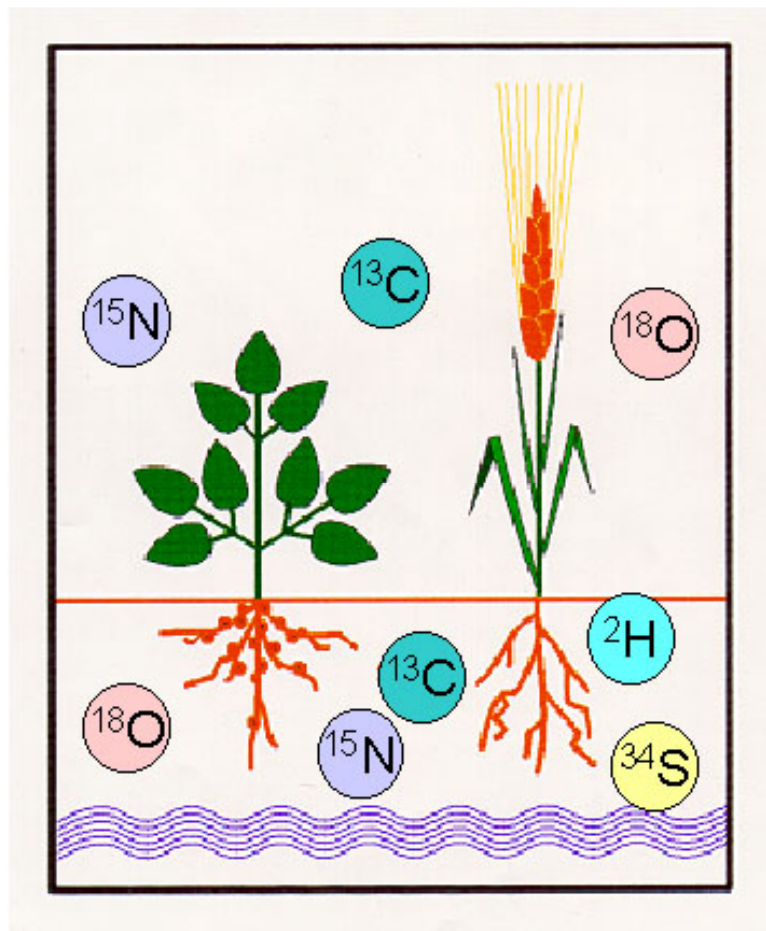# 3rd Viennese Workshop
Stable Isotopes in Biological
and Environmental Sciences

Friday, November 9th 2001
Hörsaal 4, UZA II, Geozentrum
1090 Wien, Althanstrasse 14

Edited by: Dr. W. Wanek, Dr. A. Richter and Dr. S. Wiener
(Institute of Ecology & Conservation Biology, University of Vienna)
Dr. Rebecca Hood (FAO/IAEA, Soil Science Unit, Seibersdorf, Austria)

Programm

09:00   09:30   **Welcome Address & Introduction**
H. Bolhàr-Nordenkampf (Institute of Ecology and
Conservation Biology, University of Vienna)

Session 1 (Chair M. Gerzabek)

09:30   10:00   **Spötl, Tooth & Burns**
(Institute of Geology and Paleontology, University of
Innsbruck)
Stable C and O isotopes in cave deposites: an important proxy
for environmental change.

10:00   10:30   **Horacek, Abart & Brandner** (Institute of Mineralogy,
University of Graz)
Carbon isotope record of the Permo/Triassic Boundary and the
Lower Triassic.

10:30   11:00   **Hertle, Davis & Drimmie** (Micromass GmbH, Eschborn,
Germany)
High precision soil and atmospheric trace gas stable isotopic
measurements in the investigation of sources od envrronmental
contaminants.

11:00   11:30   **Coffee break**

Session 2 (Chair R. Hood)

11:30   12:00   **Gerzabek, Haberhauer & Kirchmann**
(ARC Seibersdorf, Department of Environmental Research)
Nitrogen partitioning and ^{15}N natural abundances in soil
particle size fractions.

12:00   12:30   **Wania, Wanek & Hietz**
(Institute of Ecology and Conservation Biology, University of
Vienna)
Application of natural ^{15}N abundance in nitrogen cycling
studies of tropical rain forests.


12:30   14:00   **Lunch im Gasthaus Reznicek**

Session 3 (Chair A. Richter)

14:00 14:30   **Watzka & Wanek**
(Institute of Ecology and Conservation Biology, University of Vienna)
Stable isotopes as indicators of management intensity in montane grasslands.

14:30 15:00   **Hood, Haque, El Kadir & Khan**
(FAO/IAEA, Agriculture and Biotechnology Laboratory Vienna)
A comparison of mass spectrometry and FANCI techniques for measuring $\delta\ ^{13}C$.

