Channel Initiation Processes in Basalt and Sandstone Lithologies in Southwest Washington

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Abstract

A persistent problem for managers of headwater streams has been accurately identifying where these headwater channels begin on the hillslope and determining the physical extent of the channel network. Past research has found that local valley slope is inversely related to the contributing source area upslope of the channel head (inverse source area-slope relationship). Specifically, source areas decrease as the local gradient steepens.

This project compared channel head locations in streams underlain by two different lithologies, basalt and sedimentary. In addition, observations were made on seasonal changes in surface water expression in the streams occurring within the two bedrock types. Results from this study provide insight into channel initiation processes within steep, forested headwater systems.

Methods

- Field mapped channel heads using a high-resolution Global Positioning System (GPS) device.
- Monitored the location of the farthest upslope point of surface water presence during the driest time of year.
- Field measured local slope at channel head.
- Delineated source areas in GIS using contour lines of 10-Meter DEM.

Hypotheses

1. In sandstone, channel head locations are controlled by near-surface hydrologic processes.
   - Subject to inverse source area-slope relationship
2. In basalt, channel head locations are controlled by underlying bedrock.
   - Not subject to inverse source area-slope relationship

Results: Source Area vs. Local Slope

Channel Head Locations

No source area-slope relationship apparent at channel heads underlain by either sandstone or basalt. However, the geometric mean source areas in the two basalt sites Capitol Forest and Deadwood are approximately four times larger than the geometric mean source area at the Lonely Ridge sandstone site (p<0.001).

Results: Monitoring Observations

Surface Water Expression

- Monitored the location of the farthest upslope point of surface water expression in 16 sandstone streams (Lonely Ridge and 14 basalt streams (Capitol Forest)).
- Identified the Stream Head as the farthest upslope location of surface water presence during the driest time of year.

Conclusions

- Stationary location of surface water expression in streams underlain by basalt suggests a near-surface hydrologic control.
- Stationary location of surface water expression in streams underlain by sandstone suggests a near-surface hydrologic control.

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