HEAVY METALS PROFILES IN DATED SEDIMENTS FROM THE LAGOON OF PAPEETE (TAHITI, FRENCH POLYNESIA) : INFLUENCE OF MIXING PHENOMENA.

P.A. Harris
Centre ORSTOM de Tahiti, BP 529 Papeete, Tahiti, French Polynesia.

Fichez R., Fernandez J.-M.
Centre ORSTOM de Noumea, BP A5 Noumea Cedex New-Caledonia.

Badie C.
L.E.S.E., BP 519 Papeete, Tahiti, French Polynesia.

Sediment deposition rate during the past century was assessed by measuring the activity of excess ^{210}Pb in four sediment cores sampled in the Papeete lagoon (Tahiti, French Polynesia). The growth of Papeete and Papeete harbour has been boosted during the early sixties when the French Government decided to develop nuclear testing facilities in the atolls of Mururoa and Fangataufa. Since this period, there have been extensive human induced changes that where of great significance for the whole lagoon ecosystem. Artificial modifications of the harbour and the coastline strongly modified water exchanges between the open ocean and the small lagoon, the main feature being a 2 km long sea wall built on the barrier reef between 1964 and 1966 which is now blocking inputs of ocean water over the reef. This paper focus on one core, sampled in the harbour area.

In this particular site, geochronology results showed a dramatic increase in sedimentation rate (fig. 1), beginning in 1967 ± 4 y [1]. Before this date, the accumulation rate was 0.33 $g.cm^{-2}.an^{-1}$. After 1967, mean accumulation rate increased to 1,33 $g.cm^{-2}.an^{-1}$. From the ^{210}Pb profile it is possible to infer that the bioturbation layer, which corresponds to the surface layer with homogeneous ^{210}Pb activities, is limited to the top 8 cm depth.

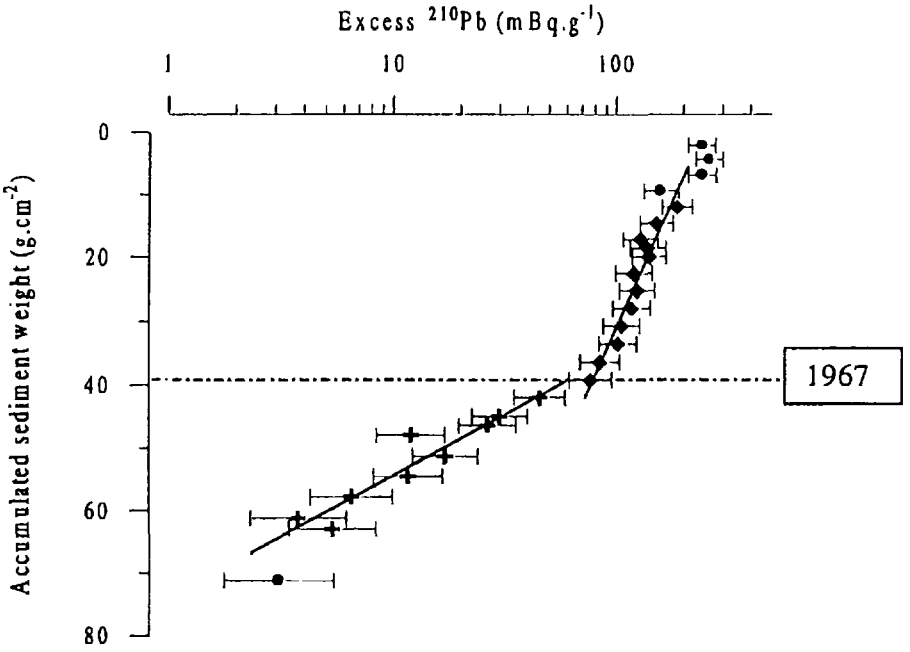

Fig. 1 : Excess ^{210}Pb activity ($mBg.g^{-1}$) versus accumulated sediment weight ($g.cm^{-2}$) in the Papeete Harbour. Note the top 8 cm bioturbated layer and the two linear fits corresponding to a breakdown in accumulation rate with an intersection dated back to 1967 ± 4 y.

Heavy metals analysis was conducted on 10 elements in order to reconstruct historical trends during the past century. Fe, Mn, Al, Ni and Cr could be considered as related to terrestrial inputs, whereas Pb, Cu, Zn and Cd gave evidence of anthropogenic contamination. Complementary, concentration in Ca was used in order to assess marine sediment inputs.

