

## Identification of anthropogenic influences on groundwater quality based on hydrogeochemistry survey in Nanfei watershed, China

J.Z. QIAN<sup>1</sup>, S.H. LUO<sup>2</sup>, Y. LIU<sup>3</sup> AND G. CHEN<sup>1</sup>

<sup>1</sup>School of Resources and Environmental Engineering, Hefei University of Technology, Hefei 230009, China (qjiazhong@gmail.com)

<sup>2</sup>School of Resources and Environmental Engineering, Henan Polytechnic University, Jiaozuo454010, China (luosh@hpu.edu.cn)

<sup>3</sup>School of Biotechnology and Food Engineering, Hefei University of Technology, Hefei 230009, China (liuy99999@163.com)

Groundwater is progressively subjected to stress as a result of both anthropogenic activities and natural chemical process. The groundwater recharges contribute main nutrients to most lakes in a watershed, thereby tending to induce serious eutrophication problems. This study has investigated the hydrochemical characteristics and the contamination of groundwater in the Nanfei watershed between Chaohu lake and old town of Hefei, China. An attempt was made to distinguish anthropogenic inputs from the influence of natural chemical weathering on the chemical composition of groundwater at Nanfei watershed. Groundwater samples were collected at 45 locations in the Nanfei area. Multivariate statistical techniques were applied to identify characteristics of the groundwater quality in the studied area. Results showed that: (1) there were very variable chemical composition of groundwater. 44% groundwater was of Na-HCO<sub>3</sub> type, and 40% groundwater was of Ca-HCO<sub>3</sub> type. The types of Ca-SO<sub>4</sub>, Ca-Cl, Na-SO<sub>4</sub> and Na-Cl accounted for 4.4%, 4.4%, 4.4% and 2.2%, respectively. Most groundwater was alkalinescence and the groundwater chemistry was more influenced by landuse and town development; (2) based on factor analysis of the chemical data, K<sup>+</sup>, Cl<sup>-</sup>, PO<sub>4</sub><sup>3-</sup> and NO<sub>3</sub><sup>-</sup> concentrations have the highest factor loadings on factor 1; Fe and Mn concentrations on factor 4; Ca<sup>2+</sup>, Mg<sup>2+</sup> and HCO<sub>3</sub><sup>-</sup> concentrations on factor 3; Na<sup>+</sup>, SO<sub>4</sub><sup>2-</sup> concentrations on factor 3. Factor 4 and 1 represent major contributions from natural processes and human activities, respectively. The levels of Ca<sup>2+</sup>, Mg<sup>2+</sup>, HCO<sub>3</sub><sup>-</sup>, Na<sup>+</sup> and SO<sub>4</sub><sup>2-</sup> derive from both pollution sources and natural weathering reactions.

This study was supported by the National Natural Science Foundation of China (No.40672154 and No.40772153), Program for New Century Excellent Talents in University (No. NCET-06-0541)

## A-type gneissic metagranites from Donghai in the SW Sulu terrane, eastern China: Geochemical constraints on the nature of protoliths and tectonic significance

JIAN-SHENG QIU\*, JIAN HU AND XI-SHENG XU

State Key Lab for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing 210093, China (\*correspondence: jsqiu@nju.edu.cn)

The Sulu terrane is geotectonically belongs to the northeastern margin of Yangtze block. Six gneissic metagranite plutons bearing alkaline mafic minerals from Donghai in the SW Sulu terrane were selected for a detailed geochronological and geochemical study to identify the nature of protolith and to discuss its tectonic significance. These gneissic metagranites are light-colored, and consist mainly of K-feldspar + oligoclase-albite + quartz. Mafic alkaline minerals, such as aegirine or aegirine-augite and arfvedsonite, have been observed in most samples. Zircon LA-ICP-MS U-Pb dating for these rocks yields a protolith age of about 770 Ma. They experienced UHP metamorphism at about 250 Ma and retrograde metamorphism at about 210 Ma. Chemically, these metagranites are characterized by high SiO<sub>2</sub> and K<sub>2</sub>O+Na<sub>2</sub>O contents, high FeO\*/(FeO\*+MgO) ratios (= 0.83~0.94), low CaO and MgO abundances, enrichment of Ga, Y, Zr and Hf, and depletion of Sr, P and Ti, and high 10<sup>4</sup>×Ga/Al ratios (=2.76~5.15). The mineralogical and geochemical features, believed to have been well preserved during metamorphism, suggest that the protoliths belong to A-type granites. Furthermore, these metagranites show relatively high Y/Nb (1.85~9.72) and Y/Ta (4.71~30.14) ratios, which is quite different from that of the A-type granites generated under an intra-plate rifting setting. They are rather similar to that of the Late Cretaceous A-type granites in the coastal areas of SE China, implying that the protoliths were likely formed in a back-arc extensional setting. The formation of the Donghai A-type gneissic metagranites suggests that the northeastern margin of the Yangtze block during the Neoproterozoic might have been under an active continental margin setting rather than an intra-plate rifting setting.

