Working Group 2

Rockwoods Spring, Missouri
Photo credit: J. Fine

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Working Group 2: Hydrology 2 (hydrology, weathering, climate & land use change)		
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Rockwoods Spring, Missouri
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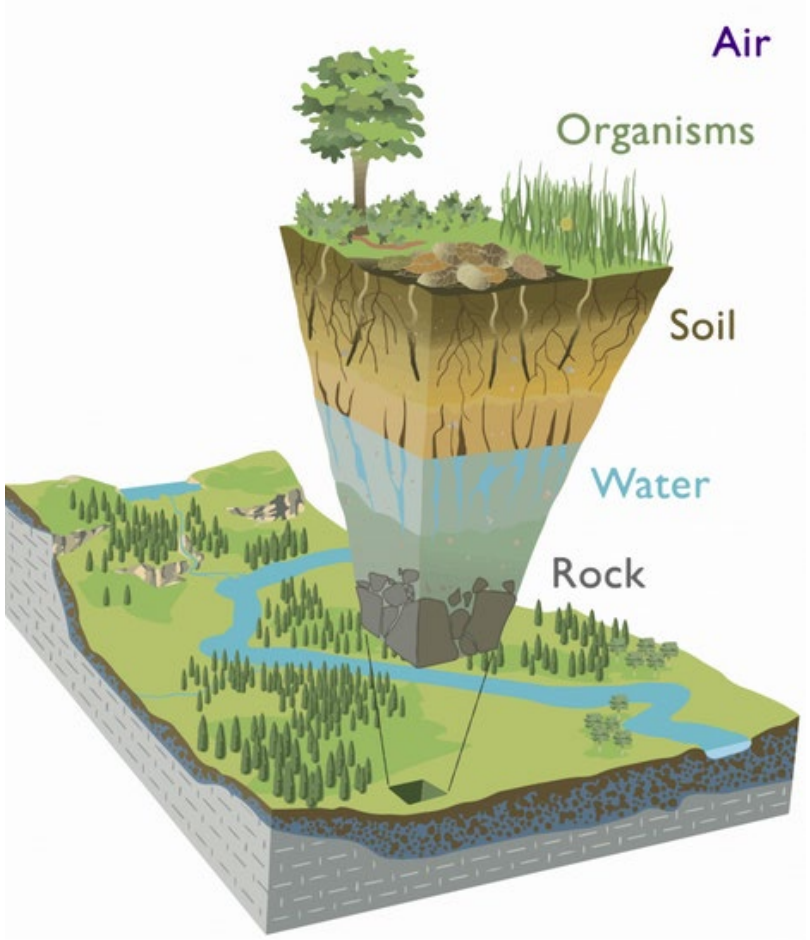
Question 1: Space

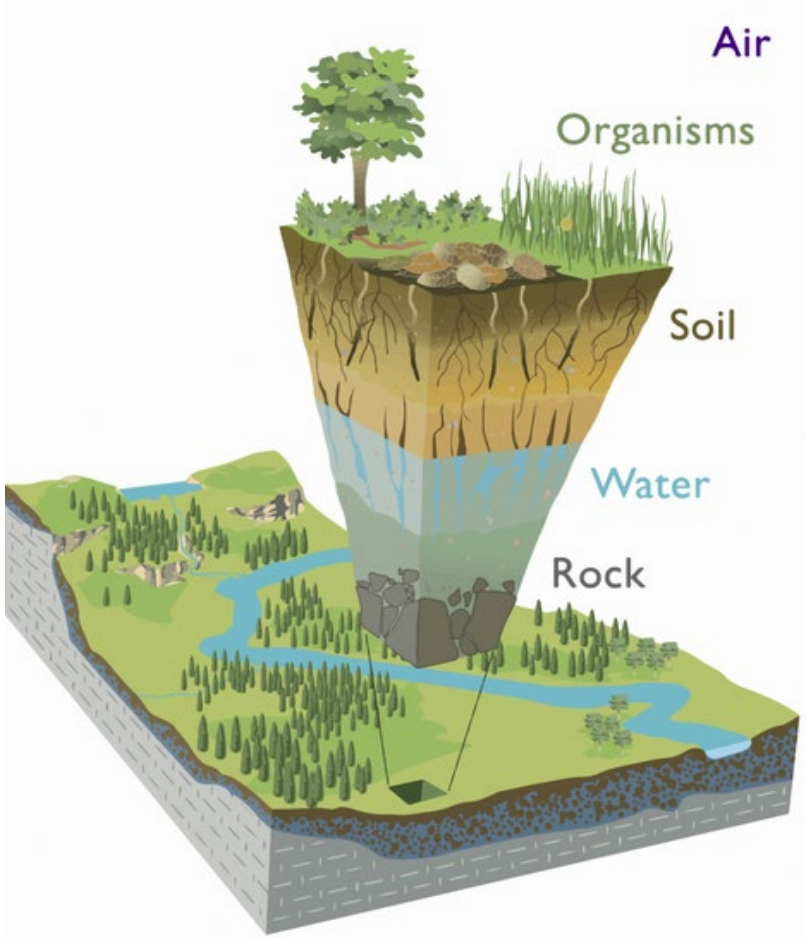
- How do small scale heterogeneities affect flow and transport at larger scales?
- How does flow and transport scaling affect different CZ processes?
- How does the scaling of flow and transport differ between carbonate and silicate CZs?



