On previously unseen flowlines and their potential significance for understanding *c*-*Q* patterns in headwater streams

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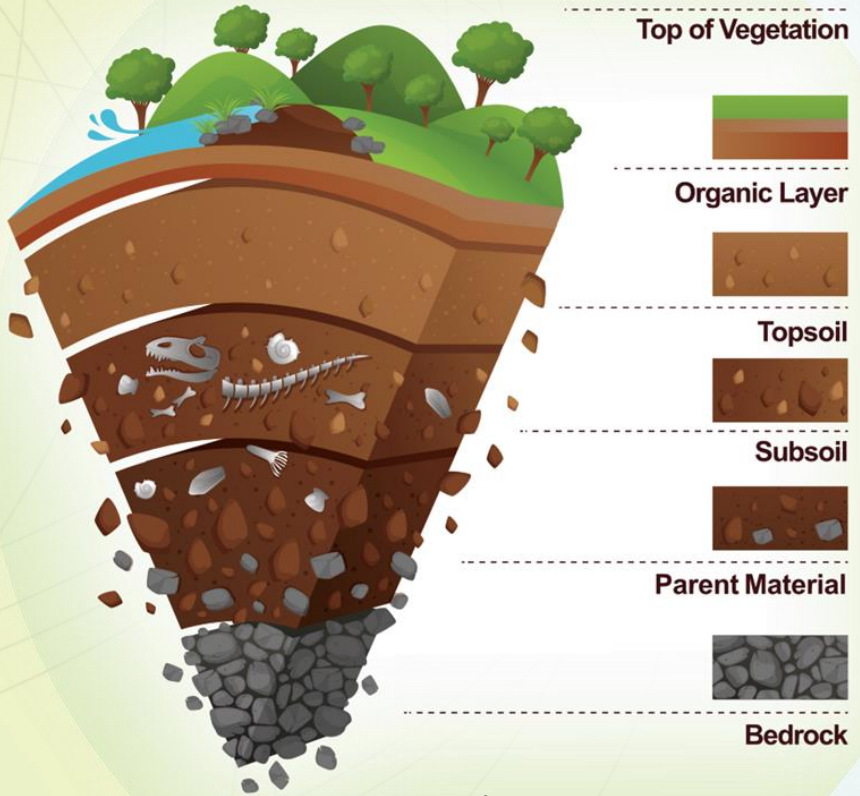
TERENO OPCAR International Conference 25-28 Sept 2023, Bonn

CZ: where paradigms intersect

Biogeochemistry

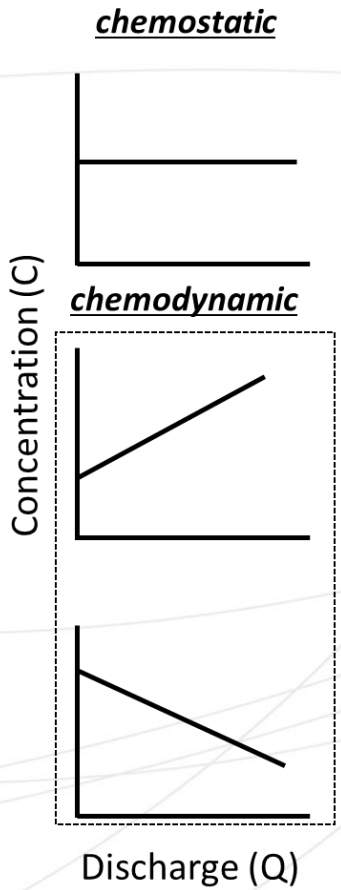


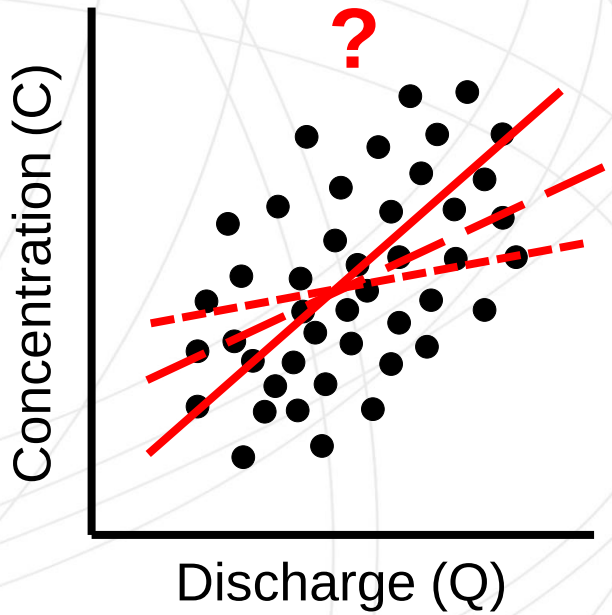
My PhD

Catchment Hydrology

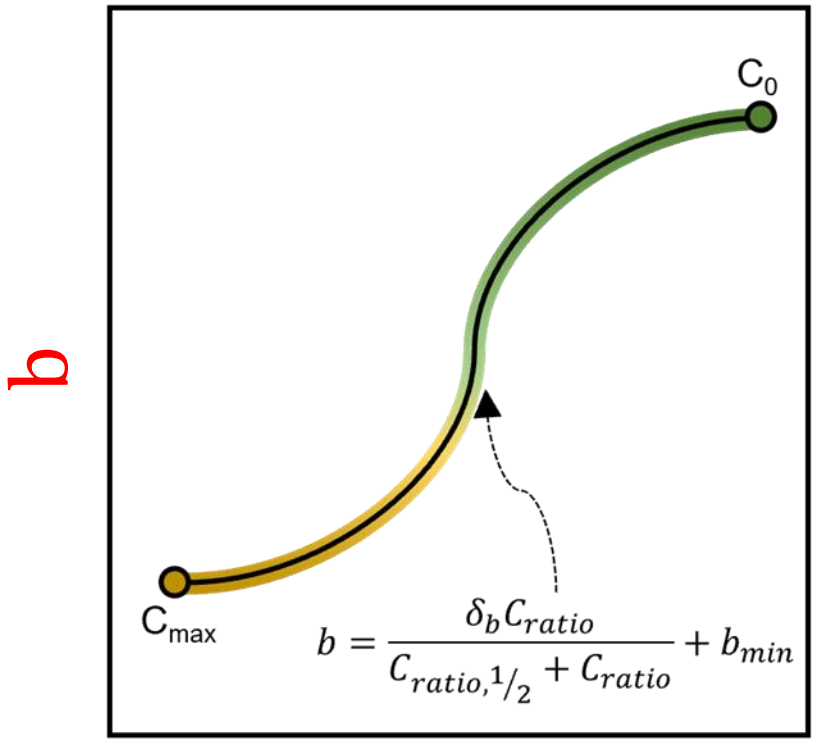
Towards integrated catchment hydro-biogeochemical theories

$$c = aQ^{-b}$$





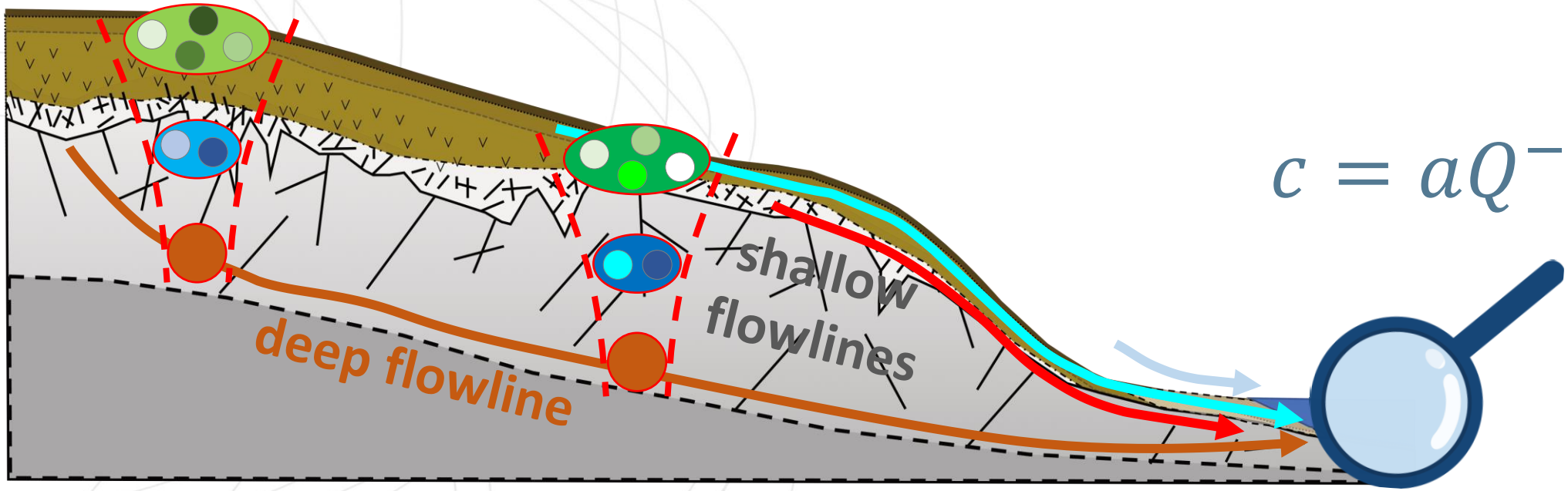
(Zhi et al., 2019)



