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Quantification of the Seismogenic Potential of a Fault

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1. Introduction

Several Quaternary faults have been found along the Ulsan fault, Yangsan fault and eastern coastline in the southeastern part of the Korean peninsula. Because some of these faults could be considered a capable fault, it has been a very delicate matter, which needs to be deal with carefully in assessing the seismic hazard for nuclear power plants. In determining whether or not the faults are capable there has been considerable debate among geologists and geophysicists in Korea.

The definitions and criteria for fault capability have been applied in Korea are both the origin and timing for most recent movement of faults (surface or near-surface deformation within the last 500,000 or 35,000 years). This regulation requires that seismic sources be characterized as to their potential for generating earthquakes and causing surface deformation. In this study we should suggest new criteria and quantitative diagnostic procedure that could estimate whether or not a fault is capable of generating earthquakes in the future.

2. Methods and Results

In view of the results so far achieved, however, in spite of many research works the issue has not been fully resolved yet done. As mentioned above it is not easy to define that the faults are active or not by the deterministic approach. In this study, therefore, we should also suggest the new probabilistic approaches that could be applied to assess seismogenic potential of the fault in the Korean peninsula on the basis of US NRC technique[1]. We expect that this method could be applied for probabilistic seismic hazard analysis in the Korean.

2.1 Fault with historical rupture

A fault with historical rupture is the most reliable evidence of a capable fault. It was reported about 10 historical earthquakes more than MMI VIII near Gyeongju area along the Yangsan fault. The greatest earthquake(MMI X) in the Korean peninsula occurred around Ulsan city in 1643[2]. It had large felt areas and triggered tsunami, liquefaction along the coast and destroys of some beacon houses. These earthquakes occurred mainly in Gyeongju-Ulsan areas in SE part of the Korean peninsula. In order to verify the historical rupture it will be continued the study of relationship between the historical earthquakes and the Quaternary faults with reference to fault activity.

2.2 Spatial association between fault and earthquake

If a fault has been causally associated with large magnitude historical earthquakes or shows unequivocal evidence of repeated late Quaternary displacement, then that fault would be considered to be seismogenic fault. There exist uncertainties in the seismogenic potential of fault. This uncertainty is expressed by the probability that the fault is seismogenic and will be less than 1.0.

It is difficult to associate older historical events with a particular fault because of uncertainties in epicenter location, and sometimes even instrumentally located event are not easily associated with known faults. Because it is important to clarify relationship between a fault and earthquake genetically we should use a range of assessments for an idealized linear fault and idealized observed seismicity to illustrate the notion of a spatial association of seismicity with a fault (Fig. 1).

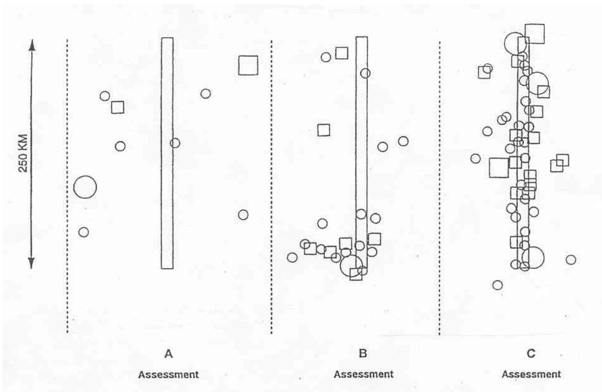

Fig. 1. Diagnostic diagram to estimate a spatial association with fault and seismicity[1].

2.3 Crustal extent of fault

Because the capable faults would be expected to extend to seismogenic depths (10-20 km), the crustal extent of fault is important to assess seismogenic potential of a fault. Most Quaternary faults in Korea are interpreted as a tectonic origin in the geological survey, and are not evidences of non-tectonic landslide, therefore, we can consider that these faults extend through the seismogenic crust.

