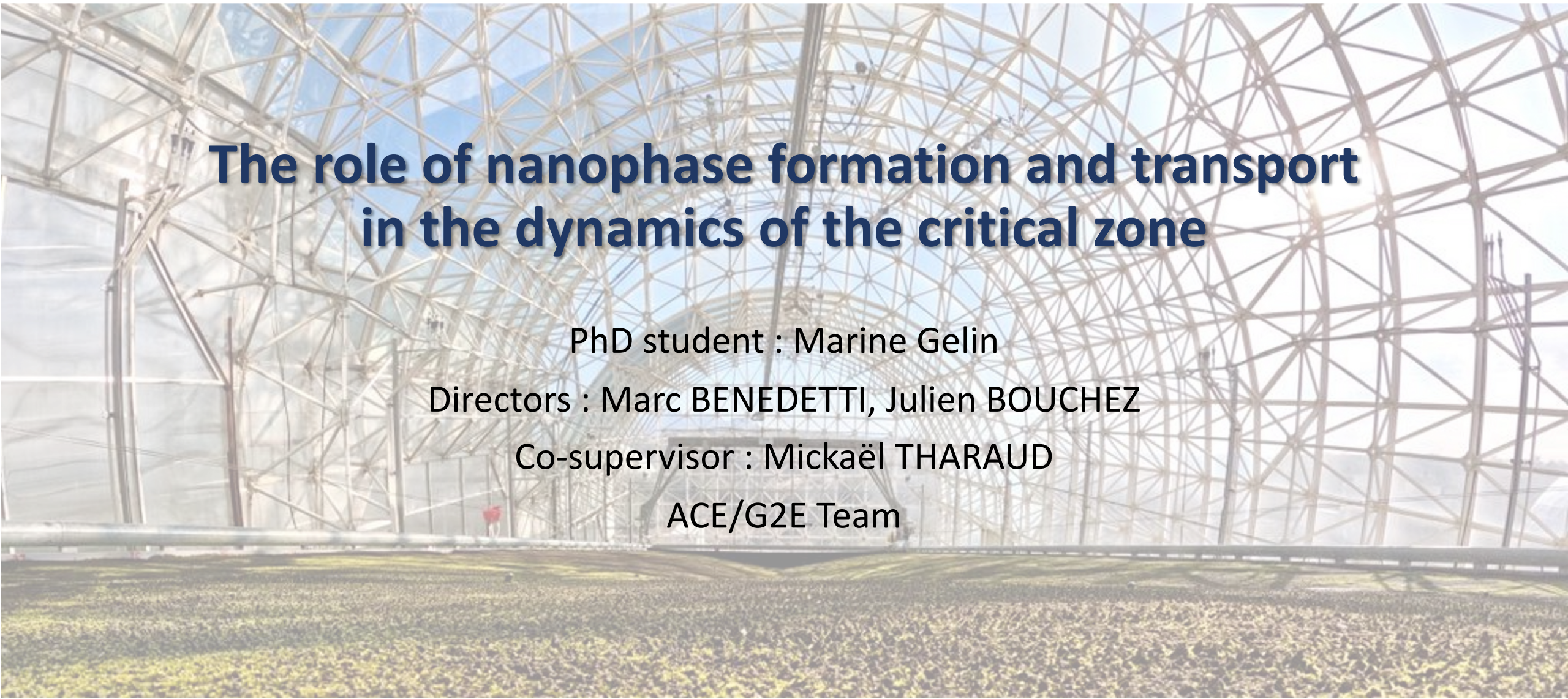


The role of nanophase formation and transport in the dynamics of the critical zone

