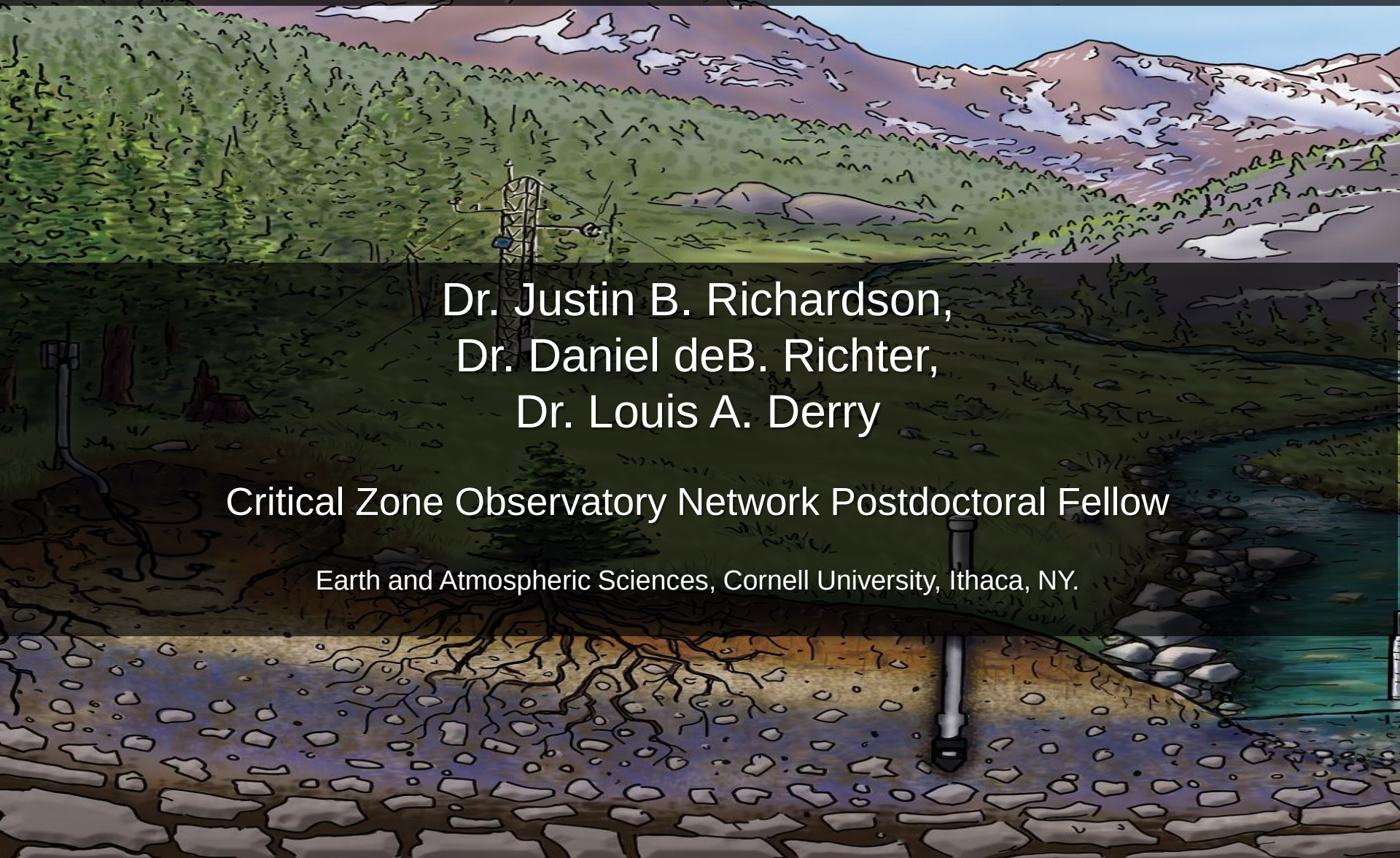
WEATHERING LOSSES AND PHASE PARTITIONING OF ALUMINUM IN THE CRITICAL ZONE USING GALLIUM/ALUMINUM RATIOS



