

A MASS BALANCE APPROACH TO ARSENIC CYCLING IN A PETROLEUM HYDROCARBON PLUME

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A 1979 oil pipeline rupture near Bemidji, MN has resulted in elevated concentrations of arsenic (As) in groundwater from biodegradation of petroleum hydrocarbons in a petroleum hydrocarbon plume. Our recent work suggests that As is naturally occurring and associates with iron (Fe) (hydr)-oxides in aquifer sediments. Arsenic is released from sediments to groundwater due to a series of interrelated biogeochemical reactions promoted by an influx of petroleum hydrocarbons that create anoxic conditions and stimulate reductive dissolution of As-bearing Fe(III) (hydr)-oxides. These reactions release aqueous Fe(II) and associated As to groundwater as byproducts, and have created an As plume with concentrations >230 µg/L. Despite elevated As in groundwater, preliminary data show a significant As reservoir in active Fe(III)-reducing sediments; some Fe-reducing sediments contain As well above baseline conditions, suggesting As is being sequestered, and concentrated, in Fe-reducing sediments. To investigate the overall fate of mobilized As, I propose to construct a mass balance for As with the objectives to (1) quantitatively describe As partitioning between groundwater and sediment; and (2) identify As sinks in aquifer sediments. These objectives are critical as current sequestration of As may be a reversible process, thus allowing future As release where it is currently sequestered. Quantitatively assessing where As mass is concentrated enables accurate predictions of long-term fate of As because the plume and geochemistry evolve over time. An As mass balance will enhance understanding of complex As cycling in hydrocarbon plumes and will improve As monitoring at petroleum impacted sites, as recommended by API.

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