論文内容の要旨

Spatial distribution of shallow crustal earthquakes and a source region of a large earthquake

浅発地震の空間分布と大地震の発生域

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The Gutenberg and Richter relationship (herein referred to as the G-R relationship) log N=a-bM, where N is the number of events with magnitude above M and a and b are constant, has been used for describing regional seismicity. On the other hand, a number of studies have reported that the G-R relationship does not hold for seismicity around active faults and interplate earthquake source region. Magnitude frequency distribution (referred to as MFD) for such active faults and source region of interplate earthquake is consistent with the Characteristic Earthquake Model (herein, referred to C.E. Model), which is characterized by a magnitude gap between the characteristic events and the other earthquakes. When we discuss about the repeating earthquake occurrence, whether the size and recurrence interval along arbitrary active fault is characteristic or non-characteristic (random), gives us one important suggestion for the possibility of earthquake prediction.

In chapter two, I examine whether the MFD along the major 98 fault systems obeys the G-R relationship or the CE Model from the geological data obtained by the Headquarters for Earthquake Research Promotion (HERP) and Japan Meteorology Agency (JMA) unified catalogue. Interval of instrumental records is fundamentally too short from the comparison with average recurrence interval of active faults because the average recurrence interval of active faults is basically from thousand to ten thousands years. Hence, I examine the shape of MFD by combining instrumental records and geological data. As a result, the number of observed events is significantly smaller than the number of expected events by the G-R relationship for almost active faults. The major 98 fault systems are thought to be various stages during its earthquake cycle. In such cases, the lack of seismicity must be filled by aftershocks of characteristic earthquake or some anomalously high episodic seismicity, if the G-R relationship holds during one earthquake cycle. However an analysis of Tanna-Fault including the 1930 Kita-Izu earthquake (M=7.3), which is thought to be characteristic earthquake, shows that the number of observed events is too small to fill the gap. Moreover, I indicate that the cumulative number of aftershocks during one earthquake cycle has little influences on this result. Taking these results under consideration, the CE Model is appropriate MFD along active faults rather than the G-R relationship. I also show that there is tendency that the larger an average slip rate is, or the shorter average recurrence interval becomes, the larger the magnitude gap becomes and interpret this trend as fault maturing or simplification caused by numerous earthquake cycles.

In chapter three, I change the subject from late Quaternary active faults to interplate source regions and also examined the shape of MFD in and around it. The earthquake detection capability and accuracy of hypocenter location is much lower. Observation stations concentrate on land and detection ability in sea region is inferior to that on land. However, while the average recurrence interval of active faults is about 1000 years to 10000 years in general, that of interplate earthquake is from several tens of years to several hundreds of years. Therefore, we examine the shape of MFD from more portion of earthquake cycle. Seismicity of all the nine interplate source regions i.e. regions off Shikotan Island, off Nemuro, off Tokachi, off Northern Sanriku, off Miyagi, and far off Miyagi, Tonankai, Nankai, and Taisho-Kanto regions, show that the number of observed events is much less than the number of expected events estimated from the Gutenberg-Richter (G-R) relationship and the occurrence rate of the characteristic earthquake. In off Tokachi region, the 1952 Tokachi-Oki earthquake and the 2003 Tokachi-Oki earthquake occurred in the same area. Hence, we can extract whole one earthquake cycle from JMA catalogue interval. The obtained MFD during one cycle indicates that magnitude gap 1.1 between the maximum-sized earthquake and the other events exists and the MFD is remarkably close to the CE Model rather than the G-R relationship.

Seismogenic layer is thought to be important parameter to prescribe the extent of source region in depth. It is reported that historical crustal large earthquakes and distribution of Quaternary active faults correlate with regional variation of seismogenic layer. These reports suggest the possibility to obtain some foresight information against the earthquake occurrence of future crustal large earthquakes from it. In Chapter four, I discuss the regional variation of the structure of seismogenic layer estimated by the spatial distribution of crustal earthquakes. As was pointed out in previous studies, I will show that the shallower and the deeper limits of crustal earthquakes become shallower near the active or Quaternary volcanoes. I will also show that the structure of the seismogenic layer is well correlated with the Curie-point depth, thermal gradient, and the crustal heat flow, and is strongly controlled by the thermal structure of the crust, as indicated by the previous studies. Neither the active faults nor large historical earthquakes will be found to spatially correlate with the horizontal gradient of the seismogenic-layer structure

In chapter five, I map the regional change of *b*-value of the G-R relationship and correlate the *b*-value with the thickness of seismogenic layer estimated by crustal earthquakes. The *b*-value of the G-R relationship decreases as the thickness of seismogenic layer becomes large and historical crustal large earthquakes seem to have occurred where the thickness of seismogenic layer is large, rather than where the horizontal variation of the maximum depth of crustal large earthquakes is large.