

## Carbon isotope composition of dissolved inorganic carbon as a tracer of geo-, bio- and anthropogenic sources of carbon: Examples from Swiss rivers and lakes

T. VENNEMANN\*, D. FONTANA AND S. PAYCHERE

Institute of Mineralogy and Geochemistry, University of Lausanne, CH-1015 Lausanne, Switzerland  
(\*correspondence: Torsten.Vennemann@unil.ch)

The carbon isotope composition of dissolved inorganic carbon (DIC), in addition to other routine field and laboratory measurements of water, have been analyzed seasonally for several rivers, lakes, dams used as sources for hydroelectric energy, and effluents from waste water treatment plants (WWT). The aim is to evaluate the DIC and its isotopic composition as a tracer for the geologic, biologic and anthropogenic contributions of carbon to the rivers and lakes.

The upper reaches of many rivers are typical Alpine catchments with sparse vegetation and a thin soil covers. Glacial melt waters and surface runoff make up the bulk of the water sources in these parts. Downstream other tributaries, themselves often being melt water fed but many also being exploited for hydroelectric power and thus with a number of dams along their course, join the major rivers. In addition, the vegetation and soil cover increases downstream in parallel with the agricultural exploitation, population density, and the number of WWT plants.

The difference in geology of the catchment as well as the soil cover thickness and hence biologic activity in the soil are reflected by the C isotope composition of the DIC.  $\delta^{13}\text{C}$  values are as high as  $-2.5\%$  in the upper source reaches of glacially fed rivers and dams, reflecting predominant uptake of  $\text{CO}_2$  from the atmosphere. Further downstream,  $\delta^{13}\text{C}$  values decrease towards  $-5$  to  $-11.5\%$ , compatible with a higher input of soil-, plant-derived  $\text{CO}_2$ . The  $\delta^{13}\text{C}$  values of DIC are higher ( $-5$  to  $-8.5\%$ ) if carbonate relative to silicate rocks dominate the catchment, unless the agricultural activity is intense and also for all lakes and dams along the rivers. The  $\delta^{13}\text{C}$  values are lower in winter compared to spring or summer, indicating a higher biological activity within the water column during spring and summer, most notable in dams and lakes. Contributions of organic carbon from WWT plants are clearly detected by 0.5 to 2.6‰ lower  $\delta^{13}\text{C}$  for DIC directly downstream of the effluents, which may have values as low as  $-27\%$ . Such sources are also clearly expressed by differences in H- and O-isotope compositions of the waters as well as their nitrate content and isotopic compositions.

## N and C isotopic compositions in high- $^3\text{He}$ Kola plume rocks

A. VERCHOVSKY<sup>1</sup> AND I. TOLSTIKHIN<sup>2</sup>

<sup>1</sup>The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK (a.verchovsky@open.ac.uk)

<sup>2</sup>Geological Institute, Kola Scientific Center RAS, Apatity, 184209, Russia (igor.tolstikhin@gmail.com)

During the Devonian magmatism (370 Ma ago) ~20 ultrabasic-alkaline-carbonatite complexes (UACC) were formed in the Kola Peninsula (NE Baltic Shield). Analyses of noble gas isotope abundances and parent element (Li, K, U, Th) concentrations in the rocks and minerals of these complexes showed extremely high concentrations of  $^3\text{He}$ , up to  $4 \times 10^{-9}$  cc  $\text{g}^{-1}$  in some samples, quite low initial  $^4\text{He}/^3\text{He} = 3 \times 10^4$ , well below the mean ratio in mid ocean ridge basalts (MORB) and high  $^{20}\text{Ne}/^{22}\text{Ne} = 13$ ; all these features indicated a contribution of mantle plume component [1, 2].

To characterise this component further, isotope composition of N, released from Kola rocks by crushing, was measured giving the range from  $-0.2 \leq \delta^{15}\text{N} \leq 6.5\%$  with the mean value  $+3\%$  [3], which was in contrast to the negative  $\delta^{15}\text{N} = -5$  inferred earlier for the MORB source mantle [4].

We have analysed N, C and Ar isotopic compositions and concentrations simultaneously in several Cpx and Mt separated from the UACC rocks. The gases were extracted using stepped combustion technique in the temperature range from 200 to 1450°C with 100° increment and analysed on two on line mass spectrometers in static mode with precision of ~1‰ for both N and C.

The samples contain variable amounts of C (700-2500 ppm) released (in the form of  $\text{CO}_2$ ) in a narrow temperature range (500-700°C) with  $\delta^{13}\text{C}$  values from  $-2.6$  to  $-7.5\%$ . The release temperature and isotopic composition of the carbon clearly indicate [5] that it comes from carbonate occurred presumably as solid inclusions in the minerals.

Nitrogen has a complex release pattern and variable isotopic composition in the range from  $-15$  to  $+10\%$  for  $\delta^{15}\text{N}$  indicating that different N components are present. The light N could represent a mantle reservoir while the heavy one could be associated with the recycled crustal material [6].

[1] Marty *et al.* (1998) *EPSL* **164**, 179–192. [2] Tolstikhin *et al.* (2002) *GCA* **66**, 881–901. [3] Dauphas & Marty (1999) *Science* **286**, 2488–2490. [4] Marty & Humbert (1997) *EPSL* **152**, 101–112. [5] Nivin *et al.* (2005) *Lithos* **85**, 93–112. [6] Jia & Kerrich (2004) *G<sup>3</sup>*, Q07005, doi:10.1029/2004GC000716