C_{SW} / C_{GW}

Toward integrated catchment hydro-biogeochemical theories

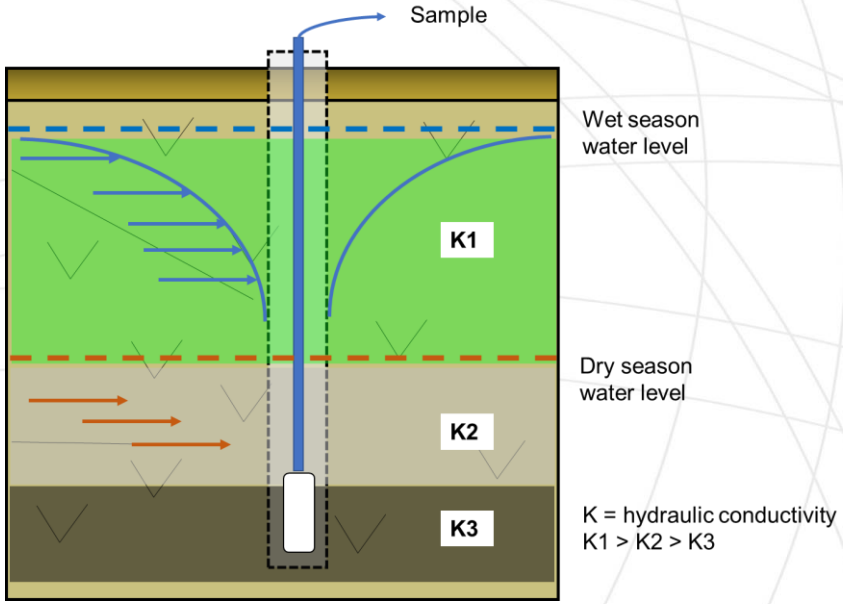
Vertical connectivity *vs.* **hydrological status**



$$c = aQ^{-b}$$

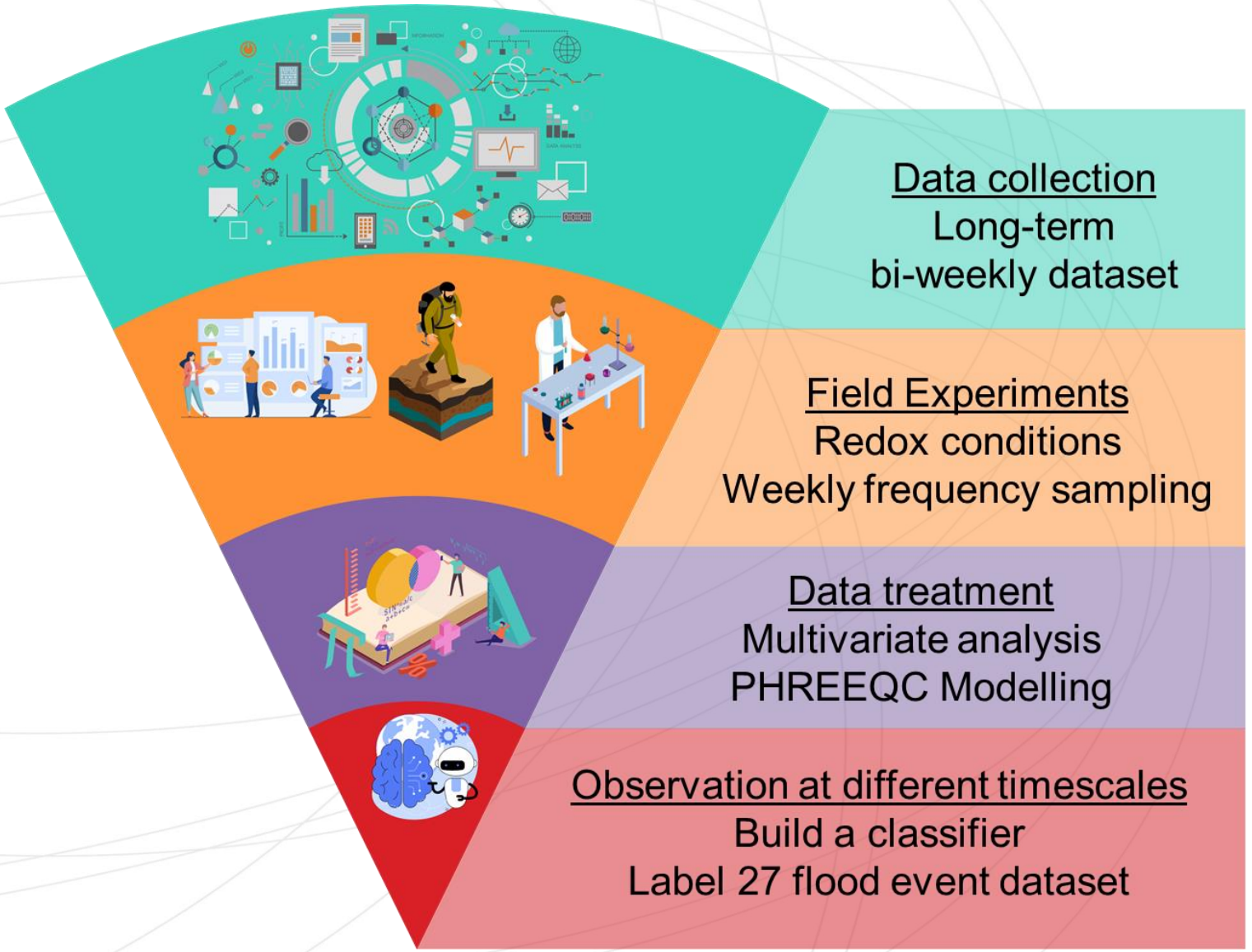
How much of this complexity could we observe?

Working hypothesis



- Water chemistry will be stratified with depth due to vertical connectivity
- Relative contribution of end members/mixture change as a function of hydrological state

