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Deciphering topographic signals of glaciation and rock uplift in an active orogen: a case study from the Olympic Mountains, USA

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1. Figures

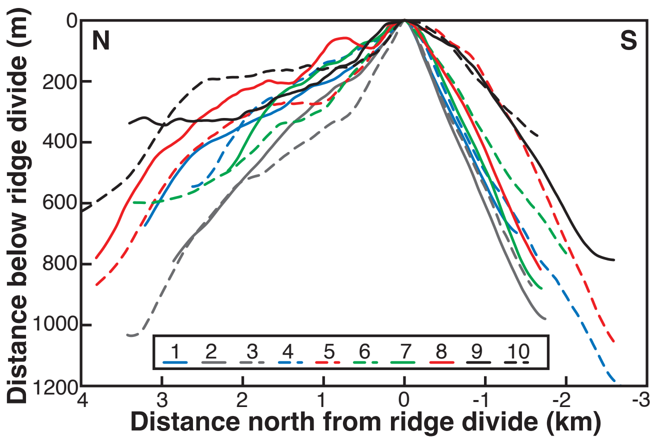

Figure S1. Mean elevation profiles across asymmetric ridges within the Olympic Mountains. See Figure 2f for swath locations. Horizontal distances have been referenced to the ridge divide position, and vertical distances have been referenced to the ridge divide elevation. Note that south facing ridge sides are much steeper than north facing ridge sides.

