Multiple origin of water salinization in a coastal aquifer, south India – Geochemical point of view

N. GASSAMA[1], S. VIOLETTE[2], N. D'OZOUVILLE[1&2] AND A. DIA[3]

[1]GéEAC, EA 2100, U. Tours, Fr (gassama@univ-tours.fr)
[2]UMR 7619 Sisyphe, UPMC, Paris, Fr (violette@ccr.jussieu.fr)
[3]UMR 6118, GéoSciences Rennes, Fr (dia@univ-rennes1.fr)

Introduction

The coastal aquifers of the Kaluvelly basin were selected because an increase of salinity together with a drastic fall in the water level have been recorded for several years. The over-exploitation of the Vanur aquifer for irrigation purposes has modified the natural groundwater flow which is sometimes reversed and flows from the sea inland. Pumping is irregular in time and space which leads to unpredictable flow. Furthermore most wells in the area are not cased resulting in some anthropogenic mixing between the aquifers.

The aim of this work is to characterize the different water bodies involved and their seasonal evolution, and to quantify processes such as mixing and water-rock interaction. One hydrological year (2000-2001) has been monitored during dry, wet and intermediate season. Here we present the geochemical results. Results will be used for water management and planning purposes. The setting of the Kaluvelly coastal basin is characteristic of the Bengal coastal zone.

Hydrological settings

Salt may originate from multiple sources: i) seawater intrusion through the upper aquifer bordering the coast or brackish water from the swamp, during seasonal decline of the water level or throughout the year; ii) upward leakage from the charnockite aquifer caused by head differences due to the pumping; iii) vertical movement of salty irrigation water and/or of industrial output; iv) enhanced leaching of sediment beds due to drainage increase.

Results

Because of the multiple origins of the salt in the Kaluvelly aquifers, chloride alone cannot be used to discriminate between sources. In addition, the common geological origin of Vanur sandstone and charnockite increases the difficulty to distinguish between "old" Vanur waters and "young" Vanur waters mixed with charnockite waters. The geochemical tools that we applied are major and trace elements and their ratio, halide ratio, and isotopes.

Data seems to indicate that the recharge is sufficient to counteract salinity increase during the study period. A seasonal salinity fluctuation is mainly observed in the Cuddalore sandstone aquifer, where water chemistry records the influence of agriculture/industry but no direct seawater input. For the Vanur sandstone aquifer, results show that the north part is in hydraulic connection with the brackish swamp and the south part receives salty waters which can originate from the Cuddalore sandstone aquifer.

Rare gas systematics on north Atlantic basalts (33 to 45°N)

C. GAUTHERON[1] AND M. MOREIRA[2]

[1] Laboratoire de Géochimie et Cosmochimie, IPGP, T14-15, 3ème, 4 place Jussieu, 75252 Paris (gauthero@ipgp.jussieu.fr)
[2] (moreira@ipgp.jussieu.fr)

Samples from the north Atlantic ridge between 33 and 45°S of Latitude were analyzed for rare gas content and isotopic ratios by crushing and step-heating.

The total rare gas content ranges between (0.09-49)x10^{-6}, (1-360)x10-12 and (0.09-61)x10-10 for ^{4}He, ^{22}Ne and ^{36}Ar respectively in ccSTP/g. The helium isotopic ratio ^{4}He/^{3}He varies between typical MORB values (80,520) and radiogenic values (108,321), (or R between 8.97 and 6.67Ra, with R the ^{3}He/^{4}He isotopic ratio and Ra the atmospheric ratio 1.384x10-6). The total ^{20}Ne/^{22}Ne ratios vary between the atmospheric ratio and mantle like value (11.4). The total ^{40}Ar/^{36}Ar isotopic ratios range between 312 (air like) and 14,765.

The samples studied here do not sample the primitive Azores plume ridge interaction, but a mantle with radiogenic helium. Moreover, the ^{4}He/^{3}He isotopic ratio increases in the north as already observed by [1]. Furthermore, neon isotopic ratios show dispersion around the MORB line, but the majority of the samples have a ^{21}Ne/^{22}Neextrapolated ratio lower than the MORB. These results are in accord with previous neon study on this ridge [2].

The radiogenic helium isotopic composition of the basalts between 40 and 45°N is similar to the composition of Sao Miguel Island [3]. They can be explained by interaction between the ridge and the Sao Miguel source mantle, sediments, continental crust or delaminated subcontinental lithospheric mantle can be proposed for the source of Sao Miguel.

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