Geomorphology 269 (2016) 85–103

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph

Tectonic control on the Late Quaternary hydrography of the Upper Tiber Basin (Northern Apennines, Italy)

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ARTICLE INFO

Article history:
Received 5 September 2015
Received in revised form 7 June 2016
Accepted 14 June 2016
Available online 16 June 2016

Keywords:
Fluvial geomorphology
Late Quaternary
Archaeology
Active tectonics
Upper Tiber basin
Northern Apennines

ABSTRACT

We examine the intramontane Upper Tiber Basin in the Northern Apennines (central Italy), where sub-orthogonal fault systems forced river deviation and the abandonment of alluvial fans since the late Middle Pleistocene. Archaeological material, spanning the Middle Palaeolithic-Iron Age, was collected mostly from the surface of the Late Quaternary alluvial landforms and related deposits (MUP and HOL units). This information contributed to the partial dating of seven major stages of drainage development. Normal faults parallel and transverse to the basin trend were active at different times and conditioned the valley pattern of the Middle (MUP1–2)-Late (MUP3) Pleistocene Tiber, Singerna, Sovara and Tignana rivers, which still flow today into the basin. The MUP1 and the MUP3 fans were beheaded by the displacement of their feeder valleys along the basin-transverse Carmine and Montedoglio faults. In some cases, the former feeder rivers underwent stream piracy but their courses mostly deviated in response of the topographic gradient created by faulting, as well as through the incision of new valleys that exploited the lithological contrast along the fault lines. The MUP3 Tignana fan was abandoned mostly due to the activity of the basin-parallel, dip-slip Sansepolcro fault. Subsidence driven by the basin-parallel Anghiari and Sansepolcro fault systems also provided the accommodation space for the MUP3 and HOl1-2 Afra fans between Late Pleistocene and early-mid Holocene. This study exemplifies the interplay between longitudinal and transverse fault systems, and the Late Quaternary hydrographic evolution of an extensional basin settled in the axial zone of an active fold-and-thrust belt. Although the faulting has interacted with the forcing exerted by the Late Quaternary climate fluctuations on the basin drainage systems, the tectonic rates are sufficiently high to represent the prime controller on base-level change and drainage routing patterns.

1. Introduction

River profiles, channel dynamics, and alluvial fans may be suitable indicators of ongoing crustal deformation (e.g., Keller, 1986; Schumm, 1986; Holbrook and Schumm, 1999; Schumm et al., 2002; Schumm, 2005; Vita-Finzi, 2012; Di Naccio et al., 2013). Drainage deflection by surficial warping, shifts in channel pattern compensating surface tilting, changes in bedload grain size and the frequency of overbank flooding, and anomalous steepening of channel gradients are common responses to tectonic perturbation (e.g., Howard, 1967; Holbrook and Schumm, 1999; Kirby et al., 2008). Among other factors, alluvial base level (Schumm, 1993; Whitfield and Harvey, 2012) may be affected by differential uplift created by faulting and/or folding that may induce headward migration of knickpoints and stream piracy (Bishop, 1995; Stokes and Mather, 2000; Whitfield and Harvey, 2012). Differential uplift may also alter the fluvial planforms inducing river channel transitions from braided or meandering to straight or anastomosing, and vice versa (Burnett and Schumm, 1983; Ouchi, 1985; Holbrook and Schumm, 1999). Active dip- and strike-slip faulting and block tilting may trigger river diversion and alluvial fan beheading (Wallace, 1975; Dumont et al., 2006), with incision of new valley reaches that may partly develop along the weakened fault line.

Different deformation mechanisms produce significant impact on the regional to local scale drainage, particularly within collisional mountain belts. Active or inactive thrust and fold systems may induce a primary structural control of the regional drainage giving rise to a fluvial pattern oriented both transverse and parallel to the tectonic strike of mountain belts (Oberlander, 1985; Hovius, 1996; Alvarez, 1999; Friend et al., 1999; Burrato et al., 2003; Stokes et al., 2008; Livio et al., 2009; Babault et al., 2012).

This pattern is well developed in the Northern Apennines of Italy, where the large-scale Quaternary evolution of the hydrographic network has been linked to tectonic controls that have caused the migration of regional watersheds, stream piracy and valley diversions

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http://dx.doi.org/10.1016/j.geomorph.2016.06.017
0169-555X/

(Mazzanti and Trevisan, 1978; Cencetti, 1988; Alvarez, 1999; Bartolini et al., 2003; Bonini and Tanini, 2009). In the classic model of a NE-migrating compressive Apenninic front followed in time and space by extension associated with the opening of the Tyrrhenian Basin (Elter et al., 1975), the late Neogene-Quaternary marks a significant period for the regional drainage development. The NW-trending chain has