Characterizing emissivity spectra from geomorphic surfaces along the southern San Andreas Fault

Poster #085

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I. Abstract

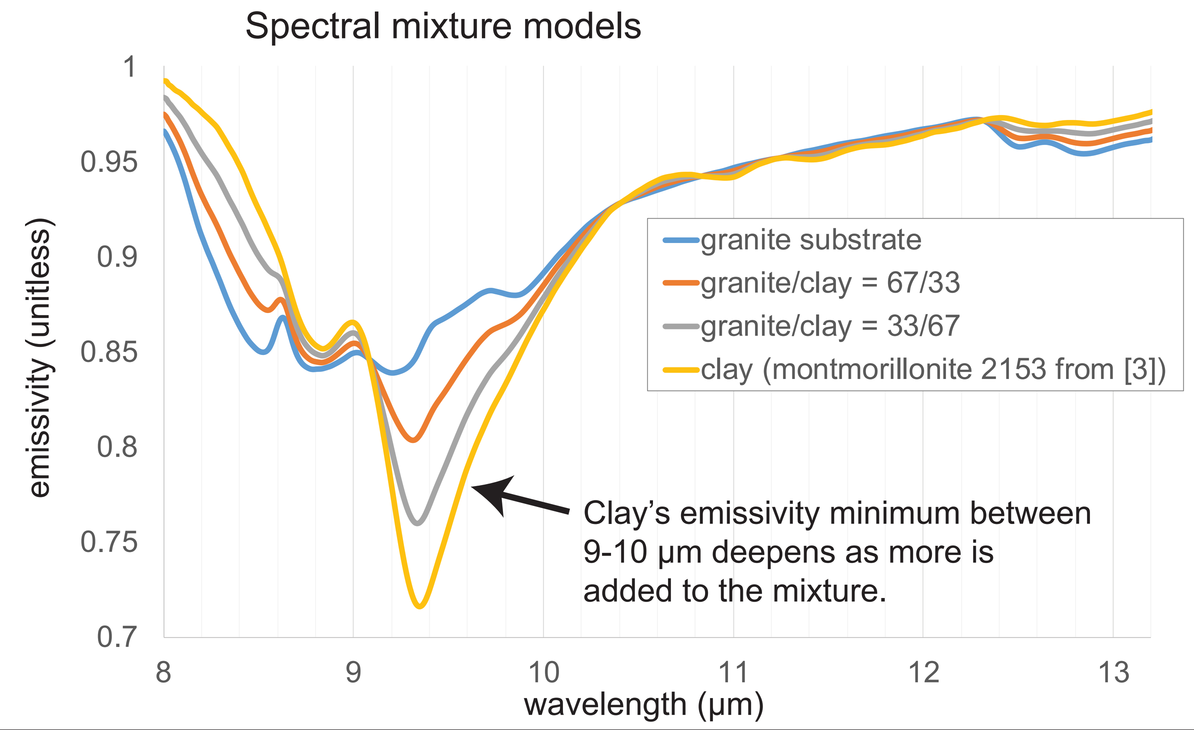
Geologic mapping and cosmogenic exposure ages of alluvial surfaces along the southern San Andreas Fault provide independent data sets to evaluate corresponding emissivity spectra from thermal hyperspectral airborne imagery. We use new 1-m pixel resolution data from 2015 covering the Mission Creek strand between Thousand Palms Oasis and Pushawalla Canyon, where a set of alluvial surfaces are progressively offset by the fault. After converting the image data from at-sensor radiance to emissivity, we examined spectra from each of four dated surfaces that span ~10 to 90 ka (Blisniuk and Sharp, 2014). This comparison reveals that the magnitude of an absorption feature located between 9-10 micron wavelengths generally increases with age of the surface. We hypothesize that the depth of this absorption feature varies by exposure age as clay minerals accumulate in coatings of desert varnish on the surface. Lab spectra for clays commonly found in desert varnish (e.g. illite and montmorillonite) show a significant absorption feature between 9-10 micron wavelengths caused by vibrational stretching in the silicon-oxygen tetrahedra that comprise the crystal lattice. In combination, these results suggest that as these geomorphic surfaces alter with age, accretion of desert varnish results in a greater contribution to the spectrum for each pixel. Using varnish development as an age proxy for relative dating is common in the literature but results have generally been inconclusive or difficult to apply more broadly due to regional and temporal changes in surface development. We plan to further analyze the emissivity spectra at specific sites to determine whether the observed spectral absorption feature behaves consistently or if sampling strategies alter the results. If the preliminary observations are robust, this technique may provide a tool for expanding existing age data, or reconnaissance evaluation of surface ages in arid locales that are conducive to varnish development, facilitating slip rate studies and guiding dating efforts for these surfaces.

