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## Origin and historical inputs of suspended particulate matter (SPM) from the Rhône tributaries: use of the non-reactive geochemical signature of particles

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### ► To cite this version:

C. Begorre, Aymeric Dabrin, M. Masson, G. Grisot, L. Dherret, et al.. Origin and historical inputs of suspended particulate matter (SPM) from the Rhône tributaries: use of the non-reactive geochemical signature of particles. EGU 2018, Apr 2018, Vienna, Austria. pp.1, 2018. hal-02607692

**HAL Id: hal-02607692**

**<https://hal.inrae.fr/hal-02607692v1>**

Submitted on 16 May 2020

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## Context

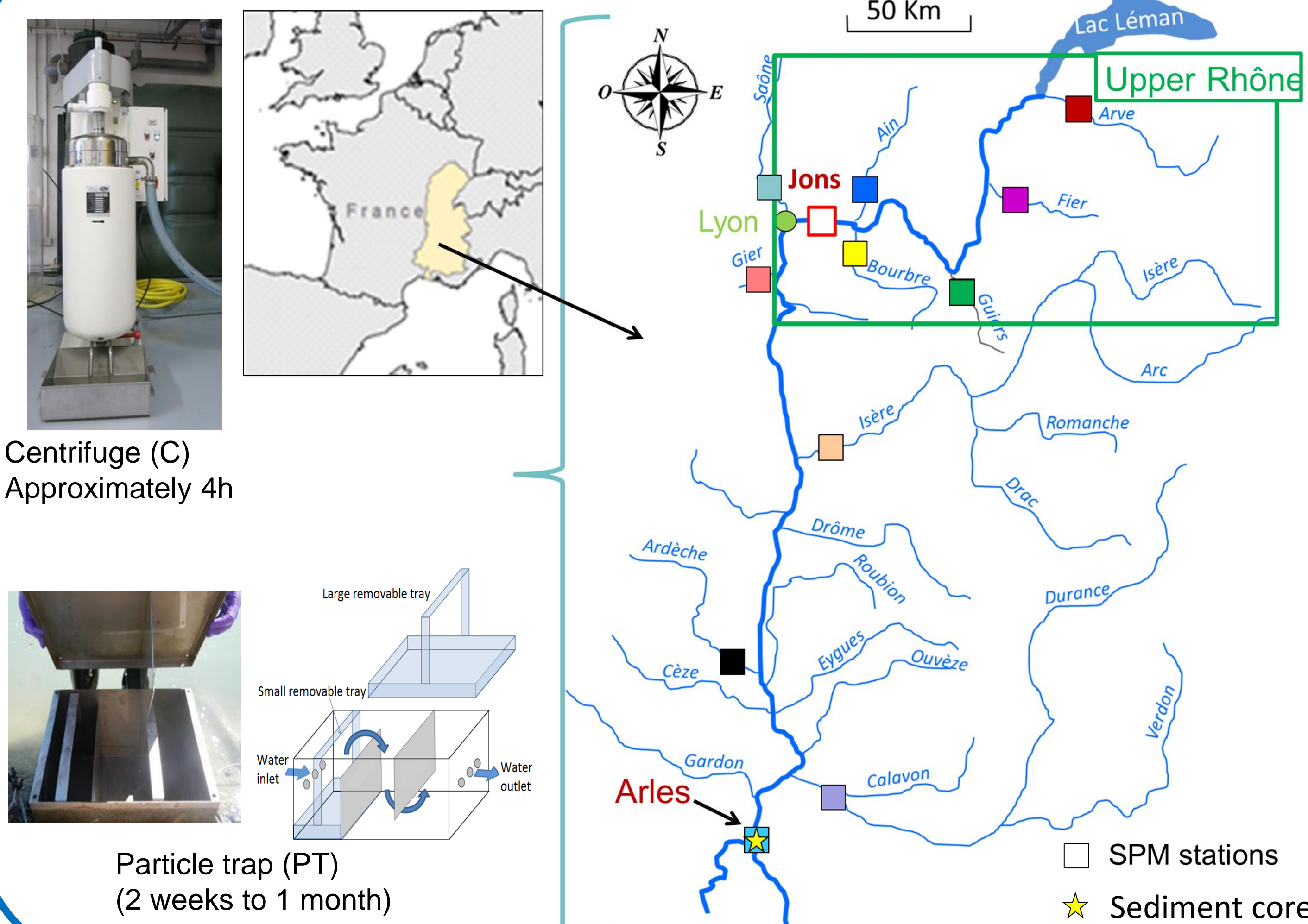
- The determination of sediment origin is essential to manage suspended particulate matter inputs in river systems.
- SPM contribute to the transport of a large amount of contaminants in rivers.
- The Rhône River is the main sediment input to the Mediterranean Sea. The Rhône sediment observatory (OSR) program aims to develop a fingerprinting approach in Rhône River watershed with a large number of SPM samples over 7 years (n = 300).

