Structural analyses of inner accretionary wedge in the Nankai trough based on borehole resistivity image

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The present geological structure of the inner accretionary wedge beneath forearc basin sediments records the history of the developing processes of the accretionary prism and the plate subduction zone. The macro scale structure of the inner wedge, however, is not well illustrated by seismic reflection due to poor contrast in acoustic impedance of the deep accretionary prism sediments. Consequently, the relationship between the development of the accretionary prism and its structural history is still unclear. We here analyze the logging data acquired in the IODP Nankai trough drilling project in order to clarify the geological structure of the inner wedge and to estimate the transition of strain direction of the Nankai trough.

In the Nankai Trough Drilling Project Exp. 314, 338 and 348, forearc basin and underlying accretionary prism were penetrated at site C0002 located in Kumano Basin. Continuous logging data are acquired from surface to approximately 3000 meter-below-seafloor (mbsf). Based on the collected resistivity image, gamma-ray, and sonic logs, we recognized and measured beddings and fractures and their strike and dip angles. Over 2000 beddings are found in the accretionary prism to be inclined in both NNW and SSE directions at high angles of 60-90°. The fractures and faults are found at 300 locations. A fracture-concentrated zone was observed around 2600-2700 mbsf, however, the fracture and faults do not show any clear trends. Although these descriptions were approximately the same as the cruise reports and previous research (Boston et al. 2016), "eye spots" were newly identified on the resistivity image. This is considered to be a closed bedding around a fold axis, because the inclination direction of the formation changes significantly above and below the eye spot. The direction of the fold axis is considered to be given by the direction orthogonal to this eye spot and to be ENE–WSW.

The depth distribution of the fold was estimated based on the depth change of azimuth and dip of the bedding. The fold properties such as fold axis, axial plane, interlimb angle, and the wavelength are calculated from the beddings at inflexion points assuming that the fold can be regarded as a concentric fold. As a result, the folds are classified mainly as open-folds with large interlimb angle of 150° to 170°, and the axis azimuths are ENE–WSW direction, which was consistent with the direction obtained from the eye spot. However, the plunges change greatly with 0-70 degrees, and it cannot be regarded as a single fold structure. These folding axes show a girdle distribution on a stereo plot suggesting that these folds were deformed secondarily by another folding having an axis in the NNW-SSE direction.

Our investigations revealed that the inner wedge of the Nankai accretionary prism consists of high-angle beddings and open-folds in two stages. Since the primal fold axes indicate the ENE-WSW direction with horizontal axial planes, it is considered that these primal folds were formed in outer wedge before tilting by accretion. During or after the tilting, the second folds have developed along the NNW-SSE direction. The direction of these primal- and second folds are consistent with the stress direction analysis using the borehole breakouts and the strike-slip fault movement in the vicinity of the giant branch fault (megasplay fault). The meso- and macro scale structure in the inner wedge, revealed in this research, can indicate the history of change in stress orientation during developing in accretionary prism.

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