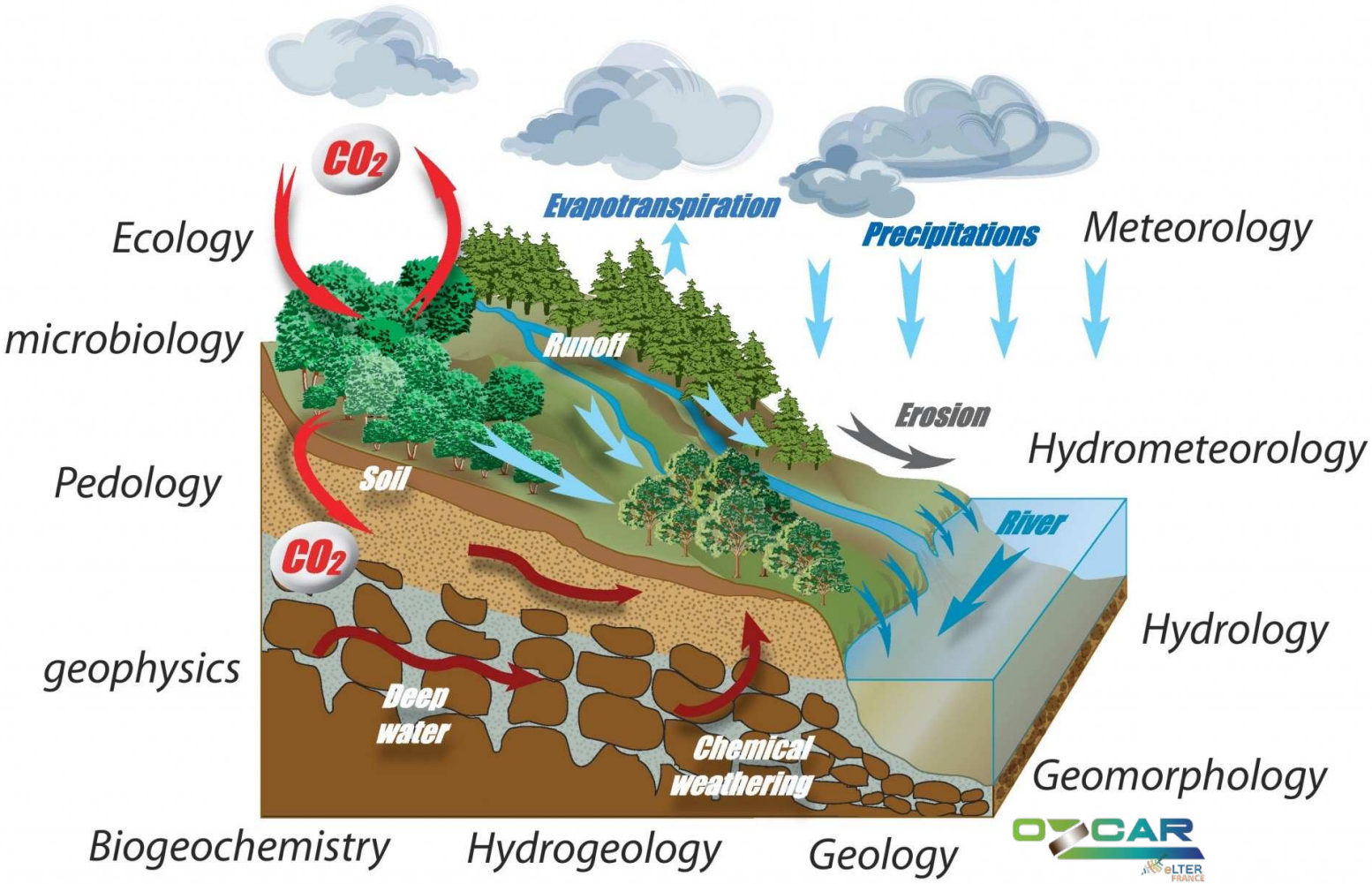
PhD student : Marine Gelin

Directors : Marc BENEDETTI, Julien BOUCHEZ

Co-supervisor : Mickaël THARAUD

ACE/G2E Team

Introduction
1. Critical zone

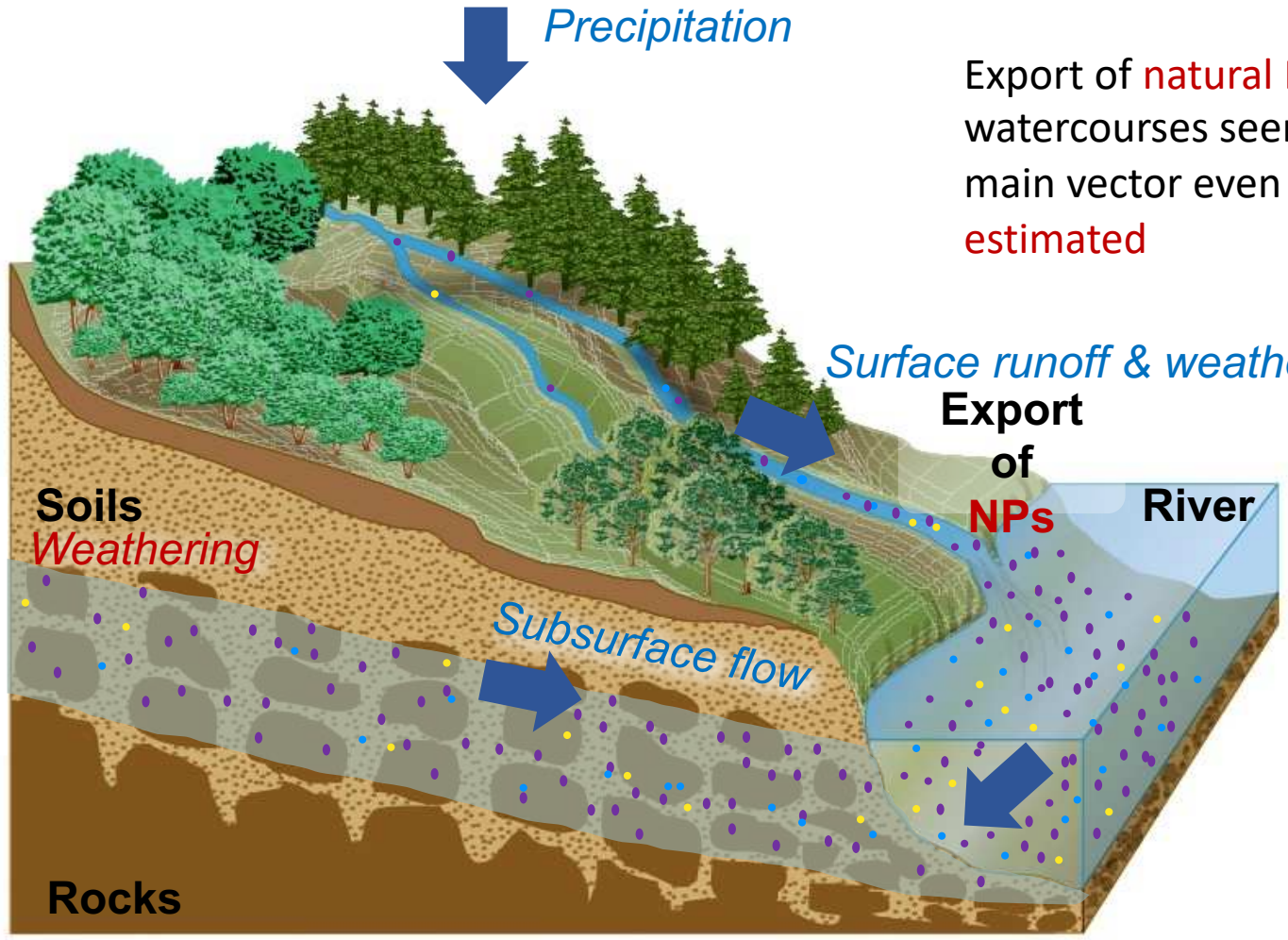


The critical zone, *« between the sky, the vegetation and the rocks ».*

Introduction
2. Export of nanoparticles in the critical zone

Products of weathering :

Clays
Metal oxides (Fe)
Sulfides
Carbonates
Phosophates

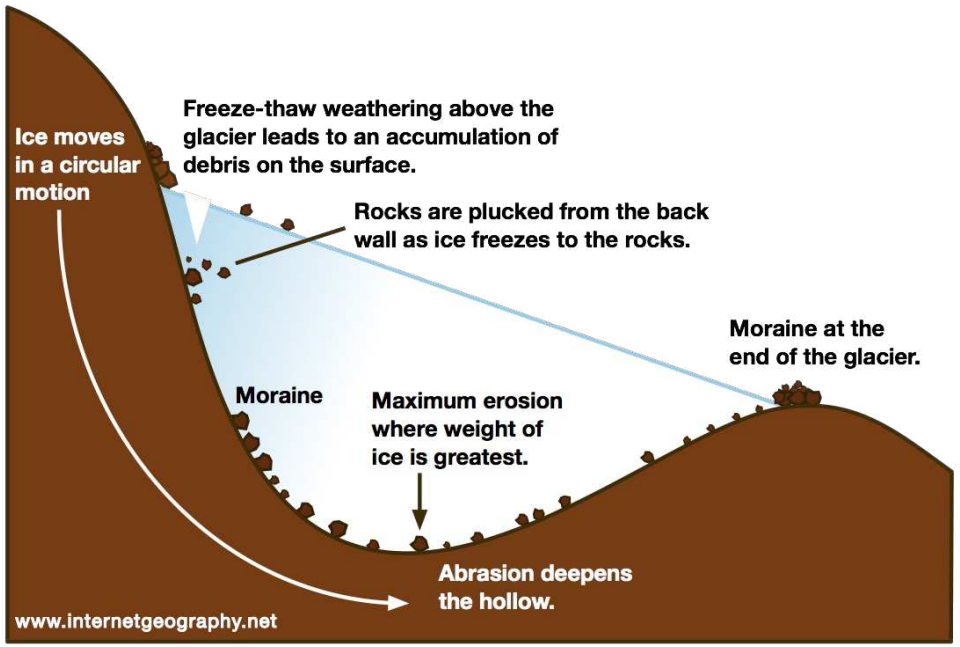


Export of natural NPs by watercourses seems to be the main vector even if it is still poorly estimated

Hypothesis: the export of fine particles is a major agent in the destruction of soils and the export of solutes in the critical zone.

