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Formation process and mechanism of slickenside

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Pseudotachylyte is well known rock to be produced by solidification of friction-induced melts during seismic fault slip. Therefore many researches of the pseudotachylyte are conducted to elucidate the microstructural process of seismic faulting. Slickenside is also known as a fault related rock (or structure), which shows smoothed surfaces developed on planes of movement. However the generation process and mechanism of slickenside has not been clarified so far, compared with pseudotachylyte. Now we study the microstructure of slickenside developed on chert block to get some information about generation process of slickenside.

The sample we studied is the chert block which occurs in the Jurassic accretionary complex in eastern Yamaguchi Prefecture, Japan. The complex, chaotic sediment, is composed of allochthonous blocks, mainly of chert, limestone, sandstone and mudstone in the argillaceous matrix, which has undergone very low grade metamorphism under conditions of Prehnite-Pumpellyite facies. The microstructural observations of quartz grains composed of the slickenside with an optical microscopy indicate that 1) they are not deformed by brittle manner even just vicinity of slickenside, 2) they show strong undulose extinction and bulging-recrystallization. TEM observation and EBSD measurement of these quartz grains reveal that 3) the dislocation tangling is typical, 4) they do not show LPO. The most important result is that 5) the amorphous layer having several ten nanometers thickness (~50nm) covers the top surface of slickenside, and 6) the composition of the amorphous layer is mainly Si, Fe and Al. These microstructural observations suggest that 1) the quartz grains were deformed plastically under high stress condition (but the plastic strain is small), 2) the amorphization of quartz grains occurred just near (~50nm) slip surface during faulting, and 3) the origin of Si, Fe and Al in the amorphous layer should be quartz grain itself and clay minerals (e.g. Biotite, Muscovite) contained in the chert. Because the quartz grains are not deformed by brittle manner, the fault slip probably occurred only within the amorphous layer.

We can not presently identify the mechanism of amorphization of quartz grains along slip surface. But we obtain the additional interesting microstructure which is the black veins and clusters in the vicinity of slickenside. These veins and clusters are mainly composed of apatite grains, whose size is ca. 5 to 10 um. Apatite is an important constituent mineral of chert, whose origin is microfossils such as fish scales, bones and so on. Therefore the generation of the black veins can be explained by the melting of the microfossils due to frictional heating of fault. We currently conclude that the slickenside was generated by frictional melting of quartz grains and clay mineral on the slip plane under high stress condition during faulting.

Keywords: slickenside, pseudotachylyte, fault, chert, microstructure