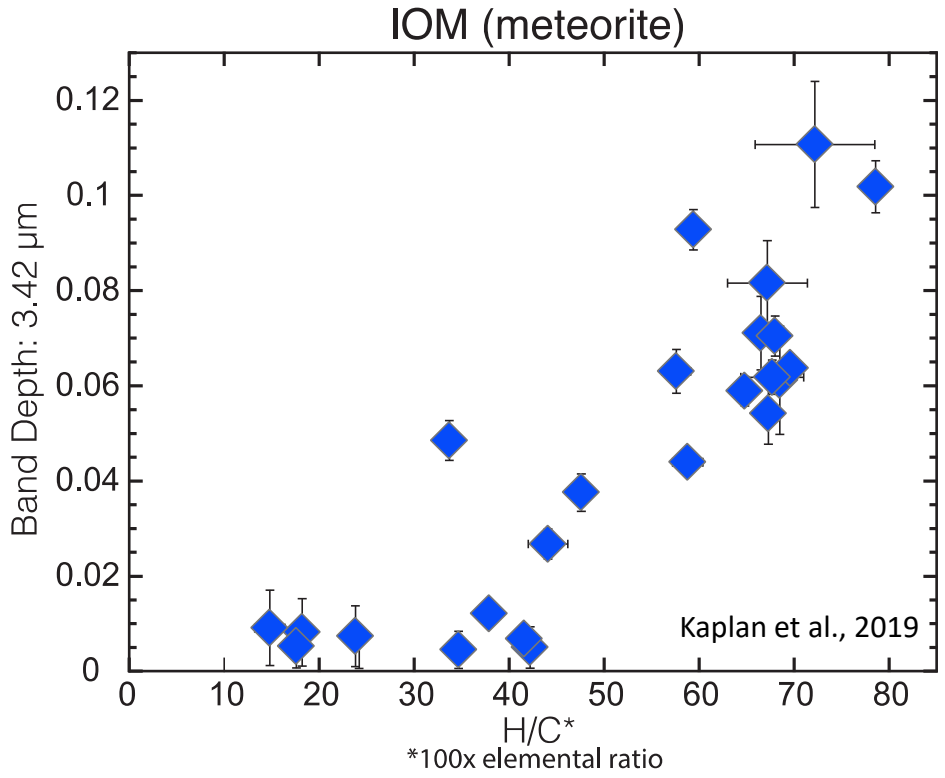
- 3.4 micron region:
  - Aliphatic C-H
  - Aromatic C-H
  - CO_3 (carbonate)
- Important variables? Detection limits?





Laboratory Spectra of IOM





- Insoluble organic matter (IOM) is a primary component of the organic matter found in carbonaceous meteorites
- Diverse organic compounds (e.g. Alexander et al., 2017)
- Up to ~5 wt.% organic C (e.g. Pearson et al., 2006)

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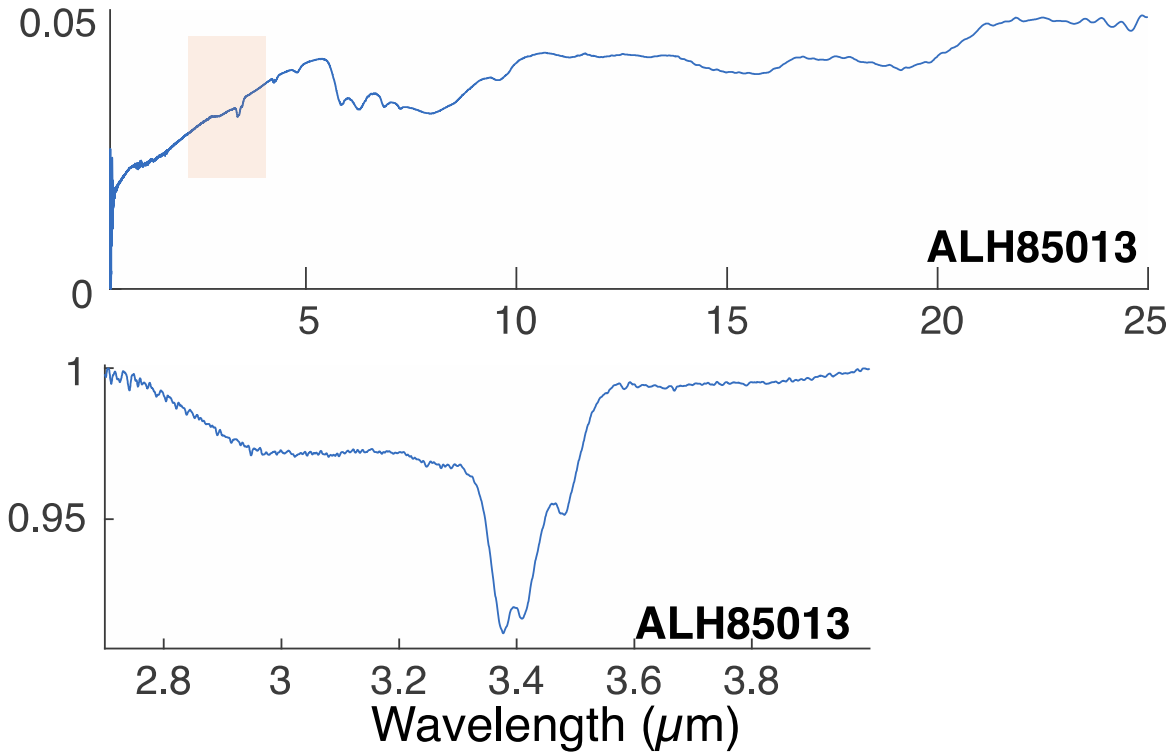

