Impact-facilitated Hydrothermal Alteration in the Rim of Endeavour Crater, Mars

D. W. MITTLEFEHLDT[1], C. SCHRÖDER[2], W. H. FARRAND[3], L. S. CRUMPLER[4], A. S. YEN[5]

[1]NASA/Johnson Space Center, Houston, TX, USA.
[2]University of Stirling, Stirling, Scotland, UK.
[3]Space Science Institute, Boulder, CO, USA.
[4]New Mexico Museum of Natural History and Science, Albuquerque, NM, USA.
[5]JPL-Caltech, Pasadena, CA, USA.

Endeavour crater, a Noachian-aged, 22 km diameter impact structure on Meridiani Planum, Mars, has been investigated by the Mars Exploration Rover *Opportunuity* for over 2000 sols (Mars days). The rocks of the western rim region (oldest to youngest) are: (i) the pre-impact Matijevic fm.; (ii) rim-forming Shoemaker fm. polymict impact breccias; (iii) Grasberg fm., fine-grained sediments draping the lower slopes; and (iv) Burns fm., sulfate-rich sandstones that onlap the Grasberg fm. The rim is segmented and transected by radial fracture zones. Evidence for fluid-mediated alteration includes m-scale detections of phyllosilicates from orbit, and cm-scale variations in rock/soil composition/mineralogy documented by the *Opportunity* instrument suite.

The m-scale phyllosilicate detections include Fe^{3+}-Mg and aluminous smectites that occur in patches in the Matijevic and Shoemaker fms. Rock compositions do not reveal substantial differences for smectite-bearing compared to smectite-free rocks. Interpretation: large-scale hydrothermal alteration powered by impact-deposited heat acting on limited water supplies engendered mineralogic transfomations under low water/rock, near-isochemical conditions.

The cm-scale alterations, localized in fracture zones, occurred at higher water/rock as evidenced by enhanced Si and Al contents through leaching of more soluble elements, and deposition of Mg, Ni and Mn sulphates and halogen salts in soils. Visible/near infrared reflectance of narrow curvilinear red zones indicate higher nanophase ferric oxide contents and possibly hydration compared to surrounding outcrops. Broad fracture zones on the rim have reflectance features consistent with development of ferric oxide minerals. Interpretation: water fluxing through the fractures in a hydrothermal system resulting from the impact engendered alteration and leaching under high water/rock conditions.

Late, localized alteration is documented by Ca-sulfate-rich veins that are not confined to fracture zones; some cross-cut the Grasberg fm. Interpretation: late fluid mobilization of soluble elements, likely in a later alteration event.