Correlation of dissolved gaseous mercury and radon profiles in the Mediterranean Basin seawater

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Abstract: Vertical profiles of dissolved gaseous mercury (DGM) and radon gas (^{222}Rn) in seawater in the Mediterranean Basin have been measured. Preliminary results indicate similar trends of both gases at some locations, but not at others. Several factors should be considered in order to better understand the relationship between levels of these two gases. The profiles should be interpreted on the basis of the different mechanisms of origin and movement of the gases, as well as their different properties.

Key words: dissolved gaseous mercury (DGM), radon (^{222}Rn), seawater profiles, correlation

INTRODUCTION

The main goal of the MERCYMS (Mercury) project is to improve our knowledge of mercury cycling in the Mediterranean Sea. Other constituents of the seawater, which either affect the level of mercury or only accompany it are of interest because they may help better understand the transport and speciation of mercury. Thus, dissolved gaseous mercury (DGM, Hg^0) and radioactive gas radon (^{222}Rn) may both originate in the bottom sediment and be transported to the water surface by carrier gases. Therefore a relationship between their profiles in the water column could be expected.

In oceanic waters, 10-30 % of the Hg may be present in the dissolved gaseous form. While reduction of Hg(II) by aquatic microorganisms was believed to be the predominant source of DGM, recent studies show that photoreduction of Hg may be another important source.[1] Most surface waters are supersaturated with DGM relative to the atmosphere and therefore elemental Hg is readily lost from water to the atmosphere.[2]

Radon is produced by radioactive decay of radium (^{226}Ra) in bottom sediments and of dissolved radium, and may originate from submarine springs and release of fresh waters generally having much higher radon levels than the sea water.[3] In contrast to mercury, radon is a noble gas and does not undergo chemical changes on its travel to the surface, but alpha - decays into its short-lived progeny.

In seawater, Mn – ^{222}Rn, CH_4 – ^{222}Rn and ^{3}He – ^{222}Rn correlations have been obtained when studying heat and chemical flux from the sea bottom.[4] Hg – Rn correlation has been studied in soil gas at eruptive sites[5] but not in seawater. Results on DGM and ^{222}Rn in seawater taken and analysed during the Urania cruises in the Mediterranean Sea in summer 2003 and spring 2004 are re-

ported, and the correlation between the profiles is discussed.

EXPERIMENTAL

Sampling locations are shown in Fig. 1 and their coordinates given in Table 1. Water samples were taken by the rosette at the desired depths. In the laboratory, DGM was purged by N_2 from 0.5 dm^3 water samples and collected in a gold trap, which was then transferred to a CV AFS analyser system. Radon was degassed from 1.7 dm^3 water samples by bubbling in a closed loop and then measured with an 0.7 dm^3 evacuated alpha scintillation cell on an alpha scintillation counter.

Figure 1. Sampling locations.

RESULTS AND DISCUSSION

Table 1 summarises the experimental parameters and shows the DGM – ^{222}Rn correlation. Four typical depth profiles are shown in Figs. 2-5. The following DGM – ^{222}Rn concentration relationship has been observed: 3 strong (Figs. 2 and 3), 3 moderate and 4 weak positive correlations, and 1 strong and 4 weak (Figs. 4 and 5) negative correlations. No final conclusions can be drawn on the basis of these preliminary results, but we do hope that after our DGM and ^{222}Rn data have been further elaborated together with other data collected during the two MERCYMS cruises, we will be able to better interpret the DGM and ^{222}Rn profiles observed. In addition, water samples were collected and will be analysed for ^{226}Ra, in order to provide additional information on ^{222}Rn balance.[6]

Table 1. Description of sampling locations and DGM – ^{222}Rn correlation coefficients.