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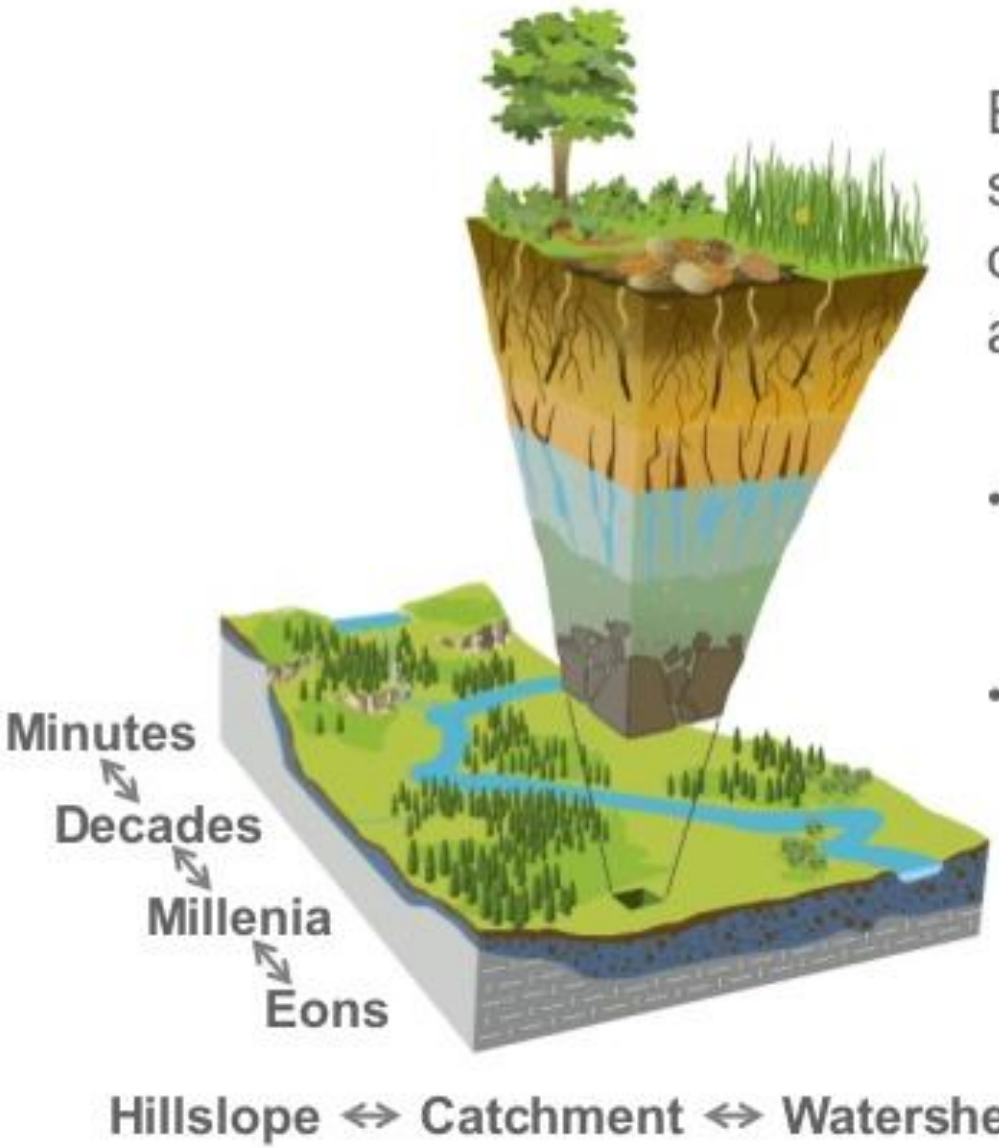
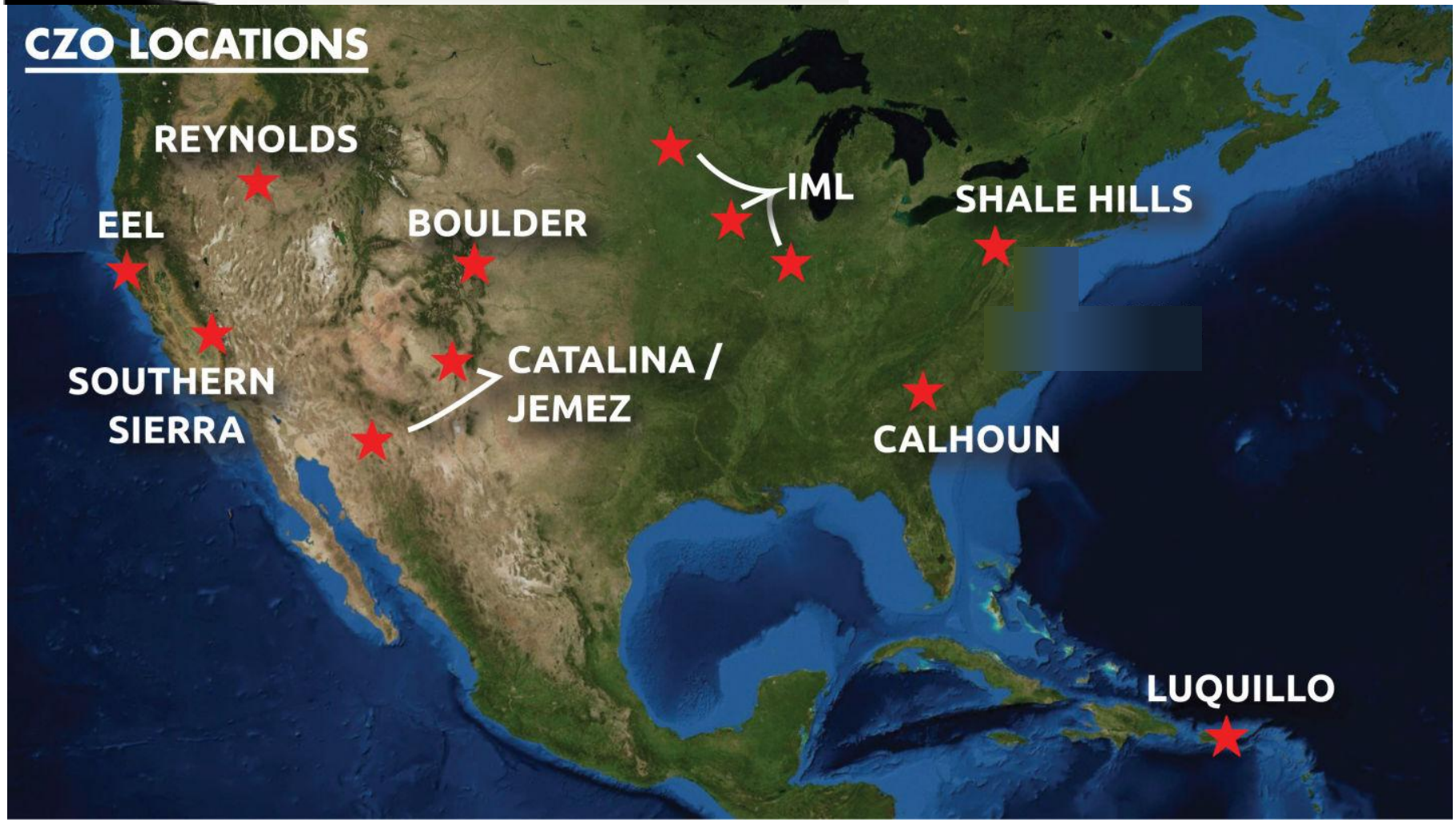
Critical Zone Science



Earth's permeable near-surface layer from the tops of the trees to the bottom of actively cycling groundwater.

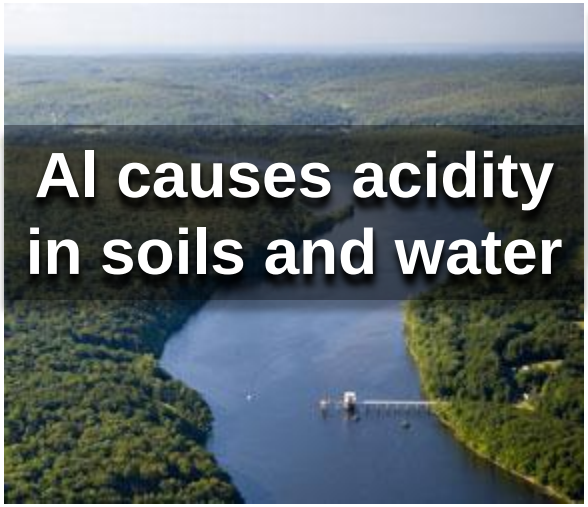
- Where rock, soil, water, air, and living organisms interact and shape the Earth's surface.
- Critical to sustaining the earth's sustaining services
  - Clean water
  - Productive soil
  - Balanced atmosphere

CZO | CRITICAL ZONE OBSERVATORIES
U.S. NSF NATIONAL PROGRAM



Weathering

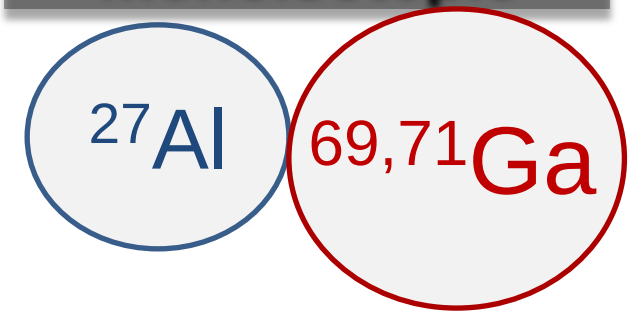
Aluminum retention or mobilization



Developing the Ga/Al pseudo-isotope system

$$\delta^{13}C_{Sample} = \left\{ \frac{\left(\frac{^{13}C}{^{12}C}\right)_{Sample}}{\left(\frac{^{13}C}{^{12}C}\right)_{Reference}} \right.$$

Aluminum is monoisotopic



To develop a low temperature pseudo-isotope system:
(1) The elements must have similar geochemical properties.

