Depth of oceanic crust underplating in subduction zone - inference from fluid inclusion analysis of crack seal vein -

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The subduction zone is one of the most active portions in the Earth. Along the subduction zone, oceanic plate and overlying sediments underthrust beneath continental or another oceanic plates. About half of the subduction zones in the world are accompanied by accretionary complexes (von Huene and Scholl, 1991). The accretion means tectonic growth of continent accompanying offscraping process of sediments and underplating of the subducting oceanic crust. The offscraping process is well documented from modern accretionary complex through ocean drilling and geophysical imaging (e.g., Scholl et al., 1987; Moor et al., 1988; Moore et al., 1991; Taira et al., 1992; Hyndman et al., 1994; Westbrook et al., 1994). On the other hand, the underplating have been studied mainly from ancient accretionary complexes on land because the drilling can not reach to the depth of underplating and seismic profiling can not clearly represent the structure of deep portion of subduction zone. The underplating may be triggered by step-down of decollement (Silver et al., 1985) and the decollement finally penetrates into the porous part of oceanic basement (Kimura and Ludden, 1995). However it is still unclear at what depth underplating occurs. Therefore in this study, it is inferred from fluid inclusion analysis.

Study area, the Mugi mélange, is located at the eastern part of the Tokushima prefecture, Shikoku, southwest Japan. The Mugi mélange is Cretaceous accretionary complex and has its origin in tectonic. The Mugi mélange comprises several thrust sheets containing oceanic crust and is considered to have been accreted by duplexing. P-T conditions in accordance with several deformation stages are important for understanding the depth and thermal condition of underthrusting, underplating and uplift in the subduction zone. General relationship between the geologic structure and thermal structure of the Shimanto Belt was revealed by Ohmori et al. (1998). Their result indicates that the thermal structure shown by vitrinite reflectance is not controlled by early stage thrusting but later stage out-of-sequence thrusting. Their result suggests that the thermal structure was gained later than underplating. Therefore vitrinite reflectance analysis is not enough to reveal earlier stage events: underthrusting, underplating and uplift. Consequently P-T condition estimated from the fluid inclusion analysis might be useful. Veins trapping the fluid inclusion might have formed in various stages from the underthrusting and underplating to uplift. Therefore, geological observation between the deformation and vein formation is essentially important to use the fluid inclusion analysis. Recently, P-T condition of fluid trapped in veins was reported from the Kodiak accretionary complex, Alaska (Vrolijk et al., 1988) and from the Shimanto accretionary complex in the Shikoku Island (Sakaguchi, 1999, Lewis et al, 2000). These studies suggested the hot fluid migration (Vrolijk et al, 1988), and change in thermal maturity in subduction zone (Sakaguchi, 1999, Lewis et al., 2000). Hashimoto (2002) revealed relationships between the deformation processes such mélange forming and duplexing, and the vein formation. In this study I focus on veins that were formed during mélange forming and estimate the depth of accretion.

The result of P-T condition during mélange forming is 120 - 190 ℃ and 100 - 140 MPa and its maximum temperature nearly coincides with result from vitrinite reflectance. This suggests that forming mélange fabric during underthrusting continued till accretion to the continental crust and its maximum pressure equals to the depth of accretion. As a result, the The Mugi mélange was accreted at 4-5 km depth from the bottom of the sea by estimating from the data of Nankai Trough today if fluid pressure is close to lithostatic.