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Longmu Co–Shuanghu–Changning–Menglian Suture Zone: Residual of Uniform Early Paleozoic Tethys Ocean

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Tethyan evolution of the Qinghai–Tibet Plateau has always been the top concern of domestic and foreign geologists. The formation and evolution of the Proto or Paleo Tethys Oceans, it is one of the geologists to explore such a long-term scientific issues. Sanjiang region is located in the eastern section of the Tethyan domain, binding site of Gondwana and Eurasia continents. It is generally believed that the Sanjiang area is represented as an archipelago ocean, which is composed of some terranes and oceanic basins during the Paleo–Tethys stage, and the Changning–Menglian suture zone is represented the main branch of the ocean. Timing of the formation of the Longmu Co–Shuanghu, Lancang River and Changning–Menglian suture zones (Fig. 1a), which belong to the Tethys tectonic domain, is of great significance for the Tethys ocean evolution and Palaeogeographic

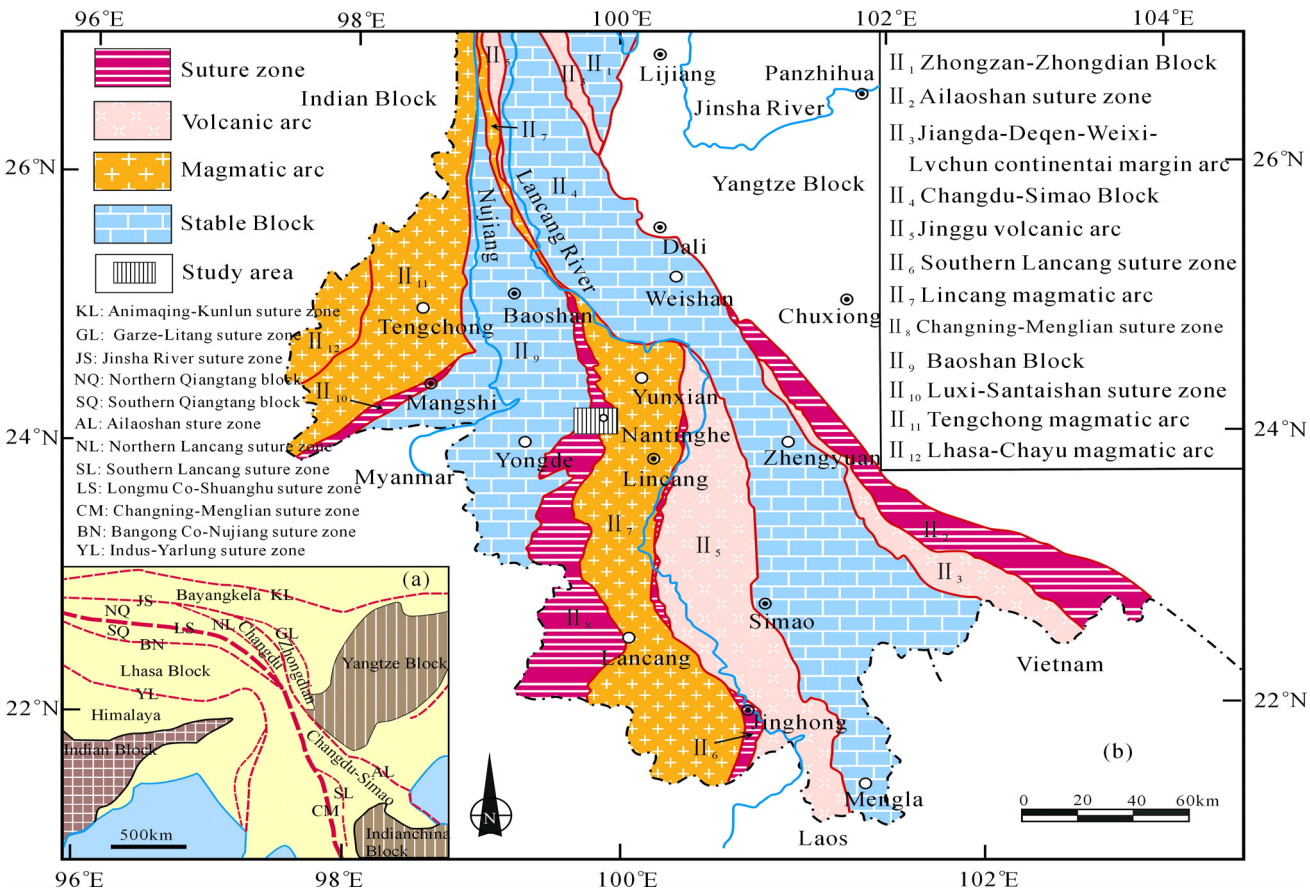

Fig. 1. Geological map showing (a) the tectonic framework and (b) a simplified geological map of the southern Sanjiang Orogen and surrounding areas (modified from Deng et al., 2012).