1. Compile a sufficiently large **dataset**
2. Observe ”**unseen flowlines**” or endmembers



Today talk structure

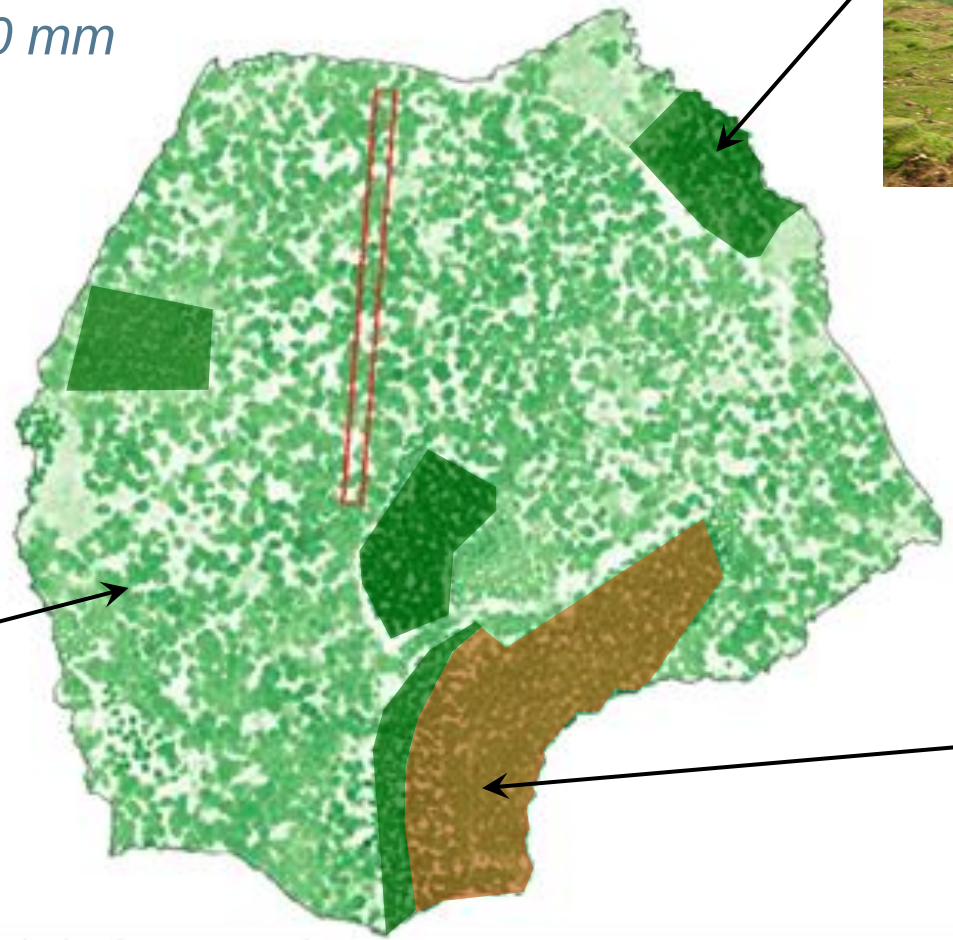
The available database

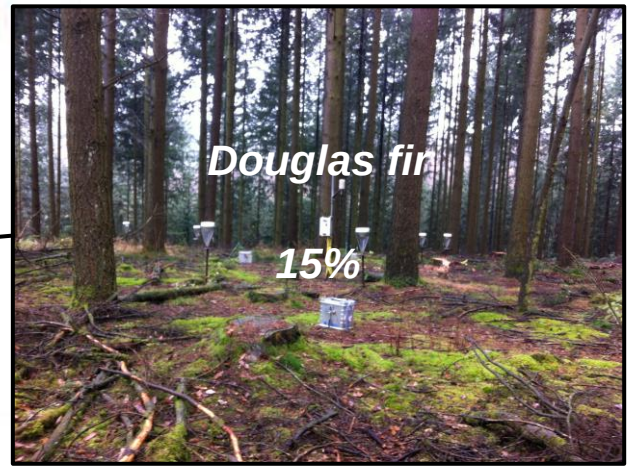
The statistical distinction
Clustering and end-members

Bi-weekly *vs*. event scale

The Weierbach Experimental Catchment

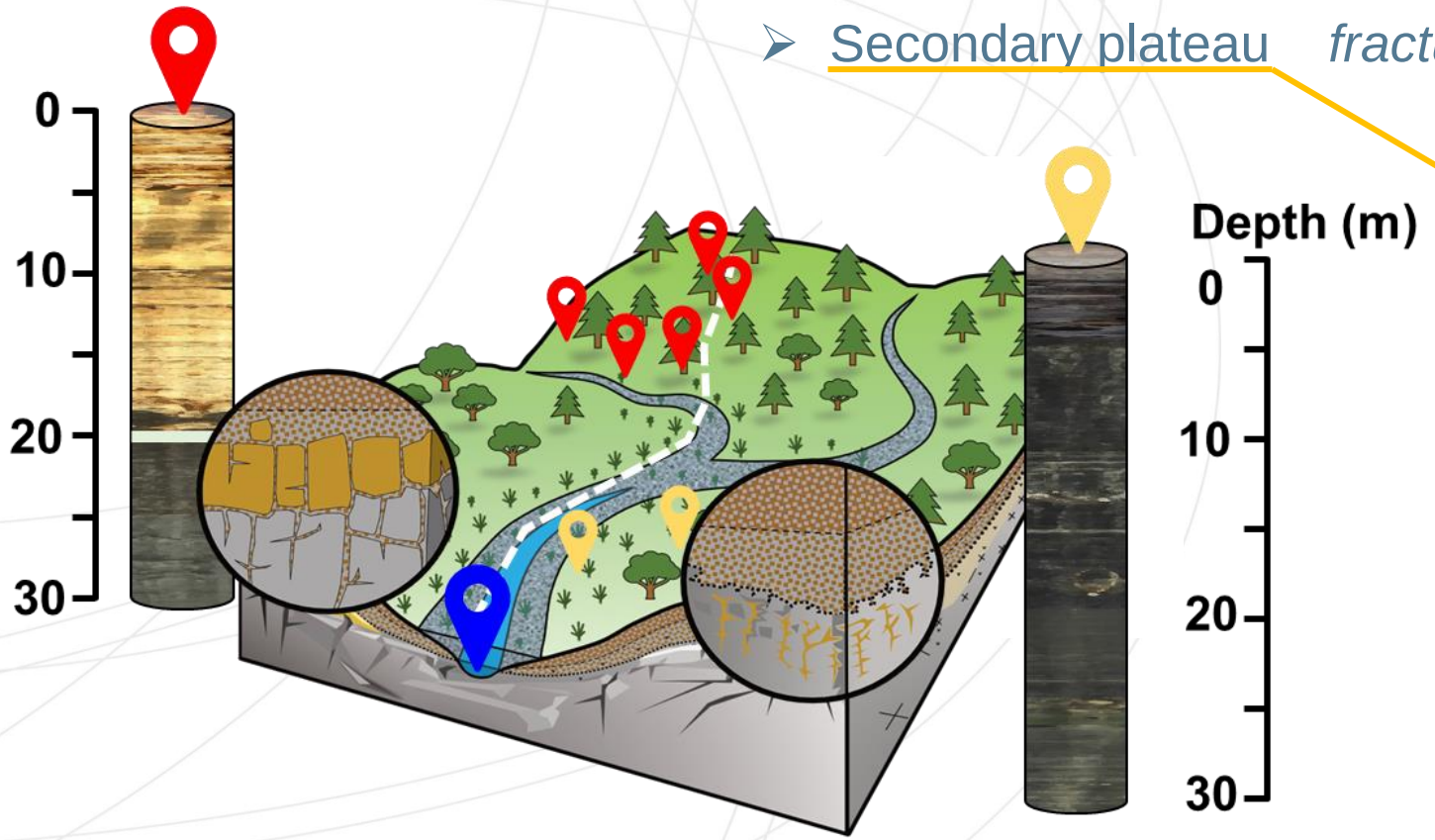
- area *45 ha*
- altitude *450–500m asl*
- mean precipitation *800 mm*

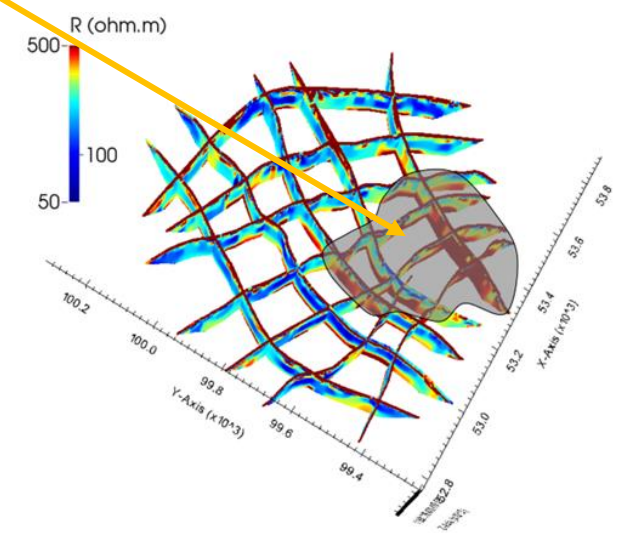




Structure of the regolith: a polygenetic system

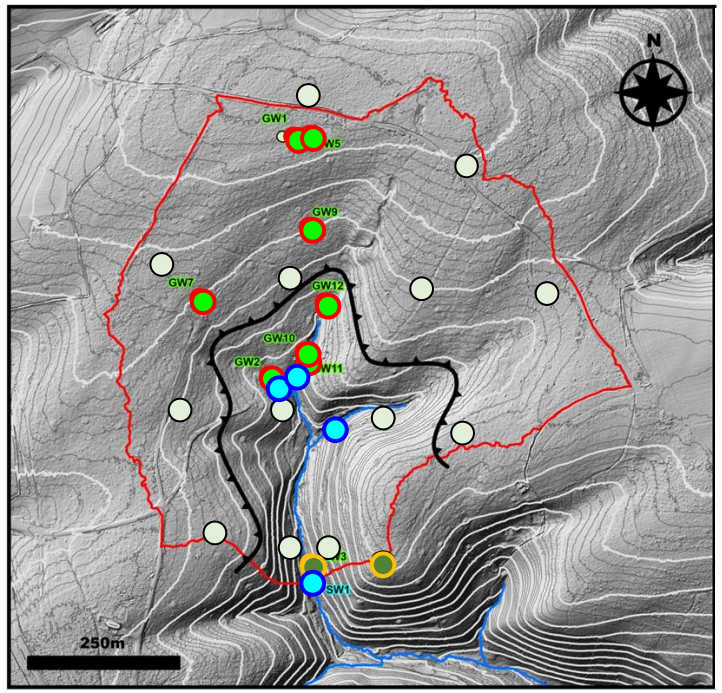
- Soil (70cm deep) *Haplic cambisol (Dystric, skeletic) from loamy PPSD*
- Primary plateau *saprolite (20m) + fractured slate*
- Secondary plateau *fractured slate*





