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A basic study for ESR dating of Europan icy faults

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Liquid water would underlie the icy crust of one of the Jovian moon, Europa. The tidal force of Jupiter causes fractures on the icy crust. The resultant gap would be filled with the erupted and rapidly frozen water. In fact observations from the spacecraft, Galileo found the linear ridges on the surface of Europa, which might be the results of repeated eruptions. Europan ocean water is considered to include sulfates, especially magnesium sulfate. Magnesium sulfate or its hydrate might precipitate in the faults. Radiation from the natural radioactive elements and cosmic rays must produce free radicals in these materials. Possibly, most of the free radicals are stable at extremely low ambient temperatures, about 130K on Europa. Thermal events such as the repeated eruptions may decrease the concentration of the free radicals to zero and the free radicals begin to accumulate again. Hence using the radical concentration, it is possible to determine when the thermal events occurred or how often the eruption has occurred. Electron spin resonance (ESR) can detect the free radicals and is used in dating of terrestrial rocks and minerals. We made analogue materials in a laboratory, irradiated them by gamma rays and studied the behaviors of the radiation-induced free radicals. This result will be applied to future dating of Europan faults.

Powdered MgSO4 and MgSO4(7H2O) and frozen aqueous solution of MgSO4 25% by weight were used as analogue materials. They were irradiated by gamma rays at 77K and measured with ESR. ESR intensities of SO3- free radical and hydrogen atom clearly increased by gamma-irradiation in all samples. Free radicals in anhydride were produced more than those in hydrate. We will report the thermal stability of these free radicals and discuss the possibility of future ESR dating of Europan faults.