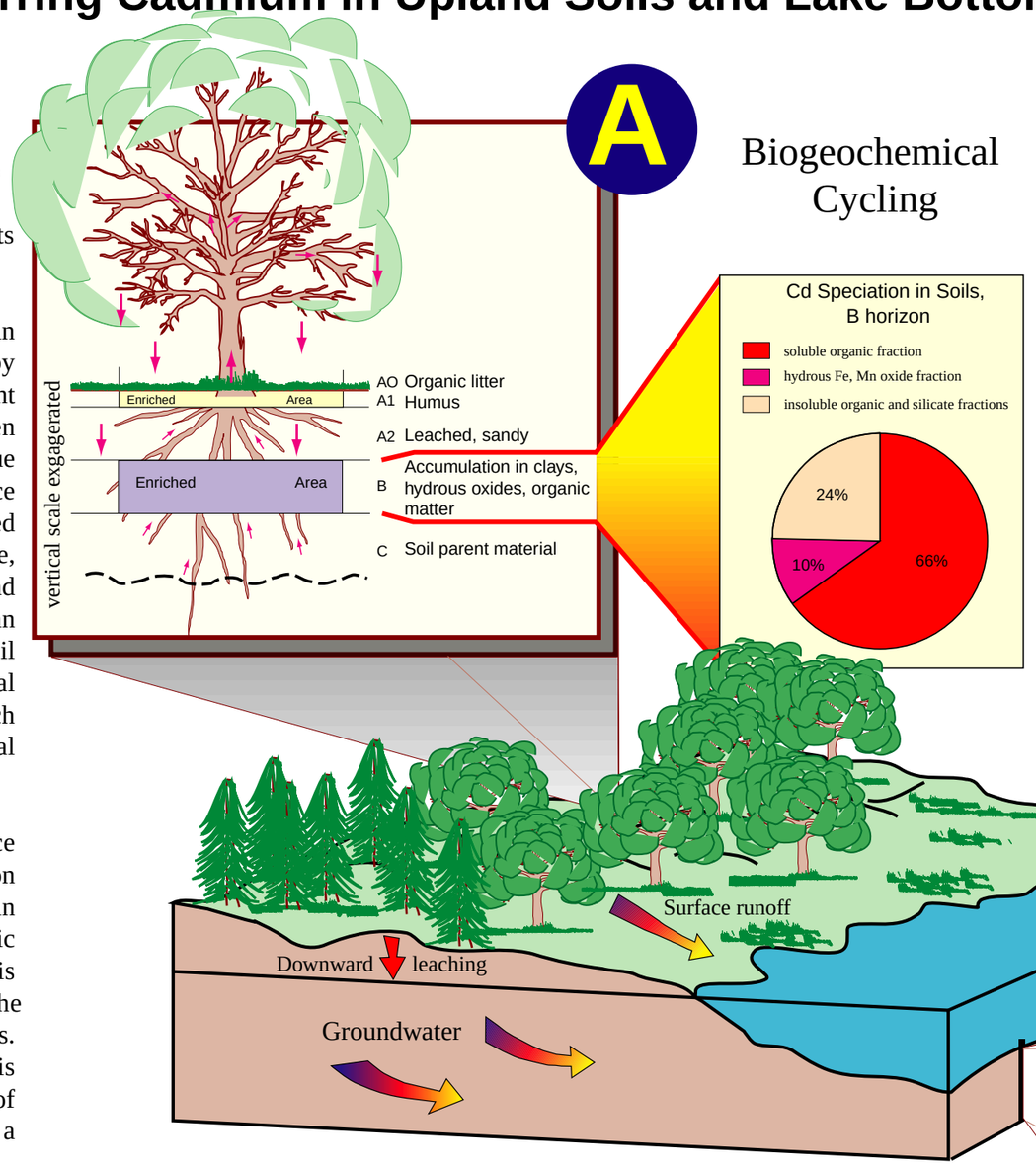
Naturally Occurring Cadmium in Upland Soils and Lake Bottom Sediments of the Boreal Forest

Biogeochemical cycling processes contribute to natural enrichment of cadmium and other trace metals in upland soils and lake bottom sediments of the boreal forest.

Some forms of metals which have their source in till and rock may become available for uptake by plants (see Fig A.). Metals incorporated in plant tissue eventually return to the soil in fallen leaves and dead wood. As the dead plant tissue decays, some metal is retained in the surface humus horizon of the soil, and some is leached downward to the underlying B horizon. There, metals accumulate in clays, hydrous oxides, and organic fractions. In this way trace metals can become enriched in different parts of the soil profile (see Fig. A). Thus, biogeochemical cycling is an important pathway along which metals enter the food chain from geological sources and become enriched in the soil.

Metals can be removed from soil by surface water and groundwater (see pathway arrows on the perspective diagram) and carried to a lake in the form of dissolved and particulate organic matter and iron-oxide complexes. In this example, cadmium is used to illustrate the pathways of trace metal concentrations in soils. As cadmium is removed from the soil, it is replenished by ongoing, chemical weathering of clays, hydrous oxides and organic matter as a continuation of the biogeochemical cycle.



The soil pie diagram (Fig. A) was constructed by averaging data from 24 well-drained upland sites within the watershed of Fairy Lake. The lake sediment pie diagram (Fig. B) was constructed by averaging 10 sub-samples of a 100 cm long core from Fairy Lake.

As part of a study on trace metals in the environment, cadmium in organic lake bottom sediments of Fairy Lake, Ontario, exists in soluble organic and in amorphous (hydrous) iron-oxide fractions (see pie chart B). The proportion of cadmium in these two fractions of lake sediment (89%) is greater than in the upland forest soil (76%) (compare pie charts A and B). Algae and aqueous plants accumulate cadmium during their life cycle and, upon death, the accumulated cadmium becomes part of the lake sediment profile (see Fig. B).

Diagenesis of lake sediment may also lead to elevated concentrations of cadmium near the sediment surface, and lower concentrations deeper in the sediment profile (see Fig. B). "Diagenesis" refers to the physical, chemical, and biological changes that occur in sediment after deposition. Unless the effects of diagenesis are known, trace metal profiles of lake sediments may not be accurate reconstructions of trace metal input from anthropogenic (human) sources.