A K-Ar age reset of frictionally melted gabbro and detect for degassed components

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Radiometric age is defined as a cooling age or a closure age of a particular mineral or of minerals. Such ages should be rejuvenesced when minerals have been caught higher temperature than their closure temperature, in general. Therefore, quantitative analysis of thermal history of a rock or a geologic event including fault movement could be performed using radiometric dating method derived from different minerals. For example, either an ESR age or a FT age of a thermal sensitive mineral is expected as a good geological tool for detecting thermal event. However, because it is not easy to evaluate either their ambient temperature exceeds the closure temperature of minerals phenomenally, there is a problem to apply radiometric dating for the purpose in the case of faulted rocks.

Because the closure temperature of K-Ar system is rather high, e.g. the hornblende is about 500-700^{o}C, a kind of melted-rocks under more high temperature, such as pseudotachylytes, are widely applied to determining fault activity with K-Ar dating method. To obtain reliable ages of fault activities, it is a key issue whether the ages were initialized by re-equilibrating their Ar isotopes with atmospheric Ar besides to be rejuvenesced. In the case that such a rejuvenescence can explicate one of a geochemical phenomena besides the filed observation, analyses of apparent K-Ar ages could be applied for fault rocks for thermal history analysis.

Here we report a preliminary experiment that effectuates high temperature frictional melting experiments with using a high-velocity friction apparatus in Kyoto University in order to test whether K-Ar age is reset by frictional heating of fault or not. A pair of hollow cylindrical gabbro sample was slid at a slip velocity of 1.3 m/s and a normal stress of 1.4 MPa. At this condition, local frictional melting started in 5 seconds and temperature around an artificial fault reached around 1100 ^{o}C in 20 seconds. Thus, temperature on fault plane is well above the closure temperature of K-Ar system.

Due to rapid equilibrium of volatiles during frictional melting of rocks, we expect that the K-Ar age should be reset by this experiment. We determined K-Ar age of gabbro sample processed by the equipment and checked the age-reset resulted from frictional high temperature degassing. The age-reset is only observed in glass completely melted. In natural condition/ filed observation, such glassy materials, indicating rocks completely melted, are faced on fault planes. Thus, the age of such glassy materials are regarded to be reset during fast fault movement by re-equilibration of Ar to atmospheric one at the faulting event. An apparent incomplete reset was observed in the part including some un-melted gabbro fragments in the experiment. In the part, mechanically fractured pieces are mixed in the glass matrices in frictional faces/zones. That is why the Ar isotope ratio might not be re-equilibrated in the experiments. The outgas sample, collected into small aluminum tube after the friction experiment among/in nitrogen atmosphere, contains carbon dioxide, water vapor, and helium from the rock samples.