## Objectives

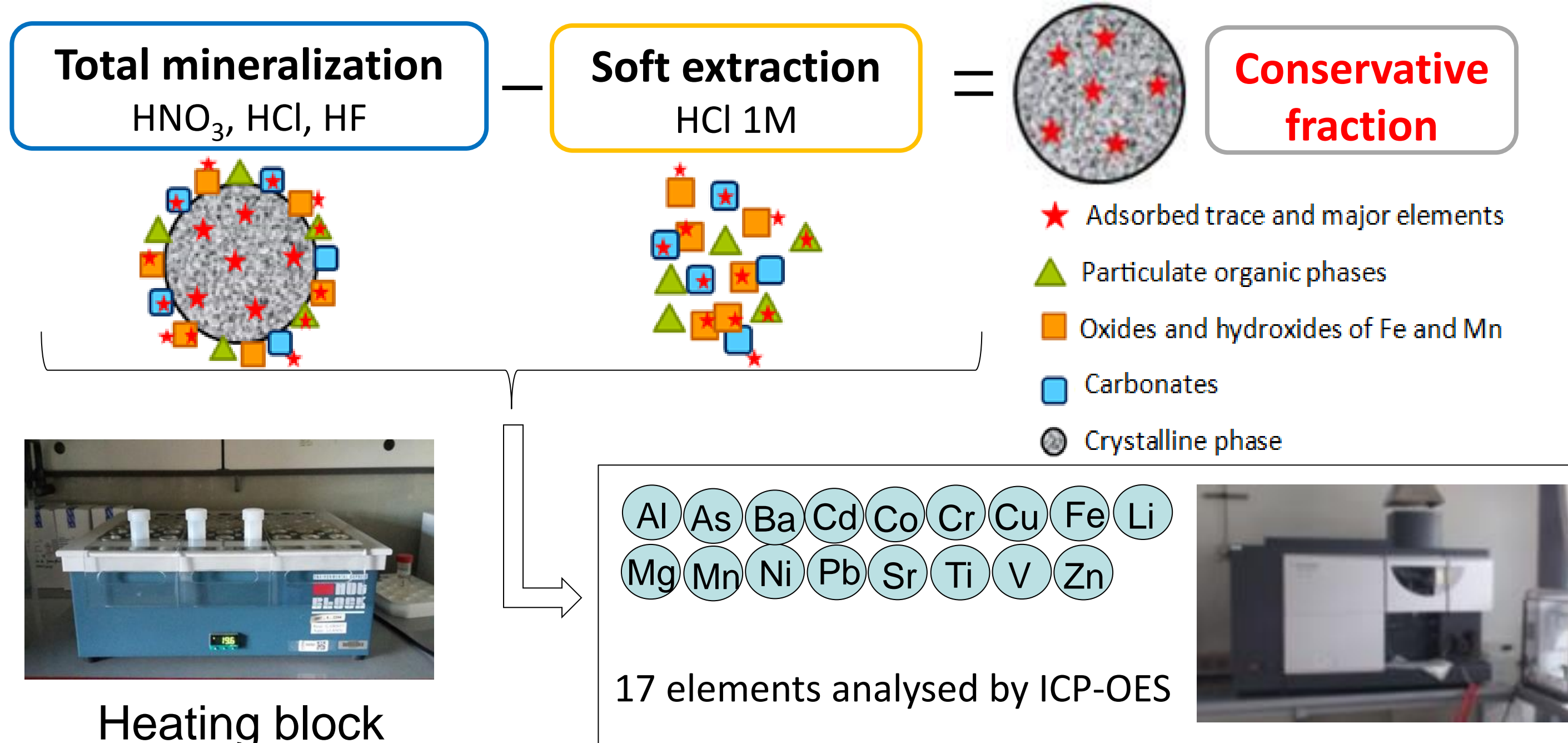
- Determine the origin of SPM from the Rhône River tributaries :
  - Estimate relative contributions of SPM fluxes using conservative tracers (major and trace elements in the residual fraction, particle size correction)
  - Estimate uncertainties associated with these contributions
- Determine the historical SPM inputs of the tributaries by applying the fingerprinting approach on a sediment core.

