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Geomorphology 78 (2006) 161–177
GEOMORPHOLOGY
www.elsevier.com/locate/geomorph

Holocene erosion, sedimentation, and stratigraphy at Raven Fork, Southern Blue Ridge Mountains, USA

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Received 1 May 2005; received in revised form 30 September 2005; accepted 17 January 2006
Available online 21 February 2006

Abstract

Holocene colluvial and alluvial stratigraphy and a radiocarbon chronology are presented for the valley of the lower three kilometers of Raven Fork, a mountain stream draining 194 km^2 of high relief (1.3 km) terrain of the Southern Blue Ridge Mountains in western North Carolina, USA, which is in a region that lacks good chronological data. Lower hillslopes, alluvial/colluvial fans, alluvial bottomlands (first terrace and floodplain), and the modern stream channel are landforms described with respect to soils, stratigraphy, and sedimentary structures. Standard methods for subsurface investigations (core holes, excavation units, exposures) are used in conjunction with extensive archeological excavations and cultural chronologies. Radiocarbon ages from each landform are used to calculate long-term-average rates of sedimentation. Results indicate that the first half of the Holocene experienced somewhat more rapid rates of hillslope sedimentation (0.3 to 1.1 mm/yr) than the last half of the Holocene (0.1–0.2 mm/yr) on footslopes, toeslopes, and alluvial/colluvial fans prior to historic time. We suggest that these subtle differences in the rates of sedimentation were driven by changes in global paleoclimate that favored a high frequency of heavy rainfall, including tropical storms and/or severe thunderstorms and more (and possibly larger) floods during the first half of the Holocene. Prehistoric rates of vertical accretion on the first terrace (T1) ranged from 0.1 to 0.8 mm/yr between about 10,000 and 3000 calendar years ago, and incision below T1 formed the late Holocene floodplain beginning at about 6000 years ago. We suggest that this incision is linked to a reduction in the supply of sediment and a reduction in the magnitude of floods. Historical rates of sedimentation on all parts of the depositional landscape (2.0–2.7 mm/yr on hillslopes and fans and 5.8–6.5 mm/yr on floodplains) were about an order of magnitude greater than prehistoric rates. We attribute these rates to human impacts, such as timber harvest and land clearing, which caused accelerated erosion. We attribute the abundance of fine-grained sediment in streams of the Southern Blue Ridge province, which is atypical in many mountain streams around the world, to the regionally widespread mantle of saprolite as a source of sediment to the fluvial system. Holocene sedimentation on all depositional landforms in the valley led to sedimentary burial of archeological materials, which highlights the need to consider site burial on lower hillslopes and terraces for evaluation of the cultural resources in the Southern Blue Ridge Mountains. These findings show that the entrenched condition of the Raven Fork channel was inherited from the middle Holocene and can be considered a "natural" state for this mountain stream, casting doubt on the negative connotation that is often assigned to entrenched channels.

Keywords: Appalachian; Sediment; Colluvium; Hillslope; Terrace; Entrenched; Channel; Archeology

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doi:10.1016/j.geomorph.2006.01.023

1. Introduction

Stratigraphic records of Holocene erosion and sedimentation have been the focus of numerous geomorphic studies around the world and provide important information about variations in climate, human impact on the landscape, and geomorphic processes (e.g., Knox, 1984; Meade et al., 1990; Gregory et al., 1995; Walling and Webb, 1996; Knighton, 1998; Wohl, 2000). The Southern Blue Ridge Mountains in the southeastern United States (the highest relief province of the Southern Appalachian Highlands), however, have received relatively little study regarding Holocene colluvial and alluvial chronologies. For example, only one of eight studies referenced by Mills (2005) in his database for the chronologies of stream terraces in the Appalachians was from the Southern Blue Ridge province. As a consequence of this lack of chronological data, geomorphic responses to climate change and human impacts in these mountains are not well understood.

Lack of good chronological data prompted Mills and Delcourt (1991) to indicate "major needs" for studies involving numerical ages, stratigraphy, and sedimentology of surficial deposits in the Appalachian Highlands. A small number of studies throughout the region of the southern and central Appalachian Highlands have published numerical ages for late Quaternary sediments (Kochel, 1987; Shafer, 1988; Jacobson et al., 1989; Engel et al., 1996; Leigh, 1996; Kite et al., 1997; Eaton et al., 2003a,b; Delcourt and Delcourt, 2004), but only two of these (Shafer, 1988; Leigh, 1996) are from the Southern Blue Ridge province. Other studies simply have relied on estimates of relative ages (Hack and Goodlett, 1960; Mills, 1981, 1982, 1988; Kochel and Simmons, 1986; Whittecar and Ryter, 1992; Mills and Allison, 1995a,b; Liebens and Schaetzl, 1997; Mills, 2005).

Here we present Holocene colluvial and alluvial stratigraphy for the lower valley of Raven Fork, which is a typical mountain stream that drains 194 km^2 of high relief (1.3 km) terrain in the core of the Southern Blue Ridge Mountains in western North Carolina, USA (Fig. 1). We provide a chronology that spans from 11,000 calendar years ago (11 ka) to present, based on 16 radiocarbon samples from hillslopes, alluvial/colluvial fans, terraces, and floodplains. These findings provide baseline data with respect to morphology and sedimentation of the stream valley that facilitate evaluation of climate change and human impact on erosion, sedimentation, channel morphology, and processes of evolution for terraces and floodplains. Also, these findings have

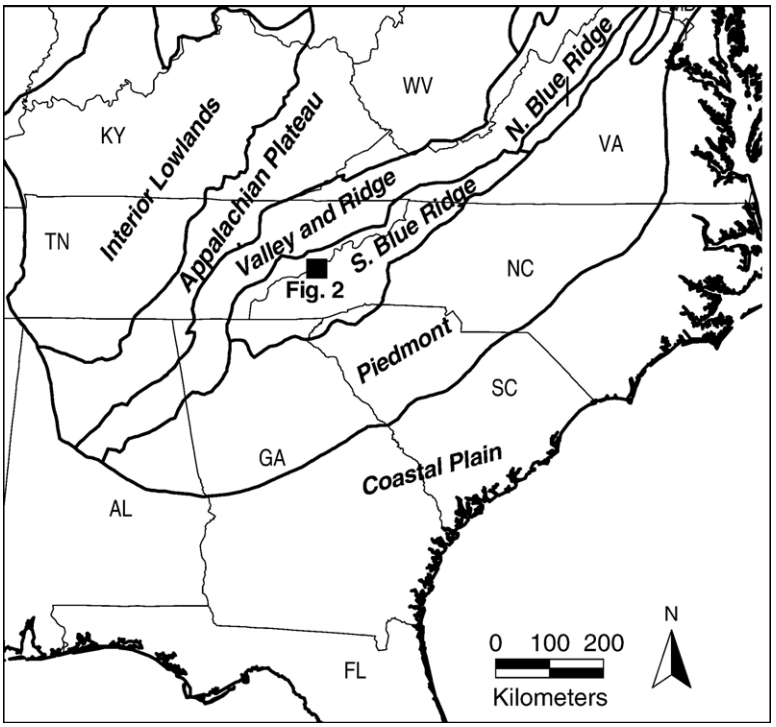

Fig. 1. Location of the study area (Fig. 2 rectangle) in the southeastern United States showing the Southern Blue Ridge and surrounding physiographic provinces.