Radioactivity in sediments along the coast of Albania

Mario KEDHI

Institute of Nuclear Physics, TIRANA **(Albania)**

Studies on the radioactivity of sea-bed sediments were carried out in Albania in the bays of Durres, Treport and Porto-Novo. The aim in the case of Durres Bay was to study the in-filling of the port channel. The studies in the bays of Treport and Porto-Novo were concerned with the construction of a new port in the Vlora Bay (1,2). The natural radioactivity measurements were made in order to construct maps of the lithology of the sea-bed of these areas and to draw possible conclusions about the movements of the sea-bed sediments. Maps of the natural radioactivity give the mean effect of the action on the sediments by hydrometeorological elements over a period of several years. Changes can be distinguished within a distance of several kilometers to several hundred kilometers. This work was the first phase of radionuclide studies which aimed at understanding the mechanism of the movement of sea-bed sediments and, at the same time, to discern the quantity and the direction of their movements.

From a large number of sea-bed samples, the granulometry of the sediments was determined. Later, a dynamic survey of the total gamma radioactivity of the seabed sediments was also carried out. The probe (NaI[Tl], d=3.8 cm, h=2.5 cm), fixed on a sled 5 cm above the sea-bed, was towed by a boat at a speed of 1m/s.

The results from a large number of measurements (902 in Treport Bay) were plotted on probability paper. Both in the case of the Durres Bay and Vlora Bay, the points were not regularly distributed around the median value. As a first approximation, one can discern three groupings that seem to correspond to different contents of clays in the sediments (Table 1). Note that for our probe and geometry, the pure siliceous sand gives 12 cps.

Table 1. Total gamma radioactivity (count per second) in sediments from the Albanian Bays.

Family	Durres Bay Percent	Durres Bay Med.±1σ, c/s	Treport Bay Med.±1σ, c/s	Porto-Nova Bay Med.±1σ, c/s
I	25	18.9 ± 0.8	11.9 ± 0.9	12.8 ± 1.8
II	60	21 ± 0.85	15.3 ± 1.5	18.8 ± 3.8
III	15	24 ± 0.8	20.4 ± 1.4	25.5 ± 2.5

The following conclusions were made :

A. Durres Bay

1. The sediments of the bottom represents a mixing of sands (60-70%) with a median grain size of 70 µm and clay (30-40%, with a mean diameter of 2-3 µm).

2. The zones of clay accumulation were determined from lesser depths to depths of 10 m not only in the channel but in the outer parts.

3. The vast clay-like stocks are sufficient to fill in the channel many times over without any need to import clays from the outer areas.

B. Treport Bay

1. According to the above-mentioned groupings, the sea-bed can be divided into three zones. The first extends to depths of 7-8 m. The sediments here are more than 80% sands (d>100 µm, mainly 100-200 µm). The second zone extends from that depth to 10-11 m. The sediments here contain sands (60-80%, d<100 µm). Beyond these depths is the third zone with material that is mainly alevrolite and clay.

2. Generally, the boundaries between these zones follow the isobaths. There are no zones of high radioactivity in the areas with generally lower radioactivity. Therefore, there are no clay-like areas in the sand media. This fact indicates that the wave action has resulted in a good selection of granulometry.

C. Porto-Nova Bay

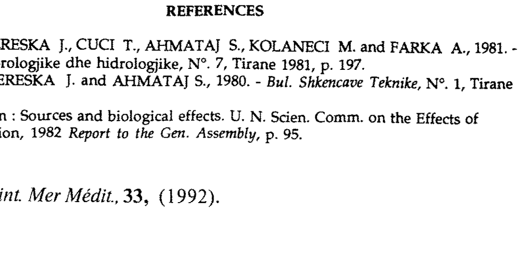
1. The first zone extends to 8 m depth and consists of pure sand. The second zone extends from that boundary to depths of 12-13 m. In the third zone at greater depths, clay-like sediments are found.

2. The western wave action has also resulted in a good selection of granulometry.

The distribution of U-238, Ra-226, Th-232 and K-40 nuclides in the coastal sediments are especially interesting for understanding the local sedimentology and geology. Not having the possibility to undertake a full-scale study, short-term sampling was carried out with the aim of obtaining limited data and drawing some conclusions about the distribution of these nuclides in the coastal zone. The results of 28 sand samples collected from 10 beaches are given in Fig. 1. The measurements were made with a Hp-Ge detector and the overall errors are 20-50% (U238), 5-8% (Ra-226), 5-10% (Th-232) and 2-5% (K-40).