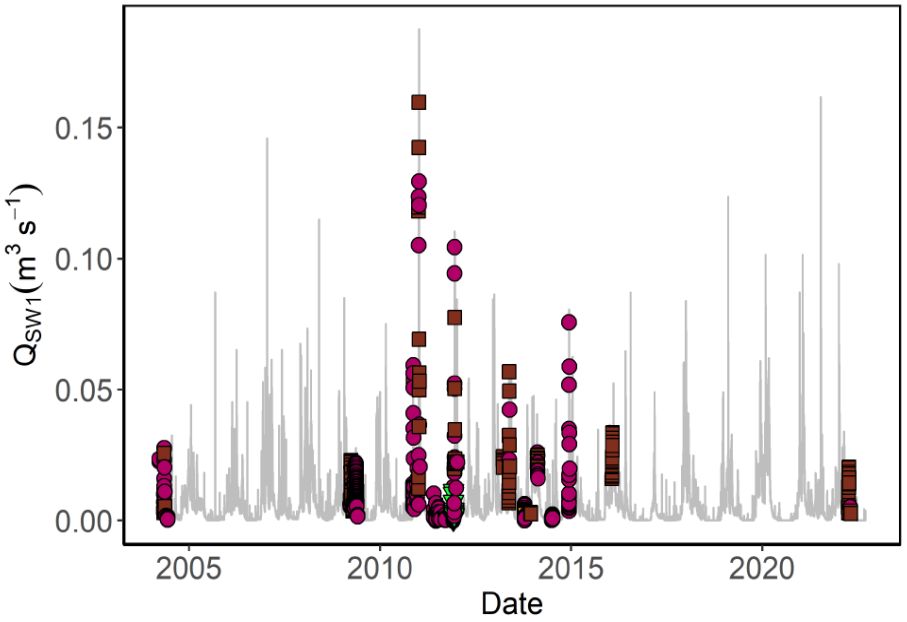
The databases: two time-scales

Long-term bi-weekly sampling



- *2009-20022 rain, throughfall, soil, GW, riparian, SW*
- *Standard water chemistry*
- *2583 samples*

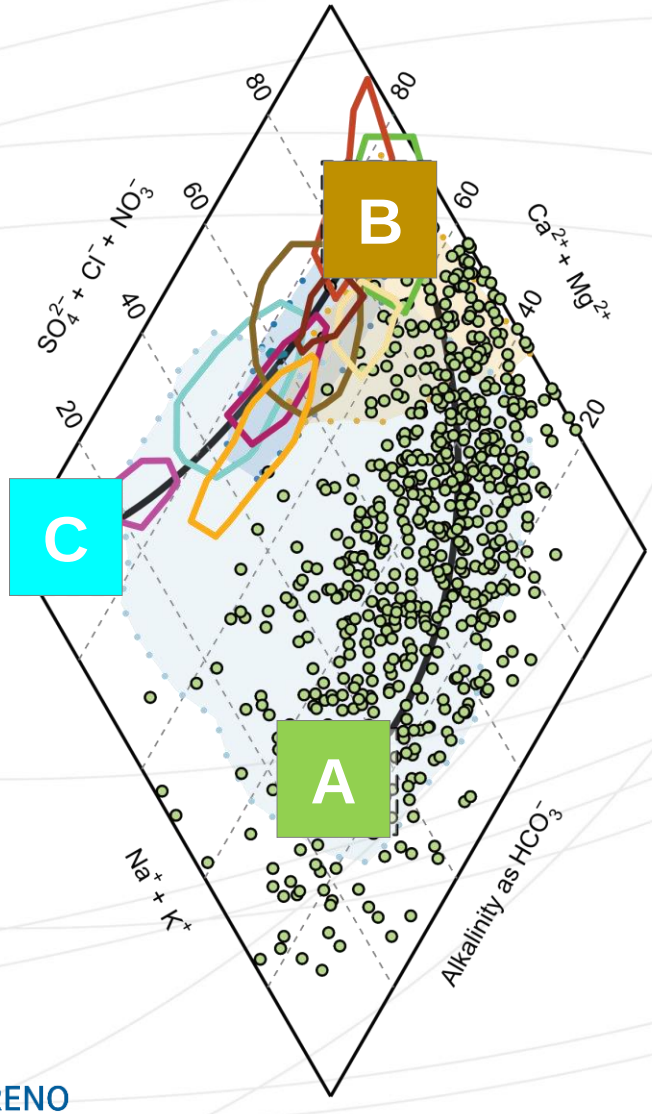
Event-scale sampling

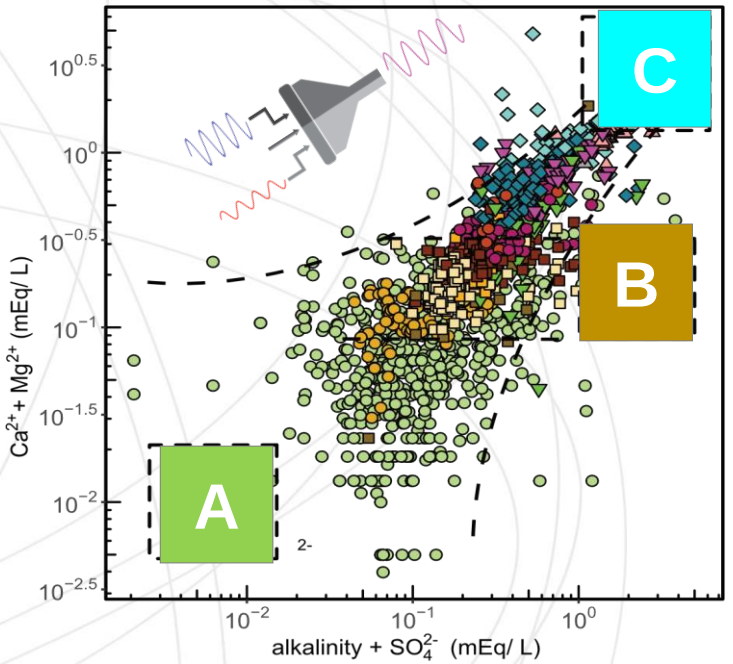


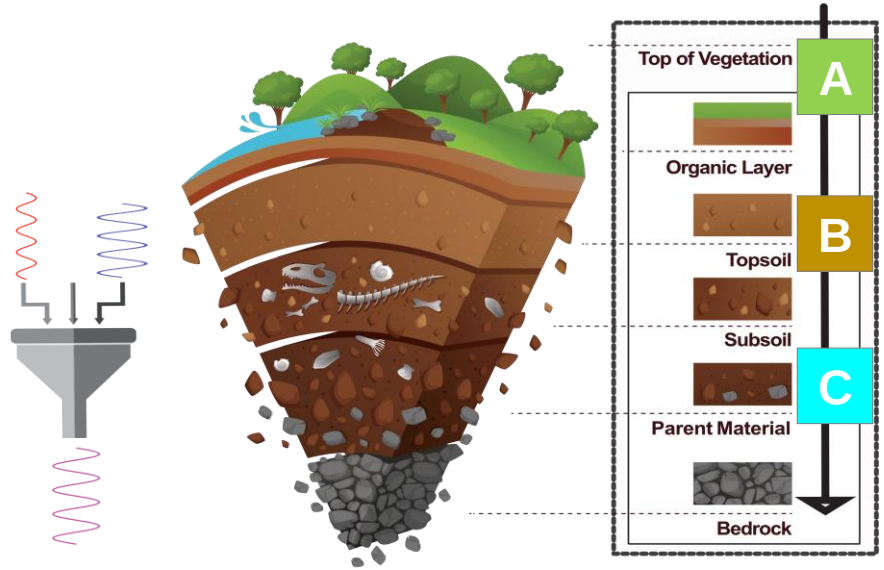
- *2005-20022* — *27 flood events*
- *Every 1h* — *5 – 40 samples*

