

**Taylor and others, 1999, "Geomorphic Controls on Sediment Transport Efficiency in the Central Appalachians: A Comparative Analysis of Three Watersheds Underlain by the Acadian Clastic Wedge"**

Study of the production, transport and storage of sediment in drainage basins is essential for understanding their evolution and geomorphic behavior. Bedrock lithology is a primary factor controlling these processes. Rock type affects watershed morphometry, regolith composition, and caliber of sediment transported by drainage basins. Quartzo-feldspathic sandstones of the Acadian clastic wedge support numerous mountain slopes in the central Appalachians, providing a dynamic geomorphic environment associated with catastrophic slope failure, debris flow activity and flooding. The mechanisms for routing and storage of sediments in this region are poorly understood, and have received little attention in the literature.

This study involves a comparative geomorphic analysis of three watersheds similarly underlain by the Acadian clastic wedge. These areas include the Fernow Experimental Forest (19 km<sup>2</sup>), Tucker County, West Virginia; the North Fork basin (49 km<sup>2</sup>), Pocahontas County, West Virginia; and the Little River basin (41 km<sup>2</sup>), Augusta County, Virginia. The Fernow and North Fork are located along depositional strike (north-south), and lie ~50 km to the west of Little River. The latter was more proximal to the Acadian source terrane. Large-scale surficial mapping (1:9,600), GIS, morphometric analysis, lithofacies analysis and channel-gravel studies are utilized to make inferences regarding controls on sediment transport efficiency.

The surficial map protocol is based on a four-fold classification that includes age, origin (genetic process), landform and material (texture). The technique emphasizes the link between landforms, materials and processes in a landscape dominated by hillslopes, mass wasting and fluvial erosion. Large-scale landform units are classified into hillslope and valley-bottom features. Hillslope landforms include ridges, side slopes, hollows, and noses. Mappable hillslope variations consist of boulder streams, boulder fields, talus slopes, patterned ground, rock-block slides, debris slide scars, and debris flow tracks. Valley-bottoms include channels, floodplains, terraces, fans and aprons. Channel gravel is typically clast-supported, moderately sorted and imbricated due to deposition by turbulent streamflow hydraulics. Fans in the central Appalachians are the products of a combination of debris-flow, hyperconcentrated-flow, and stream-flow processes. Debris flows result in poorly-sorted diamictons with crude internal stratification. Dating of surficial deposits is problematic; the four-fold mapping protocol eliminates the need for formal stratigraphic nomenclature.

Mapping of small-scale debris fans and morphometric analysis yield results that elucidate local controls on fan accommodation. Three styles of fan accommodation are recognized in the central Appalachians: valley erosion (tributary junctions), pediment erosion, and piedmont-karst solution. The style of accommodation is driven by intra-montane erosion and controlled by local bedrock geology. The optimum conditions for fan preservation in the valley-erosion mode include: (1) high drainage density, (2) high tributary junction frequency, (3) steep low-order channels, (4) high valley width expansion rates, (5) wide high-order channels, and (6) steep, colluvial hillslopes prone to debris flow.

Sandstone lithofacies play an important role in shaping watershed morphometry and regolith composition. Analysis of the study areas yields a conceptual model for local bedrock influence on surficial processes. High sandstone content produces steeper hillslopes in the Little

River compared to the western areas. Bouldery colluvium accumulates in zero-order hollows, resisting transport by normal stream flow processes. Bouldery regolith accumulates until threshold thicknesses are attained, and a triggering meteorological event releases it to higher order tributaries via debris flow. Conversely, lithofacies relations are such that gentler hillslopes are maintained at the Fernow and North Fork areas. Regolith in low-order tributaries are incrementally transported by normal stream flow, thus hollows do not attain critical slopes necessary for slope failure. The model implies that spatial distribution of debris flow in these landscapes is in part a function of sandstone lithofacies, hillslope morphology, and occurrence of high-intensity precipitation events.

GIS-based analyses of surficial map units allow first-order approximation of valley-bottom storage volumes. Volume estimations are examined in tandem with clast size analysis and bedrock-channel distribution to make inferences regarding controls on sediment transport efficiency. A conceptual model postulates that valley-width morphometry and style of hillslope delivery are the primary factors controlling sediment transport efficiency. Steep, debris flow-prone hillslopes at the Little River deliver high volumes of bouldery sediment at magnitudes greater than the channel transport capacity. Stream power patterns are complex, as low-order tributaries are under capacity, and high-order tributaries over capacity with respect to sediment load. Aggraded alluvial fill insulates valley-floor bedrock from vertical erosion, while lateral incision dominates. Valley-width expansion creates a positive response via increased storage capacity and lower unit stream power. Conversely, the Fernow and North Fork are characterized by diffusive mass wasting on hillslopes with incremental bedload transport to higher-order tributaries. Hillslope delivery rates are balanced by the rate of channel export. Mixed alluvial-bedrock reaches provide the optimal channel configuration for active valley-floor incision. Low valley-width expansion promotes high unit stream power and vertical erosion processes. The model implies that the Fernow and North Fork have been more effective at sediment transport during the late Quaternary. Given similar climatic and tectonic settings, bedrock lithofacies variation is likely the primary factor modulating hillslope gradients and debris flow occurrence.

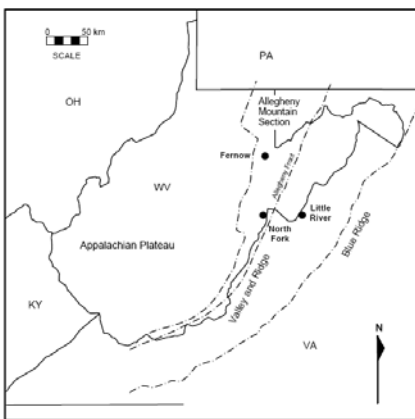


Figure 1-1. Physiographic map of the central Appalachians. Site identification codes are as follows: "Fernow" = Fernow Experimental Forest, Tucker County, West Virginia; "North Fork" = North Fork basin, Pocahontas County, West Virginia; "Little River" = Little River basin, Augusta County, Virginia. Physiographic base map is from Kulander and Dean (1986).

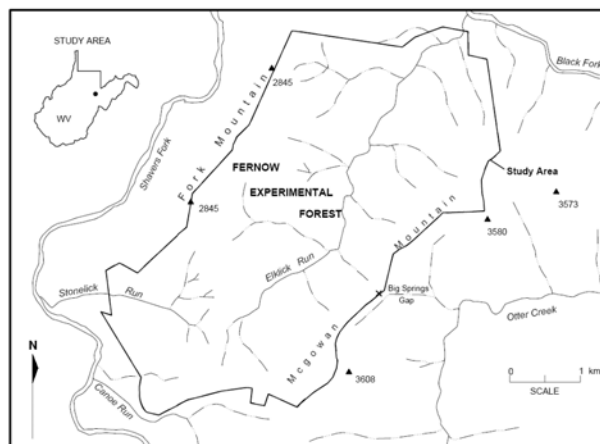


Figure 1-2. Location map of Fernow Experimental Forest, Tucker County, West Virginia. Spot elevations given in feet AMSL.