

Sulfates on Mars: How recent discoveries from CRISM, OMEGA and the MERs are changing our view of the planet

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Sulfur has been known to be present in the soils on Mars since Viking landed on the surface [1]. However, the form of this S remained elusive for decades. Recent identifications of sulfate minerals on the surface and near surface of Mars have been made by the Mars Exploration Rovers (MERs) and Mars Express and Mars Reconnaissance orbiters. Instruments on the MERs have detected jarosite in the outcrop matrix at Meridiani [2] and hydrated sulfates such as ferricopiapite in the bright salty soils excavated by Spirit's wheels [3, 4]. Coordinated analyses of VNIR, emission, and Mössbauer spectra together with chemical constraints suggest the presence of ferricopiapite, one or more other ferric sulfates (e.g. butlerite, coquimbite, fibroferrite or metahohmanite), and a phosphate such as ferriestrunzite or strengite [4].

Hyperspectral VNIR images collected by OMEGA revealed the presence of monohydrated and polyhydrated sulfates in canyon walls and mounds near Valles Marineris and gypsum at the north polar region [5]. Close-up views of Mars using the hyperspectral VNIR imager CRISM have enabled detection and characterization of these sulfate deposits on a finer scale. Recently, hydrated silica has been identified in bright layers near Juventae Chasma, one of the regions where monohydrated and polyhydrated sulfates exist in bright outcrops at the chasma walls and internal mounds [6]. Analysis of interior layered deposits in Valles Marineris indicates a diverse sulfate evaporite sequence or dynamic surface hydration processes in order to explain the coexistence of monohydrated and polyhydrated sulfates [7].

[1] Clark *et al.* (1977) *JGR* **82**, 4577-4594. [2] Klingelhöfer *et al.* (2004) *Science* **306**, 1740-1745. [3] Johnson *et al.* (2007) *GRL* **34**, L13202, doi:10.1029/2007GL029894. [4] Lane *et al.* (2007, in press) *Am. Miner.* [5] Langevin *et al.* (2005) *Science* **307**, 1584-1586. [6] Bishop *et al.* (2008) *Lunar Planet Science Conf.*, abs. #2334. [7] Roach *et al.* (2008) *Lunar Planet Science Conf.*, abs. #1823.

Isotopic evidence for changing sources of Mercury to the Arctic

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Mercury is a toxic pollutant that is atmospherically transported from natural and anthropogenic sources to pristine ecosystems including the Arctic. Mercury isotope analyses by MC-ICPMS provide a new tool for identifying Hg sources and transformations [1-6]. Environmental samples display a range of Hg isotope values due to mass-dependent fractionation (MDF) [1-5]. Mass-independent fractionation of Hg (MIF), which has thus far been demonstrated only for photochemical reduction of methyl-Hg and Hg(II) [1], has also been observed in a few studies [1, 2, 5, 6].

Modern and buried (pre-anthropogenic) organic soils ("peats") were collected at a remote Arctic coastal location near Point Barrow, Alaska, to investigate the variability in Hg isotopic composition through time. We observed decreasing Hg concentrations in peat profiles presumably due to recent increases in Hg deposition associated with anthropogenic inputs (as in Arctic lake sediments). The peats preserve a measure of the isotopic composition of Hg deposited from the atmosphere far from Hg point sources. Mercury stored in peats from throughout the Point Barrow area and independent of depth are characterized by similar ranges of MDF, with $\delta^{202}\text{Hg}$ values ($\pm 0.08\text{‰}$, 2sd) ranging from -1.18 to -1.50‰. Samples from the upper 5 cm of modern peat profiles are characterized by one range of MIF, with $\delta^{201}\text{Hg}$ values ($\pm 0.05\text{‰}$, 2sd) from -0.40 to -0.15‰, whereas samples from buried peat profiles (with pre-anthropogenic Hg) are characterized by a contrasting range with $\delta^{201}\text{Hg}$ values from -0.15 to -0.01‰. This difference in $\delta^{201}\text{Hg}$ with depth suggests either a shift in the isotopic composition of Hg being deposited at Barrow due to anthropogenic inputs, or a change in the extent of photochemical reduction of the Hg that was released to the atmosphere and later deposited at Barrow. Our results suggest that Hg isotope ratios may aid in source apportionment of Hg deposited to ecosystems and lead to a better understanding of the global Hg cycle.

[1] Bergquist & Blum (2007) *Science* **318**, 417-420. [2] Jackson *et al.* (in press) *Appl. Geochem.* [3] Kritee *et al.* *ES&T* **41**, 1889-1895. [4] Smith *et al.* (2005) *Geology* **33**, 825-828. [5] Biswas *et al.* (2007) *GCA* **71**, A94. [6] Ghosh *et al.* (in press) *G-cubed*.