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reconstruction (Jian et al., 2009; Jian et al., 2008; Metcalfe, 1994; Deng et al., 2012). However, which ocean basin represents the Proto– Paleo Tethys Ocean, still possesses two different understanding: 1) Longmu Co–Shuanghu–Lancang River suture zone, which is the boundary between Gondwana and Eurasia continents in the Qinghai–Tibet Plateau (Li et al., 2006b, 2007, 2008; Zhai et al., 2007, 2010). 2) Bangong Co–Nujiang–Changning-Menglian suture zone. Furthermore, the discovery of Early Paleozoic ocean of the Longmu Co-Shuanghu suture zone in the central Qiangtang area, which is combined with the east or south extensions, has arisen great puzzle among geologists.

Previous studies have shown that Changning–Menglian suture zone extends from the Changning and Tongchangjie of the Yunxian in the north, through Shuangjiang and Laochang of the Lancang, and to the Myanmar in the south, which contains many complete ophiolitic mélanges (Fig. 1b). The fragments of the ophiolite mainly consist of amphibolites, actinolitites, schists, serpentinization olivine-pyroxenites, cumulative gabbros, meta-gabbros and meta-basalts. The ultramafic rocks commonly display the layered, layered-like, cystic and granular pattern. Early Devonian *Monograptus uniformis* and Early Carboniferous *Palaeory phosty.lus uar spina* radiolarian in the deepwater flysch sedimentary chert were discovered in the Changning–Menglian suture zone (Fang et al., 1998; Feng, 2002; Li et al., 2010). Moreover, Tongchangjie ophiolite to the north of this study area, and the layered amphibolite in the Menghuazhai area to the 12 km east of Shuanjiang country, formed at 385 and 381 Ma (Cong et al., 1993; Zhang and Li, 1990), respectively. All of those evidences imply that there was an oceanic basin in the Changning–Menglian suture zone during Late Paleozoic.

Recently, complete ophiolite has been found in the Nantinghe area in the northern part of the Changning–Menglian suture zone, southeast Tibet (Wang et al., 2013a, 2013b). It is composed of meta–peridotite, cumulative gabbro, meta-gabbro, plagioclase amphibolite and meta-basalt. Zircon U-Pb dating of the cumulative gabbro gives concordant ages of 443.6±4.0 Ma and 439±2.4 Ma respectively (Wang et al., 2013a, 2013b). In this paper, we have obtained two samples of Zircon U-Pb dating by LA-ICPMS method again. The eighteen analyzed spots from the cumulative gabbro sample (12NTH-1) have concordant $^{206}Pb/^{238}U$ ages ranging from 420 to 457 Ma. They form a discrete population with a weighted mean $^{206}Pb/^{238}U$ age of 439.0±5.8 Ma (Fig. 2a), which is considered to be the crystallization age of the cumulative gabbro. The twenty-one analyzed spots for the cumulative gabbro sample (12NTH-5) give $^{206}Pb/^{238}U$ ages ranging from 429 to 470 Ma, with a weighted mean $^{206}Pb/^{238}U$ age of 453.9±5.6 Ma (Fig. 2b), which has further confirmed that Early Paleozoic ophiolite exists in the Nantinghe area in the Changning–Menglian suture zone.

Previous studies have shown that the gabbro shows relatively low contents of SiO_2 (46.46%– 52.11%), TiO_2 (0.96%–1.14%) and K_2O (0.48%–0.75%). Its trace element distribution patterns are partly similar to those of the mid-ocean ridge basalts, and part is depleted in high field strength elements such as Nb, Ta, Zr, Hf and Ti. These features suggest that the mafic rocks were probably formed in a MORB-like or back–arc rift basin setting