The 10 metals profiles showed a significant increase in concentrations (decrease for Ca) between 1940 and 1970, after 1970 concentrations stayed constant until present day. We considered

the increase in concentrations in the sediment layers corresponding to the transition zone to be strongly related to mixing processes due to bioturbation.

In this paper, we present a simple experimental mixing model explaining the effect of bioturbation in sediments subjected to a strong modification of the sedimenting conditions. Mathematical expression for solid sediment mixing caused by bioturbation is based on 1-D integral conservation balances [2]. Considering the bioturbated layer thickness to be unaffected by the sedimentation rate (i.e. constant over the whole core length), the mixing process can be expressed according to the following equation :

$$C_{i+1} = (F_{i+Bo}\, C_{i+Bo} + F_i\, C_i - C_i\, B_o) / B_o$$

where C_i, C_{i+1} and C_{i+Bo} are the concentrations at depht i, i+1 and i+B_o ; F_i and F_{i+Bo} are the flux of accumulated sediments at depht i and i+Bo ; and B_o is the thickness of sediment affected by bioturbation.

Calculation were made using a non-linear regression programme. The best fit was obtained with a Bo value about 8 cm as showed for either Ni (terrestrial inputs) or Zn (anthropogenic inputs) profiles (fig. 2).

In conclusion, results from the model are consistent with our first estimation of Bo by direct reading of ^{210}Pb activity profile. Furthermore, the model tend to support the validity of our hypothesis according to which the bioturbation layer is unaffected by the sedimentation rate.

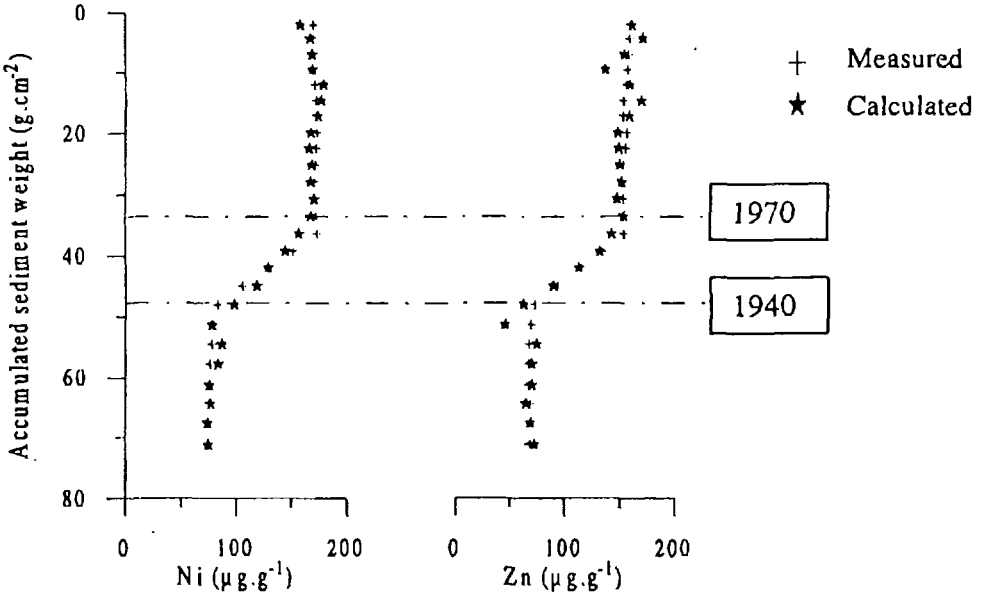

Fig. 2 : measured and calculated concentrations of Ni and Zn ($\mu g.g^{-1}$) versus accumulated sediment weight.

REFERENCES

[1] Harris P. A. (1998). Modification des caractéristiques chimiques du lagon de Papeete liées à l'activité humaine : intérêt des traceurs sédimentaires géochimiques et biogéochimiques dans la reconstitution de l'évolution de l'environnement au cours du XX^{e} siècle. Ph. D. thesis, Université Française du Pacifique, *in press.*

[2] Boudreau B. P. (1997). Diagenetic models and their implementation. Springer – Verlag Berlin Heidelberg, 414 pp.