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Research paper

ESR dating of the Eupchon fault, South Korea

Hee-Kwon Lee*, Joo-Seok Yang

Department of Geology, Kangwon National University, Chunchon, Kangwon-do, 200-701, South Korea

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Abstract

We investigated temporal pattern of Quaternary fault activity of the Eupchon fault zone in the southeastern part of the Korean peninsula, using ESR dating of fault rocks. The counterfeit E' signal significantly affected the equivalent dose on some samples. In particular, the counterfeit E' signal tends to affect samples with E' intensity close to saturation level. Storage at room temperature for 360 days and heating at 170 °C for 15 min. after γ-ray irradiation did not change significantly the intensities, the dose responses and ESR ages for OHC, Al, and Ti signals. ESR ages from the Eupchon fault zone range from 2000 to 500 ka. The fault rocks were reactivated at least five times 2000, 1300, 900–1100, 700–800, and 500–600 ka ago. These data indicate that long-term cyclic fault activity of this fault zone continued into the Quaternary. The results from this study suggest that the Eupchon fault zone can be classified as a potentially active fault and presents some potential seismic hazards to the nuclear power plant in its vicinity.

Keywords: ESR dating; Fault gouge; Quaternary fault; Eupchon fault; South Korea

1. Introduction

There are many disasters from earthquakes and volcanoes in the world. Fractures and faults play a predominant role in most rock engineering problems. Geoscientists are trying to make evaluations of potential hazards associated with structures such as power dams and nuclear power plants. While the recognition of faults is relatively easy through structural analysis and paleoseismic study, predicting when a particular fault will reactivate is very difficult. As well, the long term history of earthquake fault movements cannot be defined reasonably using the limited instrumental or historical records. Therefore dating of prehistoric fault movements is a critical tool in the evaluation of active tectonism. Once the space and time pattern of fault activity has been established, we can evaluate the possible hazards that structures such as nuclear power plant face in the near future.

Because the Eupchon fault zone cutting unconsolidated Quaternary sediments is located close to a nuclear power plant in the southeastern coastal region of Korean peninsula (Fig. 1), most of the research has been focused on the evaluation of the potential seismic hazards associated with this nuclear power plant (Kim et al., 2004). This fault zone was formed as a normal fault in the late Oligocene to early Miocene and then was reversely reactivated during the Quaternary (Kim et al., 2004). In this study, we investigated the time pattern of fault activity on the Eupchon fault zone, using ESR dating method. Fault rock samples were systematically collected from distinctive bands which appeared to be developed by sequential fault movements and are separated about 1 km along the fault zone (Fig. 1). A suite of samples (Up 13, Up 15, Up 16, Up 17 and Up 18) were collected from the fault gouge developed in the Tertiary volcanic rock covered by coastal terrace 3. Samples of Uj 1, Uj 2, Mj 1 and Mj 2 were collected from the fault rocks developed between Cretaceous sedimentary rock and Tertiary volcanic rock. The relationships between ESR ages and the structural features within the fault zones were used to evaluate the temporal pattern of fault activity of the Eupchon fault zone.

*Corresponding author. Tel.: +82 33 250 8558; fax: +82 33 242 8550.
E-mail address: heekwon@kangwon.ac.kr (H.-K. Lee).

