Manganese near-surface repartitioning and delivery to groundwater in North Carolina

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Manganese (Mn) is a groundwater contaminant of growing concern in North Carolina (NC). Consumption of high quantities of Mn in well water may lead to severe neurological problems, and ~50% of wells in NC have Mn concentrations that exceed the state standard of 50 μg L^{-1}. Although Mn is naturally derived, specific sources of Mn to groundwater are generally unknown. Spatial patterns of concentrations, which range from ~0 to >2000 μg L^{-1}, are variable, making it difficult to predict risks to exposure.

The primary objective of this research is to identify the environmental factors that regulate dissolved Mn concentrations in groundwater of the NC Piedmont physiographic region. To accomplish this objective, chemical analyses of Mn in regolith, bedrock, and well-water samples from ten NC Division of Water Resources groundwater research stations are being integrated with existing state-wide well-water data, soil maps, and geology maps. A zone of solid-phase Mn-oxide accumulation persists near the water table (~4.6-9.1 m), but solid-phase speciation – as determined by sequential extraction and X-ray absorption spectroscopy – is dominated by primary, less-reactive Mn-bearing minerals at deeper depths. Across the region, dissolved Mn concentrations in wells are generally highest just below the zone of solid-phase accumulation and decrease with depth.

These results suggest that weathering and near-surface cycling have led to Mn repartitioning and delivery to groundwater. Following accumulation near the water table, Mn is reductively mobilized and transported downward through a network of bedrock fractures, implying that integrated soil-bedrock system analyses are needed for effective Mn prediction and management.