Location	Latitude (N)	Longitude (E)	Date of measurement	Number of sampling levels	Bottom m	DGM – ^{222}Rn correlation coefficient
WPT 3	37°16'	11°53'	6.8.2003	7	95	- 0.17
WPT 4	35°45'	17°55'	8.8.2003	10	4060	0.35
WPT 5	34°19'	24°20'	10.8.2003	9	2235	- 0.25
WPT 11	37°37'	15°16'	15.8.2003	8	728	0.73
WPT 12	40°34'	14°17'	16.8.2003	5	940	- 0.92
ST. 1	40°29'	11°18'	19.3.2004	8	2883	0.85
ST. 2	41°25'	7°59'	21.3.2004	10	2600	- 0.03
ST. 3	37°52'	5°21'	25.3.2004	9	2816	0.08
ST. 4	37°29'	11°34'	27.3.2004	10	945	0.30
ST. 5	35°45'	17°55'	29.3.2004	12	4040	0.49
ST. 6	39°59'	19°00'	30.3.2004	10	919	0.09
ST. 7	37°37'	15°15'	1.4.2004	11	683	0.41
ST. 8a	38°39'	15°05'	2.4.2004	6	40	- 0.25
ST. 8b	38°39'	15°06'	2.4.2004	7	73	0.86
ST. 9	39°55'	14°00'	3.4.2004	10	2380	0.40

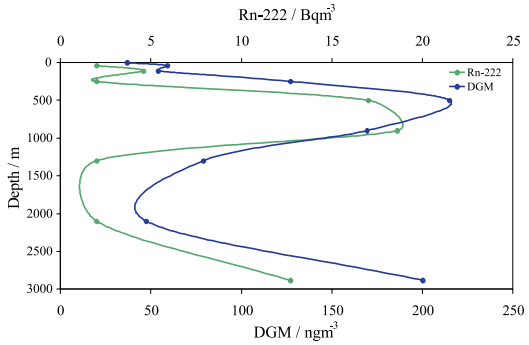

Figure 2. DGM – ^{222}Rn profile at ST. 1.

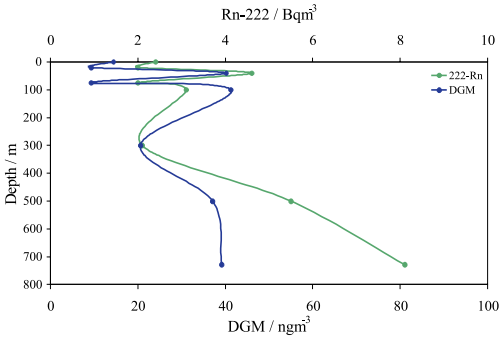

Figure 3. DGM – ^{222}Rn profile at WPT. 11.

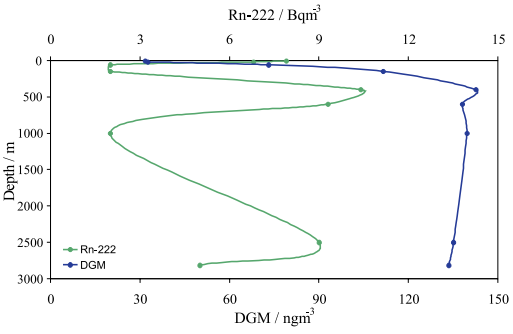

Figure 4. DGM – ^{222}Rn profile at ST. 3.

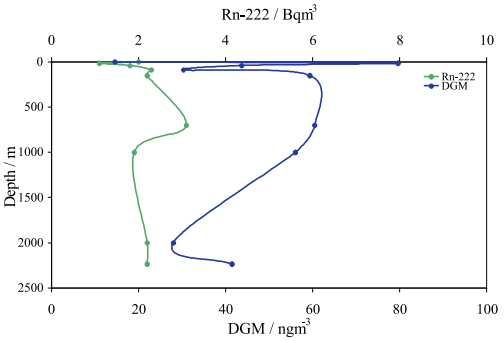

Figure 5. DGM – ^{222}Rn profile at WPT. 5.

CONCLUSIONS

Our preliminary results indicate that at some locations, DGM and ^{222}Rn concentrations in the seawater column are well correlated, while such a correlation has not been found at others. No general rules have been elucidated either from data obtained for various locations in the same season, or from comparing data obtained in summer and spring at the same station. Final conclusion will be possible after the data have been further elaborated and results of ^{226}Ra analyses will be included in the interpretation.

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