This study was financially supported by the Natural Science Foundation of China (grant no. 40772036) and the National 973 Project of the Chinese Ministry of Science and Technology (grant no. 2006CB403508).

## Using nitrogen cycle proxies to determine paleoenvironmental variables

T.M. QUAN<sup>1\*</sup>, Y. KASHIYAMA<sup>2</sup>, N. OHKOUCHI<sup>3</sup>  
AND P.G. FALKOWSKI<sup>4</sup>

<sup>1</sup>Institute of Marine and Coastal Sciences, Rutgers Univ., New Brunswick NJ 08901

(\*correspondence: quan@marine.rutgers.edu)

<sup>2</sup>Institute for Research on Earth Evolution, JAMSTEC, Yokosuka 237-0061 Japan (chiro@jamstec.go.jp)

<sup>3</sup>Institute for Research on Earth Evolution, JAMSTEC, Yokosuka 237-0061 Japan (nohkouchi@jamstec.go.jp)

<sup>4</sup>Institute of Marine and Coastal Sciences and Department of Earth and Planetary Sciences, Rutgers Univ., New Brunswick NJ 08854 (falko@marine.rutgers.edu)

Nitrogen is primarily controlled by the oxidation state of the environment via a series of biological reactions. As a result, changes in the environmental redox state will be reflected by changes in the nitrogen cycle, which can be evaluated over a wide range of time scales using proxies such as sedimentary  $\delta^{15}\text{N}$  and deep-water N:P ratios.

We have developed a theoretical model illustrating the relationship between sedimentary  $\delta^{15}\text{N}$  values and deep-water  $\text{O}_2$  concentration, reflecting the relative contributions of nitrogen fixation, nitrification, and denitrification reactions under various redox conditions. This model can be used to interpret changes in paleo-redox conditions based on the bulk  $\delta^{15}\text{N}$  profiles measured in sedimentary cores, but can also reflect the relative predominance of certain microbially-mediated reactions. We have also evaluated present-day systems and determined that deep-water N:P ratios are not only set by the elemental ratios of the remineralized organic matter but also by the deep-water oxygen concentration and basin surface area. This, combined with the relationship between  $\delta^{15}\text{N}$  and  $\text{O}_2$ , may allow us to infer historical N:P ratios for any aqueous environment, connecting the oxidation state of the environment to biological productivity and nutrient cycling. Previously reported compound-specific  $\delta^{15}\text{N}$  values measured in sedimentary-derived porphyrins [1-3] provide additional detail regarding paleoceanographic processes and organisms controlling the nitrogen cycle, allowing further interpretation of sedimentary  $\delta^{15}\text{N}$  measurements.

[1] Kashiya *et al.* (2008) *Org. Geochem.* **39**, 532-549.

[2] Kashiya *et al.* (2008) *Biogeosci.* **5**, 797-816.

[3] Chicarelli *et al.* (1993) *Geochim. Cosmochim. Acta* **57**, 1307-1311.

## Decomposition-induced changes in soil organic matter composition

SYLVIE A. QUIDEAU<sup>1</sup>, SE-WOUNG OH<sup>2</sup>  
AND DAVID PARÉ<sup>3</sup>

<sup>1</sup>Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3, Canada

(\*correspondence: sylvie.quideau@ualberta.ca)

<sup>2</sup>Department of Chemistry, Mokpo National University, Muan, Chonnam 534-729, Republic of Korea

<sup>3</sup>Canadian Forest Service, Laurentian Forestry Centre, Ste-Foy, Québec, QC G1V 4C7, Canada

On a global basis, 470 Gigatons of carbon are contained in boreal forest soils, which is close to 25% of the total carbon present in all the Earth's vegetation and soils. Yet very little is known about the exact nature and decomposition pathways of organic matter in these soils. Objectives of this study were to examine the effects of environmental conditions (vegetation, climate) and disturbance (fire, harvesting) on 1) soil organic matter composition, and 2) decomposition-induced changes in composition from a range of boreal forest and peatland ecosystems typically found in Canada.

Forest floor and peat samples (0-10 cm) obtained from 17 sites located from New Brunswick to British Columbia were incubated for one year at 10°C. Organic matter composition in pre- and post-incubation samples was characterized by solid-state  $^{13}\text{C}$  NMR using ramped-cross-polarization (RAMP-CP) on a Bruker Avance 400 spectrometer.

