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Neoproterozoic granitoids in the eastern Himalayan orogen and their tectonic implications

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ABSTRACT

The Precambrian component and evolutionary history of the Greater Himalayan Sequence (GHS), forming the core of the Himalayan orogen, remain a subject of debate. Here, we report new geochronological and petrochemical data of the Neoproterozoic granitoids that occur as the orthogneisses of the GHS in Cona area, the eastern Himalaya orogen. The zircon U–Pb dating results reveal that these granitoids have crystallization ages of Neoproterozoic of 817–838 Ma, and metamorphic ages of ca. 31 Ma. The petrochemical data show that the granitoids are medium to high-K, peraluminous granodiorite and granite, display geochemical affinities with volcanic arc granitoids. The zircon Hf isotopic compositions show that the granitoids were probably derived from the partial melting of Paleoproterozoic crustal materials. These data, combined with previous results, indicate that an extensive Neoproterozoic magmatic belt may have existed in the Himalayan orogen, and that the Neoproterozoic granitoids resulted from the Andean-type orogeny that formed along the northwestern margin of Rodinia supercontinent, and experienced the Cenozoic high-grade metamorphism during the Himalayan orogeny.

1. Introduction

The Himalayan orogen, created by the Cenozoic India–Asia collision, is the largest active collisional orogen on the Earth, and a natural laboratory to study the plate tectonics and collisional orogeny (Yin and Harrison, 2000 and references therein). The Greater Himalayan Sequences (GHS), occurring in the core of the orogen, witnessed the formation and evolutionary history of the Himalayan orogen. Therefore, the Cenozoic deformation, metamorphism and magmatism of the GHS have been widely studied (Kohn, 2014 and references therewith). In addition, the GHS, forming a part of the northern margin of the Indian continent, was located at the northern margin of the Gondwana supercontinent during the Paleozoic (Yin and Harrison, 2000 and references therein). Therefore, the Early Paleozoic orogeny of the GHS, especially the Cambrian to early Ordovician magmatism, has also been widely investigated (e.g., Johnson et al., 2001; Gehrels et al., 2003; Xu et al., 2005; Cawood and Buchan, 2007; Cawood et al., 2007; Dong et al., 2010; Wang et al., 2012; Zhang et al., 2012a). In contrast, the Precambrian magmatism of the GHS has received much less attention (e.g., Kohn et al., 2010; Yin et al., 2010; Zhang et al., 2012a). Nevertheless, several researches about the Neoproterozoic magmatism still provided important constraints on the provenance of the GHS as well as the assembly and breakup of Rodinia and Gondwana supercontinents (DiPietro and Isachsen, 2001; Singh et al., 2002; Richards et al., 2006; Yin et al., 2010; Zhang et al., 2012a; Ahmad et al., 2013).

In this contribution, we report new geochronological and petrochemical data for the Neoproterozoic granitoids in the GHS of Cona area, eastern Himalaya. These data, combined with previous results, indicate that an extensive Neoproterozoic magmatic belt was existed in the GHS along the Himalayan orogen, and that the Neoproterozoic granitoids were probably formed during the Andean-type orogeny after the assembly of Rodinia supercontinent, and experienced the Cenozoic high-grade metamorphism during the Himalayan orogeny.

2. Geological setting and samples

The Himalaya is a 2500-km-long orogenic zone constructed through the collision of India with Asia. Overall, the orogen exhibits a distinct arcuate form with sharp bends at the western and eastern syntaxes (Fig. 1). The Himalayan orogen is divided into four tectonic units from south to north: Sub-Himalayan molasses,

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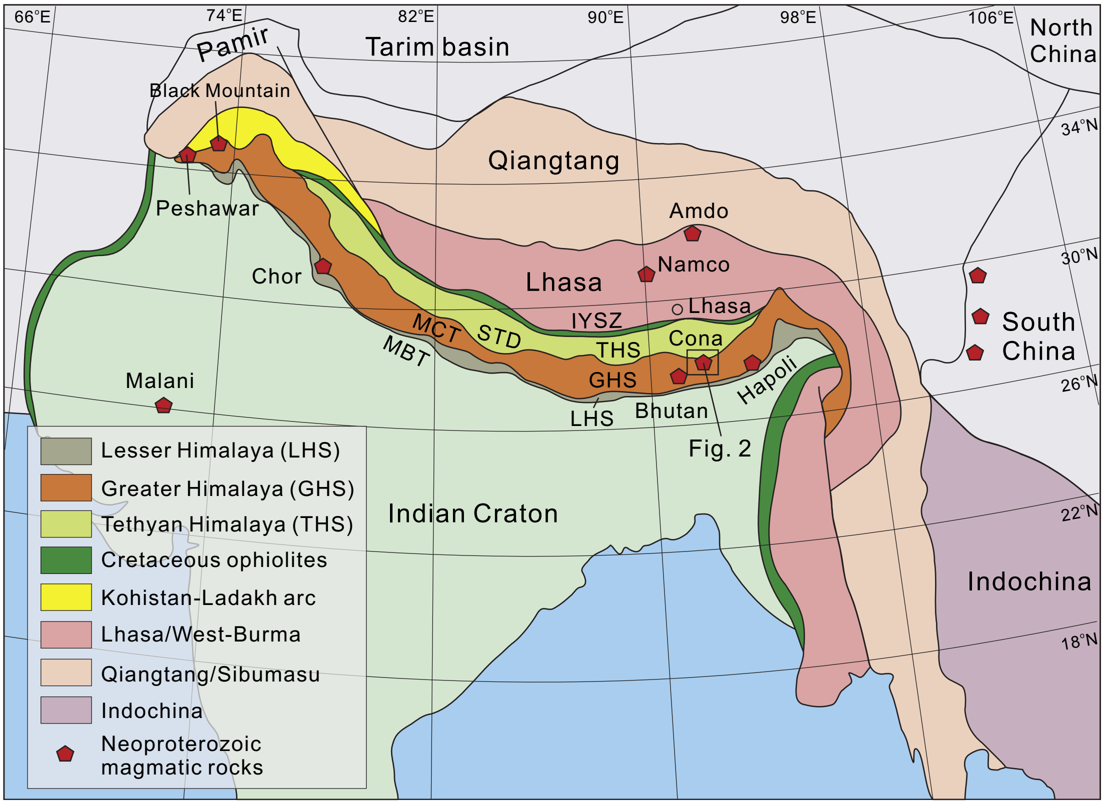

