Experimental study on chemical interaction between solid and fluid using core penetrating Atotsugawa fault fracture zone

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Crustal gas and ion in groundwater anomalies with earthquakes have been observed around active fault, however the elementally processes are still unknown. In order to examine the processes, grinding experiments were carried out under wet condition using two types of rocks taken from drilled core penetrating Atotsugawa fault: (1) Weakly Pulverized and Altered Rock (WPAR) and (2) Fault Gouge. In this presentation, two chemical process are examined; [1] Composition and amount of gasses released from rocks by grinding, and [2] Cation composition and pH of the water after grinding.

From experiments [1] using WPAR originated from metasediments, granitic rock calcarious rock and andesite, methane gas is detected except WPAR derived from andesite. Result of the experiments also show that positive relationships between surface area (dS) and amount of methane gas (n) , and the relationships can be expressed as $n = A$ (1 - EXP [$-kdS$]) . The equation corresponds to solution of $dn/d(ds) = k$ ($A - n$) , and then A will be amount of methane contained in a sample and k show degree of evolution of gas when samples are crushed. The well-fitted data to the equation suggest that the observed gas after grinding is mechanically emitted from the samples crushing. Microstractral observation of thin sections clarified fluid inclusions in quartz or calcite are abundant in granitic rocks, metasediments, and less in calcarious rock, which released methane gas by grinding. On the contrary, no fluid inclusion is observed in the minerals of andesite which did not released methane gas by grinding. Assuming that this fluid inclusion contain methane gas, methane gas released from inclusions by fractured minerals. This model could explains and . In this model, A means maximum methane gas concentration in the rock ; , and k means the density of inclusion.

From the grinding experiments[2] Na ion concentration increased with increase surface area by fracturing as well as pH value. At the same time, Mg^{2+}, K^{+}, and Ca^{2+} decrease concentration. After 300min time grinding, pH value of the solution exceed 11.2 . Increase of pH by fracturing granitic rock would be attributed to a kind of cation exchange reaction between the water and newly exposed surface of minerals by fracturing. Apparent increase of Na^{+} in solution suggested that the reaction accrued between Na^{+} on mineral surface and H^{+} in solution. The experimental data fairly lie on the curve expressed by, also supported this hypothesis. As a result relative increase of OH^{-} result in increase of pH of solution.

By comparing result of above mentioned experiment and those of gas measurements from the drill-core penetrating the Atotsugawa fault, national condition of fault zone gas is inferred. The fact that andesite rock did not generate methane by fracturing experiment is in good agreement with that methane gas was not detected from recoverd core of the andesite rock. These two facts supported that metahane gas was trapped in the fault zone was originated from fluid inclusion in the minerals. The fluid that is continuously sampled from deeper fault zone in the well (173m depth) show the steble pH value of 8.44, indicated that Na^{+} - H^{+} reaction between the mineral surface and solution may be continuously occurred as steady state reactions. Water / rock ratio is 2 for our experiments, national porosity of the fault zone is much lower than the value (0.1 to 0.4) indicating external high alkaline condition would be expected. For example, pH above 11 in the fault zone during seismic slip , which induce to expose new surfaces of minerals by fracturing.