COLORADO SCHOOL OF MINES

Mapping increases in hyporheic exchange from channel-spanning logjams

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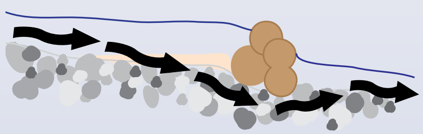
Logjams and Hyporheic Flow

Logjams in streams increase the hydraulic resistance and create pressure gradients along the riverbed that drive exchange flows in the hyporheic zone—where surface water and groundwater mix.

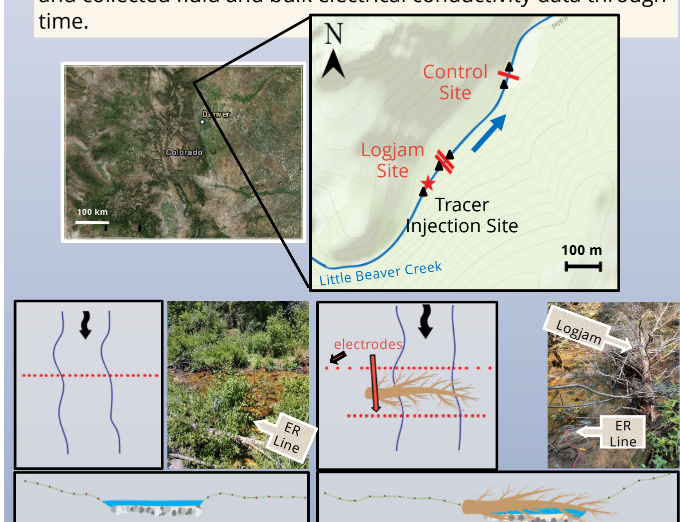
Here, we investigate the quantitative changes in hyporheic exchange due to channel-spanning logjams and varying flow rates using field measurements.



Logjams drive hyporheic exchange flows.

Field Site: Little Beaver Creek, CO, USA

We compare two transects: a control and a site with a channel-spanning logjam. We introduced a NaCl tracer test at three times during baseflow recession (one test in June, two in July), and collected fluid and bulk electrical conductivity data through time.

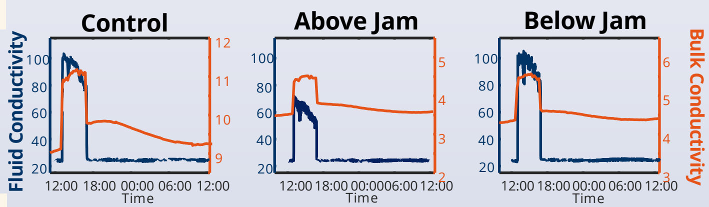


Left: the control site, without a logjam; Right: two transect in a reach with a channel-spanning jam. The cross sections at the bottom show the elevation profiles at each site.

Results of Tracer Tests

The average bulk apparent conductivity does not return to background quickly like the fluid measurements at any flow rate; these data are sensitive to tracer in the hyporheic zone.

We use moments to interpret these curves and what they tell us about hyporheic exchange flows.

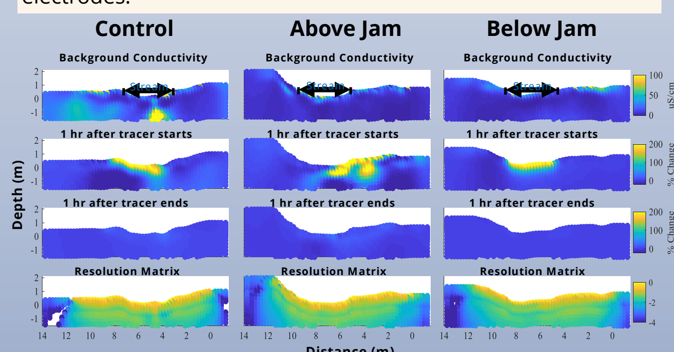


Fluid conductivity (dark blue) returns to background values right after the tracer test ends. Bulk conductivity (orange) does not and exhibits tailing. Data from the June 13-14 tracer test.

Geophysical Imaging of the Hyporheic Zone

The positive change in electrical conductivity (yellow) 1 hr into the injection shows the movement of the tracer into the hyporheic zone. After the tracer test ends, it is difficult to visually detect it in the subsurface.

Resolution decreases with depth and distance from the electrodes.



2-D electrical resistivity imaging of tracer tests at three locations from the June tracer test.

Temporal Moments

Fluid Electrical Conductivity

Temporal Moments	Control			Above Jam			Below Jam		
	6/13	7/10	7/29	6/13	7/10	7/29	6/13	7/10	7/29
M_0 (mg/L)	328	204	356	66	--	65	92	99	96
Mean arrival time (hr)	2	2	2	2	--	2	3	2	2
Variance (hr^2)	4	5	7	2	--	3	4	3	3
Skewness	39	53	87	18	--	36	38	13	13

Bulk Electrical Conductivity

Temporal Moments	Control			Above Jam			Below Jam		
	6/13	7/10	7/29	6/13	7/10	7/29	6/13	7/10	7/29
M_0 (mg/L)	225	89	91	42	12	17	48	11	15
Mean Arrival Time (hr)	7	6	5	9	8	8	10	8	7
Variance (hr^2)	36	32	29	42	40	42	36	34	33
Skewness	204	225	225	120	185	181	64	100	131

Conclusions

Our results show that 1) higher hyporheic exchange flows (HEF) occurred at the reach with a logjam, 2) logjams create complex HEF pathways that can cause bimodal breakthrough curve behavior downstream, and 3) higher discharge rates associated with spring snowmelt increase the extent and magnitude of HEF.

Numerical modeling (not shown here) supports all three field findings, and suggest that lower flows increase solute retention in streams although this is not supported by field results.

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