II. Introduction

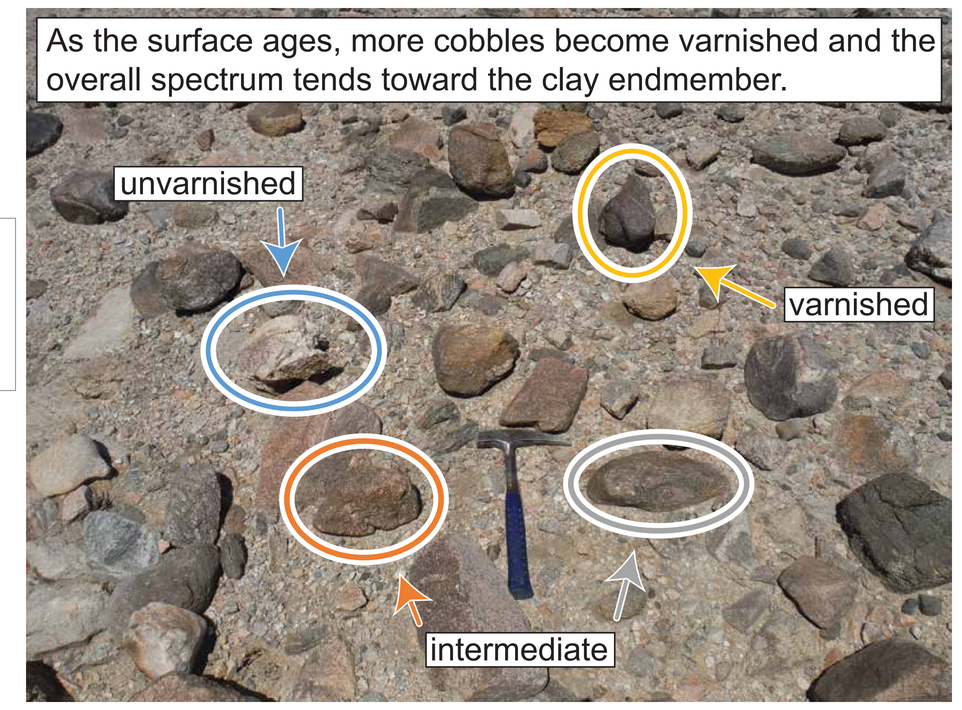
•Accretion of desert varnish is time-dependent; thus we propose using remote sensing methods to track continuous varnish development in a series of independently dated [1] geomorphic surfaces.

•Montmorillonite clay is often the main constituent in varnish [2]. Based on a mixture model (see plot to right), we hypothesize that as surfaces age, the relative abundance of varnish will increase and the clay's emissivity minimum between 9-10 μm will deepen.

