ABSTRACT

We investigated a contractional shear zone located in central Nepal, known as Kalopani shear zone. This high-temperature shear zone triggered the early exhumation of the metamorphic core in the Himalayan belt and deeply affected the tectono-metamorphic history of the crystalline rocks soon after the collisional stage. Pseudosection modeling and inverse geothermobarometry reveal that rocks involved in the Kalopani shear zone experienced pressure-temperature conditions between 0.60 and 0.85 GPa and 600 and 660°C. U-Th-Pb in situ laser ablation–inductively coupled plasma–mass spectrometry and sensitive high-resolution ion microprobe dating on monazite points to retrograde metamorphism related to the Kalopani shear zone starting from ca. 41 to 30 Ma. The kinematics of the Kalopani shear zone and associated erosion and/or tectonics caused the middle-late Eocene exhumation of the Greater Himalayan Sequence in the hanging wall of the Kalopani shear zone at least 9 m.y. before the activities of the middle tectonic–metamorphic discontinuity. Structural data, metamorphic conditions, and geochronology from the Kalopani shear zone, compared to those of other major tectonic discontinuities active within the Greater Himalayan Sequence in the Kali Gandaki valley, indicate that shear deformation and exhumation were not synchronous all over the Greater Himalayan Sequence but migrated downward and southward at different lower levels. These processes caused the exhumation of the hanging wall rocks of the activated shear zones. The main consequence is that exhumation has been driven since the middle-late Eocene by an in-sequence shearing mechanism progressively involving new slices of the Indian crust, starting from the metamorphic core of the orogen and later involving the outer portions of the belt. This challenges the common view of exhumation of the Greater Himalayan Sequence mainly driven by the coupled activity of Main Central thrust and South Tibetan detachment between ca. 23 and 17 Ma (Godin et al., 2006).

INTRODUCTION

Understanding of exhumation mechanisms of deep-seated metamorphic rocks in collisional orogens has been greatly improved by the discovery of contemporaneous contractional and normal-sense shear zones active in the same vertical section in orogenic belts such as the Hellenides, Canadian Cordillera, Appalachians, western Alps, and the Variscan belt (Godin et al., 2006). The normal-sense, top-to-the-NE South Tibetan detachment (top) and the contractional top-to-the-SW Main Central thrust (bottom) border the crystalline core of the belt, the Greater Himalayan Sequence, in the Himalayas. These two tectonic structures are regarded as the most classic example of a coupled tectonic system of faults/shear zones acting contemporaneously but with opposite kinematics (Burchfiel et al., 1992; Hodges et al., 1992) in a collisional belt. They were active between ca. 23 and 17 Ma (Godin et al., 2006).

Faults or shear zones inside the Greater Himalayan Sequence, such as the Kakhtang thrust in Bhutan (Daniel et al., 2003), the Kalopani shear zone (Nepal; Vannay and Hodges, 1996; Godin, 2003; Searle, 2010), the Modi Khola shear zone (Nepal; Hodges et al., 1996), and the Nyalam thrust (Nepal; Wang et al., 2013), have been interpreted as out-of-sequence thrusts (Mukherjee et al., 2012, with references therein). In the last few years, growing evidence of the occurrence of shear zones and metamorphic discontinuities has been reported from several localities within the Greater Himalayan Sequence in upper and lower portions. A jump in the metamorphic conditions between the upper and the lower Greater Himalayan Sequence has been reported by several authors (Carosi et al., 2007; Gropp et al., 2009; Corrie and Kohn, 2011; Yakymchuk and Godin, 2012; Imaizumi et al., 2012; Rubatto et al., 2013; Kohn et al., 2004; Kohn, 2008; Larson et al., 2010, 2013, 2015; He et al., 2015; for a review, see Montomoli et al., 2013, 2015a; Cottle et al., 2015; Khanal et al., 2015; Iaccarino et al., 2015; Wang et al., 2015).

A major regional-scale tectonic and metamorphic discontinuity separating the upper Greater Himalayan Sequence from the lower...