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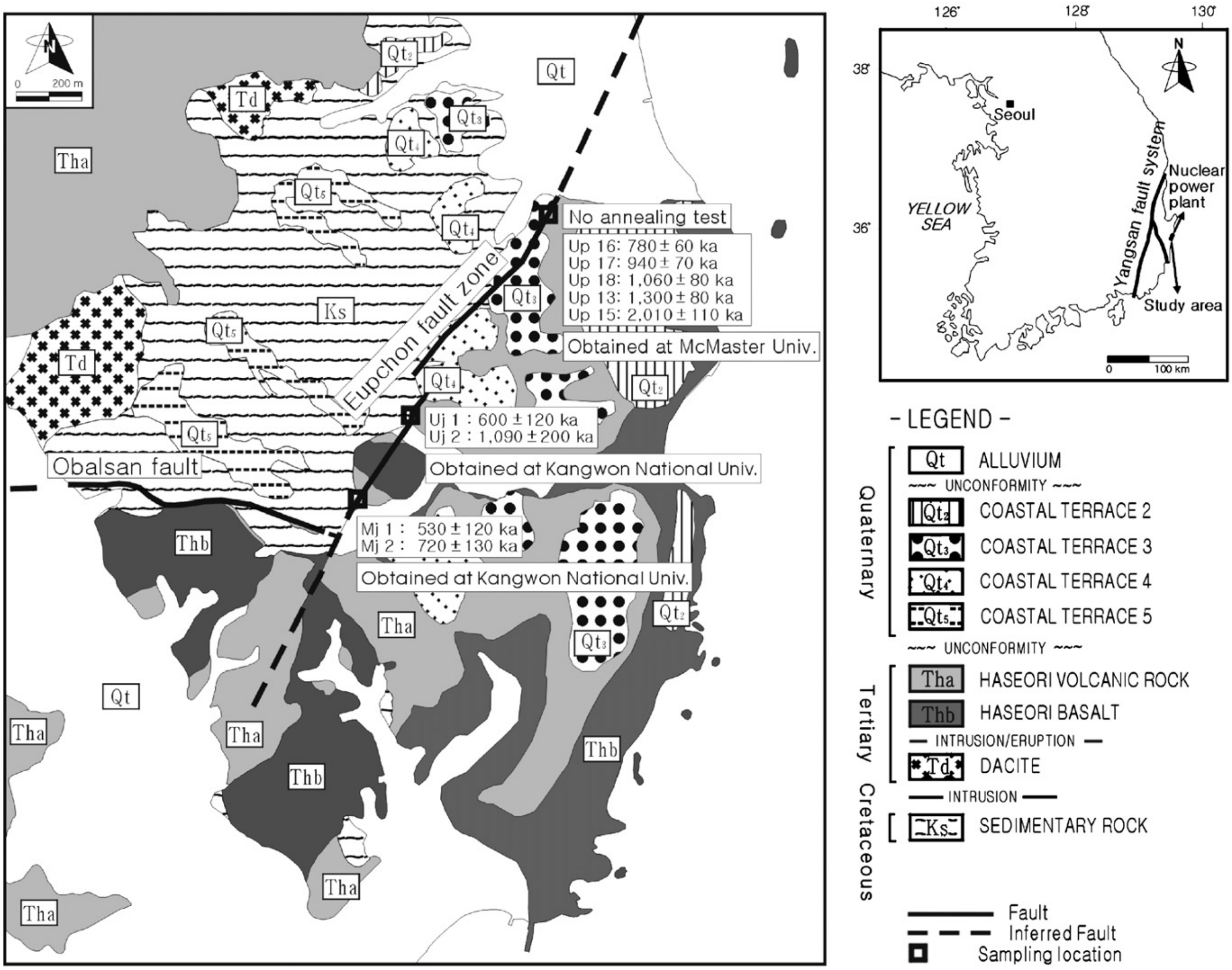

Fig. 1. Geologic map of the study area (after Kim et al., 2004) showing sampling locations and ESR ages.

2. Methods

The collected samples were lightly disaggregated by wet sieving. Size fractions of 25–45, 45–75, 75–100, 100–150, 150–250 μm were prepared, and treated to isolate quartz, using magnetic separation, and attack with fluoboric and fluosilicic acid. Aliquots of the quartz were irradiated with ^{60}Co gamma rays. A suite of samples (Up 13, Up 15, Up 16, Up 17 and Up 18) were analysed on a Bruker ESR spectrometer (EMX 300) of McMaster University at room temperature (E' signals) and at 77 K (Al and Ti signals). Instrumental settings for E' signals were: microwave frequency = 9.44 GHz; microwave power = 0.1 mW; scan width = 5 mT; scan time = 164 ms; modulation frequency = 100 kHz; modulation amplitude = 0.1 mT; and time constant = 0.05 s. For the Al and Ti spectra, the microwave power = 2 mW, scan width = 20 mT, and the other settings were the same as the room temperature measurements. A second suite of samples (Uj 1, Uj 2, Mj 1 and Mj 2) were analysed on a JES-TE 200 ESR spectrometer of Kangwon National University at room temperature (E' and OHC signals) and at 77 K (Al and Ti signals). Instrumental settings for E' and OHC signals were: microwave power = 0.1 mW for E' signals and 2 mW for OHC signals; scan width = 2.5 mT; scan time = 60 s; and time constant = 0.05 s. For the Al and Ti spectra, scan width = 5 mT; and scan time = 30 s. The other settings were the same as the measurements using the Bruker ESR spectrometer (EMX 300) of McMaster University. For the Al signal, we measured from the top point of line 1 to bottom point of line 4 and from the highest point on line 1 to the lowest point of line 14 and then calculated the average. For the Ti signal, we measured from the top point of line 1 to bottom point of line 4 and from the highest point on line 1 to the lowest point of line 5 and then calculated the average. The equivalent dose was determined using the additive dose method. The data were processed using the DATA program of Rainer Grün. The concentrations of radioactive elements U, Th and K within a suite of samples were determined by the neutron activation analysis at McMaster University and those of the second suite of samples were measured by the high-resolution gamma