

Some studies on the 1952 earthquake near Pyeongyang, North Korea

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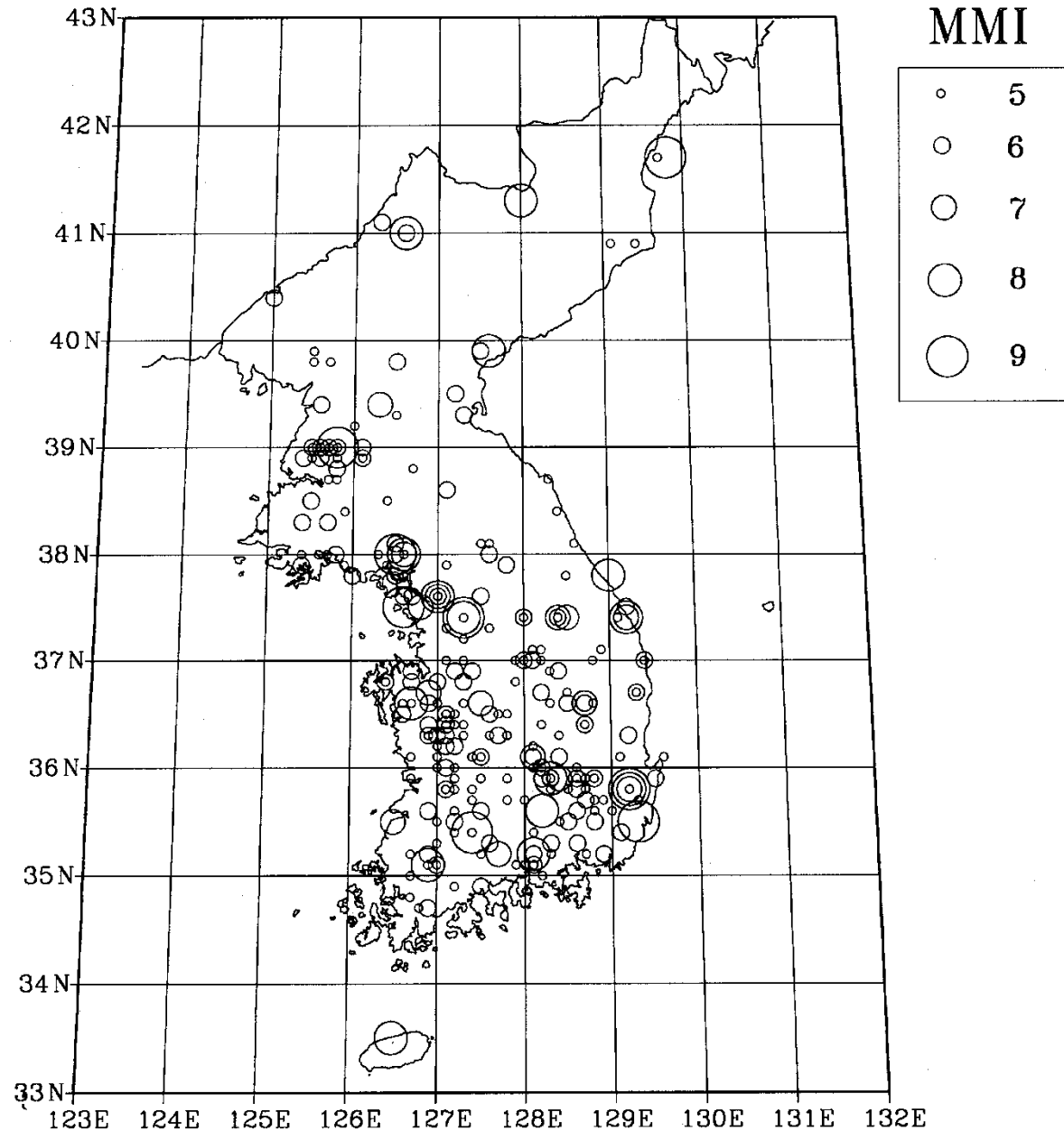
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Historical earthquake

