Analysis of Surface Materials by the Curiosity Mars Rover

INTRODUCTION

Over the first 100 sols of the mission, the ChemCam instrument returned >10,000 laser-induced breakdown spectra, helping to characterize surface material diversity. ChemCam’s laser acts effectively as a microprobe, distinguishing between fine soil grains and coarser ~1-mm grains. Based on these data, Meslin et al. report that the coarse soil fraction contains felsic (Si- and Al-rich) grains, mimicking the composition of larger felsic rock fragments found during the traverse and showing that these larger components probably break apart to form part of the soil. In contrast, the fine-grained soil component is mafic, similar to soils observed by the Pathfinder and Mars Exploration Rover missions.

Curiosity scooped, processed, and analyzed a small deposit of windblown sand/silt/dust at Rocknest that has similar morphology and bulk elemental composition to other aeolian deposits studied at other Mars landing sites. Based solely on analysis of CheMin x-ray diffraction (XRD) data from Mars, calibrated with terrestrial standards, Bish et al. estimate the Rocknest deposit to be composed of ~71% crystalline material of basaltic origin, in addition to ~29% x-ray-amorphous materials. In an independent approach, Blake et al. used Alpha Particle X-ray Spectrometer data to constrain the bulk composition of the deposit and XRD data and phase stoichiometry to constrain the chemistry of the crystalline component, with the difference being attributed to the amorphous component, resulting in estimates of ~55% crystalline material of basaltic origin and ~45% x-ray-amorphous materials. The amorphous component may contain nanophase iron oxide similar to what was observed by earlier rovers. The similarity between basaltic soils observed at Rocknest and other Mars sites implies either global-scale mixing of basaltic material or similar regional-scale basaltic source material or some combination of both. No hydrated phases were detected. However, as shown by Leshin et al., pyrolysis of Rocknest fines using the Sample Analysis at Mars (SAM) instrument suite revealed volatile species, probably in the amorphous component, including H₂O, SO₂, CO₂, and O₂, in order of decreasing abundance. ChemCam measurements of these materials also revealed the presence of H. It is likely that H₂O is contained in the amorphous component and CO₂ was liberated via the decomposition of Fe/Mg carbonates present below the XRD detection limit of 1 to 2%. Isotopic data from SAM indicate that this H₂O, and possibly the CO₂, were derived from the atmosphere. SAM analysis also revealed oxychloride compounds similar to those found by earlier missions, suggesting that their accumulation reflects global planetary processes. The evolution of CO₂ during pyrolysis and the observation of simple chlorohydrocarbons during SAM gas chromatograph mass spectrometer analyses could be consistent with organic carbon derived from a terrestrial instrument background source, or a martian source, either exogenous or indigenous.

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*References may be found on page 1477 after the abstracts.
10.1126/science.1244258
The Petrochemistry of Jake_M: A Martian Mugearite


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Soil Diversity and Hydration as Observed by ChemCam at Gale Crater, Mars


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ponent is similar to that found on Earth in places such as soils on the Mauna Kea volcano, Hawaii.

>> Read the full article at http://dx.doi.org/10.1126/science.1238932

Curiosity at Gale Crater, Mars: Characterization and Analysis of the Rocknest Sand Shadow


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The Rocknest aeolian deposit is similar to aeolian features analyzed by the Mars Exploration Rovers (MERs) Spirit and Opportunity. The fraction of sand <150 micrometers in size contains ~55% crystalline material consistent with a basaltic heritage and ~45% x-ray amorphous material. The amorphous component of Rocknest is iron-rich and silicon-poor and is the host of the volatiles (water, oxygen, sulfur dioxide, carbon dioxide, and chlorine) detected by the Sample Analysis at Mars instrument and of the fine-grained nanophase oxide component first described from basaltic soils analyzed by MERs. The similarity between soils and aeolian materials analyzed at Gusev crater, Meridiani Planum, and Gale crater implies locally sourced, globally similar basaltic materials or globally and regionally sourced basaltic components deposited locally at all three locations.

>> Read the full article at http://dx.doi.org/10.1126/science.1239505

Volatile, Isotope, and Organic Analysis of Martian Fines with the Mars Curiosity Rover


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Samples from the Rocknest aeolian deposit were heated to ~835°C under helium flow and evolved gases analyzed by Curiosity’s Sample Analysis at Mars instrument suite. H₂O, SO₂, CO₂, and O₂ were the major gases released. Water abundance (1.5 to 3 weight percent) and release temperature suggest that H₂O is bound within an amorphous component of the sample. Decomposition of fine-grained Fe or Mg carbonate is the likely source of much of the evolved CO₂. Evolved O₂ is coincident with the release of Cl, suggesting that oxygen is produced from thermal decomposition of an oxychloride compound. Elevated δD values are consistent with recent atmospheric exchange. Carbon isotopes indicate multiple carbon sources in the fines. Several simple organic compounds were detected, but they are not definitively martian in origin.

>> Read the full article at http://dx.doi.org/10.1126/science.1238937

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