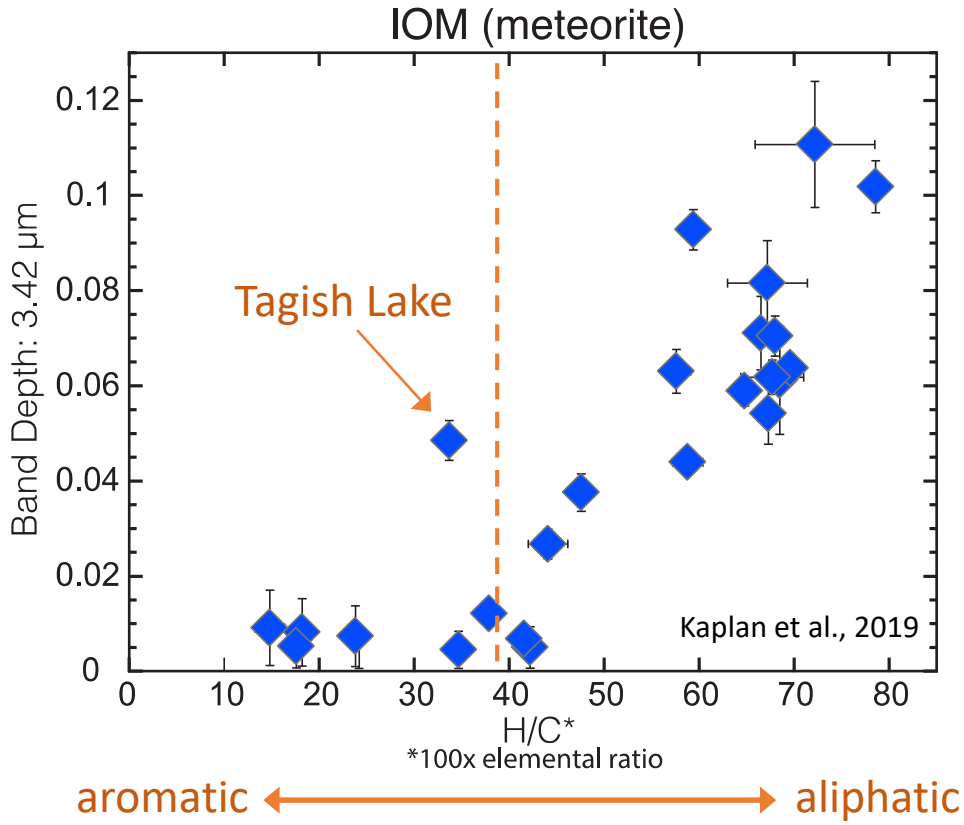

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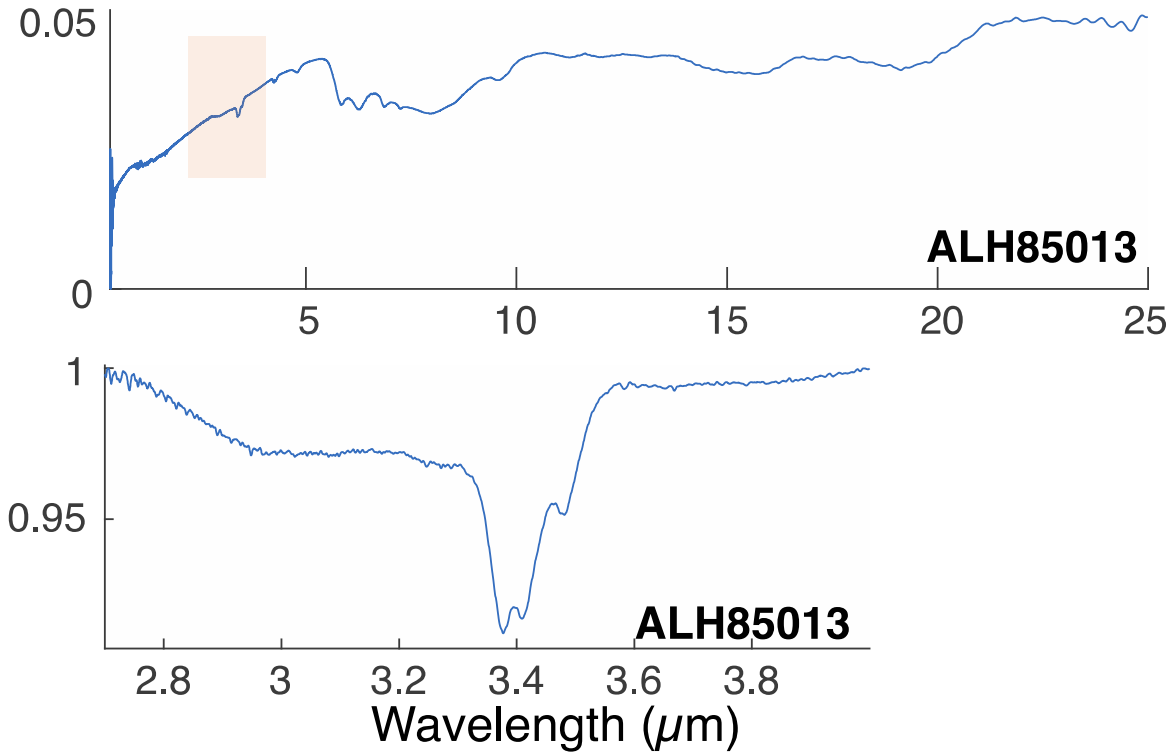

