# Effect of low gravity on water and soil-nutrient-biomass dynamics in a Martian soil-based agricultural plot

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In the hypothesis that Mars can be inhabited by a six-people crew by 2050 [1], bioregenerative agriculture has being considered as a mean to recycle water, produce food, sequester $CO_2$, produce $O_2$, and decompose organic wastes [2]. However, Mars gravitational acceleration (0.38*g*) has unknown consequences on most physical and biogeochemical processes within the root zone, where adequate supply of water, nutrients and $O_2$ is required by plants and microorganisms. On Mars, gravitational advection would be substantially different than on Earth, but it is not clear whether this would hinder, maintain or facilitate nutrient accessibility. As pore wetting in reduced gravity would be more likely to nucleate air pockets, the unsaturated hydraulic conductivity would be much lower, and air pockets could entrap gases (e.g. $O_2$) and dissolved nutrients (e.g. $NH_4^+$ and $NO_3^-$), not available to roots and microorganisms at the rates they would on Earth.

The feedback that low gravity has on water flow, and its effects on the soil-nutrient-biomass dynamics in a soil-based agricultural plot on Mars was investigated using a mechanistic soil reactive transport model [3]. We demonstrated that under a 0.38g Martian gravity, leaching of water, N and C decrease by 50-70% as compared to Earth, but emissions of $N_2O$, $N_2$ and $CO_2$ gases increase respectively by 150%, 350%, and 20% relative to Earth. Martian soil-based agriculture would require 50-70% less irrigation water volume, and about 50% less net N supply (e.g. fertilizers) as compared to on Earth. Ideally, low water and nutrient footprint would make soil-based cropping an attractive option to support life on Mars.

[1] Yamashita *et al.* (2006) *Ann. N.Y. Acad. Sci.* **1077**, 232–243. [2] Nelson *et al.* (2008) *Adv. Space Res.* **41**, 675–683. [3] Maggi *et al.* (2008) *J. Geophys. Res.–Biogeosciences* **113**, G02016.

# Lithium isotope composition of Mars – Corollary of radial heterogeneity in the early Solar System?

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Lithium concentrations and isotope ratios of a suite of Martian meteorites comprising all available lithologies show moderate variation in Li abundances (1.9–8.0 ppm), but a surprisingly large spread of $\delta^7$Li (-0.9 to 6.2‰) exceeding that of common terrestrial basalts [1]. There is no systematic difference in $\delta^7$Li between shergottites and nakhlites, whereas Li contents are higher in the latter. Proportionally important mesostasis in nakhlites carries significant amounts of Li, yet without a detectable impact on $\delta^7$Li. Strong linear and positive correlation of $\delta^7$Li and mg# in nakhlites ($r^2$=0.99) suggests that the magmatic differentiation processes are mainly responsible for the Li isotope variability and that nakhlites may be co-genetic (or magmatic differentiation follows single common path for nakhlites Mars-wide). Chemically diverse ultramafic lithologies (ALH 77005, Chassigny, NWA 2737) have identical $\delta^7$Li=4.0‰, adopted as the reference value for the Martian mantle. Leachates ($H_2O$, HCl) of nakhlite NWA 817 (~15% mesostasis) have $\delta^7$Li that are indistinguishable from the whole-rock. This further constrains the assumed presence of water on Mars and allows for only ephemeral existence of surface liquid water which would have otherwise developed high $\delta^7$Li in these samples [2].

The uniform and slightly heavier $\delta^7$Li of the Martian mantle compared to that of the Earth [3, 4] may imply existence of resolvable radial heterogeneity of $\delta^7$Li with increasing heliocentric distance in the early Solar System. Whether this difference originates from the initial heterogeneous distribution of Li isotopes in the early Solar nebula or is related to particular geochemical properties of Li is unclear. However, resolvable $\delta^7$Li differences between the Earth and Moon [5] could be explained by easier $^6$Li loss from vaporized Earth's mantle immediately following the Moon-forming Giant Impact. An alternative scenario implies preferential destruction of less stable $^6$Li in the early Solar System.

[1] Tomascak *et al.* (2008) *GCA* **72**, 1626–1637. [2] Chan *et al.* (1992) *EPSL* **108**, 151–160. [3] Magna *et al.* (2006) *EPSL* **243**, 336–353. [4] Seitz *et al.* (2007) *EPSL* **260**, 582–596. [5] Magna *et al.* (2009) *GCA* **73**, A816