

XXXVIII IAH Congress

Groundwater Quality Sustainability
Krakow, 12–17 September 2010

Extended Abstracts

Editors:
Andrzej Zuber
Jarosław Kania
Ewa Kmieciak



University
of Silesia
Press 2010



abstract id: **521**

topic: **4**
Mineral and thermal water

4.3
Hydrogeochemical characteristics of mineral and thermal waters

title: **Stable isotopes of dissolved inorganic carbon and sulphur-bearing species in mineral and thermal waters from central Portugal**

author(s): **Manuel J. F. Morais**
Centre for Geophysics of the University of Coimbra, Portugal,
manuelmorais@engenheiros.pt

keywords: thermomineral waters, stable isotopes, carbon, sulphur

1. INTRODUCTION

There are many springs of mineral and thermal waters associated with the Hercynian Beiras Batholith granites of Central Portugal, which intruded meta-sedimentary rocks of Palaeozoic age. These low enthalpy thermomineral systems reflect the deep circulation of meteoric waters in fractured granites. All waters studied have similar chemical characteristics: pH varies between 8 and 9.3; Na^+ is the dominant cation (representing over 90% of the total cations); HCO_3^- is the most representative anion, followed by Cl^- and/or F^- (always > 10 mg/L); and all of them are strongly reduced (as revealed by reduced sulphur (HS^-) and reduced nitrogen (NH_4^+)) and have very low Mg^{2+} contents (usually < 0.15 mg/L). Temperature ranges between 18 and 66°C, and total dissolved solids between ~200 and ~500 mg/L. Both natural springs and boreholes as deep as 500 meters were studied.

2. EXPERIMENTAL PROCEDURES

Samples for $^{13}\text{C}/^{12}\text{C}$ measurements were obtained by precipitation of the total dissolved inorganic carbon (DIC) as SrCO_3 by means of SrCl_2 . The precipitate was filtered and dried without any contact with atmospheric air. Gas extraction was done by acidification with 103% H_3PO_4 and purification by cryogenic distillation. Dissolved sulphide was collected as ZnS precipitated by addition of zinc acetate to the water, and later converted to Ag_2S by means of AgNO_3 . Following filtration of the ZnS , the remaining water was acidified and treated with BaCl_2 to precipitate dissolved sulphate as BaSO_4 . All isotopic analyses were done at the Stable Isotope Laboratory, University of Salamanca. The isotopic values are reported in the usual delta notation ($\delta\text{‰}$) relative to V-PDB ($\delta^{13}\text{C}$) and CDT ($\delta^{34}\text{S}$).

3. RESULTS AND DISCUSSION

3.1. $\delta^{13}\text{C}$ of the dissolved inorganic carbon

The $\delta^{13}\text{C}_{\text{VPDB}}$ values of the total dissolved inorganic carbon (TDIC) in groundwaters range from -16.9 to -10.5‰. This range of $\delta^{13}\text{C}_{\text{DIC}}$ values is accompanied by a large variation of TDIC contents. The observed linear relation between TDIC and $\delta^{13}\text{C}$ (Fig. 1) suggest that inorganic carbon in the studied waters derives from more than one source: measured $\delta^{13}\text{C}$ values can not be attributed to isotope fractionation between soil- CO_2 and DIC only.

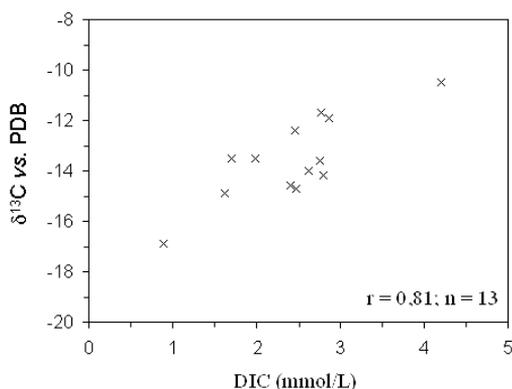


Figure 1. Relation between Total Dissolved Inorganic Carbon and $\delta^{13}\text{C}$.

A gaseous source, isotopically heavier than the organic C of soil-CO₂ (such as regional deep mantle-derived or metamorphic flux of CO₂), must be invoked.

3.2. $\delta^{34}\text{S}$ of sulphur-bearing species (SO_4^{2-} ; HS^-)

The $\delta^{34}\text{S}$ of sulphur-bearing species shows a remarkable variability: $\delta^{34}\text{S}_{\text{CDT}}$ (SO_4^{2-}) ranges from +6 to +44 ‰; $\delta^{34}\text{S}_{\text{CDT}}$ (HS^-) ranges from -25 to +2‰. Sulphate is always enriched in ³⁴S relative to reduced sulphur (HS^-). This isotopic difference ($\Delta^{34}\text{S} = \delta^{34}\text{S}(\text{SO}_4^{2-}) - \delta^{34}\text{S}(\text{HS}^-)$; mean value = 28.5‰) is interpreted as the result of biogenic reduction of sulphate occurring in these waters. An apparent reduction trend is seen on Figure 2.

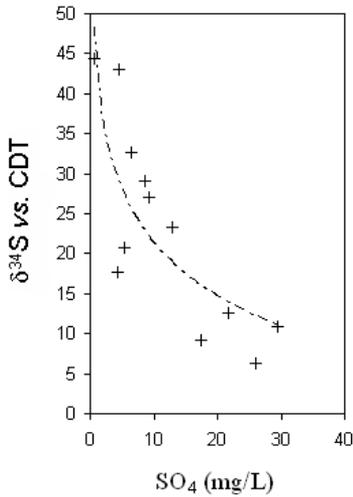


Figure 2. Comparison of sulphate concentrations and $\delta^{34}\text{S}$ values.



International Association of Hydrogeologists



AGH University of Science and Technology

2-vol. set + CD
ISSN 0208-6336
ISBN 978-83-226-1979-0