NEW ESTIMATION OF THE ATMOSPHERIC ^{210}PB FLUX TO THE NORTHWESTERN MEDITERRANEAN SEA

Garcia–Orellana J. [1] *, Sanchez–Cabeza J.A. [1, 2], Masqué P. [1, 2] and Bruach J.M. [1]

[1] Grup de Física de les Radiacions - Departament de Física, Universitat Autònoma de Barcelona. 08193 Bellaterra, Spain
* Jordi.Garcia@uab.es

[2] Institut de Ciència i Tecnologia Ambientals (ICTA), Universitat Autònoma de Barcelona. 08193 Bellaterra, Spain

Abstract

One of the key parameters needed in geochemical models of ^{210}Pb, a well known radiotracer of particle dynamics in the marine environment, is its atmospheric flux. There is a scarcity of data about this parameter in the Western Mediterranean Sea, especially regarding long term records. In this work we have evaluated the ^{210}Pb annual atmospheric flux from the analysis of 10 soils collected from coastal and island areas. ^{210}Pb fluxes ranged from 31±3 to 132±11 Bq·m^{-2}·y^{-1} with and average of 75 Bq·m^{-2}·y^{-1}, and correlate well with mean annual rainfall.

Keywords: 210Pb, atmospheric flux, Western Mediterranean

^{210}Pb ($T_{1/2}$=22.3 y) is one of the most widely used radiotracers to study biogeochemical processes in the oceans. One of the parameters that intervene to constrain the ^{210}Pb cycle is its atmospheric flux. In the Mediterranean Sea there is a scarcity of data about the ^{210}Pb atmospheric fluxes, especially regarding long term records (1 - 5). The most common procedure to estimate the annual flux is by collection of wet and dry deposition during long enough time periods to accommodate seasonal and episodic variations. Other ways are the use of natural repositories such as snow fields, lake sediments and soils that integrate large periods of time. In the Western Mediterranean, the atmospheric ^{210}Pb flux has been estimated in 81.2 Bq·m^{-2}·y^{-1} as measured in a microbial mat from the Ebro River Delta (558 mm^{-1} rainfall) (1), 110 and 102 Bq·m^{-2}·y^{-1} in Monaco (883 mm^{-1}) (4, 5), measuring wet deposition sampled in man-made collectors.

In this work we have evaluated the ^{210}Pb atmospheric flux that has been deposited over the Mediterranean Sea by determining its inventory in 10 undisturbed soils from coastal areas and islands, including Tanger (Morocco); Gata Cape and Minorca (Spain); Frejus, Port Vendres and Corsica (France); Porto Palo and Camarina (Sicily, Italy) (Fig. 1). Soils were usually sampled in a land with low vegetation and without anthropogenic impact. Excess (atmospheric) ^{210}Pb was determined by the difference of total ^{210}Pb and ^{226}Ra activities. The ^{210}Pb activity profiles were exponential with depth and the penetration in soils ranged from 5 cm to 30 cm depending mainly on the type soil. ^{210}Pb fluxes (F) were calculated using $F = I \cdot \lambda$, where I is the inventory and λ is the ^{210}Pb decay constant (0.0311 a^{-1}).

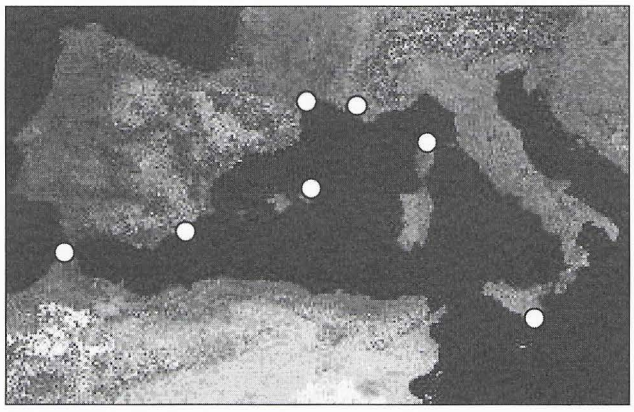

Fig. 1. Distribution of soils collected in this work.

Specific surface activities range from 46 ± 3 Bq·kg^{-1} in Sanitja (Minorca) to 102 ± 5 Bq·kg^{-1} in Port Vendres. Rainfall in the region is highly variable. For instance, in the North Western Mediterranean rainfall varies from 428 mm^{-1} in Corsica to 883 mm^{-1} in Frejus. ^{210}Pb fluxes ranged from 31 ± 3 to 132 ± 11 Bq·m^{-2}·y^{-1} with a mean value of 75 ± 27 Bq·m^{-2}·y^{-1} and correlated strongly with rainfall (R^2 = 0,87) (Fig. 2). On the basis of this correlation, we suggest that the ^{210}Pb atmospheric flux in a given area can be estimated if the mean annual rainfall is well known at any specific site from the Western Mediterranean. This facilitates the use of ^{210}Pb as a tracer of biogeochemical processes in the Mediterranean Sea and the study of erosion in soils by using this radiotracer.

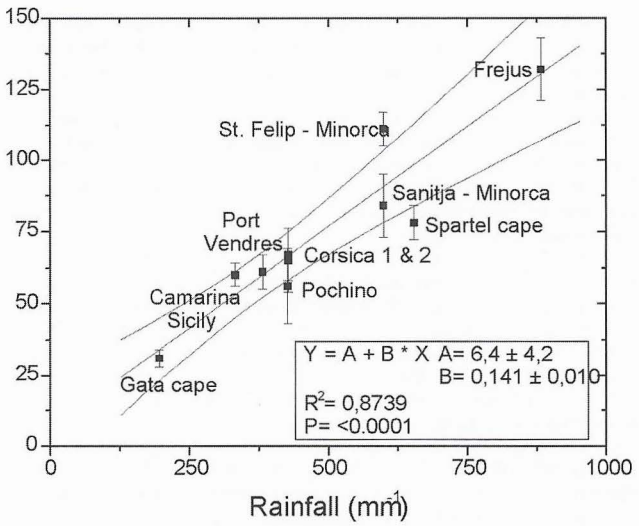

Fig. 2. Atmospheric ^{210}Pb fluxes vs rainfall in the Western Mediterranean (y= ^{210}Pb atmospheric flux and x= rainfall).

References

1 - Sanchez-Cabeza, J.A., Masqué, P. Martínez – Alonso, M., Mir, J. and Esteve I., 1999. ^{210}Pb atmospheric flux and rowth rates of a microbial mat from the Northwestern Mediterranean Sea (Ebro River Delta). *Environ. Sci. Technol.* 33: 3711-3715.

2 - Balkanski, Y.J., Jacob, D.J. and Gardner, G.M., 1993. Transport and residence times of continental aerosols inferred from global three – dimensional simulation of ^{210}Pb. *J. Geophys. Res.* 98: 20573-20586.

3 - Preiss, N., Melieres, M.-A. and Pourchet M., 1996. A compilation of data on lead-210 concentration in surface air and fluxes at the air – surface and water – sediment interfaces. *J. Geophys. Res.* 101: 28847-28862.

4 - Heyraud, M., 1982. Contribution a l'étude du Po-210 et Pb-210 dans les organismes marins et luer environment. Pp. 144. *In:* phD research work. Université Pierre et Marie Curie, Paris.

5 - Tateda, Y., Carvalho, F.P., Fowler, S., Miquel, J.C., 2003. Fractionation of ^{210}Po and ^{210}Pb in coastal waters of the NW Mediterranean continental margin. *Cont. Self Res.* 23: 295-316.