correlation from magnetostratigraphy is with chron C5Cn1 (Daxner-Höck, 2001). From Grund different gastropod species were measured, especially shells of *Ocenebra credneri* and *Turritella* sp. Additionally, stable isotope data of pectinid shells of *Pecten subarcuatus* and *Crassodoma multistriata* were established. Oxygen data from the bivalve shells vary within 3‰, but do not show the same maximum and minimum values. Especially the carbon isotope data exhibit some differences between the shells of *Pecten subarcuatus* and *Crassodoma multistriata*. Generally, *Turritella* sp. shows the highest oxygen and carbon values, and the values of *Ocenebra credneri* are similar to *Crassodoma multistriata*. These data can be compared with other Badenian localities and may help to understand local environmental differences.

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Use of $\delta^{15}N$ and $\delta^{18}O$ isotope ratios to identify sources of nitrate in the unsaturated zone.

A. Leis

Institute of Hydrogeolgy and Geothermics, Joanneum Research, Graz, Austria

Anthropogenic nitrogen inputs have led during the last three decades to increased loads of nitrate in ground water in many regions of Europe.

Also, in the Leibnitzer Field in the south part of Styria a strong increase of the nitrate concentrations in the ground water could be observed during the past decades. The Leibnitzer Feld aquifer is extremely susceptible to surface derived contamination because of its largely unconfined nature and highly permeable sands and gravels. The source of nitrate contamination in the aquifer is attributed to local, long term agricultural land use practices such as spreading big amounts of liquid manure (mainly pig manure) above the soils. To determine what action should be taken to reduce nitrate contamination of the groundwater, it is important to identifying the source(s) and the origin of nitrate in unsaturated zone.

Several microbiological and isotope investigations were carried out in the unsaturated zone to assess these processes. In the result of the microbiological investigations, it was possible to show that nitrifying bacteria are located in the whole profile of the unsaturated zone. But the intensity of the nitrification process decreased under the top soil layer strongly. However, also soil samples from a depth of 1.8m have shown still a considerable potential nitrification rate. This conflicts with the widespread idea that nitrification in soils is limited to the root zone only.

To verify these results with a independent second method we have used $\delta^{15}N$ and $\delta^{18}O$ isotope ratios of nitrate in percolation water samples. The percolation water was sampled repeatedly at the outflows of the suction plates and cups between May 1998 and April 1999 for determining concentrations, $\delta^{15}N$ values, and $\delta^{18}O$ values of nitrate. The application of the $\delta^{15}N$ and $\delta^{18}O$

isotope ratios is a useful technique to help identify sources and fate of nitrate. Due to the large oxygen isotopic difference between nitrates produced in the atmosphere and those produced by microbial processes in the soil (nitrification), the oxygen isotopes in nitrate are particularly practical for the identification of nitrate from fertilizer (Amberger and Schmidt, 1987) and atmospheric nitrates (Kendall et al., 1998). In addition, the oxygen isotopes can be used to identify processes, such as denitrification, that may change the concentration and isotopic composition of nitrate (Böttcher et al., 1990). Beside this the isotope ratios in the unsaturated zone will be also influenced by mixing. In our case, we had two different main sources of nitrate, atmospheric nitrate (Nitrate Source A) and nitrate from nitrification in soil (Nitrate Source B). During nitrification in soil the value of δ^{18}O in resulting nitrate normally decrease because the amount of isotopically heavy atmospheric nitrates decrease. Assuming also that in all depths of the unsaturated zone nitrification take place, the value of ^{18}O in nitrate must decrease with increasing depth, because the amount of atmospheric nitrates is decreasing.
The samples collected during our study are plotted in Figure 1. The mean isotopic composition of atmospheric nitrate (Source A) was determined with 9.1‰ for δ^{15}N and 37‰ for δ^{18}O. The outflow of the suction plates and cups in the unsaturated zone ranged from approximately 2‰ to 12.6‰ for δ^{15}N and 2.2‰ to 19.1‰ for δ^{18}O.

