On the neutron activation analysis of some marine sediments and their chemical composition

by

VIOREL COJOCARU*, IULIA I. GEORGESCU**,
SANDA LUPAN*** and MARIA SALAGEAN*
**Institute for Atomic Physics, Bucarest (Roumanie)*
***Polytechnic Institute, Bucarest (Roumanie)*
****Geological Department, Bucarest (Roumanie)*

Collection and description of the samples

In this work are analysed for the first time the ferromanganese concretions collected on the Romanian shallow at a depth of 30-60 m, as well as the nodule samples collected in Pacific ocean 200 km west off the port of Callaos-Perou and in the Atlantic ocean, at a depth of approxim. 5000 m. These last samples were analysed by others [1] and were taken in consideration for comparison, being analysed in the same conditions with the romanian samples. The Black sea samples are marked as follows: I, corresponding to Phase I, sediment incipience of elements and oxides about the nucleus, II corresponding in Phase II i.e.in a more advanced sedimentation process, Constantza and Sulina. All the samples were offered us by professor M. BACESCU.

The samples were irradiated for 30 hours in the VVRS-2 reactor of the Institute for Atomic Physics Bucarest, in a thermal neutron flux of 2×10^{13}n/cm^2/sec. The measurements were carried out after an 11 or 12 days cooling time using a high resolution gamma-ray spectroscopy by means of a germanium lithium drifted detector of 3.4 cm^3 and a resolution of about 2.8 KeV for the ^{60}Co 1332 KeV line. Peak areas for each radioisotope to be determined were measured adding the counts from channels on which the peak is finding and substracting the background given by the upper and lower regions; then were applied decay and count time corrections, so that the activities of the samples and standard rocks were calculated for the same decay time, after irradiation and for the same count time. See [2] for details. We pointed out that irradiations were carried out only for long-life isotopes to be detected. In table 1 are listed the concentrations of the elements in the samples, calculated from neutron activation analysis, and in table 2 is included the chemical and mineralogical probable composition of the samples. (See Figures 1, 2, 3).

Conclusions

There were determined 15 elements : Sc, Co, Rb, Sb, La, Yb, Tb, Eu, Lu, Th, Sr, Ru, Fe, Na, Br, taking in account only the gamma-rays that didn't interfere [3], [4]. The most concentrated samples in lanthanides are those of the Pacific ocean. Black sea sediments phase II, have about the same concentration as those of Pacific ocean samples in the elements : Co, Rb, Ru, Tb. The results obtained by neutron activation analysis and chemical analysis lead to the conclusions that the ferromanganese concretions phase II from the Black sea, are like those given by the Pacific ocean nodules, in regard to the iron and manganese concretions. They differ however fundamentally by the composition of their nucleus, i.e. of their core arround which the deposits of Fe - Mn are made; these are calcareous in the Black sea nodules, but silicous in the Pacific and Atlantic oceans ones. [5]. The Black sea nodules are richer in phosphates 2-4 times in average as compared to those in the Pacific and Atlantic oceans. From the neutron activated samples the Pacific and Atlantic samples present a higher concentration in microelements and Pa and Hf, while the peak of the ^{233}Pa and of ^{181}Hf are not conspicuous enough, in the Black sea samples.

[1] MERO (L.J.), 1965. — *The mineral resources of the sea.* Elsevier Publishing Company. XIII-312 p.

Rapp. Comm. int. Mer Médit., **21**, 11, pp. 869-872, 3 fig. (1973).

