

## LEAD CHEMICAL AND ISOTOPE CHARACTERISATION IN THE UPPER LOIRE RIVER BASIN, FRANCE

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**Keywords:** Geochemical background; Lead isotopes; water-rock interaction; trace metals; water framework directive

### Introduction

The Water Framework Directive (WFD) elaborated by the European Commission regulates water resources in the EC based on five years management plans. A new management plan, started in 2016, imposes strict water quality criteria to its member states, including good status thresholds for metallic contaminants. The Loire River, the most important river in France, possesses areas with lithologies naturally containing high metal concentrations in the upper part of its basin. Understanding these metal fluxes of into the river is thus a prerequisite to understand their potential impact on the quality of its water in regards to the criteria defined by the WFD.

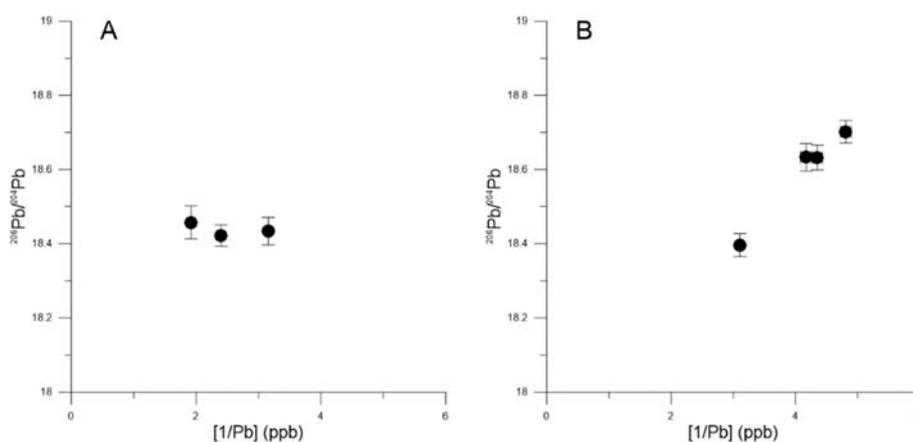
The Massif Central is a residue of the Hercynian chain composed of granitic and volcanic rocks. Both its upstream position in the Loire basin and its numerous metal mineralizations made this region a good candidate for characterizing the natural lead (Pb) geochemical background of its surface waters. To fulfill this objective we focused on the Pb chemical and isotope characteristics of non-anthropized small watersheds.

### Methods

The investigated small watersheds were selected for supposedly draining a single lithology and undergoing (as far as possible) negligible to no anthropogenic pressure. Pb isotope should allow to discriminate sources of natural Pb based on their lithologies and to evaluate their relative contributions in the upper part of the Loire River basin. 100 filtered (0.45 µm) and non-filtered water samples were collected during high water stage in 2015. Metal concentrations were measured by iCapQ ICP-MS. Pb isotope ratios were measured by standard bracketing on a HR-ICP-MC Nu Attom with no prior chemical separation to minimise any blank contribution (Newman and Georg, 2012).

## Results

For all samples measured Pb concentrations were very low: under 0.8 ppb in the dissolved fraction and under 6 ppb in non-filtered samples, which complies with the 10 ppb guideline defined by the WFD. Unexpectedly metal concentrations, in general, do not show any significant enrichment with the flow line and among the different watersheds. As expected, Pb isotope ratios are consistent between the filtered and non-filtered samples, indicating a single origin between the dissolved and colloidal loads. A detailed study of the Pb isotope ratios shows that they are confirming that some selected watersheds are actually draining a single lithology but that for some of them more than one lithology contributes to the overall Pb isotope signature (Figure 1). Results also confirm that the different lithologies can be discriminated by their Pb isotope ratios.



**Figure 1.** Mixing diagram  $^{206}\text{Pb}/^{204}\text{Pb}$  vs.  $1/\text{Pb}$  for filtered samples of a/ a volcanic watershed b/ a granitic watershed.

## Conclusion

Results of this study show that although the upper part of the Loire River basin has a high metal potential that has been highly exploited by humans, which could have altered the quality of its surface waters, Pb concentrations are still under the guidelines defined by the WFD. Natural Pb does not contribute significantly to the overall Pb budget, neither in the bulk fraction nor in the dissolved fraction. Pb isotopes indicate that even if the selected small watersheds are usually draining a single lithology, some of them drain different lithologies that each contributes to the Pb budget. Still differentiating them with the Pb isotope approach is feasible.

## References

Newman, K.; Georg, R.B. (2012). The measurement of Pb isotope ratios in sub-ng quantities by fast scanning single collector sector field-ICP-MS. *Chemical Geology*, 304-305, 151-157.