Trace metal accumulation in Finnish peat bogs with known pollution history

Tiina M. NIEMINEN[1] , Liisa UKONMAANAHO[1] , Nicole RAUSCH[2] , William SHOTYK[3]

1. Finnish Forest Research Institute, FI-01301 Vantaa, Finland. *tiina.nieminen@metla.fi, liisa.ukonmaanaho@metla.fi*
2. European Commission, Joint Research Center, Institute for Transuranium Elements, Nuclear Chemistry Unit, Analytical Chemistry section, Karlsruhe, Germany. *nicole.rausch@cec.eu.int*
3. Institute of Environmental Geochemistry , University of Heidelberg, Germany. *shotyk@ugc.uni-heidelberg.de*

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. 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^{-2}) in 1962. 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 ^{210}Pb CRS age-dating method.

At the Outokumpu site, elevated accumulation rates (AR) correspond to the intensity of mining activities, with a sharp distinct peak for Cu, while at Harjavalta 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 ^{210}Pb age dates, as well as downward Cu migration. At the background site Hietajärvi 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 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 realised 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 reveals that the applied dose (20 000 mg m^{-2}) 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.

References

Givelet, N., Roos-Barraclough, F. & Shotyk, W. 2003. Journal of Environmental Monitoring 5: 935-949.

Pakarinen, P. & Tolonen, K. 1976. Ambio 5: 38-40.

Pakarinen, P., Tolonen, K., Heikkinen, S. & Nurmi, A 1983. Ecological Bulletins 35: 377-382.

Rausch, N., Nieminen, T., Ukonmaanaho, L., Le Roux, G. Krachler, M., Cheburkin, A.K., Bonani, G. & Shotyk, W. 2005. Environmental Science & Technology 39: 5989-5998.

Shotyk, W., Weiss, D., Appleby, P.G., Cheburkin, A.K., Frei, R., Gloor, M., Kramers, J.D., Reese, S. & van der Knaap, W.O. 1998. Science 281: 1635-1640.
Weiss, D., Shotyk, W., Gloor, M., Kraamers, J.D. 1999. Atmospheric Environment 33:3751-3763.