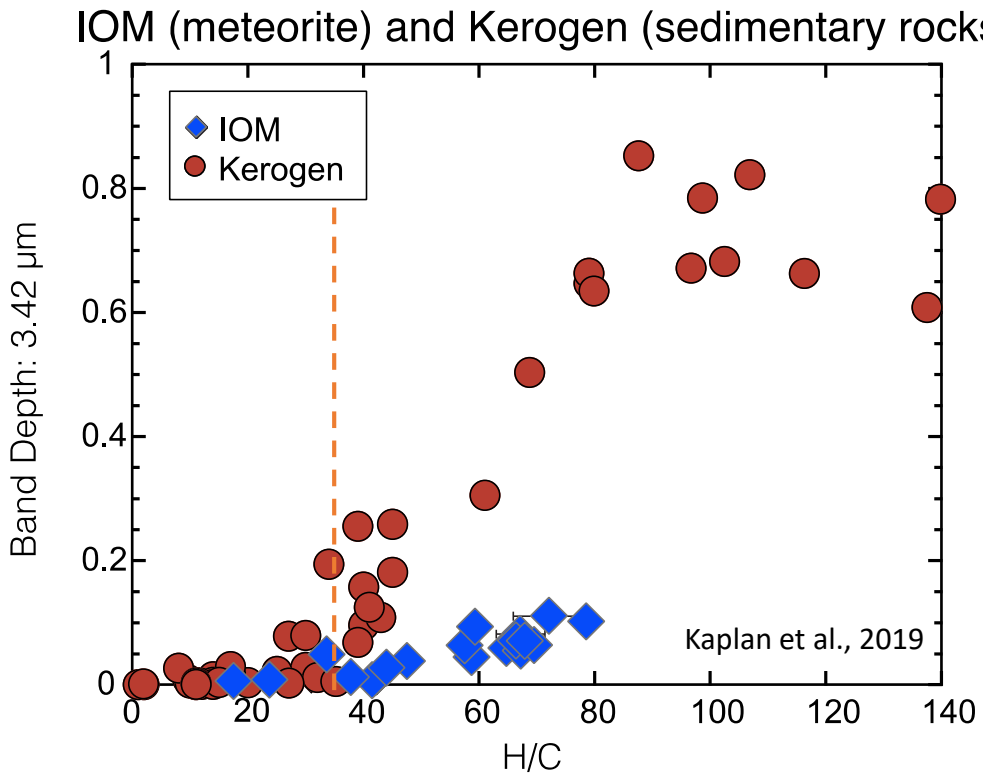

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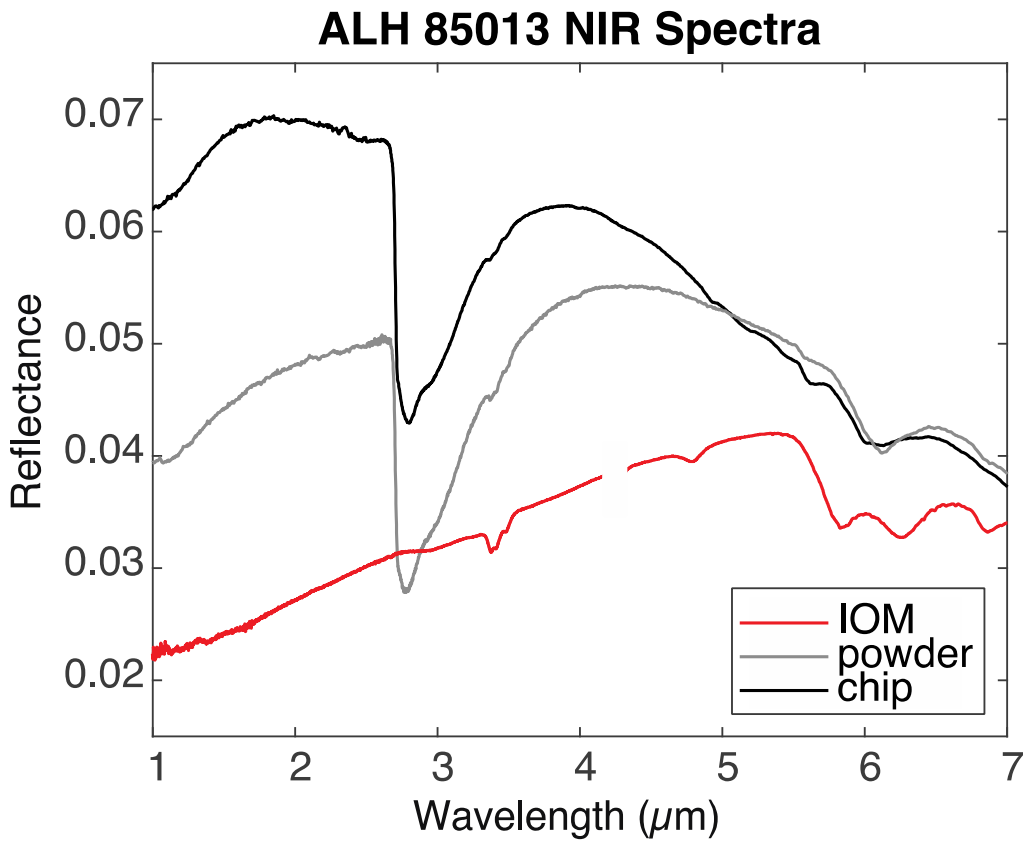

