Groundwater-Surface Water Mixing in the Hyporheic Zone Stimulates Organic Carbon Turnover

Objective

- Test hypothesis that changes in ground and river water mixing drive a coupled response in the hyporheic zone biogeochemistry and microbial community as a result of shifting ecological pressure linked to resource availability.

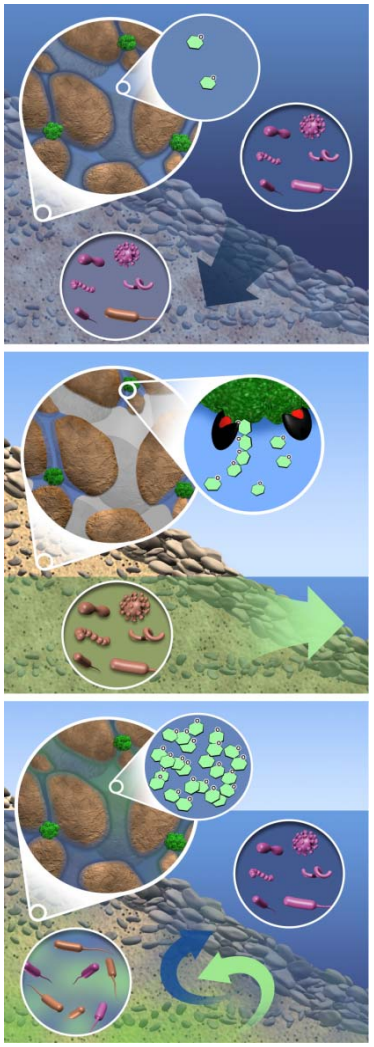
Approach and Results

- Intensive monitoring during short term fluctuations in river stage that drive changes in ground and river water mixing within the Columbia River hyporheic zone.
- Combine next generation DNA sequencing, ultra-high resolution organic carbon profiling, and ecological theory to quantify microbial community dynamics and reveal underlying drivers of change.
- Groundwater-surface water mixing shifts the coupled microbiome-biogeochemical system from mixing-driven stochastic to deterministic with elevated biogeochemical reaction rates.

Significance and Impact

- Identified a potentially important link between climate-change driven shifts in watershed hydrology and rates of elemental cycling and contaminant dynamics.
- Basis for improving hydrobiogeochemical models through the representation of mixing-driving ecological shifts.

Conceptual depiction of hyporheic zone carbon dynamics driven by changes in river stage.



At high stage the hyporheic zone is inundated with river water (dark blue arrow). Well-connected pore channels and active microbial communities continuously metabolize soluble organic carbon (visualized as green molecules) as it becomes available from enzymatic degradation of particulate organic carbon.

At low river stage the hyporheic zone is dominated by groundwater discharge (green arrow). Large interconnected pores drain following the decline in river stage. Extracellular enzymes (black and red) degrade particulate organic carbon into soluble organic carbon but unsaturated conditions limit the transport of soluble carbon to microbial cells.

A rise in river stage saturates sediments filling large pores and transporting accumulated soluble carbon to microbial cells that in turn stimulates microbial respiration.

Stegen, J.C., Fredrickson, J., Wilkins, M.J., Konopka, A., Nelson, W.C., Arntzen, E., Chrisler, W.B., Chu, R.K., Danczak, R., Fansler, S., Kennedy, D., Resch, C.T., Tfaily, M. (2015). Groundwater-surface water mixing shifts ecological assembly processes and stimulates organic carbon turnover. *Nature Communications*, In press.