15:00 15:30   **Peduzzi & Hein**
(Institute of Ecology and Conservation Biology, University of Vienna)
Stable isotopes: a powerful tool to elucidate ecological processes in floodplaines.

15:30 16:00   **Coffee break**

16:00 17:00   **Plenary Session
"Stable Isotope Network Austria?"**
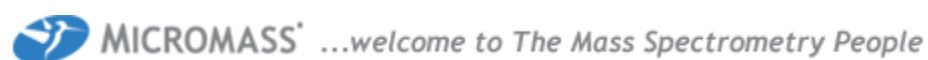
Oral Presentations

Nitrogen partitioning and ^{15}N natural abundances
in soil particle size fractions

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The present study combined a physical fractionation procedure with the natural abundance of ^{15}N to investigate the impact of organic manure and mineral fertiliser application, and fallow on changes of N associated with different soil particle size fractions. The long-term field experiment was conducted since 1956 in Ultuna, Sweden, on a Eutric Cambisol. Nitrogen in bulk soil and in particle size fractions changed significantly since 1956. N_t concentrations in bulk soil decreased in all treatments not receiving organic materials. Comparing the N contribution of particle-size fractions to the total N amount revealed the following ranking: silt > clay > fine clay > fine sand > coarse sand. The relative contribution of N in silt sized particles significantly increased from low to high bulk soil N contents, whereas N in clay and fine clay fractions decreased. C/N ratios of particle size fractions differed considerably more between treatments than C/N ratios in bulk soils. Generally C/N ratios decreased from coarse to fine fractions emphasising the tendency of smaller fractions being more significant as N sink than as C_{org} sink. ^{15}N abundances varied more between particle size fractions of single treatments than between bulk soil from differently treated plots. Within treatments we observed differences of up to 7.1 ‰ between particle size fractions. In most cases δ^{15}N values increased with decreasing particle sizes. This pattern on average was similar to changes in δ^{13}C. Our results suggest that silt sized particles acted as medium-term sink of introduced N and that ^{15}N abundances in particle size fractions sensitively reflect changes in N status in response to soil management.

Stable Isotopes: a powerful tool to elucidate ecological processes in temperate floodplains and tropical reservoirs

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Particulate organic matter (POM) is of major importance for the carbon cycling in running waters. For large rivers (like the River Danube), recent concepts stress the importance of the riparian zone and floodplains for an increased productivity and intensified organic matter cycling. In tropical countries the demand for proper management of inland water resources is increasing as a result of acute population growth and gradual industrialization. The Mahaweli River Basin of Sri Lanka is characterized by a linked inland water network of reservoirs used for irrigation, fisheries and hydroelectric power.

In freshwater systems, the $^{13}C:^{12}C$ ratio can indicate the relative importance of autochthonous (aquatic) versus allochthonous (terrestrial) sources of carbon. The dissolved inorganic carbon pool exploited by freshwater photosynthetic organisms is typically more depleted in ^{13}C than in atmospheric CO_2, which is the carbon source of terrestrial plants. Thus the stable isotope signature of plankton is significantly different from riverine (terrestrial) POM. Stable isotope signatures of POM can be used to trace the source and the quality of the present POM. Autochthonous produced organic matter is expected to stimulate the riverine food webs due to its higher biological availability than the POM of terrestrial sources. Therefore, the shift between allochthonous input and autochthonous production has a distinct impact on the biota.

The POM dynamics in floodplains are controlled by the hydrological interaction with the river and recent results show the dominance of autochthonous POM. Field and experimental data in both investigated systems show a significant relationship between $\delta^{13}C$ signatures, the elemental composition of POM and the source of the material. The combination with $\delta^{15}N$ data helps in elucidating the trophic relations in the various systems.

High precision soil and atmospheric trace gas stable isotopic measurements in the investigation of sources of environmental contaminants

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Stable Isotopes are widely applicable in the investigation of environmental issues, largely due to the fact that natural abundance isotopic signatures can be used in tracer studies. The relatively recent introduction of continuos flow techniques for stable isotope ratio measurement has significantly increased the potential number of environmental issues that can be addressed, providing data from large batches of samples due to the shorter analysis times.

Applications addressed in this paper include:

(1) The high throughout measurement of Carbon isotopic ratios for monitoring and determining the source of atmospheric CO_2, a known greenhouse gas; essential information for ensuring compliance with international treaties on emissions.

(2) The measurement of the isotopic composition of soil gas CO_2. Using the same continuous flow method as for the analysis of atmospheric gases, this application is used, for example, to address CO_2 recycling in ecosystems.

