PERTEMUAN PERSATUAN
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TECHNICAL TALKS

Shigeki Hada: Mélange and subduction in the Outer Zone of Southwest Japan

Extended Abstract

Geologically, Southwest Japan can be divided into 2 parts, namely the Inner Zone on the Sea of Japan side and the Outer Zone on the Pacific side by a major fault called the Median Tectonic Line. The Outer Zone of Southwest Japan is characterized by the distinct zonal distribution of pre-Neogene rocks and is traditionally subdivided into the Sambagawa, Chichibu and Shimanto Belts.

On the other hand, a remarkable tectonic zone called the Kurosegawa Tectonic Zone extends over 650 km across islands from Kyushu to the Kii Peninsula. The present Kurosegawa Tectonic Zone is characterized by a serpentinite mélange zone.

Two types of characteristic accretionary complex were introduced by the author in the southern side of the Kurosegawa Tectonic Zone. One is the Jurassic to Lower Cretaceous accretionary complex in the Southern Chichibu Belt ("Sambosan Belt") and the other one is the Upper Cretaceous accretionary complex in the Shimanto Belt.

The Southern Chichibu Belt is characterized by apparently alternate occurrence of steeply north dipping strata of chert and coarse clastics. This is due to the repetition of the stratigraphic unit which is composed of, in ascending order, chert layer, siliceous mudstone layer, mudstone layer and coarse clastics layer, and these are separated from each other by faults. These stratigraphic units are tectonically piled up to form an imbricate, north dipping structure. Detailed biostratigraphic study revealed that the age of each of the layers become systematically younger from the northern stratigraphic unit to the southern ones. Thus, the remarkable polarity in age can been recognized in this belt. From lithologic and biostratigraphic features, the layers of the stratigraphic units correspond to pelagic, hemipelagic and trench-fill sediments deposited on the oceanic layer 2 during the spreading of the oceanic plate from the oceanic ridge to the subduction zone. Those layers were then finally scraped off from the subducting oceanic plate and accreted on to the Asian continental plate unit by unit.

In contrast, the accretionary complex in the Shimanto Belt is characterized by the existence of mélange. In the belt, the coherent unit consisting of weakly deformed flysch and mélange are tectonically piled up to form an imbricate, steeply north dipping structure. The mélange unit is composed of inclusions of diverse shapes, sizes and compositions in an argillite matrix. In the case of Cretaceous mélange in Kochi of Shikoku, Valanginian to Albian chert, pillowed basalts with interpillow nannolimestone (Valanginian), Turonian red pelagic shale and Coniacian to Santonian red and green hemipelagites are incorporated into Campanian black shale matrix together with terrigenous sandstone. The Cretaceous mélange of the Shimanto Belt is thus interpreted as accreted trench deposits in thich oceanic plate facies were incorporated during subduction.

With regard to the origin of the mélange, physical and mechanical properties of sedimentary rocks in the Cretaceous Shimanto Belt have attracted much of the author's interest. More than 300 samples of sandstone and mudstone from both coherent and mélange units were examined. Mudstone samples from both units have densities from 2.63 g/cm^3 up to 2.67 g/cm^3. The mechanical properties of the mélange mudstones suggest that these mudstones were once significantly denser than the coherent mudstones. These mudstones also have illite crystallinities of between 4 and 7 mm. Comparison of the above values with data for the shale matrix of the mélange in the central belt of the Fransiscan suggest that not only the rocks of the mélange unit but also those of the coherent unit represent accreted and tectonically-deformed trench-floor or absyssal-plain deposits. Thus, the coherent unit includes rocks of the accretionary complex as well as slope basin deposits, and the coherent and mélange units correspond respectively to shallower and deeper parts of the accretionary wedge. The mélange sandstones have higher densities, higher P-wave velocities and lower porosities than the coherent sandstones. Generally, the former is stronger and has higher values of Young's Modulus than the latter. Comparison of these measures of physical and mechanical properties and also the observations of microstructure of sandstones indicate that rocks of the mélange unit have been subjected to ductile deformation during the formation of mélange in the deeper levels of the accretionary wedge, while the rocks of the coherent unit have been subjected to only elastic deformation in the shallower levels of the wedge.

Comparison of the above-mentioned evidences and the situation in the present-day Nankai Trough off-Shikoku, the following process is proposed for the formation of the accretionary wedge. In the Southern Chichibu Belt, an example in which accretion was accomplished by simple offscraping process was shown. The author believes that in that case, the trench-fill sediments are not thick. It, however, as seems to be the case in the Shimanto Belt, trench-fill sediments were thick, the first-stage deformation was restricted in the turbidite sequence of trench-fill sediments and thickening of accretionary wedge was accomplished by offscraping. But when the oceanic layers were reached to the deeper part, something around 10 km in the subduction zone, thrusts and decollement planes reached to the oceanic layer 2 for the first time and a characteristic mélange which included inclusions of greenstones were formed. Continuing thrusting and multi-layered decollement brought the mélange to the shallower parts of the accretionary wedge. From the study of the accretionary wedge in the Cretaceous Shimanto Belt, the author believes that the mélange in the accretionary wedge is tectonic in origin.

Report

Dr. Shigeki Hada is Professor of Geology at the Kochi University, Japan, and his fields of interest include Structural Geology and Tectonics. He obtained his Ph.D. from Osaka City University, Japan in 1973 and has previously visited Malaysia in 1964 and 1968 as a member of the Scientific Expedit of that University.

Currently, Dr. Hada is on sabbatical and his visit to Malaysia and later Thailand is related to the new IGCP Project "Pre-Jurassic Evolution of the Continental Margin of Asia" organised by Prof. Ichikawa of the Osaka City University.

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