Fig. 1. Simplified tectonic map of the Tibetan Plateau and adjacent areas, showing locations of Neoproterozoic magmatic rocks. The data sources: Peshawar (Ahmad et al., 2013), Black Mountain (DiPietro and Isachsen, 2001), Chor (Singh et al., 2002), Bhutan (Richards et al., 2006), Hapoli (Yin et al., 2010), South China (Zhou et al., 2006), Amdo (Zhang et al., 2012b) and Namco (Dong et al., 2011).

Lesser Himalayan Sequence (LHS), Greater Himalayan Sequence (GHS) and Tethyan Himalayan Sequence (THS). These units run parallel to the belt for more than 2400 km and are bounded by the Main Frontal Thrust (MFT), Main Boundary Thrust (MBT), Main Central Thrust (MCT) and South Tibetan Detachment (STD) (Fig. 1; Hodges, 2000; Yin and Harrison, 2000 and references therein).

The LHS was emplaced above unmetamorphosed foreland sediments (Sub-Himalayan molasses) along the MBT, and consists mainly of Proterozoic metasedimentary sequence, typically greenschist to amphibolite facies metamorphism (Kohn, 2014). Numerous smaller thrusts have been proposed within the LHS, especially to form the Lesser Himalayan Duplex. The GHS was emplaced above the LHS along the MCT, and consists of Proterozoic to Paleozoic metasedimentary sequence, typically upper amphibolite to granulite facies metamorphism. Additional thrusts have been proposed within the GHS. The THS was emplaced above the GHS along the STD, consists mainly of Late Proterozoic to Mesozoic sedimentary sequence, typically unmetamorphosed to lower amphibolite facies (Kohn, 2014).

The GHS constitutes a 20–30 km-thick sequence of high-grade metasedimentary and meta-igneous rocks, and is subdivided into three different lithotectonic units (Le Fort, 1975; Hodges, 2000; Searle and Godin, 2003). The lowermost unit (Unit I) is made of kyanite-bearing metasedimentary rocks with subordinate quartzite, calc-silicate and marble. Migmatites are present in the upper part of this unit. Above, Unit II, is a sequence mainly composed of high-grade calc-silicate and marble with minor pelitic and psammitic rocks. The upper portion (Unit III) of the GHS consists mainly of orthogneiss and minor kyanite/sillimanite migmatite. Therefore, most of the GHS protoliths are metasediments of Neoproterozoic to Late Cambrian age with lower Paleozoic intrusions and recently recognized Proterozoic magmatic rocks. In addition, structurally upwards (mainly within Unit 3) the GHS is intruded by Miocene leucogranite, referred as the Higher Himalayan leucogranites (Visonà et al., 2012; Guo and Wilson, 2012; Searle, 2013).

The studied Neoproterozoic granitoids occur as the orthogneisses within Unit III of the GHS in Cona area (Fig. 2). The orthogneisses show intensive fold, deformation and migmatization (Fig. 3). The associated rocks are meta-pelitic schists, including garnet-kyanite-staurolite mica schist and garnet-sillimanite mica schist, paragneisses and augen orthogneisses with protolith ages of the early Paleozoic. The studied orthogneiss sample 113–1 consists of plagioclase, quartz and biotite, with minor K-feldspar, muscovite, garnet, apatite and opaque minerals; the aligned biotites

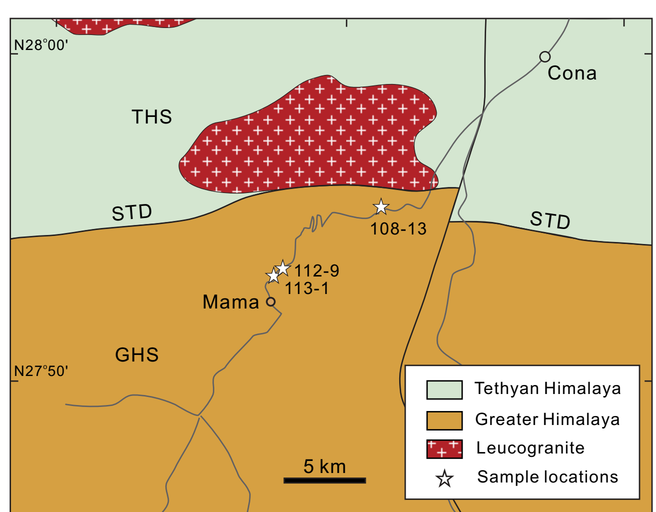

Fig. 2. Geological map of the Cona area, showing locations of the studied samples.