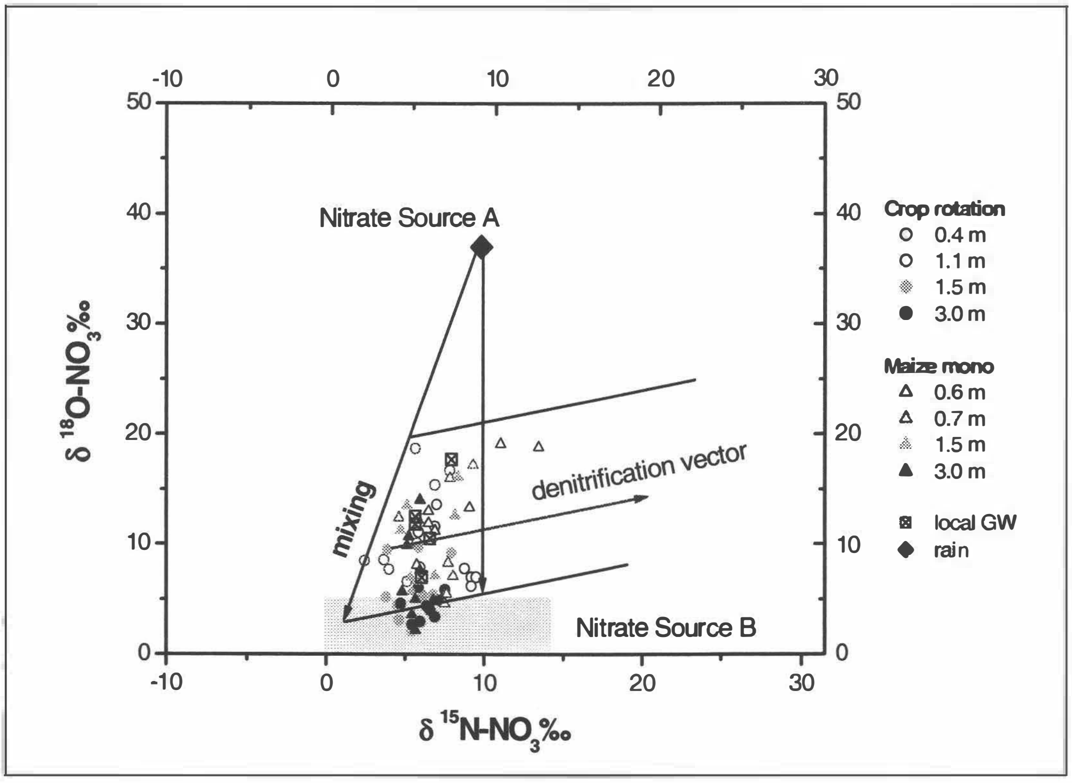

Figure 1: Mixing process actually found

The small transparent symbols indicate nitrate isotope ratios of percolation water from the upper part of the unsaturated zone. The small solid symbols show the isotope ratios of nitrate in the underlying gravel zone. The lightest δ^{18}O values were found on the deepest sampling points in the unsaturated zone. This indicate clearly that nitrification processes take place in this soil zone. It shows also very well, that nitrate produced by nitrification can be identified by δ^{18}O of nitrate. The isotopic composition of nitrate is not only a powerful tool to determining its sources, but can also provide hints about nitrogen transformation processes such as nitrification and denitrification in the unsaturated zone.

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Geology, stable isotope and fluid inclusion studies of the serpentinised Kenticha ophiolites, south eastern Ethiopia

A. Mogessie[1], A.-V. Bojar[2], R. Kaindl[1], K.H. Belete[3] & T. Solomon[4]

[1]Institute of Mineralogy and Petrology, University of Graz, Univ.pl.2, A-8010 Graz, Austria
[2]Institute of Geology and Palaeontology, University of Graz, Univ.pl.2, A-8010 Graz, Austria
[3]Golden Prospect Mining Co.plc, Addis Ababa, Ethiopia
[4]Department of Geology and Geophysics, University of Addis Ababa, Ethiopia

The Adola granite-greenstone terrane covers an area of approximately 5000 km^2 in southern Ethiopia. It is characterised by two linear, closely spaced, N-S trending belts of metamorphosed supracrustal rocks, namely the Megado volcanosedimentary belt in the west and Kenticha ultramafic belt in the east. The former consists of ultramafic and tholeiitic basic volcanics and intrusives which are intercalated with sediments made up predominantly of arkoses, feldspathic quartzites, quartzites and pelites together with subordinate polymictic conglomerates and graywackes. In contrast, the Kenticha belt is dominated by ultramafic rocks, with subordinate amphibolites, biotite schists, minor graphitic schists and marbles (Gilboy 1970; Chater 1971, Billay et al., 1997). The two volcanosedimentary belts are surrounded and separated by a gneissic terrane which comprises para- and orthogneisses with subordinate muscovite-quartz schists, staurolite-garnet-biotite schists, impure marbles and amphibolites.

The Kenticha belt has been affected by amphibolite-facies metamorphism of the staurolite-almandine and kyanite-almandine-muscovite subfacies. The ultramafic rocks generally trend north-south (7-8 km long and up to 1 km wide) and occur as hill- and ridge-forming bodies extending for about 30 km. They occupy higher structural levels in the granite – greenstone succession. The Kenticha serpentinite is composed of more than 70 vol.% serpentine, olivine, pyroxene, and opaque (chromite and magnetite). Mesh texture of chrysotile is common with minor antigorite. Olivine and pyroxene relicts imply a peridotitic protolith. Based on field relations, geochemical data and PGE over chondrite normalised plots, the Kenticha ultramafic rocks are considered to be ophiolites. Associated with these ophiolites are also complex pegmatites containing amazonites, columbo-tantalite among others. Within the granite-pegmatite system late-magmatic alterations (albitization, sericitization, kaolinization) and development of amazonite and microcline are widely developed.

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