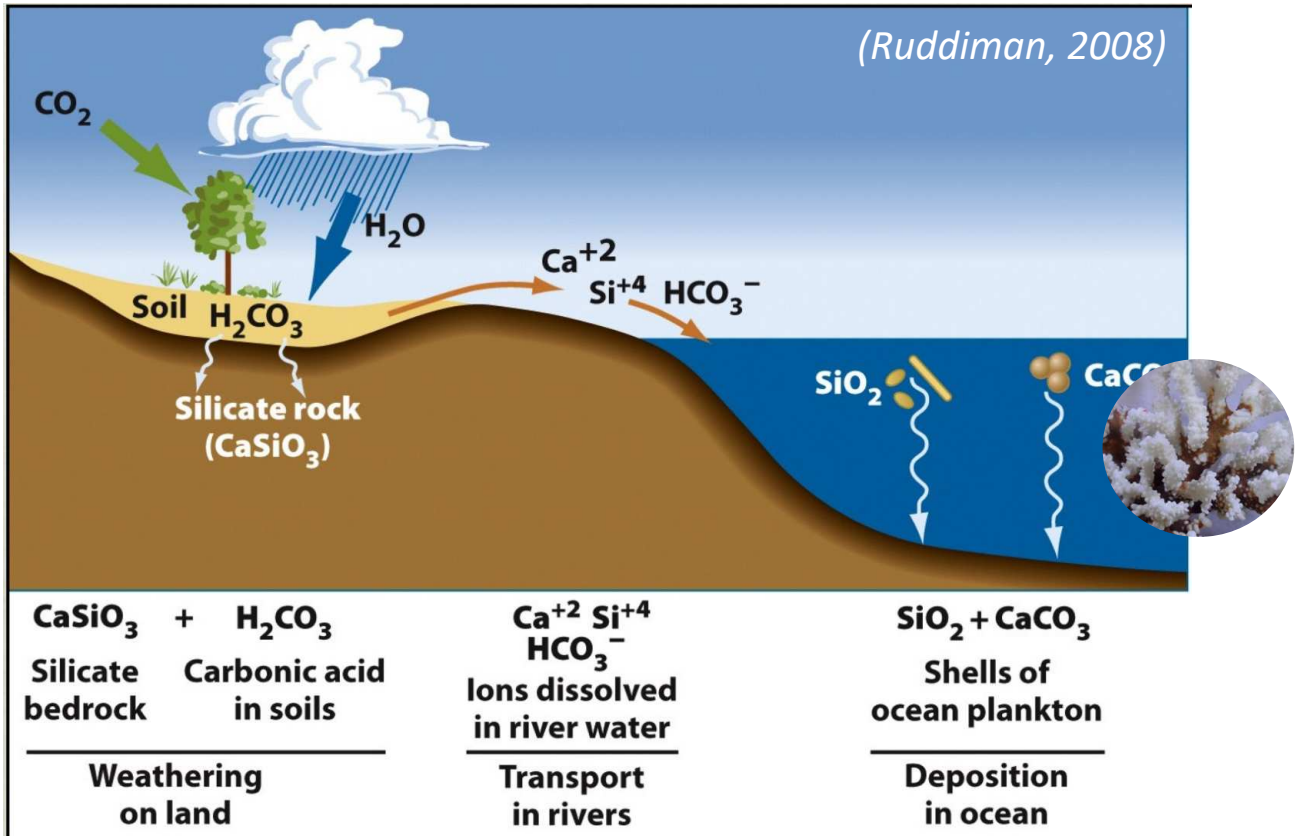
Introduction
3. The role of weathering in the production of natural NPs