End-member identification – bi-weekly DB

Vertical connectivity of biogeochemical processes

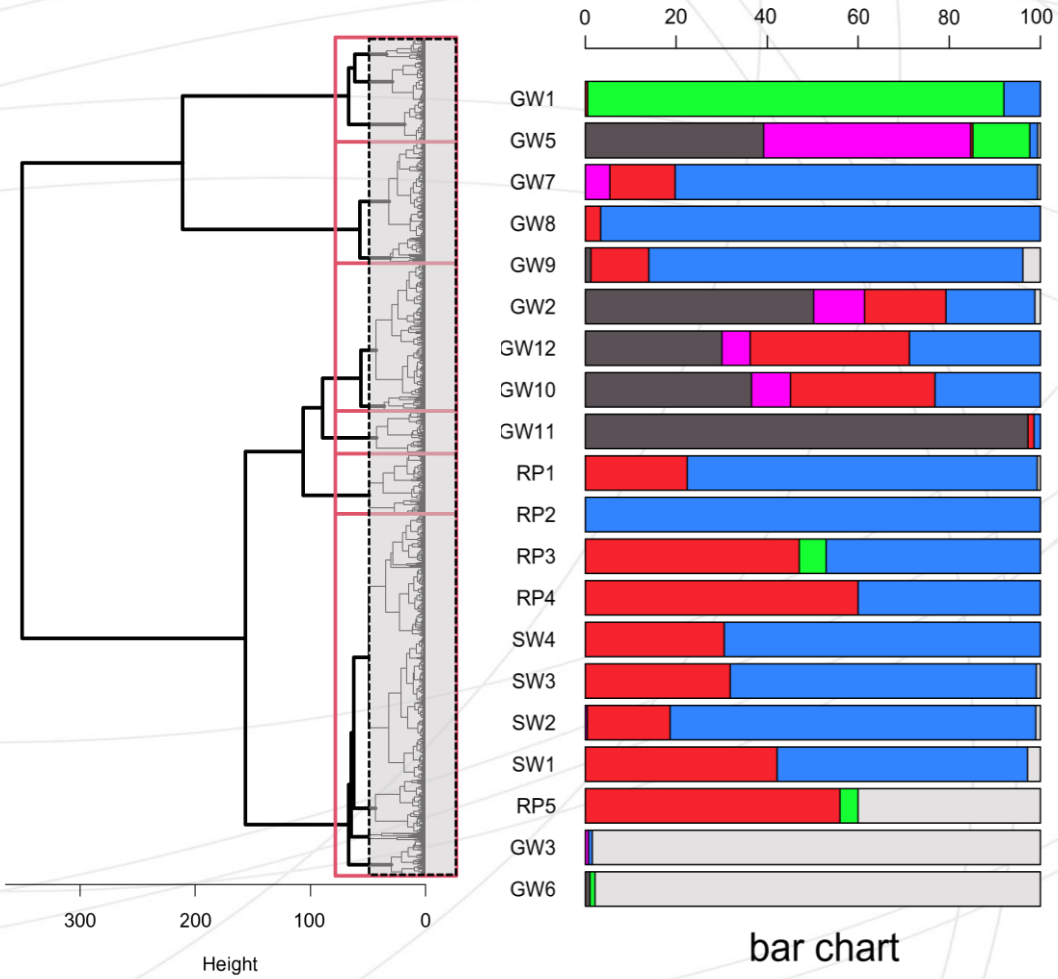






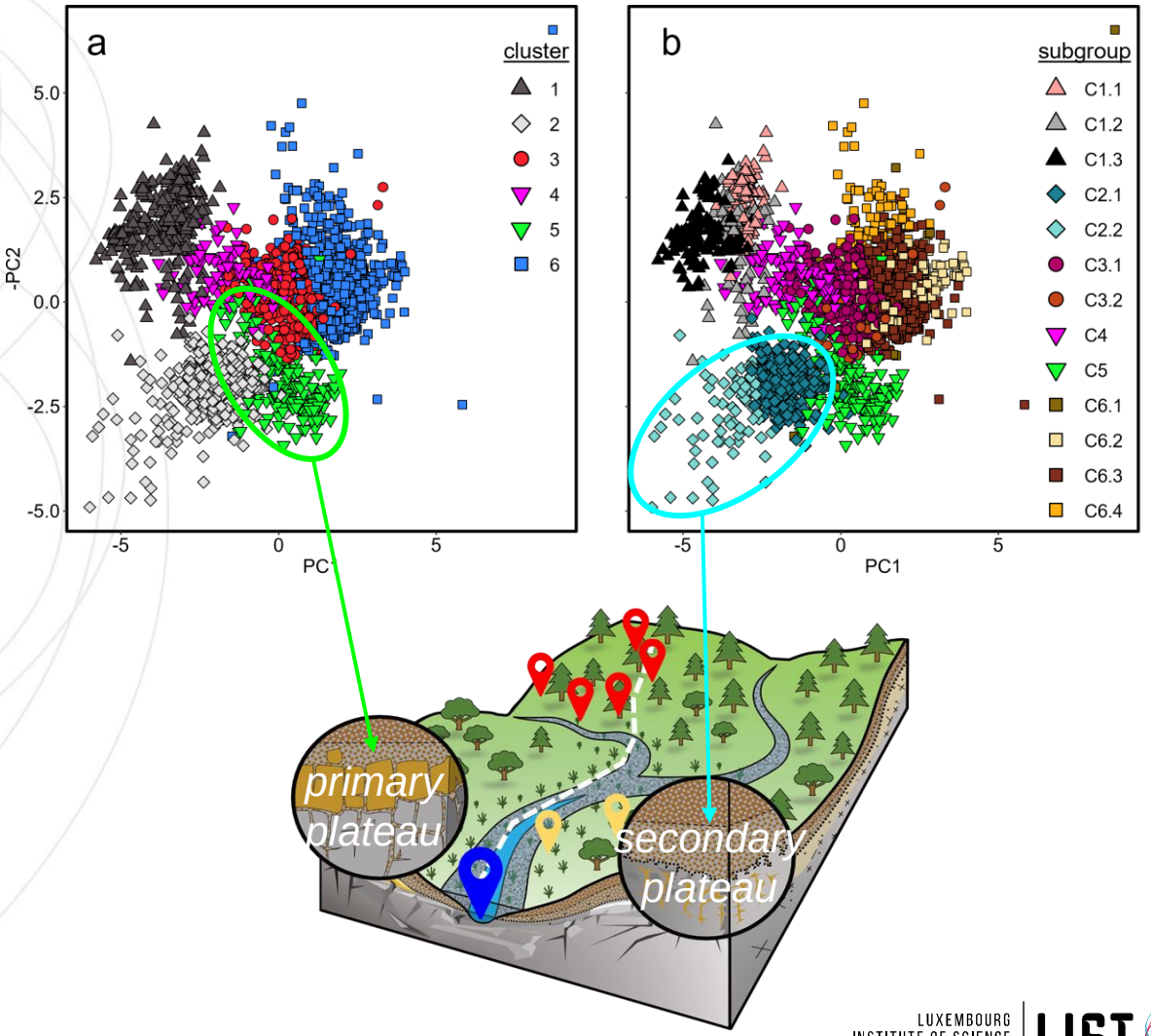
End-member identification - bi-weekly DB

