Imbricate structure of Luobusa ophiolite, southern Tibet

Hiroshi Yamamoto†*, S Yamamoto‡, Y Kaneko§, M Terabayashi¶, T Komiya‡, Ikuo Katayama‡ and T Iizuka‡

† Department of Earth and Environmental Sciences, Kagoshima University, Kagoshima 890-0065, JAPAN
‡ Department of Earth and Planetary Science, Tokyo Institute of Technology, Meguro, Tokyo 152-8851, JAPAN
§ National Institute of Advanced Industrial Science and Technology, Geological Survey of Japan, Tsukuba 305-8567, JAPAN
¶ Department of Safety Systems Construction Engineering, Kagawa University, Takamatsu 761-0396, JAPAN

** To whom correspondence should be addressed. E-mail:hyam@sci.kagoshima-u.ac.jp*

Cretaceous ophiolite sequences lie in the Indus-Yarlung Zangbo suture zone (IYSZ), which separates the Indian Subcontinent from the Lhasa Terrane (e.g. Allegre et al. 1984). A large ophiolite sequence, called the Luobusa ophiolite is about 200 km east-southeast of Lhasa in southern Tibet. The ophiolite extends 43 km in east–west and its exposure is about 70 km^2 (Zhou et al. 1996). The Luobusa ophiolite consists of mantle peridotite (harzburgite and dunite) and a melange zone, which contains pyroxenite, gabbro, pillowed basalt and chert. Podiform bodies of chromitite are sporadically distributed in harzburgite. The podiform chromitite has received much attention because it contains "unusual mineral assemblage" which includes diamond and octahedral serpentine (Bai et al. 1993 2002, Yamamoto et al. 2003). Previous studies of the Luobusa ophiolite have concentrated on petrology and mineralogy of mantle peridotite. However, the mechanism by which the mantle peridotite were emplaced has not been made clear. The difficulty in tectonic interpretation arises from the limited scope of structural data. In this study we analyzed deformation structures in the boundary zones of the ophiolite to decipher the emplacement process of the Luobusa ophiolite through the suturing of Asia and India.

The northern edge of Luobusa ophiolite in the study area has a fault contact with the Tertiary Luobusa Formation composed of molasse-type deposits. To the south the ophiolite sequence has a fault contact with the Triassic flysch-type sedimentary rocks. The northern and the southern boundaries dip gently to the south. Mesoscopic structures were observed on outcrop surfaces which are nearly perpendicular to the foliation and nearly parallel to the lineation. Microscopic observations were made on polished slabs and thin sections of oriented samples taken from the shear zones near to the top and bottom boundaries of the Luobusa ophiolite. The slabs and thin sections were made on the section perpendicular to the foliation and parallel to the mineral lineation.

A serpentine melange zone, which lies along the northern margin of ophiolite sequence occupies the structural bottom of Luobusa ophiolite. The serpentine melange zone contains lenses of gabbroic rocks, pillow lavas and Cretaceous marine sedimentary rocks. These rocks occur as blocks in a partly serpentinized ultramafic matrix. Individual lithologies are irregularly distributed and the serpentinite matrix is intensively deformed. In the outcrops and oriented samples sets of subparallel shear bands and minor shear zones occur in the serpentinite. The shear bands are oblique to foliation in serpentinite and are regarded as "C'-type shear bands" (**Figure 1**). Consistent top-to-the-north displacements are observed at three localities in the serpentine melange zone.

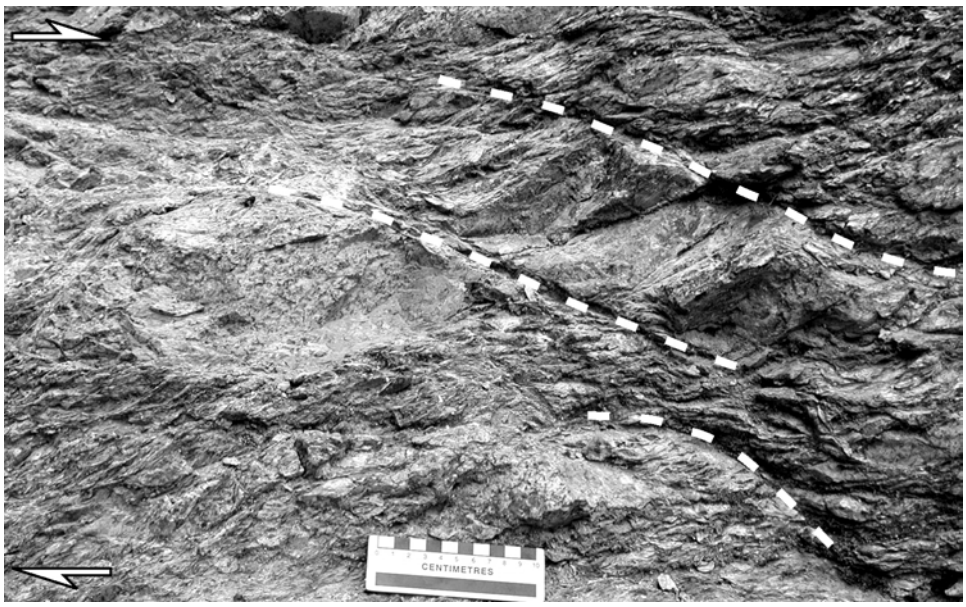

FIGURE 1. Sheared serpentinite near to the bottom of Luobusa ophiolite. The attitude of foliation is N20°W, 34°S and striation on the surface of sheared fragment of peridotite trends N13°W. Broken lines indicate C'-type shear bands (N80°E, 31°N) suggesting top-to-the-north displacement. Scale bar on the bottom is 10 cm.

