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Tectonic controls upon Kaveri River drainage, cratonic Peninsular India: Inferences from longitudinal profiles, morphotectonic indices, hanging valleys and fluvial records

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ABSTRACT

The Indian Peninsula is generally considered as a tectonically stable region, where ancient rocks, rivers and land surfaces predominate. In some parts of this ancient landscape, however, the role of tectonic landsculpting is strongly indicated by the presence of youthful topography and historical seismic activity. The present study is primarily focused on the middle domain of the Kaveri River, which displays such youthful features. The tectonic controls on this cratonic river were evaluated on the basis of the investigations of the longitudinal profiles, morphotectonic indices of active tectonics, and fluvial records. The presence of steep channel gradients, prominent knickpoints, hanging valleys, narrow bedrock gorges, and channel-in-channel morphology imply rapid erosion rates in the middle domain of the basin in response to active deformation, particularly in the reach defined by two major active faults — the Kollegal–Sivasamudram Fault and the Mekedatu Fault. Further, considering the remarkably low modern and long-term denudation rates and OSL ages of the alluvial deposits (30–40 ka), the tectonically-driven rejuvenation does not appear to be geologically recent as postulated by earlier workers.

1. Introduction

Amongst the half a dozen cratons of the Indian shield, the Dharwar Craton is considered to be one of the ancient Precambrian terrains of the world. The Kaveri (also Cauvery) River drains this ancient land surface. A significant portion of the river basin is underlain by rocks of Archaean–Proterozoic age. Unlike other cratonic areas in the tropics which are characterized by moderate to faint relief (Latrubesse et al., 2005), the Kaveri Basin displays many geomorphic characteristics of a youthful drainage and rejuvenation. More than half of the drainage basin area is above 500 m a.s.l. Furthermore, the course of this major cratonic river appears to disregard the structural grain in some segments, while fault control is particularly well reflected in the sharp-angle bends in other reaches (Fig. 1). The upper and middle courses of the Kaveri River are particularly anomalous and are believed to be an evidence of antecedence or superposition (Vaidyanadhan, 1971; Radhakrishna, 1993; Valdiya, 2001). The river takes a difficult course across the high and linear Biligirirangan–Mahadeswaramalai (BR–MM) Hill Ranges (Fig. 1), and has carved a ~100-km long, deep canyon-like valley between Sivasamudram Falls and Hogenakal Falls, with knickpoints, gorges, inner channels and hanging valleys.

One of the major unresolved questions is whether the drainage and topographic features of the Kaveri River drainage are due to recent tectonism or due to more passive incision of a previously elevated Mysore Plateau (Fig. 1). The main objective of this paper is to evaluate the drainage basin and long profile properties of the trunk-stream and its major tributaries, report OSL dated fluvial archives from the entrenched section and discuss their implications.

2. The Kaveri River: geomorphological and climatic setting

The Kaveri River drains a catchment area of about 81,155 km^2, rising in the Western Ghat and flowing about 800 km east to join the Bay of Bengal (Fig. 1). The river has the fifth largest drainage area in the Peninsular India, exceeded only by the Godavari, the Krishna, the Mahanadi and the Narmada Rivers. SRTM-DEM analysis reveals that the average elevation of the basin is ~564 m a.s.l. About 42% of the basin area lies between 650 and 1000 m a.s.l. This upland area in the headwaters largely constitutes the Mysore Plateau. Almost an equal percentage of the catchment area occurs below 400 m a.s.l. Approximately one-tenth of the basin area is above 2000 m a.s.l.

The area is underlain predominantly by Archaean–Proterozoic crystalline rocks, such as gneisses, charnockites and granites (Sharma and Rajamani, 2001; Valdiya, 2001). Quaternary sediments are present dominantly on the Tamil Nadu Plains in the eastern part of the basin. Several N–S and E–W striking lineaments, faults, and shear zones characterize the catchment and the adjoining basins (Vaidyanadhan, 1971; Valdiya, 2001; Ramaswamy, 2006).

