Igneous to aqueous: Mineralogic diversity identified by the Spirit rover in Gusev crater

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Overview

Gusev crater was selected as the landing site for the Mars Exploration Rover Spirit because of the likelihood that it contained an ancient lake, a hypothesis supported by the fact that Ma'adim Vallis, one of the longest branching valley networks on the planet, breaches its southern rim and probably served as a conduit for flowing water [1]. Spirit's Mössbauer spectrometer and Miniature Thermal Emission Spectrometer provided an unprecedented capability for in situ mineral identification. Although no lake sediments were found along Spirit's seven-km traverse from 2004 to 2010, outcrops rich in carbonate [2], sulfate [3], and opaline silica [4; 5] were discovered. Diverse igneous mineralogy also was identified in association with flood basalts, pyroclastic deposits, shallow intrusives, and vesicular lava flows [e.g., 6; 7]. An amorphous silicate phase(s) was recognized in many rocks but its origin remains enigmatic [8].

Comanche Outcrops Revisited

The Mg-Fe-carbonate-rich outcrops known as Comanche highlight some of the igneous and aqueous history of Gusev crater. As shown by [9], Comanche outcrops are the altered equivalent of the nearby olivine-rich outcrops known as Algonquin, which are remnants of volcanic tephra that likely covered the Columbia Hills and adjacent plains well before emplacement of basalt flows onto the floor of Gusev. Brines produced from minor leaching of Algonquin-like tephra deposits in an ephemeral lake would have a composition consistent with the alteration evident in the Comanche outcrops. Transport and evaporative precipitation of such fluids into the Comanche outcrops can explain their mineralogical, chemical, and textural characteristics [9].

[1] Squyres, S. W., *et al* (2004), *Science*, **305**, 5685, 794-799. [2] Morris, R. V., *et al* (2010), *Science*, **329**, 5990, 421-424. [3] Squyres, S. W., *et al* (2006), *J. Geophys. Res.*, **111**, E02S11. [4] Squyres, S. W., *et al* (2008), *Science*, **320**, 1063-1067. [5] Ruff, S. W., *et al* (2011), *J. Geophys. Res.*, **116**. [6] Ruff, S. W., *et al* (2006), *J. Geophys. Res.*, **111**, E12S18. [7] Morris, R. V., *et al* (2008), *J. Geophys. Res.*, **113**, E12S42. [8] Ruff, S. W., and V. E. Hamilton (2013), *LPSC*, **44**, abs. #1753. [9] Ruff, S. W., *et al* (in press), *Geology*.