THE WORKBENCH FOR IMAGING SPECTROSCOPY EXPLORATION AND RESEARCH (WISER) - A CUSTOMIZABLE, EXTENDABLE VISUALIZATION AND ANALYSIS TOOL FOR IMAGING SPECTROSCOPY DATA.

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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.

WISER Software: The Workbench for Imaging Spectroscopy Exploration and Research (WISER; https://ehlmann.caltech.edu/wiser/) 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 do 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 of polygon shapes or individually selected pixels (Fig. 2b). WISER currently opens .img and .tif/.tfw files and can display and go to geographic and projected coordinates.

WISER supports user-implemented plugins for integrating custom processing, which may expose their own graphical workflows and user interactions through

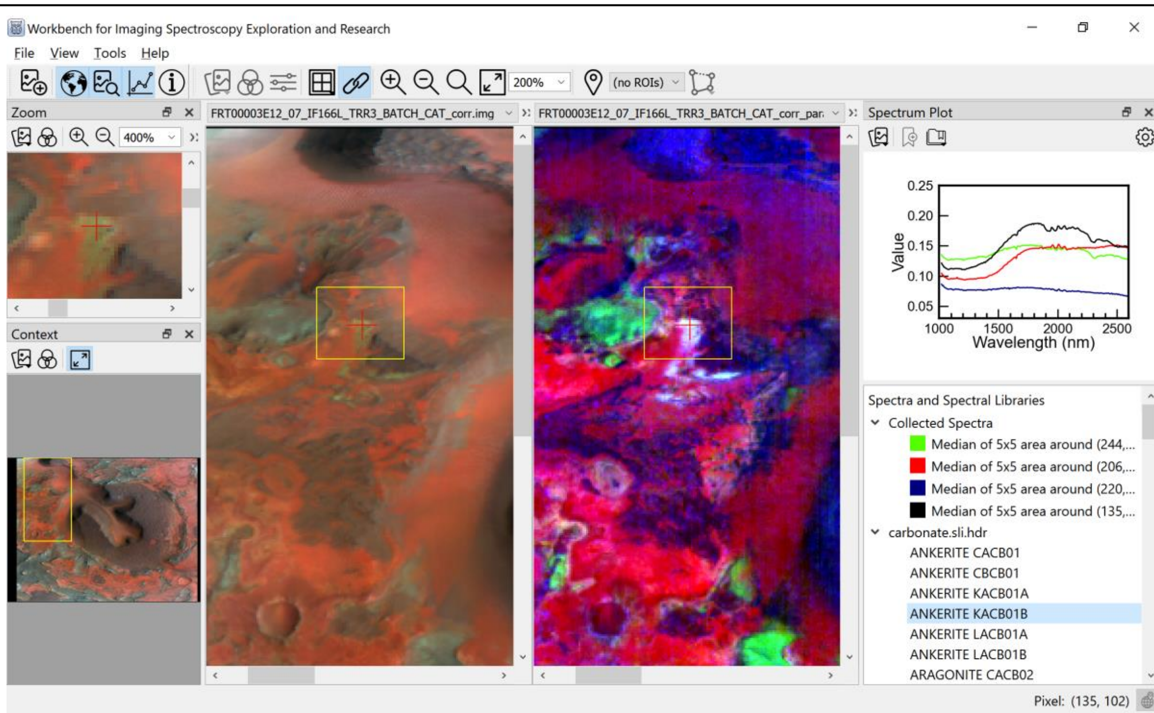

Fig. 1. Screenshot of WISER software showing two CRISM images (I/F data and a mineral parameter map) displayed in grid view and linked in the main pane, zoom and context windows, and several spectra that are 5x5 median averages collected. Note that the context, zoom, and plot window can be rearranged.

Qt5/PySide2 (e.g., Fig. 2c). A rich band-math capability is also provided, allowing users to generate and visualize computed results directly within WISER.

