

These relevant processes are defined primarily by the problem of interest and the spatial and temporal scales considered, and their influences are determined by their individual as well as combined effects. The purpose of this talk is to discuss these aspects from the viewpoint of catchment hydrobiogeochemistry. Following on recent studies, the importance of identifying the "dominant" processes aimed at "model simplification" is highlighted. In view of the difficulties (e.g. lack of technological and human resources) in measuring "all the relevant data" of interest, a simple procedure to identify the number of dominant processes using only a single available time series representing a catchment system is reviewed. The concept behind this procedure and its practical relevance, in terms of catchment complexity and nonlinear interactions among the processes, is explained. One possible way to integrate this procedure with (field) "expert advice" and (conventional) "parameter sensitivity analysis" is also presented for further simplification of the catchment modeling procedure. The potential of these ideas for the formation of a global "catchment (hydrobiogeochemistry) classification system" is finally discussed.

B44A-03 1610h INVITED

Scaling Stream Flow Response to Forest Disturbance: the SID Project

James M Buttle¹ (1-705-748-1011-1475; jbuttle@trentu.ca); Fred D Beall² (fbeat@NRCan.gc.ca); Irena F Creed³ (icreed@uwo.ca); Andrew M Gordon⁴ (agordon@evb.uoguelph.ca); Robert Mackereth⁵ (rob.mackereth@mnr.gov.on.ca); Jim W McLaughlin⁶ (jim.mclaughlin@mnr.gov.on.ca); Paul K Sibley⁴ (psibley@evb.uoguelph.ca)

¹Trent University, 1600 West Bank Drive, Peterborough, ON K9J 7B8, Canada

²Natural Resources Canada, Canadian Forest Service, 1219 Queen Street East, Sault Ste Marie, ON P6A 5M7, Canada

³University of Western Ontario, Social Science Centre, London, ON N6A 5B7, Canada

⁴University of Guelph, Environmental Biology, Guelph, ON N1G 2W1, Canada

⁵Centre for Northern Forest Ecosystem Research, Ontario Ministry of Natural Resources, 955 Oliver Road, Thunder Bay, ON P7B 5E1

⁶Ontario Forest Research Institute, Ontario Ministry of Natural Resources, 1235 Queen Street East, Sault Ste Marie, ON P6A 2E5, Canada

We do not have a good understanding of the hydrologic implications of forest harvesting in Ontario, either for current or alternative management approaches. Attempts to address these implications face a three-fold problem: data on hydrologic response to forest disturbance in Ontario are lacking; most studies of these responses have been in regions with forest cover and hydrologic conditions that differ from the Ontario context; and these studies have generally been conducted at relatively small scales (<1 km²). It is generally assumed that hydrologic changes induced by forest disturbance should diminish with increasing scale due to the buffering capacity of large drainage basins. Recent modeling exercises and reanalysis of paired-basin results call this widespread applicability of this assumption into question, with important implications for assessing the cumulative impacts of forest disturbance on basin stream flow. The SID (Scalable Indicators of Disturbance) project combines stream flow monitoring across basin scales with the RHESys modeling framework to identify forest disturbance impacts on stream flow characteristics in Ontario's major forest ecozones. As a precursor to identifying stream flow response to forest disturbance, we are examining the relative control of basin geology, topography, typology and topology on stream flow characteristics under undisturbed conditions. This will assist in identifying the dominant hydrologic processes controlling basin stream flow that must be incorporated into the RHESys model framework in order to emulate forest disturbance and its hydrologic impacts. We present preliminary results on stream flow characteristics in a low-relief boreal forest landscape, and explore how the dominant processes influencing these characteristics change with basin scale in this landscape under both reference and disturbance conditions.

B44A-04 1630h

Examining Runoff Generation Across Scale: A Test of Mixing Models

April L James¹ (514-495-0902; april.james@mail.mcgill.ca)

Nigel T Roulet¹ (514-398-4945; nigel.roulet@mcgill.ca)

¹Department of Geography and McGill Centre for Climate and Global Change Research (C2GCR), McGill University, 705 Burnside Hall, 805 Sherbrooke St. W., Montreal, QC H3A 2K6, Canada

As water moves through the landscape, it transports biogeochemical nutrients and contaminants to the stream channel. The physical processes that deliver water to the stream channel vary in both space and time. As a result, modelling of runoff generation and nutrient budgets remains a challenge. Mixing models are used to help define different sources or end-members of water (e.g. groundwater and soil waters) that mix together to make up stream water. The application of mixing models has focused on the analysis of runoff from head-water basins. However, as water moves downstream, changes in stream chemistry will indicate if the relative importance of end-member contributions changes with location. Furthermore, the geochemical definition of end-members could potentially vary with location. In this research we apply a mixing model to stream discharge taken from a series of forested basins at Mont Saint-Hilaire, Quebec to evaluate both the changing importance of end-member contributions and the validity of their geochemical definitions across scale. In this study, a mixing-model is created from analysis of stream water chemistry collected from the largest basin (1.5 km²) located furthest downstream. The model is then applied to 8 additional locations located upstream that represent progressively smaller basin areas. For each basin, we test if the same mixing-model can reproduce the observed stream chemistry. The number of contributing end-members is estimated by the mixing-model analysis but their physical interpretation relies on independent field sampling of groundwater and soil waters. This study provides a cross-basin application of end-member-mixing-analysis. The results will be used in a cross-basin analysis of runoff generation.

