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Design and Potential of a Compact Low Cost Reflectance Spectrometer and Fluorimeter

Leafia Sheraden Cox[1,2,*], Alex H. Parker[3], Alejandro Soto[3], Kevin W. Lewis[4], Marcella Roth[4]
[1]Wellesley College, Wellesley, MA [2]UNAVCO RESESS [3]Southwest Research Institute, Department of Space Studies, Boulder, CO
[4]Johns Hopkins University, Department of Earth and Planetary Sciences, Baltimore, MD

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Goal

To design, build, and test an instrument capable of measuring and analyzing fluorescence of a lunar analog sample using consumer off-the-shelf products.

The instrument must be inexpensive, open-source, compact, fast and easy to use.

Instrument

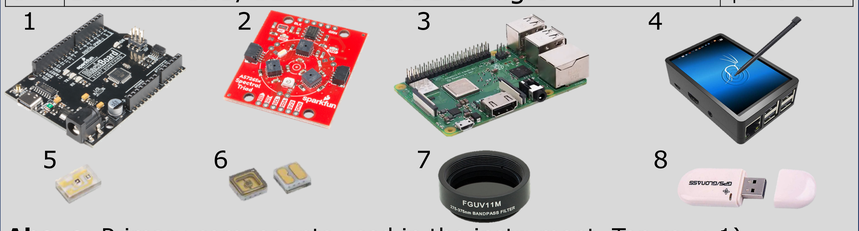
Above, left: Fully assembled instrument. Left unit includes data acquisition computer, battery, and GPS module; right unit contains sensor, microcontroller, and illumination sources. OLF8 sample at center.

Above, right: Detail image of sensor head.

360º Images

https://qrco.de/FL1MG5

	Instrument Components	Cost
1	SparkFun Blackboard C	$14.95
2	SparkFun Triad Spectroscopy Sensor	$64.95
3	Raspberry Pi 3 B+	$35.00
4	3.5 inch Touchscreen LCD for Raspberry Pi	$29.99
5	Mouser 365 nm UV-A LED	$3.30
6	Mouser 270 nm UV-C LED	$37.80
7	275-375nm Bandpass UV Filter	$92.72
8	DIYMall GPS/GLONASS USB Dongle	$13.49



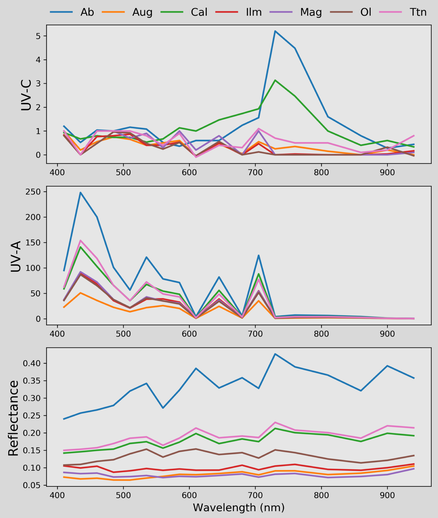
Above: Primary components used in the instrument. Top row: 1) SparkFun Blackboard C, 2) SparkFun Triad Spectroscopy Sensor, Raspberry Pi 3 B+. Bottom row: 4) 3.5 inch Touchscreen for Raspberry Pi, 5) Mouser 365 nm UV-A LED, 6) Mouser 270 nm UV-C LED, 7) 275-375nm Bandpass UV Filter, 8) DIYMall GPS/GLONASS USB Dongle.

Library and Classifier

Samples representing 34 mineral classes were selected from the Denver Museum of Nature and Science's mineral collection.

A chi-square minimization model was implemented to predict each minerals fractional composition in a given sample.

Right: Illustration of reflectance and fluorescence spectra from seven common rock forming minerals relevant to the Palisades Sill.



