Mineralogical Characteristics and Transformations during Long-term Operation of a Zero-Valent Iron Reactive Barrier

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ABSTRACT

Installation of Fe^0 permeable reactive barriers (PRBs) can be improved with the understanding of long-term mineralogical changes and transformations within PRBs. Changes and transformations in mineral precipitates, cementation, and corrosion of Fe^0 filings within an in-situ pilot-scale PRB during the first 3 years of operation were investigated by X-ray-diffraction (XRD) and scanning electron microscopy (SEM) using energy dispersive X-ray (EDX) and backscatter electron (BSE) analyses. Iron (oxy)hydroxides, aragonite and maghemite/magnetite occurred throughout the cores collected 3 years after installation. Goethite, lepidocrosite, mackinawite, aragonite, calcite and siderite were associated with the more oxidized material and cemented areas. Green rusts were in the deep zone (21-27') in more reduced conditions, while amorphous FeS was mainly in the shallow zone (15-21'). From 1.5 to 3 yrs after installation, 1) mackinawite crystallized from amorphous FeS, 2) aragonite is transforming into calcite, 3) akaganeite transformed to goethite and lepidocrosite in the more oxidized areas and cemented zones, 4) there was an increase in the precipitation of iron (oxy)hydroxides and calcium, and iron carbonate minerals, 5) there was greater cementation, and 6) there was greater oxidation, corrosion and disintegration of Fe^0 filings, especially in cemented areas. If the degree of corrosion and cementation that was observed 1.5 to 3 yrs after installation continues to occur, certain sections of the barrier (i.e. up-gradient entrance of the groundwater to the Fe^0 portion of the barrier) will last no longer than 5 years.