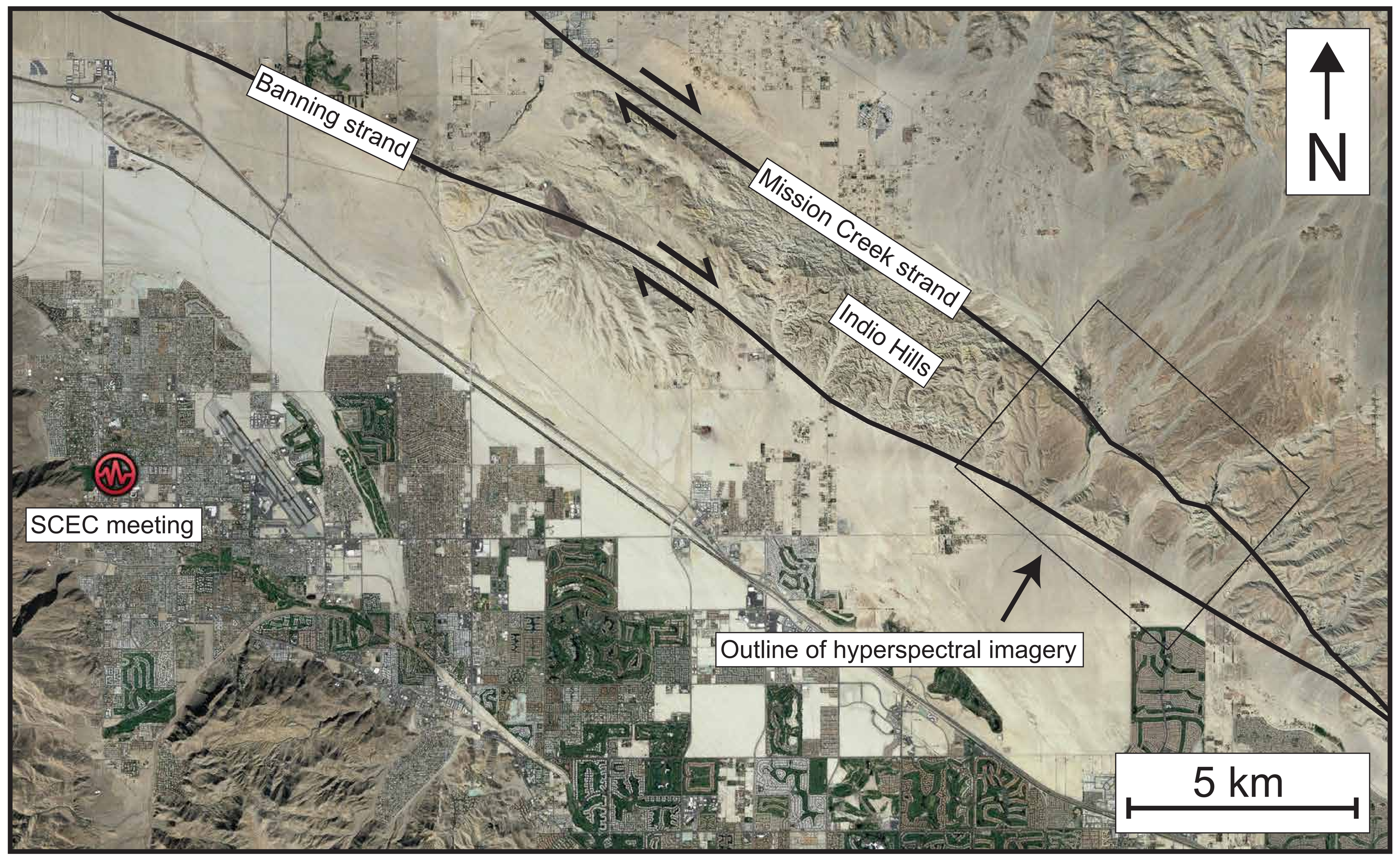
•In thermal hyperspectral airborne imagery, emissivity spectra for 1-m pixels represent mixtures of cobbles with varying degrees of varnish, so we use the depth of the clay feature as a proxy for surface age.



As the surface ages, more cobbles become varnished and the overall spectrum tends toward the clay endmember.

