Distribution of Anthropogenic Metals in Soils of the Sudbury, Ontario, Smelter Footprint

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The metal mining and smelting industry in the Sudbury, Ontario, area began before the turn of the century, developing into one of the largest metal producing complexes in the world. The atmospheric emissions of sulphur were massive, with the area-smelting complex being one of the largest point sources of SO_2 emissions in the world in the early 1960's at over 2,000,000 tonnes per annum, with reductions through implementation of abatement measures to approximately 200,000 tonnes in the 1990's. As important as the SO_2 emissions were the 1500 tonnes of metal particulates carried aloft annually in the hot gas plume, particulates composed primarily of minute iron-rich fly-ash spherules containing intergrowth of nickel, copper and other trace metals. The result of the atmospheric washout of this massive release was a denuded landscape with acidified soils contaminated with metals. This massive environmental insult means the Sudbury region provides an opportunistic macrocosm for mechanistic research on the effects of severe acidification and metal pollution on soils and ecosystems.

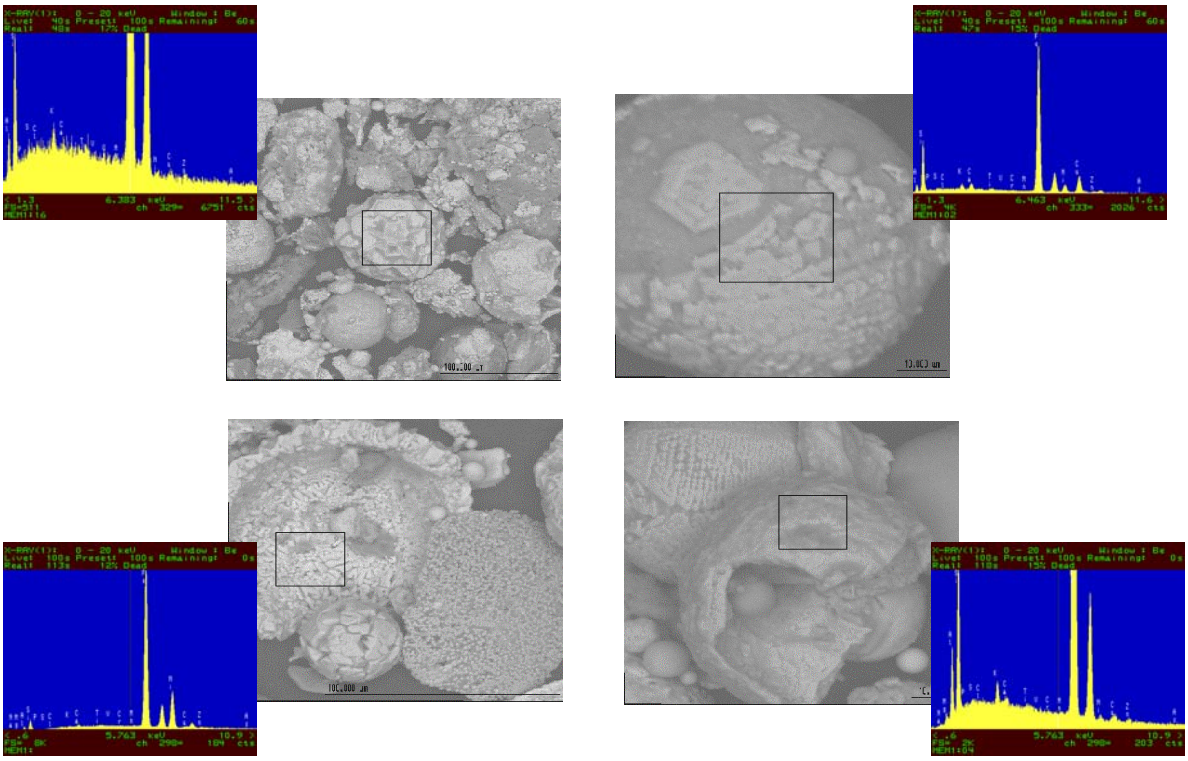

Figure I. Examples of metal-rich magnetic particles from an LFH horizon of a pedon in the Sudbury smelter footprint.

Current static pedological research initiatives are focused on describing the nature and distribution of metals and metal-rich fallout particles regional soils. The research to be presented will focus on the regional impact of smelter emissions on metal distribution within sola. The morphology, mineralogy and compositional chemistry (Table I) of metal-rich fragments filtered by the LFH horizons of selected Podzolic and Brunisolic pedons within the Sudbury smelter footprint will be described. These particles, composed of minerals such as magnetite, maghemite, and trevorite, contain varying quantities of iron, nickel, copper, cobalt, chromium, lead, arsenic, selenium, manganese and zinc (Figure I).

Table I. Total content of selected metals, potentially of anthropogenic origin, in a Podzolic pedon from the Sudbury region, Ontario, Canada.

Soil Horizons	As	Cr	Cu	Mn	Ni	Pb	Se	Zn	Fe
	parts per million								(%)
LFH	60	95	4550	1950	2560	417	24	188	5
Ae	17	42	105	369	40	12	1	32	1
Bhf1	7	82	13	324	62	12	1	117	3
Bhf2	4	66	14	227	32	6	nd	46	2
BC	7	55	17	193	23	8	1	37	2

Regional distribution patterns for anthropogenic metals, based on a regional stratified block design with randomization, will illustrate the effects of the intensive mining and smelting activity over the past century within the Sudbury ecosystem. Results from this study indicate that effects of aerosolic fallout are retained in the LFH horizons of soils in excess of 100 km from the smelting epicenter. The data will be compared with accepted environmental standards from both Europe and North America.