Tsunami Depositional Sequence Model in Shallow Bay Sediments -An Example from Holocene Drowned Valleys on the Southern Boso Peninsula, Eastern Japan-

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Abstract

Tsunami deposits are indicators of great submarine earthquakes that cannot be decoded from historical earthquake records over the long-term. Accurate ^{14}C age determination, discrimination of tsunami deposits from storm deposits and estimation of the source area of tsunamis are fundamental problems for accurate recurrence-interval analyses using ancient tsunami deposits.

Firstly, in this study, ^{14}C dating, ecological and taphonomic criteria on sample selection are discussed. "True" ages of tsunami deposits are expected from the dating of indigenous and fresh shells ecologically compatible with the depositional environment of the host rocks.

Secondly, a "Tsunami depositional sequence model" which identifies the tsunami deposit is proposed for a Holocene buried valley on the southwestern Boso Peninsula, based on depositional structures, high-resolution grain-size analyses and the taphonomy of molluscan shells. This model consists of a stack of depositional units Tna to Tnd which are used to decode the tsunami waveform. A typical tsunami has a wave period that is at least 100-times longer than those of storm waves, and includes remarkable edge waves in its middle stage resulting from the reflection of long waves on the continental shelves.

A very long wave period of the Holocene tsunami is evidenced by an alternation of hummocky cross-stratified sand units including traction

carpet and/or transport lag and mud drapes in Unit Tnb that make up the main part of the tsunami deposit. This cycling of sedimentary structures show repeated arrivals of high-density currents combined with long stagnant stages permitting the deposition of mud drapes. This cyclic structure cannot be explained by storm waves with several to 10-second wave periods, whereas tsunamis with 10-minute-order wave periods can form such structures in a small bay.

Diachrony of wave size (time series of wave energy in a wave train) is recorded as a stacking pattern of four units. Unit Tna which is composed of relative fine-grained sediments includes abundant rip-up clasts and is attributed to the early stage of a tsunami. Unit Tnb makes up the coarsest part and is attributed to larger waves in the middle stage of a tsunami. The coarsest subunits in the middle part of the unit including abundant shells and outsized clasts are thought to be formed by the largest of the succeeding waves, *i.e.* edge waves. Unit Tnc consists of an alternation of finer and thinner laminae than those of Unit Tnb, and is attributed to relatively small waves in the later stage of a tsunami. Unit Tnd is composed of a silt bed intercalating wood and plant-fragment layers, and interpreted as the subsequent foundering of wood and plant debris after a tsunami.

The cyclical occurrence of lenticular shell beds with high-species-diversity draped by muddy sand layers in the tsunami deposits also indicates the repetition of shell-concentration stages by winnowing and long wave stagnant stages. Deep sea molluscs yielded in the tsunami deposits evidence the high-energy and long-period tsunami currents.

Finally, source areas of the tsunami in the study area were inferred from correlation with tsunami propagation routes. Great plate boundary earthquakes around the northeastern margin of the Philippine Sea Plate are a probable source of these tsunamis, considering the shield effects of Boso

Peninsula to tsunami propagation. Based on a trial calculation of great tsunami potential around the sea area using the tsunami deposits, the recurrence rate of great tsunami is estimated as one every 100-300 years.

Keywords: ^{14}C dating, Depositional model, Grain-size distribution, Holocene, Sedimentary structure, Taphonomy, Tsunami deposit