Carbonate Critical Zone Research Coordination Network

Working Group 5

Weathering (Weathering, hydrology, climate & land use change)

Participants

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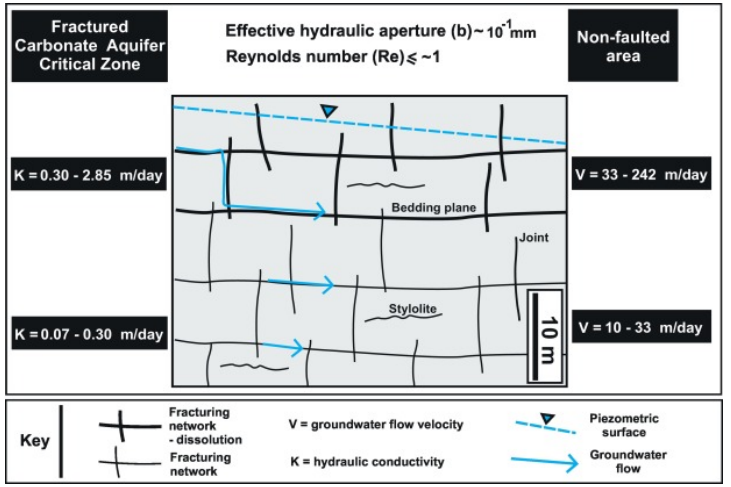
Q1: How do feedbacks between physical and chemical weathering vary with a) increasing carbonate mineral content and b) fracturing with depth in the critical zone?

Justification:

Physical weathering ⇔ Chemical Weathering

Road cut in Precambrian Boulder Creek granodiorite, showing weathered rock under a thin regolith

Anderson, S. P., von Blanckenburg, F., & White, A. F. (2007). Physical and chemical controls on the critical zone. *Elements*, *3*(5), 315-319.



Conceptual model of fluid flow on a fractured carbonate aquifer at shallow depths.

Medici, G., West, L. J., & Banwart, S. A. (2019). Groundwater flow velocities in a fractured carbonate aquifer-type: implications for contaminant transport. *Journal of contaminant hydrology*, *222*, 1-16.

Q2:How will weathering of carbonate mineral-rich critical zone (CZ) respond to anthropogenic climate change, including changing hydrologic characteristics (extreme floods and droughts) and land use (shifts in vegetation)?

Karst terrain in Belize is undergoing deforestation at alarming rates. Tropical jungle on the left and deforested land on the right.
World Land Trust, 10/04/2019

Justification:

Climate change influences

Water cycles, floods, droughts, ET

Land Use Change influences

CZ weathering through root zones

ET, permeability

Methods:

Remote Sensing, geophysics,

soil studies, spelothems

Increasing anthropogenic pressure on karst terrain through cultivation in China has led to the progressive use of marginal lands for cultivation (Chenqi and Chenjiazhai, Puding County, Guizhou Province).
Green, S. M., Dungait, J. A., Tu, C., Buss, H. L., Sanderson, N., Hawkes, S. J., ... & Johnes, P. (2019). Soil functions and ecosystem services research in the Chinese karst Critical Zone. *Chemical Geology*, *527*, 119107.

Q3: How are all phases of weathering products (dissolved, colloidal, suspended particles, bedload) transported through and from the carbonate mineral-rich critical zones?

Sediment pile accumulated at the base of a vertical shaft in Turner Avenue in the Mammoth Cave System, Kentucky. Turner Avenue is a high-level abandoned conduit so the sediment pile remains where it was deposited.
Herman et al., 2012, Carbonates and Evaporite

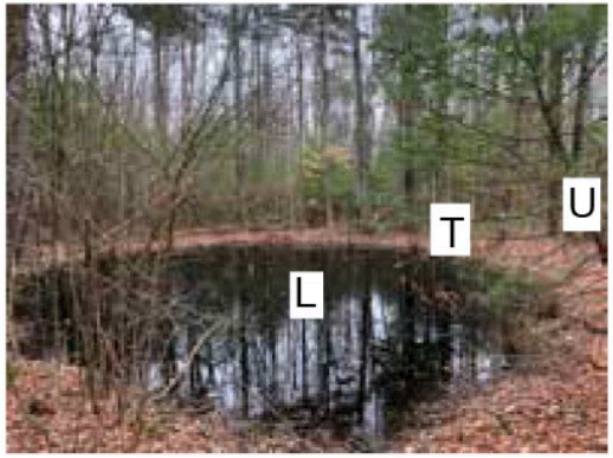
Justification:

