Earthquake Magnitudes for Certain South Korea Historical Earthquakes

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1. Introduction

The 2016 Gyeongju and 2017 Pohang earthquakes in South Korea have posed several problems to seismic hazard analyses [1-2], which is required for nuclear power plant projects and complexes. One issue is the proximity these earthquakes posed, with the epicenters and nearby nuclear power plant complexes shown in Figure 1. Another problem is that the magnitudes of these two events were very relatively large given the seismicity in the area. Another issue is that the government treats the 2017 Pohang event as a human-induced event [3].

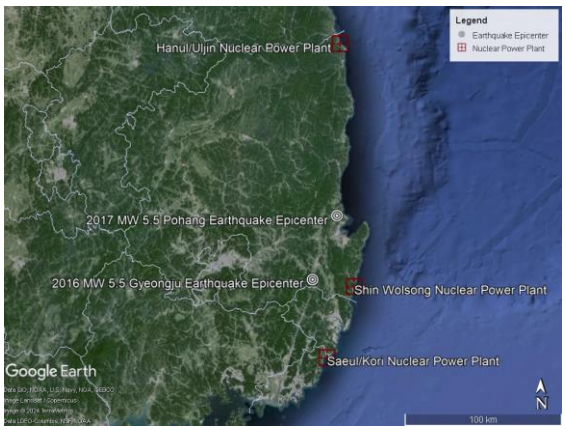

Fig. 1. Epicenters of the 2017 Gyeongju and 2018 Pohang earthquakes. Local nearby nuclear power plant complexes are also shown in the map.

The Korean peninsula is one of the few regions in the world that has a written record of macroseismic events since the beginning of the first millennium. These events were compiled by the Korea Meteorological Administration, KMA, and released as a publication log [4]. Surprisingly, for a somewhat seismically stable region, the records show there have been several large magnitude earthquakes throughout the past two millennia. To better understand, and perhaps, constrain the seismicity in the region, an estimate of earthquake magnitudes from the macroseismic events as published by the KMA would be needed.

This study attempts to estimate earthquake magnitudes for major earthquakes in the past as recorded by special historical logs.

2. Methods and Results

These earthquake magnitudes are estimated by comparing the macroseismic events to more modern instrument recorded earthquake events. These modern events have been locally recorded by the KMA as well as other international seismological agencies such as the Global Centroid Moment Tensor project [5-6]. This work will compile these events to tabulate earthquake magnitudes, earthquake intensities, and distances to estimate relationships. For the KMA historical record, Table 1 summarizes the number of frequency of events from to 2 to 1904.

Table 1. Frequency of earthquake by earthquake intensity as recorded in the Korea Meteorological Administrations historical record [4].

Intensity	II-IV	IV	V	VI
Frequency	1340	381	321	59
Relative Frequency (%)	62.0	17.6	14.9	2.7

Intensity	VII	VIII	VIII-IX	Total
Frequency	25	20	15	2161
Relative Frequency (%)	1.2	0.9	0.7	100

Analysis includes the distribution of earthquake intensities by measuring radial distances from the purported epicenter to the KMA historical record contours. An example is shown in Figure 1. The figure shows the use of software to estimate distances from earthquake intensity contours as described by the KMA historical record [4].

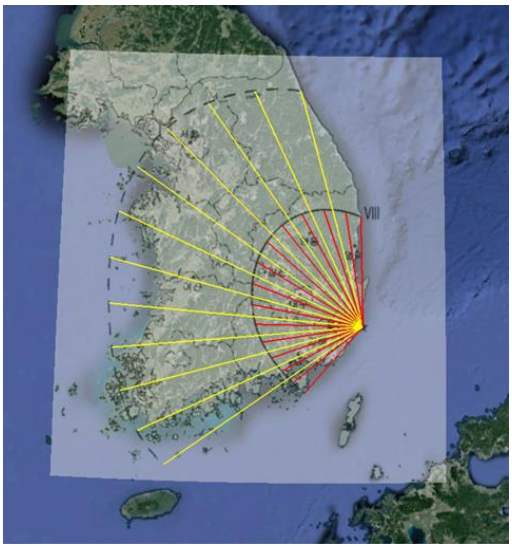

Fig. 1. Sample of overlaying historical earthquakes, occurred in 1643, on Google Earth Pro for intensity-distance measurement.

Earthquake intensity data is taken from modern records, more specifically from the 2016 Gyeongju and 2017 Pohang earthquakes. These earthquakes have both magnitude and intensity information in the KMA catalogs. A mapping is made with an example shown in Figure 2. The figure compares a the distribution of earthquake intensity against three events in the KMA historical catalog [4].

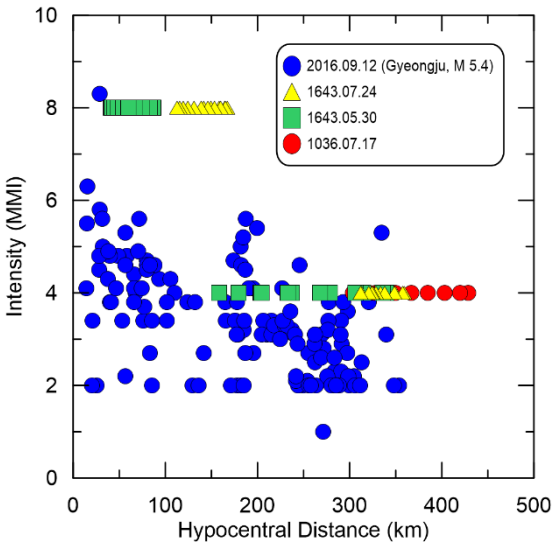

Fig. 2. Comparison of earthquake intensity-distance between the 2016 MW 5.4 Gyeongju earthquake and three macroseismic events from the southeastern region.

3. Conclusions

Investigations into correlating an earthquake magnitude to historical earthquake events by matching the distribution of earthquake intensities suggested that earthquakes with magnitudes larger than 5.5 have occurred in the past. The analysis assumes site conditions did not vary significantly across the centuries. The results are interesting because for one it would suggest larger fault ruptures are possible and that larger magnitudes should be considered in earthquake risk studies. These findings should be considered in seismic hazard analyses, especially for nuclear power projects.

Acknowledgement

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