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The lithospheric architecture of two subterranes in the eastern Yidun Terrane, East Tethys: Insights from Hf–Nd isotopic mapping

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ABSTRACT

A long-standing controversy exists regarding the tectonic division, lithospheric architecture and evolution of the eastern Yidun Terrane in the Late Triassic. A compilation of geochronological, geochemical and isotopic data (91 whole-rock Nd and 413 laser points of zircon Hf) for volcanic and intrusive rocks across the entire eastern Yidun Terrane has allowed for a detailed investigation into its lithospheric architecture. Two subterranes were identified using Hf–Nd isotopic mapping. They include a high $\varepsilon Hf(t)$ (>−3.0) and $\varepsilon Nd(t)$ (>−3.5) domain constrained in the Southern Yidun Terrane (SYT), and a low $\varepsilon Hf(t)$ (<−3.0) and $\varepsilon Nd(t)$ (<−3.5) domain constrained in the Northern Yidun Terrane (NYT). The NYT and SYT are characterized by distinctive arc-related volcanic and plutonic rocks (NYT: 235–230 Ma basalt, andesite, dacite and rhyolite, as well as a 225–215 Ma granite batholith; SYT: 228–215 Ma adakite-like andesite, as well as diorite to monzonite porphyry), detrital zircon populations (NYT: ~2.50–2.45 Ga, ~980–880 Ma and ~480–400 Ma; SYT: ~2.50–2.40 Ga, ~1.90–1.75 Ga, ~1000–720 Ma, ~480–400 Ma and ~240–220 Ma) and mineralization styles (NYT: volcanic massive sulfide Ag–Cu–Pb–Zn and epithermal Ag–Hg deposits hosted in the ~230 Ma rhyolites; SYT: porphyry–skarn Cu–Mo–Fe deposits genetically related to the ~216 Ma dioritic to monzonitic porphyries). This dataset collectively shows that the NYT magmas were likely derived from a Paleoproterozoic or older mafic to intermediate lower crust with a variably minor addition of Triassic juvenile mantle melts, whereas the magmas for the SYT magmatic rocks were dominated by the arc juvenile mantle wedge melts with subordinate input of Late Mesoproterozoic or older crustal materials. The different melting processes between the NYT and SYT were attributed to changing subduction dip in space and time, with earlier steeper subduction at ~235–230 Ma, and later shallow-dip subduction from ~228–220 Ma. During the steeper dip subduction phase, it is likely that the NYT experienced a slightly greater degree of extension than the SYT, raising the possibility of a slab segmented by a major transform fault resulting in slightly steeper subduction beneath the NYT.

1. Introduction

Three volcanic arcs developed between the Yangtze Block and the Qiangtang–Changdu Block in response to the subduction of the Paleo-Tethys oceanic slab, including the Yidun Arc, the Jomda–Weixi Arc and the Zaduo–Jinghong Arc (Fig. 1b; Sengör, 1984; Yin and Harrison, 2000; Metcalfe, 2006; Wang et al., 2014a). The largest of these volcanic arc complexes is the Yidun Arc, which developed extensive Mesozoic volcanic and intrusive rocks as well as abundant polymetallic deposits (Fig. 1c). The division and evolution of the Yidun Arc during the Late Triassic remains controversial. Hou et al. (2003, 2004) suggested that the Northern Yidun Terrane (NYT) and Southern Yidun Terrane (SYT) were divided at 30°N, displaying distinct tectonic settings, granitoid affinities and mineralization styles. The Changtai Arc in the northern segment is characterized by an intra-arc rift and a back-arc basin, along with the development of volcanic massive sulfide (VMS)-type Zn–Pb–Ag–Cu deposits and epithermal Ag–Hg deposits (Fig. 1d; Hou et al., 2001, 2004, 2007). The Zhongdian Arc in the southern segment lacks evidence for a back-arc basin, but developed extensive calc-alkaline arc volcanic rocks and porphyry–skarn Cu-polymetallic deposits (Fig. 1d; Hou et al., 2003, 2004). Wang et al. (2013a) and Leng et al. (2014) proposed that the NYT and SYT were divided at 28°30′N based on the geological evidence that the Xiangcheng and Daocheng regions have similar volcanic lithotypes to the Changtai region. Basalt, andesite and rhyolite, are widely distributed in the NYT (Wang et al., 2013a), while, andesite, trachyte and dacite are the dominant volcanic rock types in the SYT (Leng et al., 2014). It is also worth noting that the intrusive rocks are distinct between the NYT and SYT. Several large granite batholiths of ~5200 km^2 extend from Garze to Daocheng County and outcrop in the NYT (Fig. 1), whereas, the NNW-trending hypabyssal stocks including quartz diorite porphyry, quartz monzonite porphyry and granite porphyry occur in the SYT