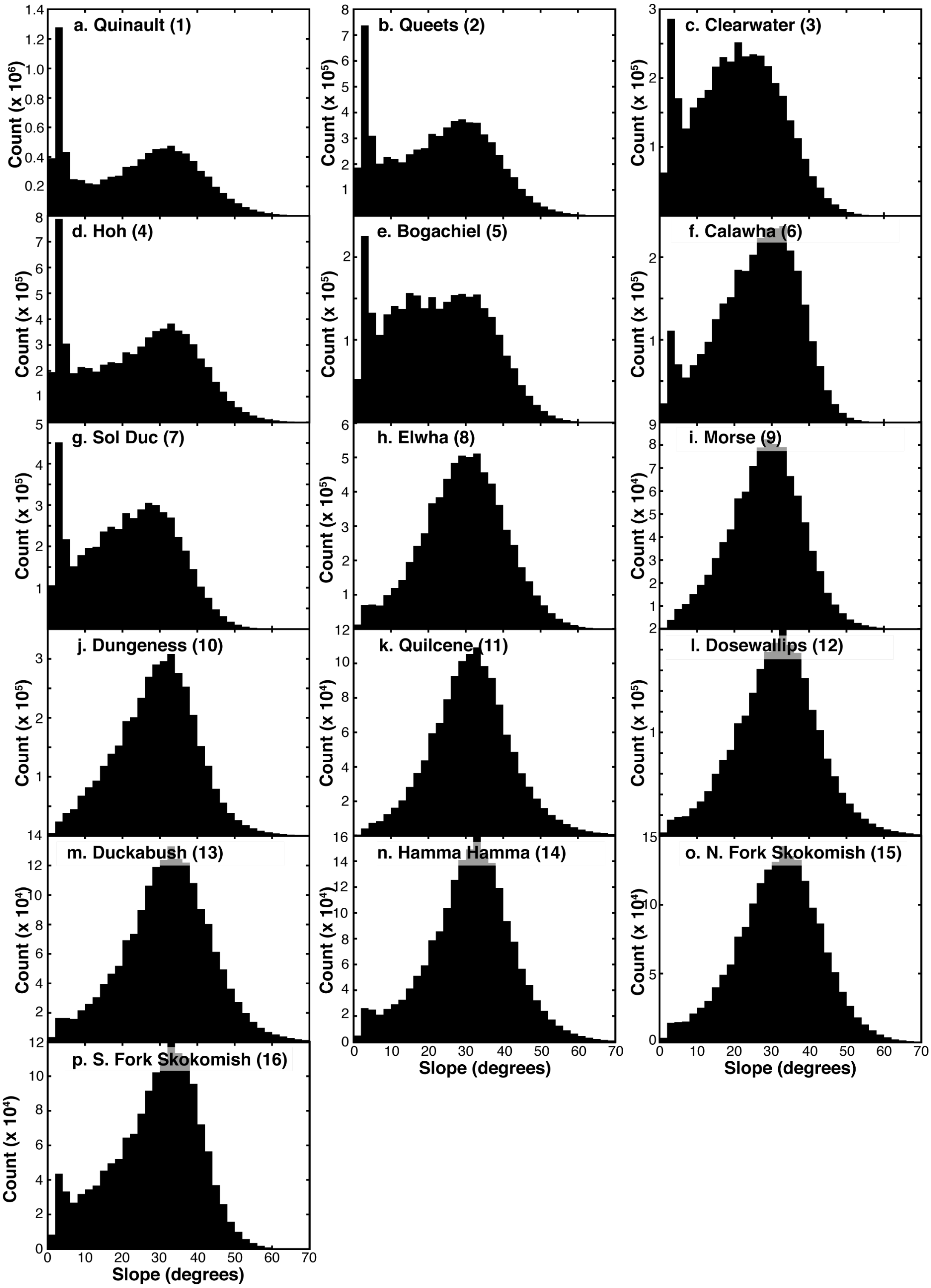

Figure S2. Slope histograms of basins in the Olympic Mountains. See Figure 2d for locations. Bin size is 2 degrees.

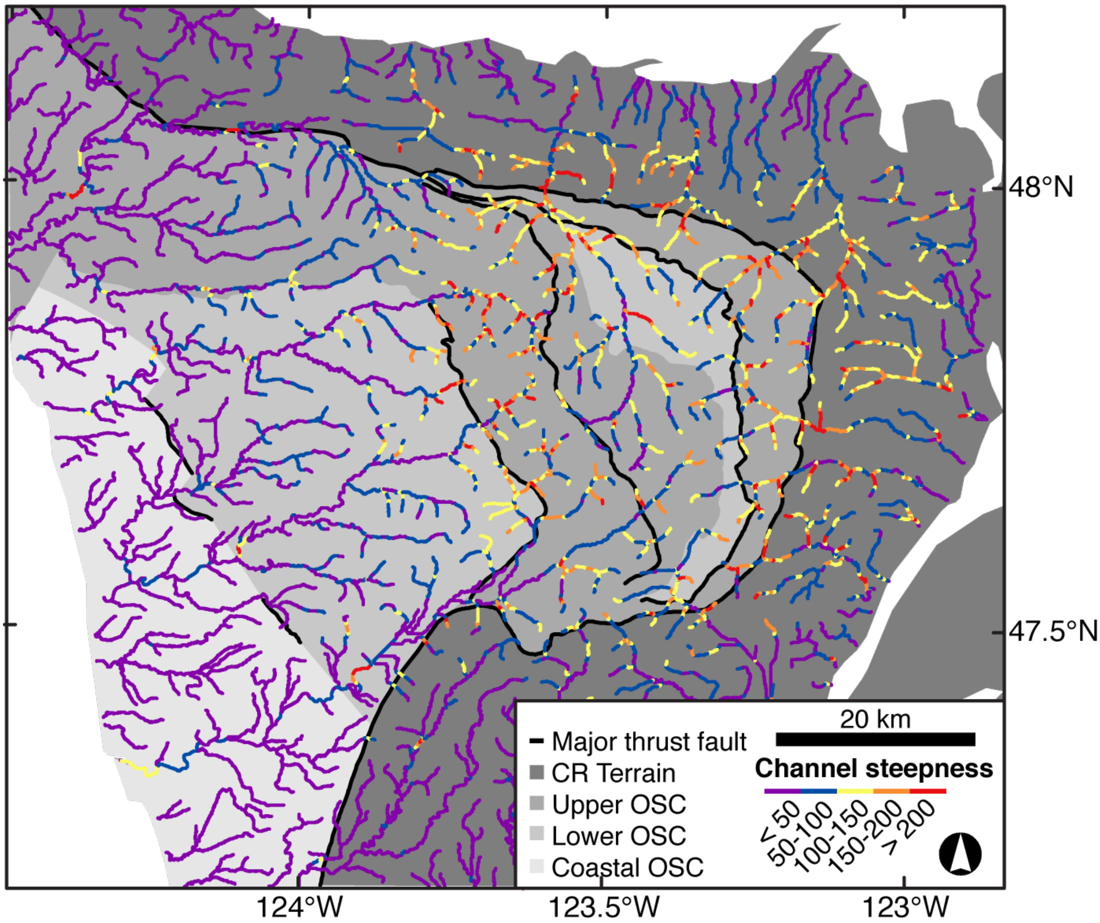

Figure S3. Simplified geologic map of the Olympic mountain range.

