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MULTISPECTRAL VNIR OBSERVATIONS BY THE OPPORTUNITY ROVER PANCAM OF MULTIPLE EPISODES OF AQUEOUS ALTERATION IN MARATHON VALLEY, ENDEAVOUR CRATER, MARS

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Since early 2015, the Mars Exploration Rover Opportunity has been exploring the break in the rim of Endeavour Crater dubbed Marathon Valley by the rover team. Marathon Valley was identified by orbital hyperspectral data from the MRO CRISM as having a relatively strong spectral feature in the 2.3 µm region indicative of an Mg or Fe-OH combination overtone absorption band indicative of smectite clay. Earlier in its mission, Opportunity examined the Matijevic Hill region on the more northerly Cape York crater rim segment and found evidence for smectite clays in a stratigraphically lower, pre-impact formed unit dubbed the Matijevic formation. However, the smectite exposures in Marathon Valley appear to be associated with the stratigraphically higher Shoemaker formation impact breccia. Evidence for alteration in this unit in Marathon Valley is provided by Pancam multispectral observations in the 430 to 1010 nm visible/near infrared (VNIR) spectral range. Sinuous troughs (“red zones”) contain fragmented cobbles and pebbles displaying higher blue-to-red slopes, moderately higher 535 nm band depths, elevated 754 to 934 nm, and negative 934 to 1009 nm slopes. The lack of an absorption at 864 to 904 nm indicates the lack of crystalline red hematite in these red zones, but likely an enrichment in nanophase ferric oxides. The negative 934 to 1009 nm slope is potentially indicative of the presence of adsorbed or structurally bound water. A scuff in a red zone near the southern wall of Marathon Valley uncovered light-toned soils and a pebble with an 803 to 864 nm absorption resembling that of light-toned Fe-sulfate bearing soils uncovered by the Spirit rover in the Columbia Hills of Gusev crater. APXS chemical measurements indicated enrichments of Mg and S in the scuff soils and the pebble, Joseph Field, with the strongest 803 nm band- consistent with Mg and Fe sulfates. The presence of Fe and Mg sulfates can be interpreted as evidence of a potentially later episode of aqueous alteration with an earlier, neutral to alkaline pH episode forming the Fe/Mg smectites and a later acid pH episode forming the Fe and Mg sulfates.

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