Microspectroscopy of Meteorites: Search for Organic – Mineral Correlations

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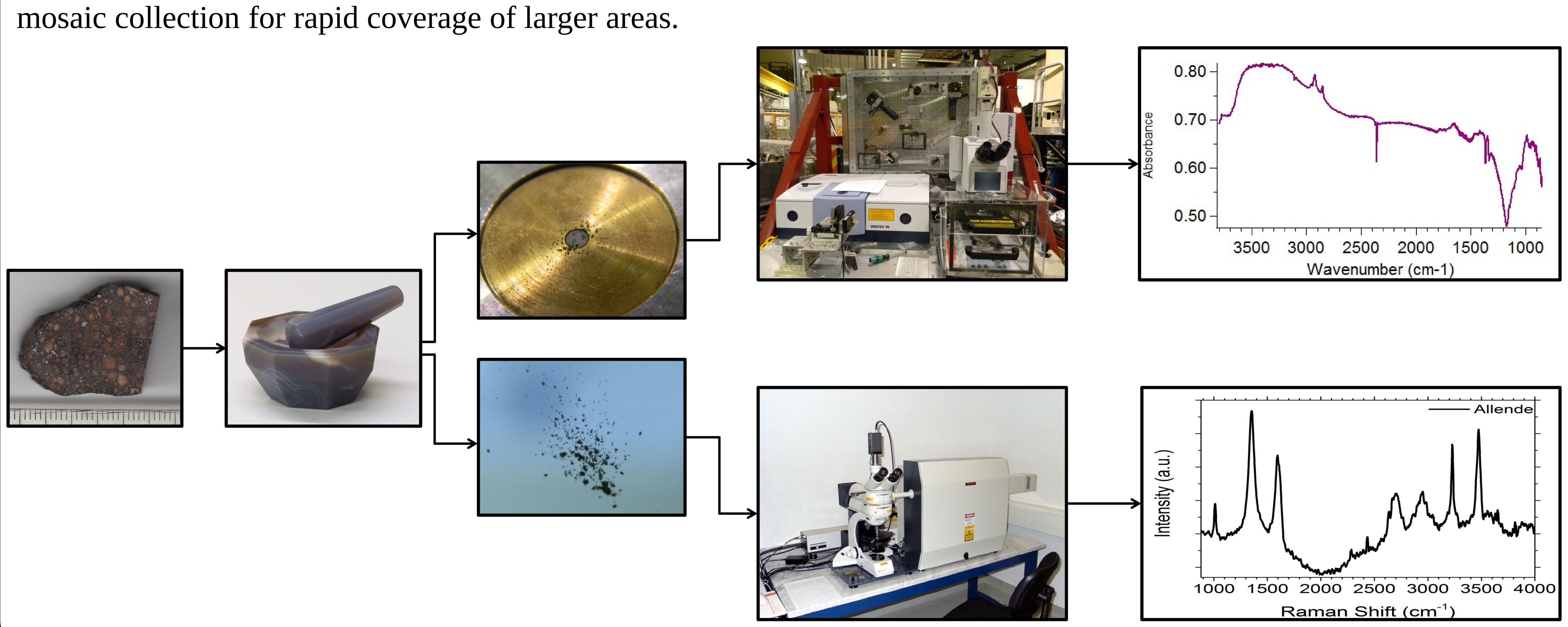
Introduction

