What is the cause of pH increase in fault zone? ˜From the view point of mineral grinding experiment ˜

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In natural fault zone, rocks and minerals were fractured by seismic slip, resulting in increase in surface area of minerals. Increasing in surface area cause minerals to be chemically activated. Therefore, fluid-rock interaction is enhanced in fluid-rich area such as subduction zone and shallow intra-plate fault zone. Fluid-rock interaction would change the physico-chemical properties of the fault zone materials. Therefore, fluid-rock reaction is important for understanding feedback relationship during earthquake cycle. However, the fundamental chemical processes of fluid-rock interaction caused by fracturing are still poorly understood. In natural fault zones, fault gouges are found as one of the pulverized rock. Fault gouges is also considered as a product of chemical reactions between rocks and surrounding groundwater. However, these chemical reactions are not completely understood.

In this study, we concentrated on changes in fluid media by rock fracturing with water, especially change in pH and dissolved chemical composition.

The questions concerning changes in fluid media are addressed in this study:

(1) What type chemical process is dominant?

(2) To what extent is fluid-rock interaction depending on mineral species.

To answer these questions, we conducted grinding experiment, which analogous to pulverization in natural fault.

We performed grinding experiment using ball-mill to investigate fluid-mineral interaction accompanied by mineral fracturing. Starting materials are silicate minerals (quartz, plagioclase, alkali feldspar, biotite, muscovite, and mixture of quartz and other minerals) as solid media, and pure water as fluid media. Our concern is fracturing of rock in natural fault zone, in which several minerals were aggregated as a result of fracturing. In regard to the mixture samples of quartz and other minerals, several mixing ration was used. We measure pH and chemical composition in water after grinding experiment.

Results of experiment showed that pH changes in fluid media and chemical composition. Result of quartz experiment showed pH decrease. Result of plagioclase, alkali feldspar, biotite, muscovite other minerals, which contain metal ion showed increase in pH. These results about pH were corresponding to previous work (Saruwatari et al., 2003, 2004). Results of plagioclase, alkali feldspar, biotite, and muscovite showed increase in ion concentration. Results of mixture of quartz and other minerals that contain metal ion showed the value between result of quartz and that of other minerals. These results show that there is some mixing ratio, under which pH did not change with fracturing.

These experimental results demonstrate that the mixing ratio of quartz and other minerals affect pH and ion composition in fluid media after grinding. The pH value may strongly affects chemical processes such as precipitation and dissolution of minerals in fault zone after seismic slip occurred. According to the experimental results discussed above, mineral composition of rocks in fault zone may be crucial for chemical process after seismic slip (especially, immediately after seismic slip).

However, the timescale in these chemical processes is still unknown. We will discuss in presentation that application of these experimental results to natural brittle fault zone.