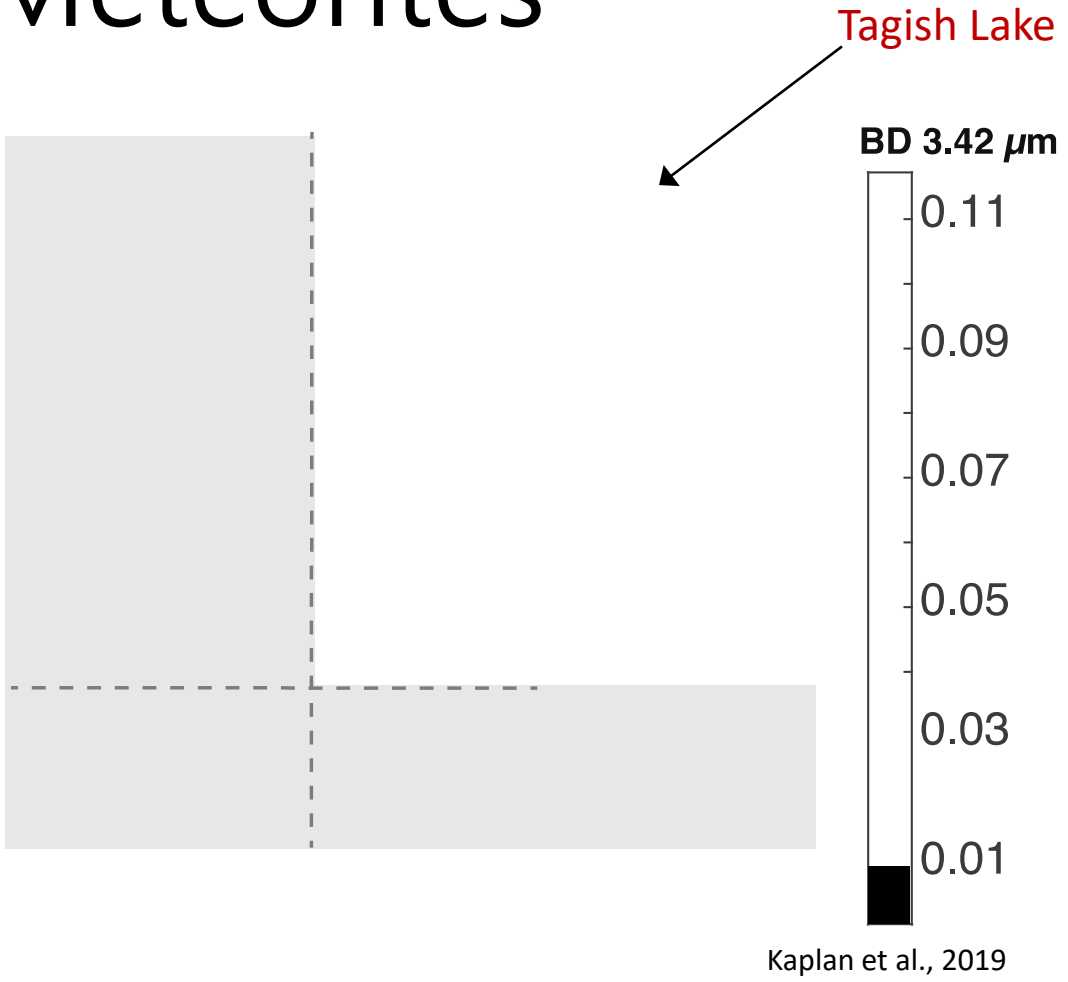

Kaplan et al., 2019

- Meteorite 3.4 micron band reflects both insoluble organic matter composition (H/C) and abundance (C wt.%) in the sample

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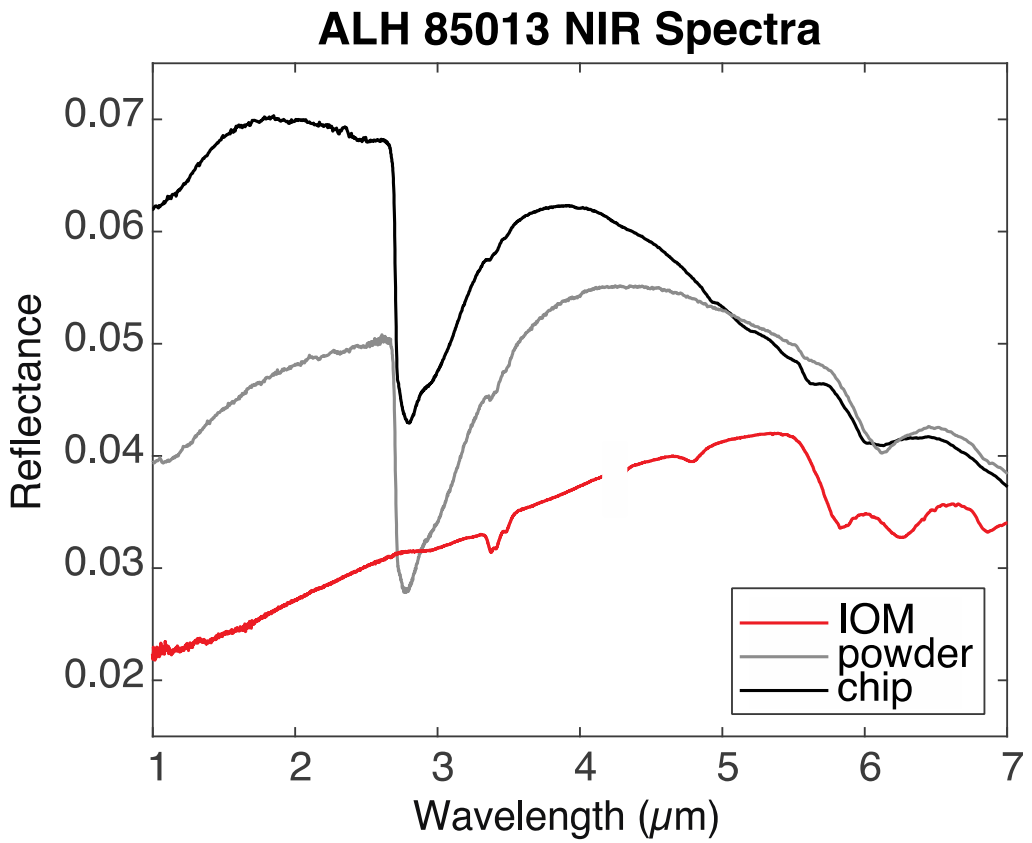