Physical weathering



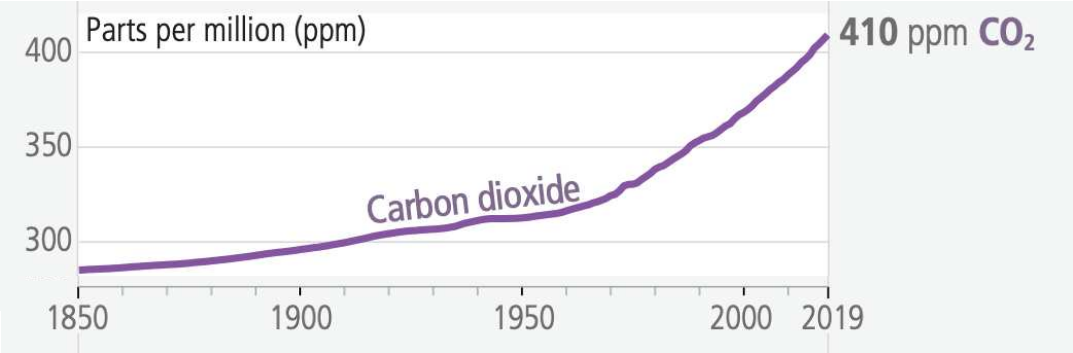
= mechanical breakdown

Chemical weathering



Introduction
4. Climate change enhanced weathering

Accelerated weathering of the rocks and minerals in soils will be promoted by



AR6 Synthesis Report: Climate Change 2023

+

heavy precipitation

+

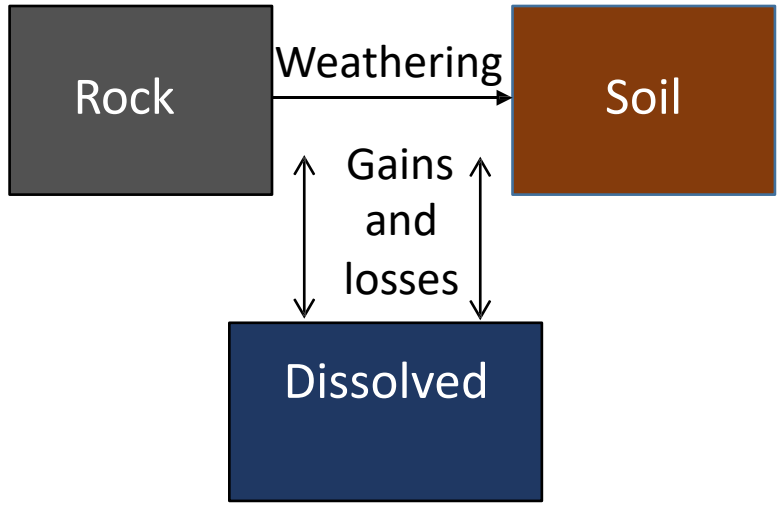
ecological drought

→

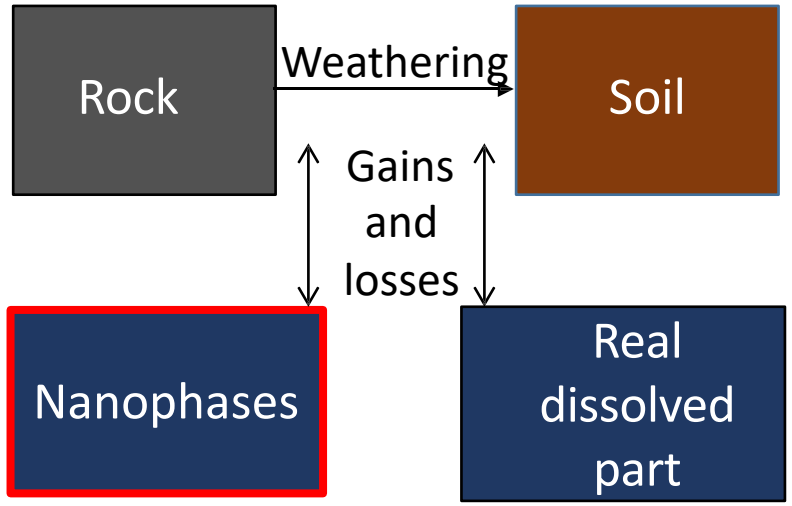
compound flooding

Introduction
5. Objectives

CURRENT



OBJECTIVE



Modified from Bern et al., 2018

1. To determine the composition of NPs produced during weathering

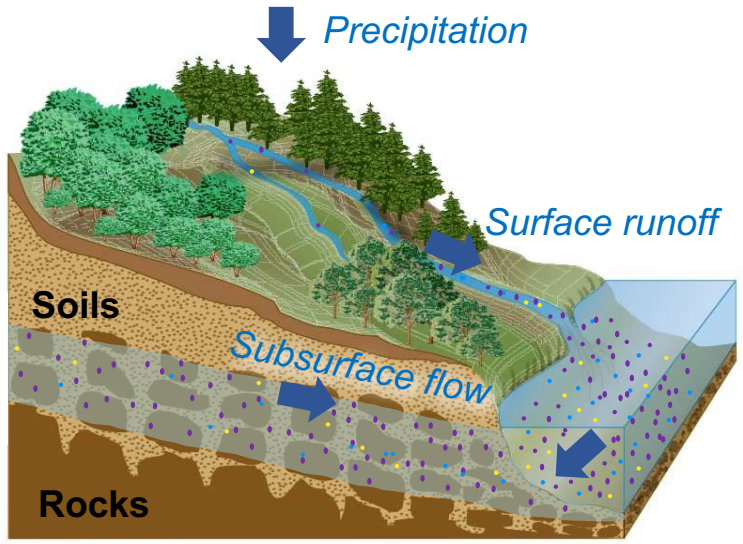
Clay minerals, ultrafine grains of silicates and iron oxides

2. Quantify the fluxes of these NPs transported in rivers and their proportions

Mainly clay minerals

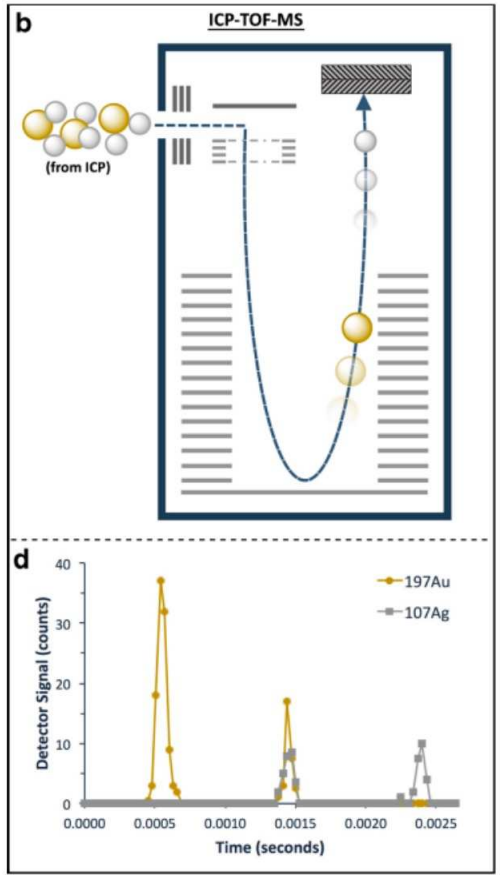
3. Improve understanding of biogeochemical processes related to major elements

