CONTAMINANT METAL CONCENTRATIONS IN ALBERTA SOILS UNDER DIFFERENT LAND USES[1]

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Metal and metalloid elements occur in soils at varying concentrations related to composition of the earth's crust, variations in surface mineralogy and weathering processes. Some such elements in one or more chemical forms pose a toxic hazard to various life forms including humans, plants, animals and microbiota. At naturally occurring concentrations these elements rarely require management because they occur primarily in stable or metastable minerals that equilibrate with low bioavailable metal concentrations in the soil solution. However, elevated metal concentrations due to contamination degrade soil quality in part through raising the concentrations of bioavailable forms. Because geochemical backgrounds vary, it is usually of interest in a soil quality investigation to assess metal contaminant concentrations on a site-specific basis and in consideration of regional expectations.

Over the past few years Alberta Environmental Protection's Chemicals Assessment and Management Division has been collecting and interpreting both ambient and industrial point source data on contaminant metal concentrations in Alberta soils. Between 700 and 800 observations have been made on 12 metal concentrations in surface soils under ambient conditions. Samples for these analyses were drawn primarily from agricultural soils prior to regulated application of municipal sewage sludge (about 200 samples) and from a program designed to sample soils from throughout Alberta in five land use categories (about 600 samples) as follows: transportation corridors, new urban and old urban parklands, rural parklands and commercial sites. Several hundred observations on industrial site soil quality are also available from investigations conducted under regulatory approvals, primarily for chemical plants, fertilizer plants, gas plants, railyards, wood preservers and the metal industry.

Analyses to date have established the normal geochemical range and approximate distribution of the common contaminant metals in upland Alberta soils as well as an overview of the magnitude, frequency and nature of contamination under some land use applications.

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Distributions of contaminant metals under non-contaminating or minimally contaminating land uses - and located away from point of diffuse sources - are interpreted to represent geochemical background. Pooling data from the sewage sludge and ambient databases shows that many soil metals commonly follow an approximate normal distributions (e.g., Co, Cr, Cu, Hg, Ni, V and Zn), but distributions with varying degrees of right skewness are common also (Ba, Cd and Pb). Classical parametric statistics such as the mean and standard deviations have greatest meaning for the first group, but both groups can be discussed in terms of the cumulative frequency distributions. This is useful in considering data from more intense land use classes. For example, it can be estimated that the probability of a soil lead concentration in excess of 25 mg kg^{-1} occurring for reasons other than contamination is less than 0.01%. Contaminant metal data from the industrial site database generally shows the same fundamental geochemical distributions seen under ambient conditions, but these are augmented by points, spikes and clusters of higher values representing contaminant release to soil. Exceedance of geochemical background at industrial facilities is common for many metals, whereas exceedance of Alberta Tier I Criteria is less common and confined to certain metals. Observations exceeding CCME Commercial/Industrial criteria are relatively few and tend to be both localized and specific to the feedstocks and wastestreams characteristic of the particular industrial activity.

Two major conclusions from the work to date are: (1) prediction or determination of geochemical background at a particular site is normally straightforward and non-contentious; and (2) with few exceptions, Alberta industries are doing a good job of protecting on-site soils from severe contamination by toxic metals.

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