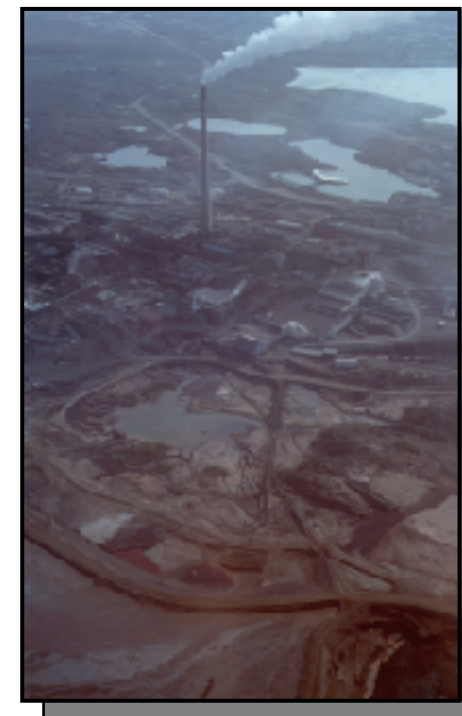


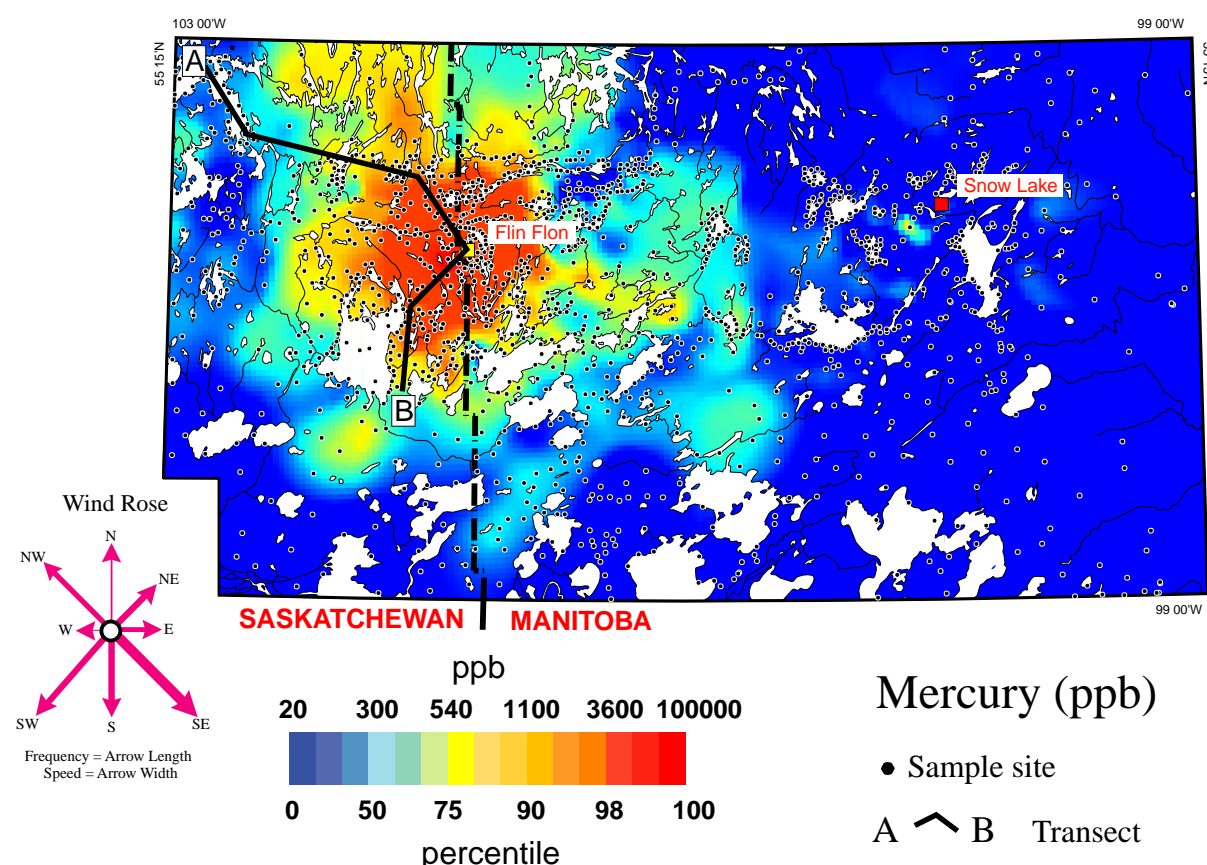
The Effects of Smelter Emissions on the Terrestrial Environment

Trace metals in surficial deposits reflect bedrock geology and the composition of glacially transported material. In some areas they can also reflect the effects of mining and smelting activities. Since the early 1930's, smelting of base metal ore at Flin Flon, Manitoba, has released large quantities of metal-rich particulates into the atmosphere. The metals include arsenic, cadmium, copper, iron, mercury, lead, and zinc, all of which can affect human health, wildlife, and vegetation. To determine the dispersal and fate of Flin Flon smelter-derived metals, about 2000 samples of humus (decomposed leaf and plant litter) and the underlying C-horizon (till) were collected over a 36,000 km² area and analyzed geochemically.