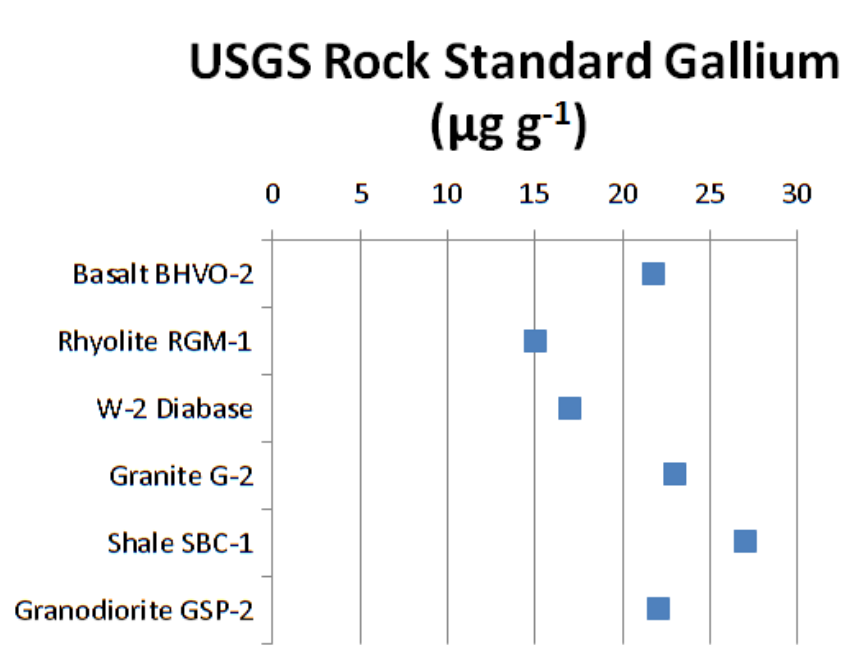
(2) Sources must have known ratios to quantify their respective contributions.

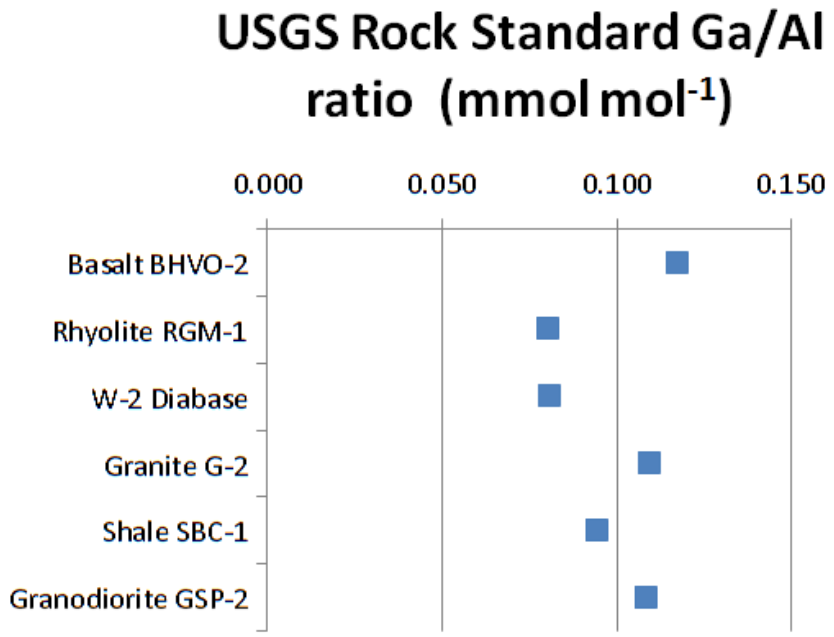
(3) Processes that affect the element ratio (fractionation) must be known.