Introduction
6. Strategy for achieving objectives



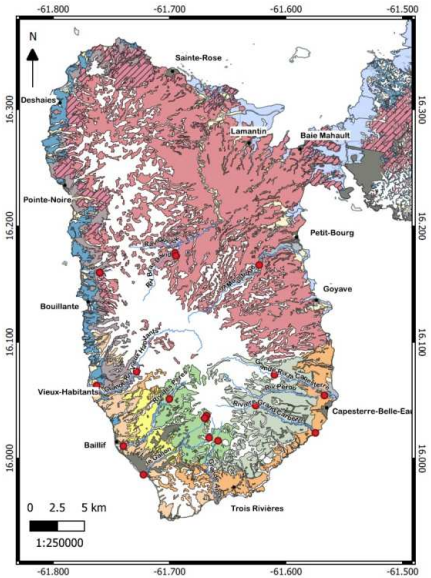
LEO mesocosm

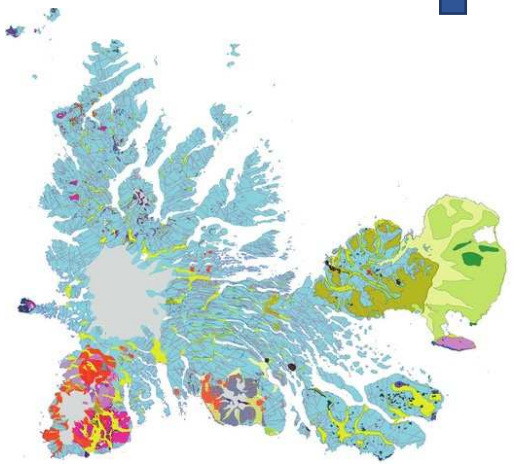
Water sample



spICP-TOF-MS

Natural site

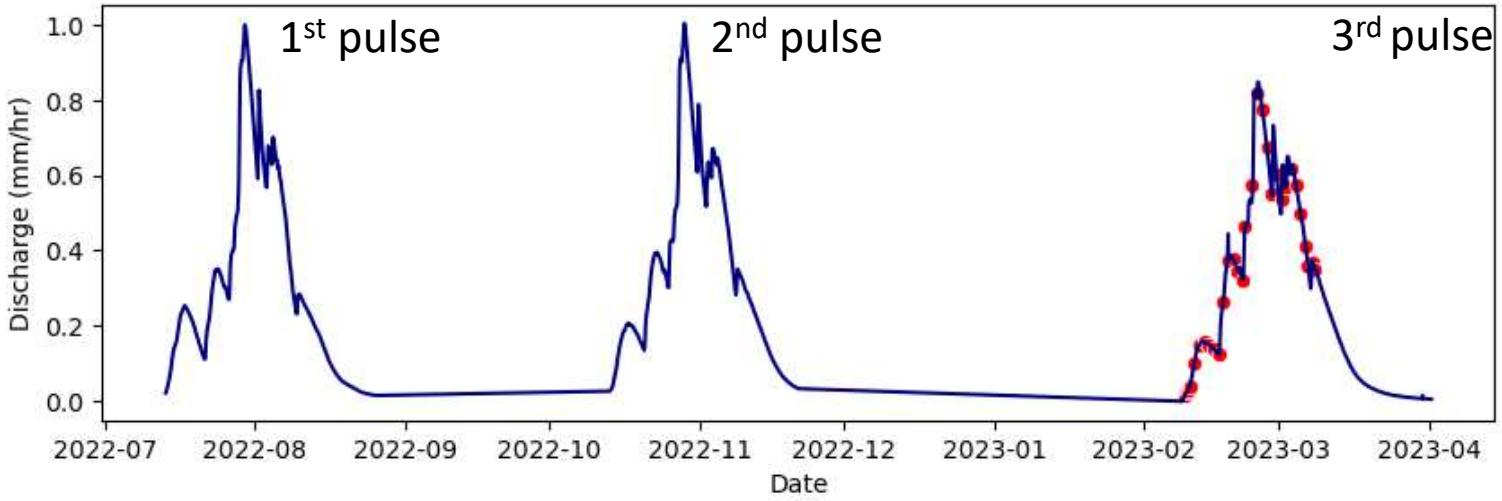




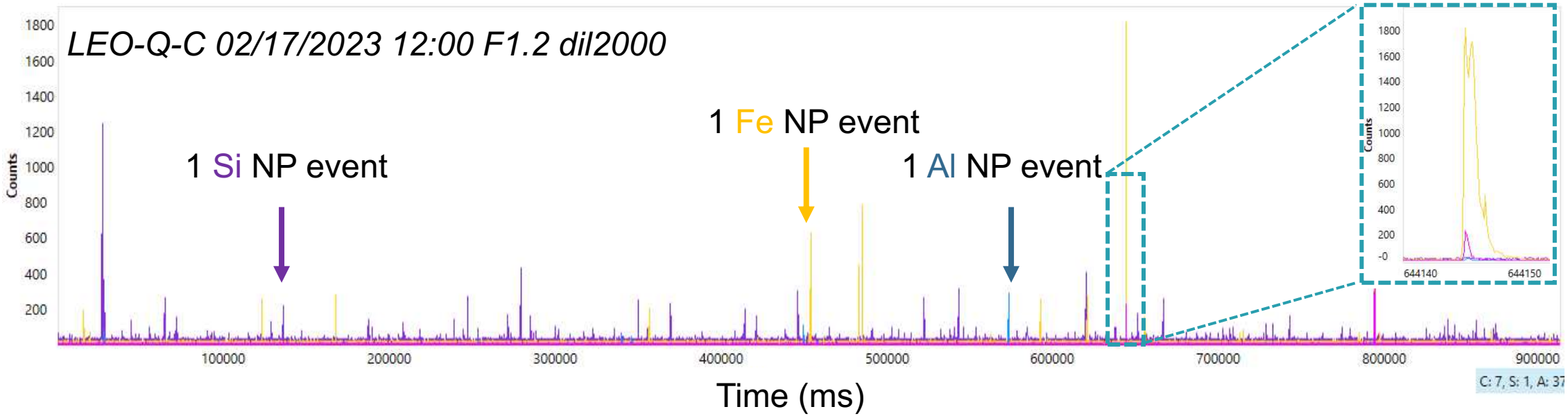
→ to quantify the role of nanophase formation in the dynamics of the critical zone.

Method
1.Field and sampling : Landscape Evolution Observatory

- Three 10° replicate artificial hillslopes 30m in length and covered with 1m of crushed basalt
  - 3 precipitation events with a period of ≈ 1 month each separated with a dry period
- Collection of effluent solutions at high frequency, and under a variable hydrological regime
- Collection of basaltic soil before/after 6months of irrigation



