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Synchrotron X-Ray Fluorescence and Secondary Ion Mass Spectrometry In Tree Ring Microanalysis: Applications To Dendroanalysis

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Beamline(s): X26A

Introduction Dendroanalysis is the study of the element distribution in the annual growth rings of trees [(1)]. Synchrotron radiation induced x-ray emission (SRIXE) has proved to be useful in environmental analysis, especially when used as a fluorescence microprobe [(2)]. The technique has been shown to be effective in dendroanalysis and can be effectively combined with secondary ion mass spectroscopy (SIMS) [(3)].

In this work SRIXE and SIMS have been used to examine the effects of remedial liming on the metal content of tree rings in red pine samples collected from an area, which had been subjected to metal deposition and acid rain. Tree rings representing rings before and after liming was examined. This research appears in: X-ray Spectrometry, 30:338-341 (2001).

Methods and Materials: Stemwood was collected from red pine (Pinus resinosa) near Daisy Lake, Sudbury, Ontario, using standard coring methods. The resulting cores were examined under a low power microscope to identify the years between 1991 and 1996. Liming had occurred in 1993. The rings corresponding to 1994, 1995, and 1996, were subjected to SRIXE analysis using the Brookhaven National Synchrotron Light Source X26A beamline collimated to produce a beam size approximately 10 X 15 microns on the sample. A white beam was used to minimize acquisition time. The sample was scanned in 500 micron steps in the x direction and 50 micron steps in the y direction, covering a total area of 2.5 x 12 mm. SIMS analysis was carried out using a Camera IMS/3f instrument at Surface Science Western using a 100 nA O^- primary ion beam. Secondary ions were collected from rings corresponding to 1991, 1994, 1994 and 1996.

Results: The SRIXE results show Ca distribution indicative of seasonal uptake, closely matching that obtained for Mn. Fe, Cu and Cr show an irregular distribution, indicating that local and bulk concentrations will often differ significantly. The SIMS results suggest an increase in the Ca/MN ratio following liming. This result is consistent with reduced soil acidity.

Conclusions: The results are consistent with seasonal uptake of metals and changes in metal uptake reflecting an increase in soil pH. The results provide direct evidence of improved soil conditions following liming.

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