2.4 Age of faulting

To make a diagnosis of a capable fault an age of faulting has been used as criteria, therefore, dating is a critical tool in the assessment of active fault. Dating techniques can be grouped as numerical, relative dating, and correlation. Numerical techniques are best, but datable materials are often lacking, and in these cases age estimation must be made using relative dating or correlation technique. In Korea dating techniques such as ESR, OLS, Rb/Sr, K/Ar, C-14 and so forth have been applied to dating deposits and deformation of late Cenozoic age. To assess the capability of fault the geological age could be divided into 3 ranks such as Tertiary, Pleistocene, and Holocene.

2.5 Tectonic geomorphology

Tectonic geomorphology is essential for complete paleoseismology investigation. The morphology of fault generated mountain fronts and escarpments can indicate relative tectonic activity. We should divide the tectonic geomorphology into 5 ranks such as very high, high, low, very low and suspicious based on the characteristic features of a straight creep and steep slope of terrace, a cliff continuing on a terrace surface, streams and ridges bending, lineament continuing and so on.

2.6 Relationship between brittle slip and stress regime

The capable fault would be acted under the current stress regime and the brittle slip of faults may be consistent with the current tectonic stress. Because earthquakes are a manifestation of the release of tectonic stresses, seismogenic faults are favorably oriented relative to tectonic stresses. We could estimate the probability of relationship between current stress by focal mechanism and brittle slip from the Quaternary faults in SE Korean peninsula (Fig. 2).

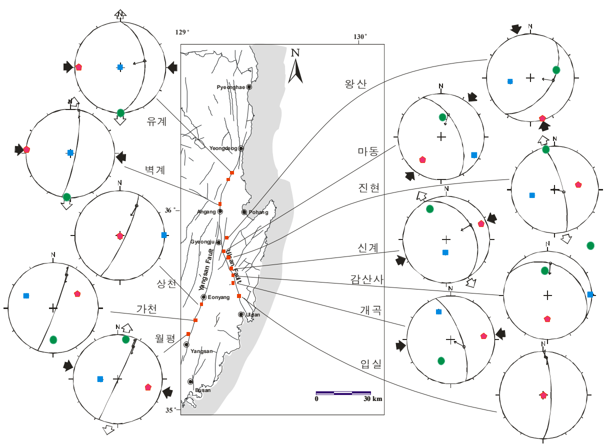

Fig. 2. Fault slip analyses from the Quaternary faults along the Yangsan and Ulsan fault, SE Korea. Black arrows and red circles indicate the maximum stress axes.

3. Concluding Remarks

We should suggest the procedure and criteria for assessing the probability that a fault is seismogenic as below Table 1. In this method relative weight and probability may be depended on expert judgment. And, we also expect that this method could be applied for probabilistic seismic hazard analysis in the Korean.

Table 1. Procedure and criteria for assessing the seismogenic potential of a fault.

Criterion		Weight	Probability	Product
Fault with historical rupture		9.0	A	9.0 × A
Association(M > 5)		7.0	B	7.0 × B
Association(M < 5)		6.0	C	6.0 × C
Crustal Extent of fault		2.0	D	2.0 × D
Age of Faulting	*Holocene*	8.0	E	8.0 × E
	Pleistocene			
	Tertiary			
Tectonic Geomorphology	*A*	7.0	F	7.0 × F
	B			
	C			
	D			
	E			
Brittle Slip/Stress Regime		4.0	G	4.0 × G
Multiple Reactivation		2.0	H	2.0 × H
Sum of Products				S
Sum of weights				45.0
Probability (Seismogenic)				S/45.0

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REFERENCES

[1] K.L. Hanson, K.I. Kelson, M.A. Angell and W.R. Lettis, Techniques for Identifying Faults and Determining Their Origins, NUREG/CR-5503, 1999.

[2] K. Lee, Historical Earthquake data of Korean, The Journal of Geophysical Society of Korea, Vol.1, No.1, pp.3-22, 1998.