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$^{40}Ar/^{39}Ar$ geochronology of post-collisional volcanism in the middle Gangdese Belt, southern Tibet

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ABSTRACT

^{40}Ar–^{39}Ar step-heating experiments on eleven mineral separates have been conducted on eight volcanic rocks and a granite-porphyry dike from the Yangying and Wuyu basins in the middle Gangdese Belt, southern Tibet. New radiometric ages for sanidine and biotite separates in four volcanic rock samples from Yangying ranges from 10.32 ± 0.07 to 11.40 ± 0.11 Ma, whereas plagioclase and biotite separates from a stratigraphic section of the Gaza Cun Formation in the Wuyu basin give ages from 12.57 ± 0.08 to 13.2 ± 0.2 Ma. A granite-porphyry which cuts the lower part of the Gaza Cun Formation gives an age of 11.09 ± 0.07 Ma, and a dacite from the margin of Wuyu basin gives an age of 15.48 ± 0.11 Ma. These age data, in conjunction with geochemical data, suggest that the mid-Miocene post-collisional volcanic rocks from these two basins have both similarities and difference in their petrogenesis. The high $[Sm/Yb]_N$ (>7) ratio and high Sr concentration (423–1065 ppm) in both suites are consistent with their parental melts derived from partial melting of eclogitized lower crust. However, the Yangying samples are more evolved than the Wuyu samples as manifested by lower MgO, Sr/Sr^*, Eu/Eu^*, and normative plagioclase. It is likely that the source material for the Yangying suite is likely more enriched in K_2O than that of the Wuyu suite, perhaps has a greater contribution from metasomatized lithospheric mantle. It is apparent that the post-collisional volcanism in southern Tibet occurred spatially scattered and temporally within a short period in each volcanic basin.

1. Introduction

The exact timing of the India–Asia continental collision remains debated, varying from ~70 to ~38 Ma (Beck et al., 1995; Searle, 1986; Searle et al., 1988; Klootwijk et al., 1992; Yin and Harrison, 2000; Mo et al., 2003, 2007; Zhou et al., 2004). Nevertheless, widespread tectonic and magmatic activities have continued on the Tibetan Plateau. High-K lavas have been erupting since ~13 Ma on the northern Tibetan Plateau. This is interpreted by some (Turner et al., 1993, 1996) as a consequence of thinning of the lithospheric mantle, marking the onset of the Tibetan plateau uplift. Others (e.g., Chung et al., 1998), however, argue that the uplift has been diachronous starting 40 Ma based on the observation that alkaline volcanism occurred from ~40 to 30 Ma in the eastern part of the plateau. Nevertheless, there are few geochronological data for post-collisional volcanic rocks for the southern region of the Tibetan plateau, because of their sparse distribution and limited volumes. The latter has thus hindered not only our understanding of the plateau-forming mechanism, but also our ability to quantify its process.

In this paper, we present in detail new $^{40}Ar/^{39}Ar$ age data on eleven mineral separates of nine rock samples from the middle Gangdese Belt in southern Tibet. These samples were taken from two volcanic fields, i.e., the Yangying and Wuyu basins, ~100 km apart from each other (Fig. 1). We interpret the age data along with geochemical data to discuss temporal and spatial distribution of post-collisional volcanism in the southern part of the Tibetan plateau and the petrogenesis.

2. Geological background and samples

One of our study locations, the Yangying geothermal field, is situated in Dangxiong County, Tibet along the China–Nepal road, about 80 km northwest of Lhasa and 55 km south of the well-known Yangbajing geothermal field (Fig. 1). It lies in one of the strings of graben basins trending generally northeast in the Gangdese Belt. The surrounding lithologies are mostly Mesozoic strata, including pre-Cretaceous slate and crystalline limestone to the northeast and Upper Cretaceous ignimbrites to the east and north-

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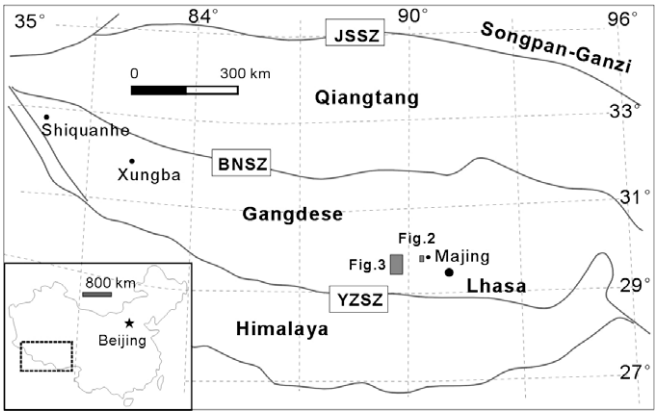

Fig. 1. Regional map of Tibet simplified from the 1:250,000 scale geologic map (Modified from Mo et al., 2008). Abbreviations: JSSZ, Jinshajiang Suture Zone; BNSZ, Bangong–Nujiang Suture Zone; YZSZ, Yarlung–Zangbo Suture Zone.

east. There are also Cenozoic strata consisting of Paleogene andesitic lavas and pyroclastic rocks to the north, Neogene dacitic pyroclastic rocks to the east and Pliocene trachyandesitic lavas and pyroclastic rocks to the west (Li et al., 1992). The strata within the geothermal field are mainly Cenozoic volcanic products, but dominated by Quaternary deposits with minor Paleogene rocks exposed at the center and northwestern part of the Yangying field (Fig. 2). The volcanic rocks of varying thickness are scattered over an area of about 10 km^2, and consist largely of pyroclastic deposits, subvolcanic intrusives as well as wildespread lava flows, extending north–south.