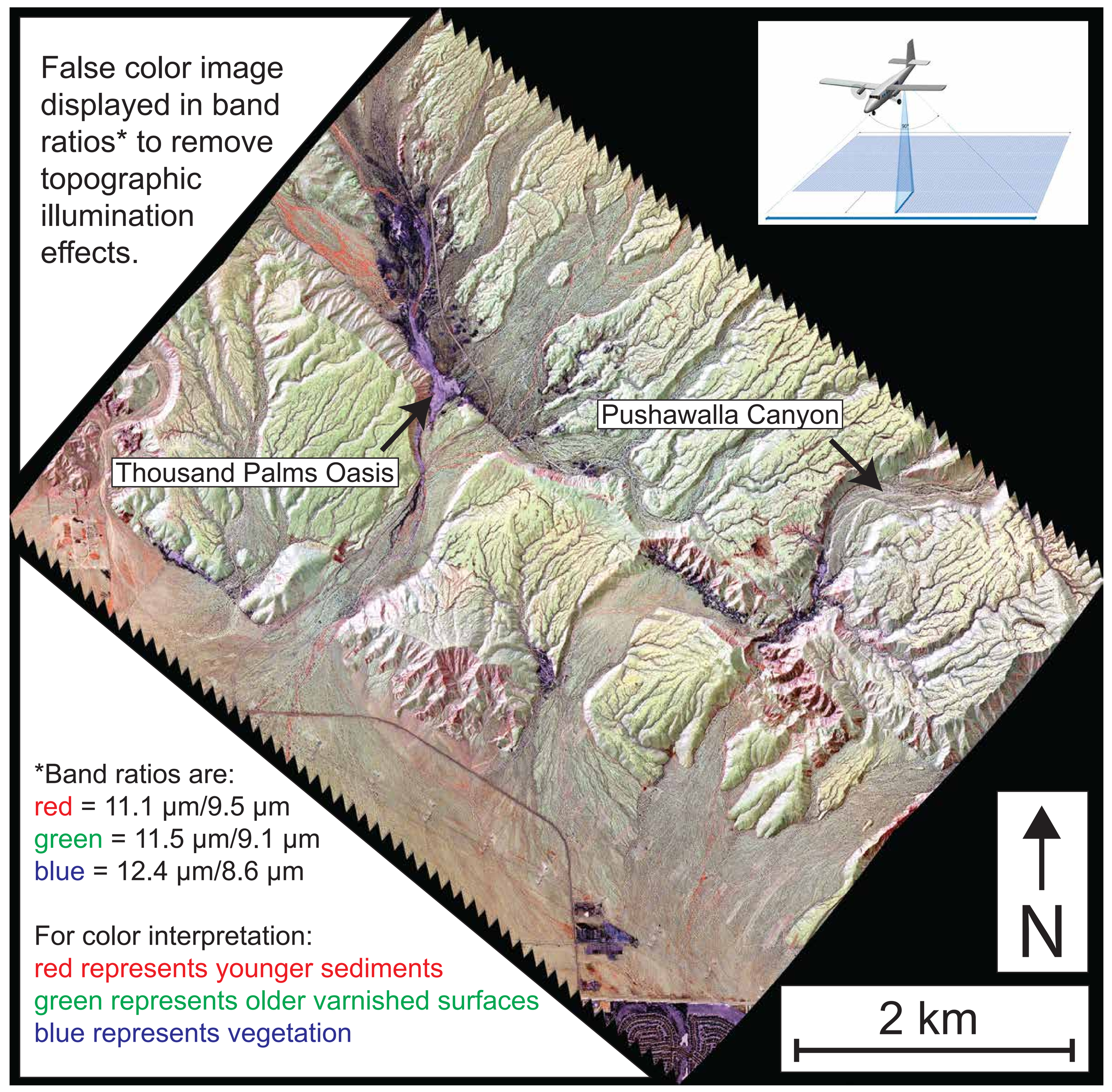


III. Study area: Coachella Valley, CA



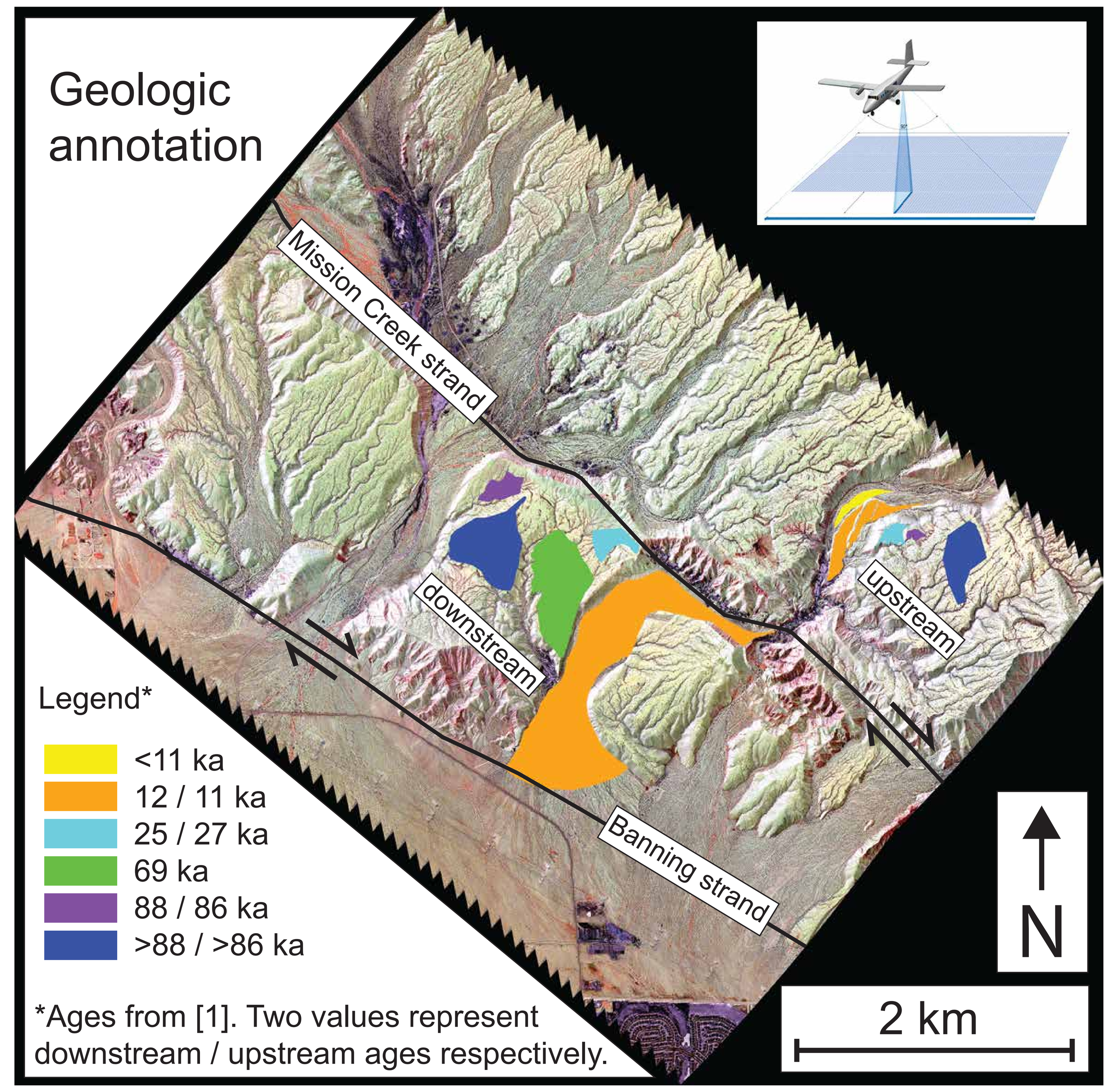
*Google Earth Imagery

IV. Mako thermal hyperspectral airborne imagery (09/24/2015)



*Band ratios are:
red = 11.1 μm/9.5 μm
green = 11.5 μm/9.1 μm
blue = 12.4 μm/8.6 μm

For color interpretation:
red represents younger sediments
green represents older varnished surfaces
blue represents vegetation

