Plenary Lecture

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The First X-ray Powder Diffraction Measurements on Mars

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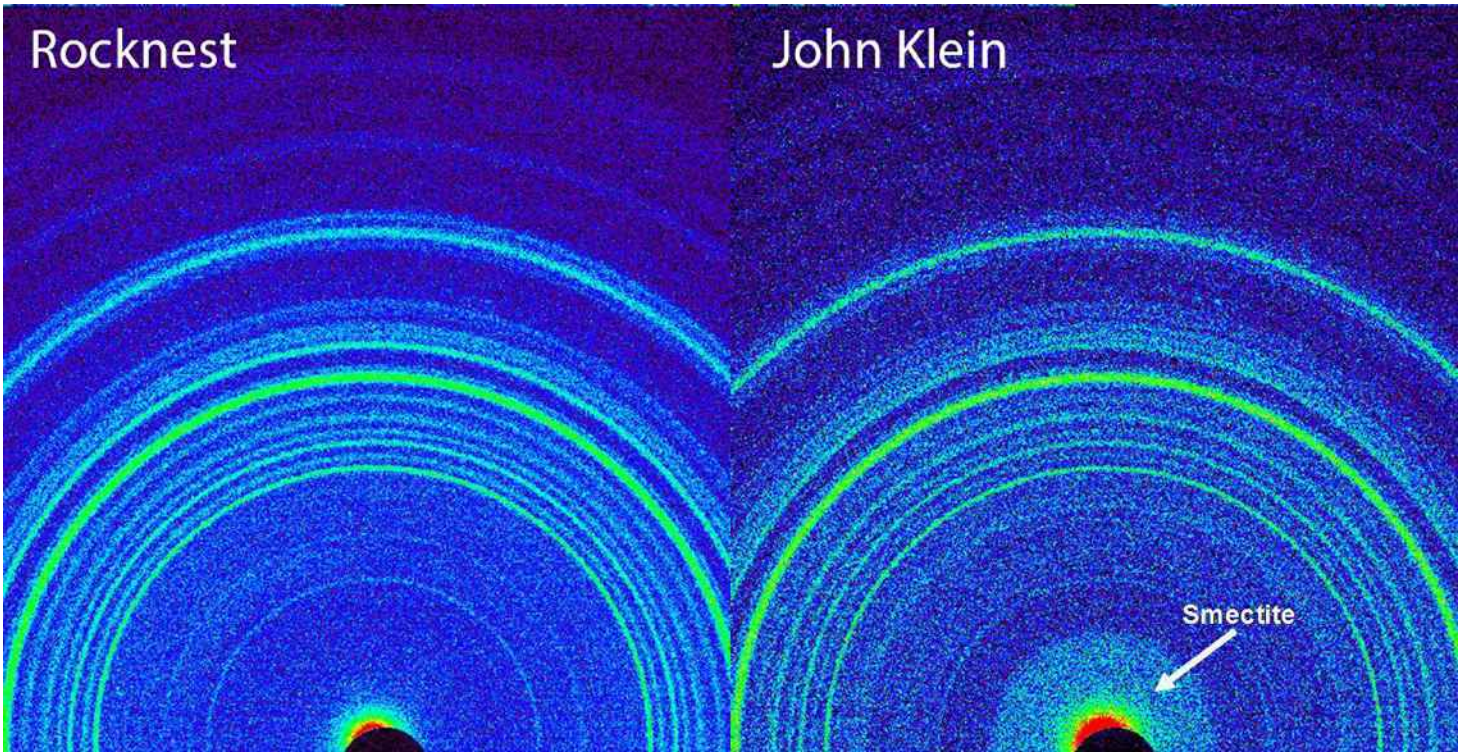
The CheMin instrument on the Curiosity rover measures XRD and XRF data using Co radiation in transmission geometry. It has analyzed <150 µm portions of eolian soil (Rocknest) and two drill-hole powders (John Klein and Cumberland) from a mudstone [1, 2, Figure 1]. XRD data for Rocknest soil revealed plagioclase, forsteritic olivine, augite, and pigeonite. John Klein and Cumberland are similar, with much less Fe-forsterite and more magnetite than Rocknest. Data were analyzed via Rietveld methods (Topas), and profiles were modeled using beryl-quartz data measured on Mars. CheMin's broad profiles limited analysis of minor phases (<3 wt. %), although the presence of minor phases was evaluated individually for every sample by including each in the Rietveld model and evaluating their effect on the fit. We found no evidence for any perchlorate, carbonate, or sulfate mineral (apart from anhydrite, and bassanite in the mudstones). No phyllosilicate was detected in the soil, but mudstone samples contained two different phyllosilicates, likely trioctahedral smectites. The John Klein XRD pattern had a broad ~10Å peak, whereas Cumberland showed broad peaks at ~13.2Å and ~10Å. The background in all XRD patterns suggested the presence of amorphous/poorly ordered components, which were analyzed using FULLPAT, giving ~27% amorphous content in Rocknest and ~20% in the mudstones. This mineralogy is very similar to that found in soils on the flanks of Mauna Kea volcano, Hawaii. Mineralogy differences between the Rocknest material and the mudstones may be explained by alteration of Fe-forsterite to smectite + magnetite. Combining these results with compositional estimates from unit-cell parameters and bulk chemistry will allow determinations of individual phase compositions, including that of the amorphous component(s). The exact nature of the amorphous component is unclear, but other data show that it is hydrous.

[1] *D. L. Bish, D. F. Blake, D. T. Vaniman, et al., Science, 2013, 341, DOI: 10.1126/science.1238932.,* ***[2]*** *D. T. Vaniman, D. L. Bish, D. W. Ming, et al., Science, 2013, 343, DOI: 10.1126/science.1243480.*



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