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Meteoritic contributions to the surface of Mars

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The Alpha Particle X-ray Spectrometers (APXS) onboard the Mars Exploration Rovers (MER) have returned more than 150 separate measurements from the surface of Mars. In these analyses, the observed nickel content of martian rocks and soils is typically in the range of ∼100 ppm to ∼1700 ppm by weight. The average chondritic abundance of Ni is 1.1% [1], substantially higher than typical surface analyses, and can therefore be used to establish upper limits on the amount of meteoritic material at the surface of Mars.

There is clear evidence for a meteoritic input to the surface of Mars, as a ∼30 cm Fe-Ni meteorite with an exceptional Ni content of ∼7 weight percent was recently discovered at Meridiani Planum [2]. How much of the other material sampled by MER is likely to be exogenic? The Ni content of the Meridiani outcrop rocks (∼700 ppm) is consistent with up to 6% of an average chondritic input. However, other analyses indicate that Mars is inherently Ni-rich, and thus, this elevated nickel content may be a reflection of the crustal composition of Mars rather than an indicator of an external input. For example, basalts on the plains of Gusev contain ∼200 ppm Ni, a value consistent with laboratory analyses of olivine phyric and lherzolitic shergottites (180 and 330 ppm). Chassigny, the only dunite among the martian meteorites, contains on average 500 ppm Ni. Exceptionally high levels of Ni (∼1700 ppm) were observed in an olivine-rich cobble at Meridiani, a further indication of the elevated indigenous abundance of nickel at the martian surface.

The soils at Gusev are generally described by a thin layer of bright dust mantling a

darker soil unit [3]. The average concentrations of Ni in the bright dust and dark soil are approximately 550 ppm and 650 ppm, respectively. The 100 ppm enhancement in the surface layer does not necessarily result from, but is compatible with, a 1.2% addition of chondritic material. This value is consistent with predictions of a meteoritic component in martian soils [4, 5] and is comparable to the estimated admixture of 1.9% [6] chondritic material in lunar fines.

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