Petrogenesis and tectonics of an intra-oceanic island arc origin Yakuno ophiolite, Southwest Japan

Yasutaka HAYASAKA* and Yoshimitsu SUDA**

*: Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University, e-mail: hayasaka@geol.sci.hiroshima-u.ac.jp
**: National Institute of Polar Research, e-mail: suda@nipr.ac.jp

Outline: Petrogenesis of granitoids in the intra-oceanic island arc has a key to constrain the process of continent–crust growth by accretion of oceanic island. Upper Paleozoic crustal section of an intra-oceanic island arc occurs in the Asago body from the Yakuno ophiolite of the Maizuru Terrane, Southwest Japan (Fig. 1). The Asago body tectonically overlies the Early Permian accretionary complex of the Ultra-Tamba Terrane. The body consists of three major structural units: Lower Unit, Middle Unit and Upper Unit. Each of these units is bounded by low angle fault (Hayasaka, 1990, in Ichikawa K. et al. eds. *"Pre-Cretaceous Terranes of Japan"*: publication of IGCP 224, 81-).

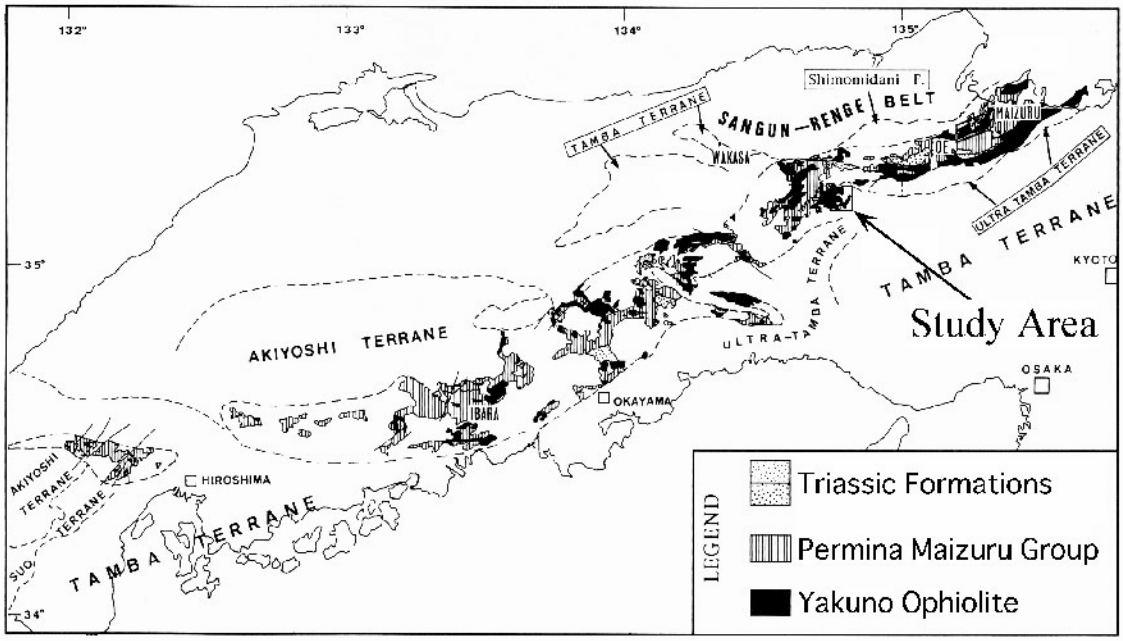

Fig. 1 Geological sketch map of the Maizuru Terrane and distribution of the Yakuno ophiolite.

Lower Unit: The Lower Unit occur as a mafic-ultramafic meta-cumulate consisting mainly of peridotite, pyroxenite, and gabbro in ascending order with minor amount of anorthosite. Chemical composition of Cr-spinel from the peridotite shows its fore-arc ophiolite affinity. The Sm-Nd whole rock-Cpx-Pl internal isochron age of the gabbro is 343 +/- 34Ma with $^{143}Nd/^{144}Nd$ initial ratio of 0.512259 +/- 0.000049. Cpx crystals in the mafic-ultramafic transition zone show metamorphic recrystallization texture, which imply relatively thick oceanic crust origin.

Middle Unit: The Middle Unit occurs as a complicated structured mafic and intermediate to felsic meta-igneous complex. Many sheeted granitoids intrude in the gneissose metagabbro and foliated amphibolite in the middle to upper part of the Unit. Those younger intrusions are mylonitized in various degree. Whole rock chemistry of the foliated amphibolite is similar to that of MORB, and the younger granitoids is of Island arc calc-alkaline series. The mafic migmatite complex associated with granitic leucosome occur in the lower part of the Unit, at where the in-situ dehydration melting-anatexis phenomenon thought to have been occurred due to heating by arc ingeous activity (Suda, 2004, Jour. Min. Pet. Sci., 99, 339-). The leucosome originated by partial melting of the older oceanic basement is considered to be major source for the younger granitoids at the island arc stage. Zircon separated from two samples of weekly mylonitized tonalite and strongly mylonitized granodiorite have yielded U–Pb ages of 282 +/- 2Ma and 285 +/- 2Ma, respectively (Herzig et al., 1997, The Island Arc, 6, 396-). And U-Th-total Pb age of monazite separated from strongly mylonitized granodiorite is 272.5 +/- 5.1 Ma. The zircon ages may show the main stage of island arc setting and the somewhat younger monazite age can be attributed to deformation-metamorphism after consolidation of granitic magma. Detailed mapping of the intensity of beta ray from outcrop using Geiger-Mueller survey meter reveal that the metabasites are subdivided into low radiation and high radiation groups. The intensity of beta ray radiation is considered to reflect their concentration of K, Th and U. Therefore, the low radiation group (30%) and high radiation group (70%) can be roughly assigned to older MORB origin and younger IAT origin respectively.

Upper Unit: The Upper Unit consists mainly of fine-grained metagabbro, quartzdiorite, metadolerite, metabasalt and mudstone. The upper half of this Unit can be correlative with the lower formation of the Permian Maizuru Group. Whole rock chemistry of the metabasalt shows a BABB affinity.

Tectonics: An evolution history of the Maizuru Terrane and the Yakuno ophiolite can be summarized in a context of a collided arc-back arc system as follows. 1) The older metabasite of the Yakuno ophiolite was formed as a thick oceanic crust (Yakuno oceanic plateau) in the Early Carboniferous (ca. 340 Ma). 2) Ancient intra-oceanic subduction have began to start near the oceanic plateau by the time of Early Permian (ca. 285 Ma). An accretion of IAT magma caused granulite facies metamorphism and anatexis by the partial melting of the lower crust of the island arc (Maizuru island arc). The younger granitic intrusion was formed during this stage. 3) Back-arc spreading coeval with arc volcano-plutonism was occurred in the Yakuno island arc forming Maizuru basin followed by the sedimentation of Maizuru Group. 4) The Maizuru arc-back arc system was collided with continental margin forming south-vergenced overturned fold of the Maizuru Group and piled nappe structure of the Yakuno ophiolite during Late Permian.