2000 Tottori-ken Seibu earthquake and relating heterogeneous structures

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Heterogeneous structures relating to the 2000 Tottoriken Seibu earthquake of M7.3(JMA) are studied from viewpoint of large scale of tectonics to small scale of source area. Variations in the thickness of the seismogenic layer is derived for the heterogeneous structure of large scale. Earthquake data from JUNEC (Japan University Network Earthquake Catalogue) and Kyoto University were used to make the thickness distribution of seismogenic layer. Small scale heterogeneity is discussed from parameters of b in frequency-magnitude relation and p in decay rate of aftershocks and detailed distribution of hypocenters together with the hypocenters of swarm-like precursory seismic activities. The parameters b and p are determined for the source area from catalogues of JMA and Kyoto University.

For the large scale of heterogeneity, the 2000 Tottori-ken Seibu earthquake occurred in the changing area of east-west directed eastern Chugoku district and northeast-southwest directed western Chugoku district. The lateral change in the thickness of the seismogenic layer seems to relate to the occurrence of large inland earthquakes. In this sense, the source area is characterized by relatively thick seismogenic layer. In addition, the heterogeneity seems to be strongly correlated with thermal structure.

Smaller scale heterogeneity of the thickness of the seismogenic layer is not so clear, but it seems to change in the source region. The aftershock area is divided into two portions; aftershocks occur on a thin plane in the southeastern part of the main shock, while on several planes in a rather broad zone in the northwestern part. In the southwest portion, the slip of the main shock is large and moderate sized shocks of M about5 repeated in 1989, 1991 and 1997. The variation seems to relate to the rupture process of the main shock and aftershock activity. Beside, at very close to the area there is a zone of low-frequency earthquakes at depth of about 30km. This suggests deep activity of pressurized fluid. The rupture of the main shock started at the northern end of the precursory shocks. This different from most of other inland earthquakes, of which rupture starts at the base of the seimogenic layer.

In general, the values b and p are larger in the southwestern part compare to the northwestern part of the aftershock area. Relatively large b and p values are found in areas that experienced previous repeated swarm-like seismic activity and large slip during the main shock. Crustal heterogeneous structures seem to bring such different rupture process described above and different parameter values. Some physical explanations are possible for the higher values of b. It can be assumed that in the areas of large slip during the main shock and previous repeated seismic activities, the stress dropped significantly. On the other hand, in the areas with relatively low b value, higher shear stress is probably applied after the main shock. According to the Coulomb failure criterion (CFF) analysis both ends of the aftershock area have an increased stress due to the main shock. Alternatively, it can be hypothesized that the areas of repeated slip are more fractured and are favoring higher b-values. As for p values, they are also large in the area of previous events. The heterogeneity of the crust may be related to the spatial variability of p-value. In detail, the highs and lows of spatial variations in b and p show patches of about 3km in diameter. This size corresponds to the rupture area of about M5 event. There may be unit of heterogeneity of this size in this area. Many M5 shocks occurred in this region.

Thus, analyses of heterogeneous structure in the source area of large inland earthquakes are very important to derive a definite knowledge of the nucleation of earthquakes. Various kinds of crustal structure should be surveyed including thermal state of the area.