THE WORKBENCH FOR IMAGING SPECTROSCOPY EXPLORATION AND RESEARCH (WISER) - A CUSTOMIZABLE, EXTENDABLE VISUALIZATION AND ANALYSIS TOOL FOR IMAGING SPECTROSCOPY DATA. R. N. Greenberger[1], D. Pinkston[1], B. L. Ehlmann[1], D. R. Thompson[2], E. L. Scheller[1], S. Baker[1], A. Keebler[1], and B. Rasmussen[1], [1]California Institute of Technology, 1200 E. California Blvd., Pasadena, CA 91125 (rgreenbe@caltech.edu; wiser@caltech.edu), [2]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109.

Introduction: Imaging spectroscopy data [1] are becoming increasingly widespread in the earth, environmental, and planetary sciences [2], yet there are few tools available to facilitate visualization of these data, develop and share codebases for novel analytical approaches, or provide dataset access for students and the public at-large. The most widely used image processing software packages are designed to work with two dimensional datasets and cannot handle the third, spectral dimension of imaging spectroscopy data. Commercial imaging spectroscopy tools have burdensome licensing fees that hinder use in academic and research environments. Further complicating this problem is data volume, with some imaging spectroscopy datasets well into the terabyte range.

WISER Software: The Workbench for Imaging Spectroscopy Exploration and Research (WISER; http://wiser.caltech.edu) is a visualization and analysis tool aimed at addressing this capability gap (Fig. 1), making it both easy and free for researchers and students to explore imaging spectroscopy datasets and perform scientific analyses without license fees. Implemented in Python 3, and leveraging Python libraries used widely in scientific computing, WISER uses modern techniques to provide a user-friendly and responsive interface for exploring imaging spectroscopy data.

At its base, WISER has critical data visualization capabilities (Fig. 1), including display of context, main, and zoom windows; ability to display multiple images at the same time with an option to link the datasets; image contrast stretch (Fig. 2a); an interactive spectral plot window; support for spectral libraries and ASCII spectral files; and ability to draw, import, export, and calculate the mean of regions of interest (Fig. 2b). WISER currently supports .img and .tif/.tfw files and can display and go to geographic and projected coordinates.

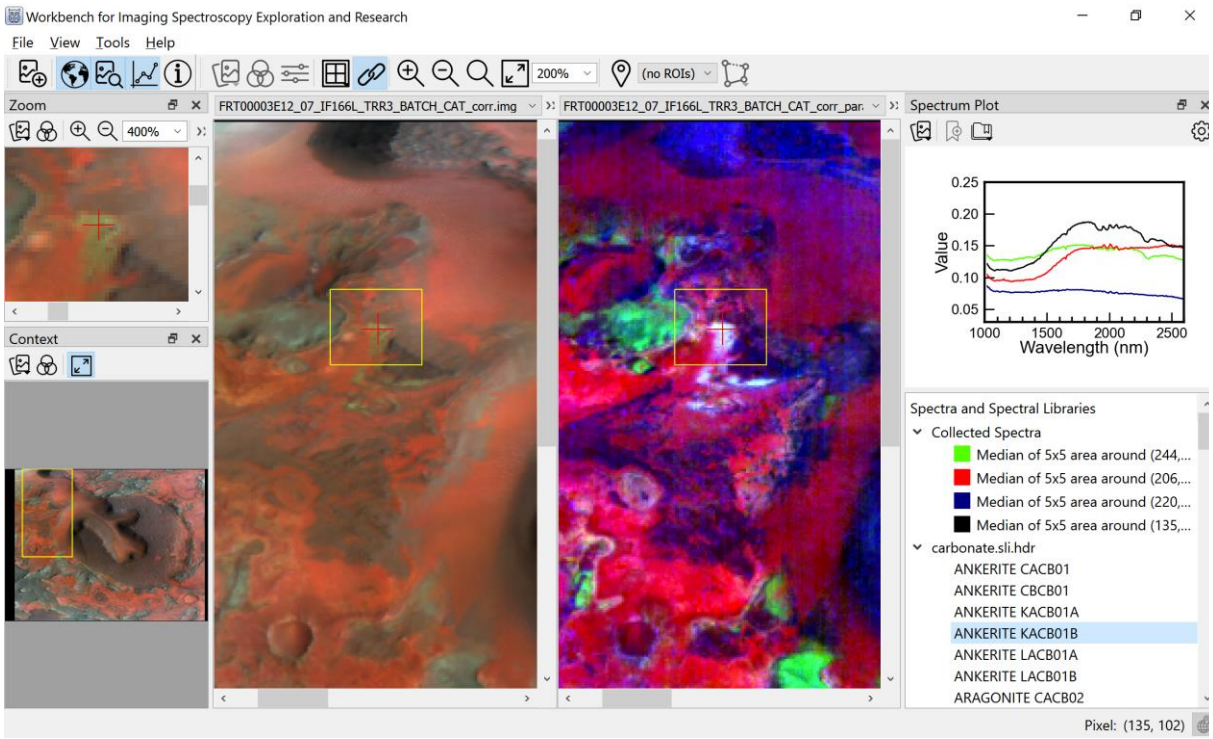

Fig. 1. Screenshot of WISER software showing two CRISM images (I/F data and a mineral parameter map) displayed in grid view and linked in the main pane, zoom and context windows, and several spectra that are 5x5 median averages collected. Note that the context, zoom, and plot window can be rearranged.