NMR results revealed significant differences among vegetation types regardless of disturbance and climate at the sampling location. The percentage of carbon mineralized during incubation ranged from 1 to 24%. Decomposition-induced changes in carbon chemistry included an overall decrease in carbohydrate concentrations, but significantly differed among vegetation types. In particular, samples from the Jack pine and Douglas fir stands, which had the highest carbon mineralization rates, showed a significantly greater increase in aromatic, phenolic, and carbonyl carbons.

## Arbuscular mycorrhiza: Mineral-specific fungal interactions

J. QUIRK\*, J.R. LEAKE AND D.J. BEERLING

Animal & Plant Sciences, University of Sheffield, UK  
(\*correspondence: j.quirk@sheffield.ac.uk)

Arbuscular mycorrhizas (AM) are the ancestral type of root-fungal associations that co-evolved with vascular land plants >400 Myr ago and today occur in ~80% of land plant species. The fungi are extremely effective at scavenging phosphorus from soil solution and passing some of this into their host plants, at a much lower carbon cost to the plant than a root system [1]. However, the capacity of AM to liberate nutrients from minerals by weathering remains uncertain and few studies have investigated the nature and effect of AM mycelial interactions with rocks and minerals.

Using plants with AM and without AM, grown in pots of sand in which we buried nylon mesh bags containing washed grains of perlite or tertiary basalt, we show for the first time strong preference of AM hyphae for basalt over perlite.

### Mineral-specific AM fungal interactions

AM fungal lengths were up to 40 times greater per unit volume of basalt grains than per volume of perlite. Plant species that are habitually non-mycorrhizal supported minimal fungal colonisation of the basalt, confirming the importance of AM fungi as the main fungi present in pots containing AM plants. This was further supported by the total lengths of hyphae in a mesh bag per unit dry mass of mineral grains which were >2 times greater in bags with basalt than with perlite, and >12 times higher than hyphal lengths observed in pots with non-mycorrhizal plants. Aqueous leachate samples of the minerals recovered from the mesh bags were found to be acidified by the plants from pH 5.2 to pH 3.7 with basalt, and from pH 4.7 to 3.5 with perlite. Acidification increased in proportion to the log of hyphal lengths ( $\text{m g}^{-1}$ ) mineral grains.

The results demonstrate preferential colonisation and growth of AM hyphae around grains of basalt compared to perlite, and the acidification associated with this more intensive colonisation will enhance acid dissolution. Our findings suggest that AM fungi may play a direct and significant role in enhancing mineral dissolution and that the fungi allocate their biomass preferentially around mineral grains such as basalt that can supply essential nutrient elements (e.g. P, K, Ca, Mg, Fe) required both by the fungi and the partner plants from which they obtain organic carbon.

[1] Leake *et al.* (2004) *Can. J. Bot.* **82**, 1016–1045.

## Proteogenomic insights into anaerobic biodegradation of hydrocarbons

RALF RABUS<sup>1,3</sup>, HEINZ WILKES<sup>2</sup>  
AND FRIEDRICH WIDDEL<sup>3</sup>

<sup>1</sup>Institute for Chemistry and Biology of the Marine Environment (ICBM), University Oldenburg, Oldenburg, Germany

<sup>2</sup>GFZ Helmholtz-Zentrum Potsdam, Potsdam, Germany

<sup>3</sup>Max Planck Institute for Marine Microbiology, Bremen, Germany

Aromatic compounds and hydrocarbons are major constituents of crude oil and widespread in nature. However, they represent unusual growth substrates for bacteria, since their extraordinary chemical stability necessitates special degradation reactions and their toxic properties may challenge bacterial viability. Aerobic bacteria use the long known oxygenases, which employ highly reactive oxygen species ( $\text{O}_2$ -derived) as co-substrates for initial hydrocarbon activation and cleavage of the aromatic ring. In contrast,  $\text{O}_2$ -independent reactions are required under anoxic conditions, which prevail in many natural environments, such as marine sediments or oil reservoirs. To our current knowledge, the fumarate-dependent activation of *n*-alkanes and alkylbenzenes to their respective alkyl- and arylsuccinates appears to be the most common reaction type for hydrocarbon activation among different types of anaerobic bacteria. Interestingly, all currently known alkyl- and arylsuccinate synthases can be grouped into three distinct phylogenetic clusters that reflect the hydrocarbon substrate range of the individual enzymes. Recent proteogenomic studies with the denitrifying betaproteobacterium "*Aromatoleum aromaticum*" strain EbN1 have allowed new insights into (i) substrate-specific regulation of respective catabolic operons, (ii) metabolic strategies to deal with the toxicity of the aromatic growth substrate, e.g. formation of PHB and specific efflux systems, and have inspired (iii) the discovery of novel aromatic growth substrates and respective degradation pathways, e.g. anaerobic degradation of *p*-ethylphenol.