B44A-05 1645h

Analysis of Soil Moisture Patterns in Forested and Suburban Catchments Using High-Resolution Photogrammetric and LIDAR Digital Elevation Datasets

David E Tenenbaum¹ (919-962-3871; davidten@email.unc.edu)

Lawrence E Band¹ (919-962-3921; lband@email.unc.edu)

Stephen T Kenworthy² (270-745-4555; stephen.kenworthy@wku.edu)

Christina L Tague³ (619-594-3230; ctague@mail.sdsu.edu)

¹University of North Carolina at Chapel Hill Department of Geography, CB 3220 Saunders Hall, Chapel Hill, NC 27599-3220, United States

²Western Kentucky University Department of Geography and Geology, Environmental Science and Technology Building, 304, Bowling Green, KY 42101-3576, United States

³San Diego State University, Department of Geography, 5500 Campanile Drive, San Diego, CA 92182-4493, United States

Field observations of near-surface soil moisture, collected over several seasons in a watershed in suburban Maryland, are compared to values of the topographic index generated using digital elevation models at a range of resolutions and data sources. A companion set of observations, DEMs and topographic index values are presented for a nearby forested catchment. The degree to which topographic index values are an effective model of near-surface soil moisture conditions varies in the two environments: The urbanizing environment requires topographic index values from a DEM with a much finer grid cell resolution to function effectively, and the relationship is stronger in wetter conditions. In the forested environment, the DEM resolution required is considerably lower, and the relationship is strong under all moisture conditions. These results provide some insights into the length scales of near-surface hydrologic processes in the urbanizing environment, and the resolution of terrain data required to model those processes.

B51A CC: 220 C-E Friday 0830h

Isotopes in Biogeochemistry Posters

Presiding: M E Uhle, University of Tennessee; E Hobbie, University of New Hampshire

B51A-01 0830h POSTER

Nutritional associations among fauna at hydrocarbon seep communities in the Gulf of Mexico

Stephen E MacAvoy¹ (202-885-3003; macavoy@american.edu)

Charles R Fisher² (cfisher@psu.edu)

Robert S Carney³ (rcarne1@lsu.edu)

Stephen A Macko⁴ (sam8f@virginia.edu)

¹Biology Department, American University, 4400 Mass. Ave. NW, Washington, DC 20016, United States

²Pennsylvania State University, Biology Department, University Park, PA 16802, United States

³Louisiana State University, Coastal Studies Institute, Baton Rouge, LA 70803, United States

⁴University of Virginia, Department of Environmental Sciences., Charlottesville, VA 22903, United States

The Gulf of Mexico supports dense aggregations of megafauna associated with hydrocarbon seeps on the Louisiana Slope. The visually dominant megafauna at the seeps, mussels and tubeworms, derive their nutrition from symbiotic relationships with sulfide or methane oxidizing bacteria. The structure of the tubeworm aggregations provide biogenic habitat for numerous other species of heterotrophic animals. Carbon, nitrogen and sulfur stable isotope analyses of heterotrophic fauna collected with tubeworm aggregations in the Green Canyon Lease area (GC 185) indicate that most of these species derive the bulk of their nutrition from chemoautotrophic sources. The isotope analyses also indicates that although two species may be deriving significant nutritional input from the bivalves, none of the species analyzed are feeding directly on the tubeworms. Grazing gastropods and deposit feeding sipunculids were used to estimate the isotopic value of the free-living chemoautotrophic bacteria associated with the tubeworms (d13C -32 to -20‰/‰; d15N 0 to 7‰/‰; d34S -14 to -1‰/‰). The use of tissue d34S analyses in conjunction with tissue d13C and d15N led to several insights into the trophic biology of the communities that would not have been evident from tissue stable C and N analyses alone.

