THE NEW DISTRIBUTION OF THE TRACER ^{137}CS IN THE EASTERN MEDITERRANEAN: RELATIONSHIP TO THE DEEP WATER TRANSIENT.

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Abstract
In the late seventies, the vertical profiles of the conservative tracer ^{137}Cs in the Eastern Mediterranean showed a relative maximum in the Levantine Intermediate Water (LIW) and an exponential decrease towards the bottom. In the late nineties, the distribution of ^{137}Cs was characterised by lower surface concentrations and higher levels at depth, related to efficient transfer of the tracer by convection processes. Moreover, the input of the new Cretan Sea Overflow Water (CSOW) from the Aegean Sea produced a marked homogenisation of ^{137}Cs concentrations all over the Ionian Sea below 1500 m.

Keywords: Eastern Mediterranean, radionuclides, deep water.

Introduction

^{137}Cs is an anthropogenic radionuclide, conservative in the open sea. Its main sources to the Mediterranean area are fallout from past nuclear weapon testing and the Chernobyl accident in 1986. From 1963 to 1986, the radionuclide concentration in surface water has regularly decreased, reflecting the decrease of the atmospheric input and vertical transport processes. The ^{137}Cs vertical profiles were characterised by decreasing concentrations from surface to bottom. In the Eastern Mediterranean, the only vertical profiles before the Deep Water Transient were obtained by Fukai *et al.* (1) and Livingston, (unpublished) in the period 1975-77. ^{137}Cs surface concentrations ranged between 4.2 and 5.5 Bq m^{-3} over the entire basin. The profiles demonstrated subsurface maxima in the upper 400 m and an exponential decrease towards the bottom. The concentrations in deep Ionian Sea (0.3-0.5 Bq m^{-3}) were about double those of the Levantine Sea. It is reasonable to assume that the spatial distribution of ^{137}Cs was similar to that of tritium in 1978 (2), which showed concentrations below 1500 m decreasing from the Western Ionian Sea towards the Levantine basin. These distributions reflected the circulation in the Eastern Mediterranean, with tracer-rich dense waters of Adriatic origin (Eastern Mediterranean Deep Water, EMDW) flowing first into the bottom of the Western Ionian Sea and then spreading eastward. In 1986 the fallout from the Chernobyl accident produced a sharp increase in ^{137}Cs concentration at the surface of the Eastern and Northern basins. Pre-Chernobyl levels were reached again in 1990. In 1995 and 1999 two sampling campaigns have been carried out in the Eastern Mediterranean to determine the recent distribution of ^{137}Cs and its relation to the Chernobyl input and to the water circulation in the area.

Materials and methods

The location of the sampling stations is shown in Fig. 1. After CTD casts, water samples (60-100 l) were collected in different water masses, to determine ^{137}Cs concentration. ^{137}Cs was pre-concentrated onboard by co-precipitation on ammonium molibdo-phosphate (AMP) at pH 1.5. 134Cs was used as yield determinant. ^{137}Cs was determined by gamma spectrometry with high purity germanium detectors (relative efficiency 60%, resolution 2.1 keV at 1332 keV). The accuracy of the results is regularly checked by participation in IAEA intercomparison exercises.

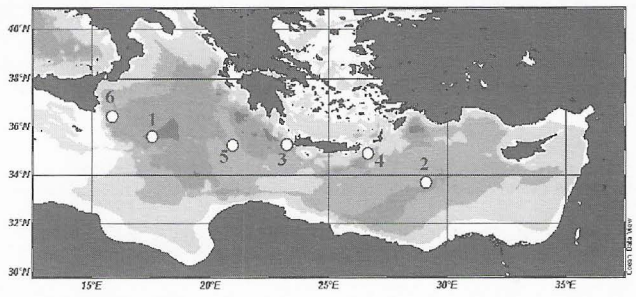

Fig.1 – Sampling points

Results and discussion

The 1995 campaign (UNESCO-POEM) found a dramatic change in the thermohaline circulation of the E-Mediterranean: a new type of water originating in the Aegean Sea, the CSOW, was flowing through the Cretan Arc straits and spreading throughout the bottom layer of the entire Levantine basin, flowing to the West and forcing upward the old deep water of Adriatic origin (3). The vertical profiles of ^{137}Cs at the two sides of Crete (St. 3 and 4) showed that the CSOW was marked by relatively high concentrations of ^{137}Cs (2-2.5 Bq m^{-3}). The most recent vertical profiles in the Ionian and Levantine Seas (St. 1 and 2) showed surface concentrations around 3 Bq m^{-3} and, as in 1977, a subsurface maximum in the LIW. However, in the bottom layer, they significantly differed from the old profiles. In the Ionian Sea, minimum concentrations (1-1.5 Bq m^{-3}) were found in the depth interval 750-1500 m, followed by an increase up to 2.5 Bq m^{-3} from 2000 m to the bottom. The deep layer was still characterised by the presence of EMDW, and the increase in ^{137}Cs concentration was due to its continuous transport from surface to bottom through convection processes in the Adriatic Sea. In the Levantine Sea (St. 2) minimum concentrations (1-1.5 Bq m^{-3}) characterised a larger depth interval, from 750 to 2000 m, but below this depth, where salinity and temperature data indicated the intrusion of CSOW, the levels increased reaching 2.5 Bq m^{-3} near the bottom. The inventory of ^{137}Cs at these two locations has more than doubled with respect to 1977, indicating an efficient transport from surface water and from the shelf areas to the deep sea.

In 1999, a new sampling campaign (SINAPSI) covered 4 stations along a transect from the Malta sill to the western side of Crete. The vertical profiles of ^{137}Cs were very similar at all stations (Fig. 2): almost constant concentrations (3-3.5 Bq m^{-3}) from surface to 300 m, decrease to a minimum value of 1-1.5 Bq m^{-3} around 1000 m and a new increase to an average value of 2.5 Bq m^{-3} from 1500 m to the bottom. Salinity and temperature profiles showed that the deep layers at the two Western Ionian stations (St.6 and 1) were characterised by EMDW, while at the other two stations CSOW dominated. As ^{137}Cs concentration was very similar in the two types of deep water, a marked homogenisation of the tracer concentration in the whole Ionian Sea is presently observed. Most of the ^{137}Cs inventory is now confined in the deeper part of the Eastern Mediterranean.

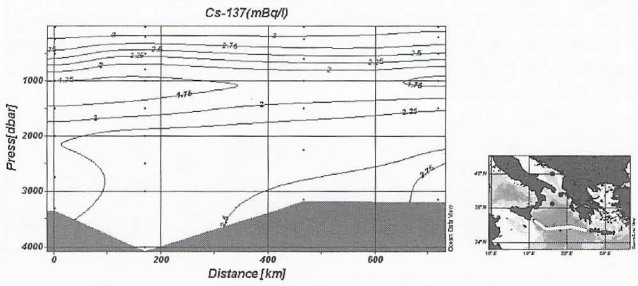

Fig. 2 – ^{137}Cs distribution along a West-East section in the Ionian Sea (1999).

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