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The Late Triassic rift-related volcanic rocks from eastern Qiangtang, northern Tibet (China): Age and tectonic implications

Xiu-gen Fu *, Jian Wang, Fu-wen Tan, Ming Chen, Wen-bin Chen

Chengdu Institute of Geology and Mineral Resources, Chengdu, 610081, China

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ABSTRACT

The Late Triassic Nadi Kangri volcanic rocks, with nearly EW trending outcrops within the Qiangtang basin, northern Xizang (Tibet), China, are composed mainly of acid tuff, dacite, rhyolite and minor basic volcanic rocks. There exists a significant depositional hiatus between the Nadi Kangri volcanic rocks and underlying strata. Therefore, the Nadi Kangri volcanic rocks represent a new evolution history of the Mesozoic Qiangtang basin. The magma emplacement age of the Nadi Kangri volcanic rocks in the Geladaindong area is 220.4 ± 2.3 Ma, representing the onset of the Mesozoic Qiangtang basin. The Nadi Kangri basalts have high Nb/Zr (0.049–0.058), Ta/Hf (0.12–0.15) and Zr/Y (4.95–6.01) ratios. In the tectonic discrimination diagrams, such as Zr vs. Zr/Y and Th/Hf vs. Ta/Hf, the Nadi Kangri basaltic rocks mostly plot in the "within-plate" setting field. The geological background and the geochemical characteristics suggest that the Nadi Kangri volcanic rocks were formed in a continental rift setting.

1. Introduction

The Late Triassic Nadi Kangri volcanic rocks, with nearly EW trending outcrops within the Qiangtang basin, northern Xizang (Tibet), China, are composed mainly of acid tuff, dacite, rhyolite, and minor basic volcanic rocks. Regionally, these rocks, covering an area of 50 km wide and 300 km long, dominantly occur in the western and eastern parts of the Qiangtang basin.

Due to rapid facies changes and lack of correlatable age data on a regional scale, it is difficult to subdivide and correlate the Nadi Kangri volcanic–volcaniclastic rocks. Recently, there has been much debate about the age and subdivision of these strata, and they were assigned to the Middle Jurassic time (Bureau of Geological and Mineral Resources of Xizang Autonomous Region, 1993; Wang et al., 2001a; Li et al., 2002; Zhu et al., 2005a,b,c) or the Lower Jurassic time (Zhu et al., 1996, 1997). In addition, due to the difficult access to the northern Tibet (China), little geochemical study has been carried out on the Nadi Kangri volcanic rocks. Consequently, the tectonic settings of these rocks are not well understood. Furthermore, most of the available data focus only on the felsic rocks from the western part of the Qiangtang basin (e.g., Zhu et al., 2002; Li et al., 2007a; Zhai and Li, 2007). It is generally believed that the tectonomagmatic affiliations of basalts and dolerite dykes are much clear than those of mafic–ultramafic intrusions and felsic rocks (Li et al., 2007b; Zi et al., 2008). Therefore, the tectonic settings of these volcanic rocks should be further studied due to the absence of the geochemical data of basic volcanic rocks.

In this paper, we present new geochemical data and a SHRIMP zircon U–Pb age of the Nadi Kangri volcanic rocks. Our aims are: (1) to date the onset of the Mesozoic Qiangtang basin; (2) to re-evaluate the tectonic settings of these volcanic rocks based on the basaltic lavas.

2. Geological background

The Qiangtang block, marked by the Hoh Xil–Jinsha River suture zone to the north and the Bangong Lake–Nujiang River suture zone to the south, respectively, consists of the Northern Qiangtang depression (North Qiangtang sub-basin), the central uplift and the Southern Qiangtang depression (South Qiangtang sub-basin) (Fig. 1a) (Zhao et al., 2001; Wang et al., 2004). Between the Qiangtang block to the south and Eurasia to the north was an old ocean, whose floor was consumed by northern subduction beneath the Kunlun terrane during Permo-Trassic time and southward subduction beneath Qiangtang during Middle–Late Triassic time (Dewey et al., 1988; Pearce and Mei, 1988; Nie et al., 1994; Kapp et al., 2003, Ye et al., 2008). In this interval, most parts of the Qiangtang basin were uplifted into a land. Meanwhile paleo-weathering crusts occurred widely in the Juhua Mountain, Shishui River, Nadigangri and Wuoro Mountain regions in

* Corresponding author.
E-mail address: fuxiugen@126.com (X. Fu).

