Localized and Areally Extensive Alterations in Marathon Valley, Endeavour Crater Rim, Mars
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Mars Exploration Rover Opportunity is exploring the rim of 22 km diameter, Noachian-aged Endeavour crater. Marathon Valley cuts through the central region of the western rim providing a window into the local lower rim stratigraphic record. Spectra from the Compact Reconnaissance Imaging Spectrometer for Mars show evidence for the occurrence of Fe-Mg smectite in this valley, indicating areally extensive and distinct lithologic units and/or styles of aqueous alteration [1]. The Alpha Particle X-ray Spectrometer has determined the compositions of 59 outcrop targets on untreated, brushed and abraded surfaces. Rocks in the Marathon Valley region are soft breccias composed of mm- to cm-sized darker clasts set in a lighter-toned, fine-grained matrix. They are basaltic in non-volatile-element composition and compositionally similar to breccias investigated elsewhere on the rim.

Alteration styles recorded in the rocks include: (1) Enrichments in Si, Al, Ti and Cr in more reddish-colored rock, consistent with leaching of more soluble cations and/or precipitation of Si ± Al, Ti, Cr from fluids. Coprecipitation of Ge-rich phases with Si occurred in the western area only; high water:rock is indicated. Pancam multispectral observations indicate higher nanophase ferric oxide contents, but the rocks have lower Fe contents. The highly localized nature of the red zones indicate they cannot be the source of the widespread smectite signature observed from orbit. (2) Outcrops separated by ~65 m show common compositional changes between brushed and abraded (~1 mm deep) targets: increases in S and Mg; decreases in Al, Cl and Ca. These changes are likely due to relatively recent, surface-related alteration of valley rocks and formation of surface coatings under low water:rock. (3) One target, from the center of a region of strong CRISM smectite signature, shows modest differences in composition (higher Si, K; lower Mn) compared to most Marathon Valley rocks, while another target ~40 cm away on the same outcrop does not; a change towards smectite bulk compositions is not observed. The smectite signature likely resulted from alteration under low water:rock such that primary minerals were partially altered to phyllosilicates, but wholesale leaching of cations by fluids did not occur.

[1] Fox V. K. et al. (2016) *Geophys. Res. Lett.* **43**, 4885.