Pyroclastic rocks occur in the entrance of the Qialagai and Pujiemu valleys whereas subvolcanic rocks are mainly confined to the southernmost part of the geothermal field (Li et al., 1992). The stratigraphic relationship of pyroclastic rocks with subvolcanic rocks is yet to be confirmed. They both are previously attributed to the Linzizong succession (see 1/1,000,000 regional geological survey reports of Lhasa by XZBGMR, 1979). However, later studies using the whole-rock K–Ar method suggest that the volcanism at Yangying may be significantly younger and is geochemically much more alkalic (Li et al., 1992; Zhang, 1998). For this reason, we collected four samples along the Pujiemu valley and Qialagao valley in order to establish the relationship between these units and to improve the age data for the volcanism at the Yangying.

The other study location is in the Wuyu basin, Namling Country, about 200 km west of Lhasa, where the Wuyu Group crops out at its margin and is distributed in an ellipse area extending in NE–SW direction (Figs. 1 and 3). The Gaza Cun Formation is in the lower part of the Wuyu Group, which rests on andesitic rocks of the Dianzhong Formation (E_1d; basal unit of the Linzizong succession) with angular discordance and conformably underlies the Zongdang Cun Formation (N_2Z). The Gaza Cun Formation is subdivided into three parts: a lower trachytic section cut by granite-porphyry dikes, an upper pyroclastic section with caldera, and a middle section of coal-bearing clastic sedimentary rocks containing plant fossils and pollen grains of Pliocene age (1/200,000 Regional geological survey reports of Xietongmon and Namling (1996), Zhao et al. (2001); Fig. 4). No systematic geochronological study is avail-

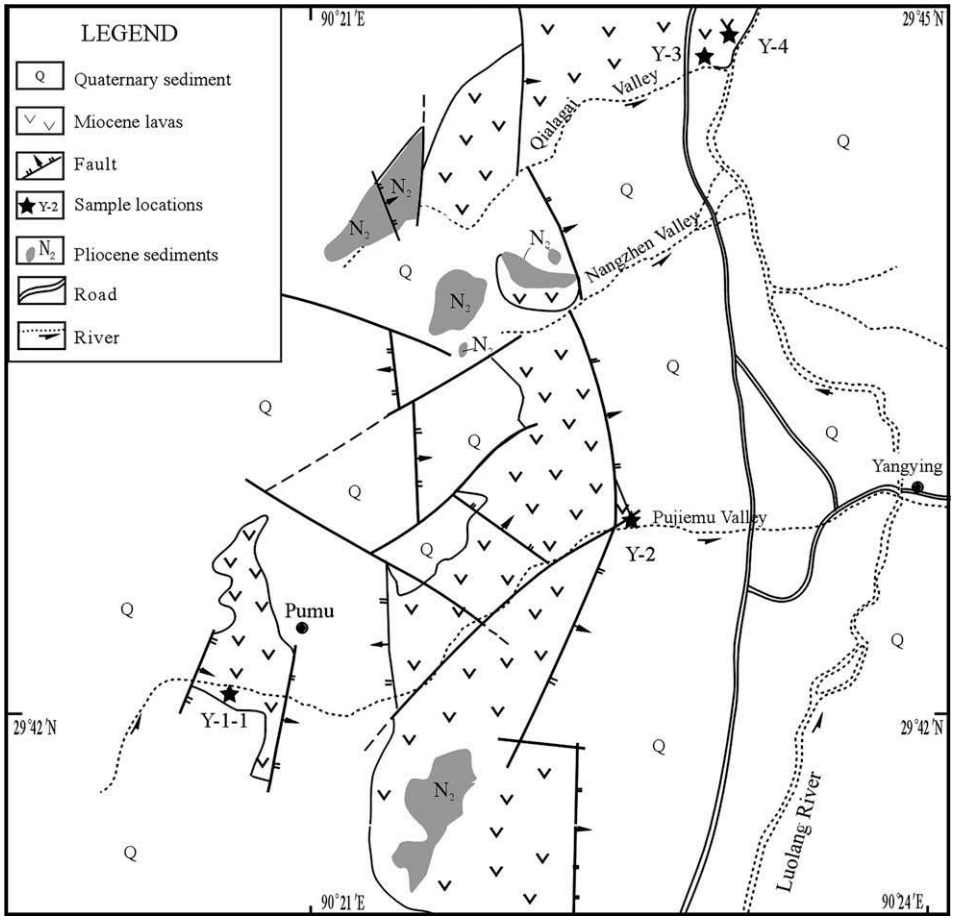

Fig. 2. Geological map showing distribution of the Cenozoic volcanic rocks in the Yangying geothermal field of Dangxiong district, Tibet, China (adapted from Li et al., 1992).