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Mineralogy of lead in a soil developed on a Pb-mineralized sandstone (Largentière, France)

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ABSTRACT

Lead speciation was determined in a soil developed on a geochemical anomaly arising from a Pb-Zn stratabound deposit in Largentière (Ardèche, France). This geological setting offers the opportunity to determine the preferred form(s) of Pb following soil formation on this unique anomaly. In the soil profile studied, Pb concentrates in the B-horizon (2055 mg/kg Pb) relative to both the A- (1330 mg/kg Pb) and C- (1874 mg/kg Pb) horizons. Plumbogummite ($PbAl_3(PO_4)_2(OH)_5 \cdot H_2O$) is the main host of Pb in the soil profile. Pb also appears to be associated with Mn-(hydr)oxides, as shown by micro-analyses (EMPA, SEM-EDS, and μ-SXRF), in the form of inner-sphere Pb^{2+} complexes, as suggested by Pb L_{III}-edge EXAFS spectroscopy. Linear least-squares fitting of background-subtracted, k^3-weighted Pb L_{III}-edge EXAFS functions derived from bulk soil samples was carried out using Pb L_{III}-EXAFS spectra of 22 Pb-containing model compounds. Quantitative assessment of Pb speciation revealed that, whereas plumbogummite is the most abundant Pb phase in the soil profile, Pb^{2+}–Mn-(hydr)oxide surface complexes are gradually replaced by Pb^{2+}-surface complexes with other phases, possibly Pb^{2+}-organic complexes, upward in the soil profile. The presence of large amounts of Pb-phosphate in the Largentière soil suggests that low solubility phosphates may be important long-term hosts of Pb in Pb-contaminated soils that have sufficiently high phosphorous activities to cause formation of these phases.