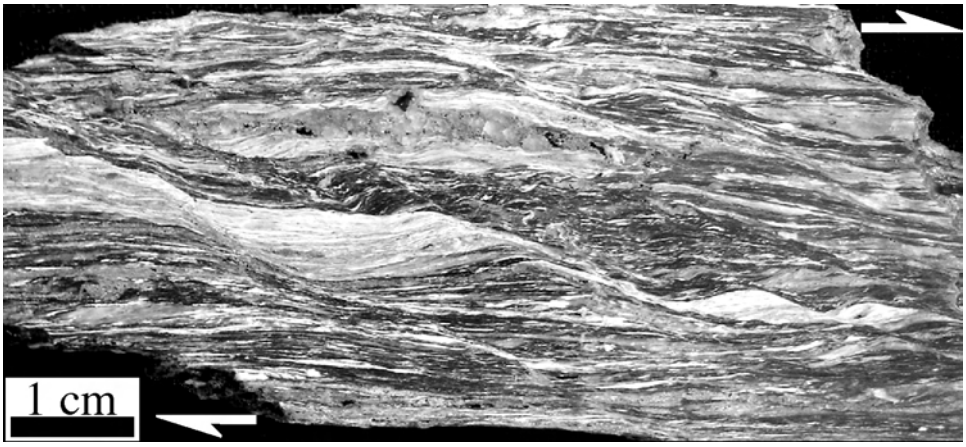

FIGURE 2. Polished surface of sheared phyllite in Triassic sedimentary rocks near to the top of mantle peridotite. C'-type shear bands displacing compositional layering indicate top-to-the-northeast displacement. The attitude of foliation is N74°W, 54°S and the trend of mineral lineation is N46°E.

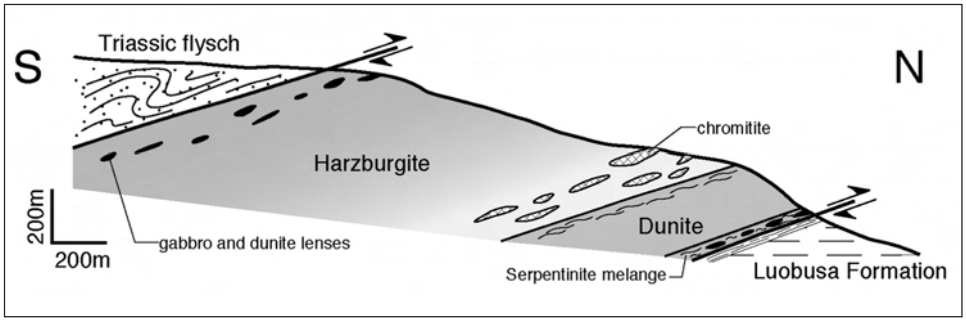

FIGURE 3. Cross-section across the Luobusa ophiolite. Arrows indicate relative motions along shear zones in the upper and lower boundaries.

Harzburgite with dunite lenses lies in the structural upper part of the Luobusa ophiolite although the structural top is not well exposed because of the flat ground surface in the southern part of study area. Feebly metamorphosed pelitic, siliceous and calcareous rocks overlie the mantle peridotite. C'-type shear bands commonly occur in siliceous phyllite (**Figure 2**). Some quartz porphyroclasts in well-foliated micaceous phyllite are mantled by asymmetric 'tails' to form 'σ-type' porphyroclasts. Consistent top-to-the-north displacements are observed in four oriented samples from separate localities.

These observations give the following constraints on kinematics of the three rock units: (1) northward thrusting of the Luobusa ophiolite upon the Tertiary Luobusa Formation, (2) northward thrusting of the Triassic sedimentary rocks upon the Luobusa ophiolite and (3) this stack of rock units forms north vergent imbricate structure (**Figure 3**). It can be interpreted that the imbricate structure was formed due to northward displacement of India continued after the welding of India with Asia.

References

Allegre CJ, V Courtillot, P Tapponier, A Hirn and M Mattauer. 1984. Structure and evolution of the Himalaya-Tibet orogenic belt. *Nature* **307**: 17-22

Bai W., MF Zou and PT Robinson. 1993. Possibly diamond-bearing mantle peridotite and podiform chromitites in the Luobusa and Donqiao ophiolites, Tibet. *Can J Earth Sci* **30**: 1650-59

Bai W., J Yang, Q Fang, R Shi and B Yang. 2002. Unusual minerals in the podiform chromitite of Luobusa, Tibet: Do they come from Lower mantle and how? Abstracts of the *Superplume International Workshop*, 2002 Jan 28-31; Tokyo: Tokyo Institute of Technology. p 153-57

Zhou MF, PT Robinson, J Malpas. and Z Li. 1996. Podiform Chromitites in the Luobusa Ophiolite (Southern Tibet): Implications for Melt-Rock Interaction and Chromite Segregation in the Upper Mantle. *J Petrol* **37**: 3-21

Yamamoto S., T Komiya, K Hirose and S Maruyama. 2003. Interesting Inclusions From Podiform Chromitites in Luobusa Ophiolite, Tibet. EOS Transactions of the American Geophysical Union, **84**, p F1514