(1) Ga and Al have similar geochemical properties

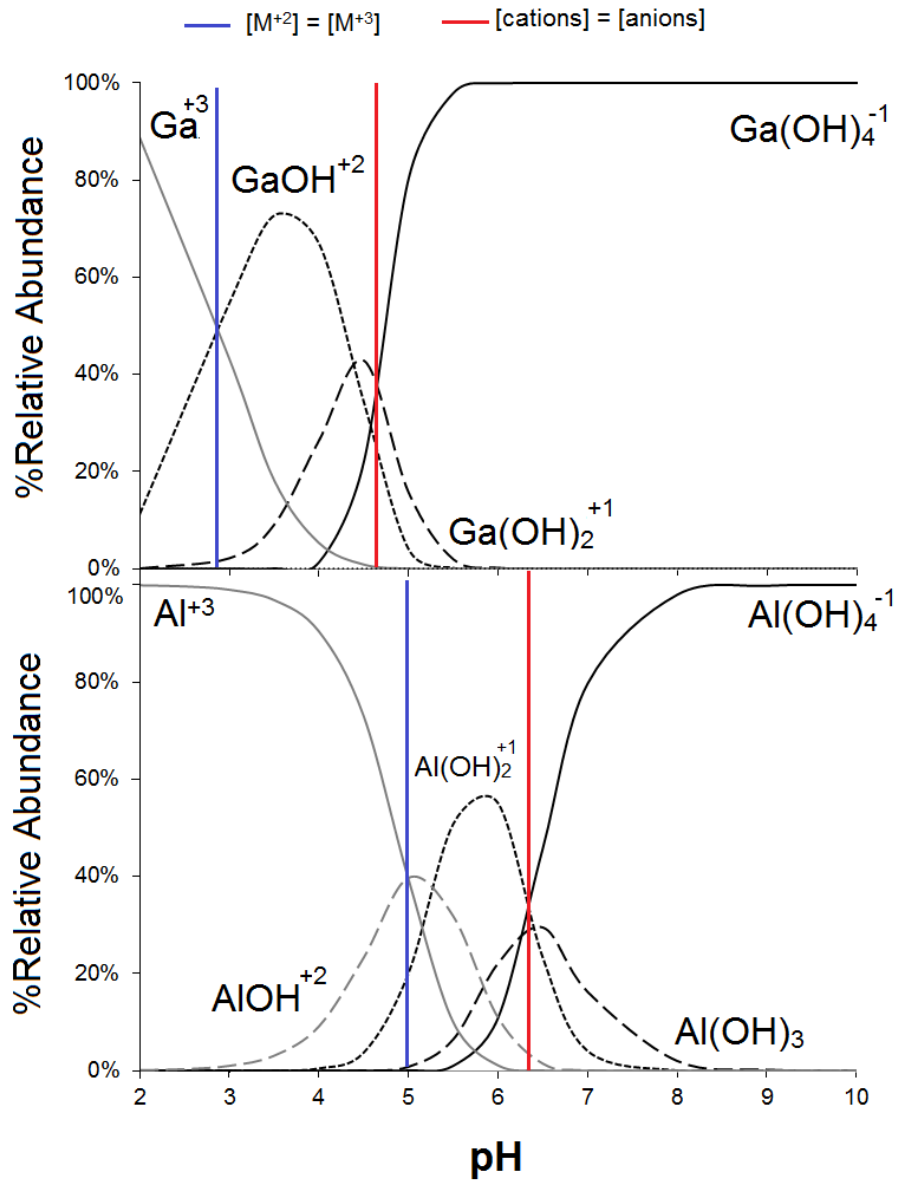
	Gallium	**Aluminum**
Charge	+3	+3
Isotopes	^{69}Ga, ^{71}Ga	^{27}Al
Atomic radii	62 pm	54 pm
Electronegativity	2.01	1.61
Redox sensitivity	None	None

(2) Gallium and Aluminum have known sources



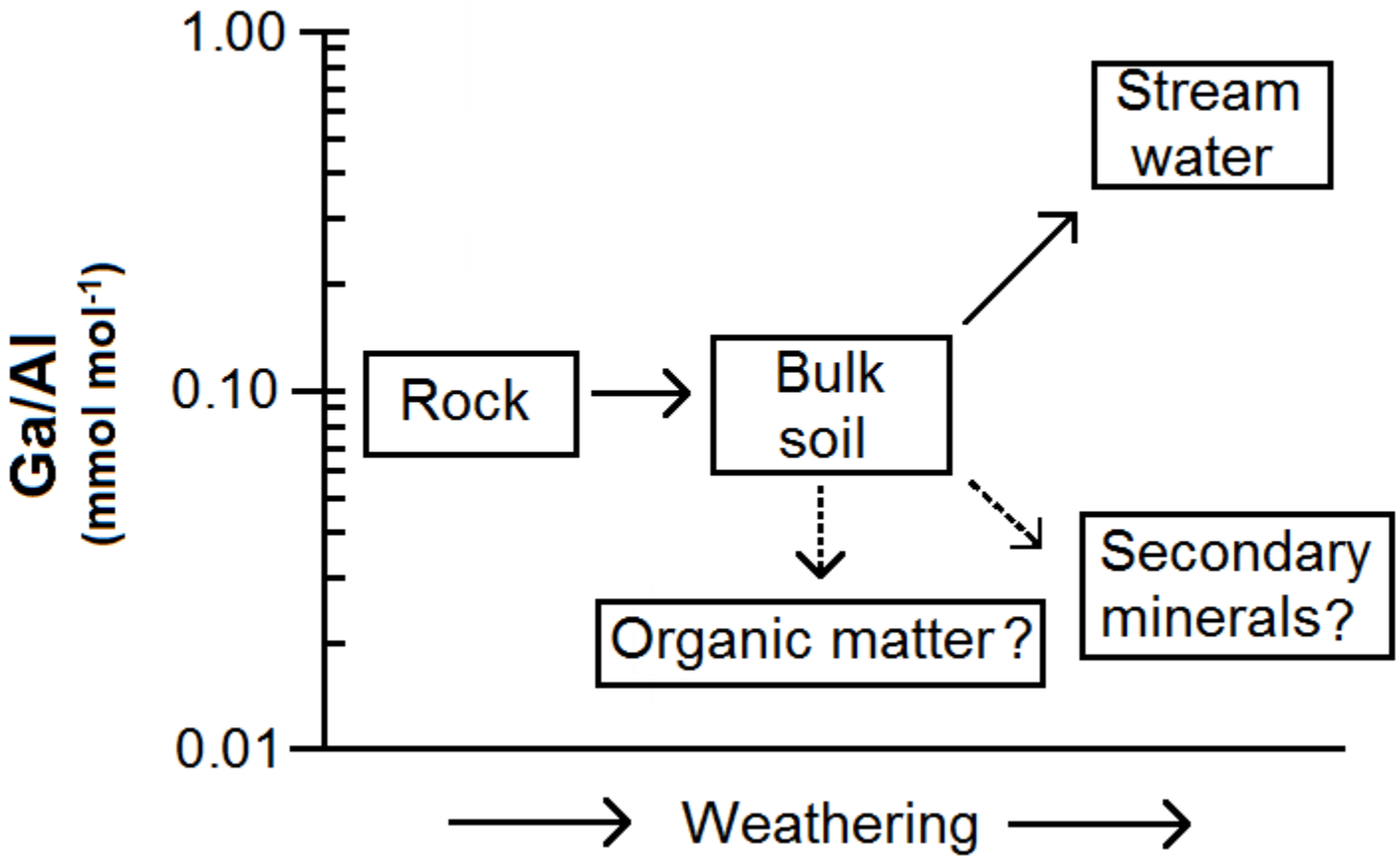


(3) Ga and Al must have known fractionation processes



Visual MINTEQ

(3) Ga and Al must have known fractionation processes



Based on data from Shiller and Frilot (1996)

Using Ga to understand Al in the Critical Zone

Question

- Are sorption/precipitation reactions affecting Ga/Al ratio in Critical Zone during weathering?

Hypothesis

- Less strongly bound fractions will have a very different Ga/Al ratio due to sorption.