A.D. 2~1904

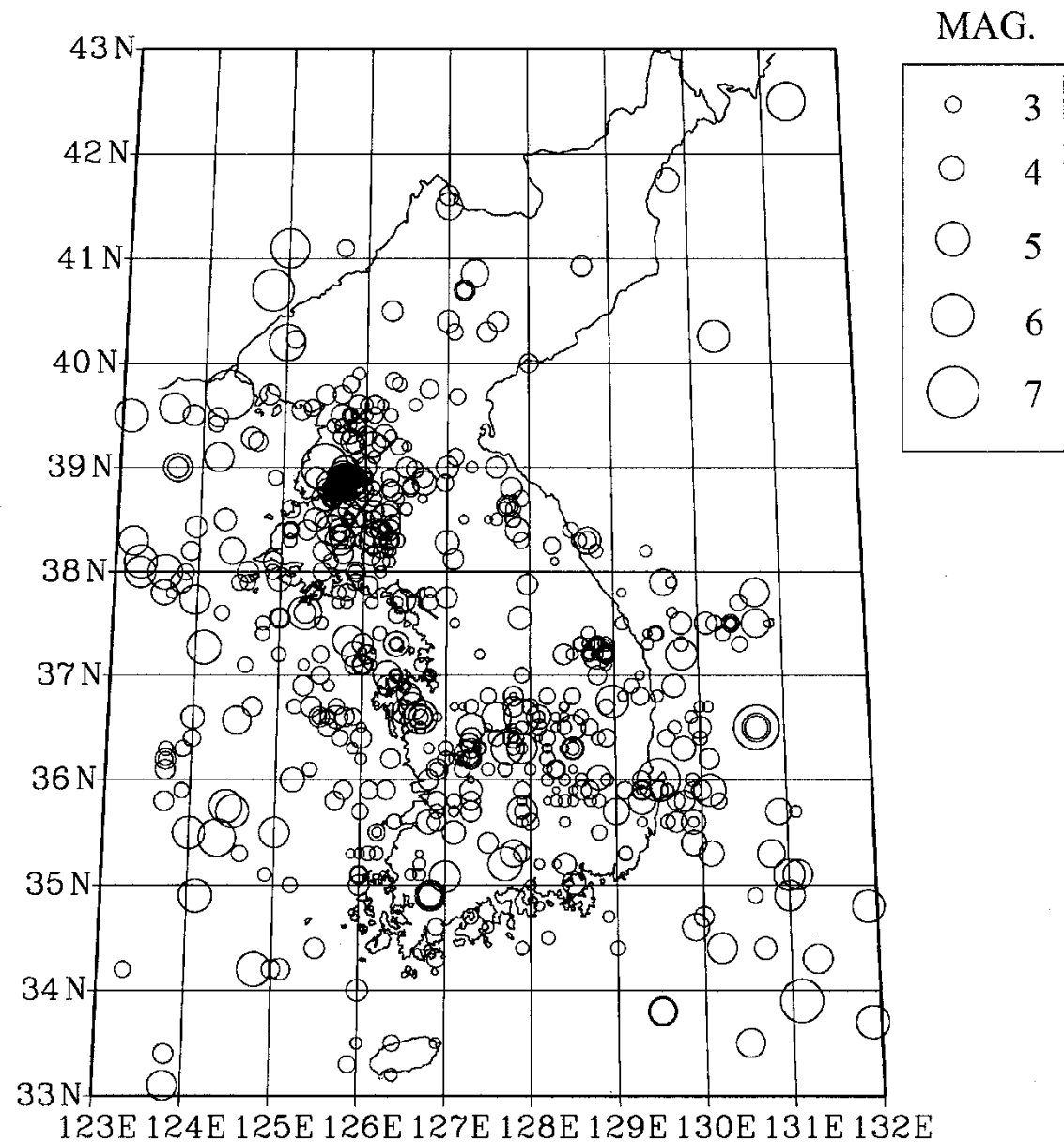
- Intraplate region with moderate seismicity
- About 2,000 earthquakes during about 2,000 years
- About 50 earthquakes with fatalities and damages



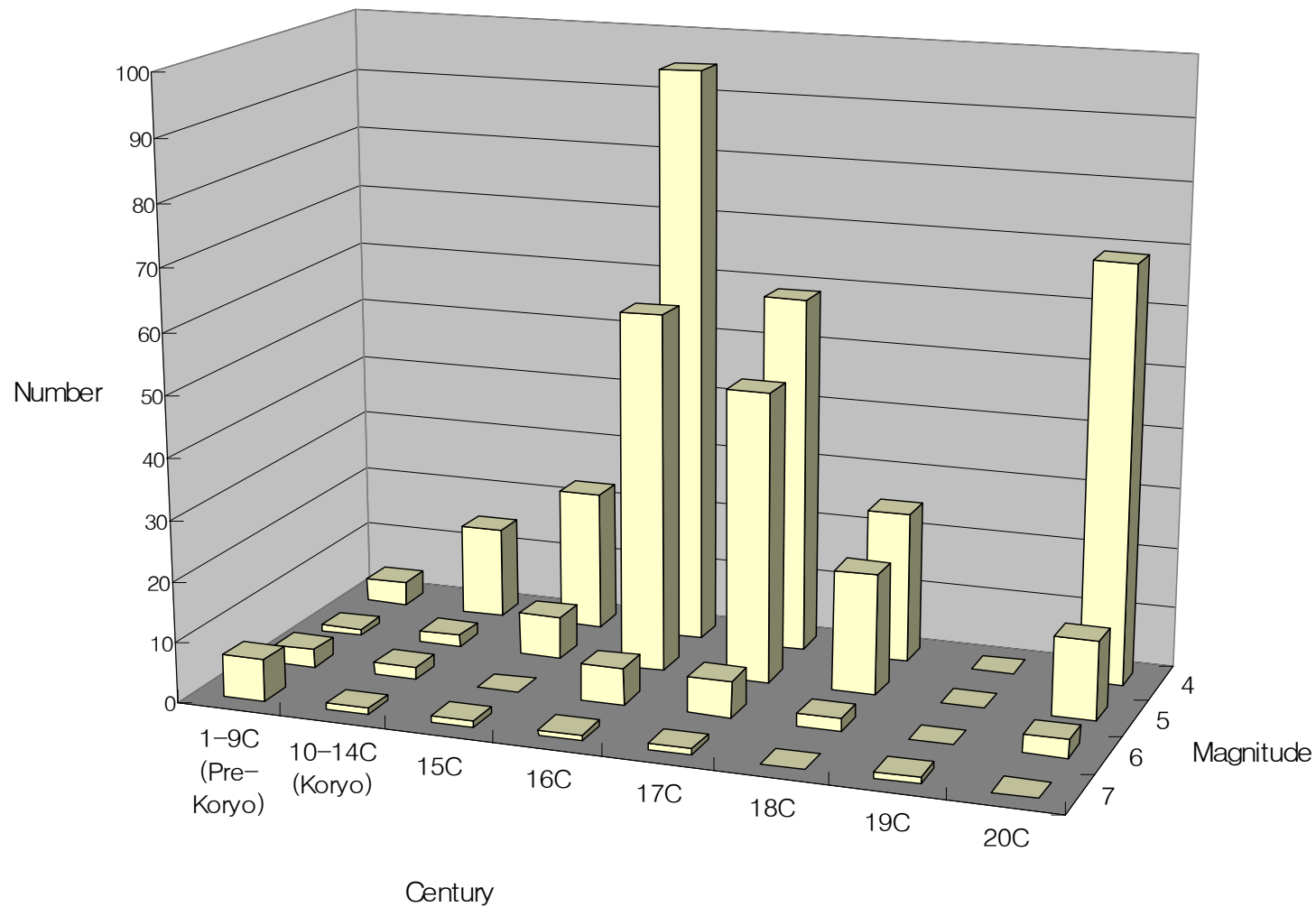
Instrumentally- recorded earthquake

A.D. 1905~1996

- Installation of a modern seismograph in Incheon during 1905
- About 20 earthquakes over magnitude 4.5 in the 20th century
- No significantly large, damaging earthquakes in the instrumental period