"After Chorover et al, 2007. Catalina-Jemez CZO."

Justification 1: Space

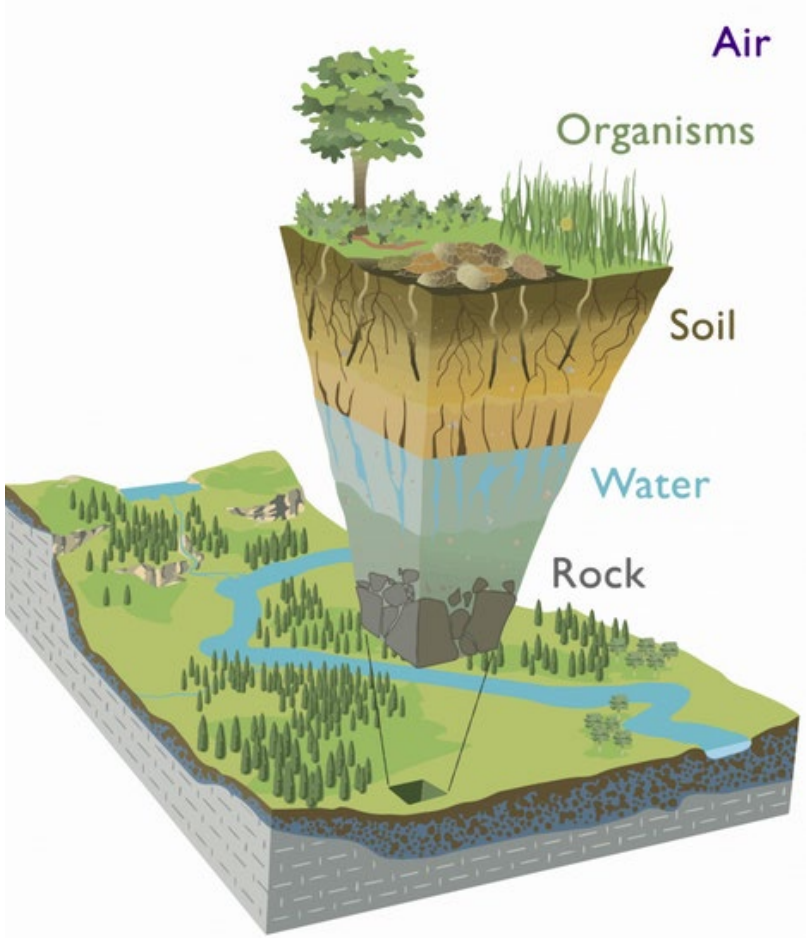
- An integrative conceptual model is needed to extrapolate/transfer knowledge across systems.
  - Carbonate research often focuses on individual systems: “*Every site is different.*”
  - We must determine the scales at which observations are transferable.



"After Chorover et al, 2007. Catalina-Jemez CZO."

Justification 1: Space

- The relevant scale(s) needed to capture the dynamics of carbonate systems will depend on the questions being asked and the critical zone processes being studied.
    - We must address what scales are needed for modeling and balance these needs with efforts to obtain more data.