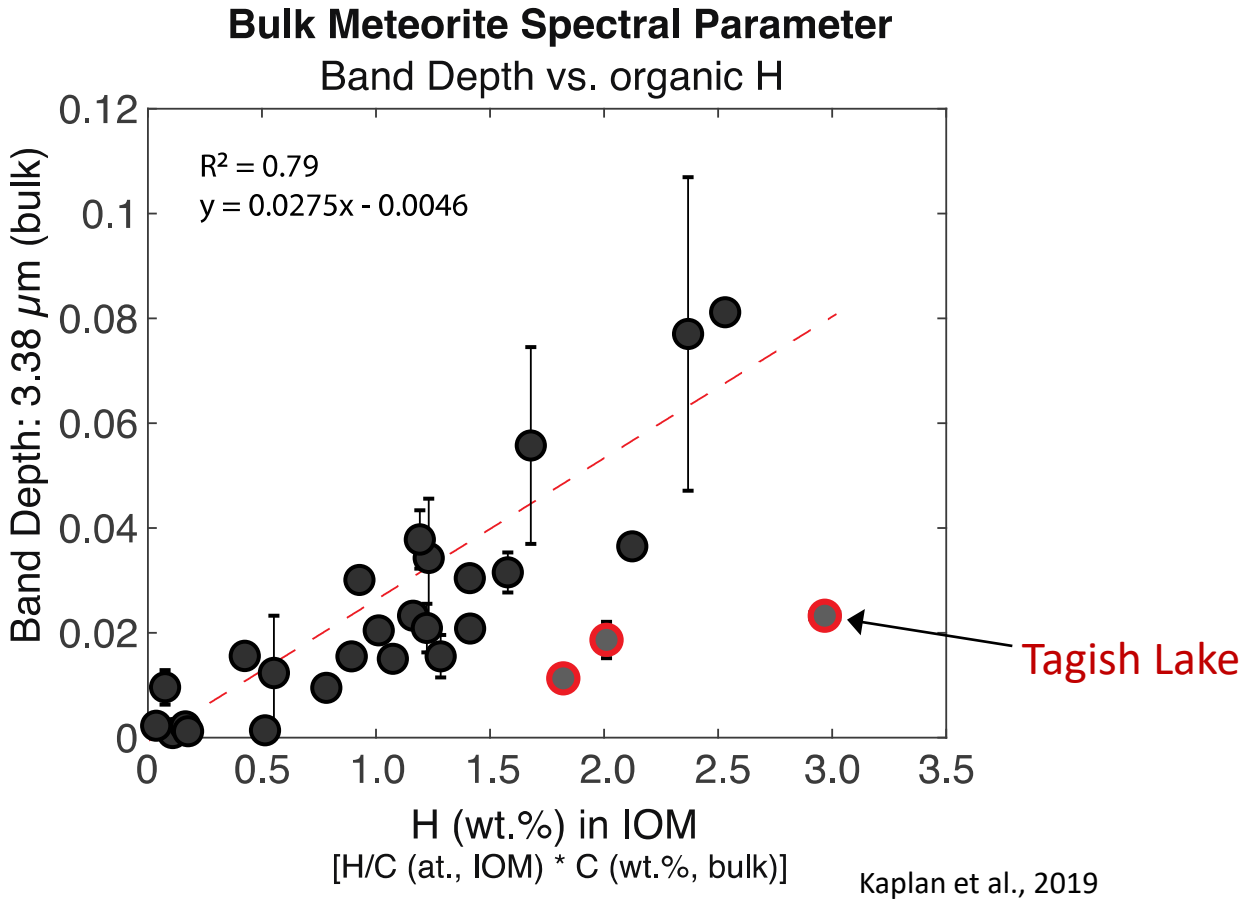

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