Remote Sensing Aqueous Surface Processes on Planets Red and Blue: From Chemical Weathering Mineralogy on Mars to Water Temperature in Alaska's Riverine Corridors

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ABSTRACT

Ever since satellites were first launched into space in the 1950s, they have been utilized for critical science on Earth and eventually, around other planets as well. In Chapters 2 and 3, we use hyperspectral imagery and other remotely sensed data to examine the formation of aluminum phyllosilicate on Mars. Al-phyllosilicates across Mars have been proposed to have formed from extensive water leaching of basalt, though regional-specific studies suggest diversity between Al-phyllosilicate-bearing regions. Considering this complexity, in Chapter 2, we reexamine Al-phyllosilicate and its associated minerals in the Nili Fossae region. Using hyperspectral imagery from the CRISM instrument, we used Gaussian fitting to automatically identify and map Al-phyllosilicate and its associated minerals. We find that in contrast to prior interpretations, the Al-phyllosilicate in Nili Fossae most likely formed from weathering of an aluminous volcanic ash rather than from extensive leaching of basalt. In Chapter 3, we expand this analysis to a global survey of 6 Al-phyllosilicate-bearing regions on Mars. We examine the composition and stratigraphy of each region to determine their weathering histories, and we compare the regions to place them in a global context. We find that most of the Al-phyllosilicate on Mars is more consistent with volcanic ash alteration rather than extensive basalt leaching, though some regions are more consistent with basalt leaching. We conclude that the Al-phyllosilicate on Mars did not all form from one process, and our results demonstrate the potential for less extensive alteration and more widespread ash-producing volcanism in Mars' history than previously thought. In addition to composition, remotely sensed data can also be used to measure temperature. In Chapter 4, we use surface temperature derived from Landsat satellite data to examine the spatial and seasonal patterns of river temperature in Arctic rivers and their surrounding floodplains. Water temperature in the Arctic is interwoven with numerous environmental processes and is responding rapidly to the changing climate, but it is poorly monitored. We demonstrate that the Landsat temperature dataset is accurate for application to Arctic river environments, and we generate and examine water temperature maps of the Yukon River watershed. With these, we show that satellite-based temperature measurements can and should be used to address critical environmental questions in this region.

PUBLISHED CONTENT AND CONTRIBUTIONS

Baker, S.R. and Ehlmann, B.L. (in review). "Aluminum phyllosilicate and jarosite formation through alteration of reworked Al/Si-rich volcaniclastic sediments in Nili Fossae, Mars". In: *Journal of Geophysical Research: Planets.*

S.R.B participated in the conception of the project, developed methodology to map minerals, analyzed the spectral and stratigraphic data, prepared figures, and participated in the writing of the manuscript.

- *Adapted for the contents of Chapter 2*

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S.R.B participated in the conception of the project, generated water temperature maps, analyzed the remote sensing and in situ data, prepared figures, and participated in the writing of the manuscript.

- *Adapted for the contents of Chapter 4*

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LIST OF ACRONYMS

ASTER. Advanced Spaceborne Thermal Emission and Reflectance Radiometer

CRISM. Compact Reconnaissance Imaging Spectrometer for Mars

CTX. Context Camera

DEM. Digital elevation model

EVI. Enhanced vegetation index

HiRISE. High Resolution Imaging Science Experiment.

LST. Land Surface Temperature.

mNDWI. Modified normalized difference water index

MOLA. Mars Orbital Laser Altimeter

MTRDR. Map projected targeted reduced data record

NDVI. Normalized difference vegetation index

OMEGA. Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité

USGS. United States Geological Survey

VNIR. Visible–near-infrared