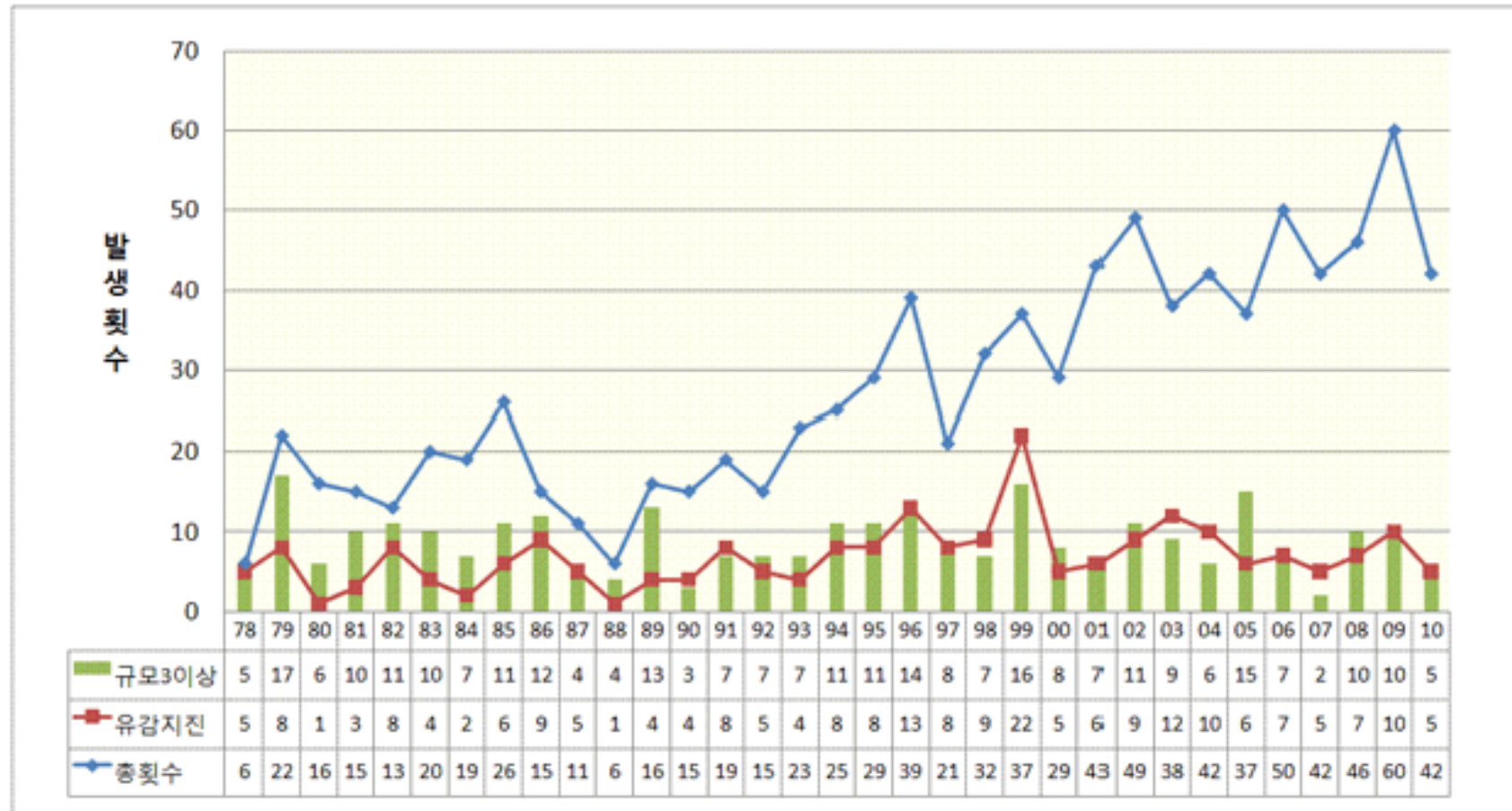


Temporal variation of seismicity in Korea



The seismic activity in the 16th and 17th centuries was very high.

