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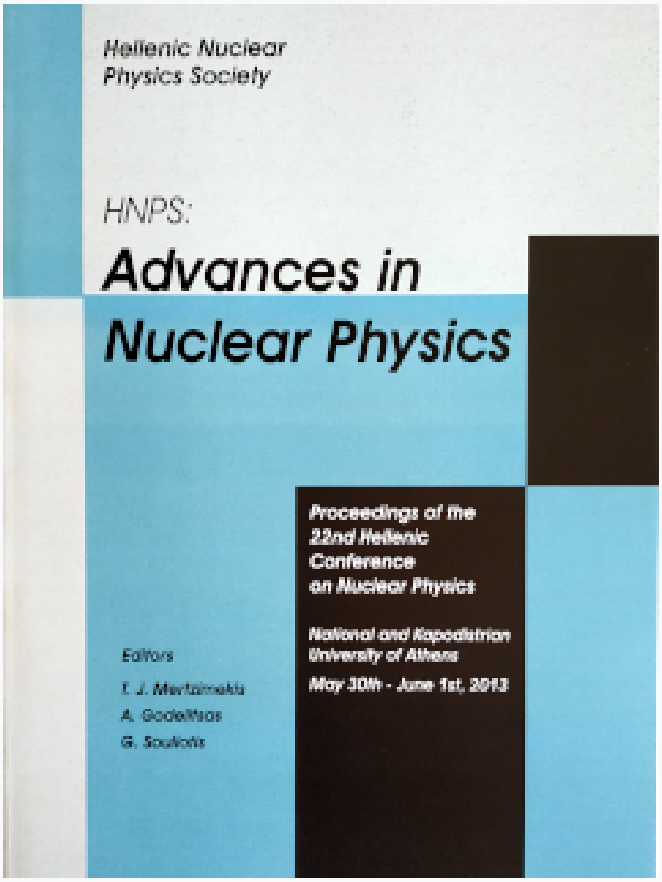

Localization of a submarine groundwater source at the eastern coast of Black Sea, Georgia, using radio-tracing techniques

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Localization of a submarine groundwater source at the eastern coast of Black Sea, Georgia, using radio-tracing techniques

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Abstract

In this work the results of a preliminary study are presented concerning the localization of a submarine groundwater discharge diffusive source at the coastal area of Georgia, Eastern Black Sea. The results were obtained during the first cruise campaign along the Georgian coastline during the October 2012 in the frame of an on-going FP7 BS-ERA.NET project. Measurements of radon gas ^{222}Rn were accomplished in seawater samples by means of an on-site radon measurement method. The samples were collected along two trajectories, parallel to the coast, of a total length of 35km. In the same samples conductivity measurements were supplementary accomplished. Where radon exhibited local maxima and conductivity local minima, seabed surface sediment samples were collected for subsequent radioactivity measurements by High Purity Germanium detector. As groundwater tracer the excess of ^{210}Pb in the sediment samples was used. Combining the results from the seawater and sediment, a part of the initial trajectory - with length of 800m - was revealed as a potential area of submarine groundwater discharge diffusive source.

Keywords: Radio-tracing Techniques, Submarine Groundwater Sources, Radon, Radon's daughters

1. Introduction

Submarine groundwater discharges (SGD) have been considered a significant pathway for dissolved matter (e.g. radioisotopes, nutrients, heavy metals, organic pollutants) transport to the oceans [1]. Radio-tracing techniques are exploited both to locate the sources of SGD and to quantify the emanating water quantity [2]. The aim of the present study was the localization of any potential SGD source, where groundwater diffuses into the coastal zone along Georgian coastline. On-site and laboratory measurements of radon and radon's daughters were performed revealing the area of the most intense diffusion of groundwater.

2. Study Area - Materials and Methods

The study area of the current work was the Western part of Georgia, along two coastal trajectories (named as North and South Cruise), parallel to coastline. The measurements were performed during 16-17 October 2012. Water samples were collected, and radon ^{222}Rn was degassed and measured on-site by means of a DURRINGE RAD7® radon monitor. Measurements of water conductivity were also realized to the same samples. At the sites where radon activity concentration exhibited maximum values and conductivity minimum, samples of sediment were collected for further analysis by means of an ORTEC® coaxial 50% High Purity Germanium detector. The sediment samples prior to the measurement were processed by a standard preparation procedure including drainage, sieving and pulverization. Also, they remained air-tightly closed for at least 21 days, so secular equilibrium between radium ^{226}Ra and radon's ^{222}Rn daughters to be achieved. Details about radioactivity measurements in sediments (calibration procedures of volumetric samples, sample preparation, methodology etc.) are described elsewhere [3].

3. Results and Discussion

The results of on-site radon and conductivity measurements in water samples taken along North and South coastal trajectories are presented in Figure 1 and Figure 2. At the same graphs are depicted the points where sediment samples were grabbed (G1-G7).

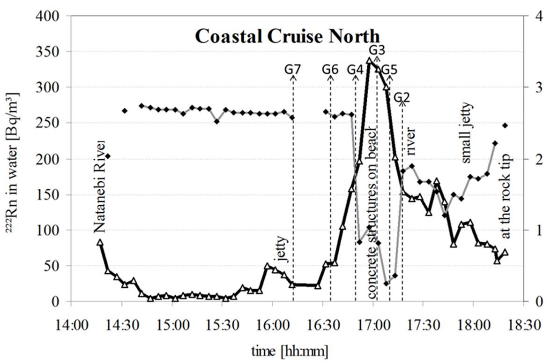

Figure 1: Radon and conductivity data measured on-site from water samples along North trajectory.