Tectonostratigraphic units (e.g., Brandon et al., 1998) overlain by a channel steepness map (shown for river reaches with accumulation areas > 2 km^2 to remove the effects of hillslopes and extant glaciers). Coast Range (CR) terrain – pillowed and massive basalts, diabase dikes, and rare pelagic limestone and reddish mudstone. Upper Olympic Subduction Complex (OSC) – mainly turbidite sandstone, and subordinate mudstone. Lower OSC – clastic sedimentary rocks, mainly turbidites. Coastal OSC – turbidites, mudstones, and minor pillow basalt. Note the lack of correlation between channel steepness, and tectonostratigraphic unit lithology or structures.

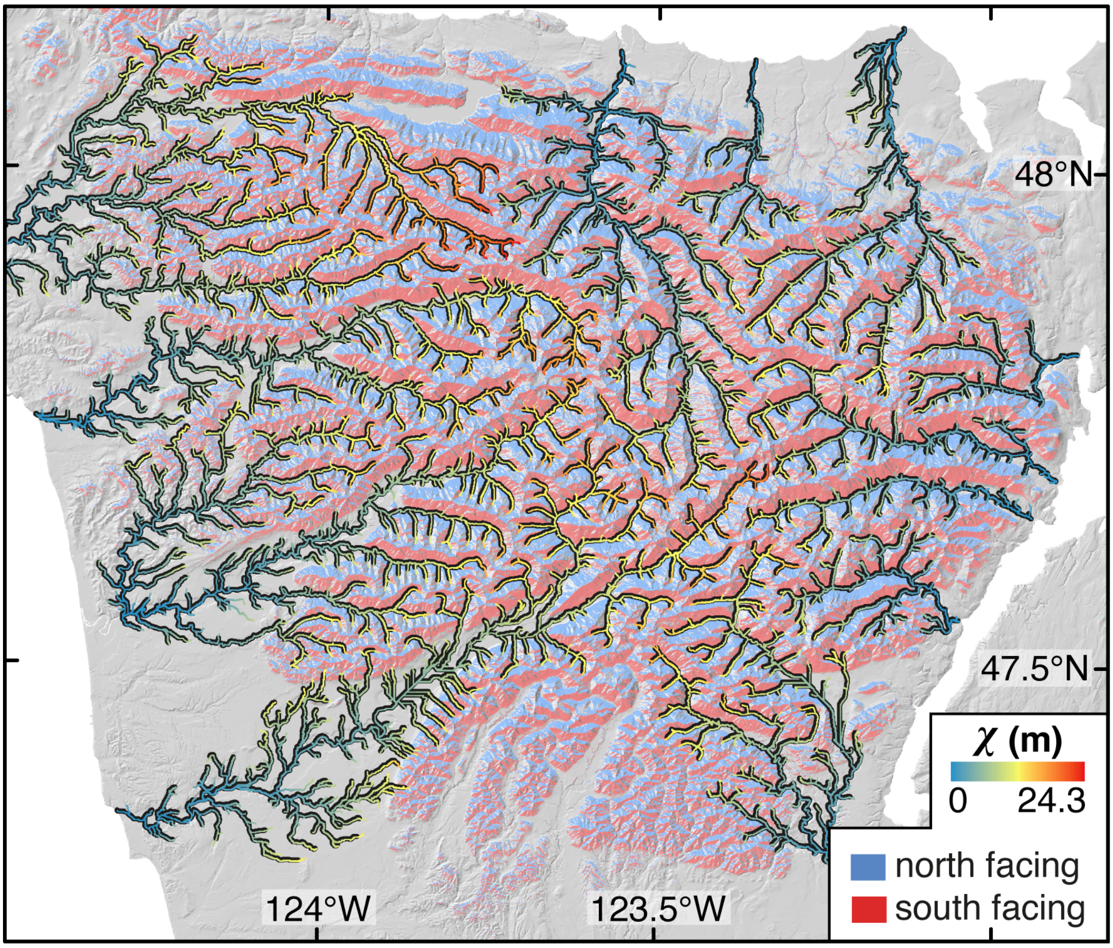

Figure S4. Hillslope dip direction (aspect) map overlain by χ values of drainage areas > 2 km^2.

