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Change in paleostress in offscraped accretionary complex, Kayo formation, the Shimanto Belt, Okinawa island

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It is important to understand a stress state of subduction zone because it is strongly related to development of accretionary complex, strength of fault, geometry of subduction zone and earthquake process. The purpose of this study is to examine paleostress in a off-scraped accretionary complex in Shimanto Belt, Okinawa island.

The study area is Kayo formation in the northeastern coast of Okinawa island. The Kayo formation consists mainly of coherent turbidites, and it was highly deformed by folds and thrusts. Those geological structures of the formation represent characteristics of fold-thrust belt in forearc area[Ujiie,1998].

Flexural slip associated with folding is commonly observed. In addition, many micro-faults cutting bedding are also observed. On the slip surfaces both of flexural slip surfaces and micro-faults, slicken lines and slicken steps are identified. From the structures, slip data (strike and dip of fault plane, slip direction and slip sense) was obtained.

The number of slip data for micro-fault is 153 in ˜2 km wide of study area. Using the slip data, we conducted micro-fault inversion analysis to examine the stress orientation and stress ratio. The stress ratio is defined as $\phi=(\sigma2-\sigma3)/(\sigma1-\sigma3)$. We used software MIM (Yamaji,2000) for stress analysis and K-means clustering (Ostubo et al, 2007) for automated picking of center of cluster. After the stress analysis, we combined the stress data with stress polygon to examine stress magnitude semi-quantitatively. The stress polygon is based on Anderson's theory. We assumed the vertical stress is always gravity force, which is converted from assumed depth.

As a result of analysis, 4 stress solution (KY1-KY4) were obtained. KY1) NE-SW horizontal compression with high stress ratio, ($\phi=0.88$), KY2) KY3) NW-SE high angle compression with low to intermediate stress ratio ($\phi=0.22,0.45$), and KY4) NW-SE horizontal compression with intermediate stress ratio ($\phi=0.65$).

We picked up the micro-fault with misfit angle less than 40? for each stress. Misfit angle is the angle between calculated slip direction and observed slip direction on the micro-fault surface. Reverse faults are dominant in KY1 and KY4 and normal faults are dominant in KY2 and KY3.

The stresses are projected to horizontal surface and to Shmax (perpendicular to fold axis), Shmin (parallel to fold axis), and Sv. Using stress ratio and stress projection above, linear functions in Shmax and Shmin space are obtained. We can examine the semi-quantitative Shmax and Shmin value for the stresses in overwrapping area between the linear functions and stress polygon.

Magnitudes of shear stresses for KY2, KY3, KY1 and KY4 on the horizontal decollement were also estimated as $\tau2=39.2$˜54.7[MPa], $\tau3=52.1$˜64.2[MPa] and $\tau1=79.0$˜212.3[MPa], $\tau4=48.0$˜137.7[MPa]. The shear stress for reverse fault (KY1, KY4) is bigger than the shear stress for normal fault (KY2, KY3). If the differences in stress represent the stress change in seismic cycle, the differences in shear stress indicate stress drop as -16.2˜173.1[MPa]. Stress drop in general earthquake ranges 0.03˜30[MPa]. The obtained stress drop in this study includes the range of general stress drop.

Keywords: Stress, micro-fault inversion, Shimanto Belt, Okinawa