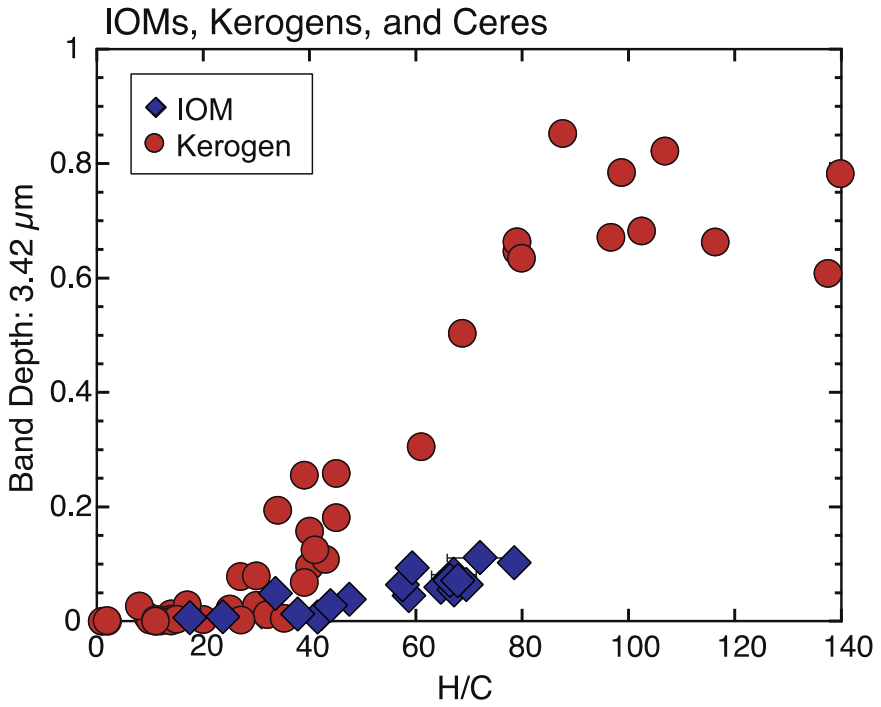
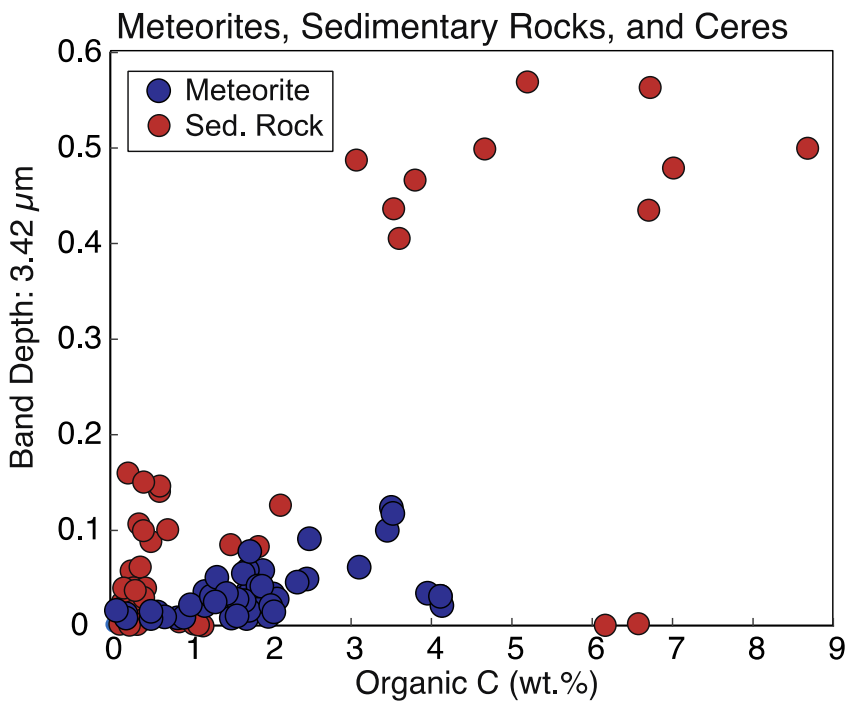
Application to Asteroids