## Material and methods

### SPM sampling strategy



### Sample treatment and analysis

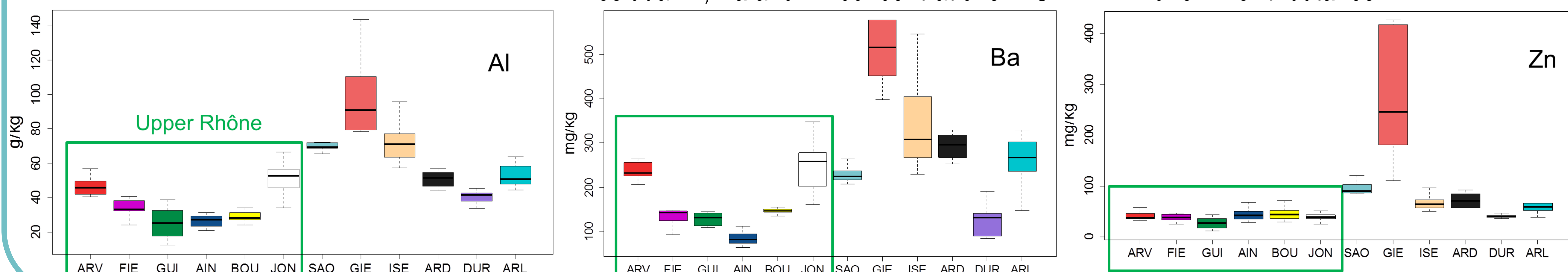


### Data treatment and geochemical mixing model :

- Kruskal-Wallis test + Discriminant Function Analysis → tracer selection
- Mixing model + Monte Carlo analysis (1000 repetitions) → relative source contribution estimates + uncertainties
- Data treatment : standardisation, particle size correction (Gellis and Noe, 2013)

