Fallout Radionuclides in Mediterranean Sediments

by

Hugh D. LIVINGSTON, Vaughan T. BOWEN and John C. BURKE

Summary Fallout Pu-239,240 and Cs-137 in a series of Mediterranean sediment cores are independent of depth of overlying water and imply rates of Pu transfer to the sediments slow compared to the Atlantic Nuclide inventories and patterns of penetration are interpreted in terms of biological activity within the sediments. High Am-241/Pu-239, 240 ratios suggest that Am sinks 4-9 times faster than Pu.

Résumé Les concentrations et les inventaires de retombées radioactives Pu-239,240 et Cs-137 dans une série de carottes des sédiments méditerranéens existent, indépendants de la profondeur de l'eau qui les recouvre; ils impliquent, comparés à ceux de l'océan Atlantique, un taux lent de transfert du Pu aux sédiments. On interprète les inventaires de nucléides et le mode de pénétration par rapport à l'activité biologique à l'intérieur des sédiments. Une proportion élevée suggère que l'Am est transporté dans les sédiments 4 à 9 fois plus vite que le Pu.

Text In a series of six Mediterranean cores collected in 1975 and one in 1969, from a range of locations ($3^{o}W$-$25^{o}E$) and depths (448-4043 m), Pu-239,240 and Cs-137 concentrations (from nuclear fallout) decreased smoothly with increasing depth within the sediment. The integrated Pu-239,240 per unit area of the sediments collected in 1975 ranged from 3.8-9.5% of that predicted to have been delivered to the sea surface. No decrease in the sediment Pu inventory was found as a function of increasing depth of overlying water. These much lower inventories, than were predicted from a model of Pu sedimentation based on Atlantic studies,[1] confirm that the rates of transfer of Pu to the sediments in the Mediterranean are much slower than in the Atlantic. The ratio Pu-239,240/Cs-137 in five of the 1975 cores ranged only from

0.019-0.025. The remarkable constancy of this ratio implies strong similarities in the properties of the particles that carry these nuclides to the sediments. Higher ratios, in a core from near to the western entrance to the Mediterranean, and in the 1969 core from near Corsica appear to reflect locally more efficient mechanisms transporting Pu to the sediments. Larger sediment inventories of Pu-239, 240 and Cs-137 are associated with increased depth of their penetration within the sediment. These variations in inventories and in patterns of penetration are believed to be consistent with varying population densities and intensity of activities of sediment dwelling organisms.[2]

Am-241/Pu-239,240 ratios measured in the top layer of the 1975 sediments ranged from 0.7-1.8. These values, considerably larger than found in most Atlantic sediments,[3] imply that Am is being transferred to the sediments at rates 4 to 9 times greater than Pu.

1. Noshkin, V. E., V. T. Bowen. "Concentrations and distributions of long-lived fallout radionuclides in open ocean sediments". In Radioactive Contamination of the Marine Environment, IAEA Vienna (1973), 671-686.
2. Bowen, V. T., H. D. Livingston, J. C. Burke. "Distributions of transuranium nuclides in sediments and biota of the North Atlantic Ocean". In Transuranium Nuclides in the Environment, IAEA Vienna (1976), 107-120.
3. Livingston, H. D., V. T. Bowen. "Americium in the marine environment -- relationships to plutonium". Presented at the Eighth Rochester International Conference on Environmental Toxicology, Radioisotopes in the Aquatic Environment, Rochester, N. Y., U.S.A., June 1-4 (1975). In press.

5. Livingston H.D., Bowen V.T., Burke J.C. - Fallout radionuclides in Mediterranean sediments.

Discussion

Rapaire J.L. (Monaco Principality) : Quelle est la quantité d'eau de mer utilisée pour obtenir une mesure de ^{137}Cs.

Livingston H.D. : 50-60 litres.

Guegueniat P. (France) : Do you have an idea of the diffusion rate of Cs and Pu in sediments ?

Livingston H.D. : We believe that our data for Cs and Pu distributions in marine sediments do not show evidence for diffusion of Cs either upwards or downwards in the sediment column. In contrast, however, over a period of ~ 5-10 years we believe our data show evidence of upward mobility of Pu in coastal sediments - perhaps as a result of the interaction of Pu with chelating organics (released by sediment organisms) which are diffusing slowly towards the sediment water interface.

Fowler S.W. (IAEA, Monaco) : How do you account for the high Am/Pu ratio in Mediterranean sediments compared to Atlantic sediments ?

Livingston H.D. : The hypothesis I would favor is that the inorganic component of the Mediterranean particle populations is much higher than the organic component than found in the Atlantic - and that the inorganic particles preferentially favor Am transport relative to Pu. I would have also favored this explanation for ^{55}Fe transport, but the similarity in Mediterranean ^{55}Fe/Pu sediment ratios and Atlantic ratios argues against ^{55}Fe and Am being trasported vertically by the same mechanisms in both water bodies. I find it puzzling

that ^{55}Fe is sedimented so slowly in the Mediterranean but at the moment would not have any useful explanation to offer.

Elder D.L. (IAEA, Monaco) : The higher deposition of Americium in the Mediterranean relative to Atlantic as well as the higher value of Am/Pu in the western Mediterranean could be explained by the fact that the average sedimentation rate in the western basin vs Atlantic is 30 and the inorganic vs organic content of particulates is higher in the Algerian margin compared to the Atlantic (comment).