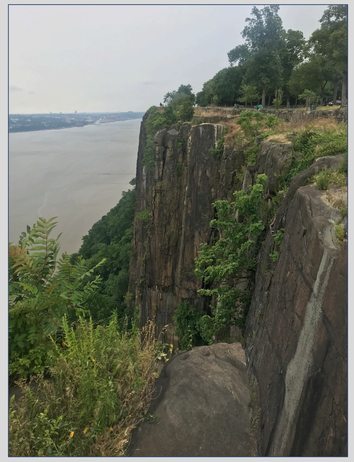
Case Study: New Jersey

The Palisades Sill in Fort Lee, NJ is considered a terrestrial lunar analog due to its composition and formation history. The sill is a diabase intrusion dated to the Jurassic/Triassic.[6]

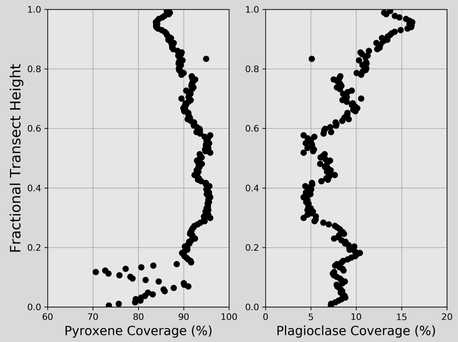
It is composed primarily of pyroxenes, plagioclases, and olivine, with a number of well-documented accessory minerals.

We conducted a complete transect of the Alpine section, consisting of 95 measurement sites horizontally separated by 25 ft.

These measurements were compared to literature compositional trends to determine if the instrument delivers reliable geochemical information[4].



Above: Image of the Palisades Sill looking South from the State Line Lookout. Transects covered the full vertical extent of the sill.



Left: Composition trends recovered from Alpine transect data. Model includes Augite, Albite, and Magnetite. Data combined with a 20-sample moving average before being fit with model.

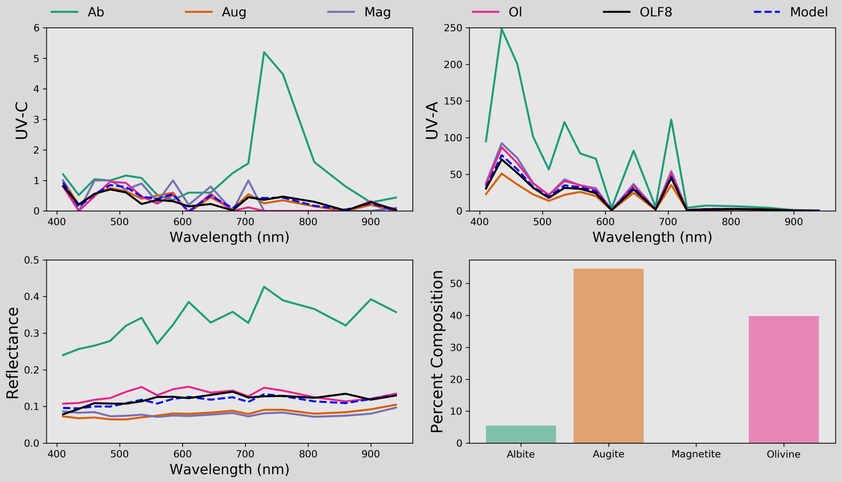
Performance

Sequential illumination from UV-C LED, UV-A LED and a white light source. Spectra were measured in 18 channels between 410nm and 940nm (20 nm FWHM). Measurement in <3 sec.

At current maximum exposure time, UV-C counts are relatively low, requiring averaging of several measurements.

Pure mineral measurements showed strong diagnostic features (e.g., strong 750 nm UV-C fluorescence of plagioclases) in minerals relevant to our field site and future lunar applications.

Preliminary composition trends recovered from Palisades Sill qualitatively similar to published trends[4].



Above: Averaged spectra of 150 measurements of hand sample OLF8 from below the olivine zone. Fluorescence is represented as in raw counts, while reflectance is calibrated based on an 18% gray card. Model-inferred composition are displayed in bar chart on lower right panel.

Potential Applications and Future Work

Instrument shows promise for measuring abundances of common lunar minerals.[7]

New power circuit can improve UV-C illumination.

Mineral database can be expanded to include extraterrestrial samples.

Instrument may also have applications in low-cost water quality assessment and environmental testing.

SwRI Southwest Research Institute · Wellesley · Project Espresso · RESESS · SERVI · Johns Hopkins University

References

https://qrco.de/R3F5

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