(3) The use of a combination of dual inlet and continuous flow techniques for the measurement of MeCl and MeBr, both suspected Ozone depleting agents. Isotopic data on both gas species can now be measured in the same sample run, thus increasing the analytical capacity of the system.

A comparison of mass spectrometry and
FANCI techniques for measuring δ^{13}C

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Until recently the only reliable way of doing ^{13}C analysis was using a mass spectrometer. For many Member States the high initial cost and running costs of a mass spectrometer precluded the purchase of such an instrument. Recent developments in optical systems have provided a robust, low-cost option for undertaking ^{13}C analysis. Although these machines were initially developed for breath testing for Helicobacter pylori they have an enormous potential as a research tool for soil science. The relatively low cost of the equipment at 15,000-25,000 USD, is within the research budgets of most institutes or universities. The simplicity of the mechanisms and optical nature mean that the equipment is relatively low maintenance and requires minimal training.

There are numerous areas to be studied using ^{13}C analysis: organic matter turnover studies shift in δ ^{13}C from C4 to C3 vegetation, organic matter residence times etc, determination of sources of stable organic matter, Δ ^{13}C differences to determine drought and salt tolerant isolines, root turnover studies, soil respiration studies, the breakdown of different pesticides in the soil, soil respiration studies as indicators of soil quality and mineralisation studies.

The paper presented will describe the preparation methods of soil and plant materials for analysis using the breath test analyser. These will include testing the system for natural abundance studies and for enrichment studies.

Carbon isotope record of the Permo/Triassic Boundary
and the Lower Triassic

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Carbon isotope data is an essential tool to learn about the global carbon cycle. Changes in the global carbon reservoirs by removal or reintroduction of organic carbon out an into the cycle respectively are often resulting from changes in the environmental conditions. Therefor the analysis of the carbon isotopic signature of marine carbonates, which reflect the isotopic signal of the seawater (with a small offset), can trace the changes in the carbon cycle and thus also environmental changes. Carbonates are easily altered in their oxygen isotope composition by diagenetic fluids but hardly changed in their carbon isotopic signal, because the amount of carbon in the carbonate rock normally by far outmatches the amount of carbon in diagenetical fluids, unless the rock undergoes significant metamorphism or surficial diagenesis. The Permian/Triassic boundary was the most severe mass extinction in earth history. More than 90% of all skeleton building organisms did not survive this event, which was followed by a long period without a significant increase of the biotic variety. This only began at the end of the Lower Triassic or even in the Mid Triassic. Therefor paleontologists proposed a period of dampened environmental conditions, which prevented quick biotic recovery after the extinction. In this contribution I present the carbon isotope signature of the Permian/Triassic boundary and the Lower Triassic of two sections in the Dolomites (North Italy), which was measured to learn about the ecological changes during that period.

Samples have been investigated for cracks, stylolithes and weatherings, which were removed before processing. The powderised samples were measured using standard methods. The analytical uncertainty is better than 1‰ (1σ). All values are given in ‰ PDB.

The carbon isotope trend decreases from high Permian values to a minimum in the lowermost Triassic (lower Griesbachian) and slowly increases towards the upper Griebachian to + 1‰ PDB. In the middle Nammalian two excursions to + 3‰ with following decreases to 0‰ are recorded. They are succeeded by an irregular rise to maximum values at +6‰ and a

decrease to negative values below - 2‰. At the Nammalian/Spathian boundary a rise to + 2‰ is recognized.

Changes in the carbon isotope ratio can result from to processes: changes in the carbon reservoirs and sequestering of organic carbon into shallow and deep oceanic reservoirs. As the two profiles were both sedimented in shallow marine environments, this process can be neglected. The first process evolves from sea level changes, oceanic anoxia and changes in productivity of organic matter. For the P/T boundary currently a combination of anoxia, erosion of coal deposits and release of methane and the eruption of the Siberian trap basalts are proposed among others, which can explain the depleted $\delta\,^{13}C$ values. The increase in the upper Griesbachian was accounted for increasing biotic activity. The worsening of the environment in the middle Nammalian in the Dolomites was ascribed to increased run-off from the hinterland. However, this cannot explain the isotopic excursions, therefor we suggest an at least Tethys wide event, as a large excursion, which corresponds to the measured shift of + 6‰ was reported from Pakistan. If the recorded carbon isotope signature proves to be global, the Lower Triassic black shales of the Panthalassa ocean would be plausible sinks for organic carbon.