Boulder Creek CZO
Granitic
MAT: 5 ºC MAP: 519 mm/yr

Calhoun CZO
Granitoids
MAT: 16ºC MAP: 1250 mm/yr

Southern Sierra CZO
Granitoids
MAT: 8 ºC MAP:1200 mm/yr

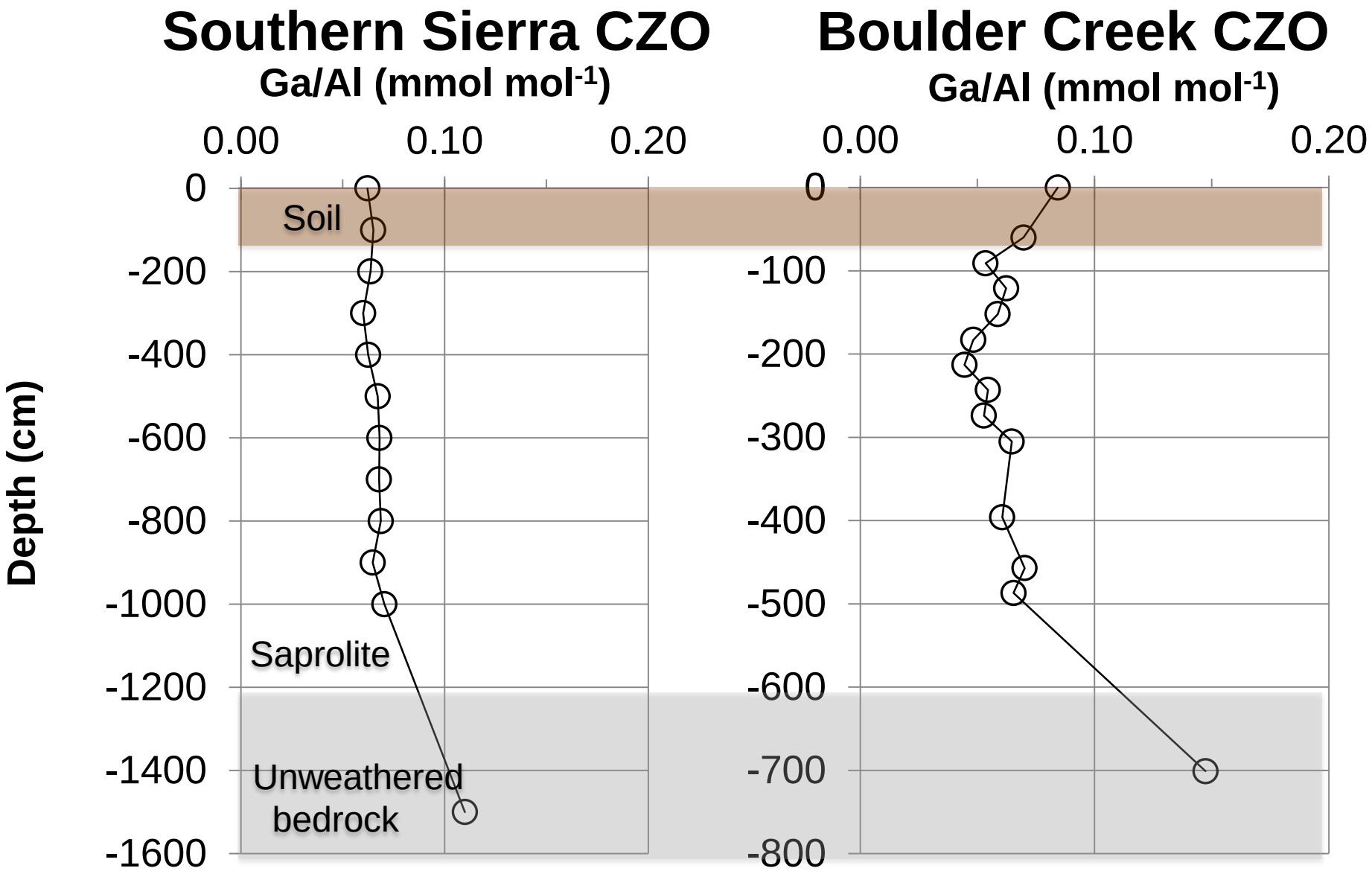
Sequential extractions

Organic matter/ extractable phase (H_2O_2 + Acetic acid)

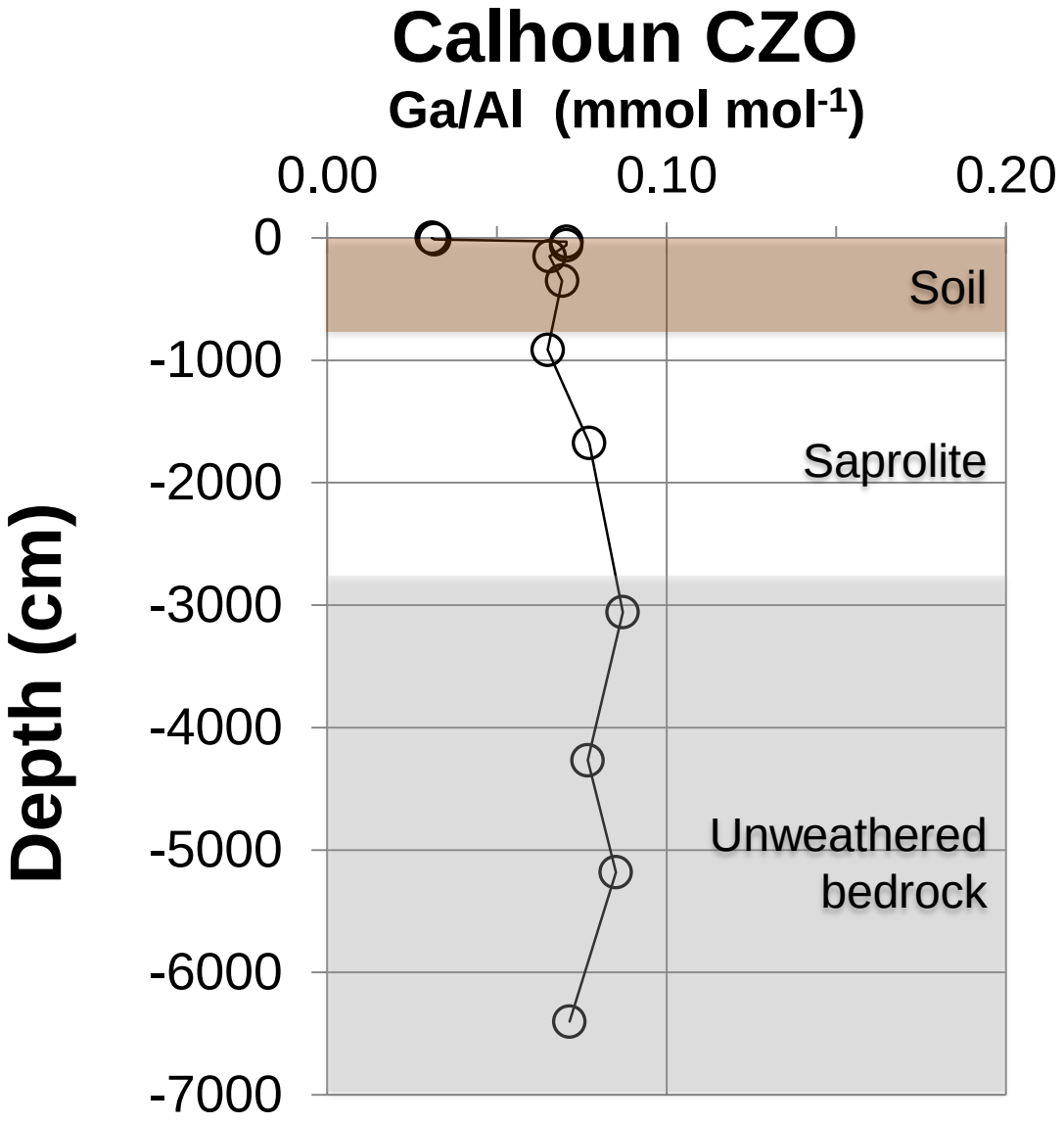
Oxide extraction (Citrate-biocarbonate-dithionite)

