Report on AMBER Workshop

„Stable Isotope Analysis in Biogeochemistry with focus on the Baltic Sea and its catchment“

The AMBER workshop took place from September 15 – 23, 2010 in Stockholm/ Sweden. 16 students (13 female & 3 male) from Sweden, Finland, Germany, Lithuania, Denmark, Poland, Switzerland, Thailand and Vietnam (see list of participants on AMBER webpage) were educated by seven teachers from Sweden, Germany and Louisiana/USA (see list of teachers on AMBER webpage). 15 of the students were Ph.D. students, most of them in different BONUS+ projects. The workshop was sponsored by the ESF Nitrogen in Europe Research Networking Programme which is greatly acknowledged. In the following a short description of the course is given. Details of the complete teaching programme can be found on the AMBER webpage.

Carl-Magnus Mörth and Brian Fry opened the workshop and gave a presentation about origin and importance of stable isotopes, with a repetition of isotope notation, calculation, history of measurement and fundamental processes concerning isotopes like fractionation and mixing. Afterwards we visit the lab for stable isotope measurements in the Department of Geological Sciences of Stockholm University. In the afternoon we heard the first three student presentations. The students introduced their projects and answered the question, why isotope analyses are important for their work. During the workshop the students could measure stable isotopes in their own samples. It was possible to measure oxygen, hydrogen and chlorine isotopes in water; carbon and nitrogen isotopes in sediments and biological material. Furthermore, sulfur isotopes could be measured in sediment. Brian Fry suggested a group work concerning water samples from all over the world and interpretation of O- and H-isotope data. In addition all course members had to give one piece of finger nail hopefully to get information about food pattern of students and teachers.

On the second day, Jan Backman held lecture about oxygen isotopes in marine sediments to present the students what isotopes are used for paleo-oceanography, for example to reconstruct the climate conditions thousands of years ago. Brian Fry presented some basic equations for mixing and fractionation like mass balance equation to calculate isotope signal of two or more end members and taught us to determine the residual isotope signature for a residual in an open system. Moreover he gave an introduction how to use stable isotopes as

tracers in ecological research. In the afternoon it was time to hear most of the remaining student presentations. The projects the students are working on vary widely reaching from investigation of contaminated groundwater systems to the assignment of changes in biogeochemistry in a changing climate or the understanding of food webs. For all of them stable isotope analyses are a helpful tool in their work.

On the third day we heard two student presentations and the rest of the day consisted of lab work. Own samples and the samples for the group task had to be prepared for further analyses with help of Heike Siegmund and Malin Söderman. In the evening a little party with a buffet took place. Here some of the students used the time to speak with teachers and developed first stable isotope models for a better understanding of their data.

The weekend was free. On Sunday most of the students and some teachers went to island of Grinda.

On Monday morning, the students continued with lab work. Afterwards Brian Fry spoke about characterization of complex food webs via multiple tracer addition of stable and radioactive isotopes. In the afternoon Carl-Magnus Mörth gave an introduction in the sulfur cycle and described how to use stable sulfur isotopes in environmental sciences (e.g. climate reconstruction) and introduced the programme Mathcad which enables the students to calculate mixing and fractionation processes of complex isotope models without knowledge of any computer language. Brian Fry delineated how he used stable sulfur isotopes to answer the question “Do fish stay at home?” concerning an ecological problem of fish migration in Louisiana estuaries.

On Tuesday, Maren Voss introduced the marine nitrogen cycle and presented the project NANI (Net Anthropogenic Nitrogen Inputs). She explained why to use ^{15}N and ^{18}O as an indicator of nitrogen sources and for a better identification of processes like uptake and denitrification. That was followed by a lecture of Annette Kock about N_2O and climate change. She named the natural sources of this greenhouse gas. She applied ^{18}O to get the source of oxygen within the gas and uses ^{15}N to identify production processes. After that we heard the last student presentation.

In the afternoon exercises in modeling took place. With the help of Brian Fry students should solve different problems in food web characterization and environmental behavior of some elements via stable isotope analysis. Some students presented first isotope models and discussed it with the whole group.

On the last day we heard a lecture of Barbara Deutsch about PO_4^{3-} source identification by means of $\delta^{18}O$- PO_4^{3-} values and a lecture of Maren Voss about isotope tracer studies of nitrogen. Afterwards the results of the group work were presented by the students: The fingernails´ signal of $\delta^{15}N$ and $\delta^{13}C$ show a strong relation to the food source. We could identify groups of carnivores and vegetarians. We figured out that Scandinavians have different signals like Germans and Americans. The δD and $\delta^{18}O$-values of students´ water data were plotted within a Global Meteoric Waterline and show strong correlation with corresponding climate conditions. Afterwards some students presented problems and results of the exercises from yesterday. At the end a student´s evaluation of the workshop took place.

The workshop was carried out in a very friendly atmosphere. All students and teachers wish to thank the local organizers Barbara Deutsch and Carl-Magnus Mörth and the research staff for their perfect organization and their support during labwork.

Stockholm, September 23, 2010

Susann Vogler