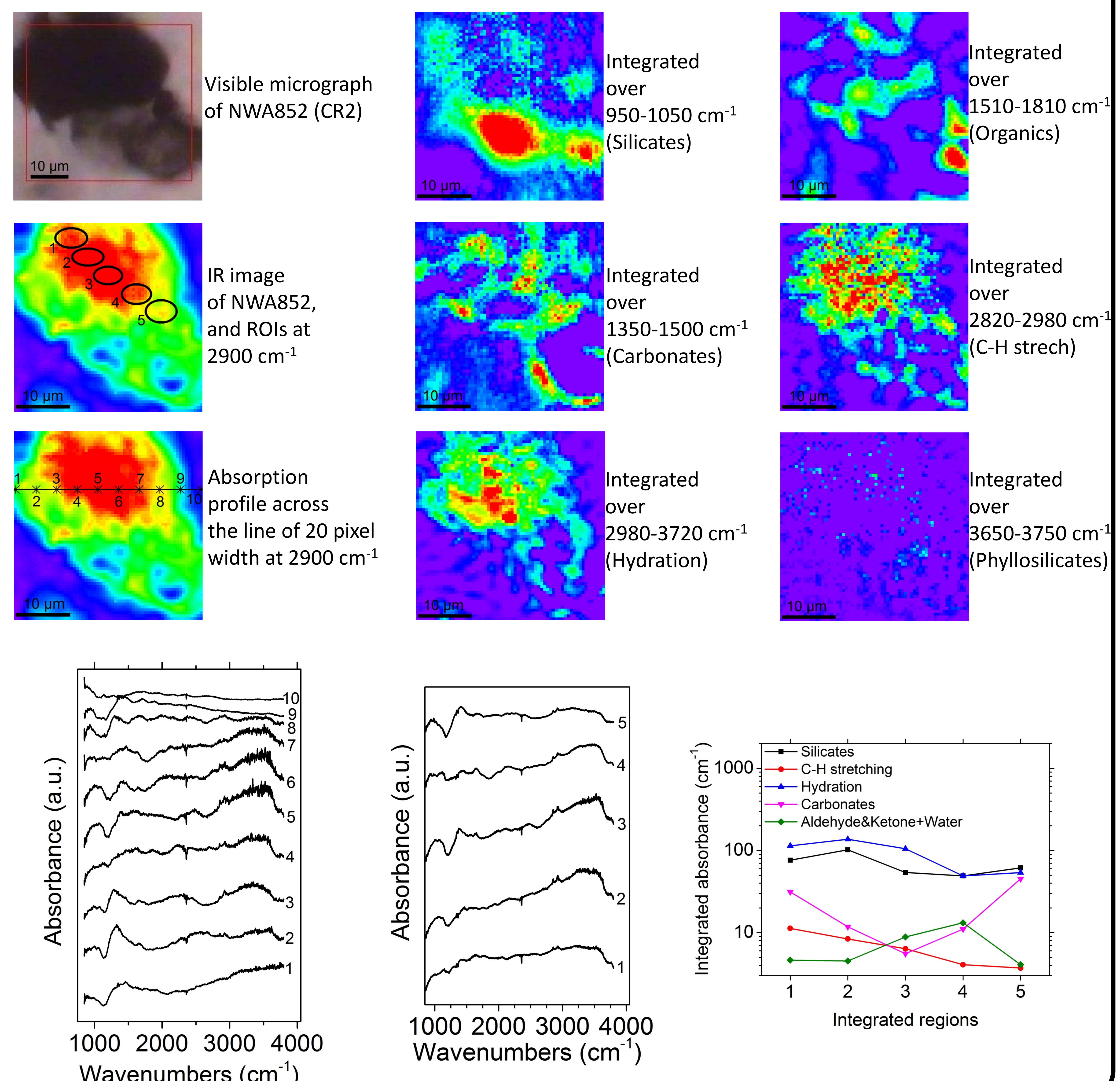
Organic molecules in meteorites can be created by catalytic reaction of C with simple precursors like H, O, N on individual ISM grains that coalesced to form meteorite source objects. The amount and type of such molecules created may depend on the mineral species. Little is known about the spatial distribution and mineralogical relationships of organic molecules in meteorites. The amount and type of such molecules may depend on the mineral species and processing, although correlation between organic compounds and specific minerals is poorly understood. Carbon has been identified preferentially at the surface of metal and troilite grains in ordinary chondrites [1]. Organic material was found in association with clays at least in CI and CM chondrites [2]. These preliminary studies support the hypothesis for at least partial processing of organic molecules among specific minerals in heterogeneous meteorites, which motivates this investigation.

Experiment

To investigate these hypothesis, we assessed correlations between concentrations of organic species and mineral species in meteorites. Infrared and Raman microspectroscopy are used to determine relative concentrations of specific minerals and physically associated organic compounds with micron spatial resolution. Mineral and organic components of meteorites are identified by infrared micro-spectroscopy with high spatial resolution, and the strengths of organic infrared absorption lines for individual meteorite grains are correlated with the oxide, carbonate, and hydration absorption bands of those grains. Meteorites are ground to fine powder with individual particle spectra measured simultaneously using the Infrared Environmental Imaging (IRENI) beamline at the Synchrotron Radiation Center (SRC) at University of Wisconsin-Madison. This achieves ~1 micron spatial resolution and 4 cm^{-1} spectral resolution over the spectral range 800-4000 cm^{-1} (2.5 – 12.5 μm). The experimental setup at SRC is comprised of a Bruker Vertex 70 spectrometer with a Bruker Hyperion infrared microscope and a Focal Plane Array (FPA) detector. The effective pixel size of 0.54 x 0.54 μm^2 allows spatial oversampling for all wavelengths, providing spatially resolved images that are diffraction-limited at all wavelengths. The single shot FPA image covers an area of up to ~50 × 50 μm^2 (96×96 pixels) in the transmission mode with automated mosaic collection for rapid coverage of larger areas.



Results



Discussion

Laboratory evidences suggest that certain minerals may be associated with, and play a role in the formation of, specific organic molecules. Such relationships seem likely in heterogeneous meteorites, for which mineral-organic correlations have been very little investigated to date. My experimental approach has unique capability to spectrally interrogate large areas at micron spatial resolution to identify and locate organic molecules and polymers simultaneously with the local mineralogy of the sample. Preliminary results suggest that, for NWA852 (CR2), silicate minerals may be correlated with hydrated minerals. Additionally, organics are not correlated with silicates, but may be associated with carbonates. Similar analysis will be performed on the micro-Raman spectra of meteorites.

References

1. Saikia B. J. and Parthasarathy G. (2009) *Goldschmidt Conf.,* Abstract #A1144
2. Pearson V. K. et al. (2002) *Meteoritics & Planet. Sci., 37,* 1829-1883

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