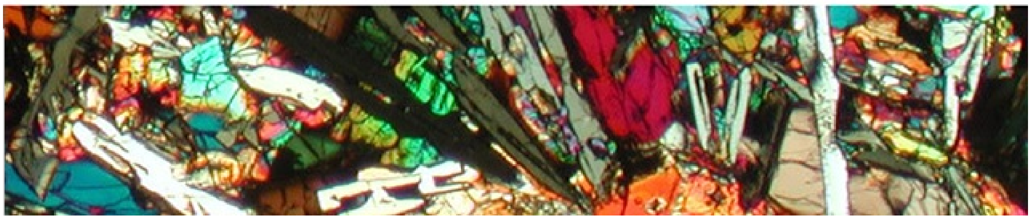
Studying signatures of water on Mars at two macro and micro scales: orbital analyses of hillslope geomorphology and ChemCam calibration for surficial rock chemistry



Studying signatures of water on Mars at two macro and micro scales : orbital analyses of hillslope geomorphology and ChemCam calibration for surficial rock chemistry

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Abstract

Questions about the presence, amount, and nature of liquid water on Mars remain major research topics in planetary science because of the implications they have for the geological history and potential habitability of the planet. Here, the signatures of liquid water on Mars are studied at two scales from two different disciplines: hillslope geomorphology and chemistry from laser-induced breakdown spectroscopy (LIBS). In the first set of studies on hillslopes, the expected differences in hillslope processes in extraterrestrial environments are explored. As on Earth, the major drivers of these processes are gravity and climate. Extraterrestrial hillslopes are unique environments that may be similar, but not identical, to hillslopes found on Earth, and care must be taken to understand how differences in hillslope parameters on these bodies may lead to changes in familiar processes and potentially form. Next, a study testing a debris flow initiation hypothesis for martian gullies was performed. Measurements of the contributing areas and slope gradients were made at the channel heads of martian gullies seen in three high resolution image stereo pairs. Our results show an area-slope relationship for these martian gullies that is consistent with that observed for terrestrial gullies formed by debris flow, supporting the hypothesis that these gullies formed as the result of saturation of near-surface regolith by a liquid. In the second set of studies, carbonate minerals and rock coatings and rinds were measured by LIBS in a simulated martian environment to better understand the signature of these materials on Mars. This work is in preparation for the Mars Science Laboratory (MSL) rover mission, in which a LIBS instrument will be part of the ChemCam suite of instruments on the rover. In the carbonate study, both chemical composition and rock type are determined using multivariate analysis (MVA) techniques. Composition is confirmed using scanning electron microscopy (SEM). Our results show that ChemCam can recognize and differentiate between different types of carbonate materials on Mars. In the weathered rock study, depth profile data are analyzed using principal component analysis (PCA) and coatings and rinds are examined using SEM and electron probe microanalysis (EPMA). Our results show that LIBS is sensitive to minor compositional changes with depth and correctly identifies rock type even if the series of laser pulses does not penetrate to unweathered material.

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