B51A-02 0830h POSTER

Iron Isotope Fractionation During Paleoproterozoic Lateritization of the Hekpoort Basalt in Gaborone, Botswana

Kosei E Yamaguchi^{1,2,3} (1-608-265-2601;

kosei@geology.wisc.edu); Clark M Johnson^{2,3} (1-608-262-1710; clarkj@geology.wisc.edu); Brian L Beard^{2,3} (1-608-262-1710;

beardb@geology.wisc.edu); Nicolas J Beukes^{3,4} (27-11-489-2305; njb@na.rau.ac.za); Jens

Gutzmer^{3,4} (27-11-489-2305; jg@na.rau.ac.za); Hiroshi

Ohmoto^{3,5} (1-814-865-4074; ohmoto@geosc.psu.edu)

¹Institute for Frontier Research on Earth Evolution (IFREE), Japan Marine Science and Technology Center (JAMSTEC), 2-15 Natsumi, Yokosuka 237-0061, Japan

²Department of Geology and Geophysics, University of Wisconsin-Madison, 1215 W. Dayton St., Madison, WI 53706, United States

³NASA Astrobiology Institute, NASA Ames Research Center (HQ), Moffett Field, CA, United States

⁴Department of Geology, Rand Afrikaans University, Auckland Park 2006, Johannesburg, South Africa

⁵Penn State Astrobiology Research Center (PSARC), Pennsylvania State University, 435 Deike Building, University Park, PA 16802, United States

Beukes *et al.* (2002) [*Geology* 30, 491-494] reported the discovery of a lateritic weathering profile developed on the ~2.2 Ga Hekpoort basalt in Gaborone, Botswana. In the lateritic paleosol, Fe is depleted in the lower pallid zone and enriched in the upper laterite and mottled zones. We have investigated the Fe mobility during laterite formation by analyzing bulk-rock Fe isotope ratios of selected drillcore samples. The studied

profile encompasses a ~25 m section from the parental basalt to lateritic paleosol and overlying reworked laterite (ferricrete). Compared to the parental basalt, the paleosol section has consistently higher $\delta^{56}\text{Fe}$ values with an upward increasing trend from 0 ‰/‰ at the bottom of the profile to +1 ‰/‰ in the mottled zone, followed by an upward decreasing trend to the top of the laterite profile (+0.3 ‰/‰). The overlying reworked ferricrete and red beds have moderately high $\delta^{56}\text{Fe}$ values of +0.2~+0.4 ‰/‰, which are comparable to those of the underlying laterite. The total Fe_2O_3 contents show an upward decreasing trend from the parental rocks (~9 wt.%) to the mottled zone (~0 wt.%), followed by increasing trend to the top of the laterite profile (~30 wt.%). The overlying reworked materials have variable Fe contents ranging from ~8 to ~50 wt.%. The elemental and isotopic data for Fe in the ~2.2 Ga lateritic Hekpoort paleosol can be explained by essentially the same processes that occur in modern laterite formation, which require (a) distinct rainy/dry seasons, (b) abundant surface biomass, and (c) an oxygenated atmosphere, to produce abundant Fe^{3+} -oxides. During wet seasons, leaching by organic acids is expected to remove low $\delta^{56}\text{Fe}$ ferrous Fe (e.g., Brantley *et al.*, 2001; *Geology* 29, 535-538) from the mid-depth soil profile, possibly aided by abundant surface biomass, resulting in depletion of total Fe contents and enrichment of the $\delta^{56}\text{Fe}$ values in the pallid zone. During dry seasons, diffusion of O_2 from the atmosphere to the soil zone may have resulted in oxidation of dissolved Fe^{2+} in soil water and precipitation of Fe^{3+} -oxides and hydroxides in mottled and laterite zones, where the high $\delta^{56}\text{Fe}$ values would be expected to occur. Our study suggests the important role of terrestrial organic matter in continental (tropical) weathering would have been important since at least Paleoproterozoic. Our study has important implications for the redox evolution of the atmosphere and the evolution of terrestrial biosphere.

B51A-03 0830h POSTER

Net Carbon Uptake by Terrestrial Ecosystems in the Han River Basin, Korea Derived from a Long-Term Hydrologic Budget

Kwang-Sik Lee¹ (+82-42-865-3447; kslee@kbsi.re.kr)

Dongho Lee^{1,2} (dlee@ieg.or.kr)

Nam-Chil Woo² (ncwoo@ygsgeo.yonsei.ac.kr)

Yongje Kim³ (yjkim@kigam.re.kr)

¹Korea Basic Science Institute, Eoeun-dong 52, Yuseong-gu, Daejeon 305-333, Korea, Republic of
²Yonsei University, Institute of Soil and Groundwater Environment, Dep. of Earth System Sciences, Seoul 120-749, Korea, Republic of

³Korea Institute of Geoscience and Mineral Resources, Gajeong-dong 30, Yuseong-gu, 305-350 Daejeon, Korea, Republic of

