SUBMARINE GROUNDWATER DISCHARGE ESTIMATES ON COASTAL WATERS BASED ON ^{222}RN MEASUREMENTS

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Abstract

Submarine groundwater discharges were estimated on two coastal area of the Mediterranean Sea from ^{222}Rn analyses in the water column. In the large Vaccares Pond (Rhone deltaic plain), the ^{222}Rn budget reveals a submarine input of about 1 10^5 m^3/d. In the small cove of Es Canutells (Minorca Island), this input is very low and probably below 2 m^3/d. Both examples highlight the use of radionuclides in the estimation of SGD which could be an important information for coastal zone management

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Submarine groundwater discharges occurs in various coastlines around the world [1, 2]. They are relatively well known and easily identifiable in karstic areas, but they are more difficult to evidence when groundwater and seawater are exchanged across sand sediment. However, this exchange could bring excess nutrients or dissolved pollutants to the coastal sea being the issue of growing concern [3]. Our understanding of submarine groundwater discharges (SGD) has improved during the last decade with the use of natural radionuclides to estimate the input of fresh or brackish water into the coastal zone (e.g. [4, 5]). Radon and radium are suitable nuclides for this purpose due to their short half-lives and their conservative behavior in salty water. They are highly enriched in groundwater compared to coastal water (factor up to 1000) due to in situ production in the aquifer, and thus, even a small input in the coastal zone may be evidenced. Here we present preliminary results of SGD estimations based on the noble radioactive gas ^{222}Rn ($T_{1/2}$ = 3.8 days) for two different coastal areas of the Mediterranean Sea : the Vaccares lagoon (France) and the Es Canutells cove (Minorca). These examples highlight the use of radionuclides in the estimation of SGD which could be an important information for coastal zone management.

The Vaccares lagoon system in the center of the Rhone deltaic plain is a good example of strong inter-relationships between human activities and ecosystem evolution. This hydrosystem is representative of human influences upon water and salinity regimes: for the last fifty years, the water resource management has led to complex situations with numerous conflicting objectives. The national GIZCAM project is dedicated to propose an integrated coastal zone management plan for this area. One of its objectives is to define the hydrological and salt budgets of the system, with a particular attention to the potential groundwater inputs.
A RAD7 system was used to measure ^{222}Rn activities from water samples collected in June 2006 within the lagoon (surface 65 km^2; maximum water depth = 2m) and from adjacent aquifers. Activities ranged from 25 to 150 Bq/m^3 showing relatively constant values over the entire lagoon. Inputs of ^{222}Rn to the lagoon are due to diffusion from the sediment, in situ production from ^{226}Ra, irrigation canals and SGD inputs. The outputs correspond to the exchange with the atmosphere and in situ decay. By assuming a steady state balance, SGD can be estimated based on the measurements of the other terms. Doing so, the flux of ^{222}Rn from SGD required to sustain the water column inventories range from 8.5 to 11.3 Bq/m^2/d. Assuming a ^{222}Rn activity of 6000 Bq/m^3 for the SGD end-member, it corresponds to a groundwater input of 9.2 10^4 to 1.2 10^5 m^3/d. This value is in good agreement with the one estimated from hydrological budget using long term measurements of water levels, precipitations and canal inputs (around 1 10^5 m^3/d).

The same approach was conducted in February 2006 in a small cove of Minorca Island (surface : 6000 m^2), where SGD inputs occurred through both the surrouding calcareous cliffs and the sand beach (program PICS). The radon budget based on calculations similar to those for the Vaccares Pond indicates a relatively low SGD with values lower than 2 m^3/d. Important errors can be associated to some parameters with such a low SGD value (especially for the exchnage with the atmosphere) and they will be presented and discussed. Additional sampling is also required to reduce these uncertainties. It will be done in winter 2007 and the first results will be presented.

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