

Experimental investigations of nanoparticle transport and deposition in aquatic environments

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Recent reports underline the potential environmental risks linked to the ‘nano’ revolution, yet little is known regarding the fate and impacts of engineered nanomaterials following their release in natural soils and groundwaters. To better understand the transport and fate of these materials in aquatic environments, a growing number of experimental studies are being conducted. Studies of nanoparticle transport commonly involve laboratory-scale sand- or soil-packed column experiments and more recently, deposition experiments using a quartz crystal microbalance (QCM). When used with silica-coated crystals, the QCM simulates deposition of nanoparticles onto a model sand surface. Such experimental investigations of nanoparticle transport and deposition provide valuable insights into their migration behavior and, hence, potential risks linked with the release of these materials in the natural environment.

Ongoing studies in our laboratory are aimed at examining the transport and deposition behavior of nano-sized TiO₂, zero-valent iron (ZVI) and commercial quantum dots (QDs) in model groundwater environments. Well-controlled experiments are conducted over a wide range of solution chemistries (e.g., varying pH and ionic strength) in an effort to link deposition behavior at the microscale (QCM studies) with the mesoscale (packed column studies). Transport studies are complemented with physicochemical characterization of the nanoparticles using several techniques (e.g., dynamic light scattering (DLS), fluorescence correlation spectroscopy (FCS), transmission electron microscopy (TEM), atomic force microscopy (AFM), and laser Doppler velocimetry (LDV)). Taken together, this data is used to interpret the stability of the different nanomaterials in aquatic environments.

Olivine-melt Ni partitioning as a function of sulfur content in basaltic systems

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A knowledge of the partitioning behaviour of Ni between olivine and co-existing silicate melt is a necessary prerequisite to models that relate to many aspects of the Earth’s evolution, such as early core formation (e.g., [1]) and magmatic processes (e.g., [2]). The majority of previous investigations into Ni partitioning have been on sulfur-free systems and only a handful of studies have looked into the effect of sulfur on Ni partitioning between olivine and melt (e.g. [1, 3]). These studies have produced contrasting results: Li *et al.* [3] suggest that sulfur has a large effect on Ni partitioning, whereas Gaetani & Grove [1] suggest sulfur has only a minor influence.

In order to reconcile this discrepancy, we have determined olivine-melt partition coefficients for Ni, Co, Fe, Mn, Cr, V and Sc in experiments at 1 atmosphere and 1370 to 1400°C, over a wide range of sulfur fugacities (sulfur-free to log $fS_2 = -1.300$) and fixed fO_2 (log $fO_2 = -9.6$), for six haplobasaltic compositions with olivine on the liquidus in the system CMAS, both Fe-free and with variable amounts of FeO added.

The $K_D^{Ni-Mg(ol-melt)}$ values at lower melt-sulfur contents (≤ 1500 ppm) determined here agree with the values reported by Gaetani & Grove [1] and suggest that the influence of sulfur is minor. Our study shows that Ni retains compatible behaviour in olivine to much higher sulfur contents of the melt (≤ 2500 ppm) than previous investigations (~ 1800 ppm; [3]) and indicates that the activities of neither NiO nor any other of the studied components are greatly affected by the sulfur content of the melt.

[1] Gaetani & Grove (1997) *Geochim. Cosmochim. Acta* **61**, 1829-1846. [2] O’Hara (1977) *Nature* **266**, 503-507. [3] Li, Ripley & Mathez (2003) *Chem. Geol.* **201**, 295-306.