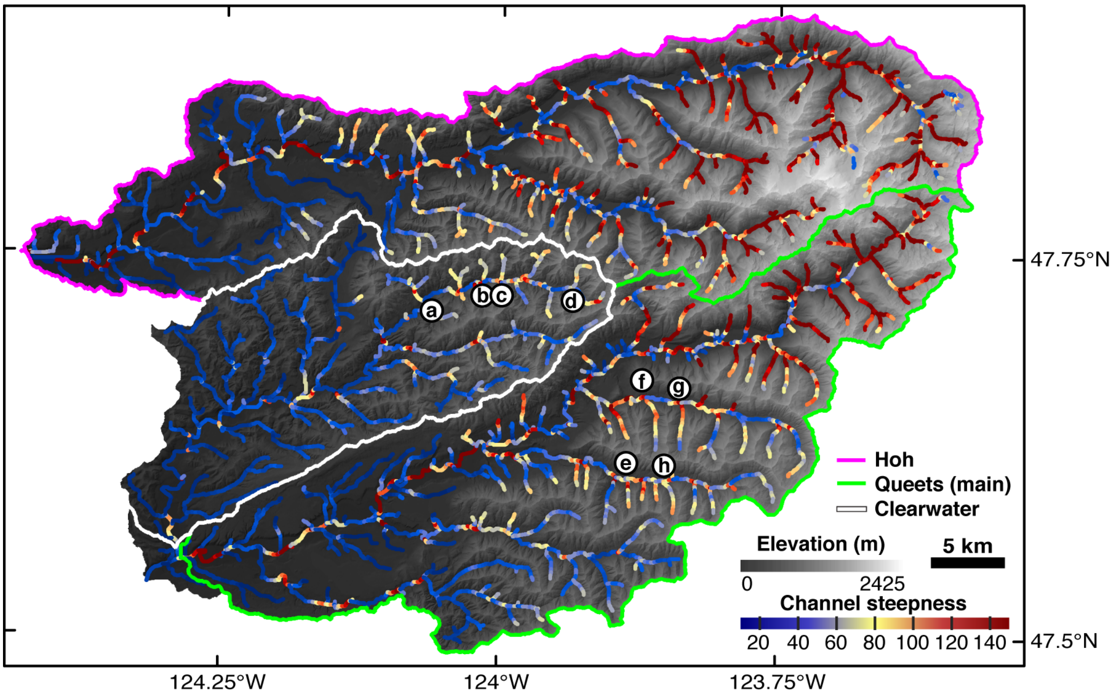

Figure S5. Digital elevation model and channel steepness map of a portion of the western flank of the Olympic Mountain range. The eight tributary rivers in Figure S6 are labeled at their confluences with the trunk rivers of the Clearwater (south flowing; a-d) and Queets (north flowing; e-h). Note the downstream reduction in channel steepness values as tributaries join the trunk rivers.