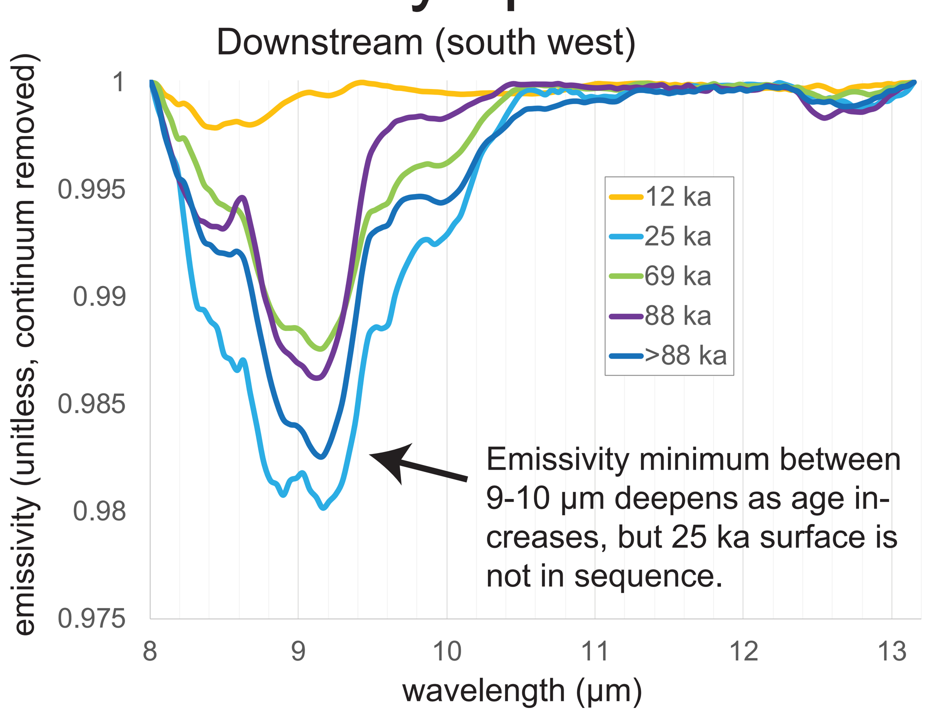


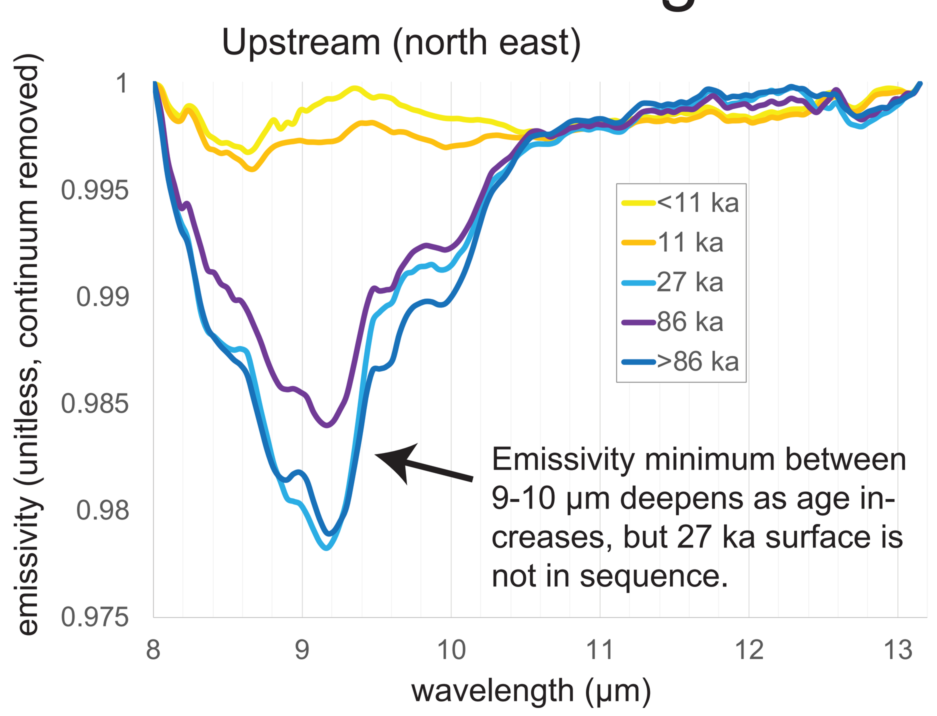
Legend*

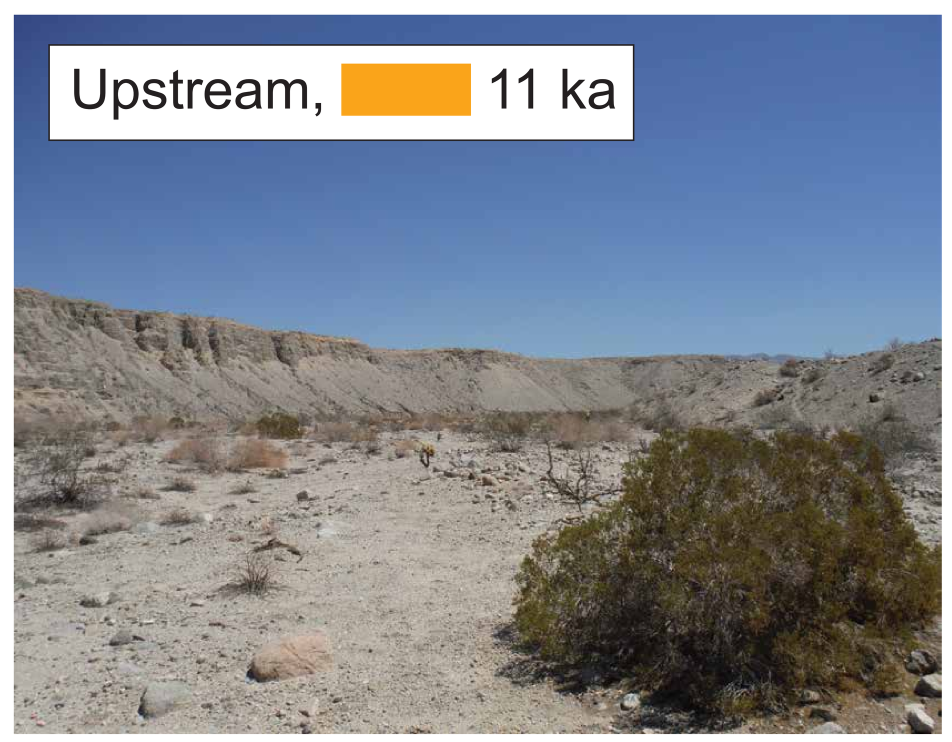
- <11 ka
- 12 / 11 ka
- 25 / 27 ka
