Multimodal Imaging of a Banded Iron Formation Sample

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Introduction

The usefulness of a multimodal imaging strategy to study complex geological and planetary samples was evaluated and barriers to its implementation were identified. Synchrotron-based XRF and microspectroscopy techniques along with benchtop Confocal Raman, FTIR and optical microscopies were used to study a single thin section obtained from the Temagami Algoma-type Banded Iron Formation (BIF) in Ontario, Ca.

Methods

Almost the entire thin section was imaged using IR microscopy at a resolution of 25 μm as a first step. Guided by this image, synchrotron XRF and absorption spectroscopy studies were conducted at the Submicron Resolution X-ray Spectroscopy (SRX) and Tender Energy X-ray Absorption Spectroscopy (TES) beamlines at the National Synchrotron Light Source II at Brookhaven National Laboratory. A combination of coarse (10 μm steps) and high-resolution (2 μm down to sub-μm steps) elemental maps were obtained at various incident beam energies. The maps were used to select locations for microbeam Fe, Ca and P XANES. We also collected Fe-XANES maps across a transition from a silica-rich to an iron-rich band. Confocal-Raman micro-spectroscopy was used to generate 3D images at 1 μm/pixel.

Results

By deploying a combination of techniques and fusing data it is possible to gain deeper insights into mineralogical, elemental and chemical properties down to sub-μm spatial scales (e.g., Fe and Ca XANES in combination with vibrational spectroscopy allows one to conclusively identify carbonate minerals). A major challenge in such multimodal analyses is the need to combine and align 2D and 3D data from different techniques each with their own spatial resolution and file format.

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