Journal of Palaeogeography
2015, 4(1): 85−98
DOI: 10.3724/SP.J.1261.2015.00069

Geochemistry and sedimentary environments

Provenance and drainage system of the Early Cretaceous volcanic detritus in the Himalaya as constrained by detrital zircon geochronology

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Abstract The age range of the major intra-plate volcanic event that affected the northern Indian margin in the Early Cretaceous is here defined precisely by detrital zircon geochronology. U–Pb ages of Early Cretaceous detrital zircons found in the Cretaceous to the Paleocene sandstones cluster mainly between 142 Ma and 123 Ma in the northern Tethys Himalayan unit, and between 140 Ma and 116 Ma in the southern Tethys Himalayan unit. The youngest and oldest detrital zircons within this group indicate that volcanism in the source areas started in the latest Jurassic and ended by the early Albian. Stratigraphic data indicate that volcaniclastic sedimentation began significantly earlier in southern Tibet (Tithonian) than in Nepal (Valanginian), and considerably later in Spiti and Zanskar (Aptian/Albian) to the west. This apparent westward migration of magmatism was explained with progressive westward propagation of extensional/transtensional tectonic activity and development of fractures cutting deeply across the Indian continental margin crust. However, detrital zircon geochronology provides no indication of heterochroneity in magmatic activity in the source areas from east to west, and thus lends little support to such a scenario. Westward migration of volcaniclastic sedimentation may thus reflect instead the westward progradation of major drainage systems supplying volcanic detritus sourced from the same volcanic centers in the east. Development of multiple radial drainage away from the domal surface uplift associated with magmatic upwelling, as observed for most large igneous provinces around the world, may also explain why U–Pb ages of detrital zircons tend to cluster around 133–132 Ma (the age of the Comei igneous province) in Tethys Himalayan units, but around 118–117 Ma (the age of the Rajmahal igneous province) in Lesser Himalayan units.

Key words northern Indian margin, Cretaceous Himalayan Orogen, volcaniclastic detritus, drainage system, zircon geochronology, palaeogeography

1 Introduction

In the Early Cretaceous, a major intra-plate volcanic event affected the entire northern India passive margin facing Neotethys, as long documented by studies of volcanic and volcaniclastic rocks exposed in various regions of the Himalayan orogeny (Figure 1). Lower Cretaceous volcaniclastic sandstones have been deposited all along the Tethys Himalayan domain, from the Zanskar Range

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Received: 2014−06−27 Accepted: 2014−10−17

(Baud *et al.*, 1984; Garzanti, 1991, 1993a) to Spiti, Nepal (Bordet *et al.*, 1971; Garzanti and Pagni Frette, 1991; Gibling *et al.*, 1994; Garzanti, 1999) and southern Tibet (Jadoul *et al.*, 1998; Hu *et al.*, 2008, 2010; Figure 2). Geochemical analyses of basaltic grains and detrital Cr-spinels from these sandstones point to the alkaline character of the volcanism, consistent with a "within-plate" tectonic setting (Dürr and Gibling, 1994; Zhu *et al.*, 2004; Hu *et al.*, 2010, 2014). Lower Cretaceous volcanic rocks have never been reported so far in the western Himalaya, but are well known to occur in the Lesser Himalaya of Nepal (Aulis Trachyte; Sakai, 1983; Sakai *et al.*, 1992) and in the Tethys Himalaya of southeastern Tibet (Sangxiu Formation; Zhu *et al.*, 2009; Qiu *et al.*, 2010; Xia *et al.*, 2014). Mafic protoliths of late Early Cretaceous age have been recognized even in Lesser Himalayan eclogites of Nepal (Groppo *et al.*, 2007). All of these volcanic rocks are generally considered as belonging to the Rajmahal-Sylhet flood-basalt igneous province of the northeastern Indian subcontinent (Baksi, 1995; Kent *et al.*, 2002) and/or to the Comei large igneous province (Zhu *et al.*, 2009).