Recently, water and carbon cycles have been investigated for a few large drainage basins in North America based on stable isotope ratios of water and the 'Water Use Efficiency' concept. This approach is best suited to derive Net Primary Productivity (NPP) averaged for years to decades depending on the residence time of water, as it is based on a long-term hydrologic budget of the study area. Using the same method, we attempt to constrain the carbon cycling in the Han river basin, Korea and evaluate its applicability and reliability. On the basis of hydrologic data measured from 1965 to 1969, the mean annual input of water (33.9 km³) in the basin (i.e., precipitation) is balanced by the annual discharge (18.9 km³) and the annual evapotranspiration (15.0 km³). The evapotranspiration flux consists of the mean annual evaporation of 6.1 km³ derived from an isotope mass balance relation, the interception of 6.9 km³ estimated from the vegetation structure in the area and the transpiration of 1.8 km³. With the representative water use efficiency of 899.6 moles H₂O/moles CO₂ for the study area, the transpiration flux is translated into a NPP of 1.3 X 10¹² g Carbon/y (51.4 g Carbon/m²/y). The estimated NPP in the study area is relatively low compared to those reported for other regions in the world with similar environmental conditions and to the heterotrophic soil respiration flux for the area estimated from the empirical relation by Raich and Potter (1995). The result is sensitive to the variability of the major input parameters such as the amount of precipitation and discharge. Therefore, the uncertainty in estimating various water fluxes needs to be verified for a proper evaluation of the role of terrestrial ecosystems of the Han river basin in atmospheric carbon cycling. A detailed temporal variation of NPP, which is often masked in this type of studies due to an averaging effect, may be examined by constraining the residence time of water and a secular variation of water regime in the study area. This work was supported by a grant (code 3-2-1) from Sustainable Water Resources Research Center of 21st Century Frontier Research Program.

B51A-04 0830h POSTER

Comparison of the Oxygen Isotope Compositions of Cellulose and Phytoliths in a North American Prairie Grass

Elizabeth A. Webb¹ (519-661-2111 x82253; ewebb5@uwo.ca)

Frederick J. Longstaffe¹ (519-661-3177; flongsta@uwo.ca)

¹The University of Western Ontario, Department of Earth Sciences, London, ON N6A 5B7, Canada

Cellulose and silica phytoliths were extracted from the leaves and stems of *Calamovilfa longifolia*, a C4 grass, grown under varying climatic conditions across the North American prairies. The $\delta^{18}\text{O}$ values of cellulose and silica decrease with increasing latitude, reflecting the variations in the oxygen-isotope composition of precipitation across the Great Plains that result from continental and temperature effects. The oxygen-isotope compositions of both cellulose and silica from the leaves record a complex signal of the isotopic composition of the soil water that feeds the plants and relative humidity conditions that affect the oxygen-18 enrichment of leaf waters. As the initial stages of cellulose formation occur in the leaves, the cellulose in both the leaves and stems form primarily from leaf water and do not differ greatly in their oxygen-isotope compositions at one location. In contrast, the oxygen isotope compositions of leaf-phytoliths are significantly enriched in oxygen-18 relative to stem phytoliths, reflecting the varying isotopic composition of the water in these tissues. Hence, the oxygen-isotope compositions of silica phytoliths may be used as a proxy for the isotopic composition of both the leaf water involved in initial cellulose formation and stem water involved in subsequent partial exchange reactions during the transport of the carbohydrates through the plant. A comparison of the isotopic compositions of these two plant products should enable us to deduce soil-water $\delta^{18}\text{O}$ values and relative humidity conditions when direct measurements are not available.

B51A-05 0830h POSTER

Isotope Effects in O(¹D)-Mediated Isotope Exchange Between O₃ and CO₂

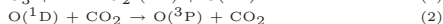
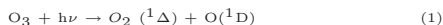
Amanda S. Cole¹ (1-510-642-4499; ascole@berkeley.edu)

Kristie A. Boering^{1,2} (1-510-642-3472; boering@cchem.berkeley.edu)

¹Department of Chemistry, University of California, Berkeley, CA 94720, United States

²Department of Earth and Planetary Science, University of California, Berkeley, CA 94720, United States

Ozone is formed with a large and unusual isotopic enrichment in ¹⁷O and ¹⁸O. This isotopic signature can be transferred to stratospheric CO₂ following ozone photolysis by the following mechanism:



Though this mechanism seems straightforward, there are several elementary reactions involved, all of which have or may have isotope effects, conventional or anomalous. Understanding the factors which control the anomalous CO₂ isotope enrichment on a molecular level will allow us to better predict the isotopic signatures of both O₂ and CO₂ being transported from the stratosphere to the troposphere (since the O₂ reservoir is anomalously depleted as CO₂ is anomalously enriched). These anomalous signatures are removed or diluted in the troposphere by interaction with the biosphere. Thus, it has been proposed that isotopic measurements of tropospheric CO₂ and of O₂ in ice cores can provide a measure of variations in the rate of removal of the CO₂ and O₂ isotopic anomalies by the biosphere, and thereby constrain gross primary production on annual timescales (CO₂) and millennial timescales (O₂). To better quantify the photochemical origin of the isotope anomaly, a detailed 0-D kinetics model was used to test the sensitivity of the CO₂ isotopic signature to measured and proposed isotope effects in the underlying reactions. The model results show that isotope effects in O₃ formation, O₃ photolysis, reaction (2), and other reactions of O (¹D) all contribute to the CO₂ enrichment in ¹⁷O and ¹⁸O.

