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The dating of fault clays – Geochronological indicators of multi-activated fault events

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Illite age analysis(IAA) method, developed for determining the age of diagenetic illite, has been also employed to determine the age of fault event. This method is based on some assumptions, including (1) clay mineralogy is the binary phase system between newly-formed 1M or $1M_d$, and $2M_1$ polytypes, and (2) $2M_1$ polytype is detrital. Therefore the IAA method suggests the only one age of newly-formed 1M or $1M_d$ polytype precipitated from the hydrothermal fluid just after faulting. However, 1M and $1M_d$ are mineralogically different phases with different conditions and stages, indicating the mineralogy of fault clays can be not binary, but ternary system among 1M, $1M_d$, and $2M_1$ polytypes. In addition, because of the hydrothermal fluid passing through the fault fracture zone with variable P, T, and chemistry, the $2M_1$ polytype can be neo-formed from the hydrothermal fluid. In spite of these, there has been no attempt to validate, if the IAA method is appropriate for the fault zone, or not. In this study, we are to present the results of the mineralogical characterization for the clay minerals in the Yeoncheon fault zone, Korea, and the K-Ar ages of different grain-size fractions, to evaluate the IAA method, and to interpret the implication of the age-dating results. For the study, 2 fault rock samples with dextral sense from the different fault event stages in the field, were collected from the Yeoncheon fault zone, developed in the Pre-Tertiary tuffaceous parent rock. For each sample, standard centrifugation techniques were used to create 3 different grain-size fractions of $<$0.1, 0.1 to 0.4, and 0.4 to 1.0μm. X-ray diffraction(XRD) anaylses were carried out using Rigaku Microfocused Multi-purpose XRD System(Mo-Kα radiation, Imaging Pate Detector) for the random mounts, and LV-SEM equipped with EDS System was used BSE(back-scattered electron) image observation for the thin sections of fault rock samples. K-Ar age-datings for the different size fractions were performed in the Okayama University. The BSE observation and EDS analyses results indicate that, in minimum, 2$\sim$3 stage-illites with different size, chemistry, and texture were formed, which would be precipitated from the fluids after fault movement. These results suggest that the $2M_1$ polytype should be not a detrital, but a neo-formed phase, indicating the IAA method should be modified for the accurate age-determination of fault events. K-Ar age-dating results of 2 dextral faults range from 70 to74Ma and 82 to 94Ma, respectively. Based on the quantification of $1M_d$, 1M, and $2M_1$ in the each fraction estimated by modeling the observed XRD patterns using WILDFIRE? and the simple simultaneous equations, we determined 3 times of multi-activated fault event, such as 110.7, 77.7, and 62.6Ma, in the Yeoncheon fault zone.