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Analysis of geometric relationships of bedrock and alluvial channels: a comparison between rivers from the Scottish Highlands and San Gabriel Mountains (USA)

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Sediment transport in rivers depends on interactions between sediment supply, topography, and flow characteristics. Erosion in bedrock rivers controls topography and is paramount in landscape evolution models. The riverbed cover indicates sediment transport processes: alluvial cover indicates low transport capacity or high sediment supply, and bedrock cover demonstrates high transport capacity or low sediment supply. This study aims to evaluate controls on the spatial distributions of bedrock and alluvial covers, by analysing scaling geometric relations between bedrock and alluvial channels. A Principal Component Analysis (PCA) was conducted to evaluate correlations between river slope, depth, width, and sediment size. The two principal components were used to implement a clustering analysis in order to identify differences in alluvial and bedrock sections. Spatial distributions of mixed bedrock-alluvial sections were investigated from two datasets - Scottish Highlands (Whitbread 2015) and the San Gabriel Mountains in the USA (Dibiase 2011)-, representing different environmental conditions, such as erosion rates, lithology, tectonics, and climate. The rock strength of both areas is high, and therefore it is excluded as a factor that explains the difference between the areas. The results of the cluster analysis were different in each environment. The main sources of variation among river sections identified by PCA were slope and width for the San Gabriel Mountains, and drainage area and depth for the Scottish Highlands. The rivers in the Scottish Highlands formed clusters that differentiate bedrock and alluvial patches, showing a clear geometric distinction between channels. However, the river analysis from the San Gabriel Mountains showed no clusters. Bedrock rivers are typically described as narrower and steeper than alluvial rivers, as demonstrated by rivers in the Scottish Highlands (e.g. slope was around 0.1 m/m for bedrock sections and 0.01 m/m for alluvial sections). However, this may not be always the case: both bedrock and alluvial sections in San Gabriel Mountains presented similar slope around 0.1 m/m. The inability to demonstrate significant geometry differences in bedrock and alluvial sections in the San Gabriel Mountains may be due to the frequency and magnitude of sediment supply of that region, which are influenced by tectonics and climate. A major difference in the supply of sediment in rivers of the San Gabriel Mountains is the frequent occurrence of debris flow. Non-linear interactions between hydraulic and sediment processes may constantly modify the geometry of bedrock-alluvial channels, increasing the complexity of analysis at larger temporal and spatial scales. This study is part of the i-CONN project, which links connectivity in different scientific disciplines. A sediment connectivity

assessment in different environments and scales may be useful to evaluate the controls on the spatial distribution of bedrock and alluvial rivers.

Dibiase, R.A. 2011. Tectonic Geomorphology of the San Gabriel Mountains, CA. PhD Thesis. Arizona State University, Phoenix, 247pp.

Whitbread, K. 2015. Channel geometry data set for the northwest Scottish Highlands. British Geological Survey Open Report, OR/15/040. 12pp.