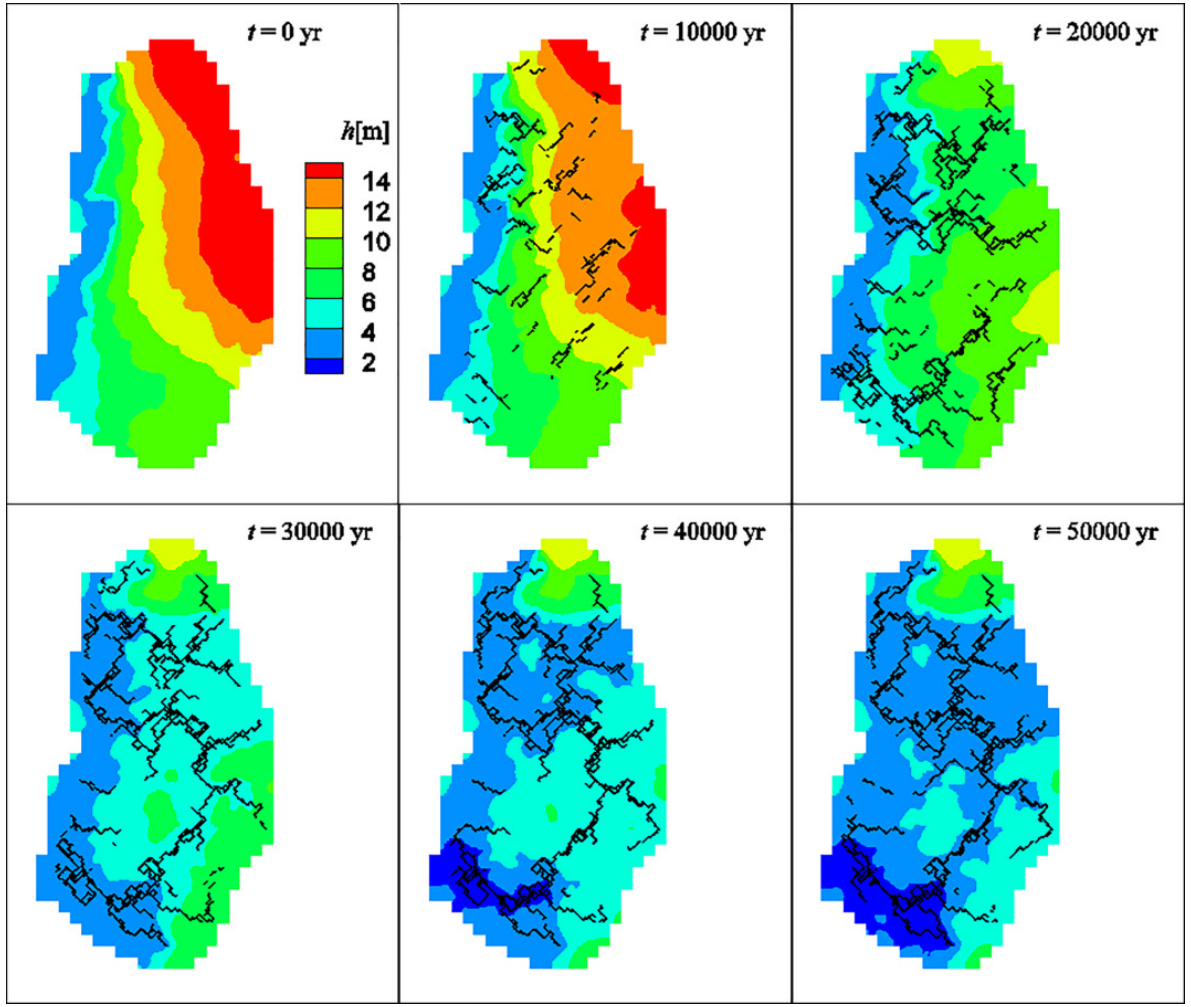


"After Chorover et al, 2007. Catalina-Jemez CZO."

Question 2: Time

- What role do different temporal scales play when considering hydrological processes under changing climate and land use scenarios?