B51A-06 0830h POSTER

Sources of Nitrate in an Adirondack Stream during Dissimilar Snowmelts.

Kathryn B Piatek¹ (315 470-6950; kpiatek@esf.edu)

Myron J Mitchell¹ (315 470-6765; mitchell@esf.edu)

Steven R Silva²

Carol Kendall²

¹SUNY-College of Environmental Sciences and Forestry, 1 Forestry Drive, Syracuse, NY 13210, United States

²U.S. Geological Survey, 345 Middlefield Road, MS 434, Menlo Park, CA 94025

To determine sources of NO₃- in surface water at snowmelt, we analyzed $\delta^{15}\text{N}$ -NO₃- and $\delta^{18}\text{O}$ -NO₃- in surface water between February and June of 2001 and 2002 and compared them to those of throughfall, bulk precipitation, snow, and groundwater. We used total Al, DOC and Si concentrations in stream water to indicate forest floor, soil, and ground water sources. The study was conducted in the 135-ha Archer Creek sub-catchment of the Arbutus Watershed in the Huntington Wildlife Forest in the Adirondack Region of New York. The 2001 snowmelt was continuous with discharge increasing from 0.6 to 32.4 mm day⁻¹. Concentrations increased from 33 to 71 $\mu\text{mol L}^{-1}$ for NO₃-, 3 to 9 $\mu\text{mol L}^{-1}$ for total Al, and 330 to 570 $\mu\text{mol L}^{-1}$ for DOC. Discharge in the 2002 melt was variable, with a maximum of 30 mm day⁻¹. The highest NO₃-, Al, and DOC concentrations were 52, 10, and 630 $\mu\text{mol L}^{-1}$, respectively, while dissolved Si decreased from 148 $\mu\text{mol L}^{-1}$ before to 96 $\mu\text{mol L}^{-1}$ during snowmelt. Values of $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of NO₃- in stream water were similar in both years. Stream, atmospherically-derived (throughfall, bulk precipitation and snow) and ground waters had overlapping $\delta^{15}\text{N}$ -NO₃- values. $\delta^{18}\text{O}$ -NO₃- ranged from +5.9 to +12.9 ‰/‰ in stream and ground water, and +58.3 to +78.7 ‰/‰ in atmospheric waters, indicating that atmospherically-derived NO₃- was not an important component of the NO₃- pulse in the stream during snowmelt. Instead, $\delta^{18}\text{O}$ -NO₃- values, increase in Al and DOC, and decrease in dissolved Si concentrations during the melt together suggested a dilution of groundwater NO₃- by increasing contributions of forest floor and mineral soil NO₃-. Atmospheric NO₃- from snow was probably initially incorporated into soil or groundwater pools.

URL: <http://www.esf.edu/hss>

B51A-07 0830h POSTER

Evidences for Cu and Zn Isotope Fractionation in Sediments and Particulate Suspended Matter of the Scheldt Estuary

Jerome Petit¹ (32-2-650-22-69; jpetit@ulb.ac.be)

Nadine Mattielli¹

Jeroen de Jong¹

Lei Chou¹

¹DSTE, Univ. Libre de Bruxelles, 50, Av. FD Roosevelt CP160/02, Brussels, B 1050, Belgium