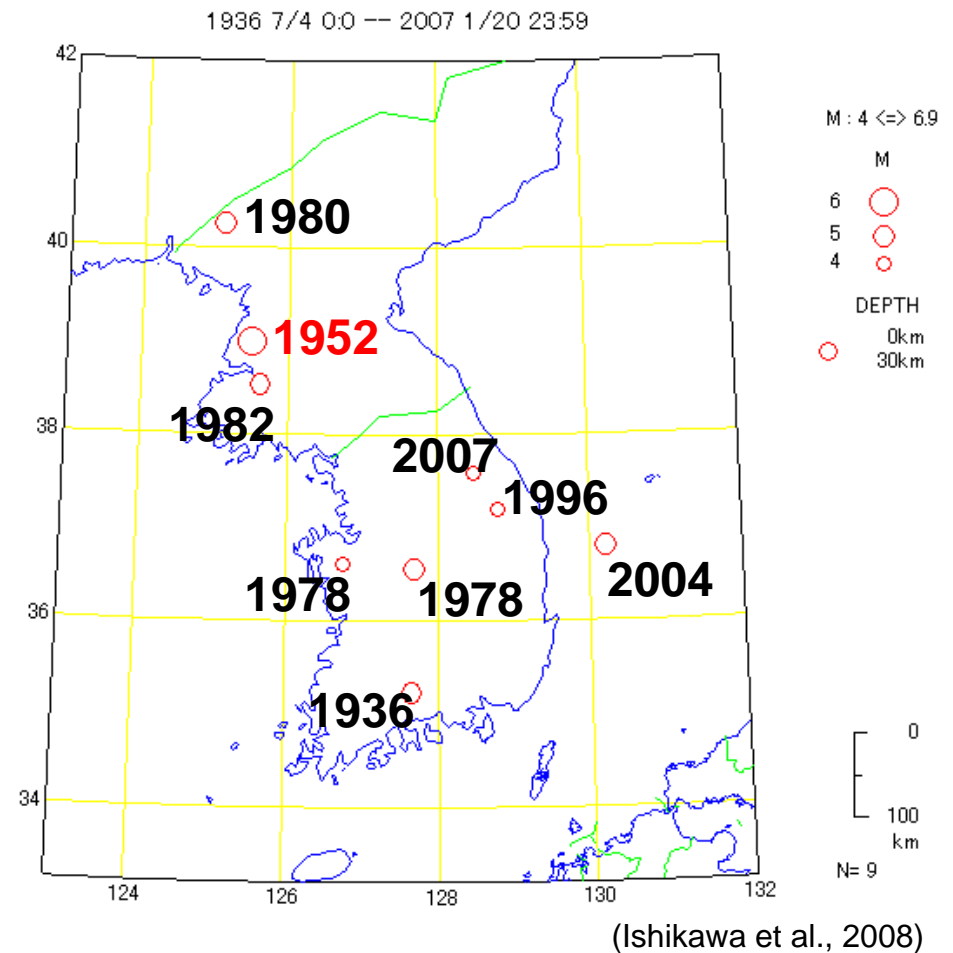
Seismic Activity since 1978



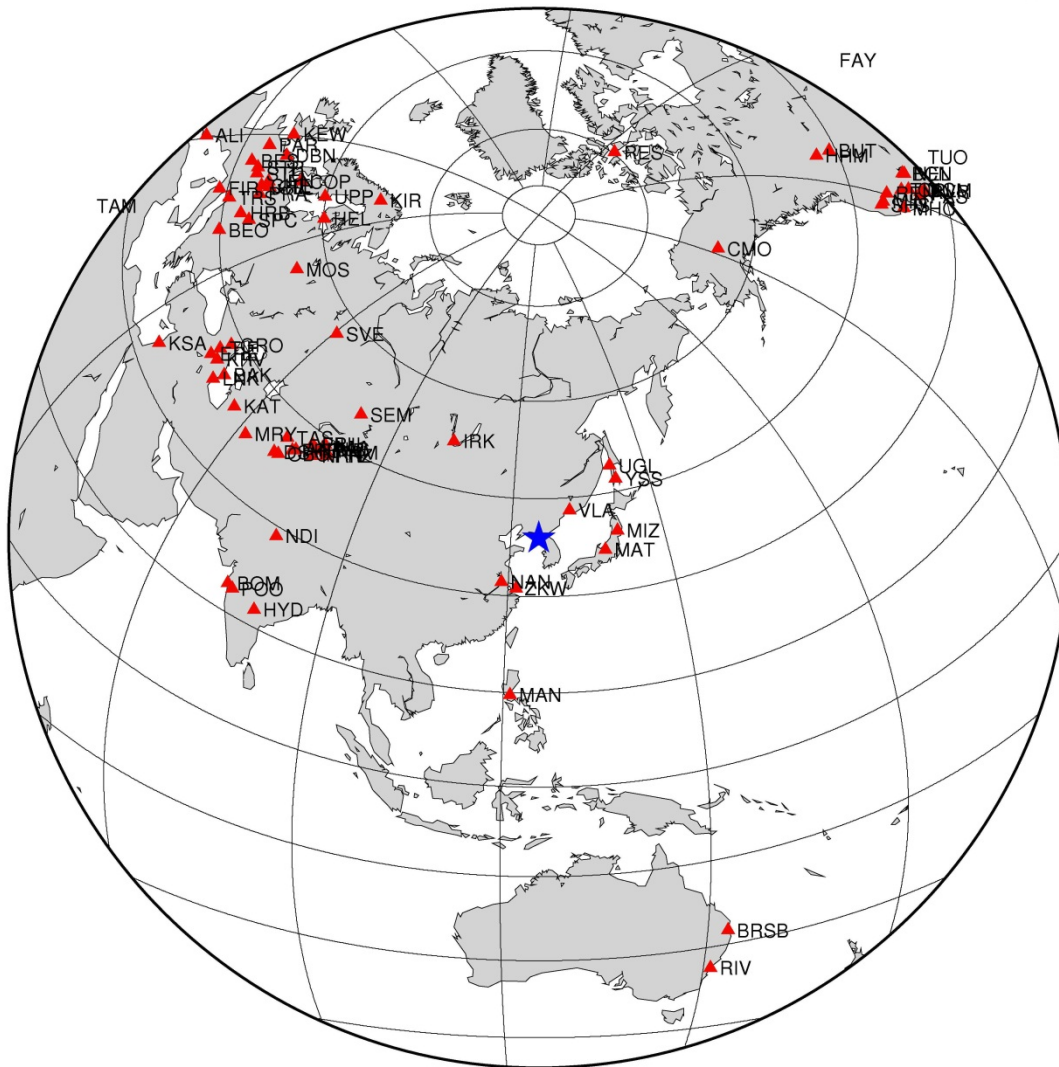
- Since 1978, seismograph stations are continually increasing.
- Detection capability of micro earthquakes has been improved.
- However, there is no obvious evidence on variation of seismic activity.

