NATURAL RADIONUCLIDES IN RECENT MARINE SEDIMENTS OF THE ADRIATIC SEA

D. Barisic [1*], A. Vertacnik [1], S. Lulic [1], G. Mihelcic [1], I. Sondi [1], M. Juracic [2], E. Prohic [2] and R. Crmaric [3]

[1] Centre for Marine Research - Department Zagreb, Ruder Boskovic Institute, P.O.Box 1016, Bijenicka 54, 10001 Zagreb, Croatia
[2] Department of Geology, Faculty of Science, University of Zagreb, Kralja Zvonimira 8, 10000 Zagreb, Croatia
[3] State Hydrografic Institute, Geophysical Department, 10000 Zagreb, Croatia

Abstract

Adriatic sea sediment cores were sampled during a series of cruises by box corer. The activities of ^{40}K, ^{228}Ra, ^{226}Ra and ^{238}U were determined by gamma-spectrometry. Activities of these naturally-occurring radionuclides are generally high in pelitic sediments, whereas the lowest concentrations correspond to sands and silts which are mainly spread along the Croatian coast. ^{226}Ra distribution generally follows the distribution of uranium, and ^{40}K and ^{228}Ra distributions are strongly influenced and governed by grain size distribution whichwhich is, in fact, the clay mineral content of these sediments. Radionuclide concentrations are generally lower in sediments with higher carbonate content.

Key-words: radioactivity, sedimentation, geochemistry, Adriatic Sea

Introduction

The content of naturally occurring radionuclides in different types of recent Adriatic sediments in Croatian territorial waters has not yet been studied. The purpose of this study was to give the very first insight into the spatial distribution of natural radionuclides in Adriatic sea sediments. The shallowness of continental shelf and solid discharges from Po and other Italian and Croatian rivers have a strong influence on the grain size distribution and sedimentation rate. The Po River carries siliceous material from igneous and metamorphic rocks, and to a lesser extent, detritial carbonates from central and western parts of the Alps and from central Apennines. Erosion of the red soil (terra rossa) and the biogenic destruction of calcareous shells provide the material which has settled along the Croatian coast. Biogenic carbonates are produced throughout the area, but they are important sediment constituents only in areas where the input of terrigenous matter is negligible.

Due to the longshore current and wave transport, a narrow littoral belt of coarser and finer sand above the wave base is formed, spreading along the western and north-western Adriatic coast. The pelitic material continues north-eastward until the Adriatic drift current prevails and changes its direction to the south. Because of that, pelitic material has settled in a belt below the wave base parallel to the Italian coast [1]. In the offshore direction (where minor quantities of fine-grained material settle) pelites are mixed with older sands by means of bioturbation and resuspension, resulting in sediments characterised by a wide range of grain size: from clayey silt to silty sand [2, 3]. Part of the north central Adriatic shelf is covered with relict sands deposited as shore sands during the Holocene transgression. Similar deficiency of clastic material input prevail along the Croatian coast. There are no large rivers draining these terrains, and the relatively small quantities of material that the eastern Adriatic rivers carry (Mirna, Rasa, Zrmanja, Krka) are deposited in their estuaries [2, 4]. Cetina and Neretva rivers carry significant quantities of material, but due to the semi-enclosed nature of the sea, recent sedimentation of terrigenous material is restricted to relatively small deltaic (Neretva) or estuarine (Cetina) sedimentation areas. The central Adriatic is a shelf edge covered mostly by mud. In this part the sedimentary supplyis both longitudinal and lateral, and the distribution of the material is governed by marine agents [3, 5].

Sampling and methods

Cores of open Adriatic bottom sediments were sampled by box corer during the ASCOP 16 cruise in summer 1990. Cores were taken along seven different transects between the borders of Croatian and Italian territorial waters in the northern and central Adriatic Sea (Fig. 1). The sediments along the Croatian coast between Rijeka and Dubrovnik were taken by drop or vibro corer during summer and autumn 1993. Drop corer was used for collecting samples in sedimentation areas of the Cetina and Neretva river mouths in autumn 1994.

After sampling, the sediments were frozen at -18°C and kept until further use. Before the analyses, the samples were thawed at room temperature and dried at 106°C to the constant weight. Two core sections of open Adriatic and the Po River prodeltaic sediments were analysed: 0-3 cm and 12-15 cm. Only surface sections (mainly the first 20 or 30 cm) of cores taken along Croatian coast were analysed. Cores

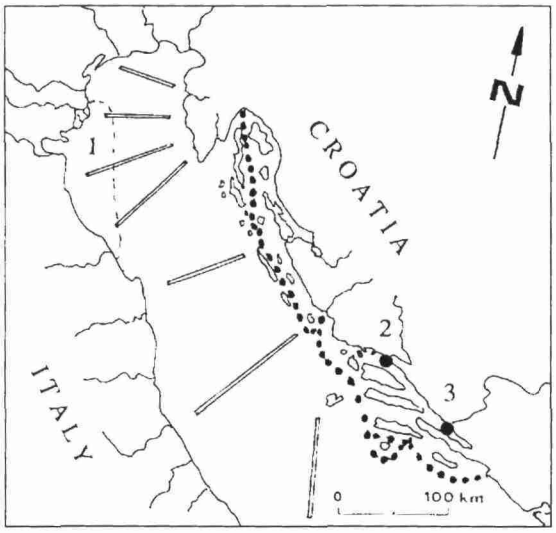

Fig. 1. Sketch-map of studied area. **1** - the Po River prodeltaic area; **2** - the Cetina River estuarine area; **3** - the Neretva River prodeltaic area; double lines - profiles between Croatian and Italian territorial waters; dot line - profile between Rijeka and Dubrovnik

taken in the Cetina and Neretva sedimentation areas were divided into 2 or 3 sections (*circa* 50 cm each) before analyses. Samples were granulometrically characterised by wet sieving, using ASTM standard sieves for fractions >32 μm, and by Coulter Counter (Model TA II) for fractions <32 μm. Dried soil samples were placed in the counting vessels of known geometry, sealed and stored at least for 4 weeks to allow ingrowth of gaseous ^{222}Rn. At the end of the ingrowth period, the samples were counted on a HPGe detector connected to a 4096 channel analyser. The detector system was calibrated using standards supplied by Amersham International, while precision and accuracy were checked by parallel measurement of IAEA-306 and IAEA-314 standards. Spectra were recorded for 80,000 seconds. Recorded spectra were processed on PC using GENIE PC software.

Resultats and discussion

The measured activitie ranges of ^{40}K, ^{228}Ra, ^{226}Ra and ^{238}U, as well as the mean values for different sedimentation areas in the Adriatic sea are presented in Table 1. Cores taken along transects between the Italian and Croatian coast (open Adriatic) were divided into three groups (sands, sands and pelites, pelites) and these results are also showenalso. The activities of measured natural-occurring radionuclides are higher in pelitic sediments. The lowest concentrations of naturally occurring radionuclides corresponded to the sand and silts which are mainly spread along the Croatian coast. However, the activity of ^{238}U in bottom sediments of open Adriatic sea progressively increases toward the open sea (from Croatian to Italian territorial waters). It seems that relatively elevated uranium activities in recent marine sediments are the consequence of terrigenous influences, *i.e.* deposition of material carried by rivers. This is evident in cases of the sedimentation areas of the Po and Neretva rivers which partly carry