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Seasonal variability in alluvial cover in bedrock canyons

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Active incision in bedrock rivers sets the pace of landscape evolution. The rate of incision depends primarily on the shear stress exerted by the flow on the bed and the sedimentological and geological characteristics of the river reach. Little is known about the flow field, sediment transport and morphology in steep-walled bedrock canyons, where flow experiences significant friction of the walls and transport is supply-limited. Here, we present results from two recent field campaigns into the Fraser Canyon in British Columbia. A set of flow and topography measurements through several bedrock canyons under low flow conditions (discharge <2000 m3/s) is compared to a data set collected following a spring freshet (moderate discharge >5000 m3/s). We present high-resolution topographic maps of the canyon floor and walls derived from a multibeam echosounder survey. Under low flow conditions, a thick (up to 10 m) alluvial cover builds up at the canyon entrance and within the canyon. Under moderate flow, the cover is flushed out and the material is passed through the canyon reach. This observation under moderate flow coincides with the strengthening of a plunging flow structure at the canyon entrance that causes increased shear stresses at the bed. Our findings suggest that this combination of variability in channel bed exposure and bed shear stress concentration and intensification through plunging flow structures is a cyclic phenomenon and controls bedrock incision in the Fraser Canyon on a seasonal scale.