Radioactive Contamination Factor (RCF) in marine sediments from Cuba north and south coasts.

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Introduction

Radioactive contamination started in 1945 with the first nuclear explosion test in Alamo Gordo, New Mexico, USA, followed by two war actions in Hiroshima and Nagasaki. At present time radioactive contamination is a fact easily proved by radioactive detection from marine sediments, chosen samples in view of the much larger proportion of sea surface on the planet. This sort of samples contain appreciable concentration of minerals with natural radioactive isotopes such as ^{40}K. Therefore, the only way to asses the magnitude of radioactive contamination is by comparing it with forever present natural radioactivity. So in this work, radioactivity from fission product ^{137}Cs (R_1) is compared with that of natural radioisotope ^{40}K (R_2) as percentage, both found in marine sediments.

Navarrete et al. define the Radioactive Contamination Factor as:

$$RCF (\%) = [R_1(^{137}Cs) / R_2(^{40}K)] \times 100$$

In 2014 Navarrete et al. found in mexican waters, minimal values compared to natural radioactivity. However, these results might acquire greater interest, only if they are compared with those obtained by other countries, in samples taken up from a large number of sites, as much as possible, and very well distributed all over the sea surface, which represents about 80% of that of entire planet.

	Location	Latitude N	Longitude W	% RCF
station 1	Northern Gulf of Mexico	25°51'06"	96°12'00"	0.73
station 2	Northern Gulf of Mexico	25°51'06"	95°49'00"	1.17
station 3	Northern Gulf of Mexico	25°51'06"	95°25'00"	1.21
station 4	Northern Gulf of Mexico	25°19'48"	96°20'00"	0.79
station 5	Northern Gulf of Mexico	25°19'48"	96°59'00"	1.09
station 6	Northern Gulf of Mexico	24°56'54"	96°32'18"	0.58
station 7	Northern Gulf of Mexico	24°28'30"	95°56'00"	0.68

Map of sites where marine sediments samples where taken in Gulf of Mexico

Materials and Method

Sampling sites were established; samples of marine sediments were taken up along the cuban coasts, specifically were taken in Nautico beach and Guanabo beach about 100-200 m out of sea, at 2-5 m depth in the north coast and in the south coast were taken in Bibijagua beach and Batabano gulf. Then, samples were dried out in the laboratory by heating them at 40°C for 2 days on a flat recipient. They were grounded in a glass mortar, sieved in a 2000 μm sieve and conditioned in Marinelli containers and carefully weighed, in order to be detected from 12 to 24 hours in low background scintillation detector (NaI (Tl)) and hyperpure germanium detector (HPGe), coupled to a PC charged with Maestro program II of radioactive detection, in which background counts had been previously detected at same time span than samples

Low background scintillation detector (NaI(Tl)) and hyperpure germanium detector (HPGe).

Radioactive contamination factor (RCF) has been obtained as percentage of contaminant radioactivity from ^{137}Cs (662 keV γ rays), related to that of natural radioactivity from ^{40}K (1462 keV γ rays), both expressed as Bq/g.

Results

In order to find the total content of cesium and potassium. The analysis of major elements was performed by Wavelength Dispersive X-ray Fluorescence (WD-XRF). In addition was performed an Inductively coupled plasma mass spectrometry analysis (ICP-MS) The results were:

Total content	Guanabo beach	Nautico Beach	Bibijagua beach	Batabano Gulf
K_2O % w/w (WD-XRF)	0.47	0.16	0.28	0.61
Cs μg/g (ICP-MS)	0.25	0.11	0.21	0.27

RCF values obtained for the south coast of Cuba:

Sample counting	RCF (%)
Bibijagua beach	5.2
Batabano gulf	4.3

RCF values obtained in each case for the north coast of Cuba are superior to those obtained in previous studies are shown.

Guanabo Beach, Havana City. Cuba
Latitude : **23.1711** Length : **82.1278**

Sample counting	Disintegration per second ^{40}K	Disintegration per second ^{137}Cs	RCF
Guanabo beach	14.1503	1.6110	**11.4 %**
Nautico beach	8.3413	0.9403	**11.3 %**

Nautico Beach, Havana City. Cuba
Latitude : **23.097**   Length : **82.4514**

Sample counting	Disintegration per second ^{40}K	Disintegration per second ^{137}Cs	RCF
Guanabo beach	0.6091	0.0590	**9.7 %**
Nautico beach	2.5806	0.2805	**10.9 %**
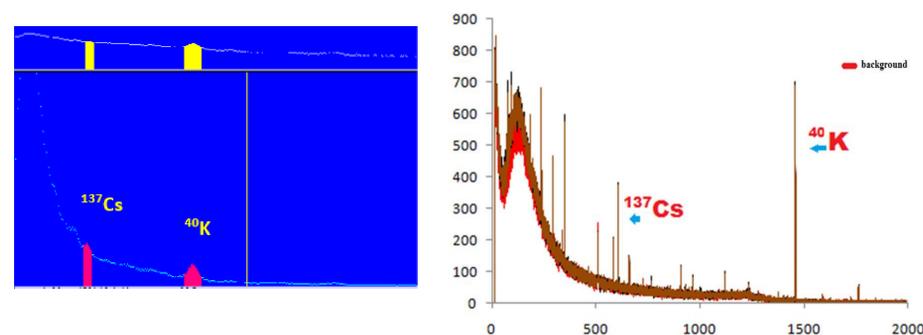
Spectrum obtained for Guanabo beach with a) the scintillation detector (NaI(Tl)) and b) with the hyperpure germanium detector (HPGe).

Conclusions

Proportion of contaminant ^{137}Cs compared to natural ^{40}K in marine sediments seems to be a suitable method to measure the present radioactive contamination whose origin seems to be plus than 2, 000 nuclear explosions performed mainly in the sea between 1945 and 1960.
Marine sediments as main repository of radioactive contamination in cuban sediments are much more receptive and representative than atmosphere and land.
There is some statistical variation among the RCF values obtained by each detector.
There are notable differences in RCF values between the marine sediments of the northern and southern coasts of Cuba.

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