Stable C and O isotopes in cave deposits:
an important proxy for environmental change

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Following the pioneering study of a subaqueous calcite in the narrow vein of Devil's Hole, Nevada (Winograd et al., *Science* 1992) carbonate minerals in subsurface cavities — collectively known as speleothem — have gained wide attention in (paleo)environmental research. This and a subsequent study (Coplen et al., *Science* 1994) demonstrated that stable C and O isotopes in speleothem calcite record climatically induced hydrological changes that can be firmly tied into a chronological framework by Th/U-disequilibrium dating of calcite.

About 10% of the surface of the continents is occupied by carbonate rocks showing karst features and an estimated 25 percent of the global population is supplied largely or entirely by ground waters emerging from karstified rocks. Whereas fast-flowing high-discharge waters show short mean residence times and actively contribute to cave passage formation, low-discharge seepage waters follow narrow conduits and spend significantly longer time in the subsurface. These groundwaters are typically supersaturated with respect to calcite and form a variety of speleothem morphologies in caves including dripstones (stalactites, stalagmites, etc.).

We are undertaking a detailed study of speleothems from caves in the Eastern Alps with emphasis on stalagmites (columnar forms with upward growth direction) and flowstones (sheet-like morphologies). Stable isotopes of C and O determined on microsamples drilled along the extension axis of speleothems are utilized as tracers of hydrological and pedogenetic/vegetation changes. Our strategy is to (i) sample both rainwater, soil water, dripwaters and actively growing speleothems to fully characterize the modern system of isotope distribution in karst regimes, and (ii) apply these relationships to fossil speleothem samples to reconstruct paleoenvironmental changes within the currently datable time frame of up to approximately 400.000 years before present.

Application of natural ^{15}N abundance
in nitrogen cycling studies of tropical rainforests

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The natural ^{15}N abundance is often used to study nitrogen (N) cycles of forests. Martinelli *et al.* (1999) found generally higher δ^{15}N values of soils and tree leaves in tropical forests than in temperate forests, which indicate more open N cycles in tropical than in temperate forests. Ecosystems with more open N cycles, i.e. higher N input and output rates relative to internal N cycling, become slowly enriched in ^{15}N by NO_3^- leaching or NO_x emission. These processes affect the ^{15}N natural abundance of soil, and consequently, that of vegetation by increasing the δ^{15}N signals. The major N sources in tropical rainforests are soil, litterfall, atmospheric deposition and N_2-fixation. Commonly, δ^{15}N signatures of atmospheric deposition and N_2-fixation differ from those of soils and litter. Thus, natural abundance of plants can give information about the N source they use.

In this study we investigated the N cycle of a "sub-ecosystem" of the Esquinas rainforest, namely the forest canopy. Forest canopies constitute an underestimated component of the N cycle of lowland rainforests. Characterized by thick layers of canopy soils covered with mosses and dense epiphyte[1] vegetation they function as a buffer for various nutrients between the atmosphere and the soil. The aim of this study was to investigate the natural abundance of possible N sources for canopy-based plants, the epiphytes themselves and the N losses via leaching.

Vascular and non-vascular epiphytes and canopy soils were collected from four canopy zones and analysed for N contents and δ^{15}N signals. In addition, N concentrations and δ^{15}N signatures of bulk precipitation, throughfall, and stemflow were measured during the wet and the dry season. The δ^{15}N values of epiphyte leaves decreased significantly from the lower zones (means of -3.9 and -4.3‰) to the upper zones (means of -5.4 and -6.1‰) of the canopy.

In contrast, $\delta^{15}N$ signatures of canopy soils (average -0.3‰) differed little between the zones. Bulk deposition was enriched in ^{15}N (+4.3‰) compared to all other potential N sources and was higher than throughfall and stemflow (+0.5 to -1.3 ‰). $\delta^{15}N$ values of atmospheric deposition were inversely related to those of the epiphyte leaves, whereas N isotopic composition of canopy soils did not vary significantly. Consequently, we conclude that the variations in foliar N isotope composition of epiphytes were not simply caused by utilization of isotopically different N sources, but by different ^{15}N discrimination during N acquisition.

Referenzen:

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[1] epiphytes are non-parasitic plants growing on other plants, e.g. trees, without soil contact

Stable isotopes as indicators of management intensity in montane grasslands

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In this study patterns of natural abundance of ^{15}N in plants and soil are used in an attempt to understand the influence of management regime on nitrogen cycling in montane grassland systems. Plant and soil samples were collected from 8 to 50 year old experimental grassland plots at the 'Federal Research Institute for Agriculture in Alpine Regions' in Gumpenstein (Austria). The 36 investigated treatments differ in cutting frequency (2-6 times per year) and/or in the amount (0–180 kg N ha^{-1}a^{-1}) and the quality of fertilization (mineral fertilizer, cattle slurry, liquid and solid stable manure applied at different times of the year, manure compost). Samples of shoots and roots of 3 plant species (*Dactylis glomerata*, *Taraxacum officinale*, *Trifolium pratense*) as well as of hay and aftermath and samples of top soil (0-5cm) and of fertilizer were analyzed for total N and δ^{15}N.

