

The formation process of the oxygen vacancies in quartz of granites and uranium ores

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The method of ESR (electron spin resonance) dating was applied to various minerals based on the principle that unpaired electrons, detected by ESR, are created by natural radiation to be accumulated in geological time scale. The range of this dating method has been thought to be within the period of Quaternary because of the thermal stability of the unpaired electrons which are in quasi-stable states in the crystal lattice. The authors have revealed the relationship between diamagnetic oxygen vacancies and the paramagnetic E1' center in quartz, in order to examine the possible dating range using oxygen vacancies. Its thermal stability was found to be long enough to discuss the whole history of the Earth. We have also shown that there is a clear correlation between the amounts of the oxygen vacancies in quartz and the ages of the host granitic rocks. This has been applied to another application to identify the source regions of eolian dust coming to the area of Japanese Islands.

It is necessary to identify the formation process of the oxygen vacancies in quartz in order to utilize the defects for dating. We proposed that they are created by beta and gamma rays coming from outside of quartz while alpha recoil nuclei from U and Th in quartz matrix in ppb order were thought to create oxygen vacancies. In the present study, we applied pulsed ESR technique to obtain spin-spin relaxation times, which are the function of local distance between spins. The relaxation times E1' center of quartz irradiated by electrons and gamma rays were several factors larger than those irradiated by He ions. This is a reasonable result because He ions, with high linear energy transfer, should create defects in a high density. The relaxation times of the E1' center of quartz from granites and uranium ores are close to those irradiated by electrons and gamma rays, indicating that they are created by beta and gamma rays coming from outside of quartz.

It is also necessary to explain the fate of the oxygen vacancies which should have been created by alpha particles especially in uranium ore where huge amount of alpha particles around quartz. It will be reported how these oxygen vacancies should have been changed with time based on the results of annealing experiments on He ion irradiated samples.