



A framework for assessing the contaminant attenuation potential of aquifers by iron and manganese-reduction

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Natural attenuation processes, particularly biodegradation, are important controls on the fate and transport of contaminants in soils and groundwater. Petroleum hydrocarbon compounds, a group of common organic groundwater contaminants, are typically biodegraded under a range of geochemical conditions. Where susceptible to biodegradation, organic compounds are biodegraded under aerobic conditions, then coupled to nitrate-reduction, Mn-reduction, Fe-reduction, sulphate-reduction, and finally by methanogenesis. For aerobic, nitrate-reducing, sulphate-reducing and methanogenic processes, the concentration of terminal electron acceptors (O_2 , NO_3^- , SO_4^{2-} , CO_2) in the groundwater defines the oxidative capacity of the system. By contrast, in the case of Mn- and Fe-reduction, the oxidative capacity is primarily controlled by the mineralogy of the aquifer or sediment solids through which contaminated groundwater flows. Mn and Fe metal oxides are a potentially significant reservoir of mineral-based oxidation capacity in aquifers, although this potential is seldom quantified to a level which is informative for risk-assessments of contaminated sites.

This poster describes a classification scheme devised to assess the importance of Fe^{3+} and Mn^{4+} reduction in the coupled oxidation of organic compounds in aquifers and riverbed sediments. It considers an idealised aquifer and BTEX plume conceptual model, and uses an electron-acceptor mass balance approach to determine the bioavailable Fe and Mn that needed to attenuate the plume within a specified flow distance in the aquifer. It can be used as an initial screening tool for prioritising further investigation of natural attenuation processes at hydrocarbon impacted sites, in line with good practice guidance on monitored natural attenuation (MNA).

The methodology for determining representative attenuation potential classes is described and the attenuation classification scheme is presented for both Fe^{3+} and Mn^{4+} reduction. The application of the classification scheme is illustrated with national-scale geochemical data from UK aquifers, which shows the spatial variability in natural attenuation potential, and where further investigation on in-situ biodegradation rates by Fe/Mn-reduction is warranted as part of detailed risk evaluation.