

## Trace metal accumulation in Finnish peat bogs with known pollution history

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### Introduction

In Finland, the analysis of surface peat from ombrotrophic bogs has been used for estimating the regional distribution of atmospheric trace metal deposition (Pakarinen and Tolonen 1976, Pakarinen et al. 1983). The recent progress in analytical techniques makes it possible to study also the vertical element distribution in peat profiles, and even to reconstruct historical records of atmospheric trace metal deposition by using the modern accurate age-dating techniques (Shotyk et al. 1998). Thus far, ombrotrophic peat cores have proved to be meaningful archives of Pb (Weiss et al. 1999) and Hg (Givelet et al. 2003), but there are much less information concerning e.g. Cu and Ni.

Most of the studies on vertical trace metal distribution in ombrotrophic bogs have been carried out at background sites, where the overall deposition has been low. In heavily polluted conditions, the distribution of elements may drastically change due to the elevated burden of the accumulated elements.



Fig. 1. Location of the study sites.

### Material and methods

We collected peat samples (15cm x 15cm x 100cm) from four ombrotrophic peat bogs in Finland: 1) Outokumpu close to a former copper mine; 2) Harjavalta, close to a Cu-Ni smelter; 3) Hietajärvi, a rural background site without any local point sources and 4) an old ore-prospecting simulation experiment at Alkkia treated with Cu and Ni sulphate (20 000 mg m<sup>-2</sup>) in 1962 (Figs 1 and 2). Peat cores were cut into 1cm slices, and the Cu concentrations were measured using ICP-MS and Ni and Pb concentrations using XRF. Age-depth relationship of the cores was determined using <sup>210</sup>Pb CRS age-dating method.



Fig. 2. Peat core of the Outokumpu sampling site.

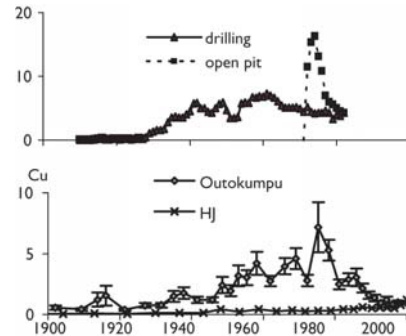


Fig. 3. a) Ore production rates at the Outokumpu mines. b) Cu accumulation rates at the Outokumpu peat bog.

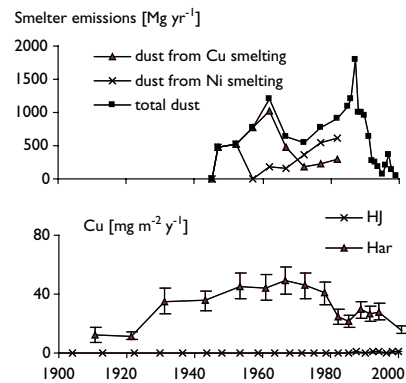


Fig. 4. a) Dust emissions from the Harjavalta smelters. b) Cu accumulation rates at the Harjavalta peat bog.

### Results and discussion

At the Outokumpu site (Fig. 3), elevated accumulation rates (AR) correspond to the intensity of mining activities, with a sharp distinct peak for Cu, while at Harjavalta (Fig. 4) the increase in Cu AR predates the true beginning of Cu smelting in the area (Rausch et al. 2005). However, this might be a consequence of uncertainties in <sup>210</sup>Pb age dates, as well as downward Cu migration. At the background site Hietajärvi (Fig. 5) Cu AR increased considerably from ca. 1945 onwards, the greatest values occurring during the 1990s (Rausch et al. 2005). Monitoring of annual trace metal deposition in bulk precipitation started in 1990 at Hietajärvi, and the monitored Cu deposition is in good agreement with the Cu ARs for the same period. The Pb ARs at Hietajärvi (Fig. 6) follow largely the same pattern as Cu ARs until 1990, but thereafter there is a decreasing trend in the Pb ARs. A corresponding decrease can be observed in the monitored Pb deposition.

No age-dating could be realized for the Alkkia core taken from the old ore-prospecting simulation experiment. The peat formation apparently completely ceased in 1962 due to the extremely high doses of metal sulphates applied. Cumulative Cu inventory of the Alkkia bog (Fig. 7) reveals that the applied dose (20 000 mg m<sup>-2</sup>) is retained by the top most 15cm-thick layer of the peat, while the corresponding dose of Ni has migrated deeper in the profile. The applied Ni dose is found in the top most 35cm-thick layer.

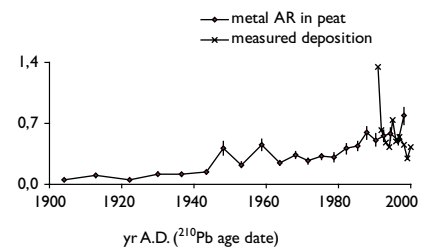


Fig. 5. Cu accumulation rate at the Hietajärvi peat bog and the monitored atmospheric bulk deposition of Cu.

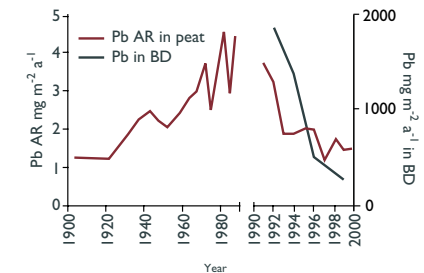


Fig. 6. Pb accumulation rate at the Hietajärvi peat bog and the monitored atmospheric bulk deposition of Pb.

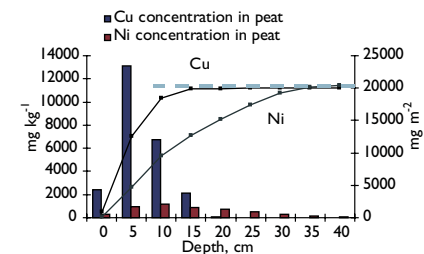


Fig. 7. Vertical distribution of Cu and Ni concentrations (left axis) in peat sampled from pine bogs treated with either Cu sulphate or Ni sulphate in 1962. The lines presents the cumulative amounts of Cu and Ni retained by the peat layer (right axis).

### References

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