Petrogenesis and Tectonic Significance of Mafic-Ultramafic Rocks from Southwest Yunnan, China

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Supporting Online Materials

Geological background and sampling sites

Many records of remnant oceanic crust and pelagic deposits exist in southwestern Yunnan and the adjacent areas, indicating the existence of a wide Palaeotethyan archipelagic ocean from the Late Palaeozoic to the Early Mesozoic (Fang et al., 1998; Yang et al., 2007). According to previous studies, some of the best-known orogenic belts in China, such as the Ailao-Mojiang belt, the Lantsang belt, the Changning-Menglian belt and the Nujiang belt, were sutures of the Palaeotethys. Of these belts, the Changning-Menglian belt is considered to represent the main basin because it preserves the longest oceanic record (from the Early Devonian to the Middle Triassic) and contains the widest variety of sedimentary types (Liu et al., 1993; Fang et al., 1994; Zhong, 1998). The Changning-Menglian belt extends into Myanmar and western Thailand (i.e., Chiang Mai, Petchabun and other locations), crosses the Gulf of Thailand, connects the Ben Tong-Raub ophiolite belt on the Malay Peninsula, and forms the more than 2000-km-long north-south suture of the main basin of the Palaeotethys (Liu et al., 2002) (Figure A1a). Mangxin, the study area, is located at the southern end of the Changning-Menglian belt in China and in the northern portion of the Changning-Menglian-Chiang Mai-Raub oceanic basin system. This area contains abundant outcrops of Late Palaeozoic mafic-ultramafic pillow lavas, radiolarian chert, manganese rocks and pure dolomitic carbonate rocks, thus providing an important window for understanding the evolution of the Palaeotethys.

Existing geological records have revealed that the oceanic basin of the Changning-Menglian belt began to expand during the Early Devonian, rapidly developed from the Middle to Late Devonian, and reached its largest scale during the Early Carboniferous. Subduction then occurred during the Middle Carboniferous, and its remnant stage spanned from the Late Permian to the Middle Triassic (Ding & Zhong, 1996; Fang & Feng, 1996; Fang et al., 1998). The following observations indicate that the basin reached its largest extent during the Early Carboniferous. (1) Radiolarian chert exhibited its highest purity and widest distribution. (2) Pelagic deposits were more abundant, and manganic rocks with polymetallic and phosphate nodules were common in these layers. (3) Unprecedented deep-water deposits represented by turbidites and contourites developed along the continental margins. (4) Intraplate mafic-ultramafic lavas are widespread (Fang & Niu, 2003); although isotopic ages have not been reported for these lavas, fossils from the intercalated radiolarian cherts and overlying carbonate rocks confirm that their main eruption age was Early Carboniferous, specifically, Tournaisian) (Feng et al., 1997; Zhang & Feng, 2002).

The samples studied here were collected from the region south of Mangxin, where a rock system that includes peridotites, picrites, basalts and radiolarian siliceous rocks crops out. Siliceous rocks are widely distributed in this area and are intercalated with igneous rocks. These cherts are mainly dark grey to black grey, which is consistent with the background of the archipelagic ocean. The age of the radiolarians suggests that the eruption age was Early Carboniferous (i.e., Tournaisian) (Feng et al., 1997; Zhang & Feng, 2002). The picrites in Mangxin generally exhibit pillow structures (Figure A2) and can be divided into two different types based on their structures and compositions. The Type-1 samples (MX01, MX02, MX03, and MX04) were collected along both sides of the Nanlei River, while the Type-2 samples (MX05 and MX06) were collected from the hills on the eastern side of the Nanlei River. The accumulative peridotites (AP01, AP02) were collected near the sampling site of the Type-2 picrites. The basalts were collected along both sides of the Nanlei River (10MXW112, 13MX2-1, 13MX2-2, 13MX8-1, 13MX8-4, 15MXE008-1, 10MXE801, and 10ML501) and the northern area of Mangxin (10YT102, 10YT503, 15YT003-1, 15YT003-2, 15YT004-1, 15YT004-2, and 15YT012-1) (Figure A1b).

