Summary

This is a comprehensive report titled "Study on stress field and forecast of seismic activity in the Kanto Region", conducted from fiscal 1994 to 1998 by the Seismology and Volcanology Research Department, MRI, as a special research project. This study consists of three subjects,

1) The objective evaluation and forecast of seismicity,

2) A database for seismic processes and crustal activities, and

3) Kinematic modeling for estimating crustal activities.

The results are summarized in the six chapters in this report.

Chapter 1 details a study on objectively evaluating and forecasting seismicity. We adopted a method to evaluate seismicity objectively and quantitatively, applied it to the Kanto region, and succeeded in detecting seismicity change before the earthquake off the east coast of Chiba prefecture in 1987 (M=6.7). We also found a periodic change of seismicity, of about 10 years, in south-west Ibaraki prefecture, one of the most active regular seismicity areas in the Kanto region. This characteristic can be considered valid for the long-term prediction of large earthquakes in this region because such a periodic change in seismicity is considered to be related to the plate motion fluctuation. The other important topic covers the characteristics of foreshocks, which has long been a key issue in earthquake prediction. It is been well known that many earthquakes in the Izu region have been accompanied by active foreshocks. By using the seismicity data in this region, we developed an empirical discrimination method of the foreshocks, focusing on the spatial and temporal concentration of seismicity, and studied the forecast of the main shock in a probabilistic manner. We then applied this method to the events accompanied by active foreshocks in the Izu region, and clarified that in most cases except volcanic origin events and swarms, foreshock activities showed quiescence just before the main events. We also found that the temporal variation of foreshock frequency can be approximated by the inverse power law of time, by stacking many foreshock activities.

Chapter 2 reports the results of strong ground motion observations in the Kanto region. Source process effect, attenuation along the propagation path, and amplification near the site are decomposed from the observed record by inversion, and some characteristics are studied. We also developed a tool to determine the seismic moment and fault parameters of small earthquakes from the seismogram, and enabled the estimation of those parameters for events with M_w down to 3.4.

Chapter 3 presents the source processes of the 1894 Tokyo earthquake and the 1921 Ryugasaki earthquake, which both caused significant damage to the Kanto region, estimated from old seismograms surviving to date. In addition, the tectonic characteristics of those events are discussed taking the plate structure and seismicity into account.

Chapter 4 explains the seismic data telemetry system via communication satellite. This system was installed to collect seismic waveform data from all over Japan for the studies relevant to this project. Chapter 4 also explains the database creation system. We developed a method to determine earthquake mechanism solutions by using broadband seismograms collected by this system.

Chapter 5 discusses the recent crustal deformation of the Kanto region estimated from the strain, GPS and tide gauge observation. We created a CD-ROM database of volume strain data in the Kanto and Tokai regions with an original sampling rate, and developed a tool to extract a seismic waveform and compare it with the synthetic waveform, enabling the in situ calibration of the strainmeter by using the seismic responses. We also analyzed recent data of the Double Coaxial Strainmeter in Odawara, and found that the precipitation effect can be considerably reduced by combining upper and lower data, and that the lower data records the representative strain field of this area. We have been conducting continuous GPS observations at tide gauge stations of JMA in the south Kanto region. Precise baseline analysis revealed that the vertical change of the relative displacement can be detected within an accuracy of a few millimeters by using monthly averaged results, and that the vertical crustal movement deduced from tide gauge observation is consistent with GPS observation, both of which indicate a relative movement between the south end of the Boso peninsula and Izu Oshima.

Chapter 6, the final chapter, covers a study on kinematic modeling for estimating crustal activities. This chapter reports on a theoretical approach in forecasting crustal activities. We showed that the Coulomb's failure function (CFF) value, which represents a stress change in a surrounding area due to an earthquake occurrence, is valid for predicting the focal area of the next earthquake invoked by a preceding one. We proposed a new tectonic model of the south Kanto region based on the spatial distribution of the earthquakes occurring in the crust in this region. We also created a prototype finite element model of the very complicated underground plate structure of the south Kanto region. Using this kinematic model, we studied the stress and strain field change by the subduction of the plate or the occurrence of inter-plate earthquakes in a three-dimensionally heterogeneous medium.