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A Preliminary Spectral Analysis of Historical Earthquakes in the Korean Peninsula

S. Na (1), J. Cho (1), J. Baek (1), P. Park (1), and Y. Barkin (2)
(1) Korea Astronomy and Space Science Institute, Daejeon, Korea, (2) Sternberg Astronomical Institute, Moskow, Russia
(sunghona@kasi.re.kr / Fax: +82-42-861-5610)

Resume

Total 2080 earthquakes occurred in the Korean peninsula during the last 900 years. According to preliminary results of spectral analysis for this time series of local earthquakes, some of the identified periods for those earthquakes are: 40, 21, 16 years - long periods and 30, 15, 10, 7 days - short periods. 1 year period is prominent on the spectrum. Tidal and seasonal perturbations exert as triggering mechanism.

1. Introduction

Earthquake occurrence may seem to be a random process. But scientific reports assert that there exist periodicities in earthquake occurrence, both from the theoretical point of view and from data analysis [1], [2], and [3]. In this study, a record of the historical earthquakes occurred in the Korean peninsula is processed by using two method of spectral analysis. It is one scientific interest to see some periodicities of geophysical origin existent in such local earthquakes of time span slightly shorter than one thousand years, although the peaks on the spectra are not so outstanding.

2. Data Analysis

Total 2,185 earthquakes occurred during Feb 34AD ~ March 1904 in the Korean peninsula. But the quality of record before 1000AD is inferior, so that only the record of the latter period of about 900 years has been retained for this study. It is desirable to separately deal with earthquakes of different magnitudes, but all earthquakes were equally treated as equivalent signal in this study. A time series of daily basis composed of 1 and 0 (1 for day of earthquake and 0 for day of no earthquake) is made based on the historical record. Both Fourier transform and maximum entropy method are used.

2.1 Fourier spectrum

In Fig. 1, a Fourier amplitude spectrum (divided by period) is drawn as function of period. Division has been done, because longer period components have actually smaller contribution on the period axis and may mislead. While many strong peaks of shorter periods exist, 40, 21, and 16 years are picked as main ones in this range of Fig. 1. In fact, 40 and 21 year peaks were also identified in the worldwide earthquake occurrence [2]. Though not shown in Fig. 1., one conspicuous peak of one year period has been also found in different period range of the same spectrum.

2.2 Maximum entropy spectrum (MEM)

Maximum entropy method has been applied to acquire spectra of Korean historical earthquakes. Using the acquired MEM spectra for different filter length, a maximum likelihood spectrum is deduced and is illustrated in Fig. 2, which shows short period components. Although the peaks are not quite conspicuous, the ones in Fig. 2 coincide with periodicities such as monthly, semi-monthly, 10-days, weekly periods, and confirm other studies [1],[3].

3. Discussion and Summary

Tidal stress is believed to be one of triggering mechanism of historical earthquakes in Korea. Periodicity of one year has been identified, so that seasonal load fluctuation is believed to exert as significant cause of stress in the Earth's crust. Tide and seasonal variation are once again confirmed as sources of seismic activity. Long periods of about 40 and 21 year have been identified in the local earthquake occurrence as well, though their origins are not known yet. More spectral analyses will be done and reported.

4. Figures

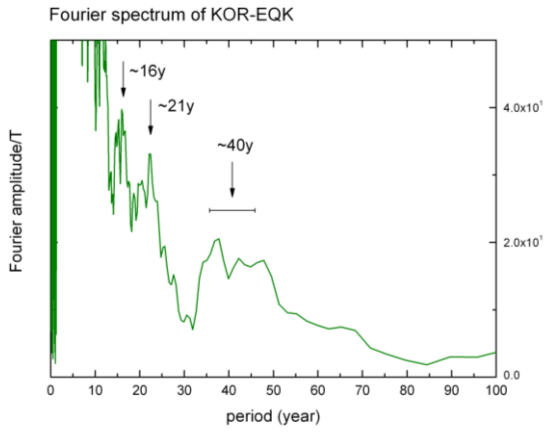

Figure 1: Amplitude spectrum of the time series composed of Korean historical earthquakes as described. To suppress the increase of graph for longer period, amplitude is dived by the period. The unit is [1/day/yr]. Normalization not applied.

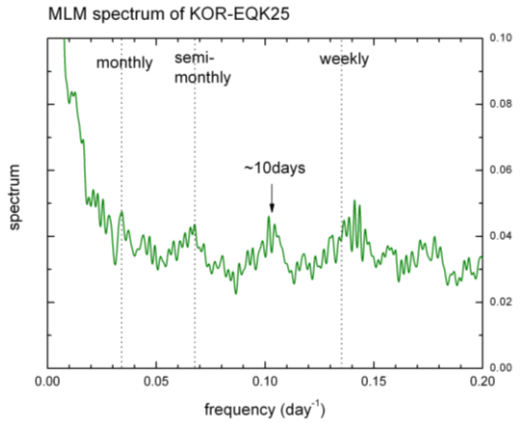

Fig. 2 Maximum likelihood power spectrum of the time series composed of Korean historical earthquakes. Normalization not applied.

5. Table

Table 1: Part of Korean historical earthquakes data.

Epoch	Location	magnitude
-	-	-
1407 Feb 08	37.6, 127	3.5
1407 Aug29	38.9, 126.1	3.5
1407 Nov23	36.2, 128.2	3.5
1408 May19	37.6, 127	4.7
1409 Jun 09	36.6, 128.5	3.5
-	-	-
-	-	-

References

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