Recent developments in MC-ICP-MS technology allow high precision measurements of heavy stable isotopes, such as Cu and Zn isotopes, which have been shown to undergo biotic or abiotic fractionation (1). Application of Zn isotopes to the study of aquatic ecosystems has already shown some interesting perspectives in their potential use as biogeochemical tracers in deep ocean carbonates (2) or Fe-Mn nodules (3). However, until now no investigation of possible Cu and Zn isotopic fractionation has been carried out within estuaries that are important pathways for hydrological and geochemical cycling of metals. Cu and Zn isotope geochemistry has been studied in sandy to loamy surface sediments (top 20 cm) and in suspended particulate matter (SPM) along a transect in a strong tidal estuary, the Scheldt estuary situated in Belgium and the Netherlands (November 2002). Further to separation of Cu, Fe and Zn by one step ion-exchange chromatography, Cu and Zn isotopic ratios are measured with a "Nu-Plasma" MC-ICP-MS. Instrumental mass bias is corrected using reference materials (Zn JMC, Cu NIST SRM 976 and Ga JMC standard) by simultaneous standard-sample bracketing and external normalization (500 ppb Zn doping for Cu isotopic analyses in static mode and 250 ppb Ga doping for Zn isotopic analyses in dynamic mode), together with a Ni correction. These methods lead to long-term reproducibility (2σ at 95 % confidence level) of ± 0.07 per mil for $\delta^{66}\text{Zn}$ (n=100 over 7 analysis sessions) and ± 0.06 per mil for $\delta^{65}\text{Cu}$ (n=120 over 8 analysis sessions) for 500 ppb of reference material. Average beam intensities are 6 V/ppm. Precise and reproducible results are obtained for concentration as low as 100 ppb for Cu and Zn. Expected Cu and Zn enrichment in SPM (120 ppm and 1200 ppm respectively) and sediments (being 6 to 10 times lower than SPM) in the upper estuary and progressive decrease in metal content by mixing downstream of the maximum turbidity zone (MTZ, around 5 psu) are observed. Results show that variations in Cu and Zn isotopic composition are smaller in SPM ($\delta^{66}\text{Zn}$ varying

from 0.35 to 0.17 and $\delta^{65}\text{Cu}$ from -0.13 to 0.18) than in sediments. Cu and Zn isotopic signatures of sediments show a clear trend of lighter isotopes removal from the MTZ seaward with $\delta^{66}\text{Zn}$ varying from 0.21 at 2 psu to 1.11 per mil at 33 psu (and $\delta^{65}\text{Cu} = -0.37$ to 0.24). In contrast, Zn isotopic compositions in SPM are more homogeneous with average $\delta^{66}\text{Zn}$ of 0.24 ± 0.18 over all the transect. Cu isotopic composition in SPM are very constant downstream of the MTZ with average $\delta^{65}\text{Cu} = -0.06 \pm 0.08$ but become more scattered within MTZ (varying from -0.04 to 0.18). These preliminary results pinpoint important variations in Cu and Zn isotopic compositions within estuarine systems and contrasted isotopic signatures in Cu and Zn between SPM and sediments. Results suggest the important role of early diagenesis in the isotope geochemistry of heavy metals in estuarine environment. This study provides a stepping stone for further investigation of interacting processes involved in controlling the cycling of metals in the Scheldt estuary. (1) Zhu et al., *Earth Planet. Sci. Lett.* 200 (2002), 47-62
(2) Pichat et al., *Earth Planet. Sci. Lett.* 6598 (2003), 1-12
(3) Maréchal et al., *Geochem. Geophys. Geosyst.*, 1 (2000), GC000029

B51A-08 0830h POSTER

What Carbon Sources Support Groundwater Microbial Activity in Riparian Forests?

Noel P. Gurwick¹ (607 255-2606; npg1@cornell.edu); Peter M Groffman² (845 677-7600 x128; groffmanp@ecostudies.org); Daniel C McCorkle³ (508-289-2949; dmccorkle@whoi.edu); Mark H Stolt⁴ (401-874-2915; mstolt@uri.edu); Dorothy Q Kellogg⁴ (401-874-7532; qkellogg@uri.edu); Arthur J Gold⁴ (401-874-2903; agold@uri.edu)

- ¹Cornell University, Program in Biogeochemistry Fernow Hall, Ithaca, NY 14853, United States
²Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545, United States
³Woods Hole Oceanographic Institution, Department of Geology Mailstop 8, Woods Hole, MA 02543, United States
⁴University of Rhode Island, Department of Natural Resources Science One Greenhouse Road, Kingston, RI 02881, United States

A major question in riparian research is the source of energy to support subsurface microbial denitrification activity. The supply of microbially-available carbon frequently limits microbial activity in the subsurface. Therefore, identifying the relative importance of carbon sources in the riparian subsurface helps explain the sustainability and spatial heterogeneity of denitrification rates. We have investigated the importance of buried, carbon-rich soil horizons, deep roots and dissolved organic carbon as potential carbon sources to support groundwater denitrification in riparian forests in Rhode Island. We used field observations, laboratory incubations and in-situ experiments to evaluate these sources at four sites in different geomorphic settings. In particular, we measured the ^{14}C -DIC signature and DIC concentration of ambient groundwater and groundwater that had been degassed, re-introduced into the well, and incubated in-situ. Buried horizons appear to be an important source of carbon in the subsurface, as shown by active respiration in laboratory incubations; greater microbial biomass in buried carbon-rich soils compared to surrounding carbon-poor soils; and the presence of very old carbon (>1,000 ybp) in DIC 225 cm beneath the surface. DIC collected from shallower wells showed no clear evidence of ancient carbon. Roots also appear to be important, creating hotspots of carbon availability and denitrification in the generally carbon poor subsurface matrix. Dissolved organic carbon did not stimulate denitrification in aquifer microcosms in the laboratory, suggesting that this was not an important carbon source for denitrification in our sites. Determining which carbon source is fueling denitrification has practical implications. Where buried horizons are the key source, surface management of the riparian zone will likely have little direct influence on groundwater denitrification. Where roots are the key source, changes in the plant community are likely to influence denitrification capacity in the subsurface.