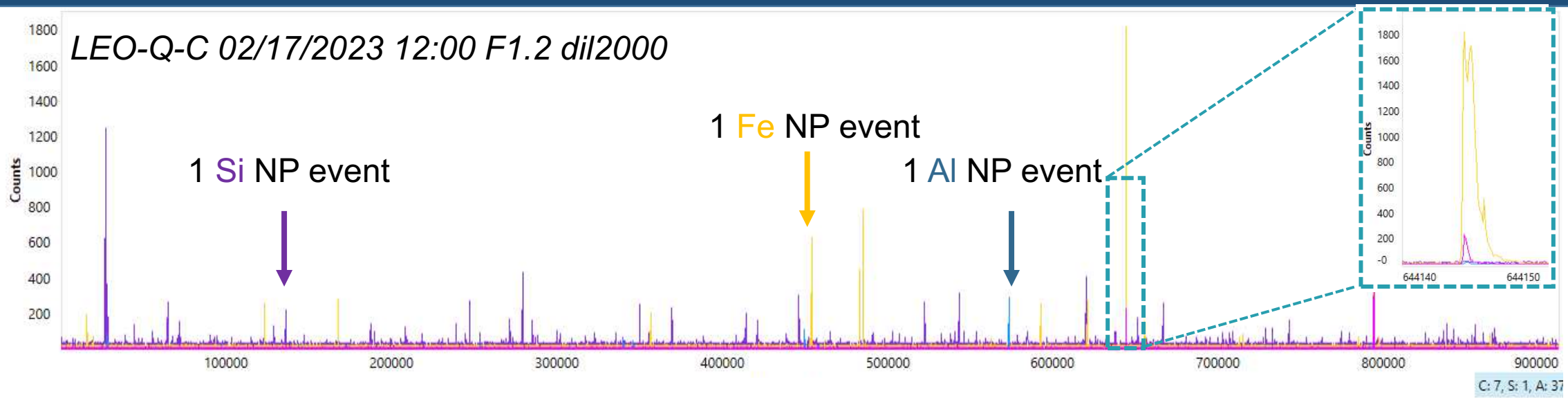
Result
1. Chemical composition of NPs



Vitesse
Nu instrument

- 15 minutes of analysis from ^{23}Na to ^{73}Ge
- NP multi-elemental composition → molar fraction
- NP number concentration (NP mL^{-1})
- NP mass distribution