Over the last year, we have continued to fix bugs and provide feature enhancements within WISER, including the ability to lock the pane from which WISER displays spectra when multiple images are linked in grid view (critical when displaying, for example, a spectral image and corresponding parameter map) and improved the functionality of the math toolkit. We are also building our own plugins while simultaneously troubleshooting the plugin mechanism and improving the documentation. Plugins developed or in progress include continuum removal of individual spectra and images (Fig. 2c), decorrelation stretch, layer stacking, 2D scatterplots, principal component analysis, independent component analysis, minimum noise fraction transforms, linear unmixing, and matched filter.

In our own research, we have used WISER with a variety of datasets, including field/laboratory imaging spectroscopy data [e.g., 3, Fig. 2c], 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, EMIT Earth imaging spectrometer data, and the upcoming 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, mosaicking, and band math optimization for large images. We also will build and release additional open source plugins.

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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. [4] Mueller et al., this meeting.

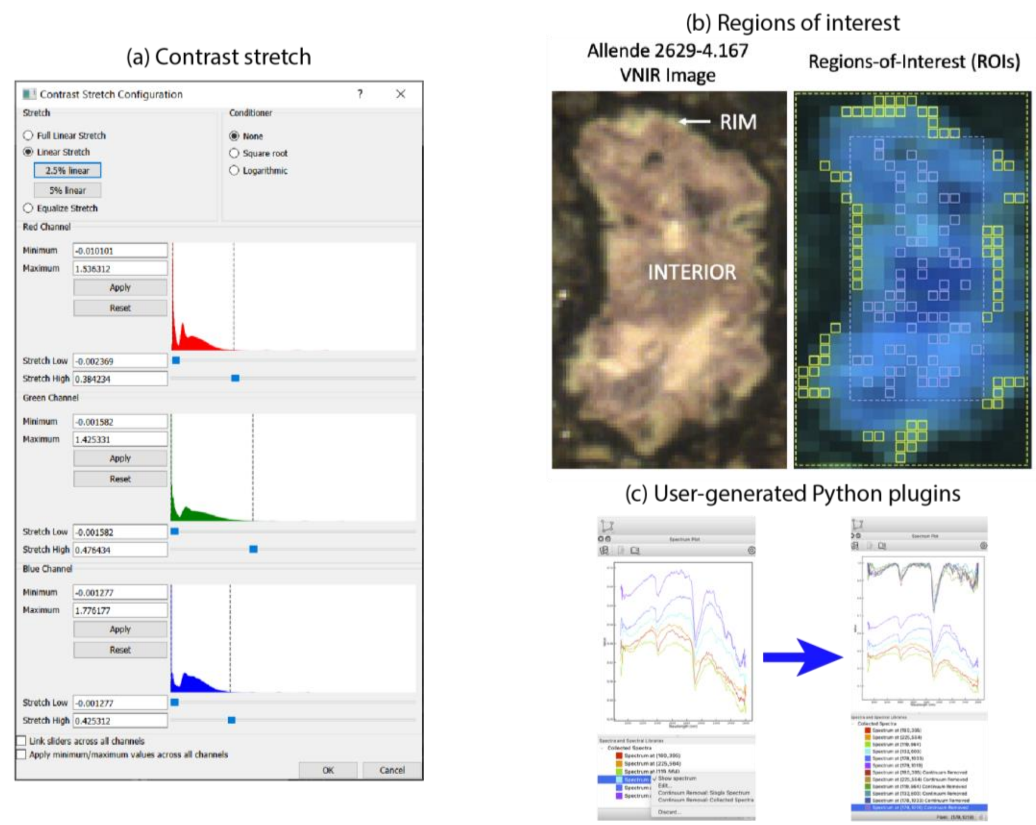

Fig. 2. Example features in WISER demonstrated with microimaging spectroscopy of a calcium aluminum inclusion in a meteorite [4] and miscellaneous spectra. (a) Contrast stretch enhancement options, including manual and automatic stretches. (b) Regions of interest (free-form polygons, rectangles, and/or points) [4]. Mean of regions of interest can be calculated and displayed. (c) Any plugin can be written in Python and exposed within WISER (in this example, a continuum removal plugin).