



Iron oxide mineralogy and stable iron isotope composition in a Gleysol with petrogleyic properties

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Properties of Fe oxides are poorly understood in soils with fluctuating water tables and variable redox conditions. The objective of this research was to (i) characterize the mineralogical composition of Fe oxides and (ii) determine the relationship to the stable Fe isotope ratio in a soil with temporally and spatially sharp redox gradients. The lowland Gleysol (Petrogleyic) is in Northwest Germany, and consists of oximorphic soil horizons (Ah 0-15 cm, Bg 15-35 cm, CrBg 35-70 cm) developed from Holocene fluvial loam overlaying glaciofluvial sand with reductomorphic properties (2Cr horizon, +70 cm). Field measurements during the course of 28 months included the monitoring of groundwater table, soil redox potential, and analysis of the soil solutions. Solid Fe phases were studied by room temperature and cryogenic ^{57}Fe Mössbauer spectroscopy, and stable Fe isotope compositions by multiple collector inductively coupled plasma mass spectrometry. Permanent reducing conditions occurred in the 2Cr horizon with dissolved Fe concentrations of 44.8 mg L⁻¹ (median). Total Fe increased from 50 g kg⁻¹ (Ah) over 316 g kg⁻¹ (Bg) up to 412 g kg⁻¹ (CrBg), and was lowest in the 2Cr horizon (7 g kg⁻¹). Ferrihydrite (51% of total Fe) was dominant over goethite (24%) in the Ah horizon. Conversely, nanogoethite dominated both the Bg (94%) and CrBg (86%) horizons. Iron in siderite amounted to 7% in the CrBg horizon. Iron isotope compositions yielded a range of $\delta^{57}\text{Fe}$ values from +0.29‰ (Ah horizon) to -0.30‰ (Bg horizon). In contrast to the overlying CrBg ($\delta^{57}\text{Fe} = -0.19‰$) and Bg horizons, the 2Cr horizon is characterized by a relatively high $\delta^{57}\text{Fe}$ value of +0.22‰