1. Hierarchical Cluster Analysis

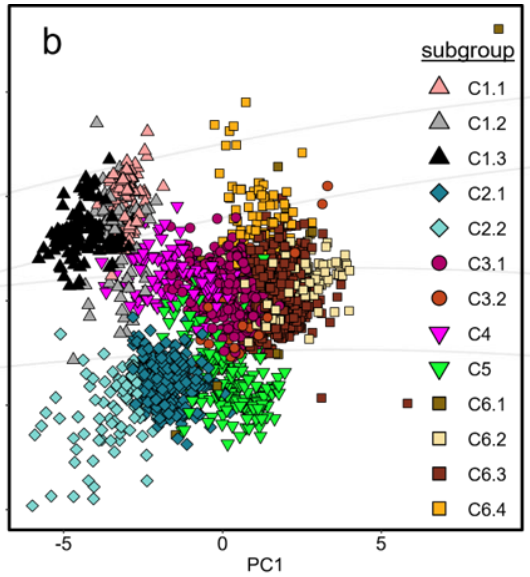


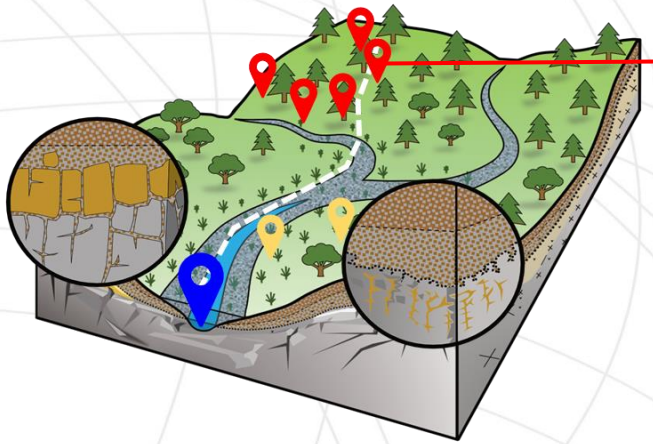
2. Principal Component Analysis

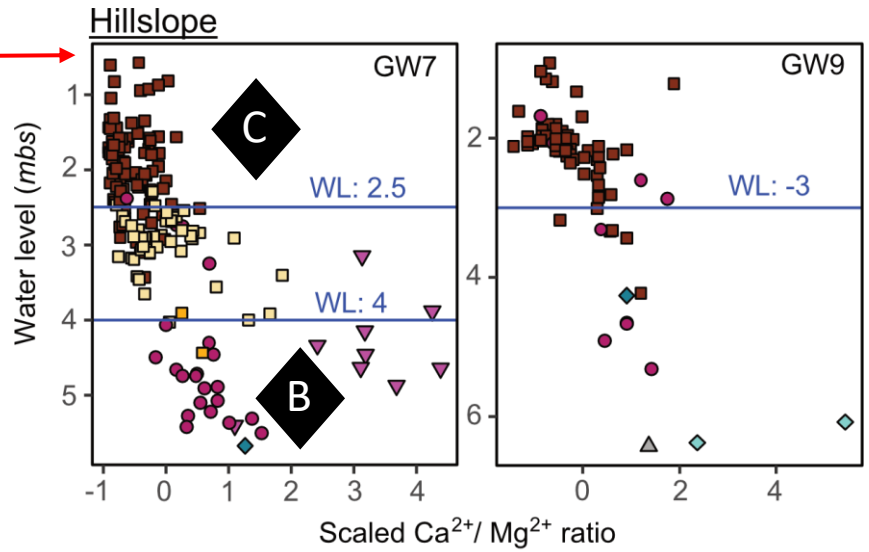
Clusters *subgroups*



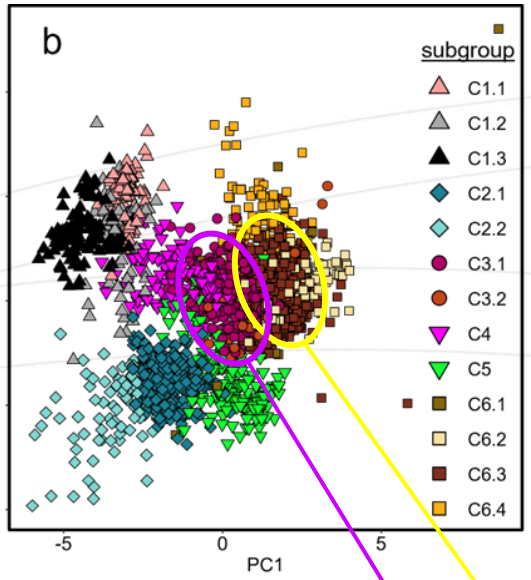
Near stream end-member identification – bi-weekly DB