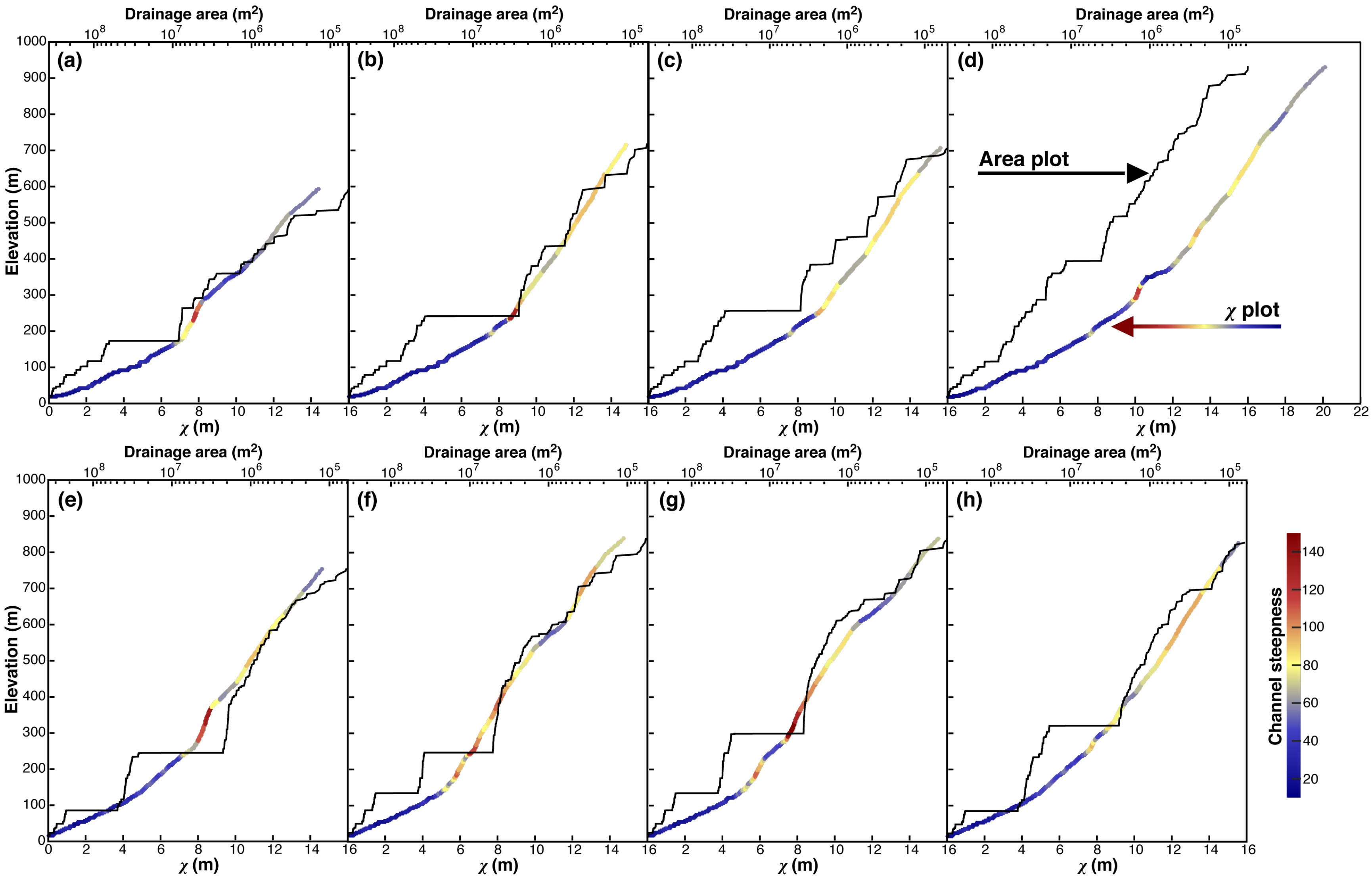
Drainage area (m^2)
10^8
10^7
10^6
10^5
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
Elevation (m)
χ (m)
Area plot
χ plot
Channel steepness

Figure S6. χ and area plots of eight tributaries of the Clearwater and Queets rivers (see Figure S5 for locations). While the Queets has a well know glacial history, it has been proposed that the Clearwater basin did not experience any significant glacial incision. Note the remarkable similarity between the form of the χ plots. These plots and the channel steepness map demonstrate that the locations of major knickpoints are not dictated by spatial position or elevation. In fact, the most significant changes in channel steepness occur at large changes in upstream drainage area. This suggests that step increases in ice discharge has led to step reductions in channel steepness values.

2. References

Brandon, M. T., Roden-Tice, M. K., and Garver, J. I., 1998, Late Cenozoic exhumation of the Cascadia accretionary wedge in the Olympic Mountains, northwest Washington State: Geological Society of America Bulletin, v. 110, no. 8, p. 985-1009.