Total digestion/ residual fraction ($HF + HClO_4$)

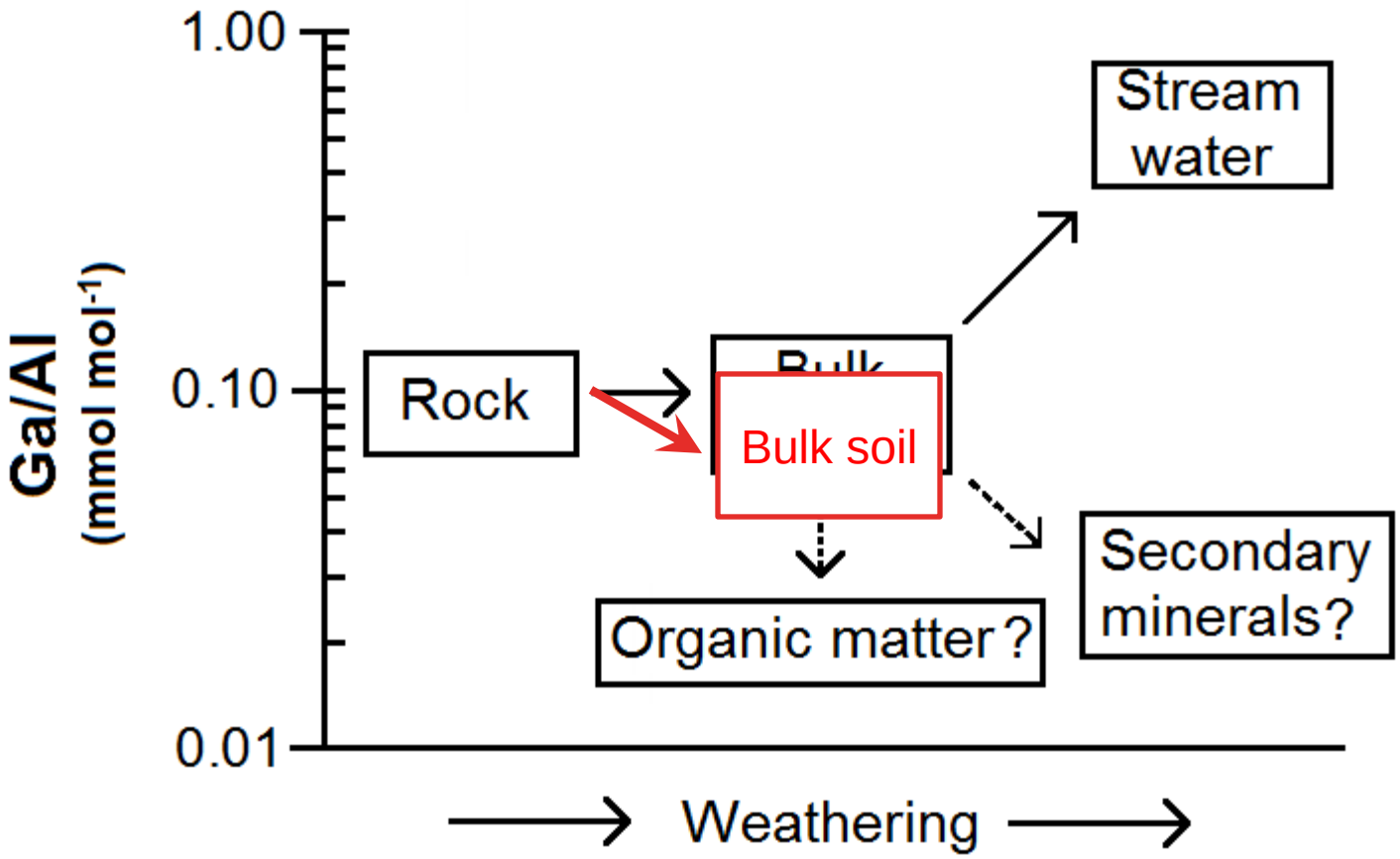
Residual fraction



Residual fraction