This article provides new U−Pb ages of zircon grains

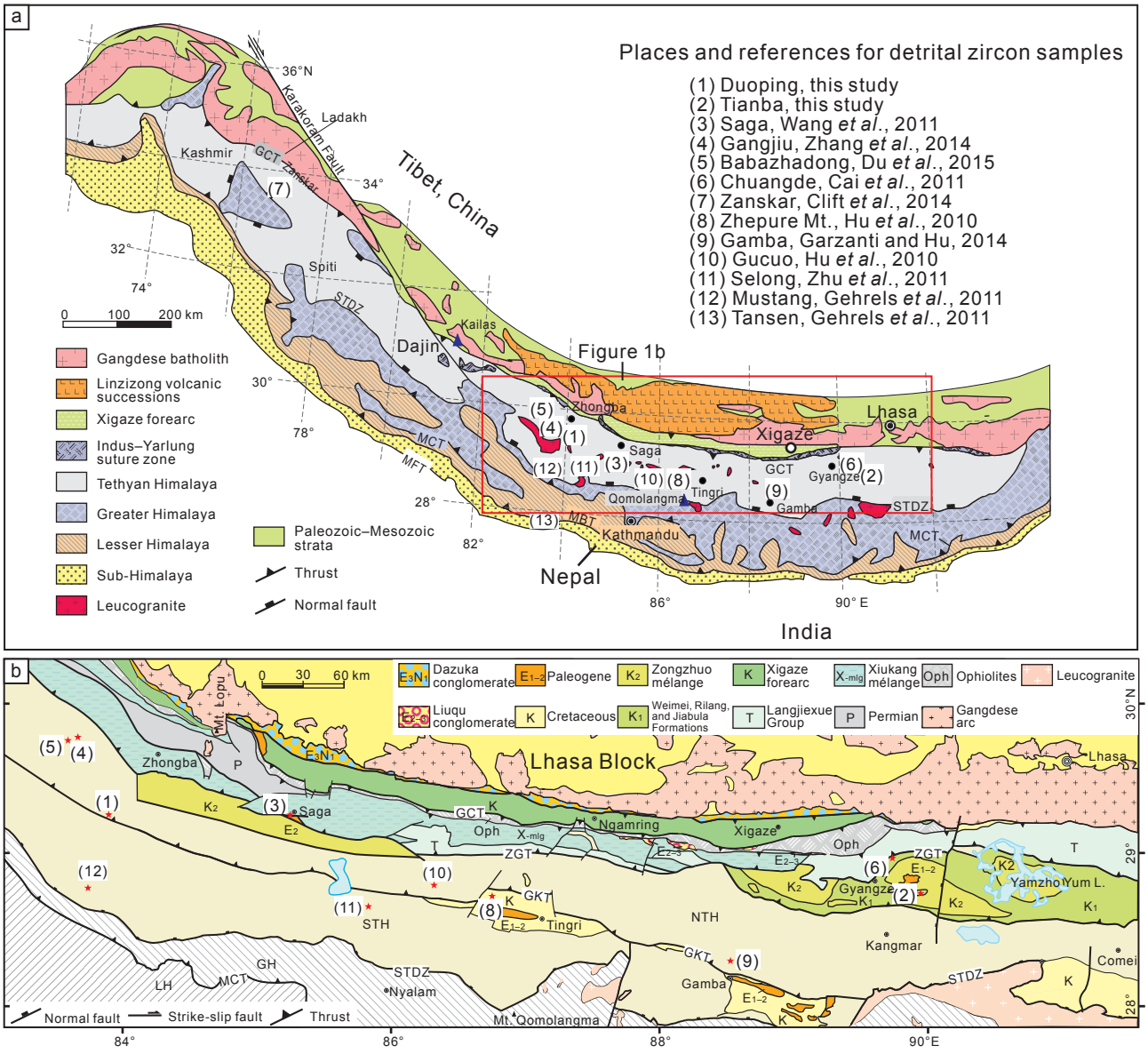

Figure 1 a−Geological map of the Himalayan belt; b−Simplified geological map of the southeastern Tibet. Locations of sandstone samples considered for detrital-zircon geochronology are shown. GCT = Great Counter Thrust; ZGT = Zhongba−Gyangze Thrust; GKT = Gyirong−Kangmar Thrust; STDZ = South Tibetan Detachment Zone; MCT = Main Central Thrust; MBT = Main Boundary Thrust; MFT = Main Frontal Thrust; NTH = Northern Tethyan Himalaya; STH = Southern Tethyan Himalaya; GH = Greater Himalaya; LH = Lesser Himalaya.