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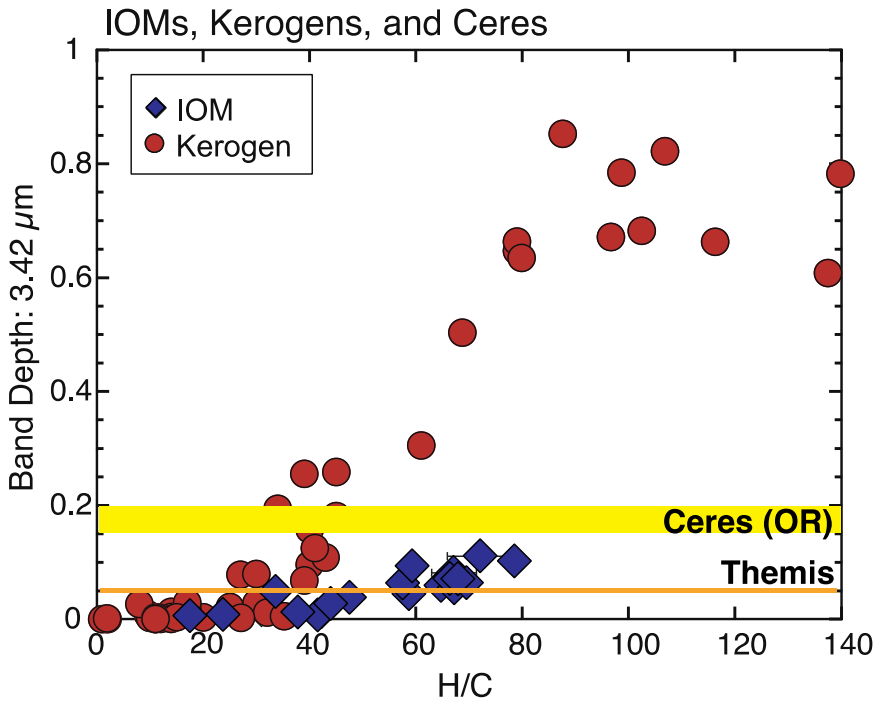
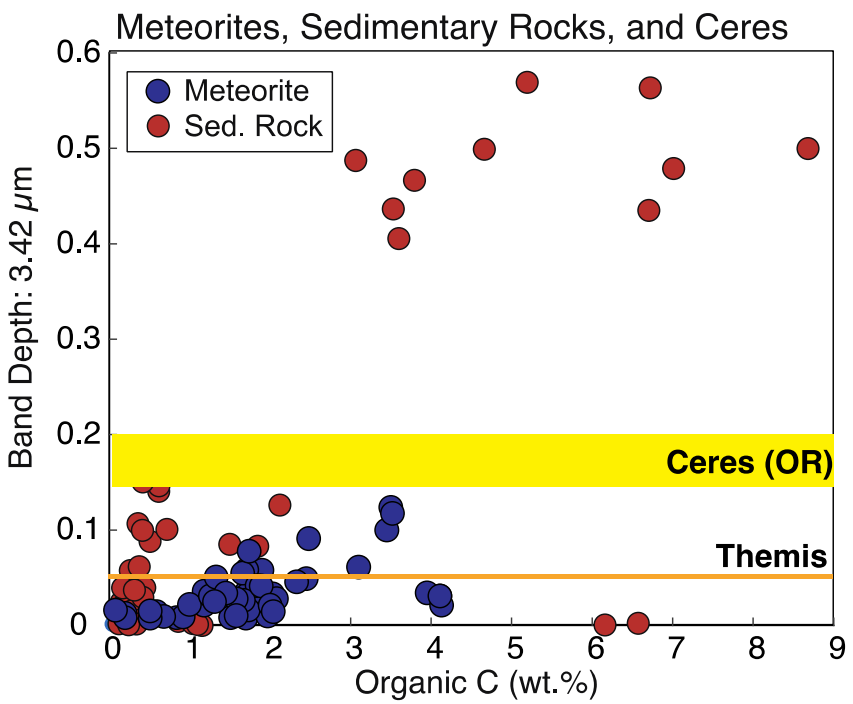
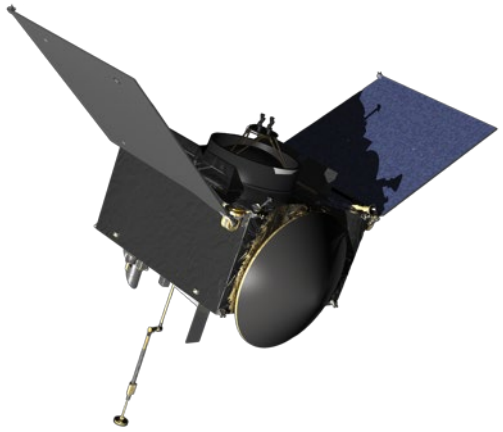


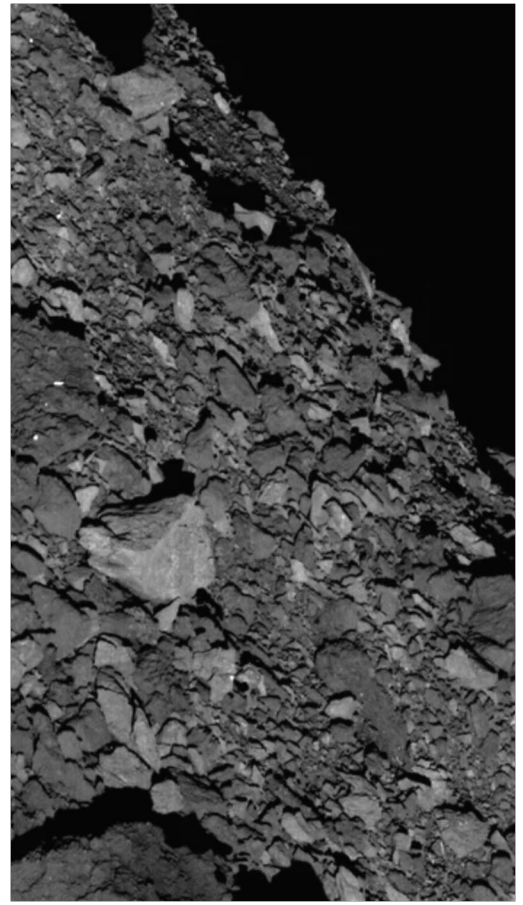


- Ceres has higher organic abundance and/or more aliphatic organics than the carbonaceous chondrites (Kaplan et al., 2018)
- Band depth can be used to asses H/C and C wt.% for asteroids

Conclusions



- Calibrations from meteorites and IOM can help us interpret organic abundance and composition from VIS-NIR spectra of asteroids
- Two main variables effect the 3.4 μm absorption: organic abundance and composition
  - Composition from isolated organics (kerogen, IOM)
  - Abundance from meteorites
- Detection limits exist
  - Organic carbon abundance > 1 wt.%
  - H/C > 0.2 – 0.4
- Similar analyses will be performed for OSIRIS-REx at high (< 20 m) spatial resolution using the OVIRS instrument



