ESR Dating of Altered Rock from Unzen Volcano, Western Kyushu, Japan

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Electron spin resonance (ESR) dating has been tried on quartz from hydrothermally altered rocks in the Unzen geothermal field, Western Kyushu, Japan. The Unzen field is roughly separated into two parts (north-eastern and south-western) by a national road running across the center of the field. The north-eastern part is very active with fumaroles and hot springs. The south-western part will be old only with altered rocks. ESR ages were obtained from six samples: three (UJ-8,16,17) from the north-eastern part and other three (UJ-21,22,22') from the south-western part. It is examined that ESR dating will apply to geothermal area by the comparison of these ESR ages to present geothermal manifestation.

ESR method is one of microwave spectroscopy which can detect lone electrons. ESR age is obtained from the density of lone electrons produced by natural radiation. The density of lone electrons is in proportion to the total radiation dose (TD). ESR age is calculated by TD(Gy) / Dose(Gy/y). TD can be obtained by comparing ESR intensity of unirradiated samples with that of samples irradiated artificial gamma ray. Dose (D) is calculated by concentrations of U, Th and K analyzed chemically or radiometrically. ESR signals are from some lattice defects in quartz (e.g. E',Ge centers and OHC) which holds lone electrons. Dating can be made on each lattice defect individually. Usually three ages can be obtained from one sample due to different thermo-stability of each signal.

In this study, the signals of E' center and OHC can be observed from all the samples, and Ge center's can be from UJ-8,17,21,22,22'. The OHC signal is strongest and clearest among three centers'. ESR ages were calculated on the assumption that the concentrations of U, Th and K are same as the values of UJ-22' (U:5.5ppm, Th:2.3ppm, K:0.02%). Every ages are younger than the age of their original (Yatake lava) which is 260ky by fission track dating (Sugiyama *et al.*1986). The ages from OHC are younger in the north-eastern part than in the south-western part. UJ-8 which was collected at a place with 57°C at a depth of 20cm show the youngest age of 18ky. The age from OHC which is more thermo-stable than that of E' center (Taguchi *et al.*1988) shows a good correlation with the present geothermal manifestation. E' ages are always younger than the OHC ages on each sample. UJ-8 from the active north-eastern part is youngest in E' age among the dated samples. However, the young E' age from non-active south-western part may suggest that the area has been active until recently. In conclusion, the non-active field with young E' ages of quartz will be still promising for the search of geothermal energy.

Table 1. ESR ages from hydrothermally altered rocks in the Unzen geothermal field.

Sample No.	Constituent Minerals	Total Dose (Gy)	Concentrations of U, Th, K	Dose (Gy/y)	ESR Age (ky)
UJ-8	Quartz Cristobalite	E' 5.0 OHC 30.5 Ge 52.8	U 5.5ppm Th 2.3ppm K 0.02%	1.63E-3	E' 3 OHC 18 Ge 33
UJ-16	Quartz Kaolinite	E' 30.5 OHC 60.0			E' 18 OHC 37
UJ-17	Quartz Kaolinite	E' 24.7 OHC 73.9 Ge 100.8			E' 15 OHC 45 Ge 61
UJ-21	Quartz Kaolinite	E' 14.4 OHC 163.5 Ge 184.0			E' 9 OHC 98 Ge 113
UJ-22	Quartz	E' 8.2 OHC 173.4 Ge 241.8			E' 5 OHC 106 Ge 148
UJ-22'	Quartz	E' 18.9 OHC 130.7 Ge 133.9			E' 12 OHC 80 Ge 80

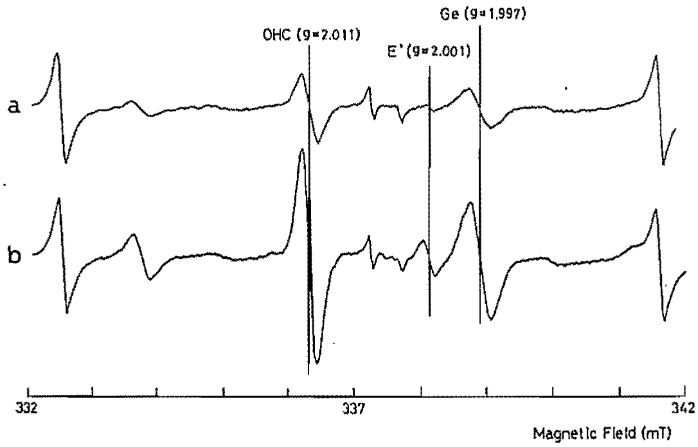

Fig.1 ESR spectrum of UJ-22'.
a:unirradiated sample b:irradiated sample(300Gy)