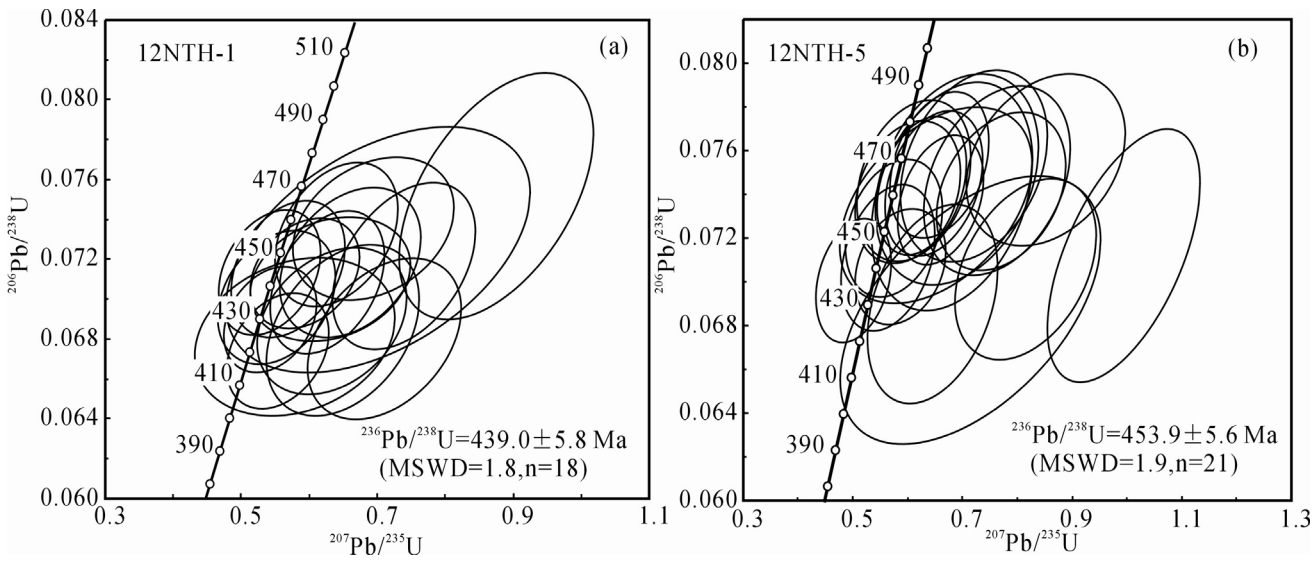

Fig. 2. U-Pb concordia diagram of zircons from cumulative gabbro in the Nantinghe ophiolite

(Wang et al., 2013a). Which combine with previous research results, allows us to consider that there are at least two episodes ophiolites in Early and Late Paleozoic.

Longmu Co–Shuanghu suture zone mainly exposes in the Gangmari–Mayigangri area in central Qiangtang Block. The ophiolite mainly consist of Carboniferous–Permian low–grade metamorphic and strongly deformed medium–high pressure metamorphic rocks, ultramafic, cumulates complex rocks, pillow basalt, chert, marble, and gabbro–diabase dikes/dykes. Longmu Co–Shuanghu suture zone is considered to be the boundary between Gondwana and Eurasia continents in the Qinghai–Tibet Plateau (Li et al., 2006b, 2007, 2008). However, due to the lack of complete ophiolite sequence, this interpretation has not been widely accepted by the researchers (Li et al., 2009; Pullen et al., 2011).

Recent studying results have suggested that the Early Palaeozoic oceanic basin has expanded in the Longmu Co–Shuanghu suture in the central Qiangtang of the Tibet Plateau. The Palaeozoic ophiolite and ultrahigh-pressure metamorphic belt were found at Guoganjianianshan and Taoxinghu areas (Li et al., 2006a), respectively. The cumulative gabbros from the ophiolite, with SHRIMP zircon U-Pb ages of 438±11 Ma (Li et al., 2008), 432±7 Ma, and 461±7 Ma (Wang et al., 2008), have been interpreted to be formed a tectonic settings similar to the N-MORB (Zhai et al., 2007). These results suggest that there is an Early Palaeozoic ophiolite in Longmu Co–Shuanghu suture. In addition, Permian MORB-like ophiolite and Triassic radiolarian chert at Jiaomuri area in the central Qiangtang region, Late Devonian and Permian radiolarian chert at Caiduochaka area to the east of the Shuanghu region (Zhai et al., 2013), indicate that the ophiolites occurred in the Qiangtang region during the Late Palaeozoic. The above observations confirm that there are at least two episodes of ophiolites in the Longmu Co-Shuanghu belt during the Early and Late Palaeozoic.

Generally speaking, the mid-ocean ridge setting is suggested by the N-MORB-like patterns of trace element distribution, whereas the backarc rift basin is indicated by the coexisting MORB- and IAB-like patterns of trace element distribution (Zheng, 2012). Therefore, the Early Palaeozoic ophiolites for the Changning–Menglian suture zone and the Guoganjianianshan and Taoxinghu areas from the central Qiangtang are consistent with each other not only in the formation time but in the tectonic setting. They would have formed in the backarc rift basin and be emplaced due to the closure of backarc basin and arc-continent collision (Zheng, 2012). Consequently, the ophiolites of Guoganjianianshan and Taoxinghu in the Qiangtang region are likely to integrate with those ophiolites of Nantinghe in the Changning-Menglian suture zone from the Sanjiang area. Both of them probably represent the fragments of oceanic crust of the uniform Palaeozoic Tethys Ocean: the Longmu Co–Shuanghu–Changning–Menglian Palaeozoic Tethys Ocean (Fig. 1a), which existed from Ordovician to Permian at least. Combined with the formation age of the Late Palaeozoic magmatic zone in Lincang magmatic arc (Fig. 1b), we suggest that the Changning–Menglian oceanic crust occurred in the Early Palaeozoic at least, which was subducted eastward, leading to the eruption of the Dazhonghe volcanic rocks during 421–418) Ma (Mao et al., 2012), closed at t he end of the Permian, following arc–continental collision in the Triassic and eventually been unconformably overlain during the Upper Triassic (Li et al., 2010).

Key words: Early Paleozoic ophiolite, Changning-Menglian Suture zone, Longmu Co-Shuanghu suture zone, Tethys Ocean, Sanjiang area

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