

# On the $^{90}\text{Sr}$ carried by the Po river into the Adriatic Sea in the 1962-1972 period

by

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As it is well known the  $^{90}\text{Sr}$  concentration of the Adriatic Sea water resulted [1-4] always higher (about two times on average) than in other Italian seas. The mean values (pCi/l) recorded for three different periods are :

Sea	1960-61	1963-64	1970-71
Ligurian-Tyrrhenian	0.07	0.60	0.16
Adriatic	0.16	1.25	0.26
Ionian	—	—	0.22

The aim of this work is to evaluate the contribution of the  $^{90}\text{Sr}$  carried by Italian rivers, mainly the Po river, into Adriatic Sea compared with the radioactivity directly delivered from local fallout on marine surface.

Collecting all available data from literature and others from our own papers, we were able to assemble a set of pertinent values concerning only  $^{90}\text{Sr}$  and only the 1962-1972 period.

In Table 1 the  $^{90}\text{Sr}$  amounts (Q) deposited per year (Ci/y) in the whole rain collection basin of the Po river are listed : the figures were calculated[5] from the mean concentration values of fallout collected in significant stations and considering a deposition area of about 75,000 km<sup>2</sup>.

Other values (Q<sub>i</sub>) concern the  $^{90}\text{Sr}$  flown into Adriatic Sea. Such data were calculated on the basis of measurements of  $^{90}\text{Sr}$  concentration carried out periodically[4] at a station near the river mouth (Guarda Veneta, Rovigo) and the average flow rate at that point. The  $^{90}\text{Sr}$  concentration values range from 0.4 to 1.8 pCi/l and the flow rate is on the average equal to 1430 m<sup>3</sup>/sec.[6]. Note that Q<sub>i</sub> values in brackets were calculated by concentration data of pertinent stations of the same hydrological system.

It can be observed that in the considered period (1962-1972) the  $^{90}\text{Sr}$  activity outflow (Q<sub>i</sub>) is 347 Ci corresponding to about 5.4 % of the activity Q fallen in the Po river basin (6400 Ci).

The  $^{90}\text{Sr}$  Ci/y carried by suspended matter (q<sub>m</sub>) is also reported in the table for the 1966-1969 period[7] : although the suspended matter annually transferred into the sea resulted to be about 10 × 10<sup>6</sup> tons, the percentage of q<sub>m</sub> on Q<sub>i</sub> is negligible (about 3-4 %). In fact, contrary to the behaviour of other radionuclides,  $^{90}\text{Sr}$  is slightly fixed to suspended matter and sediments.

The  $^{90}\text{Sr}$  deposition on the Adriatic Sea surface ( $\sim 100\,000\text{ km}^2$ ) from fallout has been evaluated by some Authors (see  $Q_A$  in Tab. 1), assuming the same radioactive rainfall both on the sea and on the continent[8]. It can be noted that  $Q$  and  $Q_A$  values decrease from 1963 to 1972 by a factor of 20-25 while those of  $Q_i$  only by a factor of 3-4. As for the  $^{90}\text{Sr}$  contribution of the Po river to the marine water with respect to that derived from fallout, in the far right column of the table the percentages of  $Q_i$  on  $Q_A$  are listed : in the first period (1962-1965) is 3-6 %, in the second 10-20 %. Taken as a whole, the fresh Po river water (347 Ci) contributes 5.7 % to the local fallout input (6134 Ci).

At last, also evaluated was the  $^{90}\text{Sr}$  contribution due to Reno river (50  $\text{m}^3/\text{sec}$ ) in which the  $^{90}\text{Sr}$  concentration ranges 0.5-2.3 pCi/l, Piave river (10  $\text{m}^3/\text{sec}$ ) and other rivers having different characteristics (mainly the bed permeability) such as Adige and Brenta. On the basis of their outflow[6], and assuming, when lacking, the same  $^{90}\text{Sr}$  concentration as in the Po river, the contribution of the other Italian rivers resulted about 1.9 %. Globally the contribution of the North river waters to  $^{90}\text{Sr}$  from local fallout in the Adriatic Sea can be evaluated about 7.6 % (indicative value).

Before concluding it can be remarked that the Adriatic Sea and mainly the North region represent a quite complex marine environment [9,10] having low water masses, peculiar geomorphologic aspects, highly variable salinity and temperature, high evaporation, and being not directly or slightly interested by the Mediterranean currents. For this reason, to explain the higher  $^{90}\text{Sr}$  concentration in this sea it will be necessary to study the balance of this ecosystem and the exchanges occurring with the Mediterranean waters, taking into account results of the present paper and other environmental parameters.

TABLE 1.

Year	Strontium-90 (Ci)				$100 \cdot \frac{Q_i}{Q_A}$ (%)
	Q	$Q_i$	$q_m$	$Q_A$	
1962	847	(31)	—	1068	(2.9)
1963	2700	81	—	2232	3.6
1964	1424	51	—	1296	3.9
1965	450	30	—	527	5.7
1966	277	33	1.46	296	11.2
1967	120	18	0.40	126	14.3
1968	150	28	0.91	157	17.8
1969	90	21	0.77	102	20.6
1970	120	13	—	118	11.0
1971	165	19	—	134	14.2
1972	57	(22)	—	78	(28.2)

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