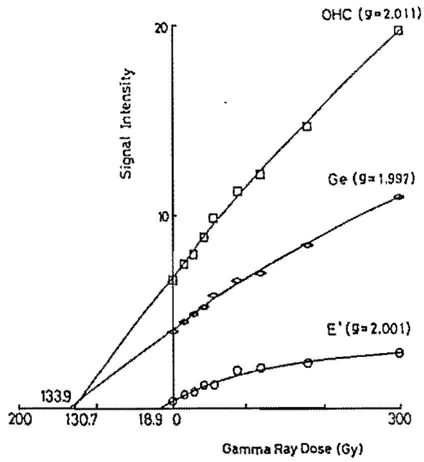

Fig.2 Variation of ESR intensity by artificial gamma ray.

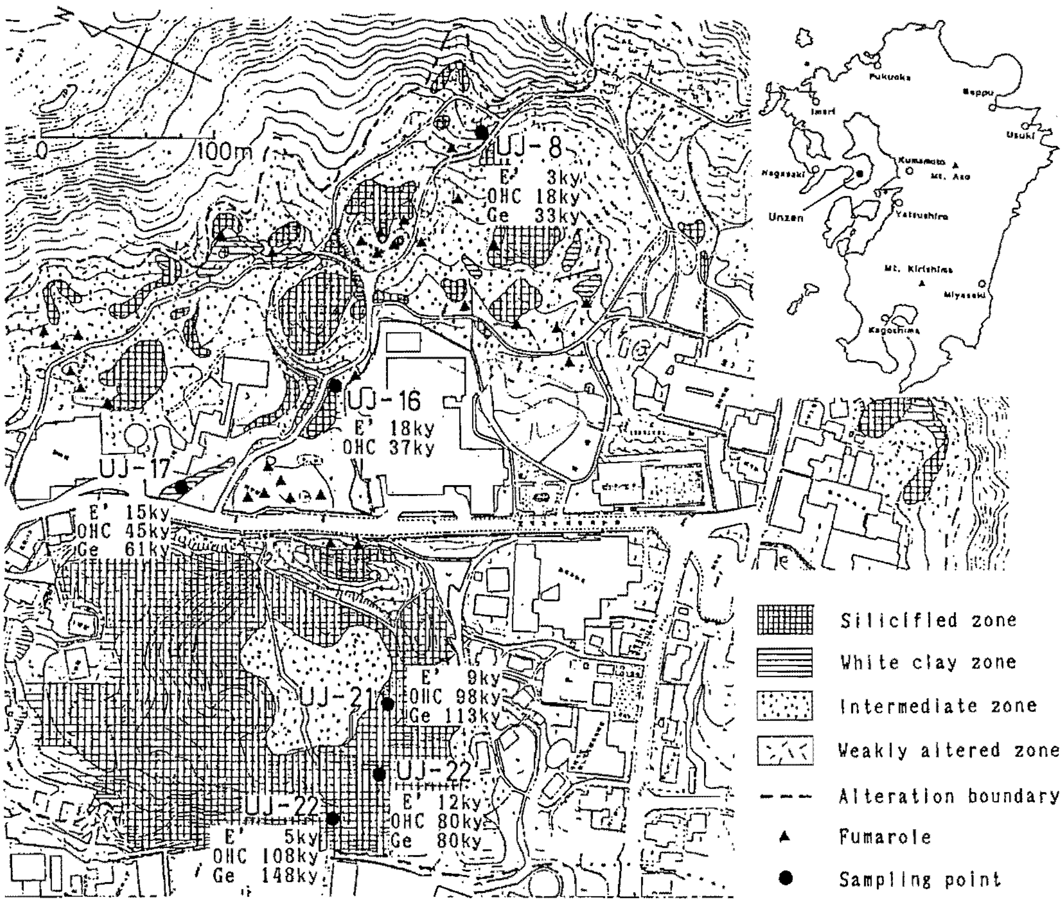

Fig.3 Map showing the distribution of thermal manifestations in the Unzen geothermal field, in which ESR ages are plotted.