## Residual metal concentrations in SPM samples

Residual Al, Ba and Zn concentrations in SPM in Rhône River tributaries

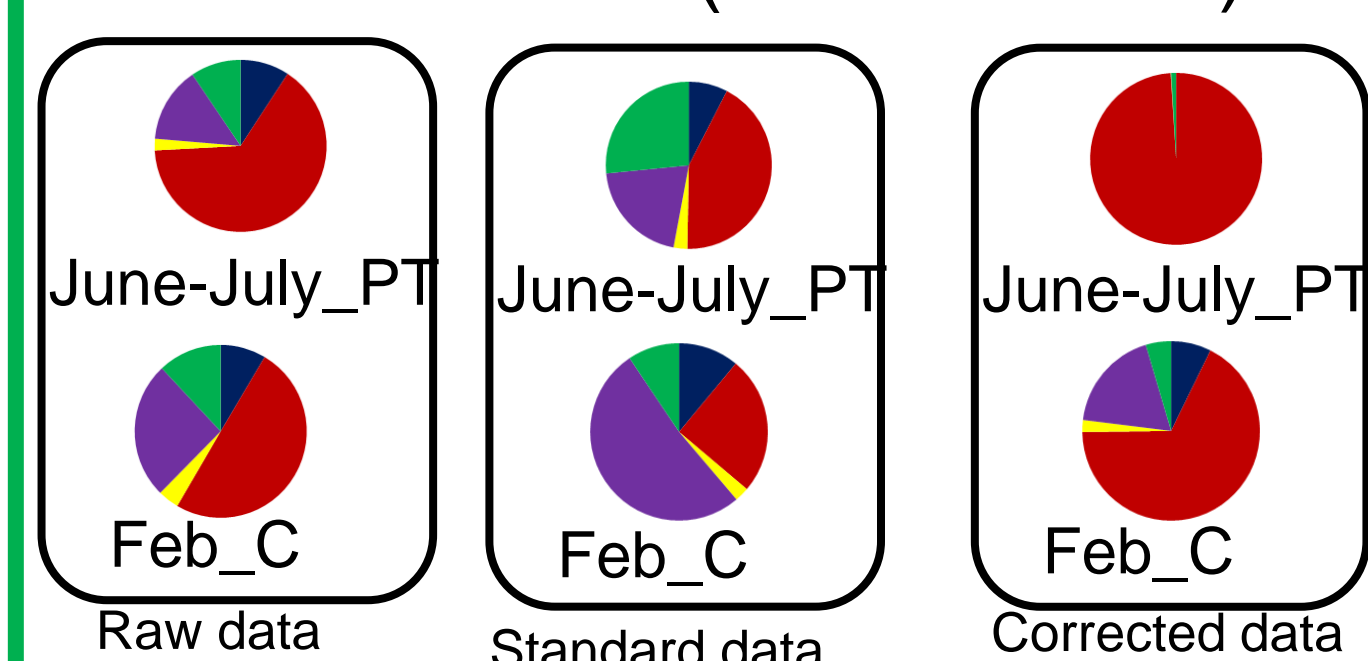


- Al reflect the grain size
- Ba is a discriminating element but not Zn at the Upper Rhône scale → confirmed by Kruskal-Wallis test and DFA

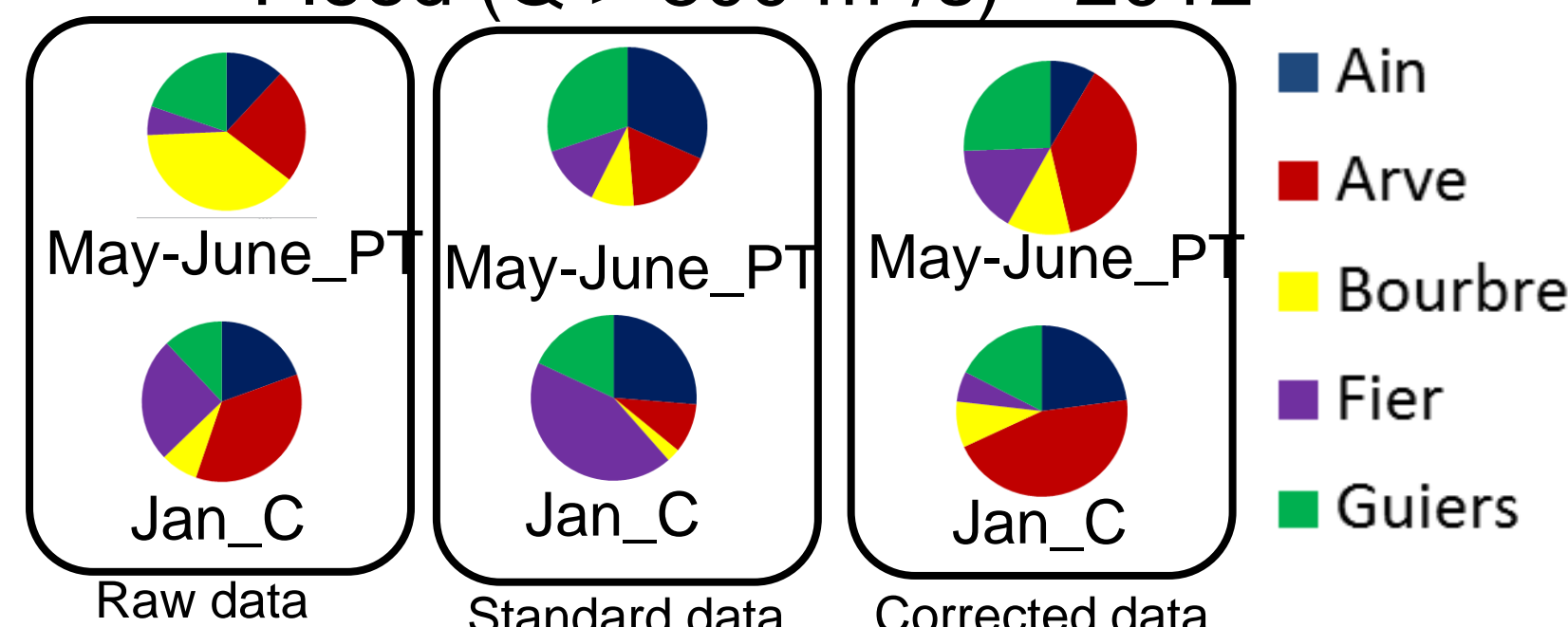
## Source fingerprinting in the Upper Rhône

