Toxic metal removal from soil and water by novel surface active maghemite nanoparticles: environmental implications

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The importance of the interface between geosphere and biosphere is known and biogeoscience represents one of the most fascinating frontiers of mineral science, especially if explored at the nanoscale. The occurrence of so called heavy metals in superficial waters, representing the main transport pathway, and in soils, as intermediate step to transfer to the biosphere is of special interest. The heavy metal release, transport and dispersion into the biosphere have a direct impact on the environment and on human health. Therefore, there has been an increasing development of applications for water and soil remediation, among which magnetic nanoparticles stand out. Environmental application and risk assessment of manufactured nanoparticles greatly depend on the understanding of their interactions with water and soil. Novel superparamagnetic nanoparticles (SAMNs), constituted of stoichiometric maghemite (γ-Fe2O3), characterized by specific surface chemical behavior without any coating or superficial modification, are stable in water for months as colloidal suspensions, present a high average magnetic moment and can be easily derivatized to immobilize specific molecules (Magro et al., 2012a, b). The study of the applicability of SAMNs as adsorbent for As(V) and Cr(VI) in soil and water will be investigated. In order to understand and evaluate the environmental behavior of SAMNs, appropriate contaminated sites, characterized by rocks and soils with high concentrations of Potential Toxic Elements (PTEs) will be identified. Mineralogical and minerogenetic characterization of primary and secondary phases directly or indirectly involved in controlling mobility, distribution and bioavailability of selected PTEs will be performed. The final step of the project will be focused on establishing the relationships between SAMNs behavior and soil properties in controlled experiments.

The results will highlight three important contributions and applications: (i) characterization of the mechanism of Cr(VI) and As(V) adsorption on novel maghemite nanoparticles; (ii) development of a novel treatment for Cr(VI) and As(V) removal from contaminated wastewaters and polluted soils; and (iii) identification of a large scale process for contaminated wastewater and soil remediation by Cr(VI) and As(V).

M. Magro, G. Valle, U. Russo, L. Nodari, F. Vianello, 2012a. Patent no. WO 2012/010200A1.

M. Magro, G. Sinigaglia, L. Nodari, J. Tucek, K. Polakova, Z. Marusak, S. Cardillo, G. Salviulo, U. Russo, R. Stevanato, R. Zboril, F. Vianello, Acta Biomater. 2012b,8, 2068-2076.