Study on Earthquake Prediction by Geophysical Method

Abstract

In 1979, the Tokai District and its neighbouring area was designated as an "Area under Intensified Measures against Earthquake Disaster" on the basis of the "Large-Scale Earthquake Countermeasures Act". The Japan Meteorological Agency (JMA) is responsible for the short-term prediction of a large-scale earthquake which may take place in the area.

The JMA has developed various real-time systems for monitoring changes in seismic activities and detecting tectonic precursors. In 1979, responsibilities for gathering other data such as groundwater, radon, and ground tilt were transfered from other governmental institutions to the JMA. This has required the JMA to install a new real-time system for routinely processing these various telemetered data, in order to detect anomalous changes which make it possible to discriminate precursory evidence from noise.

Under the circumstances, development of a real-time system for monitoring seismic activities and fundamental researches on the discrimination of precursory phenomena were carried out by the Meteorological Research Institute (MRI) of the JMA, as one of the major items of the fourth Five-Year Plan of the National Program of Earthquake Prediction Research in Japan (1979-1983).

The following is the summary of the results obtained by the project research :

In chapter 1 are stated the position of the research, the necessity of the development of a new system, and the technical know-how which will be used in the development of a new system.

The design of the comprehensive real-time system for processing various telemetered data and for detecting unusual variation in seismic activities and crustal movement are described in Chapter 2. Earthquake prediction as a routine service in the JMA requires the real-time evaluation of changes in seismic activities and other geophysical and geochmical phenomena. Furthermore, it is necessary to discriminate precursory changes from noise by the diagnosis procedures accumulated in the past.

In view of the situation, two different systems were designed, one consisting of a rather large computer and another of many microprocessors. In the report are fully explained the processes through which hard- and software were designed and results obtained by the test run

using the systems. Moreover, detailed descriptions are also given on some problems revealed by the test run and on the fundamental conception for designing a comprehensive system for routine service in the JMA.

In Chapter 3 are described the researches conducted on an automatic extraction of arrivals of P and S waves on a digital seismogram. Fundamental problems in discriminating signal from noise are examined on the conventional procedures as well as the present one developed on the basis of the Bayes method in statistics.

The orientation of the epicenter as well as the phase extraction is one of the merits in the present method. A computer program, which was written on the basis of the developed algorithm, was applied to many seismograms. The test was successful, showing remarkable improvement on the old method in accuracy of the arrival time of P and S waves.

In Chapter 4 is reviewed the automatic processing of digital seismograms by various computers and microprocessors. Particularly the microprocessors used in the existing system for processing digital data such as earthquakes and the crustal movement in the JMA were carefully examined. In view of the merits and demerits of each system examined, a microprocessor system was designed.

In Chapter 5 are given results obtained by simplified bubble tube type tiltmeters. The observation of crustal movement was carried out at Irako and Owase in central and southwestern Honshu during the period from 1979 to 1984. The observation has made it clear that the crustal movement was considerably influenced by precipitations, but no significant change in the crustal movement related with earthquake occurrence was detected. The influence of rainfall on the crustal movement suggests that the study on relationship between local crustal movement and rainfall is required in detecting a weak crustal movement prior to earthquake occurrence.

In Chapter 6 are described researches on various precursory phenomena associated with large earthquakes. Particularly, the crustal movement, geoelectric and geomagnetic anomalous phenomena and seismicity in the Tokai District were studied. Furthermore, foreshocks associated with large earthquakes occurring in Japan and its vicinity were studied. The following are the results obtained :

i) By tidal observations in the Tokai District, the land subsidence and changes in the subsidence rate at Omaezaki and its vicinity were verified.

ii) Relation between anomaly in geopotential and earthquakes was studied using the ocean-bottom seismograph system installed off the coast of Omaezaki, central Honshu.

iii) Though there exists a seismic gap for events of magnitude 4 and larger in the focal region of the Tokai District, where the occurrence of a large earthquake has been anticipated, many micro-and small earthqukes have occurred in the gap area. The relation between seismic activity and occurrence of a large earthquake in the gap area was studied.

iv) Statistical studies on many foreshock activities associated with large earthquakes indicate that useful information will be obtained from the magnitude-time sequence and pattern of the magnitude frequency relationship as well as the b value of the magnitude-frequency.