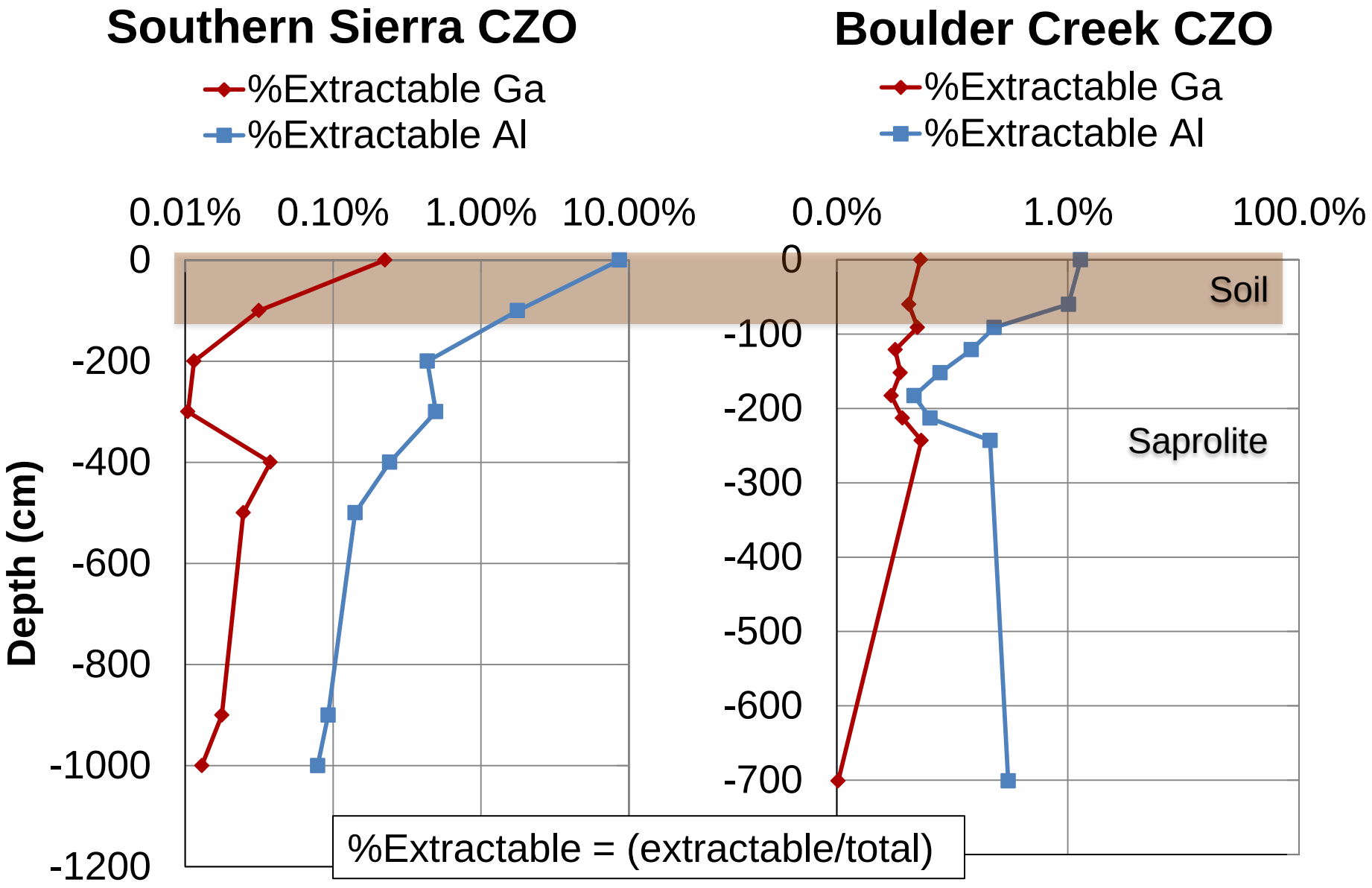


(3) Processes that fractionate Ga/Al ratio

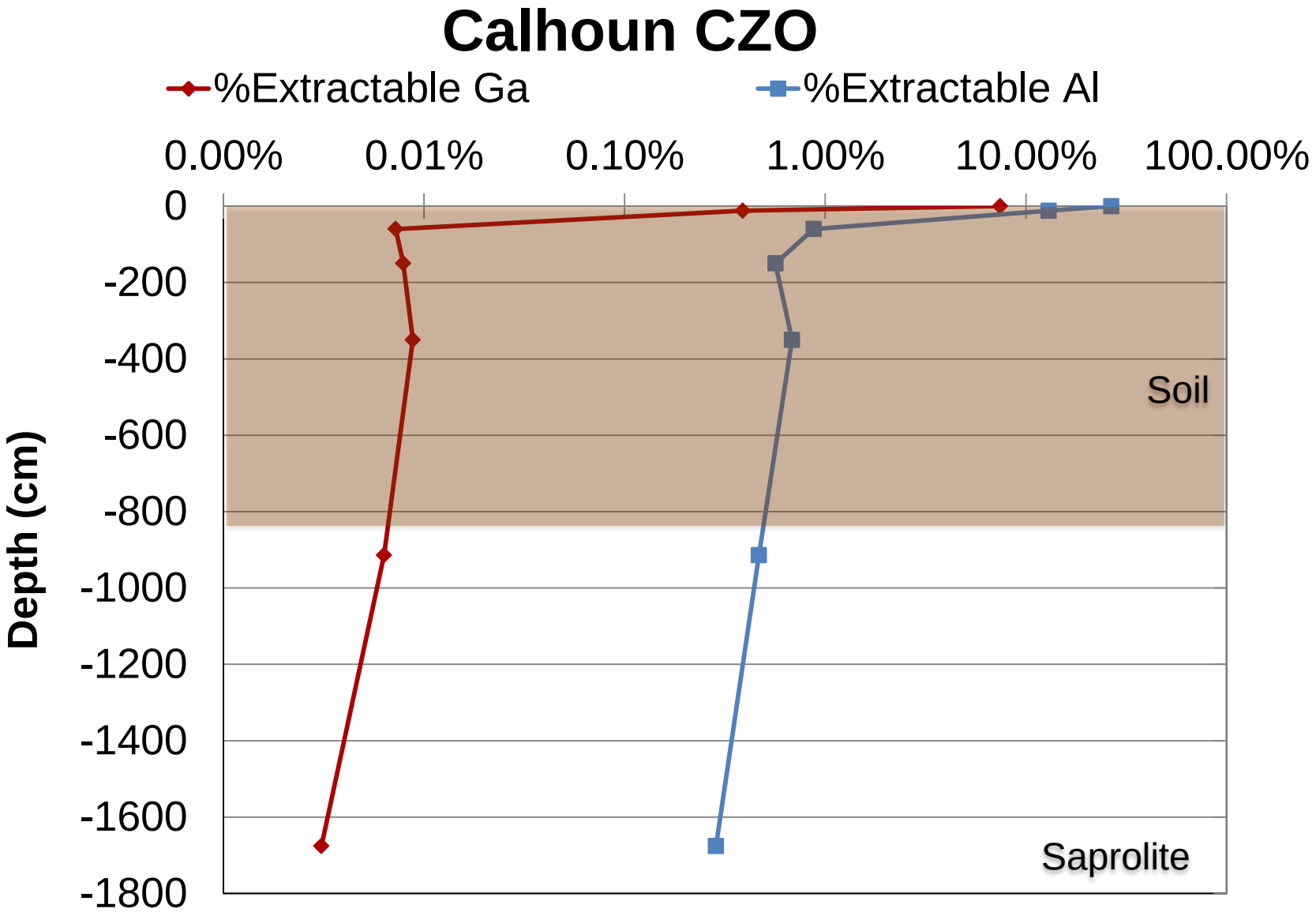


Based on data from Shiller and Frilot (1996)