B51A-09 0830h POSTER

Microbial Reworking Organic Matter in the Hauraki Gulf, New Zealand: Evidence from the Stable Isotopic Composition of Sedimentary D- and L-Amino Acids

Maria E Uhle¹ (865 974-0402; muhle@utk.edu)

Elisabeth L Sikes² (732-932-6555ext518; sikes@imcs.marine.rutgers.edu)

Scott D Nodder³ (s.nodder@niwa.cri.nz)

Melissa M Hage¹ (mhage@utk.edu)

Meg E Howard¹ (mhoward@utk.edu)

¹Department of Earth and Planetary Sciences, University of Tennessee 1412 Circle Drive 306 EPS Bldg, Knoxville, TN 37996, United States

²Institute of Marine and Coastal Sciences, Rutgers University 71 Dudley Rd, New Brunswick, NJ 08901, United States

³National Institute for Water and Atmospheric Research, 301 Evans Bay Parade Kilbirnie, Wellington, New Zealand

Amino acids are one of the more labile classes of organic matter in marine sediments. These compounds are the structural components of proteins and constitute the largest reservoir of organic nitrogen in most organisms. Their distribution and abundance have been used to assess diagenetic status of organic matter and their isotopic compositions have been linked to organic matter source identification. Organic matter in marine environments is derived from both allochthonous and autochthonous sources. Detailed source apportionment is difficult using bulk chemical characterization owing to the contribution of organic matter from multiple sources. Chemical and isotopic characterization of individual organic compounds, however, can yield detailed information on organic matter sources in complex systems. Sediment samples were recovered in 1999 from the Hauraki Gulf of New Zealand aboard the HMS Tangaroa. Near-shore and shelf environments were sampled along major currents to investigate the source and distribution of organic matter in the gulf. Amino acids were isolated from sediments by acid hydrolysis and quantified by gas chromatography/mass spectrometry following derivatization to their respective N-TFA-isopropyl esters. Isotopic compositions of the stereoisomers were determined by gas chromatography/isotope ratio mass spectrometry. Amino acid distributions from several sites throughout the gulf show a predominance of D- over L-amino acids, which reflects microbial input of amino acids in these sediments. At the Firth of Thames, the concentration of L-amino acids is greater than the D- isomers, which may be due to input of fresh algal material at this site. The isotopic compositions of many amino acids at this site reflect a marine source, which is consistent with the stereoisomer distributions. The carbon isotopic compositions of glycine and leucine at all sites are significantly depleted in ^{13}C relative to typical values for marine and terrestrial sources and appear to be a good indicator of microbial reworking of the sediments.

B51A-10 0830h POSTER

Constraints on Ca/Sr as a Proxy for Calcium in Forest Ecosystems

Claire J. Hoff¹ (603-862-3876; choff@cisunix.unh.edu)

Erik A. Hobbie² (603-862-3581; erik.hobbie@unh.edu)

Rich Hallett³ (603-868-7657; rah@unh.edu)

Jan Colpaert⁴ (jan.colpaert@luc.ac.be)

Julie G. Bryce¹ (603-862-3139; julie.bryce@unh.edu)

¹UNH Dept. of Earth Sciences, James Hall, Durham, NH 03824, United States

²UNH Complex Systems Research Center, Morse Hall, Durham, NH 03824, United States

³USDA Northeastern Forest Experiment Station, PO Box 640, Durham, NH 03824, United States

⁴Limburgs Universitair Centrum, Environmental Biology Universitaire Campus B-3590 Diepenbeek, Belgium