Geochemical mixing model results from SPM data : relative source contributions in %

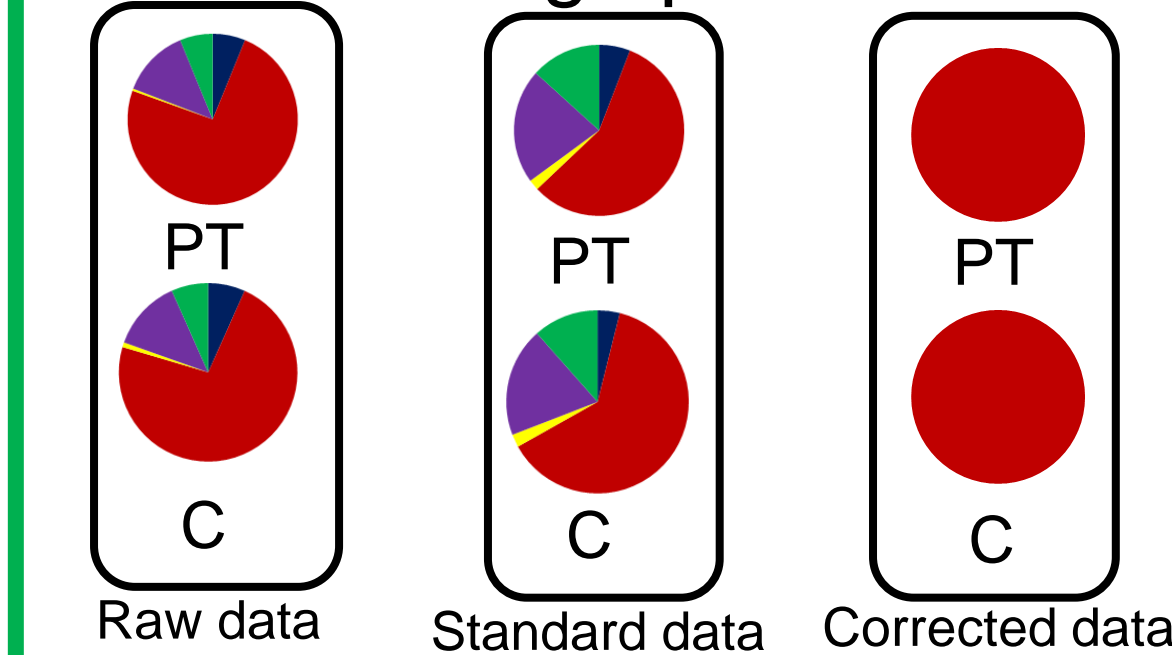
### Low water flow (Q ≤ 800 m<sup>3</sup>/s) - 2012