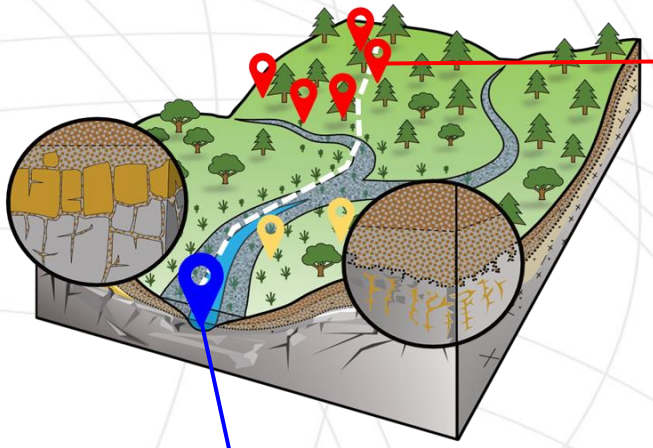


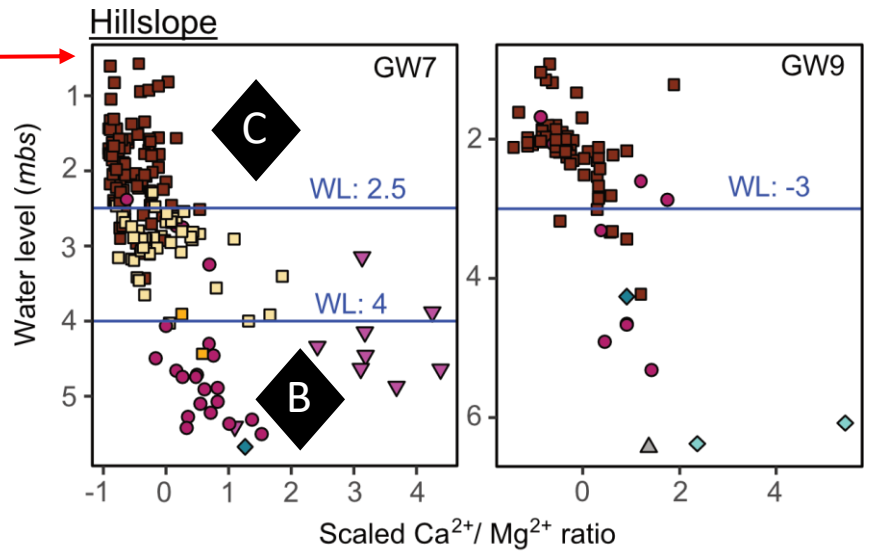


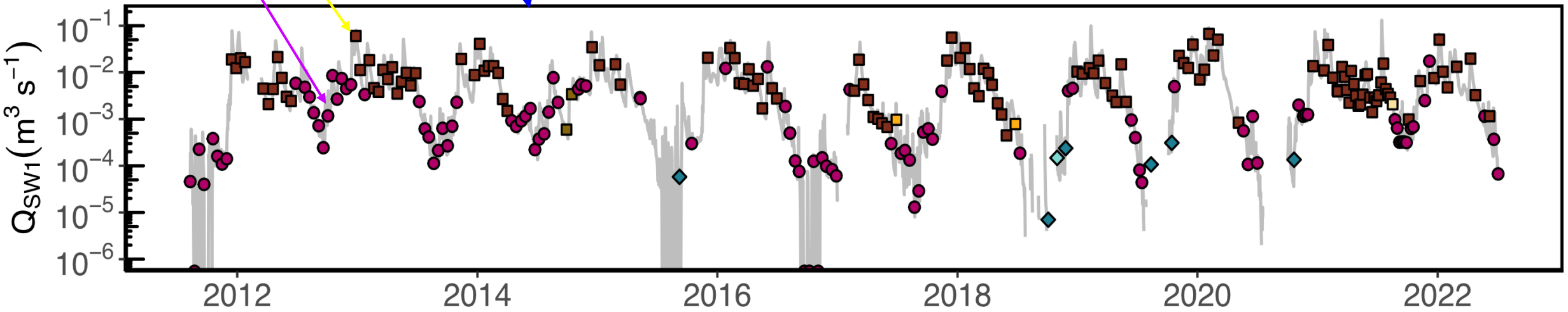


Near stream end-member identification – bi-weekly DB



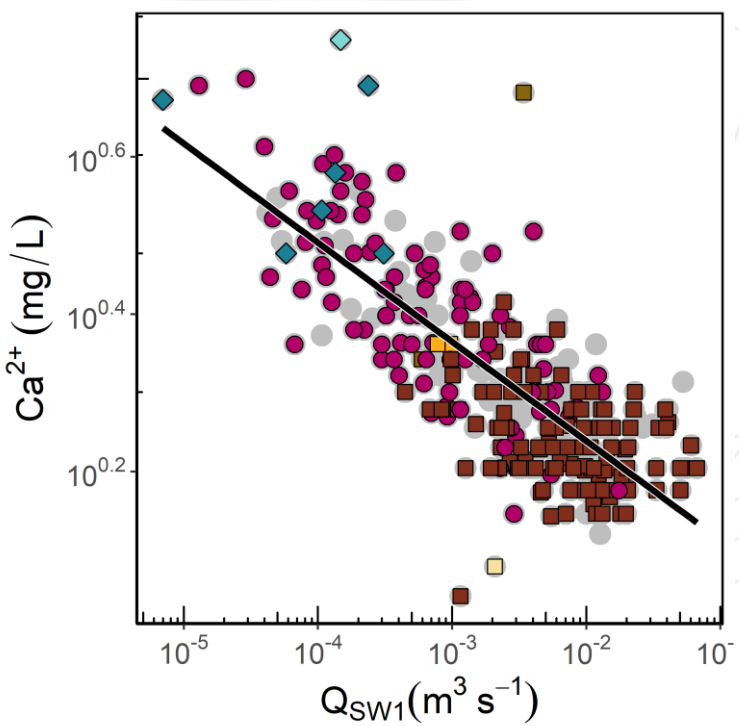


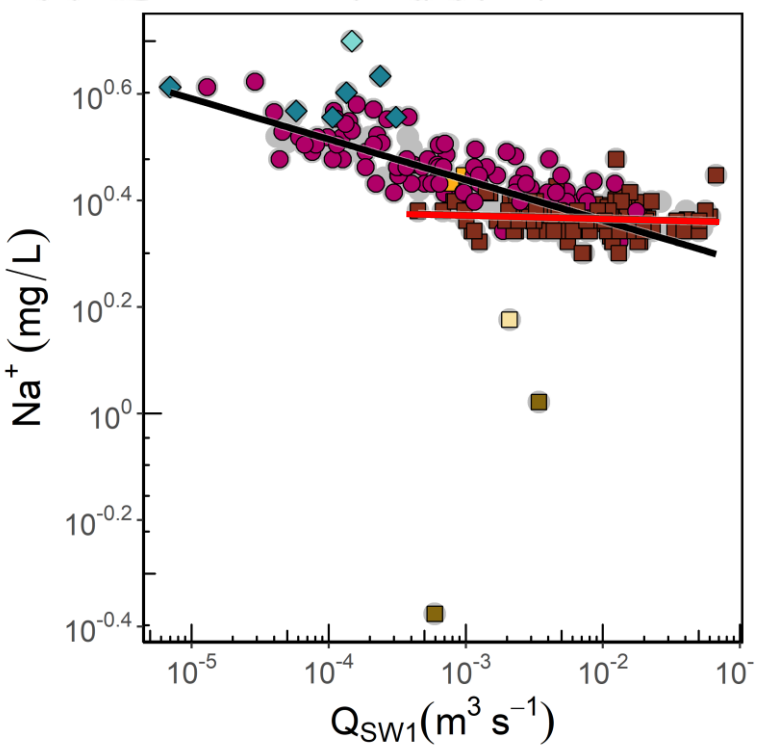


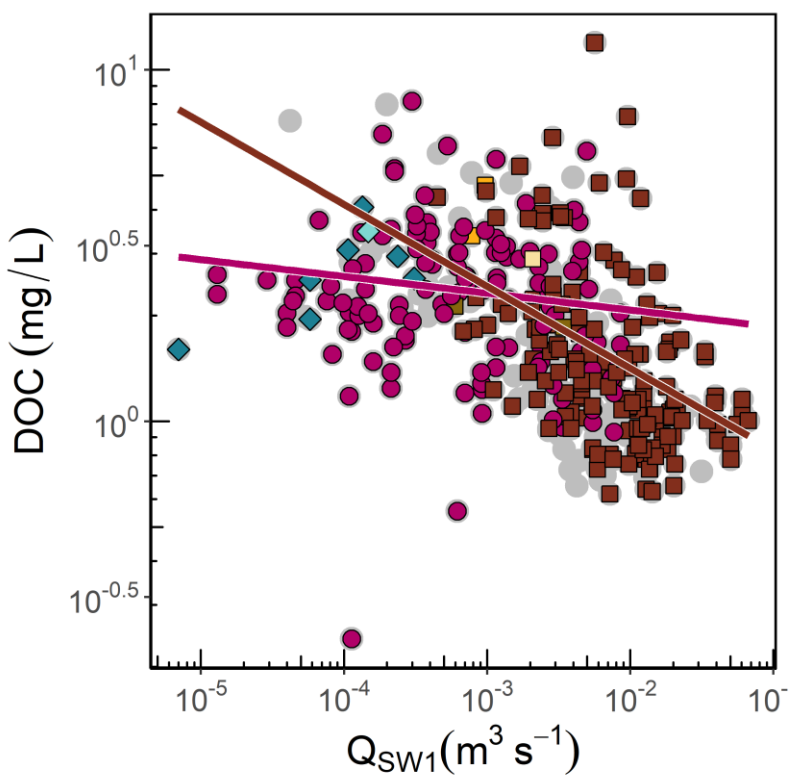


Different c-Q power laws at catchment scale – bi-weekly DB

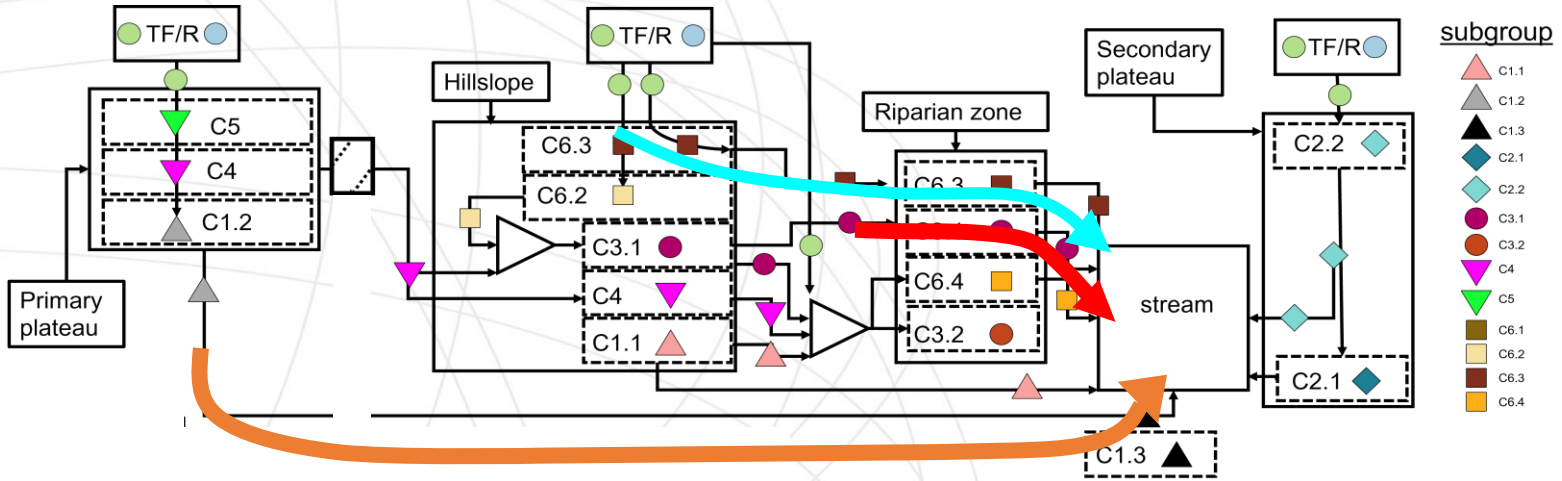
$$c = aQ^{-b}$$

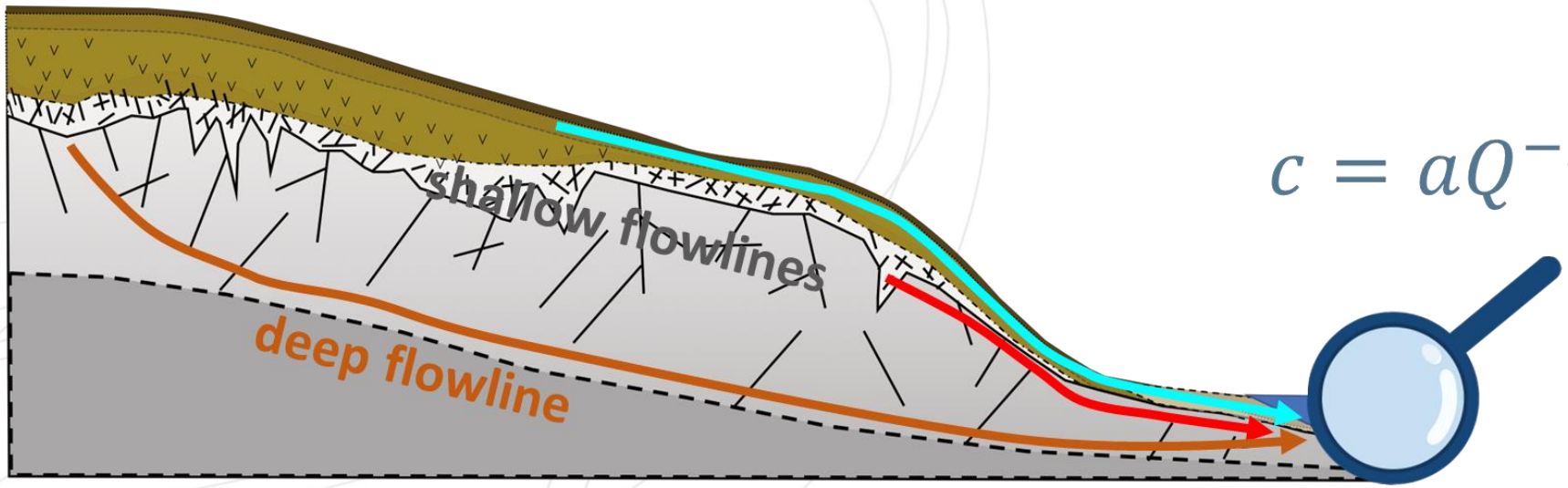






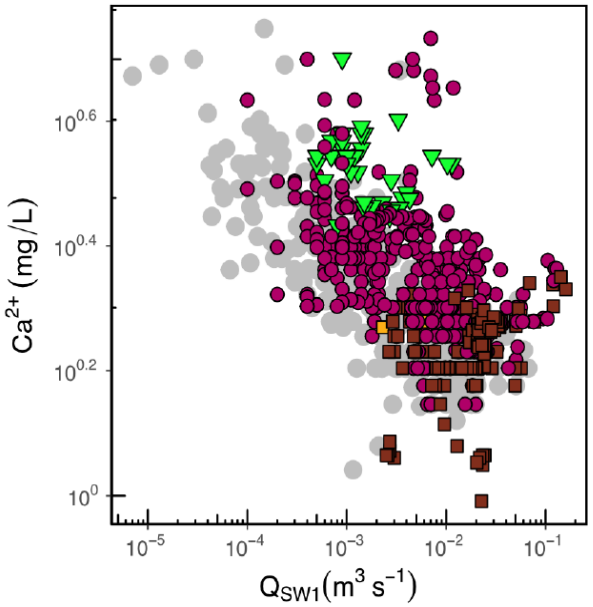
Proposition for a cluster-based concept – bi-weekly DB

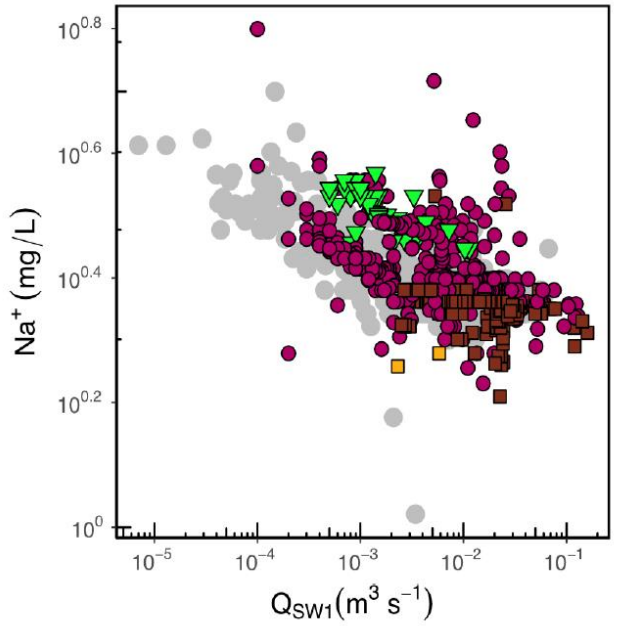


