論文の内容の要旨

Reexamination of Great Earthquakes along the Japan Trench Based on Geological Analysis and Numerical Modeling for Tsunami Deposits
（津波堆積物の地質学的分析及び数値モデリングに基づいた日本海溝沿いの巨大地震の再検討）

氏　名　　楠本　聡

In this thesis, the M9-class great earthquakes that have occurred along the Japan Trench, especially the 869 Jogan earthquake, are reexamined using a geological analysis of tsunami deposits and numerical modeling of tsunami sediment transportation.

Chapter 1 summarizes the world's earthquakes that have caused large tsunamis, as well as the history, current status, limitations of tsunami deposit studies, and tsunami sediment transport modeling. Chapter 2 summarizes the great earthquakes along the Japan Trench, previous studies of them, and the sedimentary environment and previous studies of three study sites (Idagawa lowland, Minami-Soma City in Fukushima Prefecture, the Sendai plain in Miyagi Prefecture, and the Numanohama marsh, Miyako City in Iwate Prefecture). In this study, both a geological survey and sediment transport modeling were performed for at the Idagawa lowland, and the modeling results were compared with previous geological surveys for the Sendai plain and Numanohama marsh.

Chapter 3 summarizes the methods (i.e., sedimentological analysis, microfossil and diatom analysis, radiocarbon dating, Bayesian age-depth model for depositional ages, and recurrence intervals of event deposits) for the tsunami deposit surveys. After that, the methodology for the hydrodynamic sediment transport modeling is described in detail. The sediment transport modeling is a method of solving the equations of continuity in the suspended load and bedload layers and the exchange rate between these layers. This method considers a single grain size, but the present study applied it to multiple-sized sand particles. Three representative diameters were selected based on a grain size distribution measured from tsunami deposits and modeling performed after estimating model parameters. Tsunami reduction due to the effect of coastal forest is also modeled and verified.

Chapter 4 summarizes the results of tsunami deposit surveys at the Idagawa lowland. Seven sandy event layers from the past 3800 years were identified. Based on the sedimentological structure of the event deposits and diatom assemblages above and below event deposits, five of them were judged as being caused by tsunamis, and the others by storm surges. The average recurrence interval for the tsunamis was 560-950 years, and the depositional age of the second event layer was constrained between AD 800 and AD 1310. Thus it might correspond to the 869 Jogan tsunami deposits. Two storm deposits were also formed just after the tsunami events (<200 years) and the sediment environment inferred from diatom assemblages was a marine to brackish inner bay or lagoon. Therefore the large tsunamis might have collapsed a sand dune and the lagoon or mudflats were more susceptible to storm impacts before the redevelopment of the dune.

Chapter 5 summarizes the results of the two-dimensional tsunami inundation simulation and the one-dimensional sediment transport modeling applied to the 2011 Tohoku tsunami deposits at the Idagawa lowland, Sendai plain, and Numanohama marsh. Eleven scenarios with variable slip amounts and distributions based on previous models were prepared and the results were compared with the observations. Regarding the Idagawa lowland and Sendai plain, the results from previous model well matched with the observations by considering tsunami reduction due to coastal forest. Conversely, the results were not able to reproduce the observations of the Numanohama marsh, probably because the tsunami deposit was coarser than those of the Idagwa lowland and the Sendai plain. In addition to the effects of coastal forest, the effects of duration of the sediment transport modeling, water depth at the offshore boundary and model parameters (i.e., coefficients of bedload and pick-up rates) are also examined and the model validity, sensitivity, and accuracy of estimating the source model of an earthquake from tsunami deposit data is discussed.

Chapter 6 summarizes the estimated magnitude and source location of the 869 Jogan earthquake derived from the tsunami inundation simulation and sediment transport modeling to the tsunami deposits at the Idagawa lowland and the Sendai plain. The results from models with a large slip area off Miyagi Prefecture reproduced the observations. Thus, it is concluded that the 869 Jogan earthquake was an M9-class giant earthquake, but the magnitude and fault length was slightly smaller than the 2011 Tohoku earthquake.

Chapter 7 presents the conclusions for this thesis. The recurrence interval for giant earthquakes along the Japan Trench and the limitations of evaluating earthquakes from tsunami deposits and numerical simulation are discussed.