Over the last year, WISER gained several key capabilities, primarily focused on custom analysis tasks. WISER now supports user-implemented plugins for integrating custom processing, which may expose their own graphical workflows and user interactions through Qt5/PySide2 (e.g., Fig. 2c). A rich band-math capability is also provided, allowing users to generate and visualize computed results directly within the application. Currently supported operations include arithmetic, power/root, and comparisons/conditionals. The band-math support may also be extended with user-implemented functions that encapsulate more advanced computations.

In our own research, we have used WISER with a variety of datasets, including field/laboratory imaging spectroscopy data [e.g., 3], MRO/CRISM data, AVIRIS/AVIRIS-ng, and Landsat datasets, and we plan to use WISER for analysis of Mars-2020 Mastcam-Z multispectral imager data, and upcoming EMIT Earth imaging spectrometer data and Lunar Trailblazer imaging spectrometer and multispectral imager datasets. Other multispectral or hyperspectral datasets with .img or .tif formats will work in WISER.

Future enhancements: We will continue to build and support WISER. Future feature enhancements include the ability to project images, not just view/go to coordinates for images with available projection information, geographic image linking, image mosaicking, and band math operation optimization for large images. We also will build open source plug-ins with basic image processing analyses such as principal component analysis and spectral angle mapper.

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References: [1] Goetz, A. F. et al. (1985), *Science, 228*, 1147-1153 [2] Thompson, D. R. and Brodrick, P.G. (2021), *Eos, 102* [3] Greenberger et al., 2020, *JGR Solid Earth, 126*, e2021JB021976.

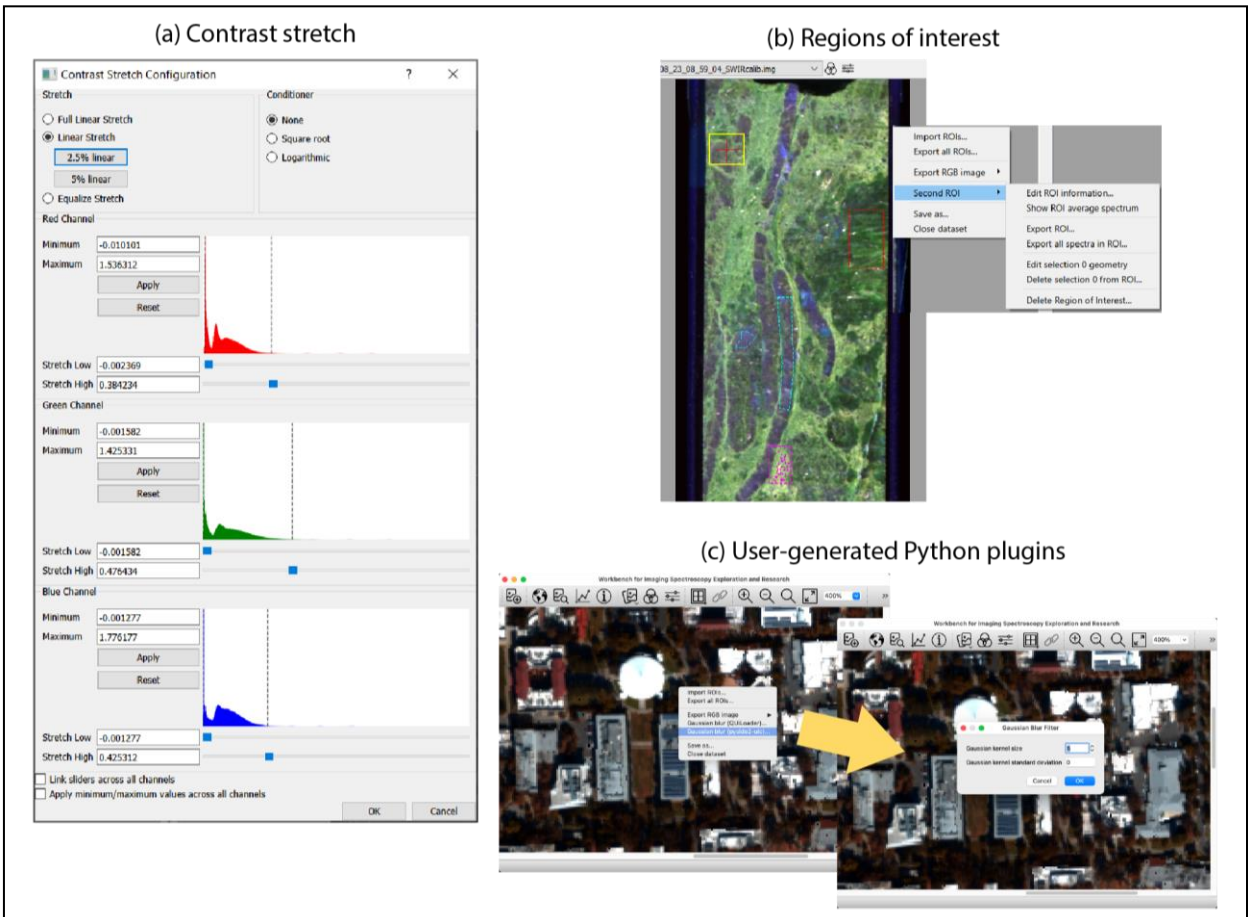

Fig. 2. Example features in WISER demonstrated with microimaging spectroscopy from the Oman drill core [3] and AVIRIS-ng data. (a) Contrast stretch enhancement options, including manual and automatic stretches. (b) Regions of interest, which can be free-form polygons, rectangles, and/or points. The mean of the regions of interest can be calculated and displayed in the plot window. (c) Any plugin can be written in Python and exposed within WISER.