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NATURAL RADIOACTIVITY IN THE MARINE ENVIRONMENT OF A MINING WASTE DISPOSAL AREA

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INTRODUCTION

The aim of this study is to examin the levels of natural radioactivity in the Larymna Bay, Northern Evoikos gulf, Greece. Every year approximately 2.500.000 tn of mineral waste-by-product of Fe-Ni ore treatment- are deposed in the area. During the initial stage of the treatment process the ore is mixed with lignite in 86:14 per the total mixture weight,from Ptolemais mine. This lignite is reported to contain enhanced levels of uranium series radionuclides (Tab. 1) and this is reflected in the residual ash. The ore burning results also in production of large amount of dust, which is piped to the gulf through the coolant fluid. Samples of sediments and organisms have been collected and the concentrations of uranium and thorium series radionuclides as well as ^{40}K have been determined.

SAMPLING - TREATMENT - MEASUREMENTS

The samples have been collected during the warm period of 1984 and the cold period of 1986, from 4 sampling stations, covering the mineral waste disposal area as well as disposal-free reference areas. The sediments have been collected by a Van-Veen qrab of 0,1 m^2 collection surface, while marine organisms - by using a 400HP motorboat towing a net witha cod-end mesh of 16mm between stretched knots. The depth varied from 40 to 90m. Before the disposal ore and mineral waste samples were also collected. Sediments and ore samples were dried at 400°C and then homogenized and screened. Groups of equal sized fishes, after identification, were ashed at 400°C for 3-4 hours, flesh and bones separetely. The measured mass was 10-25g for ashes and 40-100g for sediments. A high-resolution gamma spectrometry system with HpGe-detector of 20% relative efficiency was used for the determination of the concentrations of natural gamma-emmitting nuclides.

RESULTS AND CONCLUSIONS

A summary of the results are shown in table 1. There is an agreement in the concentrations of ^{238}U and ^{232}Th series radionuclides and ^{40}K in the mineral by-product collected before disposal and at the sea bed. In comparison with the primary ore, the concentrations of ^{238}U series radionuclides are 3-4 times higher. This is probably due to the contribution of the lignite ash from Ptolemais, where concentrations of ^{238}U-series radionuclides up to 400 $Bq \cdot Kg^{-1}$ were observed (see also Ref. 1, 2). Therefore we can conclude that there is an influence in the levels of natural radioactivity of sediment samples from the examined area concerning especially the ^{238}U radionuclides. This is not reflected to the examined organisms. The observed variations in the measured values in these organisms are due to the different bioaccumulation by the various species and tissues of them. These values are also comparable with those in organisms from other places of Greece (3).

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Table 1.
Concentrations of natural radionuclides in sediments and organisms from a mining waste disposal area $Bq \cdot Kg^{-1}$

Samples	^{234}Th		^{226}Ra		^{228}Ac		^{40}K	
lignite	50 - 80		55 - 75		8 - 9		28 - 48	
lignite ash	200 - 360		230 - 440		30 - 50		140 - 240	
ore	10		6		7		110	
mineral sea bed sediment samples and mineral waste samples	45		28		16		140	
sediment samples from other * areas of mining activities in the Greek peninsula	54		50		22		627	
sediment samples from other areas of the Greek peninsula (3)	13 - 26		4 - 9		4 - 5 - 9		100 - 360	
Fish	Flesh	bone	Flesh	bone	Flesh	bone	Flesh	bone
	20-60	10-65	2-7	4-9	ND-4	2-8	730-2500	330-670
Crustacea	whole body	exoskeleton	whole body	exoskeleton	whole body	exoskeleton	whole body	exoskeleton
	10-30	14	3-8	4-11	2-14	ND	240-710	280-580

* unpublished data

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ENVIRONMENTAL RADIOACTIVITY OF BULGARIAN BLACK SEA COAST

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Introduction In order to obtain information about the present status and possible impact of river Danube on the natural radiation environment along the Bulgarian part of the Black sea coast, investigations on the distribution of some long-lived gamma emiters in selected regions and marine samples have been carried out by the Laboratory of Dosimetry and Radiation Protection. In this abstract some results from activity and gamma background measurements, are presented.

Materials and Methods The natural gamma background was measured one meter above the soil surface in more than 60 locations along the shore using a field radiometer VA-J-0,5 (DDR) with improved sensitivity. Soils, beach sands and bottom sediments were collected from the top 10-15 cm., then treated by a dry ashing procedure and homogenized mechanically. The concentrations of ^{226}Ra, ^{232}Th, ^{40}K and ^{137}Cs were determined by a low background scintillation spectrometer with sensitivity of 3,7;1,48;0,74 /$Bq.kg^{-1}$/ for radium, thorium and cesium respectively. All spectra were analyzed by a special computer programme.

Results and Discussion Investigations on the distribution of natural and artificial radionuclides in Black sea have been carried out by russian and romanian autors[1]. However, data about the environmental radioactivity of the Bulgarian coast are scarce and incomplete. Therefore we started first with gamma radiometry of soils, beach sands and bottom sediments, then representative samples were analyzed for the determination of some long-lived gamma emiters.

Gamma background measurements along the coast revealed an exposure rate Px within (1,58-16,7).10^{-6}/$A.kg^{-1}$/ or (1,7-18)/$\mu R.h^{-1}$/ at an average of 7,98 3,34.10^{-6}/$A.kg^{-1}$/ or 8,6 3,6/$\mu R.h^{-1}$/. Very low values were registered over the beach strip of camping "Karvuna", probably due to the shielding action of the very low radioactivity of the beach sands, as it has been shown by our gamma spectrometry measurements. ^{222}Rn activities in soil gas were 10 to 20 times lower than at other locations[2].

The mass specific activities of ^{226}Ra, ^{232}Th, ^{40}K and ^{137}Cs were in the range of:

^{226}Ra - (3,7-104)/$Bq.kg^{-1}$/ or (0,1-2,8)/$pCi.g^{-1}$/
^{232}Th - (1,48-48,1)/$Bq.kg^{-1}$/ or (0,04-1,3)/$pCi.g^{-1}$/
^{40}K - (81,4-555)/$Bq.kg^{-1}$/ or (2,2-15,0)/$pCi.g^{-1}$/
and ^{137}Cs-(0,89-96,2)/$Bq.kg^{-1}$/ or /0,024-2,6)/$pCi.g^{-1}$/

It can be seen, that the concentrations of the above radionuclides are in good agreement with these reported by other autors[3]. Since the sediments were collected near the shoreline, their radioactivity could be related in general to the concentrations of natural radionuclides in coastal rocks and soils. However, local currents and sedimentation processes may have influence upon the distribution of certain radionuclides, e.d. ^{137}Cs. While the relatively high concentrations of ^{226}Ra in bottom sediments from the northern part of the coast are probably due to the existing underwater mineral springs and gas eruptions along a sub-seabed fault line, ^{137}Cs activities seem to be connected with a current, originating near the Danube delta. Nevertheless, cesium presumably comes from the worldwide fallout, since the impact of the nuclear power plants along the river Danube is likely to be insignificant. This assumption could be supported by the similar concentrations of ^{137}Cs in sediments from local coastal rivers.

Conclusion The environmental radioactivity of soils, beach sands and bottom sediments from the Bulgarian coast is determined mainly by the presence of naturally occuring radionuclides. ^{137}Cs concentrations as a whole are below these of ^{226}Ra, ^{232}Th and ^{40}K and originate from worldwide fallout.

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