The relation between the amounts of H2 and H+ generated by free-radical reaction between pure water and crushed quartz

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Materials within a fault zone are pulverized repeatedly by earthquake rupture events. In each event, the rock forming crystals are crushed, resulting in increase of new surface area. Generally the new surfaces are highly activated. Wakita et al. (1980) observed the significant amounts of H2 gas in the soil along the Yamasaki fault, Hyogo, and they suggested that these hydrogen gas was generated by chemical reaction between the crushed rocks and water. An experimental study by Kita et al. (1982) confirmed that the H2 gas are generated by the free-radial reactions between H2O and crushed rocks and proposed the following reaction mechanism.

Si radical + H20 -) SiOH + H radical

The relationship between the Hydrogen gas anomaly and fault activity has been studied by many workers (Sugisaki et al., 1983; Ito et al., 1999). The concentration of H2 gas, however, usually fluctuate and no high concentration is frequently observed along a fault where significant amount of hydrogen gas was reported before (Nakamura and Wakita, 1985).

Recently , Tanaka and Locknar (submitted) reported the generation of H+ ions by the experimental study of crushing quartzite immersed in pure water and proposed following reaction mechanism taking the hydrogen gas into account.

Si radical + H2O -) SiOH + X H+ + (1-X)/2 H2

where X is partition coefficient between H+ ion and H2 gas. Therefore, to clear the relation between the earthquake activity and H2 gas behavior, the effect of generation of H+ ion into water should be considered. To examine the partition mechanism between the H2 gas and H+ ion, we performed crushing experiments of immersed quartz and measure the change of the concentration of generated gas and ion. Experimental procedure is as follows.

Quartz samples (15 g), deionized and distilled water (10 g) and alumina ball, 2 cm in diameter, were put together in a vessel. We shaked the vessel to crush the samples, then pH of solution was measured. The amounts of generated H+ ion can be estimated from pH value. On the other side, crushed samples were collected and dried, then the surface area of samples were measured applying BET method. Using these values, we can estimate the newly created surface of quartz. Consequently, generation of H+ ion is positively correlated with the increase of the area of quartz surface. Furthermore, it is suggested that the amount of H+ ion correspond to about 1 % of Si radicals assuming all Si atoms provide one Si radical on the newly created surface of quartz.

We are going to estimate the amounts of generated H2 gas in the reaction vessels collected by syringe using gas chromatograph. The relationship between the amount of H2 gas and H+ ion, the amounts of the sum of gas and ion and the amounts of Si radicals will be discussed. Furthermore, how the variation of solution composition is concerned with the change of partition ratio between the H2 gas and H+ ion will be discussed.