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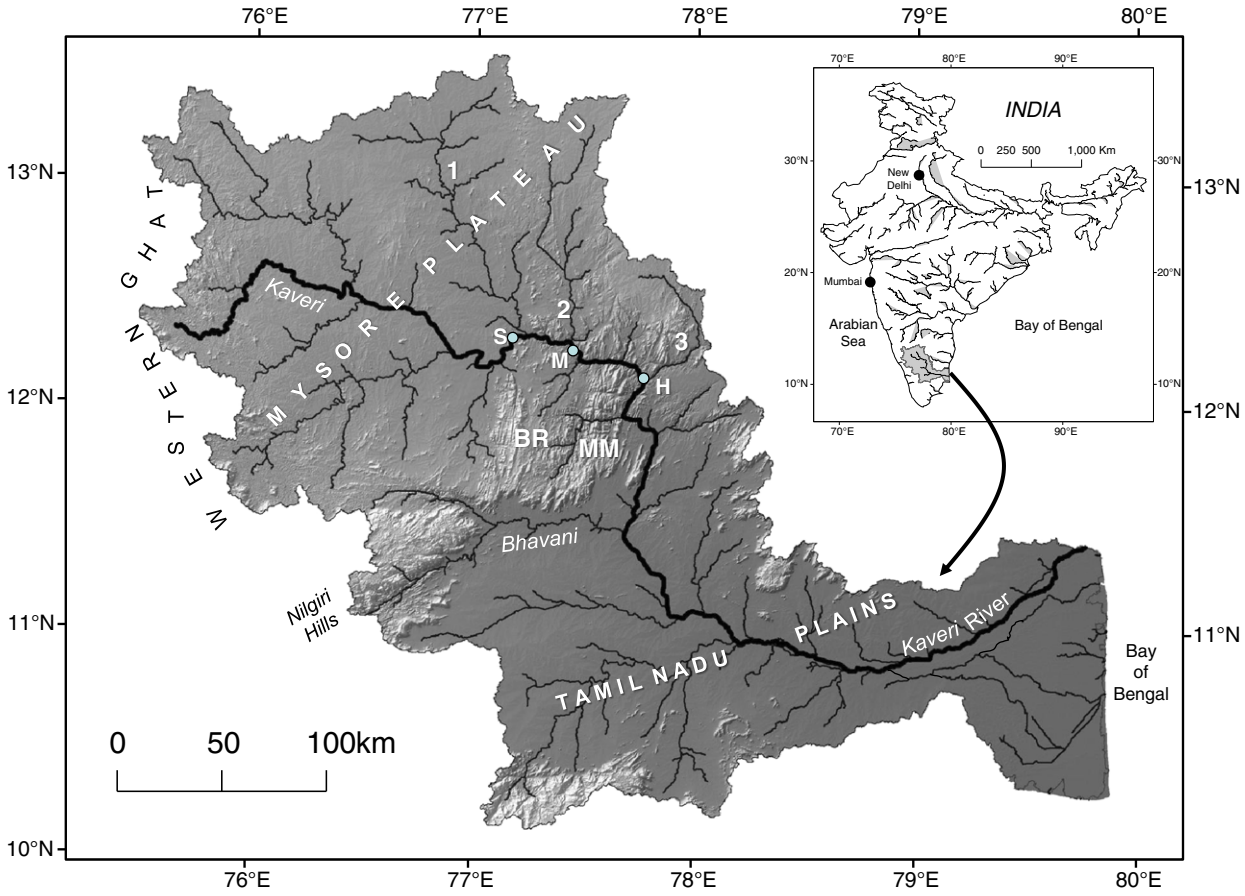

Fig. 1. Map of the Kaveri Basin showing the location of the study area. The inset map shows the location of Kaveri Basin in India. BR = Biligirirangan Ranges; MM = Mahadeswaramalai Ranges S = Sivasamudram Falls, M = Mekedatu, H = Hogenakal Falls. 1 = Shimsha River, 2 = Arkavathi River, 3 = Chinnar River. All distributaries in the delta region are not shown.

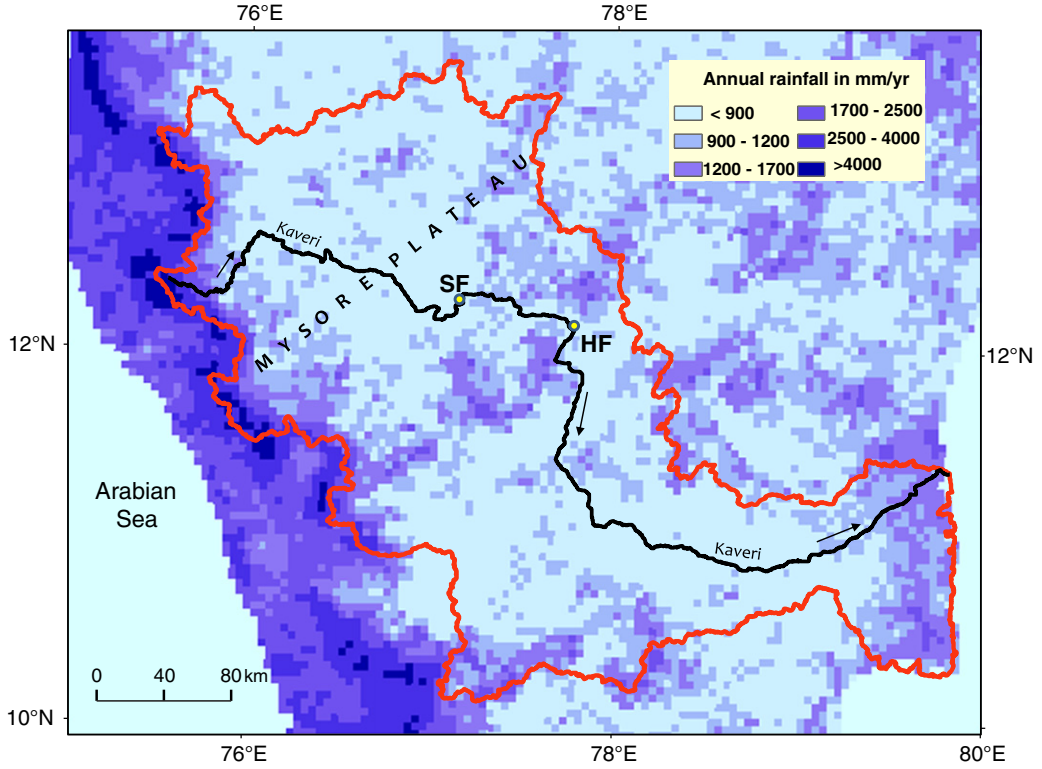

Fig. 2. Distribution of average annual precipitation over the Kaveri Basin and adjoining basins. Average annual precipitation from TRMM satellite. SF = Sivasamudram Falls, HF = Hogenakal Falls. Basic data after Bookhagen and Strecker (2008) and Bookhagen and Burbank (2010).