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Reconstructing the environmental impact of smelters using Pb isotope analyses of peat cores from bogs: Flin Flon, Manitoba and Harjavalta, Finland

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Located on the Manitoba – Saskatchewan border, the city of Flin Flon has been home to a metallurgical complex since 1930, processing Cu and Zn ores from surrounding mines and consisting of a concentrator, Zn plant, and Cu smelter. Peat cores were collected from two sites, dated using ^{210}Pb, and measured for a broad suite of potentially toxic trace metals. A peat core collected from the bog at Kotyk Lake (30 km NE of FF) shows declines in ^{206}Pb/^{207}Pb from the natural "background" values of 1.25 at the base of the core, to a minimum of 1.02. A peat core collected from the bog at Sask Lake (88 km NW of FF) shows declines in ^{206}Pb/^{207}Pb from the natural "background" values of 1.35 at the base of the core to a minimum of 1.05. But the isotopic evolution of Pb shows significantly declines in ^{206}Pb/^{207}Pb beginning in the late 1800's, presumably because of long-range atmospheric transport from other sources. The ^{206}Pb/^{207}Pb values increase in both cores starting in the 1960's, and reach a recent maximum in the 1990's, apparently reflecting the growing use and eventually phase out of leaded gasoline use. Since the 1990's, the ^{206}Pb/^{207}Pb have continued their decline, apparently reflecting the elimination of leaded gasoline and the growing relative importance of Pb from the smelter. The temporal evolution in Pb enrichment factors follows the history of the metallurgical complex, with the maximum EF values (calculated using Sc) reaching maxima of ca. 100 x (Kotyk Lake) and 10 x (Sask Lake). The maximum rates of atmospheric Pb accumulation are approximately 1200 and 120 μg/m^2/yr, respectively.

In Finland, peat cores were taken from three bogs: the Pyhäsuo mire in SW Finland, 6 km NE from the Cu Ni smelter at Harjavalta (HAR); at the Viurusuo complex in eastern Finland, 8 km SW of the Cu Ni mine in the town of Outokumpu (OUT); and at Hietajärvi (HJ), in the Patvinsuo National Park of eastern Finland. The cores from HJ and OUT document 3,000 years of anthropogenic Pb and provide a remarkably similar evolution of Pb isotopes, reaching values as low as ^{206}Pb/^{207}Pb = 1.151 (AD 1982) and 1.148 (AD 1984), respectively. At HAR, the minimum values are lower (^{206}Pb/^{207}Pb = 1.120) and earlier (AD 1954 -1967), presumably because of emissions from the smelter. The Pb concentrations in the porewaters from HAR are approximately an order of magnitude greater than the other sites, and the ^{206}Pb/^{207}Pb values significantly lower (ca. 1.12 vs. 1.15), because of the combined effects of greater Pb deposition and surface water acidification (pH 3.5 versus pH 4.0 in the other bogs).