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Primary deformation and related change of physical properties of sediments in shallow part of accretionary prism

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Non-metamorphosed and high-porous sediments, which are thought to be part of an accretionary prism, are well-exposed in the southern part of the Miura and Boso Peninsulas, central Japan. Neogene deep marine volcaniclastic sedimentary sequences, namely the Misaki and Nishizaki Formations, are composed of forearc sediments accreted to another forearc during the Izu arc collision against the Honshu arc, and represent the shallow part of an accretionary prism. Detailed structural analysis were applied to make clear the deformation and related change of physical properties in early-phase accretion process of sediments.

Based on the mode of deformation, the accretionary prism in the Misaki and Nishizaki Formations could be divided into three units; 1) the basal gouge zone associated with the basal thrust movement, 2) the thrust fault-dominated unit in the lower part of the off-scraped body which is located just above the basal gouge zone, and 3) the upper coherent unit in the upper part of the off-scraped body. The basal gouge zone develops in the lowermost off-scraped body and consists of three parts; main gouge zone, cataclastic deformation zone, and shear band zone. In the thrust fault-dominated unit, trenchward verging thrust systems are developed. Almost all the thrusts are related to form duplex structures which converge upward to the next duplication, forming well-regulated arrays. The connections of the regulated duplex structures further form large-scale duplex structures, in which roof and floor thrusts are composed of smaller scale-duplex arrays that would be considered as a single thrust in a macro-scopic scale. Deformations associated with such thrust faults are rare in the upper unit, where trenchward and landward slumping and chaotic sediments formed by liquefaction are common instead.

Strain geometries obtained from measurement of anisotropy of magnetic susceptibility (AMS) and physical properties such as porosities, P-wave velocity, and pore size distributions are quite different in the respective three structural units. Sediments in the upper coherent unit show layer-parallel flattening fabrics. Comparing with this, sediments in the thrust fault-dominated unit show plane strain field of less magnetic foliation, and those in the gouge zone flattening fabrics parallel to the detachment fault plane with stronger magnetic foliation and lineation. Sudden 7 to 9% down drop of porosity and P-wave velocity increase are recognized at the boundary between the thrust faults dominated lower unit and the coherent upper unit. Similar down drop is also recognized in the contact between the thrust fault-dominated unit and gouge zone. Mercury porosimetries indicate that pore size distribution in the thrust fault-dominated unit is characterized by a small amount of large pores, whereas those in the coherent unit by a large amount.

These analyses verify the strain history during accretionary prism process in its shallow part. In the first stage, sediments in every part suffer vertical compaction fabric before accretion in general. When horizontal compressional stress is exerted during accretionary prism formation, the previous compaction fabric is disturbed accompanied with porosity decrease in several tens meters width before the displacement occurs. In the last stage, displacement of thrusting occurs in a restricted zone where strain is localized. Flattening fabric parallel to the thrust fault and further porosity reduction occur associated with this thrusting only in the gouge zone.

Thus, the deformation features in the Misaki and Nishizaki Formations imply many structural styles, strain geometries, and related physical properties that formed under semi-lithified conditions in shallow part of accretionary prism. These must be essential information to discuss the rock mechanics and properties in a seismogenic zone.