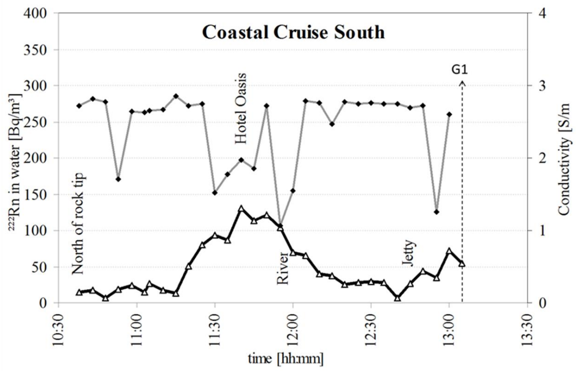

Figure 2: Radon and conductivity data measured on-site from water samples along South trajectory.

The activity concentration of both ^{238}U and ^{232}Th daughters in the sediment samples were measured to reveal any possible accumulation of radioisotopes rich in groundwater (e.g. radon ^{222}Rn and/or thoron ^{220}Rn daughters). The results are depicted in Figure 3 and Figure 4 correspondingly.

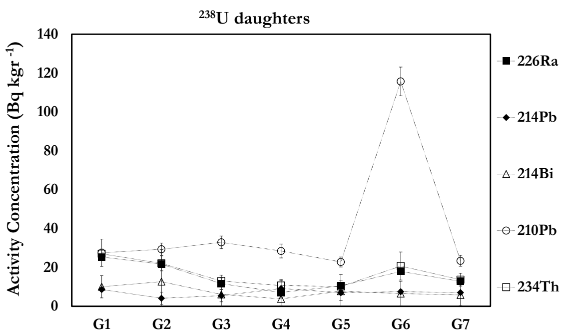

Figure 3: ^{238}U daughters activity concentration in sediment samples at the points G1-G7.

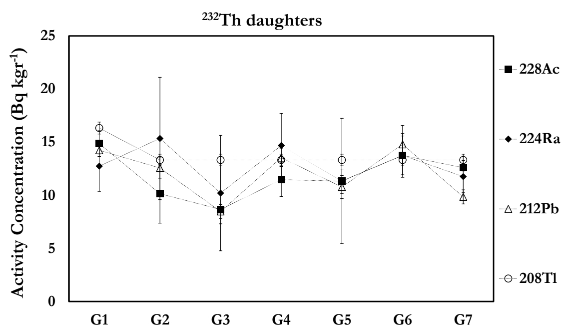

Figure 4: ^{232}Th daughters activity concentration in sediment samples at the points G1-G7.

From the results in sediment samples, an accumulation process of ^{210}Pb is clearly revealed at the area of point G6. ^{210}Pb is the longest-lived ^{222}Rn daughter. The latter is rich in groundwater and emanates through the seabed along with groundwater in SGD sites. During its diffusion, ^{222}Rn may decay producing several daughter nuclei until ^{210}Pb which has the longest half-life (138 days). To discriminate the portion of ^{210}Pb produced as result of radon/groundwater diffusion through the seabed from the portion supported by the parent nucleus of ^{226}Ra, the excess/unsupported activity concentration of ^{210}Pb is calculated by subtracting the activity concentration of ^{226}Ra from ^{210}Pb.

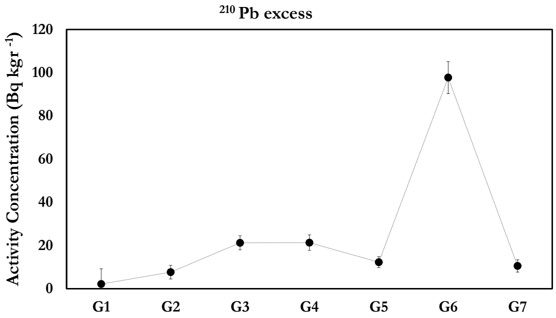

Figure 5: ^{210}Pb excess activity concentration in sediment samples at the points G1-G7.

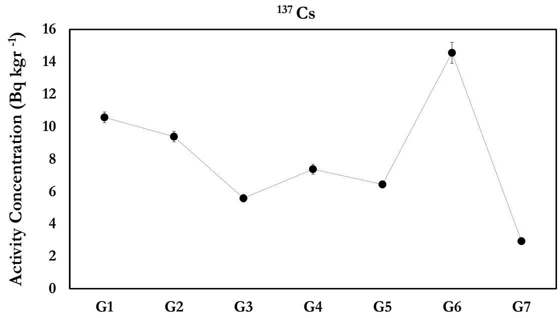

Figure 6: ^{137}Cs activity concentration in sediment samples at the points G1-G7.

The results in Figure 5 show accumulation of excess/unsupported ^{210}Pb near point G6, which is an evidence of presence of groundwater discharge source in the proximity of this area. Furthermore, groundwater may transport remnants of anthropogenic ^{137}Cs from terrestrial areas to coastal sediments as a result of SGD sources. At the same point where excess ^{210}Pb is accumulated, the activity concentration of ^{137}Cs exhibits the maximum value in the study area (Figure 6). This second observation strengthens the assumption of SGD source presence in seabed area near point G6.

4. Conclusion

In this study radio-tracing techniques were exploited to localize a submarine groundwater discharge area along the coastal zone of Georgia, Eastern Black Sea. The accumulation of excess ^{210}Pb, in combination with enhanced activity concentration of anthropogenic ^{137}Cs, is a strong evidence of the presence of a diffusive SGD source in the vicinity of point G6. This SGD potential area has a length of approximately 800m. Future field works will be focused on this area and *in-situ* gamma-ray spectroscopy methods [4], [5] will be exploited to monitor the activity concentration of radon's daughters. In this manner, results as time-series may be obtained [6] supporting the efforts of quantification of the emanating groundwater.

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