I. The 19 March 1952 earthquake near Pyeongyang, North Korea

- Importance
 - Presumably the largest earthquake in the Korean Peninsula since 1905
 - Largely unknown earthquake information due to the Korean War
 - No seismograph station in the Korean Peninsula
 - Highly significant to seismic hazard in the Korean Peninsula
- Estimated magnitude
 - Rustanovich et al.(1963): $M=6.3$
 - 中国国家地震局科技情报中心 (1987): $M_s=6.5$
 - Yuche Li(2001): $M=6.5$
 - Ishikawa et al.(2008): $M_d=6.5$

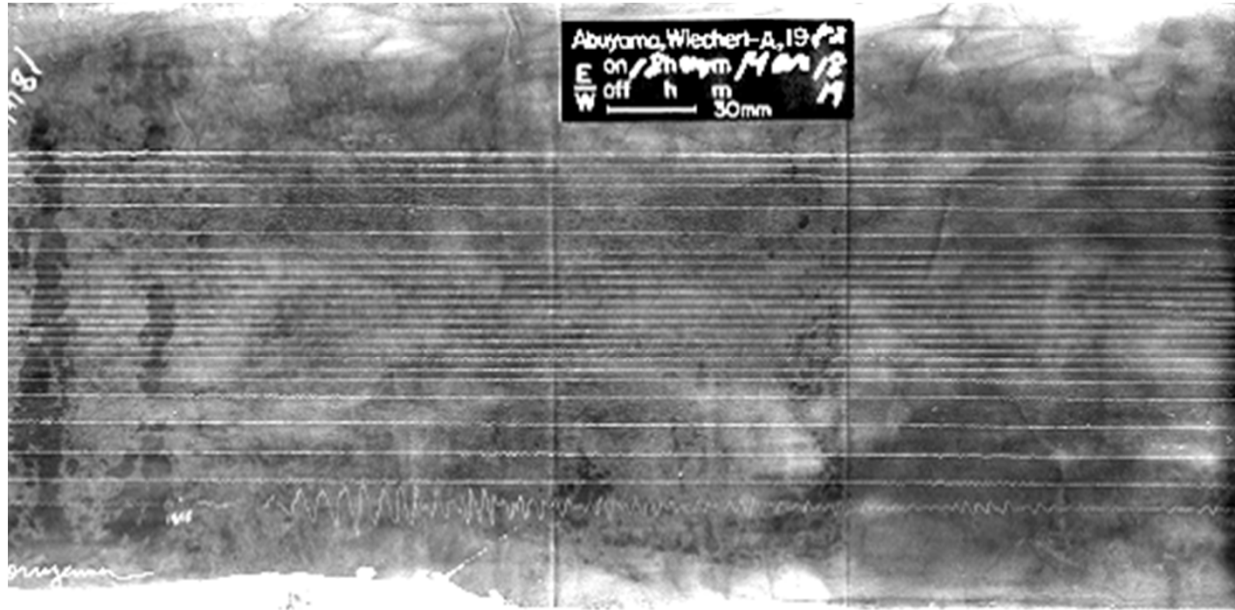


II. Collection of data related to the 1952 earthquake

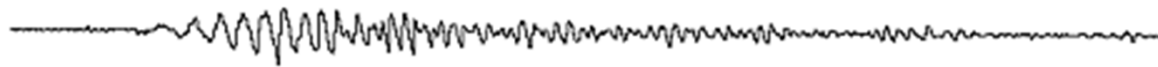


- Searching for global observations of the 1952 earthquake from ISC Bulletin
- Figuring out whether each station has the seismograms of the event or not
- Collecting information on the type of seismograph and paper, and recording parameters during the earthquake

