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Cadmium Accumulation in Browse Vegetation, Alaska — Implications for Animal Health

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Introduction

We conducted biogeochemical investigations of Cd transport and uptake by vegetation over a metamorphic and intrusive terrane in the Fortymile River watershed and Mining District, east-central Alaska. The occurrence of Cd in eolian-dominated sub-arctic soils developed over five major rock units was examined, as well as its relative bioaccumulation in willow. Although the bioaccumulation of Cd by willow (Salix spp.) has been known for some time (Gough 1991), the connection to adverse animal health, under natural (geogenic) conditions, has only recently been demonstrated (Larison et al. 2000, Mykelbust and Pederson 1999). We present Cd data for three soil horizons and the leaf and twig material of Salix glauca L. (grayleaf willow) collected at sites within defined rock units. The cycling of Cd and its bioaccumulation in willow are compared among rock types and soil horizons.

Results and Discussion

Cadmium in study area soils is derived from aeolian dust (loess) and the weathering of the primary bedrock. Plots of rare earth elements (REE, normalized to chondrite abundance's) in samples of A, B, and C soil horizon soils were similar to REE patterns in regional loess samples and did not correspond to bedrock patterns. Not surprisingly, therefore, we found essentially no difference in the concentration of Cd in soils developed over different lithologic units. In addition, the anthropogenic input (from mining) at sites we sampled was found to be minimal. Cadmium levels in soil (Fig. 12.1) are generally higher than that found in the study area rock types (~2 ppm)(Day 2000). In our acidic soils (pH 4.5–6.0), Cd should be mobile (readily leached), and should tend to form complexes with carbonates, hydroxides, and phosphates. Interestingly, Cd concentrations decrease with increasing soil depth — a trend directly proportional to soil organic matter content.

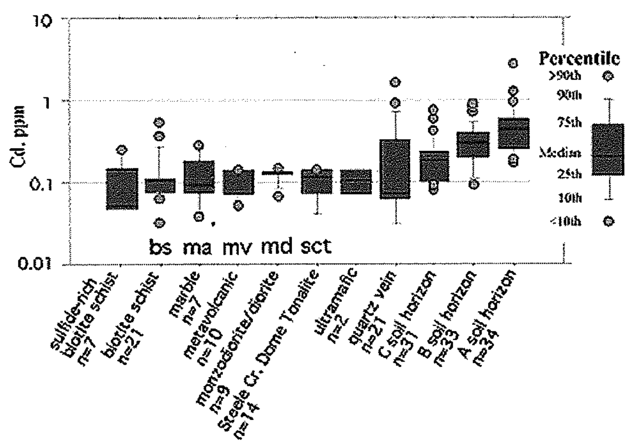

Figure 12.1: Percentile box plots of Cd concentrations in rock units and soils of the Fortymile River watershed. Selected rock units keyed to Figures. 12.2 and 12.3 include supracrustal rocks (biotite schist, bs; marble, ma; basaltic metavolcanic, mv) and intrusive rocks (monzodiorite and diorite, md; Steele Creek Dome tonalite, sct).

Enrichment factors (EF), a measure of the relative uptake by a plant of an element from its substrate — a sort of "bioavailability" assessment, are presented in Figure 12.2 for Cd in willow leaf material. This procedure normalizes the data, with respect to a geochemical reference element (in this case Ce), for each of the soil horizons developed over the five major rock units. For example, an EF of 5000 means that the plant is 5000 times more enriched in a given element compared to the substrate. Cadmium EF values show a marked soil-horizon difference increasing with depth. This difference reflects the greater concentration of Cd in the upper soil horizons. This trend is true for all rock units.

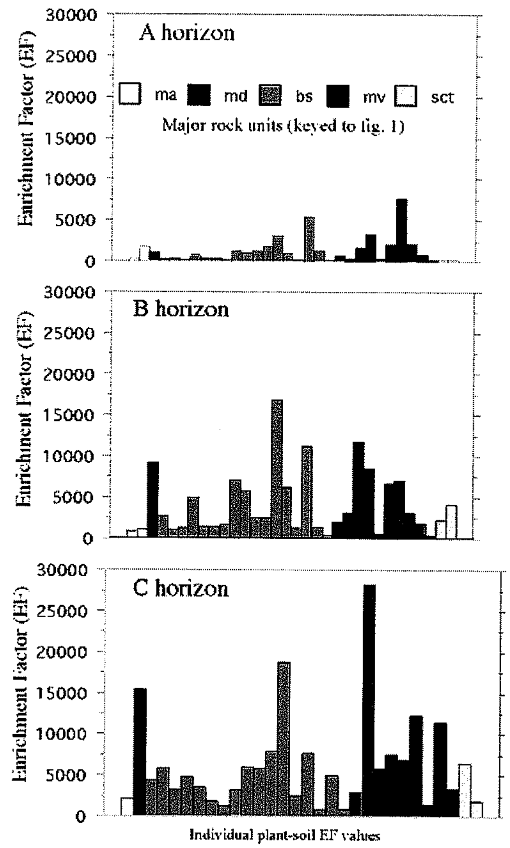

Figure 12.2: Enrichment factors for Cd in willow leaf material for A, B, and C soil horizons developed over five major rock units.

Cadmium concentrations in willow leaf and twig material (Fig. 12.3) were about an order of magnitude greater than those found in corresponding samples of different shrub species (Alnus spp.) and moss (Hylocomium splendens Hedw.) collected at the same sites (Gough 1999). White-tailed ptarmigan inhabiting the Colorado Mineral Belt has been shown to develop renal tubular damage that is linked to a diet of willow buds (Larison et al. 2000). Further, these authors hypothesized that Cd poisoning may be more widespread then previously suspected, among other willow-feeding herbivores (e.g., hare, beaver, and moose), in areas with high Cd in browse species. When compared to the mean of similar material collected in the Colorado Mineral Belt (2.1 ppm), our values are also elevated (mean ~1.1 ppm, Fig. 12.3). We suggest that the potential exist for a similar risk to herbivore health from Cd intake in this part of Alaska.

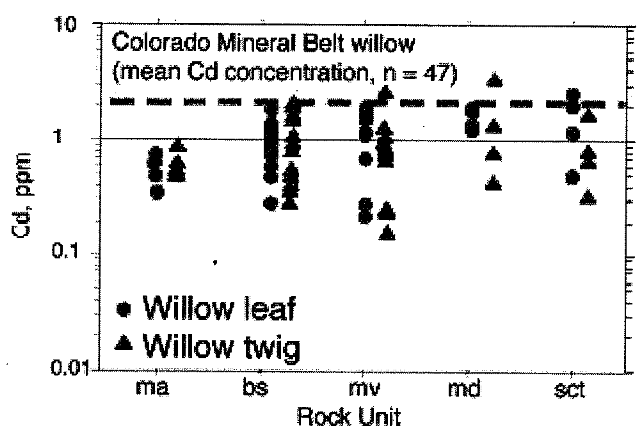

Figure 12.3: Concentrations of Cd in willow leaf and twig material growing over differing rock units (keyed to Figure 12.1) from Alaska compared to similar material from the Colorado Mineral Belt (latter from Larison et al. 2000).

References

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