- 69 ka
- 88 / 86 ka
- >88 / >86 ka

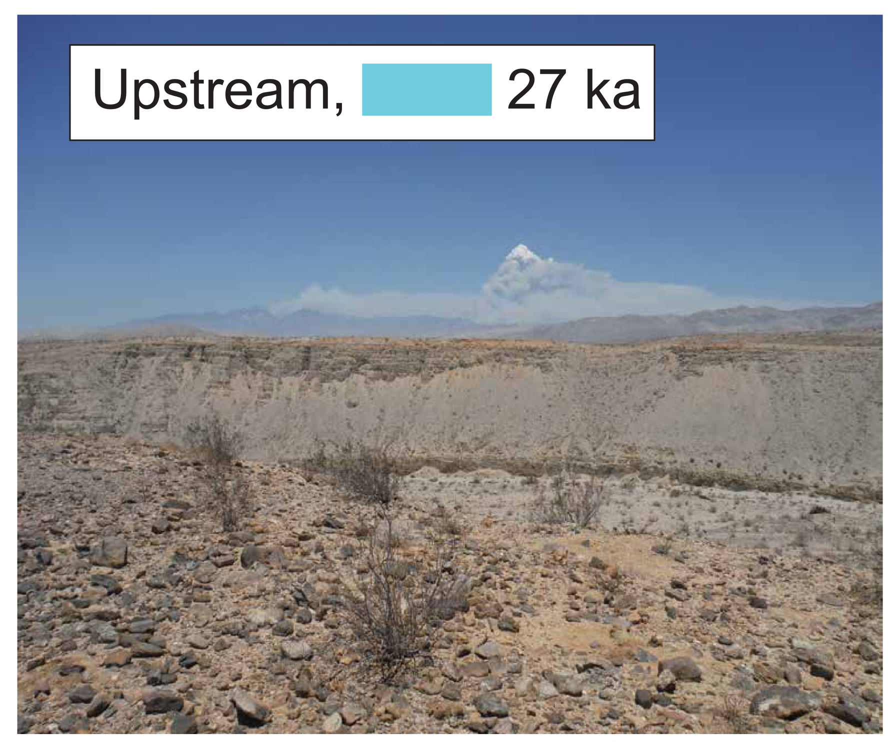
*Ages from [1]. Two values represent downstream / upstream ages respectively.

