Late Oligocene high-temperature shear zones in the core of the Higher Himalayan Crystallines (Lower Dolpo, western Nepal)

R. Carosi,1 C. Montomoli,1 D. Rubatto,2 and D. Visonà3

Received 2 October 2008; revised 20 November 2009; accepted 13 January 2010; published 25 August 2010.

[1] A high-temperature shear zone, Toijem shear zone, with a top-to-the-SW sense of shear affects the core of the Higher Himalayan Crystallines (HHC) in western Nepal. The shear zone developed during the decompression, in the sillimanite stability field, of rocks that previously underwent relatively high-pressure metamorphism deformed under the kyanite stability field. PT conditions indicate that the footwall experienced higher pressure (~9 kbar) than the hanging wall (~7 kbar) and similar temperatures (675°–700°C). Monazite growth constrains the initial activity of the shear zone at 25.8 ± 0.3 Ma, before the onset of the Main Central Thrust zone, whereas the late intrusion of a crosscutting granitic dike at 17 ± 0.2 Ma limits its final activity. Monazites in kyanite-bearing gneisses from the footwall record prograde metamorphism in the HHC from ~43 to 33 Ma. The new data confirm that exhumation of the HHC started earlier in western Nepal than in other portions of the belt and before the activity of both the South Tibetan Detachment System (STDS) and Main Central Thrust (MCT) zones. As a consequence, western Nepal represents a key area where the channel-flow-driven mechanism of exhumation, supposed to be active from Bhutan to central-eastern Nepal, does terminate. In this area, exhumation of crystalline units occurred by foreland propagation of ductile and, subsequently, brittle deformation. Citation: Carosi, R., C. Montomoli, D. Rubatto, and D. Visonà (2010), Late Oligocene high-temperature shear zones in the core of the Higher Himalayan Crystallines (Lower Dolpo, western Nepal), Tectonics, 29, TC4029, doi:10.1029/2008TC002400.

1. Introduction

[2] The Himalayan mountain belt, developed during the India–Asia collision since ~55 Ma, is regarded as a classic collisional orogen. It is characterized by the impressive continuity over hundreds of kilometers of tectonic features such as thrusts and normal faults, as well as large volumes of high-metamorphic grade rocks and granite exposed at the surface. This constitutes an invaluable field laboratory to unravel the tectonic and metamorphic evolution of crystalline units and the mechanisms of exhumation of deep-seated rocks in orogens.

[3] Low-angle normal faults are among the most prominent exhumation features preserved in the Himalaya. The South Tibetan Detachment System (STDS) at the top of the HHC in central and eastern Nepal was recognized early [Caby et al., 1983] as a system of low-angle normal faults. Their contemporaneous activity with the shortening along the Main Central Thrust (MCT) at its base [Burchfiel and Royden, 1985; Burg et al., 1984; Burchfiel et al., 1992; Hodges et al., 1993; Brown and Nazarchuk, 1993; Coleman, 1996; Carosi et al., 1998, 1999; Searle, 1999; Godin et al., 1999] led to the development of new models for the exhumation and exhumation or channel flow of crystalline rocks [e.g., Burchfiel et al., 1992; Edwards et al., 1996; Grasemann et al., 1999; Grujic et al., 2002; Beaumont et al., 2001; Daniel et al., 2003; Catlos et al., 2004]. These models bear on our understanding of the tectonic and metamorphic evolution of the Himalayan belt, which has implications for the evolution of other ancient and recent orogens [Chemenda et al., 1995; Hatcher and Merschat, 2006].

[4] The activity of the main structural discontinuities in the Himalayas, such as the MCT and the STDS, is bracketed mainly between 23 and 17 Ma [Hodges, 2000, and references therein] (central-western Nepal: Godin et al., 2006]). Although the later tectonic and metamorphic history of the HHC is well constrained, very few data are available on the long period spanning the onset of collision and the initial stages of exhumation at ~23 Ma. In this study we present new structural, petrological, and geochronological results for the HHC of western Nepal (Figures 1 and 2), documenting a previously unrecognized high-temperature shear zone in the core of the HHC. U-Th-Pb monazite ages from a mylonite record the oldest shear zone documented in the crystalline unit. We propose that its earlier activity played a primary role in the exhumation, decompression, and partial melting of the HHC, before the onset of exhumation by the activity of the MCT-STDS system localized along its tectonic boundaries.

2. Geological Setting

[5] In the Nepal Himalaya four main tectonic units, separated by tectonic discontinuities, are found [Gansser, 1964; Le Fort, 1975; Lombardo et al., 1993; Upreti, 1999; Hodges, 2000; Yin, 2006] (Figure 1) that from top to bottom are