^{210}PB AS A TRACER OF SEDIMENTARY PROCESSES IN THE CONTINENTAL SLOPE: THE ROLE OF SUBMARINE CANYON SYSTEMS IN THE WESTERN MEDITERRANEAN SEA

P. Masqué [1] *, J.A. Sánchez-Cabeza [1], J. Garcia-Orellana [1], J.M. Bruach [1], A. Palanques [2], M. Elkathab [2], P. Puig [2], J. Fabres, A.M. Calafat, M. Canals [3]

[1] Institut de Ciència i Tecnologia Ambientals – Departament de Física, Universitat Autònoma de Barcelona. Bellaterra, Spain
* Pere.Masque@uab.es
[2] Institut de Ciències del Mar – CMIMA (CSIC), Departament de Geologia Marina i Oceanografia Física, Barcelona, Spain
[3] GRC Geociències Marines, Departament d'Estratigrafia, Paleontologia i Geociències Marines, Universitat de Barcelona, Spain

Abstract

The natural radionuclide ^{210}Pb is used here to assess the extent to which transfer of particles and sedimentation in continental margins is controlled by the presence of canyons. We studied three sites in the Western Mediterranean Sea, focusing on the evaluation of the global budgets of ^{210}Pb and the temporal variability of the activity distributions in the water column and fluxes derived from sediment traps and activity profiles in bottom sediments.

Keywords: sedimentation, submarine canyons, Pb-^{210}, Western Mediterranean

Tracers with well constrained input functions can be used to study particle transport processes in continental margins (i.e. transfer of sediment from the continent to the ocean), a fundamental issue to better understand the organic carbon cycle in the oceans. Amongst them, ^{210}Pb is of particular interest, as its half-life (22.3 years) is suitable for the kind of processes to be characterised (1-4). This work has been carried out at three continental margin sites in the Western Mediterranean Sea: i) the Foix Canyon off Barcelona; ii) the Guadiaro Canyon, east of the Gibraltar Strait; and iii) a depression in the Balearic Islands margin. Sampling stations were located at different depths at the axis of the canyons/depression and at the adjacent open slopes. ^{210}Pb was determined in the water column, bottom sediments and sinking particles (collected with sediment traps). This strategy allowed us to: build a balance of the ^{210}Pb distributions using the water column and bottom sediment inventories; estimate sediment accumulation and mixing rates using excess ^{210}Pb (and ^{137}Cs) activity profiles in the sedimentary record; and compare these to mass and ^{210}Pb fluxes obtained from deployments of sediment traps during one year at each site.

The Barcelona site is characterised by sediment accumulation rates significantly higher along the axis of the canyon than in the open slope, and a sedimentary depocenter was identified at mid-slope (0.51 ± 0.02 $g \cdot cm^{-2} \cdot y^{-1}$), between 600 and 850 m depth. The expected fluxes of ^{210}Pb to the bottom sediments associated to sinking particles, calculated from the balance of the annual atmospheric flux, *in situ* production from disintegration of ^{226}Ra and ^{210}Pb decay, are only 7-36% of those actually measured with traps and derived from inventories in bottom sediments. This suggests the existence of lateral input of ^{210}Pb, which would be driven by particulate material that is transported as nepheloid layers from the continental shelf and the upper slope along the pathways of the prevailing currents after resuspension events. This material would be focused down the canyon axis, thus indicating that the canyon acts as a natural trap.

At the Guadiaro site, where the canyon incising the slope is also clearly defined, the highest sediment accumulation occurs at 600 m depth in the axis of the canyon (0.290 ± 0.015 $g \cdot cm^{-2} \cdot y^{-1}$). This sedimentation rate is between 3 and 4 times larger than those determined in the canyon head (260 m depth) and that those at about 700-770 m, deeper in the continental slope, regardless of the location in the Guadiaro submarine Fan or in the open slope. Similarly to the Foix Canyon, this also indicates the presence of a sedimentary depocenter at mid-slope depths. Moreover, from the relationships between the ^{210}Pb activities and fluxes and the total mass fluxes obtained with the sediment traps, it is suggested that the Guadiaro Canyon is also effectively acting as a conduit of resuspended particles originating in the shelf and/or the upper slope. In addition, the activity profiles and inventories of ^{210}Pb and ^{210}Po ($T_{1/2}$ = 138 days) in the water column indicate that the scavenging of particle-associated elements is only slightly enhanced in the axis of the canyon, thus confirming that the sediment transport would be mostly driven by near-bottom nepheloid layers. In fact, the distribution of both elements in the water column seems to be governed by regional-scale processes, as similar temporal variability was observed for stations located in the central region of the western Alboran Sea.

At the Balearic Islands site, sediment accumulation rates were similar in and out of the depression (about 0.07 $g \cdot cm^{-2} \cdot y^{-1}$), much smaller than those at the continental slope off Barcelona and only slightly lower than those in the deep slope at the Guadiaro site. The balance between the estimated ^{210}Pb fluxes from the water column and the actual ^{210}Pb flux reaching the sea floor as measured in bottom sediments is off by only a 20%. Although resuspension and subsequent transport of material offshore may also take place in the Balearic margin, the absence of major rivers precludes the magnitude of the fluxes of being large and vertical particle fluxes are dominant. On the other hand, there is no significant difference of fluxes between the depression and the open slope. Thus, the submarine depression does not act as an efficient conduit for the particulate material, nor as a preferential depositional area, and it can be considered as controlled by the open slope regime.

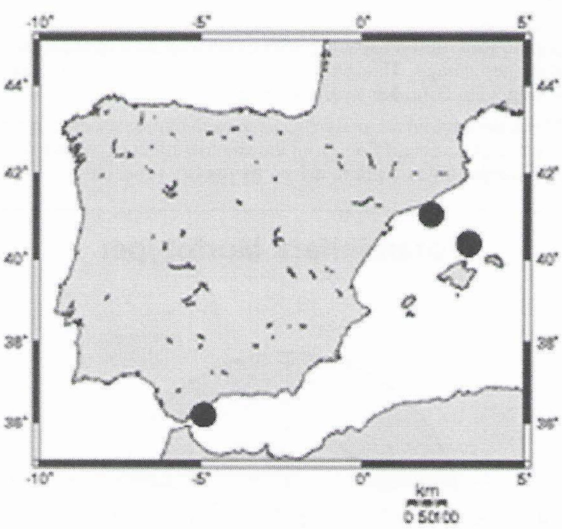

Fig. 1. Location of the three study sites in the Western Mediterranean Sea.

References

1 - Biscaye, P.E., Anderson, R.F., 1994. Fluxes of particulate matter on the slope of the southern Middle Atlantic Bigth: SEEP-II. *Deep-Sea Res. II*, 41: 459-509.

2 - Buscail, R., Ambatsian, P., Monaco, A., Bernat, M., 1997. ^{210}Pb, manganese and carbon: indicators of focussing processes on the northwestern Mediterranean continental margin. *Mar. Geol.*, 137: 271-286.

3 - Sanchez-Cabeza, J.A., Masqué, P., Ani-Ragolta, I., Merino, J., Frignani, M., Alvisi, F., Palanques, A., Puig, P., 1999. Sediment accumulation rates in the Southern Barcelona continental margin (NW Mediterranean Sea) derived from ^{210}Pb and ^{137}Cs chronology. *Prog. Oceanog.*, 441 (1-3): 313–332.

4 - Zuo, Z., Eisma, D., Gieles, R., Beks, J., 1997) Accumulation rates and sediment deposition in the Northwestern Mediterranean. *Deep-Sea Res. II*, 44: 597-609.