Passive treatment of perchlorate, nitrate, and sulfate in contaminated groundwater using zero valent iron and wood chips

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21i. Groundwater Remediation

Perchlorate is widespread in the environment due to its use in rocket propellants, explosives, fireworks, and other applications. Its high mobility and ecotoxicity make treatment of perchlorate-contaminated water urgent [1]. Reactive media can be used to remove perchlorate in water in permeable reactive barriers and a variety of bioreactors [2]. In this study, a series of four column experiments was used to evaluate the effectiveness of reactive media for use in passive treatment systems for removal of perchlorate, nitrate, and sulfate from contaminated water associated with mining and blasting sites.

One column was packed with silica sand as a control, the other three columns were packed with granular zero valent iron (ZVI), wood chips (WC), a mixture of granular zero valent iron and wood chips, adjusted with 50 vol.% of silica sand. The experiments were operated in two stages; the flow rate was maintained at 0.5 pore volume (PV) day^{-1} in the first stage and at 0.1 PV day^{-1} in the second stage (after approximately 100 PV of flow in each column).

Results and Conclusion

Nitrate, sulfate, and perchlorate were effectively removed during the second stage of the experiment: nitrate (~10.8 mg L^{-1} NO_3-N) was almost completely removed to concentrations <0.02 mg L^{-1} NO_3-N in all columns; sulfate was removed with a variable removal of up to 70% of input sulfate (~24.5 mg L^{-1}) in Column WC; perchlorate (~857 μg L^{-1}) was effectively removed to concentrations <28 μg L^{-1} in Column WC and to concentrations <2 μg L^{-1} in Column ZVI+WC during the last 30 pore volumes in the second stage of the experiment.

The removal of nitrate and perchlorate followed first-order and zero-order kinetic equations, respectively. Nitrate and perchlorate were removed simultaneously within Columns WC and ZVI+WC, however, nitrate was removed much more rapidly than perchlorate. Nitrate inhibition of perchlorate removal was observed in Column WC at nitrate concentrations >2 mg L^{-1} NO_3-N. However, adding ZVI into WC effectively eliminated the inhibition of perchlorate removal by nitrate in Column ZVI+WC. Sulfate did not inhibit perchlorate removal in any of the columns in this study.

[1] Ward (2008) *Springer* [2] Giblin et al. (2000) J. *Environ. Qual.* **Volume29**, 578-583.

Triassic high-Mg adakitic andesites from Linxi, Inner Mongolia: Insights into the fate of the Paleo-Asian ocean crust and fossil slab-derived melt-peridotite interaction

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As the eastern Chinese extension of the central Asian orogenic belt, the Inner Mongolia-Daxinganling orogenic belt (IMDOB) has been regarded as a complex collage of island arcs, microcontinental blocks and fragments of oceanic crust that were amalgamated together during the Paleozoic closure of the eastern Chinese segment of the Paleo-Asian Ocean between the North China Craton and south Mongolia Block. The IMDOB is celebrated for its subduction-accretion tectonics and as being the world's most important juvenile crust production in Phanerozoic times.

Bulk element and isotopic compositions, single zircon U-Pb ages and trace element compositions of the Triassic high-Mg adakitic andesites (HMAs) from the Linxi area in the IMDOB were studied in this work to understand its petrogenesis and implications for Phanerozoic crustal growth. The Linxi HMAs are characterized by typical features of high-SiO_2 adakite with high Mg# and high Cr and Ni contents. Coarse clinopyroxene (cpx) phenocrysts with reverse zoning were found. These cpx phenocrysts have cores with lower Mg# and Ni contents, and higher incompatible element contents (e.g., Zr and La) compared to their mantles and rims. Bulk rock Sr-Nd isotopic compositions ($^{87}Sr/^{86}Sr_I$ = 0.70382 - 0.70396 and $\varepsilon_{Nd(t)}$ = 3.2 - 4.5) fall in the range of mid-ocean ridge basalt (MORB) and modern subduction-related adakites. Single zircon U-Pb dating by LA-ICP-MS suggests an eruption at ca. 238 Ma. Combined with the tectonic setting and Precambrian zircon age spectrum, these features suggest that the Linxin HMAs were derived from the subducted Paleo-Asian oceanic slab with sediments shed from the north China Craton and hybridized by peridotite in the mantle.

Trace element-age variations of zircons indicate that the oceanic crust was formed during Carboniferous-early Permian times, and then subducted during ca. 270 – 260 Ma. Melting of the subducted oceanic slab and hybridization by peridotite could have been initiated at ca. 250 Ma. It is suggested that the southern accretionary zone between the North China Craton and the Solonker suture in the IMDOB, where the Linxi HMAs are located, could have been consolidated by Carboniferous-Permian times. This implies that the Linxi HMAs could have been derived from partial melting of a fossil oceanic slab after the subduction, and subduction-related melting may have been delayed if the slab was subducted under an old, cold craton. Although we are unsure of the true extent of the fossil oceanic slab, the genesis of the Linxi HMAs is essentially a snapshot of the melting of a subducted slab lagging behind subduction, and melting of fossil oceanic slab could have played an important role in the Phanerozoic crustal growth in the IMDOB.