Acknowledgements

Ralph Milliken, *Brown University*

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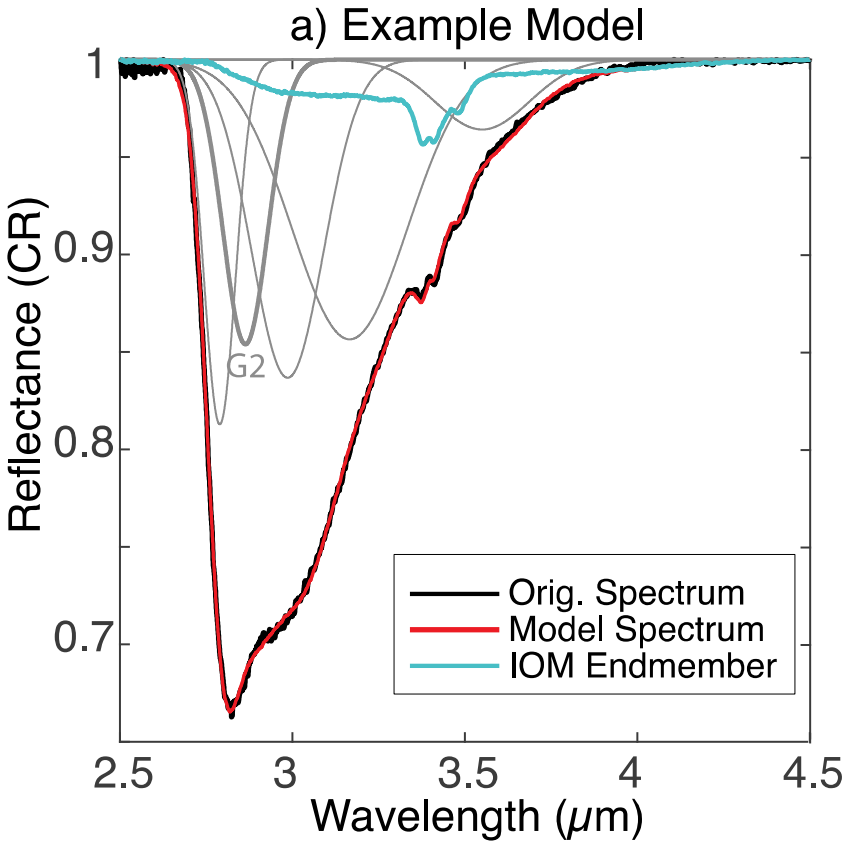
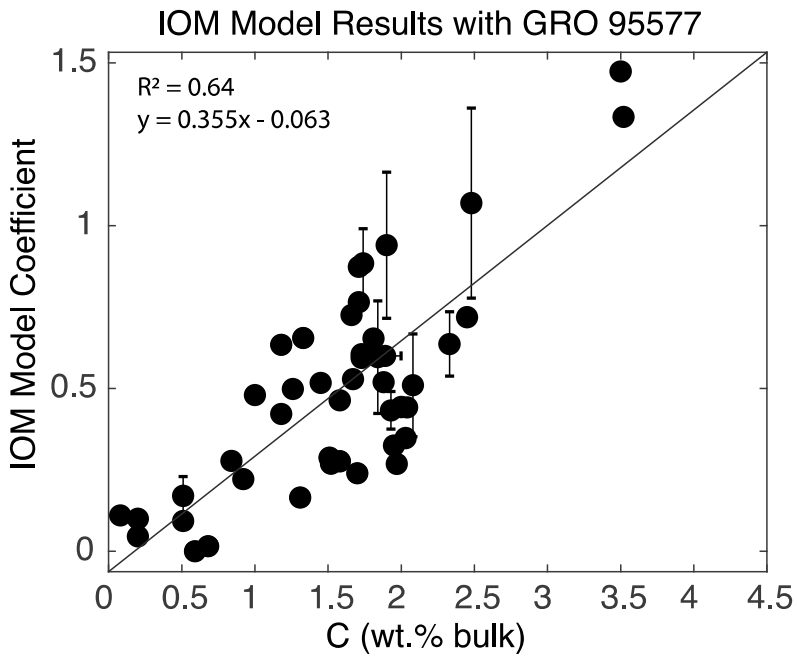
Chris Herd, *University of Alberta*

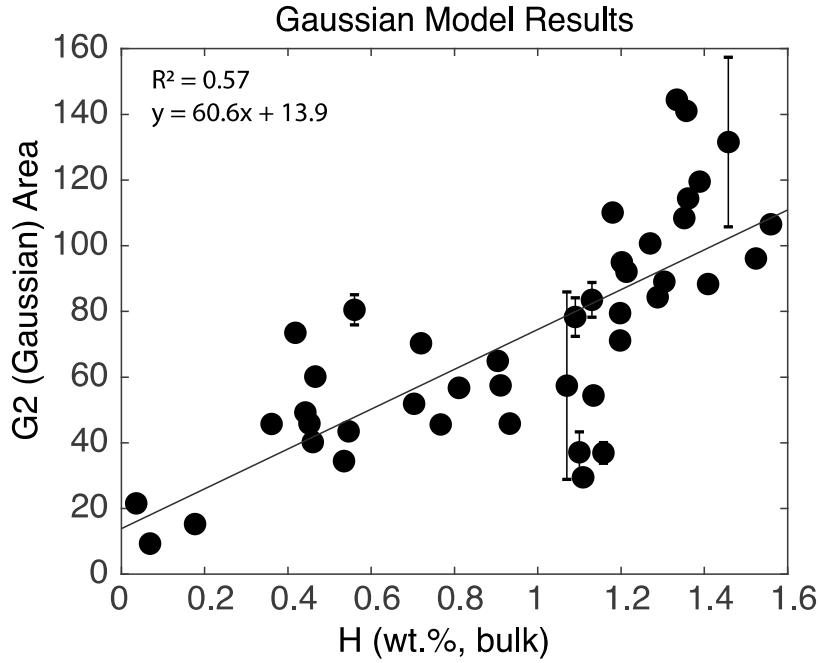
OSIRIS-REx Team

Laboratory Spectra of Meteorites

- A method for estimating organic abundance and hydration?
  - Particulate samples have adsorbed water that typically effects hydration estimates with the 3 micron band







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