Water movements in a lagoon and a harbour as constrained by lead isotopes in mussels

M. Labonne — GEOTOP-UQAM, case postale 8888, succ. Centre-Ville, Montreal, Canada, H3C 3P8

D. Ben Othman
J. M. Luck — Laboratoire GBE, case 57, Universite Montpellier 2, pl. Bataillon, 34095 Montpellier, France

Mussels, through their ability to concentrate metals from seawater (10^3 to 10^4) are generally used as bioindicators in many programmes of coastal survey (NOAA, French Mussel Watch). They have many advantages: they are widely distributed, easy to analyse and allowing weekly-integrated records.

The previous studies generally used concentration variations in the mussels soft parts to determine anthropogenic impact, but concentrations alone do not allow us to constrain the metal origin(s). We use lead isotopes as tracers of human activities both on fleshes and shells (Labonne *et al.*). The comparison of the data with the various sources of lead already identified and geochemically characterized in the catchment allow us not only to determine the origins and proportions of natural and anthropogenic leads, but also trace water movements.

The Thau lagoon is located in the South of France near Montpellier. This lagoon was chosen because of the various sources of both natural and anthropogenic inputs. The surrounding rocks are principally Jurassic limestones and Miocene marls (Petelet *et al.*). Along the lagoon coast we find the Sète harbour which presents a high density of industries: fertilisers and cement factories, boat workshops. An important highway crosses the watershed and several outputs of water treatment plants reach the lagoon (Monna *et al.*).

Young mussels (*Mytilus galloprovincialis*) from the sea were introduced at several locations of the Thau lagoon: in the Sete harbour, in the lagoon centre, at the exutory of the main river feeding the lagoon and near a local city. Sampling was done in January 96, May 96 and July 96.

The water movements inside the Harbour were also studied by the sampling of wild mussels directly in the channels (July 1996). Four locations were chosen: one close to a boat workshop in the main channel and three on a smaller channel near industrial piers.

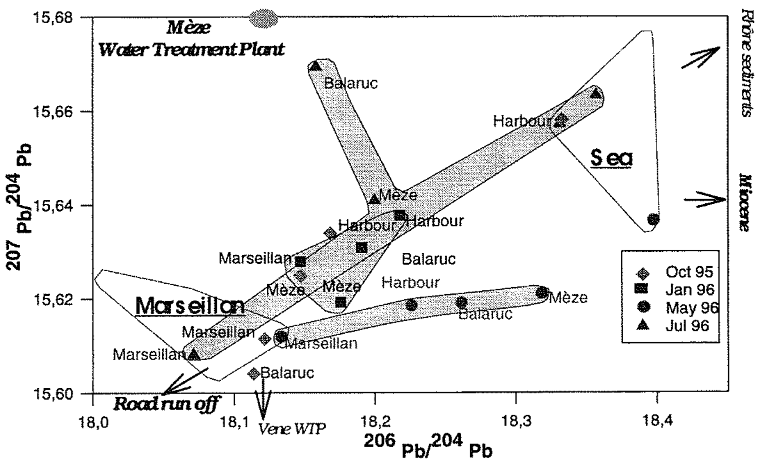

FIG. 1. Diffusion of C and O in calcite.

In a $^{207}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ diagram, the isotopic compositions of the harbour samples plot in the same domain with values intermediate between an anthropogenic endmember which encompasses the road (highway runoff, (Ben Othman *et al.*)) and the water treatment plants, and a natural one corresponding to the rocks. The isotopic compositions of the Harbour mussels define a third, relatively stable endmember representing the Harbour and its associated activities.

The seasonal isotopic variations in the lagoon samples are all plotted in the same diagram. The lead isotopic compositions in fleshes plot between two main endmembers: an anthropogenic one with low values and a natural one, much more radiogenic. Alignments in this diagram may be understood as mixtures in various proportions of the two main sources of Pb, which can then be extrapolated in terms of water mixings.

Three kinds of situations are observed depending on season and wind. Nice alignments of the points are observed for May 96 and July 96 samples. This corresponds to a progressive mixing of Pb sources from one end of the lagoon to the other. On the other hand, January samples plot all clustered in the centre of the diagram. This clustering corresponds to a good homogenization of the lagoon waters and of their loads due to many storms at this period.

Pb isotopic compositions also show that some locations can be under the influence of specific geochemical signatures and trace water movements such as seawater entries which strongly depend here on the wind direction.

References

Goldberg, Koide, Hodge, Flegal, and Martin (1983) *Estuarine Coast. Shelf. Sci.*, **16**, 69–93.

Claisse and Simon (1991)*EGSA 19th Symposium*, 341–7.

Labonne, Ben Othman and Luck (1998) *Appl. Geochem.* (in press)

Petelet, Ben Othman, and Luck (1997) *C.R. Acad. Sci. Paris*, **324**, 753–61.

Monna, Ben Othman and Luck(1995) *Sci. Total Environ.*, **166**, 19–34.

Ben Othman, Luck and Tournoud (1997) *Chem. Geol.*, **140**, 9–28.