### Flood (Q > 800 m<sup>3</sup>/s) - 2012



### Dam flushing operations - June 2012



- Discriminant elements : Ba, Mg, Fe, Cu, Cr, Mn, Ni, V, Sr, Li, Ti, Co

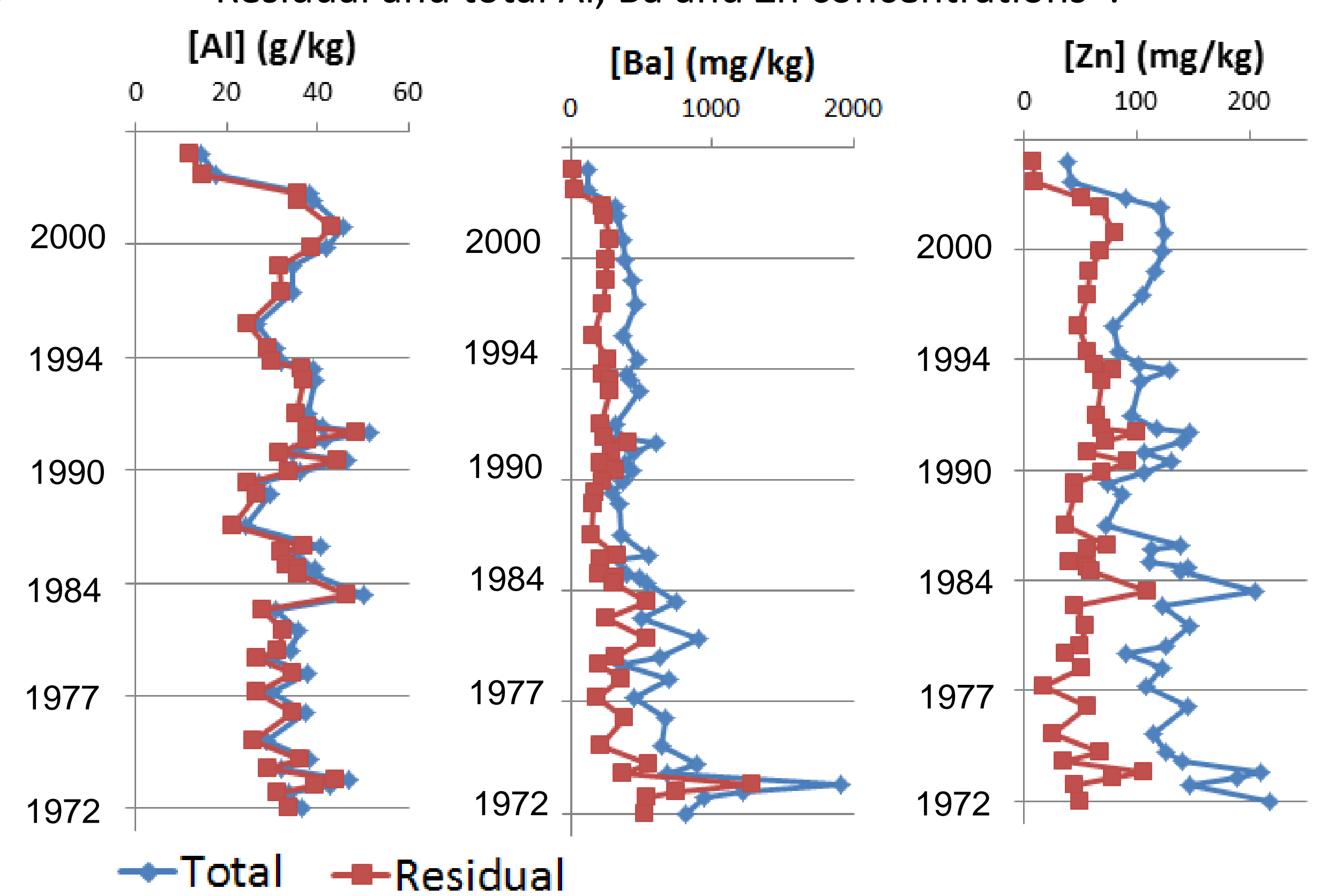
- The Arve and Fier rivers are the main contributors in SPM fluxes at the Jons station

Source contribution (in %, corrected data) with absolute uncertainties at Jons station

	Arve	Fier	Guiers	Ain	Bourbre
Low water flow (n = 13)	95 ± 2	2 ± 2	1 ± 3	1 ± 6	1 ± 4
Flood (n = 6)	60 ± 10	10 ± 11	14 ± 19	9 ± 12	7 ± 16
Dam flushing (n = 8)	95 ± 2	0	3 ± 3	1 ± 2	1 ± 2

## Preliminary results on sediment core

Residual and total Al, Ba and Zn concentrations :



These results will be used to trace the history of sediment sources at the Arles stations.

## Conclusions

- Original approach to trace with the residual fraction of SPM in Upper Rhône
- Discriminant elements were found
- Robust relative contribution results at the sample and Upper Rhône scales

## Perspectives

- Try to reduce uncertainties of relative contributions by applying a particle size correction factor [1]
- Complete the OSR SPM database as a number of samples are missing, on some tributaries, to trace SPM sources at Arles station and in sediment core
- Historical SPM inputs in the Upper Rhône
- Compare SPM and sediment core results

[1] Gellis, AC, et Noe, GB., 2013. Sediment source analysis in the Liganore Creek watershed, Maryland, USA, using the sediment fingerprinting approach : 2008 to 2010. Journal of Soils and Sediments 13, 1735-1753.