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One sample is not enough: Differences and similarities in element concentrations of tree rings in dependence of sampling direction and height along the stem

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Dendrochemistry, i.e. the chronological analysis of element concentrations in the rings of living trees and archaeological wood is an evolving field. Attempts have been made to attribute trends, peaks or depletion of certain metal elements to volcanic eruptions, atmospheric pollution and other abrupt and gradual environmental or climatic changes (e.g. Padilla and Anderson, 2002; Pearson et al., 2009; Watmough, 1999). Once scientifically successfully established, the relationship between environmental drivers (the contemporary growth environment) and element concentrations in tree rings may offer great annually or even intra-annually resolved proxy potential as trees or archaeological/subfossil wood are widely available.
Current challenges to dendrochemistry are mainly due to: 1) Possible radial or vertical translocation processes of elements in the wood (active during heartwood formation or passive) that might blur or obscure any dendrochemical signal and hamper precise dating of events. 2) Labour and time intensive methods (e.g. atomic absorption spectrometry (AAS) or inductively coupled plasma mass spectroscopy (ICP-MS)) that normally require sample digestion or solvent extraction and limit the amount of samples which can be processed. This leads to usually small sample sizes (<10) in dendrochemical studies, with mostly only one sample (core) per individual analyzed.
X-ray fluorescence (μXRF) provides a non-destructive, high resolution and timesaving alternative and offers the opportunity to increase sample size, but needs to be methodologically tested to ensure scientific accuracy. In our study we systematically compare count-rates of certain elements (Al, Si, P, S, Cl, K, Ca, Cr, Mn, Fe, Ni) between three different stem expositions (N, S and W) and three different heights (base, middle and top) along the stems of mature deciduous (Castanea sativa Mill.) and coniferous (Pinus sylvestris L.) trees. Measurements are conducted with an ITRAX Multiscanner equipped with a Cu X-ray beam on 1.2 mm thick wooden laths with a resolution of 50 μm, averaged within annual ring boundaries and normalized for comparison.
First results point to both differences and similarities in count-rates of the analyzed elements along stem radii and stem heights. Namely, clear but non-systematic differences were observed for most elements at high frequency (interannual) resolution, whereas longer term (decadal) trends were rather similar. This holds true for nutrients, non-nutrients as well as their ratios that for example could serve as indicators for changes in soil acidity. To enhance the desired common environmental signal and to average out physiologically controlled differences in element distribution in the xylem, we propose to analyze more than one sample per tree and to develop specific chronology building procedures also in dendrochemical studies. Meeting these initial challenges promises a host of new opportunities in dendrochemistry and all its scientific and practical applications.

Padilla, K.L., Anderson, K.A., 2002. Trace element concentration in tree-rings biomonitoring centuries of environmental change. Chemosphere 49, 575–585.

Pearson, C.L., Dale, D.S., Brewer, P.W., Kuniholm, P.I., Lipton, J., Manning, S.W., 2009. Dendrochemical analysis of a tree-ring growth anomaly associated with the Late Bronze Age eruption of Thera. J. Archaeol. Sci. 36, 1206–1214.

Watmough, S.A., 1999. Monitoring historical changes in soil and atmospheric trace metal levels by dendrochemical analysis. Environ. Pollut. 106, 391–403.