Nitrate and sulphate isotopic study in surface and groundwaters from the Naukluft Mountains, Namibia

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Nitrate concentrations exceeding 50mg/l- NO_3^- in groundwater are known as health hazardous, leading to the Methemoglobinemia disease (World Health Organisation, WHO guideline for drinking water). High NO_3^- levels are usually linked to human activity, to manure spreading or to fertilizer dissemination. However, it has been noticed (Heaton et al., 1983 and 1984; Barnes et al. 1992; and Stadler et al. 2008) that in arid or semi-arid environments, with a low density of the population and almost inexistent agriculture, are likely to the groundwater may also exceed the 50mg/l nitrate level.
The present work was conducted in the semi-arid to arid region of the Naukluft Mountains in Namibia. They are situated ca. 200km southwest of the capital city of Windhoek, next to the sandy Namib Desert. Boreholes and surface water samples were collected at the end of June 2008 during the dry season, and in February 2009 during the rainy season. Cation and anion concentrations, water level depth, as well as electrical conductivity measurements indicate that a number of boreholes have a recent and local recharge, whilst others stay unchanged with time. The water samples were collected and treated following the procedure described in Silva et al. (2000), with some adaptations.
The values for $\delta^{15}N$ have a range between +2.0‰ and +21.8‰ (with an exception at +37‰) and the values for $\delta^{18}O$ have a range between -1.7‰ and +17.7‰. Despite small problems that may have affected the isotopic values for some samples, the results clearly indicate a natural source of most nitrate. The decomposition of vegetation and the atmosphere are the main sources. However, the boreholes with nitrate concentrations exceeding 50mg/l (concentrations reaching up to 700mg/l were measured) appear to be contaminated by human activities, such as leaking on-site sanitations, infiltration of sewage water or cattle wastes. These sites are indeed situated next to settlements, farms, or cattle enclosures. Wildlife wastes in the natural environment are also likely to contribute to the nitrate budget of shallow aquifers, through preferential pathways near watering points.
This is consistent with a local and relatively rapid recharge.
The procedure described by Silva et al. (2000) uses an anion-exchange resin to collect nitrate and other anions including sulphate or chloride. It was adapted to collect barium- sulphate powders in order to analyse their sulfur isotope composition. The isotopic compositions have a large range of values (from +7‰ to +23‰), indicating mixing between gypsum dissolution and sulphide mineral weathering and maybe microbial activity for some of them. Regional variations have been observed with a link to the geological substratum.
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