Total nitrogen content of top soil was more dependent on the type than on the amount of applied fertilizer, with higher values found at plots treated with solid manure. At a given fertilization regime, total N in the top soil as well as in the agriculturally harvested plant material increased with cutting frequency. In the two investigated non-legume species total N was further related to the level of fertilization. Comparing fertilizers, highest δ^{15}N values were found in cattle manure compost followed by solid manure, slurry and (stored) liquid manure, δ^{15}N of mineral fertilizer was 0‰. δ^{15}N values of both top soil and hay material were mainly related to the quality (δ^{15}N) of applied fertilizer and only to some extent to the level of fertilization, whereas no influence of cutting frequency could be observed. Similar results were obtained for the two investigated non-legume species. Natural abundance of ^{15}N in *Trifolium pratense* indicated, that this legume derived most of its N from fixation of air-N$_2$ by symbiotic rhizobia, independent of the level or kind of applied N fertilizer. Despite differences between species, δ^{15}N values of hay were highly correlated to those of top soil (r^2=0.87). Generally, our results show, that management intensity is sensitively reflected in natural abundance of ^{15}N in plants and soil organic matter in grassland ecosystems. However, only further analyses of different compartments (soil horizons, soil N pools) – currently being done - will allow for a more complete interpretation of differences in N cycling between treatments.

Posters

Measuring gross and net mineralization of manures in the field and under glasshouse conditions

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Organic materials are potentially important sources of N in crop production, especially for resource poor farmers. In order to successfully manage organic materials as nutrient sources the parameters that determine the release and uptake of N by crops must be identified. Therefore it is important to understand the nutrient dynamics of the processes which lead to the release of nitrogen from organic materials.

Experiments were conducted in both the glasshouse and the field in which the nitrogen dynamics were studied. In the glasshouse measurements of plant N uptake from manure was undertaken using the new approach to the isotope dilution technique. Two manure types were assessed sewage sludge and turkey manure under non- N limiting conditions. The test crop grown was maize and the soil used was Seibersdorf.

In the field measurements of both net and gross mineralisation were undertaken using the soil incubation method and the isotope dilution gross mineralisation method. Soil cores were injected with ^{15}N and sampled for inorganic and ^{15}N analysis 24 hours and 96 hours after injection.

Results from these studies will be presented in a poster format.

A comparison between several isotopic and non-isotopic methods for evaluation biological nitrogen fixation in soybean (*Glycine max L.*)

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To assure proper management and fully realize the benefits of the Legume-*Rhizobium* symbiosis it is necessary to be able to quantify the amount of nitrogen fixed. To date, several method such as dry matter yield (DM), total nitrogen uptake (N-uptake), total N difference method, nodule observations, acetylene reduction assay (ARA), xylem-solute technique and ^{15}N methodologies are available, each of them having some advantages and disadvantages. Therefore, some reasearchers have suggested using several method for measuring biological nitrogen fixation. A growth chamber experiment to compare DM, N-uptake, total N difference, nodule observation and A-value (N-15) methods on N deficient soil (12.6 mg/kg mineral nitrogen) without indigieous rhizobia was performed on a randomized compelete block design with four replications. The A-value ^{15}N method was used as a reference method in this study. Inoculation treatments were three efficient *bradyrhizobium* strains, i.e. Helinitro, Rhizoking, and Goldcoat as well as a uninoculated control. For quantifying nitrogen fixed using the A-value method, two solutions of N-15 enriched ammonium sulphate containing 9.616 and 2.086 % N-15 atom excess were applied at the rate of 6.667 and 33.334 mg/ kg N at growth stage V2 to fixing and growth stages V2 ,R2 and R5 to refrence pots. Four months after planting, at stage R6, the pots were harvested and a number of plant growth parameters required for the above mentioned methods were measured**.**

There were significant differences between the *bradyrhizobium* strains. Goldcoat, Rhizoking fixed significantly more N than Helinitro with %Ndfa (% N derived from atmosphere) being more than 90%. Regression analyses between the studied parameters showed that simple correlations between %Ndfa using A-value method, N-uptake and nitrogen fixation using the N-difference method were significant ($r=0.799$** and $r=0.644$*, respectively). However, the correlation for %Ndfa and dry matter yield, dry matter yield of nodule and nodule number were 0.365^{ns}, -0.628* and -0.871**, respectively. The correlations between amount of N fixed using N difference method and these parameters were the same. (where ^{ns}, * and ** mean no significant difference, significant differences at the probability level of 0.05 and 0.01, respectively).