FIG. 1

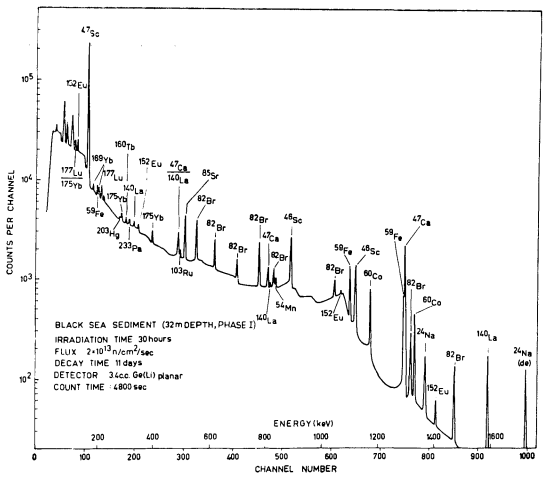
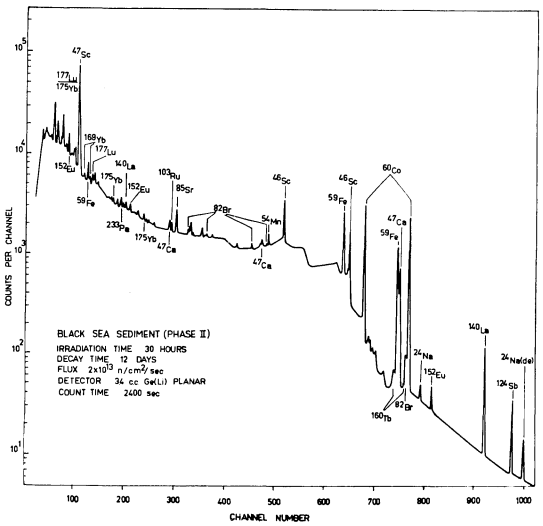


FIG. 2



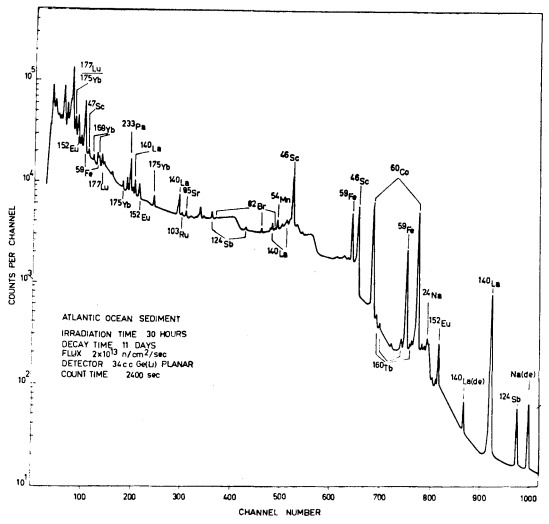


FIG. 3

FIG. 1. — Gamma-ray spectrum of neutron activated Black-sea sediment, phase I. Constantza.
FIG. 2. — Gamma-ray spectrum of neutron activated Black-sea sediment, phase II, Sulina (region of Danube Delta).
FIG. 3. — Gamma-ray spectrum of neutron activated Atlantic ocean sediment. Station 7799-5070 m. depth, 32°31′ lat.(N) and 67°41′ long. (W).

References

[1] MERO (L.J.), 1964. — The mineral resources of the Sea. Amsterdam Ed. Elsevier Publishing Company., XIII - 312 p.

[2] GEORGESCU (I.I.), COJOCARU (V.), LUPAN (S.) & SALAGEAN (M.), 1972. — Sur la radioactivité du milieu marin et l'analyse par activation neutronique de certaines algues de la mer Noire. *Rapp. Comm. int. Mer Médit.*, **21**, 6, pp. 309-310.

[3] COJOCARU (V.), FILBY (R.H.) and ISPAS (M.), 1970. — Determination of the elements in standard german rocks by neutron activation analysis. *Geochim. cosmochim. Acta, (sous presse)*.

[4] LEDERER (C.M.), HOLLANDER (J.M.) & PERLMAN (I.), 1967. — *Table of Isotopes*. New-York 6th Ed., Wiley.

[5] PETTERSON (H.), 1959. — Manganese and nickel on the ocean floor. *Geochim. cosmochim. Acta*, **17**, pp. 209-213.

TABLE 1. — Element concentrations in marine sediments, micrograms/gsedim.