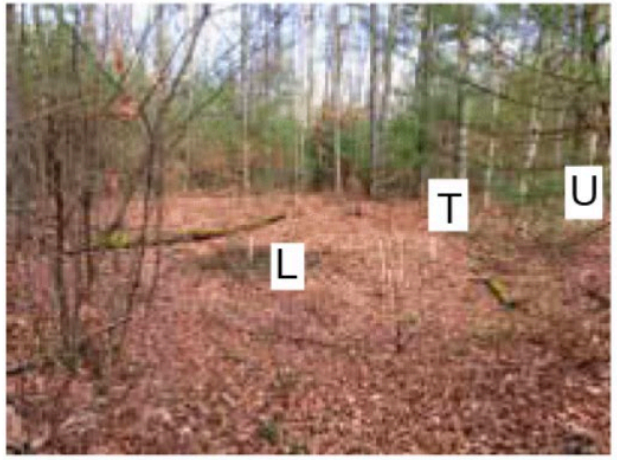
Weathering creates and mobilizes dissolved and suspended materials within and out of the CZ.

Changing water chemistry and altering surface ecosystems to which they discharge.

Solid material transport can influence CZ porosity and permeability

Q4:What are the primary hydrologic and geochemical controls on development of redox gradients in carbonate critical zones (CZ) and how do the redox gradients impact variations in pH gradients and weathering reactions?



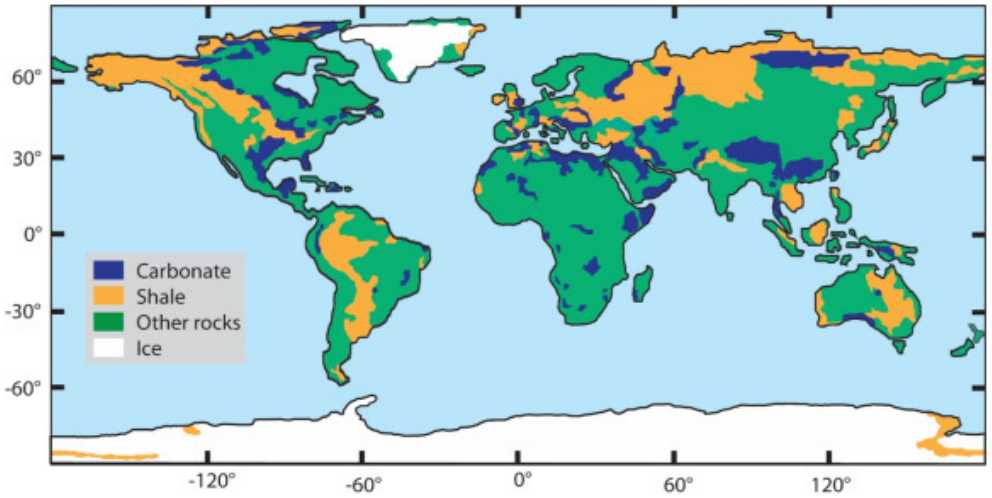


Example of flooded and drained seasonal wetland with marked upland (U), transition (T), and lowland (L) positions affecting weathering reactions.
LaCroix, R. E., Tfaily, M. K., McCreight, M., Jones, M. E., Spokas, L., & Keiluweit, M. (2019). Shifting mineral and redox controls on carbon cycling in seasonally flooded mineral soils. *Biogeosciences*, *16*.

Justification:

Controls of redox state are poorly known but drive weathering reactions of metals and nutrients

Need to determine types of OM and acids other than CO_2



Global exposures of carbonate (blue regions) at Earth's surface where carbonate CZ will develop. Regions labeled as shale (brown regions) may contain varying fractions of carbonate minerals that could affect CZ processes. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.) Modified from Amiotte Suchet et al. (2003) and Martin (2017).
Sullivan, P. L., Macpherson, G. L., Martin, J. B., & Price, R. M. (2019). Evolution of carbonate and karst critical zones.