Preliminary data on continental Late Maastrichtian environment, South Carpathians

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The Hateg basin is located in the south-western part of the South Carpathians and it is filled with sediments that overly the crystalline rocks of the Getic nappe. The Latest Cretaceous (Middle and Late Maastrichtian) with continuous transition to Paleocene is represented by two continental lithostratigraphic units: the Densus-Ciula and the Sinpetru Formations. The Late Maastrichtian of Densus-Ciula Formation at Unirea Quarry is represented by a pebbly alluvium with massive, matrix supported conglomerates, cross bedded sandstones and mudstones, the last one containing calcretes and dinosaur remains, including eggs and hatchlings of herbivorous dinosaurs (Grigorescu et al., 1990; Weishampel et al., 1993). In order to constrain the Late Maastrichtian paleoenvironment in which dinosaurs lived, calcretes and dinosaur eggshells were analyzed for carbon and oxygen isotopic composition. The standard procedure for carbonate analysis at the Graz laboratory includes CO_2 extraction/measurement with Kiel II/Finnigan MAT MS.

The eggshells reveal $\delta^{18}O$ values between 29.5 and 30.5‰ (SMOW) and $\delta^{13}C$ between -13 and -14‰ (PDB). The $\delta^{18}O$ of eggshells are linear related to the $\delta^{18}O$ of water ingested by the species (Sarkar et al., 1991; Tandon et al., 1995). According to the empirical relationship between eggshell and water composition, eggshells with values of 29-30‰ indicate that the $\delta^{18}O$ of water from which the species drunk was around -3‰. The $\delta^{13}C$ of the eggshell is controlled by the animal's diet but is also strong modified by metabolic fractionation. For example, the $^{13/12}C$ ratio of carbohydrate feeder eggs is 16‰ heavier than the food material (Schaffner and Swart, 1991). As the measured $\delta^{13}C$ range between -13 and -14‰, the isotopic

composition of the food source was around -30‰. This indicate that the main food source consisted of plants with C3 photosynthetic pathways.

The carbon isotopic composition of calcretes is controlled by the composition of CO_2 in soils which is further controlled by the proportion of C3 and C4 plants (Smith and Epstein, 1971; Cerling and Quade, 1993). Due to $^{13}CO_2/^{12}CO_2$ differential degassing in soil and the isotopic fractionation between CO_2 and carbonate, the total enrichment between carbonates and organic matter vary from 16.5 to 13.5‰ (between 0 and 25°C). As the measured $\delta^{13}C$ values of calcretes, range between -8 and -9‰ they indicate also a C3 source of food with a composition around -25‰. Knowing the $\delta^{13}C$ of calcretes, the estimated pCO_2 values suggest concentrations around 1000 and 1500 ppmV at that time. These concentrations are between two and tree time the modern values. The oxygen isotopic composition of calcretes are related to temperature and the isotopic composition of soil water, which is further related to local meteoric water. The calcret`s $\delta^{18}O$ range between 24 and 25‰. For a temperature around 25°C, calcretes precipitated from water with $\delta^{18}O$ around -3‰. Due to processes of evapo-transpirations water form which calcretes precipitated are considered to be enriched relative to rain water. The two source of data (eggshells and calcretes) constrain the source of drinking water to a narrow range probably indicating the limited mobility of the species.

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Fate of $^{15}NO_3^-$ in a Montane Forest Ecosystem

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The investigation was part of the project consortium "Balancing of nitrogen fluxes in a forest ecosystem in the Tyrolean Alps" which is coordinated by the Federal Forest Research Center, Vienna. The aim of the project was the quantification of nitrogen fluxes in a catchment by evaluating the nitrogen inputs, the internal cycling of nitrogen and nitrogen losses as emissions of nitrous oxide or nitrate leaching to the groundwater. In particular we wanted to evaluate the role of microorganisms for the nitrogen dynamics in the investigated forest ecosystem by determining microbial nitrogen transformations and gaseous nitrogen losses.

The investigated forest is situated in Tyrol (Achenkirch) close to the border between Austria and Germany at an altitude of 920 m a.s.l. The dominating tree species are spruce (*Picea abies*) and beech (*Fagus sylvatica*). In order to investigate the fate of deposited $^{15}NO_3^-$ in the ecosystem the following experiment was conducted in June: ^{15}N-KNO_3^- with high ^{15}N-enrichment (58.2%) was applied to a circular plot (diameter 1 m) at a rate of 0.5 kg N ha^{-1}. For the application a syringe was introduced to a depth of 1-2 cm of the L/F layer and the solution injected into the soil using a grid of 10 cm. Gas samples were taken from closed chambers immediately after $^{15}NO_3^-$ application and after one and 40 days. At the end of the experiments soil samples were taken to determine the amount of mineral N and microbial biomass N. Shoots and roots of individual plant species were separated and analysed. In addition, ion exchange resin bags had been installed and accumulated N was determined.

