



Cobalt speciation and exchangeability in soils

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The worldwide manufacture of steels and alloys, among other anthropogenic activities, involves the production and utilization of approximately 43,000 tonnes of cobalt (Co) per annum. Release of Co from these activities could engender some risk to exposed communities. While Co is an essential micronutrient for mammals as the central element of vitamin B12, excess Co can lead to toxic, carcinogenic and mutagenic effects. The environmental risk posed by Co contamination is largely a function of its oxidation state in soil and water. Simple compounds of Co(III) are strong oxidizing agents; however, natural and anthropogenic ligands can stabilize this species to varying extents in aqueous solutions. In its reduced form, Co(II), simple salts and aquo-complexes are stable in aqueous solution but the presence of other ligands can promote its oxidation to Co(III). The objective of our work is to assess the potential biological availability of Co and examine Co speciation in a range of soils with varying physiochemical properties. In this study, we have characterized cobalt species in several soils from Australia, Europe, and the United States with varying properties such as manganese, iron and aluminium oxide content, pH, and organic carbon content. We have assessed the applicability of using a modified isotopic dilution technique with selected ligand exchange and high performance liquid chromatography-inductively coupled plasma-mass spectrometry to determine the exchangeable Co fraction in these soils. Cobalt speciation in soils is influenced to a large degree by the presence of Mn, Fe and Al oxides. In this work, we observed nearly complete oxidation of added Co(II) to Co(III) on the surfaces of soils high in Mn, Fe and Al oxides. We have also investigated the effects of several common reducing agents on the relative stability of ligand-bound Co(II) and Co(III) in soil solutions following their extraction from the soil solid phase.