Calcium is a key plant nutrient and important base cation in ecosystems. Our current efforts to quantify Ca cycling in ecosystems rely on indirect proxies, e.g., Ca/Sr or Sr isotopic systems (1). An important assumption in these applications is that the elemental ratio of calcium to strontium faithfully represents calcium cycling and that little fractionation occurs through biogeochemical and physiological processes. However, several researchers have reported variations in Ca/Sr, e.g. among different tree tissues (2) and during weathering processes (3), raising doubts about the suitability of the proxy. To address the question of reliability, we measured Ca/Sr values in a culture study in which Scots pines were grown at low or high nutrient supply rates (3% per day or 5% per day). Because mycorrhizal fungi are intimately involved in plant nutrient supply, plants were also grown either uncolonized or colonized with one of two different species of mycorrhizal fungi (*Suillus luteus* and *Thelephora terrestris*). Our preliminary results indicate that Ca/Sr values differ between high and low nutrient treatments, root and foliage, and mycorrhizal treatments. In individual seedlings, roots have lower Ca/Sr than foliage by absolute factors of 2-5. The magnitude of the effect is apparently determined by a combination of environmental factors including both the nutrient and mycorrhizal treatments. These results indicate that Ca

and Sr are partitioned differently between nutrient and mycorrhizal treatments and between plant fractions despite the common nutrient broth and substrate. Thus, Ca/Sr values alone are not reliable tracers of Ca within an ecosystem because of partitioning of Ca and Sr during nutrient transport within the plant-mycorrhizal system. We are presently refining analytical techniques and conducting leachate experiments to improve the quantification of this Ca/Sr fractionation. We are also exploring the use of isotopic tracers to study calcium biogeochemical cycling in forest ecosystems. (1) Blum, J.D., et al. 2002. *Nature* 417: 729-731. (2) Bailey, S.W., et al. 1996. *Water Resources Research* 32: 707-719. (3) Vitousek, P.M., et al. 1999. *Oecologia* 121: 255-259.

B51A-11 0830h POSTER

Stable Isotopic Studies and Ecosystem Research in Asia

Jeffrey S Owen¹ (owenje@earth.sinica.edu.tw)

Ming Kuang Wang² (mkuang@ccms.ntu.edu.tw)

Hen Biau King³ (hbking@serv.tfri.gov.tw)

Shuh Ji Kao¹ (sjkao@earth.sinica.edu.tw)

¹Environmental Change Research Center, Academia Sinica, Taipei 115, Taiwan

²Department of Agricultural Chemistry, National Taiwan University, Taipei 106, Taiwan

³Taiwan Forestry Research Institute, Council of Agriculture, Taipei 100, Taiwan

Stable isotope studies could contribute much to our understanding of ecosystem nutrient cycling, fate and transport of pollutants, and human impacts on the environment in Asia. As examples of ongoing studies within the Asian region that utilize stable isotopic techniques, results from two studies investigating relationships among patterns in $\delta^{15}\text{N}$ and net rates of nitrogen transformations in forest ecosystems in Taiwan are shown. In an evergreen hardwood forest in northeastern Taiwan ($24^{\circ}34\text{N}$, $121^{\circ}34\text{E}$), soil $\delta^{15}\text{N}$ values in the forest floor ranged from -1.8 to 1.8‰ . Mineral soils had higher $\delta^{15}\text{N}$ values (4.1 to 6.0‰). Foliage $\delta^{15}\text{N}$ values for overstory trees ranged from -6.6 to -2.0‰ . In a montane ecosystem in central Taiwan ($23^{\circ}28\text{N}$, $120^{\circ}48\text{E}$) we found that net rates of N mineralization were related to soil C:N ratios. In this mixed grassland-forest system, foliar $\delta^{15}\text{N}$ values of the dominant species ranged from -6 to -3‰ . Surface soil $\delta^{15}\text{N}$ values were between -1 and 3‰ with a greater difference between foliar and soil values in grassland soils. Our results illustrate the need for more information regarding fundamental patterns in rates of ecosystem nitrogen cycling in Asia, especially as related to wider scale patterns in nutrient cycling within the region, to demonstrate potential insights from these kinds of studies.

B51B CC: 220 C-E Friday 0830h Measurement and Modeling of Carbon, Water, and Energy Exchange in Northern Ecosystems III Posters

Presiding: H Margolis, Universit Laval; C Coursolle, Universit Laval

B51B-01 0830h POSTER

A comparison of soil profile CO_2 production dynamics across adjacent intact, clearcut and partial cut forests

Amy Myette¹ (902-867-5073; amyette@stfx.ca)

Lisa Kellman¹ (902-867-5086; lisa@stfx.ca)

Hugo Beltrami¹ (902-867-2326; hugo@stfx.ca)

David Risk¹ (902-867-3667; drisk@stfx.ca)

¹Environmental Earth Sciences Laboratory, St. Francis Xavier University, P.O. Box 5000, Antigonish, NS B2G2W5, Canada

Changes in soil vegetation cover alter a suite of factors that control the balance of carbon stored in soil profiles including the heat balance, hydrological regime, physical properties and input and turnover of organic matter in soils. Altering these factors will change the absolute quantity of soil respiration but may also shift the relative proportions of deep versus shallow CO_2 production. Although studies have investigated net changes in soil surface respiration resulting