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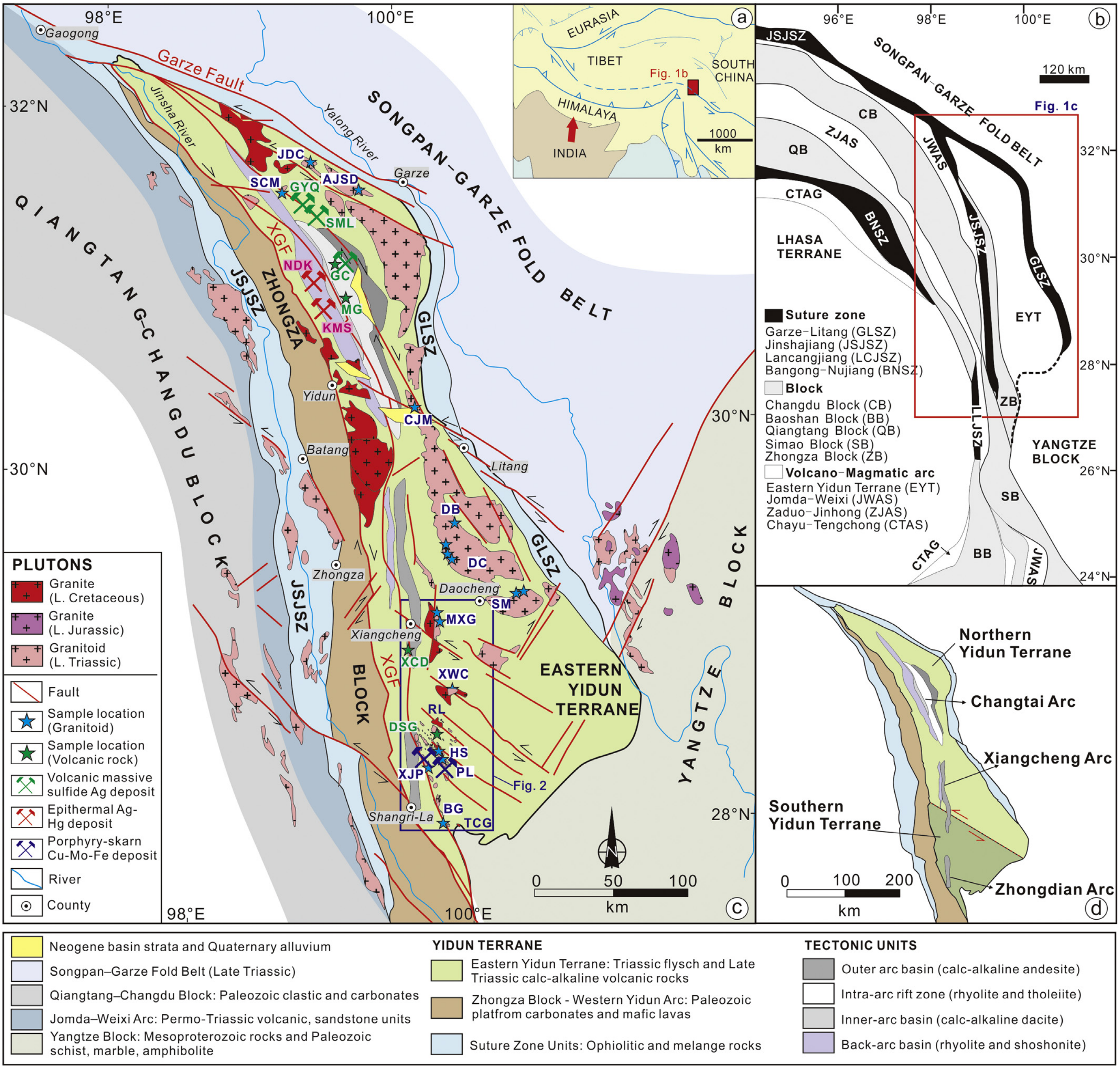