Organic matter/extractable fraction



Organic matter/extractable fraction



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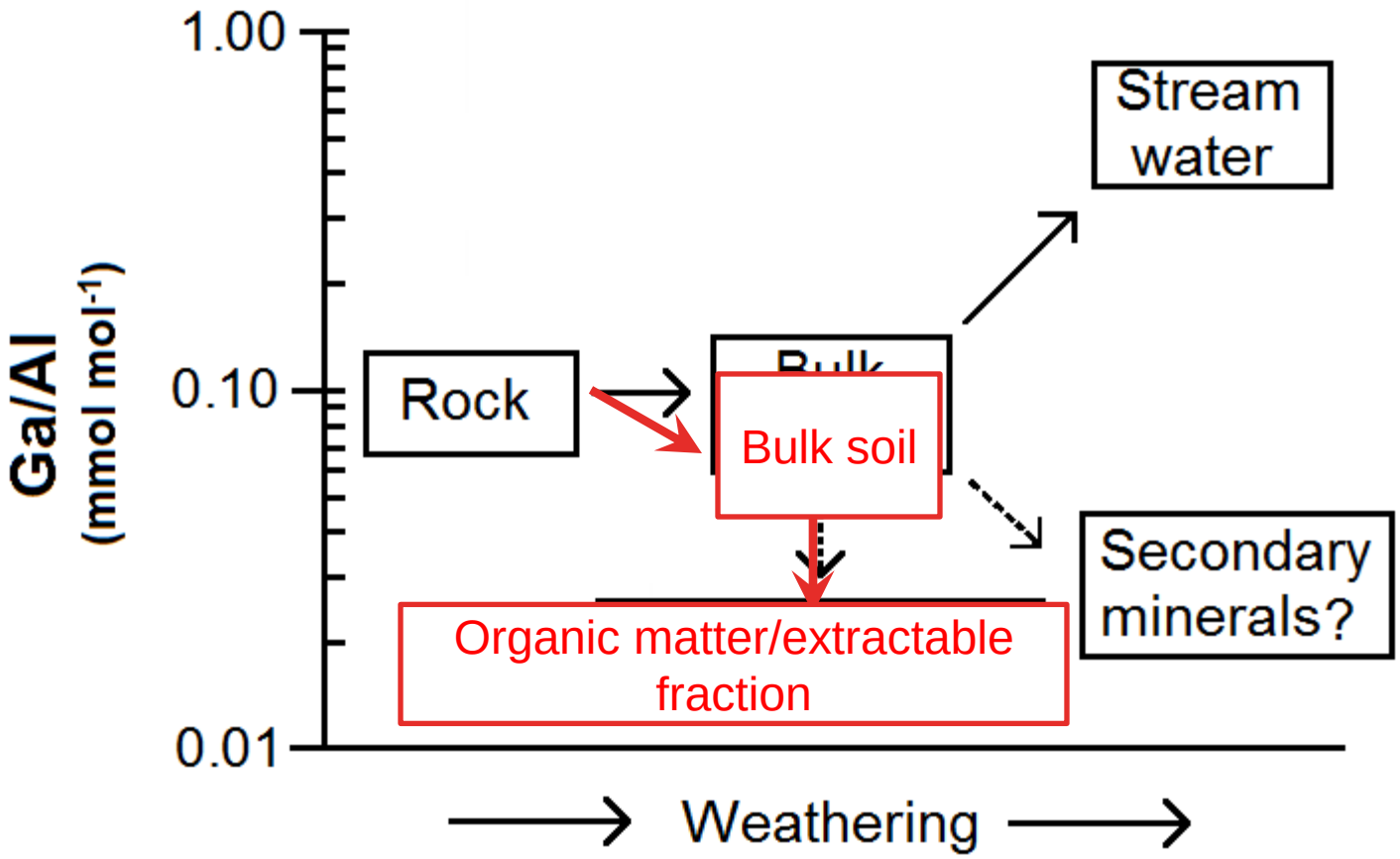
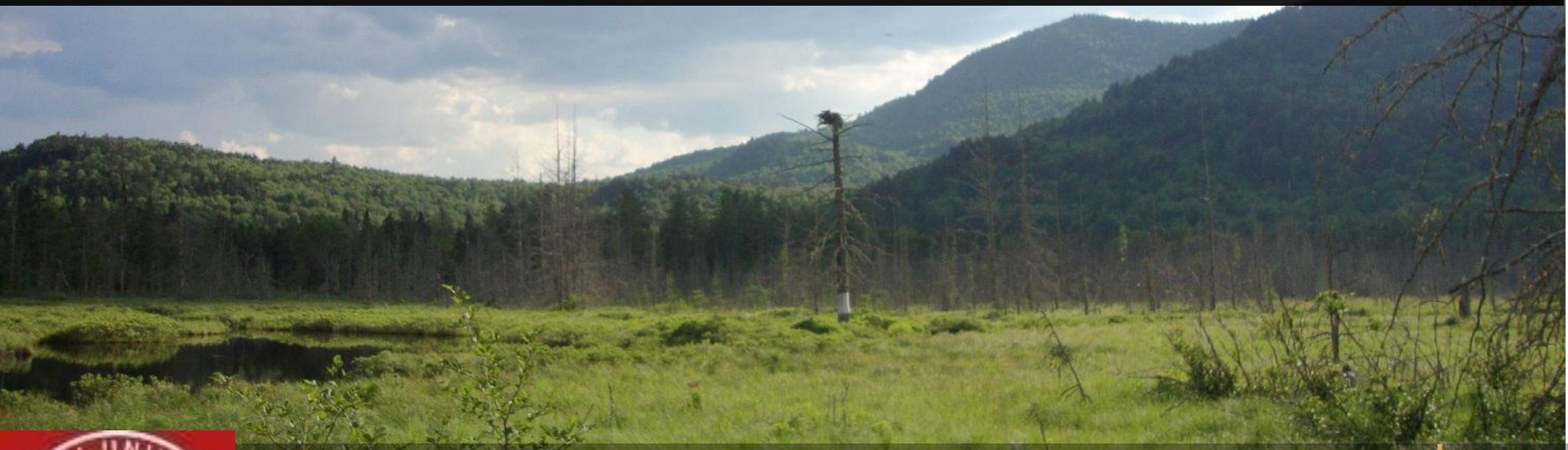


Based on data from Shiller and Frilot (1996)

• Summary

- Ga/Al ratio decreased during the bedrock-regolith-soil transition.
- Ga/Al in the organic matter/exchangeable fraction was very different.
- The Ga/Al ratio maybe useful for distinguishing colloidal and dissolved losses of Al.



Thank you!
Questions?