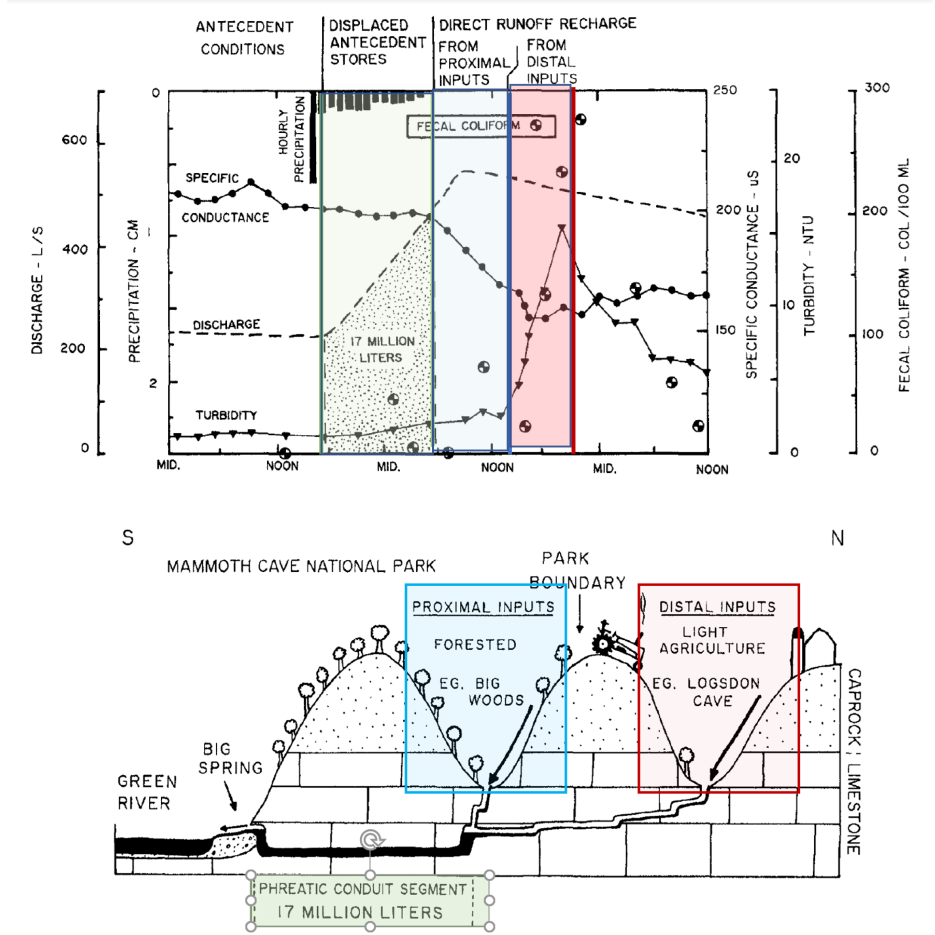
- What are the rates of change for flow, carbon cycling, and weathering in response to climate and land use changes?



Modeled evolution of a conduit network and hydraulic head field over time (de Rooij and Graham, 2017).