III. Obtainment of analog seismograms and digital conversion



Example of the
analog seismograms



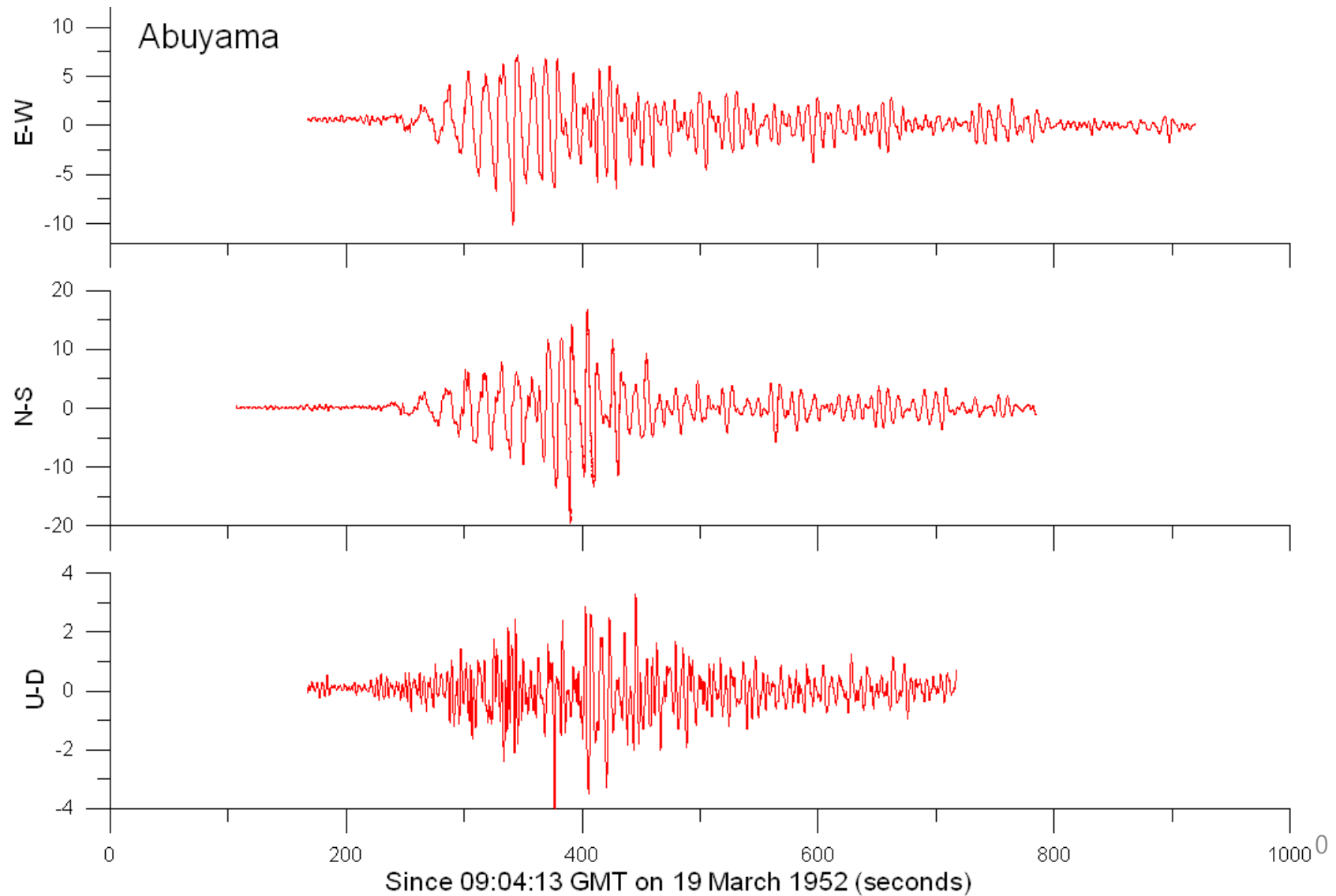
Digitization

- Obtainment of the analog seismograms of the 1952 earthquake from the eight seismograph stations in the neighborhood countries
 - Japan: Abuyama, Matsushiro, Mizusawa seismograph stations
 - China: Zikawei, Nanking seismograph stations
 - Russia: Vladivostok, Sverdlovsk, Pulkovo seismograph stations
- Digital conversion to extract seismic traces from the images of analog seismograms

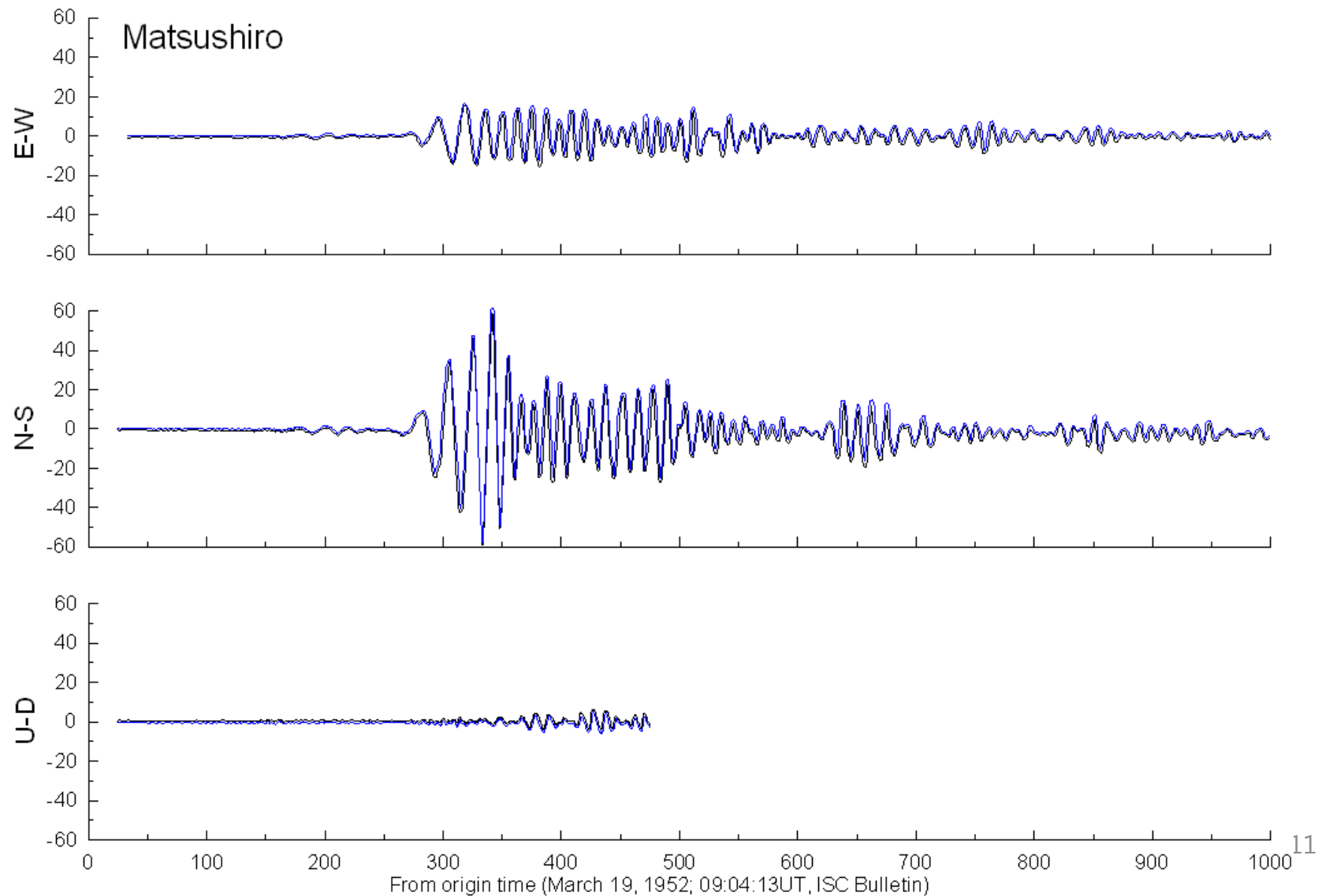
Analog-to-digital conversion

- Extraction of seismic traces from the image of analog seismograms: Teseo software (Pintore et al. 2005)
- Difficulties in digitizing the raw seismograms: low resolution, bad continuity of seismic trace
- Successful digitization of the analog seismograms from the Abuyama, Matsushiro, and Sverdlovsk seismograph stations among a total of the eight stations
- Correction of instrumental response and geometry
 - Instrumental responses of the three stations
 - Lack of information on the geometry of instruments: arm length supporting pen of the recording system, angle between pen and paper
 - Hard to correct the recording curvature of the analog seismograms
 - Implicit errors in the analysis of seismic source parameters through waveform modeling

