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Linkages between sediment supply and channel morphology in gravel-bed river systems

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Mountain river systems are characterized by a wide range of channel patterns and varying levels of instability. In steeper channels- torrents and cascades- resistant bed and bank materials tend to limit entrainment and transport, except during large floods or debris flows. In lower-gradient channels, with meandering or braided planforms, bed and bank materials are mobilized more frequently, consequently channel geometry is maintained by a long-term balance between bank erosion and the lateral migration and growth of bars. These differences in stability are largely a reflection of position with the drainage network, but other factors, such as valley confinement and drainage basin sediment supply (both quantity and grain size), play equally strong roles in the downstream evolution of channel morphology. In this talk we present data and preliminary results from a comparative study of the influences of sediment supply on channel morphology in rivers draining high-elevation basins in the Rocky Mountains and the French Alps. Study sites are located in river basins with high to very high relief (1000-3000 m), and hydrologic cycles dominated by snowmelt runoff. The scaling between peak flows and drainage basin area is very similar in both regions. There are sharp contrasts, however, in the underlying rock types, and the connectivity between hillslopes and channels, such that the sediment supply to rivers in high-relief areas of the French Alps is orders of magnitude higher than in the Rocky Mountain region. Rock type also influences the grain size and durability of the sediment delivered from hillslopes, thus sand and fine gravel are abundant in French alpine channels. The net effect of finer grain sizes in channels with steep slopes is to produce Shields numbers that are 2-3 times the threshold for motion at channel-forming discharges. These conditions are quite different from conditions in Rocky Mountain channels where the Shields numbers at bankfull flows are typically much closer to the threshold for motion. The contrasts in sediment supply and channel stability noted here exist in many other regions of the world, and we encourage further research on mountain stream systems to better understand linkages between sediment supply and river channel dynamics.