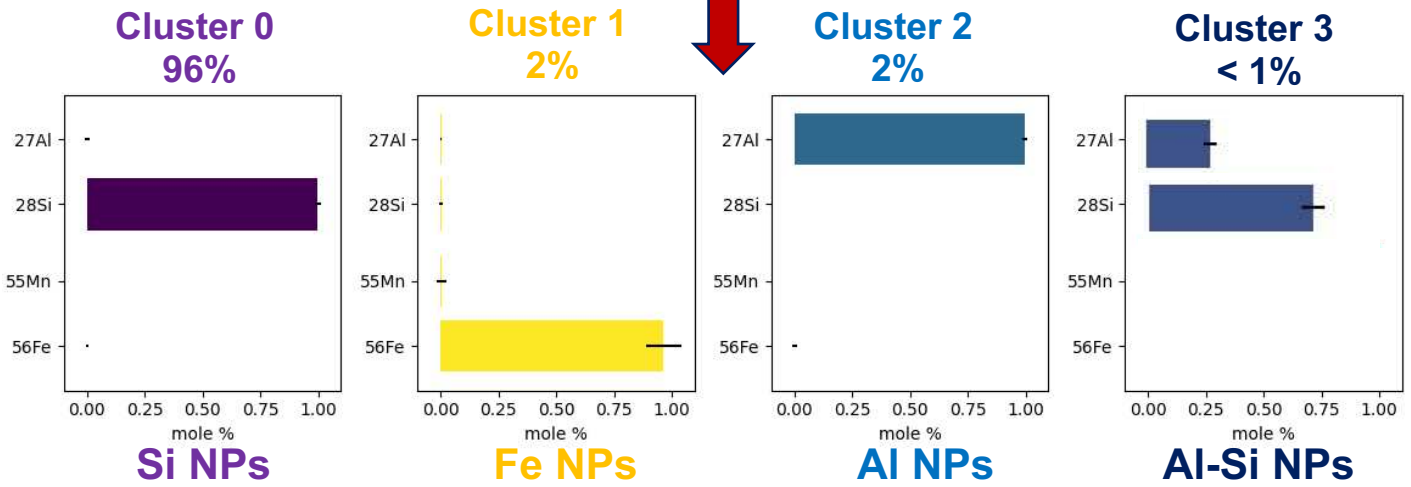
Result
1. Chemical composition of NPs



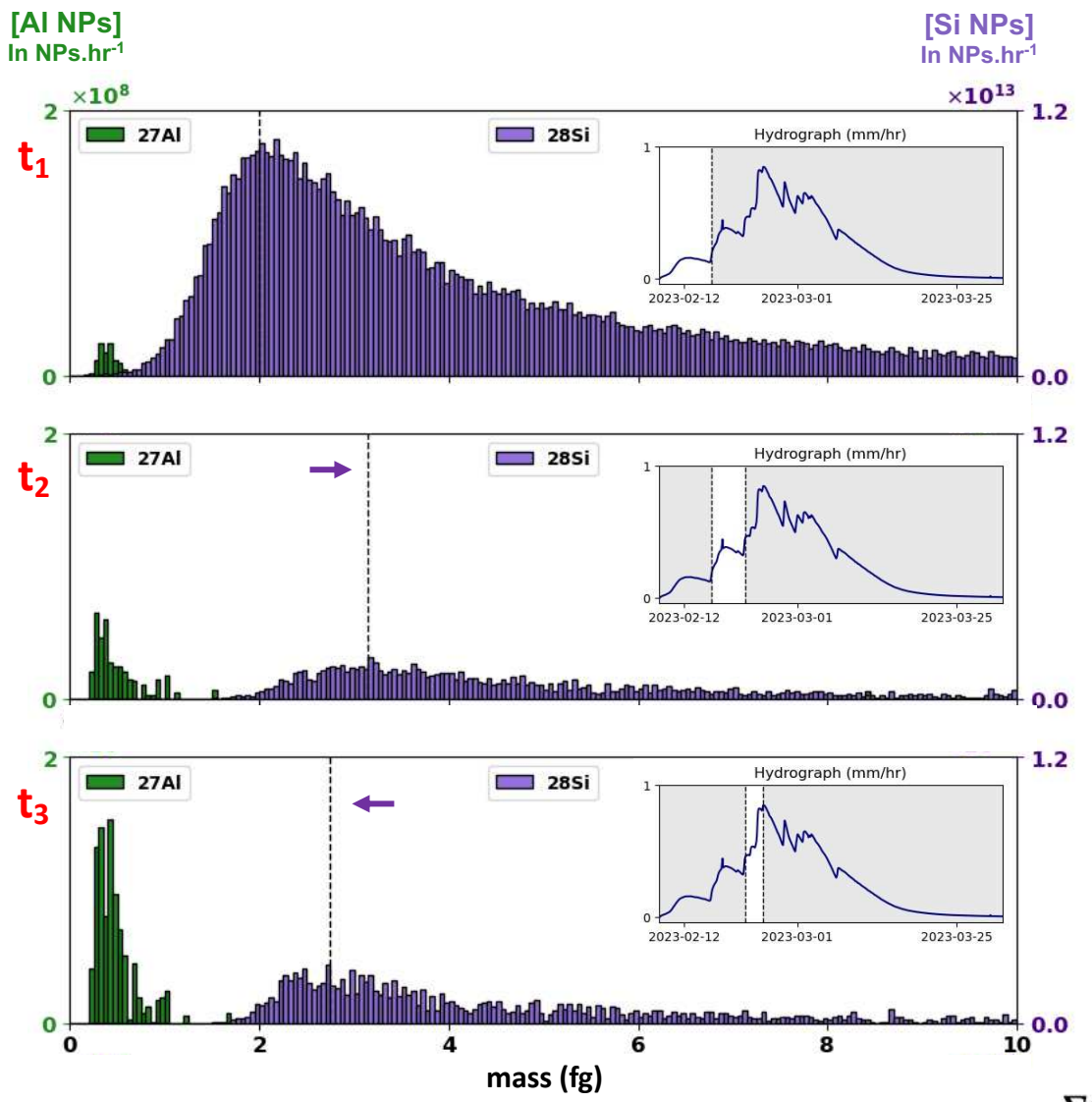
Vitesse
Nu instrument

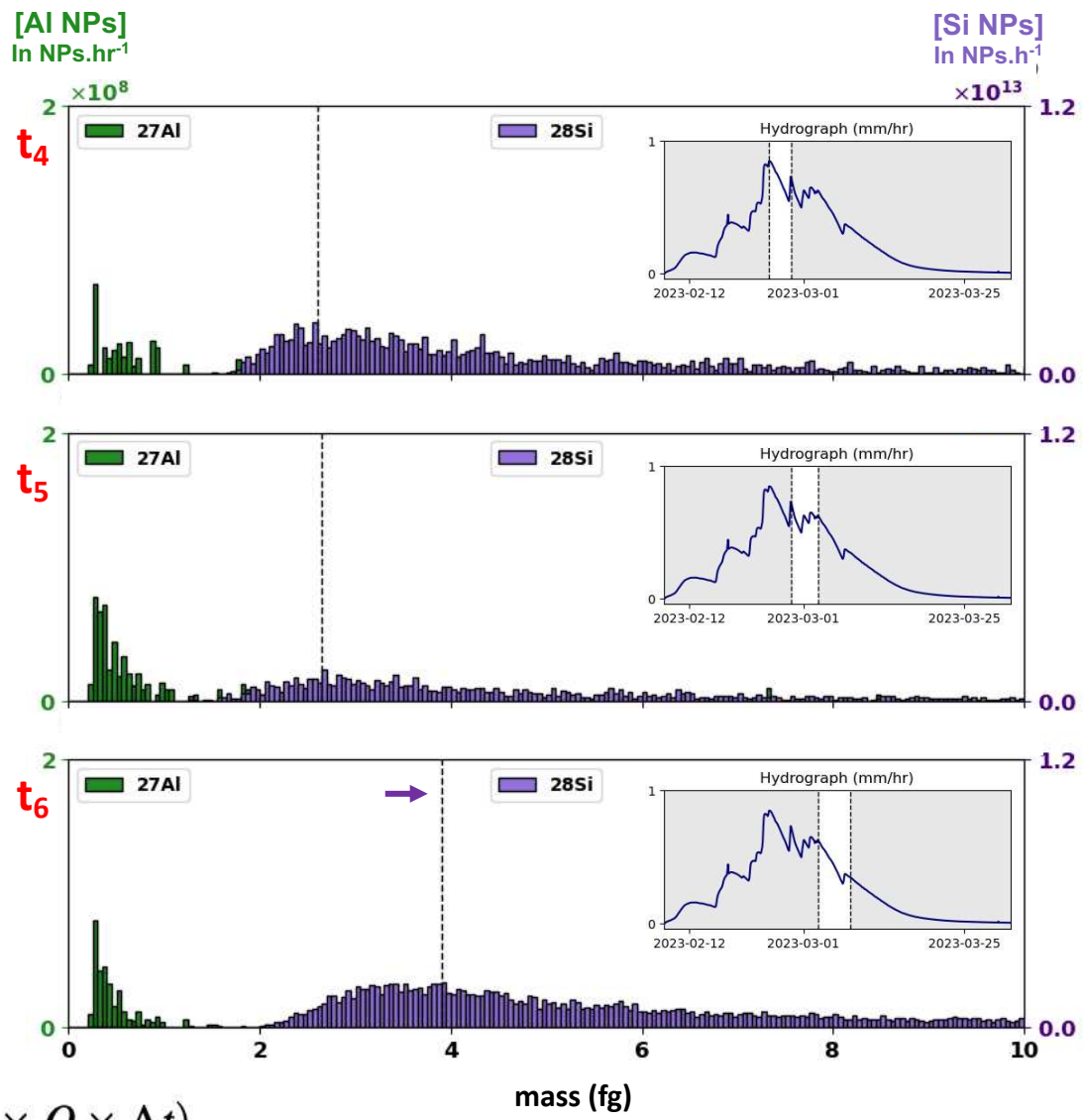
CLUSTERING

(Tharaud et al., 2022)



Result
2. NPs mass distribution





$$F_i = \frac{\Sigma(C_i \times Q \times \Delta t)}{\Sigma(\Delta t)}$$

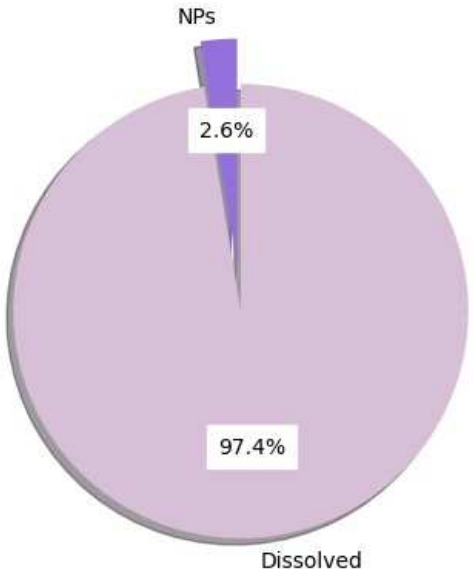
Result
3. Export rate

NPs export rate :

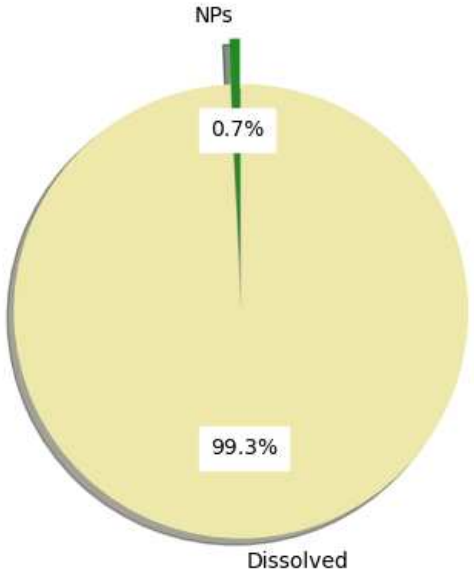
- Si : 84 ug/hr/m^2
- Al : 0.12 ug/hr/m^2
- Fe : 1.35 ug/hr/m^2