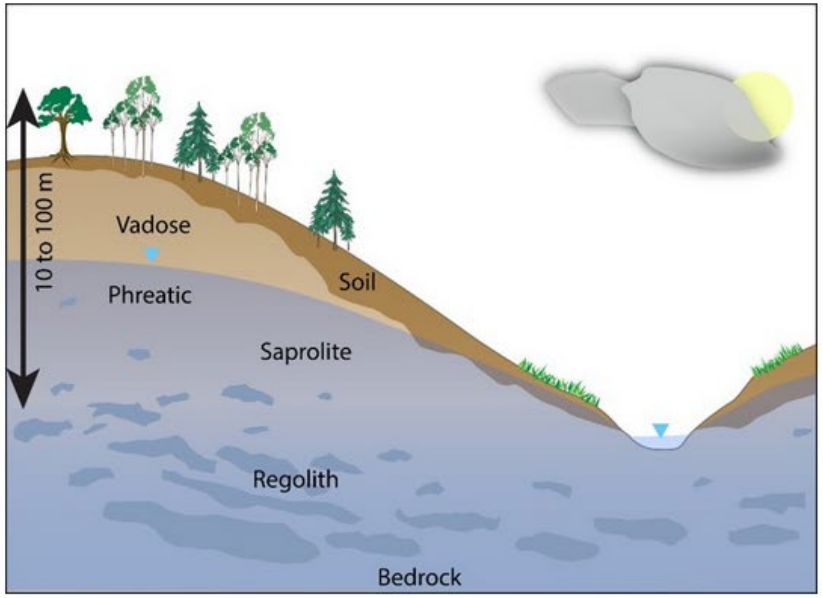
Justification 2: Time

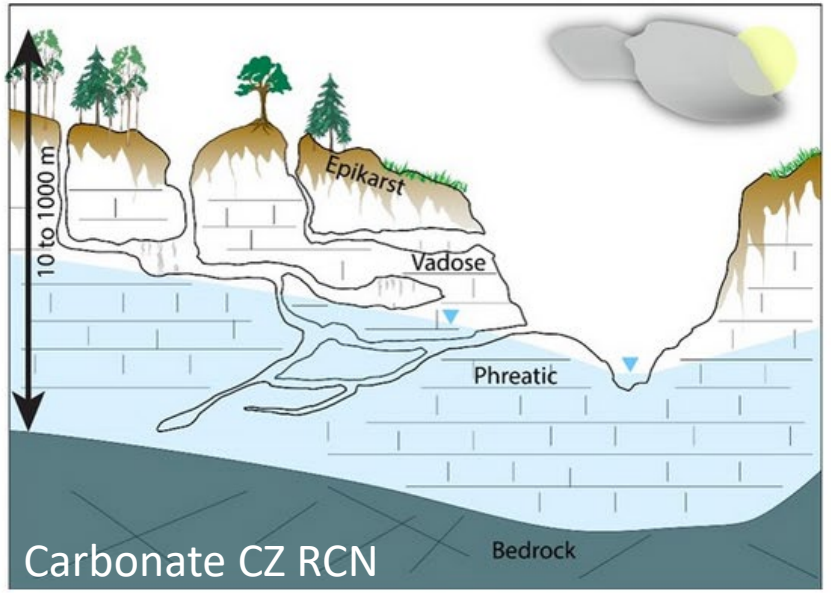
- We must understand human impacts on carbonate CZs and at what timescales they are important.
  - Critical for developing adaptation and mitigation strategies.
- The carbonate CZ may be a bellwether for change.



Variable arrival time of different tracers in Mammoth Cave karst, Kentucky (Ryan and Meiman, 1996).

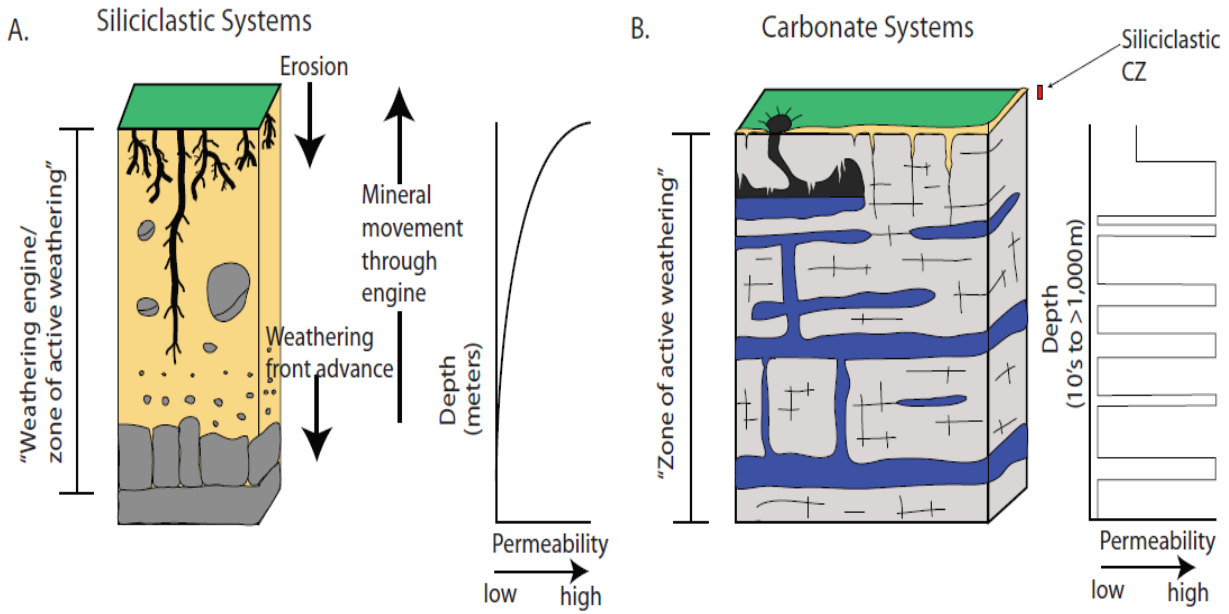
Question 3: Lithologic gradient





- How do physical and chemical processes vary across the silicate to carbonate gradient?
  - For example:
    - What role do carbonate CZs play in the global carbon cycle when compared with silicate CZs?
    - How might this change over time as a result of climate change?

