The behavior of surface radicals on mechanochemically activated silicates

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High concentration of hydrogen gas has been occasionally observed in soil gas along active faults (Wakita et al., 1980; Sugisaki et al., 1983). Such hydrogen gas is thought to be generated by a chemical reaction (radical reaction) between fluid and active surface of minerals newly created by fault activities (Wakita et al., 1980). Subsequent laboratory experiments have confirmed that hydrogen gas is truly generated during fracturing of silicate minerals in wet condition (e.g., Kita et al., 1982, Kameda et al., 2003). However, the reaction mechanism has not been fully understood.

Delogu (2011) carried out a crushing experiment of quartz in a solvent of ethanol with 2,2-diphenyl-1-picrylhydrazyl, as a radical scavenger, and evaluated directly the amount of hydrogen radicals using UV-vis spectrophotometry. In this study, we applied this method to albite, another common constituent mineral in crustal faults, in an attempt to elucidate the behavior of hydrogen radicals in natural fault zones.

Our experiments revealed that hydrogen radical is generated during grinding of both quartz and albite. The amount of the hydrogen radicals increases as the specific surface area of the ground sample increases. Comparing the amount of the hydrogen radicals generated, those from albite is much smaller than from quartz. These results are reasonable because the density of Si radicals on well-cleaved (010) and (001) planes of albite is estimated to be 1/6 of that on quartz. In addition, Hochstrasser and Antonini (1972) showed that alkali metals interfere the generation of hydrogen radicals. This property may also affect the amount of surface radicals on ground albite.

When we compare the amount of hydrogen radicals with those of hydrogen gas per unit area of newly created surface reported by Kameda et al. (2003), the hydrogen radical is more than one order of magnitude greater than hydrogen gas. This suggests that most of generated hydrogen radicals disappear before combining to be hydrogen molecules.

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