Dissolved export rate :

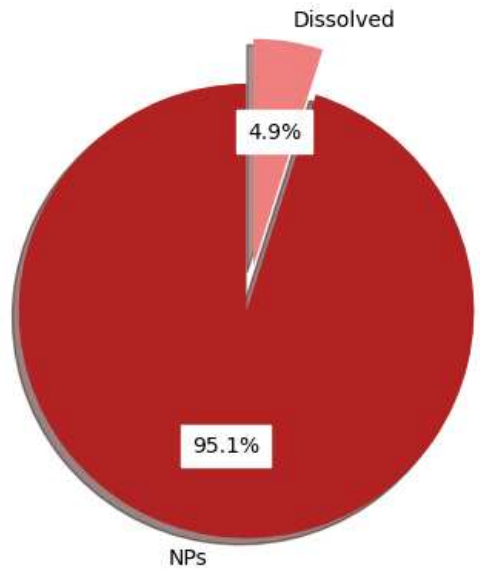
- Si : 3187 ug/hr/m^2
- Al : 16.67 ug/hr/m^2
- Fe : 0.07 ug/hr/m^2



Si



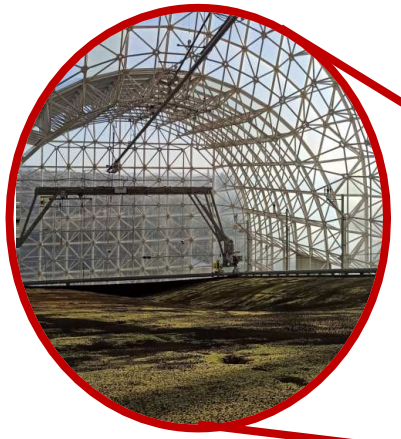
Al



Fe

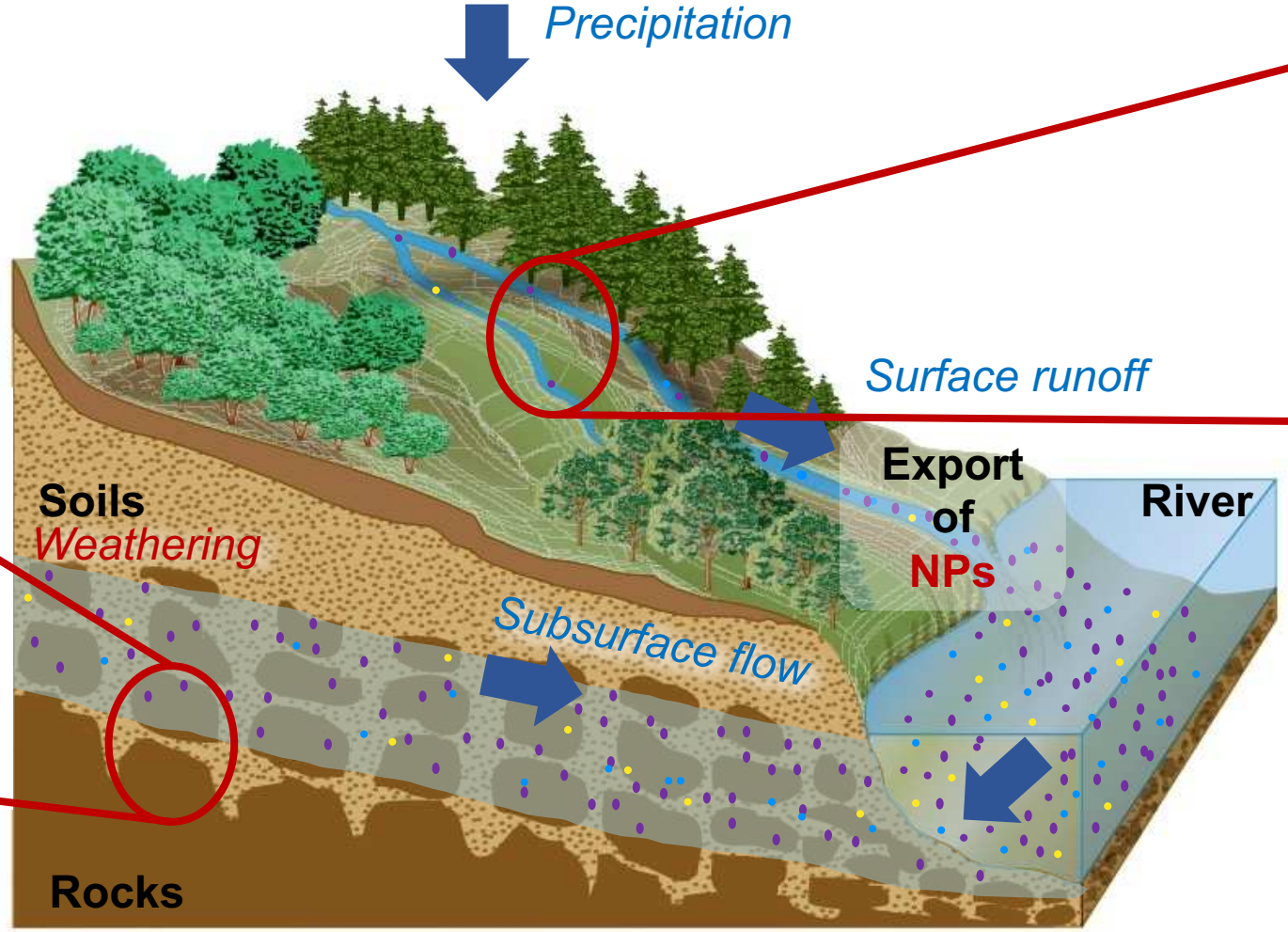
Conclusion & Perspectives

LEO

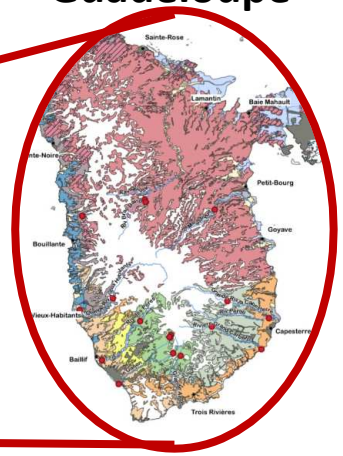


Young system with fresh rocks

Si NPs mainly exported



Guadeloupe



Particular system with rock age from 2.7 Ma to present

Al NPs mainly exported

Thanks for your attention!