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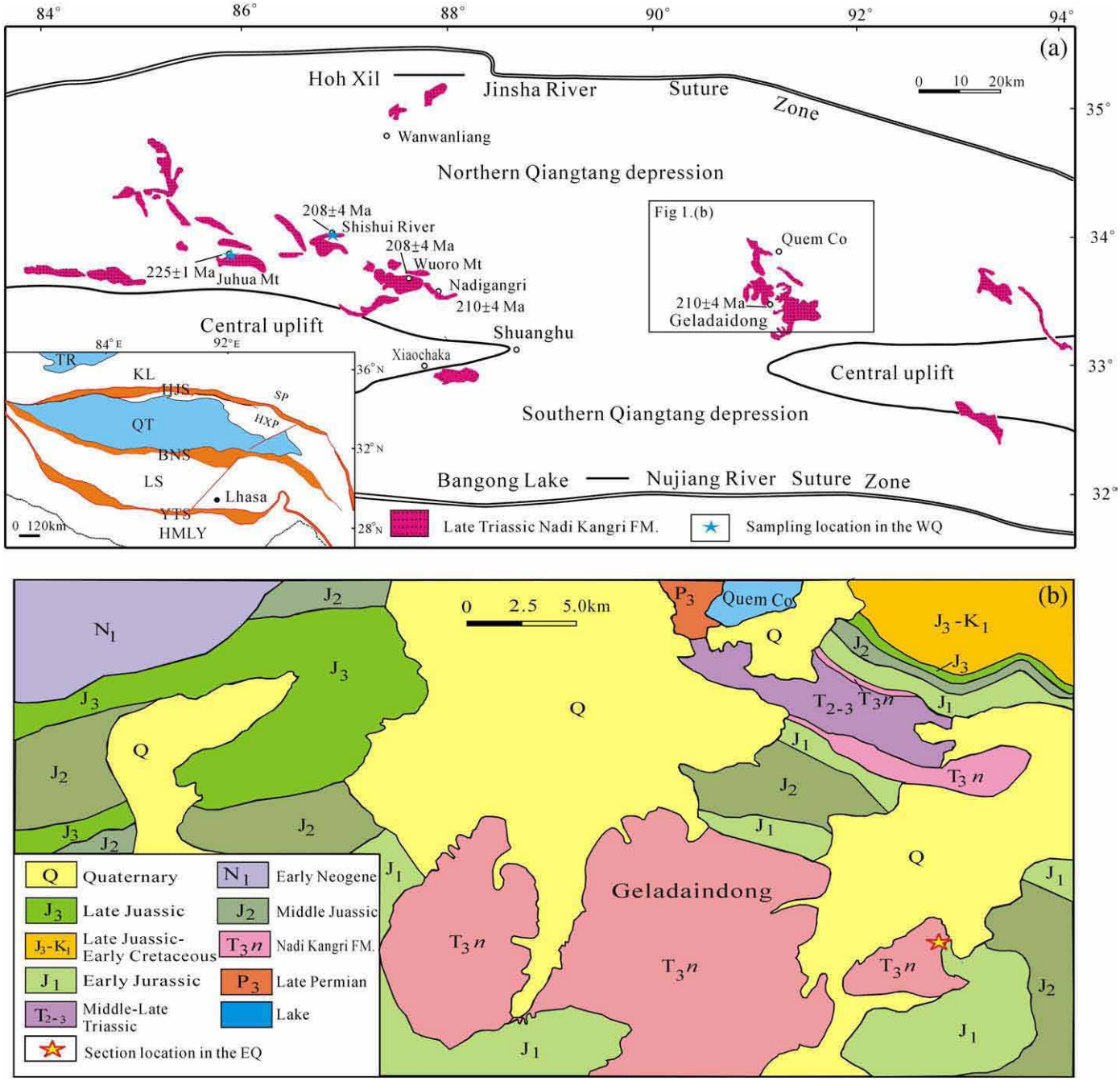

Fig. 1. (a) Simplified tectonic map of the Qiangtang basin showing the distribution of the Nadi Kangri volcanic rocks. (b) Simplified geological map of the Geladaindong area (modified from the 1:250,000 geological maps, Yao et al., 2003). TR = Tarim basin; KL = Kunlun terrane; SP = Songpan–Ganzi flysch complex; HJS = Hoh Xil–Jinsha River suture; HXP = Hoh Xili piedmont zone; QT = Qiagtang basin; BNS = Bangong Lake–Nujiang River suture; LS = Lhasa terrane; YTS = Yarlung Tsangpo suture; HMLY = Himalayas.

the Qiangtang Basin (Fu et al., 2007; Wang et al., 2007a). Subsequently, these weathering crusts were overlain unconformably by a succession of volcanic–volcaniclastic strata, i.e. the Nadi Kangri volcanic–volcaniclastic strata (Fu et al., 2008; Wang et al., 2008), marking the onset of the Mesozoic Qiangtang basin.

The early sedimentary successions of the Mesozoic Qiangtang basin, starting with a restricted continental molasse unit, consist mainly of alluvial and fluvial sedimentary facies associated with continental volcanic explosion facies (Wang et al., 2004). These successions are overlain by littoral to shallow-marine facies associations. Following the littoral to shallow-marine facies association, a drowned carbonate-platform facies association was formed as a result of rapid differential subsidence and the consequent sea-level rise and transgression. Therefore, the early sedimentary history of the Mesozoic Qiangtang basin is characterized by a progradational sequence of transition from continental to marine facies and reflects a progressive rift extension.

The Mesozoic rift-related volcanic rocks, i.e. the Nadi Kangri volcanic rocks, with fluidal and amygdaloidal structures, consist mainly of felsic volcanic rocks varying in thickness on different outcrops. Additionally minor basalts, with massive and amygdaloidal structures, are also observed in the Geladaindong area, eastern