The δ ^{15}N enrichment was highest in initial N₂O emissions and in extracts of ion exchange resin bags. Among the investigated plant species *Mercurialis perennis* was most efficient in scavenging NO$_3^-$. Fine roots contained more labelled N than coarse roots and shoots

of beech saplings. In contrast, grass leaves showed a higher ^{15}N enrichment than roots. Microbial biomass N only showed weak δ ^{15}N enrichment.

On an area basis, surprisingly high levels of labelled N remained in the extractable soil fraction. Due to the high coverage of the plot with grass, most of the ^{15}N was stored in grass leaves compared to the other investigated plant species.

In this experiment, which was conducted in spring time, plants seemed to be more efficient in NO_3^- uptake than microorganisms.

Dual labelling of cowpeas and nitrogen fixing tree species using simple chamber technologies

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Nitrogen and carbon cycling have been shown to be intrinsically linked in soils. Thus to study the turnover of organic matter and the nutrient dynamics in soils it is often necessary to investigate both the fate of nitrogen and carbon. Dual labelling with ^{15}N and ^{13}C allows the fate of both elements to be traced and accounted for. ^{13}C labelling can be achieved relatively simply and cheaply.

In this poster we describe two experiments were dual labelling of cowpeas and nitrogen fixing tree seedlings was undertaken, using a simple perspex chamber and a low technology chamber sealed with carbon dioxide impermeable plastic.

Dual labelling of trees using a tree injection technique

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The use of trees in agroforestry systems is improving agricultural production for resource poor farmers world wide. In addition trees are being used as fodder legumes and green manures. The use of stable isotopes has greatly improved our understanding of nutrient cycling in perennial legume systems however due to the difficulty in labelling there has not been so much success with tree crop systems.

One approach is the labelling tree material using a tree injection technique, the principle is that the label is injected into the transpiration stream of the plant and this equilibrates within in the plant leading to a uniformly labelled plant material. This technique has been successfully undertaken with highly ^{15}N labelled urea. This poster will describe the results of a study using highly ^{15}N and ^{13}C labelled urea.

Development of preparation methods for $^{13}C/^{12}C$ soil and plant analysis, using optical breath test analysers

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Until recently the only reliable way of doing ^{13}C analysis was using a mass spectrometer. For many Member States the high initial cost and running costs of a mass spectrometer precluded the purchase of such an instrument. Recent developments in optical systems have provided a robust, low-cost option for undertaking ^{13}C analysis.

Although these machines were initially developed for breath testing for Helicobacter pylori they have an enormous potential as a research tool for soil science. The relatively low cost of the equipment at 15,000-25,000 USD, is within the research budgets of most institutes or universities. The simplicity of the mechanisms and optical nature mean that the equipment is relatively low maintenance and requires minimal training.

There are numerous areas to be studied using ^{13}C analysis: organic matter turnover studies shift in $\delta\,^{13}C$ from C4 to C3 vegetation, organic matter residence times etc, determination of sources of stable organic matter, $\Delta\,^{13}C$ differences to determine drought and salt tolerant isolines, root turnover studies, soil respiration studies, the breakdown of different pesticides in the soil, soil respiration studies as indicators of soil quality and mineralisation studies.

The paper presented will describe the preparation methods of soil and plant materials for analysis using the breath test analyser. These will include testing the system for natural abundance studies and for enrichment studies.

Early screening of wheat cultivars for salinity tolerance using carbon discrimination

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Selection of wheat cultivars for salt tolerance has been largely unsuccessful. Carbon isotope discrimination (Δ) may provide a useful screening tool for salt tolerant varieties, as it is an integrated measure of the response of photosynthetic gas exchange to environmental variables such as water availability, light, humidity and salinity (Farqauhar et al.,1987).

Despite some of the similarities between the effect of water and salt stress on plant growth, few attempts have been made to quantify the effect of salinity on Δ, and its potential as a breeding selection characteristic. Initial studies carried out under this programme showed that there was a significant linear decrease in Δ with increasing salinity (Shaheen and Hood, 2001).

Experiments were conducted in the greenhouse to determine the effect of salinity treatments on plant Δ values. The results from the glasshouse experiments were compared with field data from field experiments. It was shown that there was a very strong correlation between the Δ value of the wheat seedlings at four weeks after germination in the 16 dS/m treatment and the observed yield under saline conditions in the field. This suggested that using Δ ^{13}C as a tool for early selection of salt tolerant cultivars is a potentially useful technique.