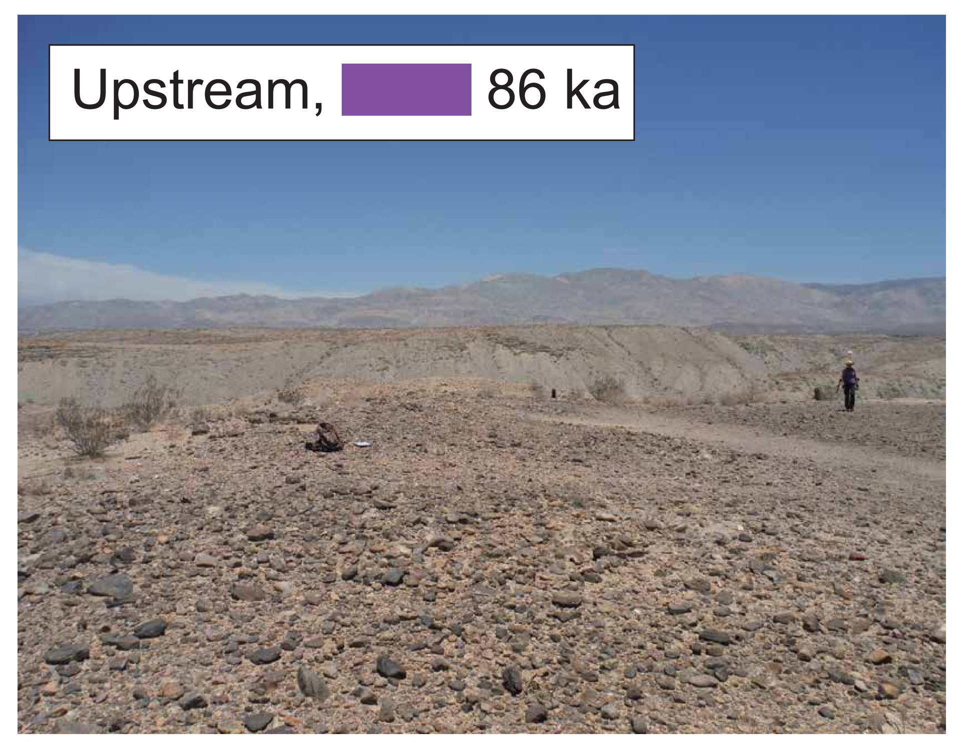
V. Emissivity spectra and demonstrative field images











Smoke cloud is from the Lake Fire of San Bernardino County, 06/25/2015.

VI. Conclusions

•Using thermal hyperspectral airborne imagery has allowed us to characterize geomorphic surfaces by considering clay content in variable desert varnish coatings.

•The depth of the clay-in-desert-varnish spectral feature generally increases with age of surface.

•The clay's spectral feature for the 25 ka and 27 ka surfaces are not in sequence with the overall time series. Do these ages represent maximum varnish accumulation potential? We will try to understand why these surfaces do not fit into the general sequence.

VII. Acknowledgments

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VIII. References

[1] Blisniuk, K., and Sharp, W.D., 2014, Estimating geologic slip rates on the southern San Andreas Fault, California: U-series and ^{10}Be dating: U.S. Geological Survey Final Technical Report for USGS Award No. G13AP00031, 9 p.

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