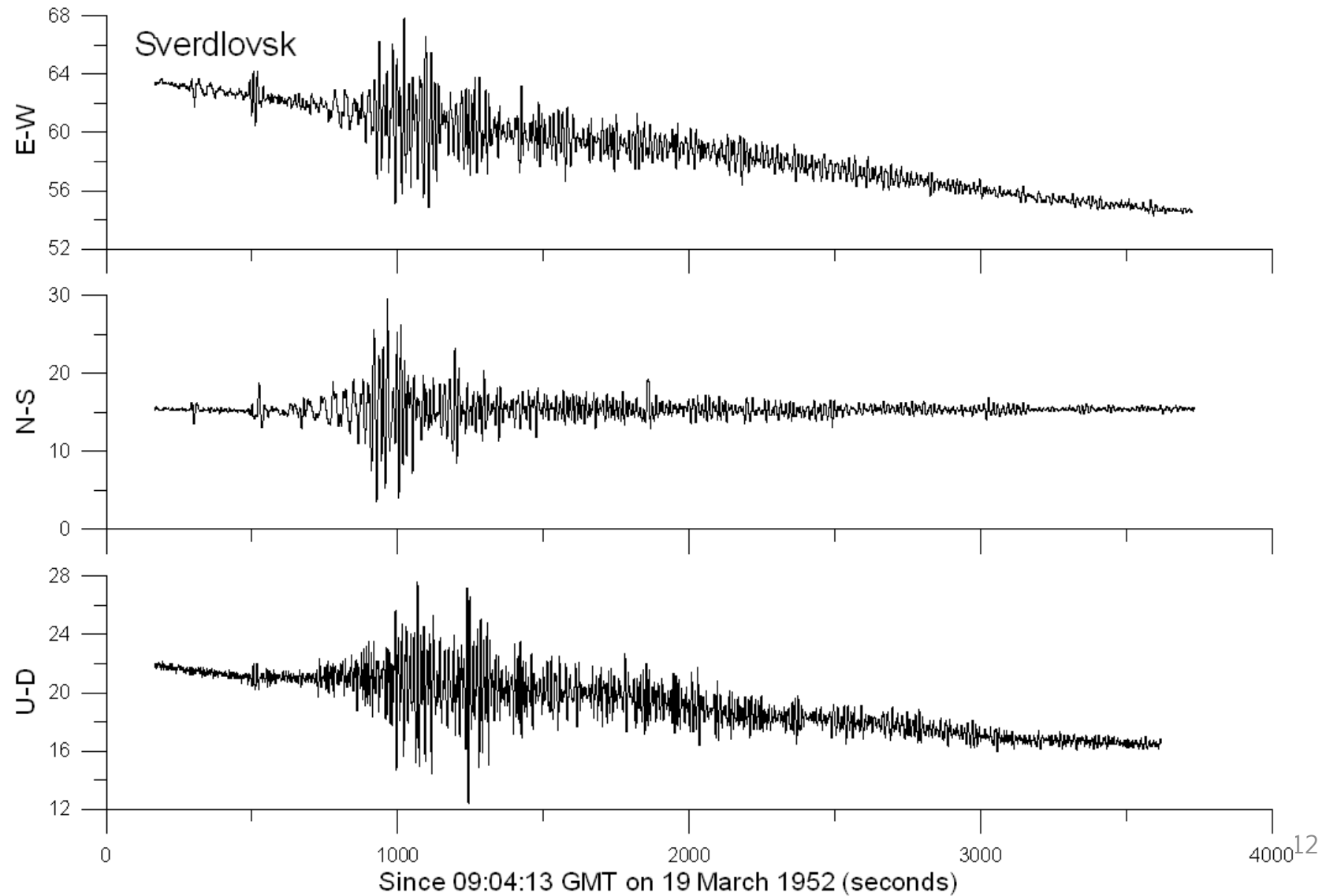
Abuyama



Matsushiro

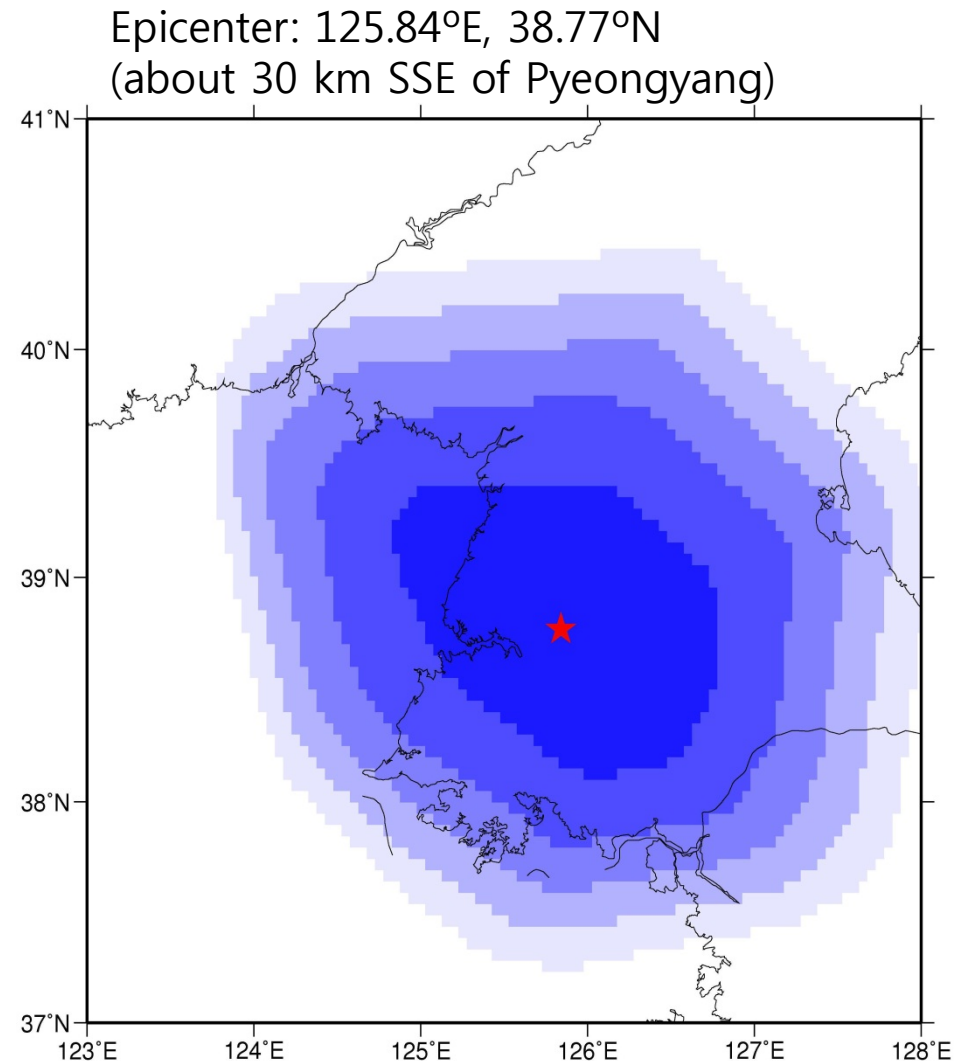


Sverdlovsk



IV. Source parameters of the 1952 earthquake

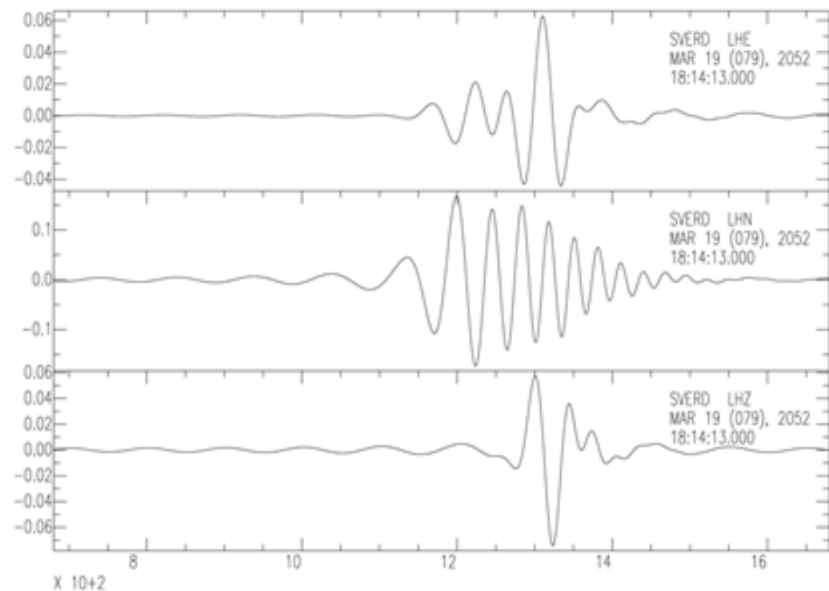
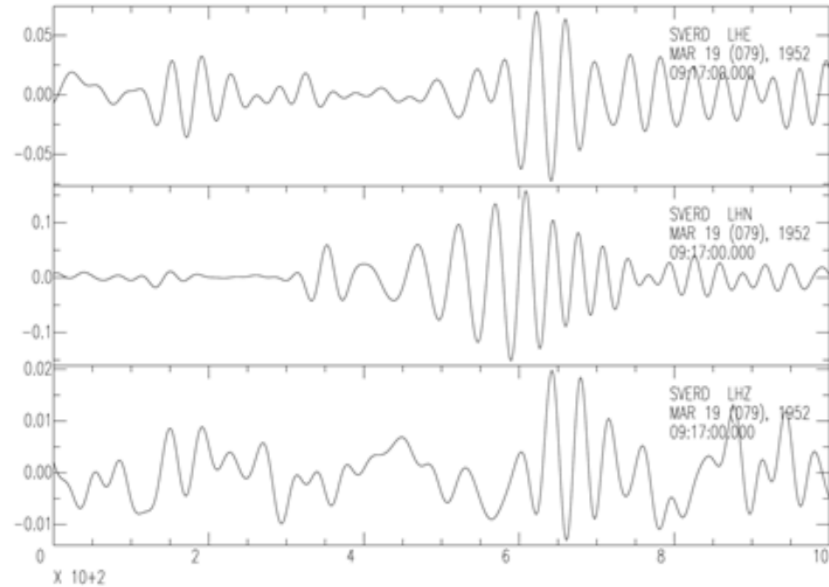
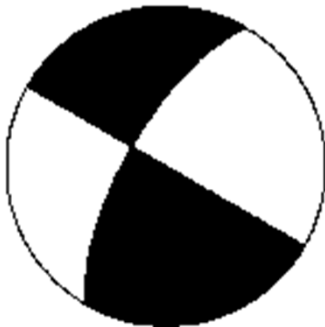
- Arrival times
 - ISC Bulletin
 - Travel-time report from Japanese seismograph stations
- Determination of epicenter using grid-search method based on travel-time data
- Determination of origin time from Wadati diagram using travel-time data: 1952/03/19-18:04:15(local time)



IV. 파형모델링

- Synthetic seismograms: Mineos (Masters et al. 2007)
- Depth: 10 km fixed
- Velocity structure: PREM model
- Lowpass filter < 10 s
- Waveform fitting on one-cycle swing including the largest peak
- Seismic moment
 - 2.45×10^{25} dyne-cm ($M_w = 6.17$)
- Fault-plane solutions
 - Strike 120° , dip 90° , rake 340°
 - Strike 210° , dip 70° , rake -180°
 - NE-SW and NW-SE strike-slip fault

Strike 120 Dip 90 Slip 340



V. Summary on the source parameters of the 1952 earthquake

- Origin time: 1952/03/19, 18:04:15 (local time)
- Epicenter: 125.84°E, 38.77°N (near Pyeongyang)
- Magnitude: Mw 6.2
- Fault plane solutions (strike, dip, rake)
 - (120°, 90°, 340°)/(210°, 70°, -180°)
 - NE-SW and NW-SE strike-slip fault

[postscript]

- This is on-going project.
- More data would be highly helpful for upgrading the quality of the source parameters.
- Thus, if you have any connection on seismograph stations which were operated in 1952, we would appreciate it if you inform me of it.