Oxygen isotopic signals of upper carboniferous conodonts from the US- Midwest

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Oxygen isotope data can be used to determine paleotemperatures of ancient oceans. The stable isotopic composition of pristine calcitic brachiopod shells is preferentially used to decipher the oxygen isotopic composition of ancient oceans and to calculate sea-surface paleotemperatures. However, diagenesis may alter the oxygen isotopic composition of carbonates [1] and since Paleozoic brachiopods preferentially occur in shallow-water deposits, it generally becomes difficult to construct reliable high-resolution stable isotope records. In contrast to brachiopods, conodonts are abundant apatitic microfossils in Paleozoic sediments that can be used to set up high-resolution $\delta^{18}O$ records.

This contribution presents an oxygen isotopic study of conodonts from the Pennsylvanian cyclothems. The cyclothems are investigated in midcontinent North America (Kansas, Oklahoma) and typically comprise a transgressive limestone, offshore gray to black phosphatic shales and regressive limestones. Individual cycles are capped by paleosols. These shallowing-upward cyles have been interpreted as glacio-eustatic in origin [2]. We measured the oxygen isotopic composition of conodonts from the transgressive limestones, 'core' black shales, gray shales as well as the lower part of the regressive limestones. The main focus of this study is to get a measure for potential changes in the oxygen isotopic composition of conodont apatite that might be related to the build-up of ice caps in high latitudes and contemporaneous cooling of low latitudes

The oxygen isotopic composition of condont apatite was measured using a laser-based microsampling technique [3]. This technique enables to measure quantities of 1 mg of conodont apatite with an analytical uncertainty of 0.2‰ (1σ).

Measured oxygen isotope values for all samples range from 19.6 and 22.4‰ V-SMOW. Condonts from the offshore gray shales show a narrower range in $\delta^{18}O$ with values ranging from 20.1 to 21.6‰ V-SMOW. Assuming that the oxygen isotopic composition of Pennsylvanian seawater during the deposition of the gray shales (interglacial) was comparable to today (0‰ V-SMOW), calculated paleotemperatures range from 18.5 to 25°C. Interestingly, these results agree well with paleotemperatures derived from $\delta^{18}O$ values of brachio-

pods from the same lithologies [4] and with paleotemperatures predicted by atmospheric general circulation models [5]. Within individual cyclothems we observe a change in $\delta^{18}O$ of almost +2‰ with condonts from the offshore shale facies being depleted in ^{18}O relative to conodonts from the regressive limestone facies. The increase in $\delta^{18}O$ parallels shallowing of the depositional environment and is interpreted to reflect the enhanced storage of ice in high latitudes and to minor extent climatic cooling of the equatorial realm. In conclusion, the conodont apatite oxygen isotope data support the interpretation of the Pennsylvanian cyclothems as glacio-eustatic cycles. Taking into account the absence of conodonts from the glacial maximum, the glaciation during the Upper Carboniferous might have been comparable to or even exceeding the Pleistocene glaciation.

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Statistical Analysis of Back Trajectories Helps Explain Differences in Stable Isotope Composition of Precipitation at High Elevation Stations in the Austrian Alps

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Differences in the isotope content of precipitation water during July and August 1998 between Patscherkofel (2247 m) and Villacher Alpe (2140 m) are studied with help of trajectory statistics. Both sites are elevated points in the Alps. The trajectory model FLEXTRA uses 3-dimensional wind fields (including the vertical component of the wind) from the European Centre for Medium-Range Forecasts in Reading. Trajectories are calculated 240 h (= 10 days) backwards and are released each hour at 3 levels, 100 m above model topography, 700 hPa (approx. 3000 m) and 500 hPa (approx. 5000 m). For statistical analysis 24*31 trajectories are compiled for each month and end point. The area, for which the analysis is done, spans 24°W to 25°E and 31°N to 65°N.

Each trajectory is weighted with the hourly precipitation sum at ist end point. Only trajectories connected with precipitation events at their starting points and starting times are of interest, therefore trajectories without precipitation are not considered (weight = 0). For statistical trajectory analysis a grid is used with horizontal resolution of 0.5° degrees and the vertical column is divided in 500 m intervalls. The trajectories ending at Villacher Alpe and Patscherkofel in August 1998 appear to have more in common than in July 1998. In July 1998 a higher portion of trajectories comes across the Mediterranean before arriving at Villacher Alpe. One might conclude that the moisture source area is different for both trajectory end points in July 1998. Villacher Alpe seems to receive a certain fraction of moisture originating in the Mediterranean, which Patscherkofel does not receive during July 1998. In August 1998 both end points receive moisture to a similar extent from the Atlantic and the Mediterranean.

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