Exploring Water Quality and Flow Paths Using Boron Isotope Data

A.T. SLADE[1]*, N.R. WARNER[2], A. VENGOSH[2] AND B. WHITEHEAD[1]

[1] School of Environment, The University of Auckland, 23 Symonds Street, Auckland 1142, New Zealand, a.slade@auckland.ac.nz (* presenting author)

[2] Division of Earth and Ocean Sciences Nicholas School of the Environment, Duke University, Durham, NC 27708

Boron isotope data is rarely used by water quality (WQ) authorities to elucidate processes occurring in hydrologic systems in order to improve WQ management protocols. In concert with a suite of chemicals this study explores the use of boron as a tracer in a WQ study that also helps reveal potential flow paths for water in a pulp and paper waste site. The results not only provide the local WQ authorities with a tool for improving the management of their waterways, they come at a critical stage in the history of the site as the parties legally responsible for the waste and management of the site will change in December of 2012.

Study Site

A pulp and paper waste site, located on top of active geothermal features, in the Bay of Plenty region of New Zealand is at risk of having a sustained and detrimental impact on the environment given the following historical and contemporary issues: 1) the waste site floods periodically causing temporary ponding, which in the past has resulted in the banks of the adjacent Tarawera River (TR) to breach; 2) the natural underlying geologic units and waste material generated by the pulp and paper mill are highly permeable; and 3) the two shallow unconfined aquifers in and under the waste are thought to house substantial volumes of water that are connected to the TR. As such, it is important to identify the source, provenance, and chemical profile of the water as it migrates through the geologic units and waste material in an effort to assist in mitigating any future environmental impacts.

Results of Study

This study involves a comprehensive chemical evaluation of water samples collected between 2009 and 2011, from the pulp and paper waste site, with an emphasis placed on boron isotope data. The types of water sampled and their associated $\delta^{11}B$ values collected from the 1 km^2 area that encompasses the waste site were: surface water (10.1-15.4‰); groundwater (-5.0-0.0‰); leachate (-1.5-6.7‰); geothermal water (-1.2‰); natural spring water (11.9‰); and rain water (25.9-28.9‰). The collation of the data provides a final assessment of the waste site's hydrologic system through the lens of boron isotope chemistry and showcases the ability to use it to improve WQ management protocols.

Timing and carbon sources for microbial processses in the deep terrestrial carbon cycle

SLATER, G.F.*[1], MAILLOUX, B[2]., SILVERN, R.[2], LI, L[3], SHERWOOD LOLLAR B[3]., ONSTOTT T.C.[4],

[1]McMaster University, Hamilton, Canada, gslater@mcmaster.ca,
[2]Bernard College, New York, USA
[3]University of Toronto, Toronto, Canada
[4]Princeton University, USA

The presence of microbial communities living in ancient, fractured rock in deep (2-3+ km) subsurface terrestrial environments suggests that the metabolic activities of these organisms may play a role in fluxes of carbon moving into, or out of, these deep Earth environments. This study investigated the carbon source and metabolic activities in fracture water feeding an artesian borehole located 1.3 deep in the Beatrix mine, South Africa. Isotopic analysis of the ^{18}O and ^{2}H of the waters lie along the GMWL but offset from modern precipitation indicating a paleometeoric origin confirmed by noble gas derived residence times on the order of a few Ma (1).

Multiple isotope analysis of carbon isotopes (^{13}C, ^{14}C) was applied to microbial cellular components (PLFA, DNA) and potential carbon sources and/or metabolites including dissolved inorganic carbon (DIC) and CH_4. $\Delta^{14}C$ of DIC was observed to be -980 ‰, slightly enriched above expectation for geologically old carbon ($\Delta^{14}C$ = -1000 ‰). Concurrently, PLFA and DNA $\Delta^{14}C$ were -940 ‰ demonstrating microbial utilization of highly ^{14}C depleted carbon sources. This is the first study we are aware of to compare two such distinct cellular components. The close agreement of these independent measurements supports the accuracy of both approaches. The fact that these microbial cellular components were slightly isotopically enriched related to the DIC suggests inputs from a ^{14}C enriched carbon source. The potential role of methane ($\delta^{13}C$ =-52 ‰ at this site) as a C source in this ecosystem is suggested by the $\delta^{13}C$ of PLFA from these communities (-50 to -65 ‰). This hypothesis will be investigated by on-going isotopic analysis of the ^{14}C methane and ^{13}C DIC pools.

[1] Lippman et al, (2003) GCA 67: 4597-4619