Fig. 1. (a) Tectonic outline of the India and Eurasia collision zone, showing the study area. (b) Simplified tectonic map of the Tibetan Plateau showing the major Suture zones, Blocks and volcanic-magmatic arcs adjacent to the Yidun Terrane. (c) Simplified geological map of the eastern Tibet Plateau, showing the Yidun Terrane, Yangtze Block, Songpan–Garze Fold Belt, and the Qiangtang–Changdu Block, as well as the major tectonic units fault systems, suture zones, and granitoid intrusions in the region (modified after Hou et al., 2004; Yang et al., 2016a). (d) Division of the Northern Yidun Terrane and Southern Yidun Terrane (this study) and division of the Changtai Arc, Xiangcheng Arc and Zhongdian Arc (Hou et al., 2003). Abbreviations for tectonic units: GLSZ = Garze–Litang Suture Zone; JSJSZ = Jinshajiang Suture Zone; XGF = Xiangcheng–Geza Fault. Abbreviations for age: L. Cretaceous = Late Cretaceous; L. Jurassic = Late Jurassic; L. Triassic = Late Triassic. Abbreviations for Triassic magmatic rocks: AJSD = Ajisenduo; BG = Bengge; CJM = Cuojiaoma; DB = Dongcuo; DC = Daocheng; DSG = Disuga; GC = Gacun; HS = Hongshan; JDC = Jiaduocuo; MGD = Miange; MXG = Maxionggou; PL = Pulang; SCM = Sucuoma; SM = Shengmu; XCD = Xiangcheng; XJP = Xuejiping; XWC = Xiuwacu. Abbreviations for Triassic mineral deposits: GYQ = Gayiqiong; SML = Shengmolong; NDK = Nongduke; KMS = Kongmasi.

(Fig. 2). In the recent two decades, multiple studies have been published on these Late Triassic granitoids (e.g., Reid et al., 2005, 2007; Wang et al., 2011; Cao et al., 2016), volcanic rocks (Wang et al., 2013a; Leng et al., 2014; Chen et al., 2017) and sedimentary rocks (Wang et al., 2013b; Wu et al., 2016). These rocks were emplaced in the Yidun volcanic arc and were related to the subduction and closure of the Garze–Litang Ocean (a branch of the Paleo-Tethys Ocean; Reid et al., 2005, 2007; Wang et al., 2011; Wang et al., 2013a; Leng et al., 2014). Although these contributions mainly focused on one aspect at a time, considering the collective data could have revealed the distinct source characteristics and petrogenesis of the Late Triassic volcanism and magmatism between the NYT and the SYT.

Hafnium and Neodymium isotopes are powerful tools to trace the nature of basement rocks and the age of continental crust (Griffin et al., 2002, 2004; Kemp et al., 2006). Hafnium and Neodymium isotopic mapping have recently been used to study the crustal evolution and reconstruction of lithospheric architecture in orogenic terranes (McCuaig et al., 2010; Mole et al., 2012, 2014a, 2014b; Zhang et al., 2013; Hou et al., 2015; Wang et al., 2016, 2017a, 2017b). The Yidun Terrane is almost completely covered by Late Triassic sedimentary rocks, and lacks