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Modal, heavy minerals and detrital garnet analyses of Ultra-Tamba Terrane, in the Kyoto Nishiyama area, Southwest Japan

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This study documents the first attempt to elucidate the provenance of the Takatsuki Formation that distributed in the Kyoto Nishiyama area, Southwest Japan, using modal, heavy minerals and detrital garnet analyses. Over the last 4 decades, the examination of heavy mineral and detrital garnet analyses of the Ultra-Tamba Terrane was evaluated by using the Hikami Formation (Kasahara and Musashino, 1986). Although the depositional age of this formation was regarded as Permian, their age is problematic (Sugamori, 2009b). The Takatsuki Formation consists mainly of alternating and broken sandstone and mudstone beds with felsic tuff and siliceous mudstone. The formation includes well-preserved Late Permian (Late Wujiapingian) radiolarian fossils (Sugamori, 2006) and is interpreted as a subduction-related accretionary complex (Sugmaori, 200 9a). This suggests that clastic rocks of the Takatsuki Formation are Late Permian trench-fill sediments. It is expected that the Takatsuki Formation has useful information about the provenance of Late Permian trench-fill sediments of the Inner Zone.
Petrographic modal analysis of eight medium-grained sandstone samples revealed that the Takatsuki sandstones are lithic and feldspathic wacke consisting of matrix (25-36; av. 29.5 %), quartz (12-17; av. 14 %), K-feldspar (1-5; av. 3 %), plagioclase (18-29; av. 25 %), rock fragments (18-31; av. 25 %) and accessories (1-3; av. 1 %). Rock fragments are dominated by felsic to intermediate volcanic rocks (90 %) together with mafic volcanic rocks, serpentinite, granite and clastic rocks.
The heavy mineral suite (except for opaque minerals) of four samples and another sample, in decreasing order of abundance, mainly consists of epidote group, titanite, garnet, zircon, spinel, and zircon, epidote group, garnet, titanite, spinel, respectively. The proportion of euhedral to rounded zircons in these samples is one to one. Detrital garnets contain anisotropic garnets (about 10 to 25 %) in the advance analysis.
One sandstone sample contains a minor amount of garnet (40 grains), which comprises almandine (45 %), grandite (27.5 %), spessartine-rich almandine (15 %) and grossular-rich almandine garnets (Takeuchi et al., 2008). On the other hand, following the Mn-Mg-Ca diagram (Teraoka, 2 003), the sample includes 37.5 % intermediate P/T facies (Ia: up to amphibolite facies), 27.5 % grandite (G), 22.5 % low P/T facies type garnet (L) and 12.5 % high P/T facies (H) type garnets. The Takatsuki sandstone includes high content of felsic and intermediate volcanic rocks, with common occurrence of euhedral zircons. The presence of few granites and allanite grains gave an impression that granites were exposed at source area. It is considered that a part of L and Ia type garnets were derived from these felsic rocks. Rounded zircon grains indicate that clastic sedimentary rocks were a part of the source rocks. Spinel is thought to be released from ultramafic to mafic rocks. This is supported by the presence of serpentinite fragments. These rocks are presumed to be the Renge belt (including the Oeyama ophiolite) or the Yakuno ophiolite. H and a part of Ia type garnets are derived from high P/T and epidote to amphibolite facies metamorphic rocks, respectively. These rocks could be compared with the Renge belt. Grandite garnets of the Takatsuki Formation are considered to have been derived from skarn due to including andradite-rich to grossular-rich grandite garnets (Takeuchi, 2009). This skarn is

thought to be in the continent owing to no pre-Triassic skarn in Japan (Kametaka, 1999). Thus, felsic and intermediate volcanic rocks are major provenance of Late Permian trench-fill sediments. In addition, the presence of aureoles on the continent, granites, mafic to ultra-mafic rocks and medium to high-pressure type metamorphic rocks may exert contributions from the source area.

Keywords: East Asia, subduction-related accretionary complex, provenance,
Late Permian trench-fill sediments, Takatsuki Formation, detrital garnet