

Mesocosms as an Essential Tool to Assess the Environmental Exposure to Nanomaterials during their Life Cycle

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In the past decade, there has been a growing concern about the use of nanoparticles/nanomaterials which are now present in 1000+ consumer products. There is no established current state of the art regarding the risks associated with the manufacturing and use of nano-enabled products, but rather a large collection of a somewhat contradictory literature. The vast variety of parameters and processes (physico-chemical, (micro)biological, (eco)toxicological...) is the source of a complexity level that cannot be easily resolved.

Hazard is the factor that is generally studied first but the multiplicity of experimental protocols makes it difficult to efficiently use these data. The exposure cannot be easily defined because of the complex interplay of intrinsic properties of the nanomaterial, their process dictated surface modification(s), and the evolution of their speciation during aging in regular use, accidental release or disposal scenarios.

A way to circumvent experimental artifacts in the determination of environmental exposure is to let nature have its way. Of course, for practicality, nature needs to be "harnessed", and experiment management/monitoring becomes a predominant issue. The use of mesocosms, i.e. downscaled ecosystems with sizes ranging from a table top aquarium to backyard swimming pools, is the most promising way to achieve relevant evaluation of environmental exposure to-/ bioavailability of- nanomaterials at varying stages of their life cycle.

The current work demonstrates how such mesocosm experiments need to be implemented in terms of operational setup to be relevant for the assessment of exposure scenarios. First results provide a validation of this approach.

Magnesium isotopic composition of the lower continental crust: A xenolith perspective

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The large isotope fractionation during low-temperature water-rock interactions and limited fractionation during igneous differentiation make Mg isotopes a potentially powerful tracer of the influence of chemical weathering on the continental crust composition. Magnesium isotopic composition of the upper continental crust is highly heterogeneous [1], and on average heavier than the mantle [e.g., 2]. By contrast, the Mg isotopic composition of the hydrosphere, as represented by seawater [e.g., 3], is very light. The distinct Mg isotopic distribution among the mantle, upper continental crust and the hydrosphere is interpreted as a result of continental weathering, during which light Mg isotopes are partitioned into the hydrosphere relative to the weathered regolith [4].

Better understanding the Mg isotopic cycling between the crust, mantle and hydrosphere requires knowledge of the bulk crustal Mg isotopic composition, which is heavily influenced by the deep crust. Here, we report Mg isotopic data for two sets of well-studied lower crustal granulite xenoliths from North Queensland, Australia (Chudleigh and McBride suites) [5, 6]. The Chudleigh granulites are a suite of cogenic crystal cumulates derived from mafic magmas that intruded and assimilated the preexisting lower crust. Their mineralogy varies from olivine-bearing assemblages to plagioclase-garnet-clinopyroxene assemblages indicating a range of equilibrium temperatures (600 to 1000 °C) and depths (20 to >40 km). McBride granulites range from mafic to felsic bulk compositions, with most of them formed through mixing between mantle-derived basalts and preexisting crust. Overall, these two sets of granulite xenoliths match the estimated composition of the lower crust and hence are ideal for studying the average Mg isotopic composition of the lower crust.

Magnesium isotopic compositions of Chudleigh xenoliths are homogenous and mantle-like, with $\delta^{26}\text{Mg}$ varying from -0.3 to -0.2‰. By contrast, $\delta^{26}\text{Mg}$ of McBride xenoliths is highly variable from -0.7 to +0.2‰, significantly overlapping that of the upper continental crust. The contrasting behaviors of Mg isotopes between Chudleigh and McBride xenoliths mainly reflect their different proportions of mantle vs. crustal Mg. Based on these xenoliths, the lower continental crust has a heterogeneous Mg isotopic composition, with a weighted average $\delta^{26}\text{Mg}$ of -0.2‰, which is similar to that of the upper crust, but slightly heavier than the mantle.

[1] Li et al. (2010) *Geochimica et Cosmochimica Acta* **74**, 6867-6884. [2] Teng et al. (2010) *Geochimica et Cosmochimica Acta* **74**, 4150-4166. [3] Ling et al. (2011) *Rapid Communications in Mass Spectrometry* **25**, 2828-2836. [4] Teng et al. (2010) *Earth and Planetary Science Letters* **300**, 63-71. [5] Rudnick et al. (1986) *Geochimica et Cosmochimica Acta* **50**, 1099-1115. [6] Rudnick and Taylor (1987) *Journal of Geophysical Research* **92**, 13981-14005.