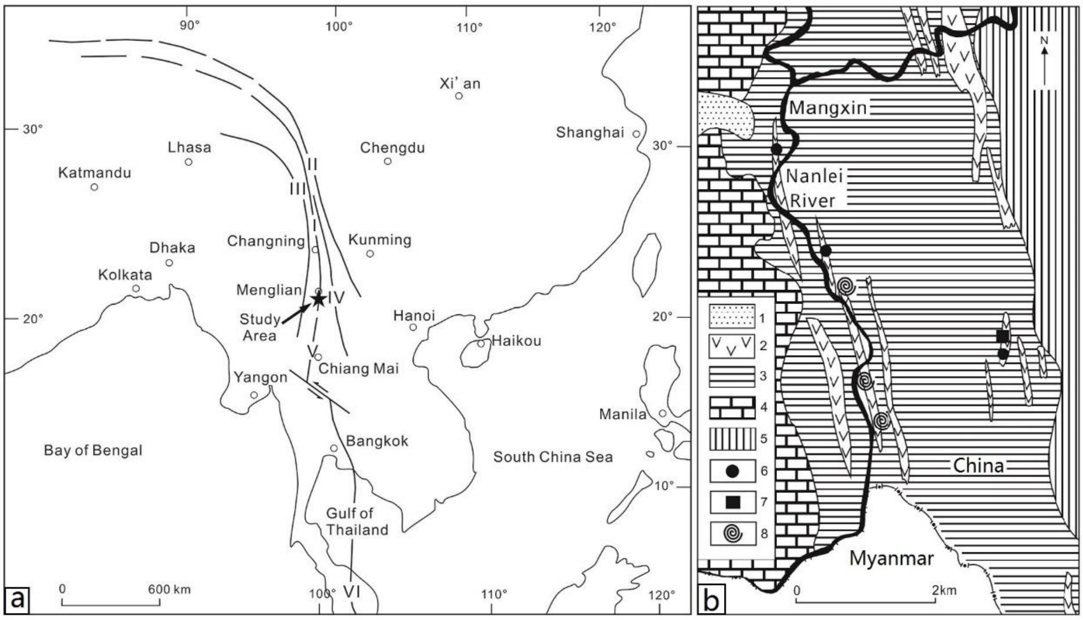

Figure A1. Geologic maps of the study area: a, regional tectonic framework of the Palaeotethys as indicated by several orogenic belts: I, Changning-Menglian Belt; II, Ailao-Mojiang Belt; III, Nujiang Belt; IV, Lantsang Belt; V, Chiang Mai Belt; VI, Ben Tong-Raub Belt; black star, Mangxin, the study area; b, the sampling locations in the study area: 1, Quaternary; 2, ultramafic volcanic interlayers; 3, radiolarian cherts with basalt pillows; 4, sea mountain–oceanic island carbonate rocks; 5, radiolarian cherts of oceanic basin strata; 6, sampling sites of the Mangxin picrites; 7, sampling site of the Mangxin accumulative peridotites; 8, radiolarian fossil sites of Zhang and Feng (2002)

Figure A2. Outcrop of picrite pillows (sampling site of Type-2 picrite).

Analytical methods and data

All of the major and trace elements were analysed at the State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan. The major element oxide contents of the whole-rock samples were analysed by XRF-1800 spectrometry (Sequential X-Ray Fluorescence Spectrometer, SHIMADZU, Japan). For the analysis of the major elements, sample powder was dried for 2 hours at 105°C and melted in a high frequency furnace at 1000°C with a mixed flux of $45Li_2B_4O_7+10LiBO_2+5Li$, NH_4NO_3 and LiBr to make quenched glass sections. Two standard materials (GBW07105 and GBW07109) were analysed. The trace element contents were analysed by ICP-MS (inductively coupled plasma mass spectrometry, Agilent 7700x, Japan). HNO_3 and HF were used as reagents for sample dissolution. Five standard materials (BCR-2, AGV-2, BHVO-2, GSR-1 and GSR-3) were analysed. The analysed data and standard data are shown in Appendix 1.

The major and minor element compositions (Si, Na, Cr, K, Mg, Al, Mn, Ca, Fe, Ti and Ni) of the olivines and spinels from the Mangxin picrites were analysed with a JXA-8100 EPMA (electron probe microanalyser, Jeol, Japan) at the Institute of Geology, Chinese Academy of Geology Sciences. The analytical conditions were optimized for SPI standard silicates and oxides at an accelerating voltage of 15 kV with a beam size of 5 µm, a 100-nA beam current, a spectral time of 10 sec, and ZAF correction. The elemental compositions of the matrices in the picrites represented the average values of multipoint measurements as analysed with a beam size of 50 µm. The average values and standard deviations of the elemental compositions of the olivines, clinopyroxenes and spinels are provided in Appendix 2.

References for supporting online materials

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