The suspended sediment samples taken from Vjosa Seman, Shkumbin and Erzen rivers were analyzed for Cs-137, U-238, Th-232 and K-40. The mean values were 4.6, 25, 32, and 360 Bq/Kg respectively. It should be noted that the mean activity and typical range of U-238, Th-232 and K-40 activities in soils is 25 (10-50), 25 (750) and 370 (100-700), respectively (3). Our rivers every year transport in suspension to the sea about 50 million tons of sediments ; therefore, about 200 GBq Cs-137, 1200 GBq U-238, 1600 GBq Th-232 and 28000 GBq K-40 are entering Albanian coastal waters every year.

Fig. 1. Natural radioactivity of different sands from the Albanian coast.



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Transfer of artificial radionuclides through the Adriatic food-web

Laura TASSI PELATI

Department of General Biology and Physiology - University of Parma **(Italy)**

Organisms and sea water were sampled in different areas of the northern and central Adriatic Sea from May 1986 to December 1987. The areas surveyed were the Gulf of Trieste, the Gulf of Venice, the coastal zone near Ancona and the western part of the "Fossa di Pomo".

Organisms and the water samples were prepared and analyzed by Ge-Li gamma spectrometry. In sea water only radiocesium was determined. On the other hand, several radionuclides from the Chernobyl fallout were determined in pelagic and benthic organisms belonging to different trophic levels of the Adriatic food-web.

The impact of the Chernobyl accident was more relevant in the northern Adriatic than in the central region; in fact, at the beginning of May 1986, the Cs137 concentration in sea water was about ten times higher in the Gulf of Trieste than near Ancona. In a similar way zooplankton, *Sardina pilchardus* and *Mytilus galloprovincialis* collected simultaneously in both zones, displayed different levels of radiocontamination (TASSI PELATI and ALBERTAZZI, 1986).

After May 1986, the variety of radionuclides in the organisms had greatly decreased; nevertheless, for several months it was possible to determine Cs137, Cs134, Ru103, Au106 and Ag110m (TASSI PELATI *et al.*, 1987). A significant decrease of Cs137 and Cs134 in sea water was observed during the winter months of 1986 and the first months of 1987 after the pycnocline broke down and the water masses became mixed. In the zooplankton there was also a quick decontamination because of the excretion processes and resultant element turnover (TASSI PELATI *et al.*, 1987). The rapid removal of Chernobyl fallout from surface waters by zooplankton activity was also observed near Corsica (FOWLER *et al.*, 1987).

It has been noted that, in the transfer to planktivorous fish such as *Sardina pilchardus* and *Engraulis encrasicholus*, the variety of the radionuclides was greater in the viscera than in muscle tissue; moreover, the radiocesium was transferred from viscera to muscle to a greater extent than radioruthenium. The distribution of Cs137 and Cs134 concentrations in *Sardina* and *Engraulis* has been studied in detail on samples collected every two months, from June 1986 to December 1987, in the Gulf of Venice. It has been established that *Sardina* accumulates more cesium than *Engraulis*. In both these species Cs137 was distributed in the following way: 60% in muscle, 15% in viscera, 25% in the head and internal skeleton (TASSI PELATI *et al.*, 1989), a distribution in good agreement with the literature (COUGHTHREY *et al.*, 1985). Among the samples of the mussel *Mytilus galloprovincialis* from the different zones (Trieste, Venice, Ancona), those collected in the Gulf of Trieste near the mouth of the Timavo River were more contaminated than the others. Ru103 and Ru106 were more concentrated in the mussels than Cs137, Cs134 and Ag110m (TASSI PELATI *et al.*, 1987).

As expected, the littoral species in the Gulf of Trieste contained the highest levels of fallout. In fact, a typical rocky shore community *Enteromorpha*, *Fucus*, *Patella*, immediately after Chernobyl, contained the greatest number of radionuclides and the highest concentrations (TASSI PELATI and ALBERTAZZI, 1986). Concentrations decreased in the transfer from seaweeds to the limpet. This intertidal biocenosis was studied from 1986 to 1987 and the resulting radiocesium and radiosilver trends are noteworthy. For example, *Fucus* concentrated less cesium but more silver than *Enteromorpha*, and *Patella* contained concentrations of silver higher than those in the seaweeds upon which it feeds (TASSI PELATI *et al.*, 1992).

The phenomena which occurred in the Adriatic littoral community after Chernobyl has also been observed in biota from the British coast (CAMPLIN *et al.*, 1986).

Finally, for organisms from the coastal area near Ancona and the "Fossa di Pomo", it was possible to observe the different concentration capability for Cs137 in some species of fish in relation to their habitat and to their position in the food-web. For instance during 1986 in predator fish such as *Merluccius merluccius*, Cs137 concentrations were lower than in planktivorous fish like *Sardina*, while in 1987 the opposite was true. This clearly shows the usefulness of following the transfer of the most persistent contaminants in the longer-lived organisms which form the terminal steps of the marine food-web.

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