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Climatically controlled terrace staircases in uplifting mountainous areas

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Abstract

A staircase of terraces was identified in the mountainous (middle) reaches of the Dunajec River valley, West Carpathians, providing insights into the record of climatic and tectonic mechanisms involved in terrace formation. The alluvial sediments of six terraces (T2–T7) were dated and used to determine the mechanisms of river terrace formation in this uplifting area during the Late Quaternary. Dating by optically stimulated luminescence (OSL) providing a basis for a chronostratigraphic scheme, with ages ranging from 158.9 to 5.38 ka. The resulting ages reveal alluvial sediments deposited during MIS6, MIS4, MIS3, MIS2 and MIS1. The formation of terrace staircase is attributed to an alternation of progressive river incision and sediment aggradation in response to climatically induced fluctuations in discharge and sediment supply. The production of straths, which become bases for terraces, occurred during climate transitions as well as during warm stages. Vertical aggradation of the terrace alluvium took place predominantly during the cold and dry glacials, although interglacial alluviation was also recorded. River incision occurred during warming and cooling transitions, and also during interglacial or interstadial stages. The valley down-cutting ceased during glacial periods due to increased sediment input resulting in aggradation. This paper outlines the complex climato-tectonic controls on the terrace staircase genesis on the scale of 10^3–10^5 years.

Keywords: river terraces; climate change; tectonic uplift; Quaternary; Carpathians

1. Introduction

River terraces are remnants of former river floodplains that are preserved above present-day river channels, often in staircase systems. The formation of terrace staircases is attributed to both tectonic uplift and changes in the climatic boundary conditions (e.g. Bridgland, 2000; Maddy et al., 2001; Vandenberghe, 2003; Wang et al., 2009; Bridgland and Westaway, 2008; Dutta et al., 2012; Hu et al., 2012; Madritsch et al., 2012; Necea et al., 2013; Stange et al., 2014; Huang et al., 2014; Gao et al., 2016). Variations in tectonic and climatic conditions cause perturbations in the fluvial system, which, over time, lead to