Elem.	Blakc sea sedim.Phase I Constantza	Black sea sediment Phase II Sulina	Atlantic ocean sediment St.7799-5070 m	Pacific ocean sediment Callaos (Perou)
Sc	0.81 ± 0.05	2.60 ± 0.15	14.40 ± 0.72	9.54 ± 0.52
Co	29.12 ± 1.92	90.80 ± 5.20	155.07 ± 8.84	93.03 ± 6.51
Rb	24.60 ± 12.30	183.85 ± 35.0	222.5 ± 46.7	192.30 ± 92.3
Sb	2.53 ± 2.02	15.60 ± 11.7	7.30 ± 5.70	209.02 ± 156.8
La	7.60 ± 0.91	12.76 ± 1.80	117.0 ± 11.0	261.46 ± 23.5
Yb	0.25 ± 0.07	0.66 ± 0.20	2.87 ± 0.77	9.38 ± 2.53
Tb	0.14 ± 0.10	0.47 ± 0.27	1.37 ± 0.74	0.54 ± 0.62
Eu	0.32 ± 0.11	0.35 ± 0.16	2.84 ± 0.82	6.84 ± 0.20
Lu	0.00052 ± 0.00013	0.080 ± 0.020	0.071 ± 0.017	0.11 ± 0.026
Th	1.08 ± 0.13	2.41 ± 0.24	30.38 ± 2.43	23.65 ± 2.01
Sr	0.14 ± 0.024	0.193 ± 0.036	0.22 ± 0.05	0.605 ± 0.12
Ru	0.064 ± 0.024	0,51 ± 0.18	0.126 ± 0.06	0.336 ± 0.118
Br	0.0062 ± 0.0018	0.0092 ± 0.0041	0.019 ± 0.004	0.05 ± 0.01
Fe	1.55 ± 0.07	7.65 ± 0.33	7.52 ± 0.32	16.72 ± 0.72
Na	0.30 ± 0.12	0.325 ± 0.26	1.25 ± 0.20	2.42 ± 0.73

Obs. The concentration of Sr and Ru were measured relative, by reporting their peaks to the peak) of Sr and Ru of the *Phyllophora b.* alga that had a higher content of these microelements, and were considered as (1), unity. — Br, Fe and Na were calculated in (%), per cent.

TABLE 2. — Chemical composition of the ferromanganese concretions.

Constituent	Black Sea				Atlantic Ocean	Pacific Ocean
	Phase I Constantza %	Phase II Constantza %	Phase II Sulina %	St. 7799-5070 m %	Callao (Perou) (Georgescu and cowork.) %	Mero [1] %
MnO_2	5.50	21.80	13.17	8.22	18.78	31.7
Fe_2O_3	3.60	26.00	10.40	11.54	27.00	24.3
SiO_2	1.83	7.60	4.85	36.71	26.02	19.2
Al_2O_3	0.16	1.21	0.86	8.25	2.69	3.8
CaO	48.00	14.35	33.00	7.00	2.38	2.3
MgO	0.65	1.50	1.00	7.60	2.50	1.28
CO_2	37.92	11.20	26.12	1.00	4.26	—
P_2O_5	0.44	1.92	0.94	0.41	0.51	—
SO_3	0.12	0.03	0.37	0.32	0.13	—
Na	0.22	0.19	0.37	1.50	1.40	2.6
K	trace	0.41	0.31	1.00	0.97	0.8
Ti	trace	0.10	0.06	0.25	0.30	0.67
Cu	0.003	0.001	0.003	0.08	0.010	0.53
Ni	0.010	0.010	0.010	0.15	0.030	0.99
Co	0.003	0.003	0.003	0.030	0.010	0.35
Cr	0.010	0.010	0.030	0.040	0.030	0.001
V	trace	0.001	0.003	0.015	0.010	0.05
Mo	trace	0.003	0.020	0.007	trace	0.052
W	trace	0.02	0.02	—	0.05	0.06
$Ca_3(PO_4)_2$	0.96	4.20	2.05	0.90	1.11	0.3
$CaCO_3$	84.61	21.51	56.46	1.43	3.02	4.1
$MgCO_3$	1.36	3.14	2.09	0.67	5.23	2.7
H_2O	1.26	12.00	8.08	15.87	11.40	13.0
Insoluble in HCl	1.83	9.46	5.69	49.64	28.40	26.8