Major, trace elements and Sr-Pb isotopes in rains: constraints on origin

D. Ben Othman
J. M. Luck
Laboratoire GBE, case 057, Université Montpellier II, pl. E.Bataillon, 34095 Montpellier, France

Rain is known to bring in (a catchment) some elements in large quantities: when it is located close to the sea, it is strongly influenced by marine aerosols, and it also very often carries metals in significant quantities, even in areas remote from cities or industries. It is therefore important to assess the geochemical and isotopic characteristics of rains in order to quantify fluxes and erosion processes in catchments, not to mention the informations we can derive on the internal processes during rain generation and the origin(s) of incoming material.

Analytical

Major, trace elements and Sr-Pb isotopes have been measured on various rains collected in the South of France (Languedoc-Roussillon), from both continental and marine origins. The area is predominantly covered with vineyards and the few industries are clustered around the large marine Harbour at Sète. Several rains were collected in 1996-97 through a Φ60 cm plastic funnel covered with teflon and were stored without air in acid-cleaned PE/PP bottles. Samples were filtered within a few hours under class 100 air in a clean lab, on acid-cleaned PVDF filters (0.2 μm) and both loads were analysed.

Results and discussion

Regarding some trace elements (U, Ni), our rains show levels similar to remote countries (e.g. Congo (Freydier *et al.*, 1997)). Some other metals typically associated to human activities (Cu, Zn, Cd, Pb) show strong enrichments.

Several metals are correlated with eachother (e.g. Pb-Cd; Ni-Cu). The [Pb]/[Cu] ratios are within the

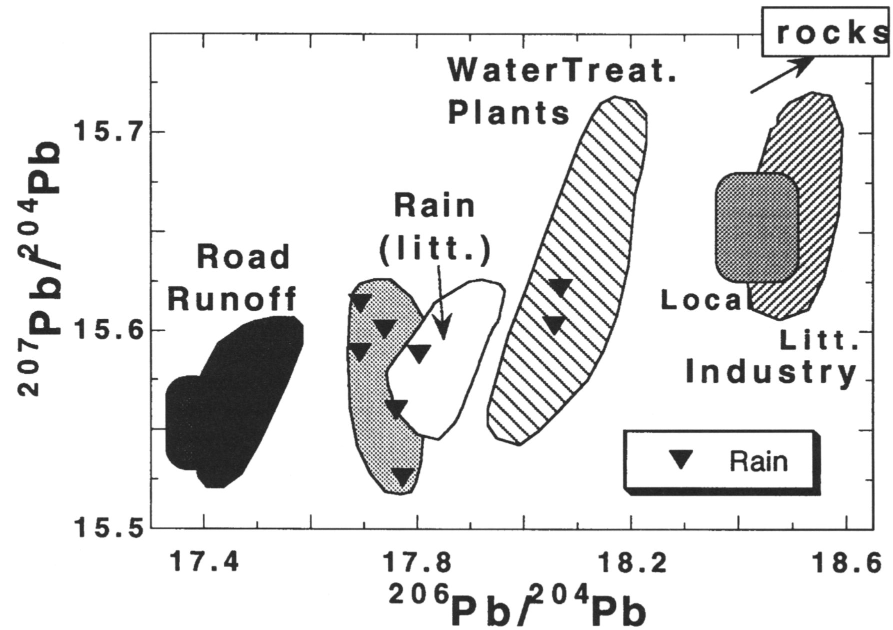

FIG. 1. (modified after Luck and Ben Othman, *Chem. Geol.*, accepted).

range determined for other rains in the Western Mediterranean (Chester *et al.*, 1997)).

As expected, all marine rains show the influence of seaspray aerosols in their high [Na], [Mg], [Cl] contents, but the low values of $^{87}Sr/^{86}Sr$ (0.7083–0.7089) combined with high [Ca] contents show also the incorporation of locally derived carbonate aerosols. Continental rains show more radiogenic values for Sr (0.7098), although not as high by far as in the Massif Central (Négrel and Roy, 1998) , strongly influenced by granitic terrain aerosols.

Lead isotopes for continental rain also show the influence of radiogenic Pb derived from rocks. Meanwhile marine rains show less radiogenic values: they define a domain strongly tilted in the $^{206}Pb/^{204}Pb$-$^{207}Pb/^{204}Pb$ diagram with $^{206}Pb/^{204}Pb$ around 17.7–17.8. This domain is parallel to, but lower than industrial data from the litterature (Petit *et al.*, 1984) (Fig. 1). Such a feature has also been observed for other rain samples over Paris (Roy, 1996) , even inside a single event: this can probably be related to the presence in the rain of at least two distinct sources of Pb with different isotopic signatures, presumably present in different types of aerosols being scavenged at different rates. Surprisingly, the values in our area are slightly less radiogenic than in the center of Paris: this difference is probably due to the larger influence of more radiogenic industries in Paris than to an excess of gasoline-derived Pb in Montpellier. Finally it seems remarkable that the slope of all these samples is also parallel to that of Water Treatment Plants in the area suggesting similar fractionations and maybe similar (industrial?) sources although not in the same proportions.

References

Chester, R., Nimmo, M. and Corcoran, P.A. (1997) *Mar. Chem.*, **58**, 293–312.

Freydier, R., Dupré, B. and Lacaux, J.P. (1997) *Atmosph. Environ. (in press).*

Négrel, P. and Roy, S. (1998) *Applied Geochem. (submitted).*

Petit, D., Menessier, J.P. and Lamberts, L. (1984) *Atmos. Env.*, **18**, 1189–93.

Roy, S. (1996) Thesis, Univ. Paris 7.