Geochemistry of Mn and its spatial distribution in the Murshidabad District of West Bengal, India

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Elevated concentrations of manganese (Mn) have been observed in the groundwaters of West Bengal, India. As a neurotoxin Mn is known to cause a variety of adverse health effects, ranging from neuromuscular problems to the inhibition of neurological devlopment, particularly in children. The realization of this additional contaminant in the arsenic afflicted regions of southeast Asia poses serious implications with regards to human health. Hence, the current study aims to address three objectives pertaining to the geochemistry of Mn in Murshidabad: i) the extent, occurrence, and overall distribution of groundwater Mn; ii) characterization of the DOM within the groundwater and the resultant effects that are imposed on dissolved Mn; and iii) the relationship between Mn, As, and various inorganic constituents and their impact on the subsequent release and accumulation of Mn.

A total of 34 water samples were collected (29 tubewells, 4 pond, 1 river) from six villages in Murshidabad. Three of these villages (Hariharpara, Beldanga, Naoda) contain reducing groundwaters (Mean Mn: 0.931±0.420mg/L), while the remaining three (Nabagram, Kandi, Khidirpore) contain oxidizing groundwaters (Mean Mn: 0.739±0.333mg/L). Eighty-three percent (n=29) of the wells surveyed contain Mn levels that exceed the recommended WHO limit of 0.4 mg/L, with Mn persisting in circumneutral pH environments and under a broad range of ORP's (-108<mV<156). Positive correlations are observed between dissolved Mn and Sr^{2+}, Ca^{2+}, Mg^{2+}, total As, Al^{3+}, and $\Sigma S(-II)$, whereas inverse relations are observed with K^{+} and Cs^{+}. DOC values varied slightly among the oxidizing (Mean DOC: 1.75±0.400mg/L) and reducing (Mean DOC: 1.85±0.389mg/L) aquifers, hosting a positive correlation with Mn in reducing environments and a negative correlation in oxidizing environments. The reducing aquifers are also high in As, indicating that the microbially mediated reductive dissolution of As-sorbed Mn mineral phases is probable. Fluorescence analyses, geochemical modeling of Mn speciation, and petrographic examination are being combined in this study for more insight into the mechanisms of Mn release.