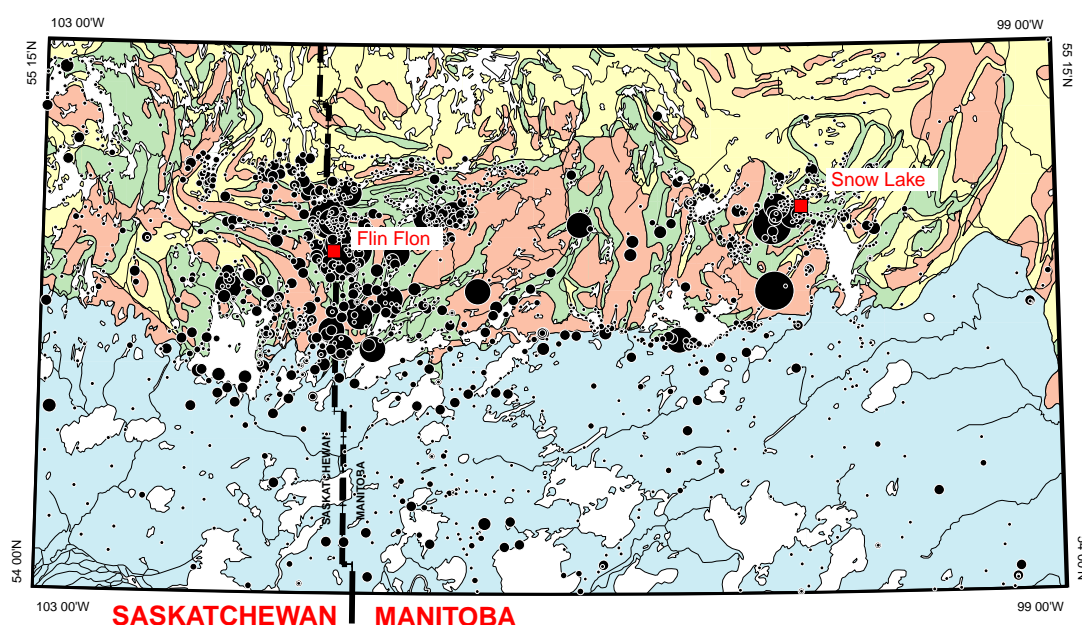
Trace Metals in Humus

In humus, concentrations of smelter related elements decrease with distance from the smelter stack, describing a "bull's eye" pattern up to 85 km wide. The shape of the bull's eye is slightly distorted in the directions of prevailing winds. Adjacent to the smelter stack, mercury concentrations are up to 500 times greater than background levels (see concentration/distribution graph below). The map at the left depicts the bull's eye distribution for mercury, and it is similar to the patterns for other smelter-emitted elements. Near the smelter, heavy metals are largely retained in smelter-derived particulates (as shown in the grain images below), and with distance, the number and size of these particles decrease, and/or the composition varies. This suggests that particulate emissions are subject to density sorting by wind. The distributions of trace metals unrelated to smelter emissions (e.g. nickel, cobalt, chromium) do not exhibit the bull's eye pattern.



Trace Metals in Till

In C-horizon till, concentrations of all smelter-related elements are commonly lower than in humus and show no direct relationship to distance from the smelter (see dot map and graph). At depths greater than 40 centimetres, trace metal distribution is related primarily to bedrock composition, modified by the effects of glacial erosion, transport, and deposition. The dot map displays concentrations of mercury in till superimposed on bedrock geology. Till derived from carbonate rock (blue on geology map) contains lower trace metal concentrations than till derived from Shield terrain. High concentrations of mercury in till in the Flin Flon and Snow Lake areas are related to naturally occurring mercury in bedrock.



Mobility of Metals

In both humus and till, trace metals are either "mobile" and readily available for uptake by plants and other organisms, or "non-mobile" and unavailable. Mercury is retained primarily in immobile phases in both humus and till (see pie charts on graph). Humus collected in areas of high contamination (>100,000 ppb) adjacent to the smelter contains significant concentrations (41% of the total) of mercury in "mobile" forms which may represent an environmental hazard. Elevated concentrations of mercury in the underlying till suggest downward leaching, although enrichment could also reflect natural values associated with known ore bodies in the Flin Flon area. At distances greater than 85 kilometres from the smelter, mercury concentrations approach regional background in humus, and less mercury (30% of the total) is "mobile".

