論文内容の要旨

A fate of sediments in subduction zone
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This study aims at revealing sediment transfer cycles in subduction zones quantitatively, sediment deformation resulting from underthrusting and its consequences for plate boundary processes.

In a subduction zone where accretionary prism is well developed, terrigenous material flows into a trench, deposits there and subducts with oceanic plate beneath the continents. Some part of sediments is accreted by off-scraping or underplating, but at the same time basal erosion scrapes material off the continental hanging wall, which implies opposite mass transfer. These material cycle is never estimated quantitatively but very important for every field of research on subduction zone. A role of underthrusting sediment in plate boundary is also significant for understanding of subduction processes. Such behavior of sediments in subduction zone is to be investigated in this thesis.

I studied (1) deformation of underthrusting sediments, (2) its relationship with plate boundary process and (3) quantitative estimate of sediment cycle.

Shimanto Belt as an analogue of the Nankai Trough

The Shimanto Belt which is thought to be a good onland analogue of the Nankai Trough was investigated. Tectonic mélange of the Shimanto Belt is ascribed to underplated sediments. Paleomaximum temperature of Lower and Upper Mugi Mélange and Makimine Mélange are estimated as 150, 200, 340 °C, respectively [Ikesawa et al., 2005; Kiminami and Ohno, 1999]. These values cover the whole range of seismogenic zone condition (150-350 °C, Hyndman and Wang, 1993). Thus studying those mélanges can provide better insights into the evolution of deformation during subduction.

(1) Deformation of sediments

Shale matrix: Anisotropy of Magnetic Susceptibility

Magnetic fabric analysis revealed that 1) shape parameter, oblate to triaxial, and anisotropy degree, small to large, changed with subduction. And 2) orientation of magnetic ellipsoids is in accordance with foliation. That means deformation of matrices has tectonic origin. Change in shape from oblate to triaxial ellipsoid indicates a change dominant shear field from pure shear to simple shear.

Sandstone block: Aspect ratio of boudins

The results showed 1) decrease of aspect ratio and 2) decrease in size of boudins with increase of burial depth. 3) Another peak relatively high aspect ratio value emerged in Makimine mélange and 4) they are smaller than the others.

Sandstone block: Classification of deformation

D1 (web cataclasis). Black reticular texture, microscale brittle deformation.

D2 (brittle fracture). Intense deformation which divides boudins. Gradual grain fining assimilation to matrix is observed in the edge of the blocks.

D3 (riedel shear). Riedel shears clearly cut sandstones.

Deformation in sandstones (D1 to D3) is very localized. In contrast, deformation in matrix shale is penetrative.

(2) Mélange as a plate boundary rock

Mugi mélange consists of five thrust sheet units in which ghost ocean floor stratigraphy can still be recognized. The mélange divided into two sections by a fault between unit 3 and 4. This fault that produces a paleothermal gap is an out-of-sequence thrust with large vertical displacement. A roof fault appears to have been active parallel to the isotherm and contains fragments of pseudotachylyte. These facts suggest that the roof fault was a seismogenic décollement or splay fault.

(3) Mass balance in subduction zone

Studied area is central mountainous region of Japan and the eastern Nankai Trough. Central mountains are located at the collision zone between Northeast and Southwest Japan block and the lifting rate is quite high that causes high surface erosion rate. Accretionary prism is well developed along the Nankai Trough where bathymetric and seismic exploration has been thoroughly carried out. Sediment transport channel is directly connected with the trough through the submarine canyon in this area so that it is appropriate to consider a simple erosion-deposit model.

Erosion rate (*Ed*): Ohmori [1978] estimated the erosion rate of major river system estimated from the amount of accumulated sediments in the water reservoirs. He established an empirical equation between mean altitude of the area (*H*) and denudation rate (*DR*) as follows: $DR = 0.3031 \times 10^{-9} \times H^{2.1894}$

I calculated the total denudation rate in the central mountains region higher than 1000 meters using Ohmori's denudation rate data, yielding 1.72 x 10^7 [m^3/y].

Growth rate of accretionary prism (off-scrape, *Go*): Using Westbrook's equation $V_t = v_c \int_0^{z_d} (1 - \phi_0 e^{-b_0 z}) dz$, the growth rate of accretionary prism in the eastern Nankai Trough is 1.67 x 10^7 [m^3/y].

Growth rate of accretionary prism (underplate, *Gu*): Extrapolate the ratio of off-scraped and underplated unit (100:9) from the geological map of the Shimanto Belt, growth rate by underplating

is 0.15 x 10^7 [m^3/y].
The value of subducting mass (*S*) should be positive because of existence of highly metamorphosed rocks. Considering total mass balance, value of basal erosion (*Eb*) is expressed as follows: $Eb = Go + Gu + S - Ed$, then I obtained Eh > 0.10 x 10^7 [m^3/y].

Summary and Discussion

Deformation of underthrust sediments

1. Matrix: oblate to triaxial strain, that is pure shear to simple shear, respectively.
2. Sandstone: deformation as D1 to D3 continues at least until the down-dip limit of seismogenic zone.
3. Mélange formation occurs continuously changing its formation mechanism.

Contribution to plate boundary process

1. The second pseudotachylyte from accretionary prism was found.
2. Mélange can be recognized as a huge fault rock whose roof is a seismic slip plane.

Mass balance in arc-trench system

1. Onland erosion rate almost equals to the growth of accretionary prism.
2. Trench-filled deposits are mainly accreted by off-scraping.
3. Rates of underplating and basal erosion are minor mass transfer mechanism.

In this study, observation that sediments keep deforming in the seismogenic zone differs from the common idea of that sediment lithification finishes before reaching this zone, then the rock could produce stick slip. The deformation of mélange is unclear but slow deformation in and around subduction zone is a possible candidate for the mechanism. I estimated mass balance of sediments in southwest Japan and the Nankai Trough that indicates the amount of sediments buried deeper is quite small but has an important role as a fault rock in plate boundary.

This thesis figured out a fate of sediments that are eroded from mountains, drained into and deposited in the trench, deformed with underthrusting and finally underplate.