Geophysical Research Abstracts
Vol. 12, EGU2010-9193, 2010
EGU General Assembly 2010

What climate information is recorded in stable isotope ratios of wood lignin methoxyl groups?

Markus Greule and Frank Keppler
Max Planck Institute for Chemistry, Joh.-Joachim-Becher-Weg 27, D-55128 Mainz, Germany

The stable isotope composition of the bioelements C, O, H and N in plant organic matter is known to be a very powerful for various environmental impacts. Particularly tree rings are suitable for this analysis because they exhibit a "climate archive" with a yearly or even biannual resolution. One of the most determined wood compounds is cellulose which amongst others is used to reconstruct the temperature due to measurement of stable hydrogen and oxygen isotopes. Therefore cellulose is converted into cellulose nitrate to eliminate the exchangeable hydroxyl hydrogen or equilibration methods are used. However, a general problem associated with the determination of the stable hydrogen values of marker compounds for the study of climate and environmental conditions is the isolation of the pure compound for analysis by isotope ratio mass spectrometry. Exploitation of components of wood as markers, in particular, has been restricted by the very labour intensive and time consuming preparation of samples (e.g. cellulose nitrate).

An alternative way to record climate information from tree rings was recently proposed by Keppler et al. (2007) who measured the stable hydrogen values of methoxyl groups in wood. Lignin methoxyl groups are considered to be stable, i.e. the hydrogen atoms of the methoxyl moiety do not exchange with those of plant water during ongoing metabolic reactions in the plant. Thus the initial deuterium content of the methoxyl groups of lignin in woody tissue at formation is retained throughout the lifetime of the tree and in preserved tissue. The methoxyl content of lignin in wood is usually determined by the Zeisel method (Zeisel, 1885) – the reaction between methyl ethers and hydroiodic acid to form methyl iodide. Exploiting this reaction for the measurement of stable hydrogen values of lignin methoxyl groups ensures that during the entire analytical procedure the isotope signal is preserved since no isotopic exchange occurs between the methyl groups and HI and no isotopic fractionation in the course of CH3I formation is observed (Greule et al. 2008, Greule et al. 2009). Moreover the method requires only a small quantity of sample (down to 1mg wood) and only minimal and straightforward sample preparation and analysis (1 hour including all steps). Due to the small sample amount tree cores collected by 5mm increment borer are sufficient to perform isotope analysis with annual resolution.

Here we present stable isotope analysis of lignin methoxyl groups of several tree ring sequences and discuss the potential of this method to serve as a climate proxy. In addition we will show that the method has great potential to assist with the constraint of the geographical origin of wood.

Literature:

Keppler F, Harper DB, Kalin RM, Meier-Augenstein W, Farmer N, Davis S,
Schmidt H-L, Brown DM, Hamilton JTG. New Phytologist 2007; 176 : 600.
Zeisel S. Monatshefte für Chemie 1885; 6 : 989.
Greule M, Mosandl A, Hamilton JTG, Keppler F. Rapid Commun.Mass Spectrom.
2008; 22 : 3983.
Greule M, Mosandl A, Hamilton JTG, Keppler F. Rapid Commun.Mass Spectrom.
2009; 23 : 1710.