Characterization and reactivity of geogenic manganese-oxides from South Africa

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This study characterizes the physical and chemical properties and the reaction kinetics of the geogenic manganese oxides found in Graskop, South Africa. Despite their importance in cycling redox-sensitive compounds in natural systems, much remains unknown about the oxidative capacity of natural manganese-oxides under environmental conditions. To study how these manganese-oxides react, soils were collected from Graskop, South Africa. Soils were excavated with a range of manganese concentrations up to 200 g/kg. The soil in each horizon was analyzed to determine the chemical and physical properties of the soils, including cation exchange capacity (CEC) and point of zero charge (PZC). A sequential extraction was used to determine the chemical form of the manganese and iron in this soil. X-ray powder diffraction (XRD) and scanning electron microscopy (SEM) were used to characterize the mineralogy of the crystalline material found in the clay fraction. A series of batch reactions were used to determine the capacity of these soils to oxidize arsenite into arsenate. Reactions were conducted under varied pH and temperature to elucidate how these conditions influenced the oxidation reaction. Samples were analyzed by liquid chromatography-inductively coupled plasma-mass spectrometry (LC-ICP-MS). Solid samples were analyzed at NSLS-II on beamline 4-BM (XFM) and micro-XRD was used to determine the mineralogy of the manganese nodules and soil matrix on the micro-scale. This study provides key insights to more fully understand the role of manganese-oxides in controlling redox-sensitive reactions in the environment.