Justification 3: Lithologic gradient

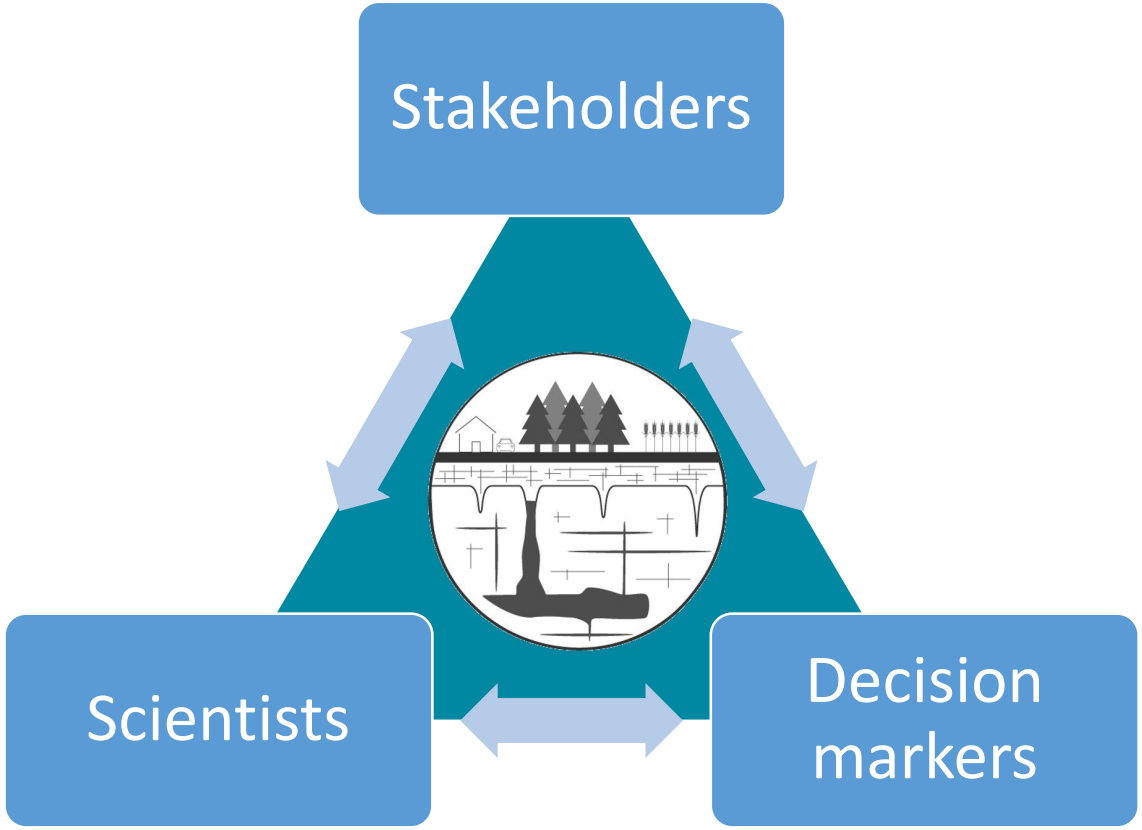


The "Critical Zone Reactor" in siliciclastic systems (A) creates intense surface weathering and shallow critical zones (10^0 - 10^1 m). In carbonate systems (B), weathering via dissolution is still induced by surface processes (OM dynamics), but occurs preferentially at discrete subsurface horizons, resulting in extreme heterogeneity in permeability and thicker zones of weathering (10^1 – 10^3 m), with no accumulation of secondary weathering products (Graham et al., 2012).

- We need context to understand how different bedrock conditions affect CZ processes.
- We must determine what conceptual models of CZ processes transfer across the silicate-carbonate spectrum.
- If we overlook carbonate CZs, we could be ignoring an important bellwether.

Question 4:
Coproduction of CZ science

- How can we advance our science and its communication by engaging local stakeholders (e.g., indigenous people) and decision makers in our carbonate CZ research?



Justification 4: Coproduction of CZ science

- Codeveloping new science with local communities is critical.
- We must break boundaries among scientists, decision makers, and people who are affected (stakeholders).
- We can learn from stakeholders' experiences and traditional ecological knowledge.