

Impact of organic carbon on Mn colloid formation, stability, and contaminant metal behavior in aquatic environments.

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Manganese (Mn), an essential element for human health, can cause adverse health effects even at low environmental concentrations.¹ Mn oxides are naturally abundant in soils and sediments and also form as reaction products when permanganate (Mn(VII)) is used for contaminant remediation in soils and groundwater. Mn oxides participate in various redox and complexation reactions with organic carbon, leading to Mn release and impacting groundwater quality. Previous studies have focused primarily on the reduction of Mn oxides to dissolved Mn phases and have often neglected the formation and stability (i.e., ability to resist aggregation) of Mn colloids, a key factor controlling Mn transport and environmental behavior. This study investigates the effect of organic carbon on Mn oxides with respect to Mn speciation, colloid formation, and aggregation. Humic acid (HA) at varying concentrations was reacted with 0.5 mM Mn oxide suspensions at C:Mn molar ratio of 0 to 15. C-Mn colloid formation was quantified by size-fraction experiments, along with characterization using XRD, XPS, TEM, and DLS. The presence of carbon facilitated Mn release and C-Mn colloid formation, with the percentage of Mn colloids increasing by 31.9 % as C:Mn molar ratio increased from 0 to 15. These C-Mn colloids were more stable than Mn oxides in groundwater, maintaining a hydrodynamic diameter of ca. 150 nm over 30 days (C:Mn=3), while Mn oxides readily aggregated into larger particles (>6000 nm). The presence of contaminant metals also influences the stability of C-Mn colloids, which were most stable in the presence of Mn^{2+} , followed by Co^{2+} , Zn^{2+} , and Cd^{2+} . These findings provide insight into the mechanisms governing Mn release from soils and sediments, the formation of Mn colloids, and their mobility in groundwater. Examining the aggregation behavior of C-Mn colloids in the presence of contaminant metals offer valuable insight into the environmental fate of Mn and its potential to sequester and mobilize contaminants. Insights from colloid aggregation kinetics can help optimize water treatment processes and predict contaminant behavior in polluted environments, contributing to the development of more effective environmental management and remediation strategies.

[1] Pajarillo, E.; et al. *Advances in Neurotoxicology* 2021, 5, 215–238.