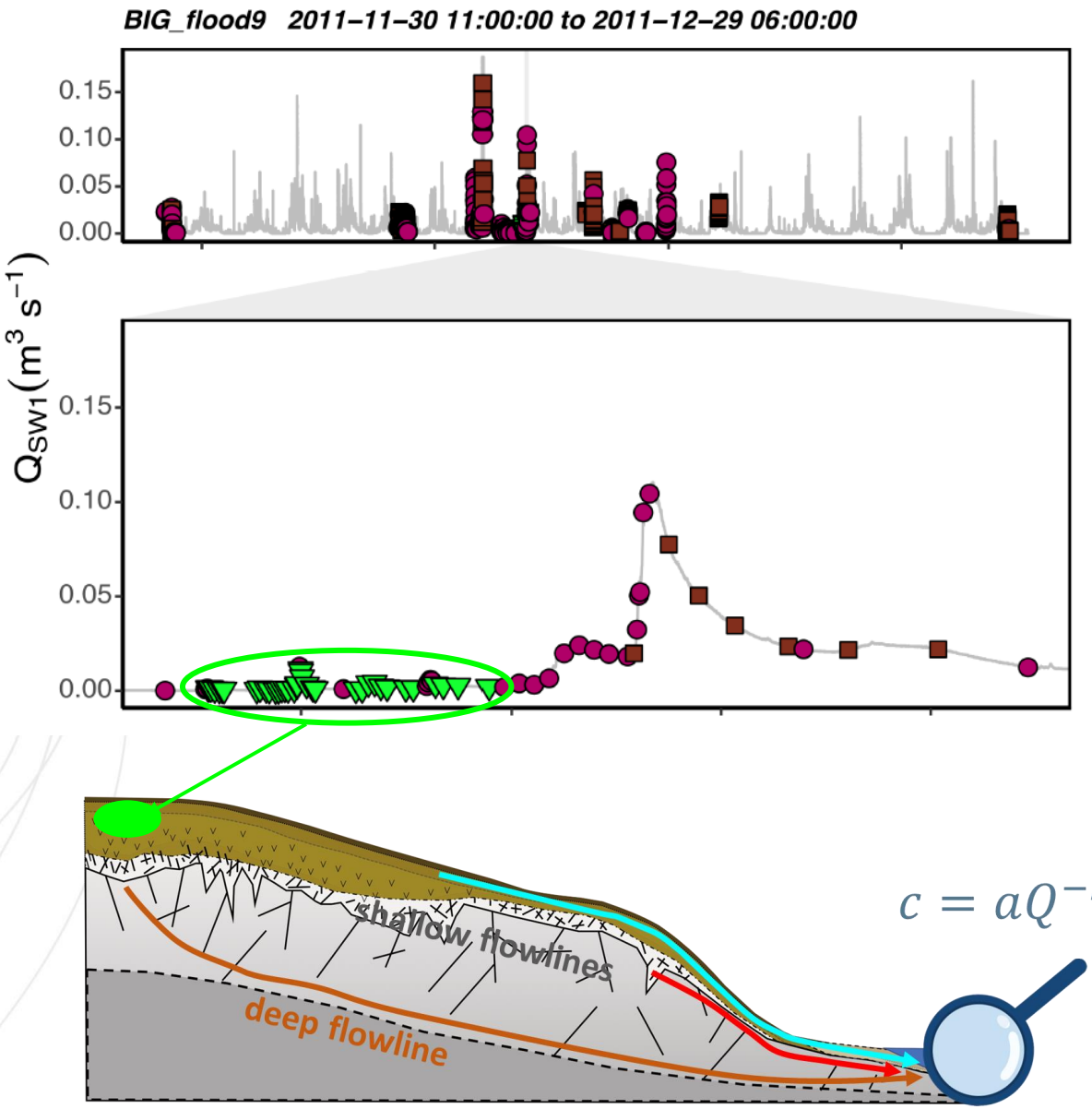


$$c = aQ^{-b}$$

Event time scale







Wrap up

1. Access to a large dataset that has SW and GW a new approach to an old problem could be applied

- *HCA and PCA, hidden end members could be identified and studied*
- *look beyond near stream end members and identify potentially deeper end members*

2. Are we observing end-members?

- *Cluster validation based on PHREEQC inverse modelling*

3. And now….

- Quantify the water fluxes related to the observed clusters/flowlines
- New consideration of the real weathering processes that contribute to stream/river chemistry