Modern and geohistorical tsunamiites

T. Shiki, T. Tachibana, Y. Tsuji, T. Haraguchi, O. Fujiwara, and T. Yamazaki

1. Introduction

Two different types of tsunamiites develop near Nagoya, central Japan (Fig.1-1). The Miocene upper bathyal conglomeratic tsunamiites crop out at Tsubutegaura, Cita Peninsula. And, a number of historical tsunamis which surged on-land are well recorded in the coastal lake and beach deposits in Ise-Shima district and the area around Lake Hamana. Comparative studies of these tsunami-induced deposits provide significant information to make clear the features of tsunamis and to examine tsunami disaster prevention problems.

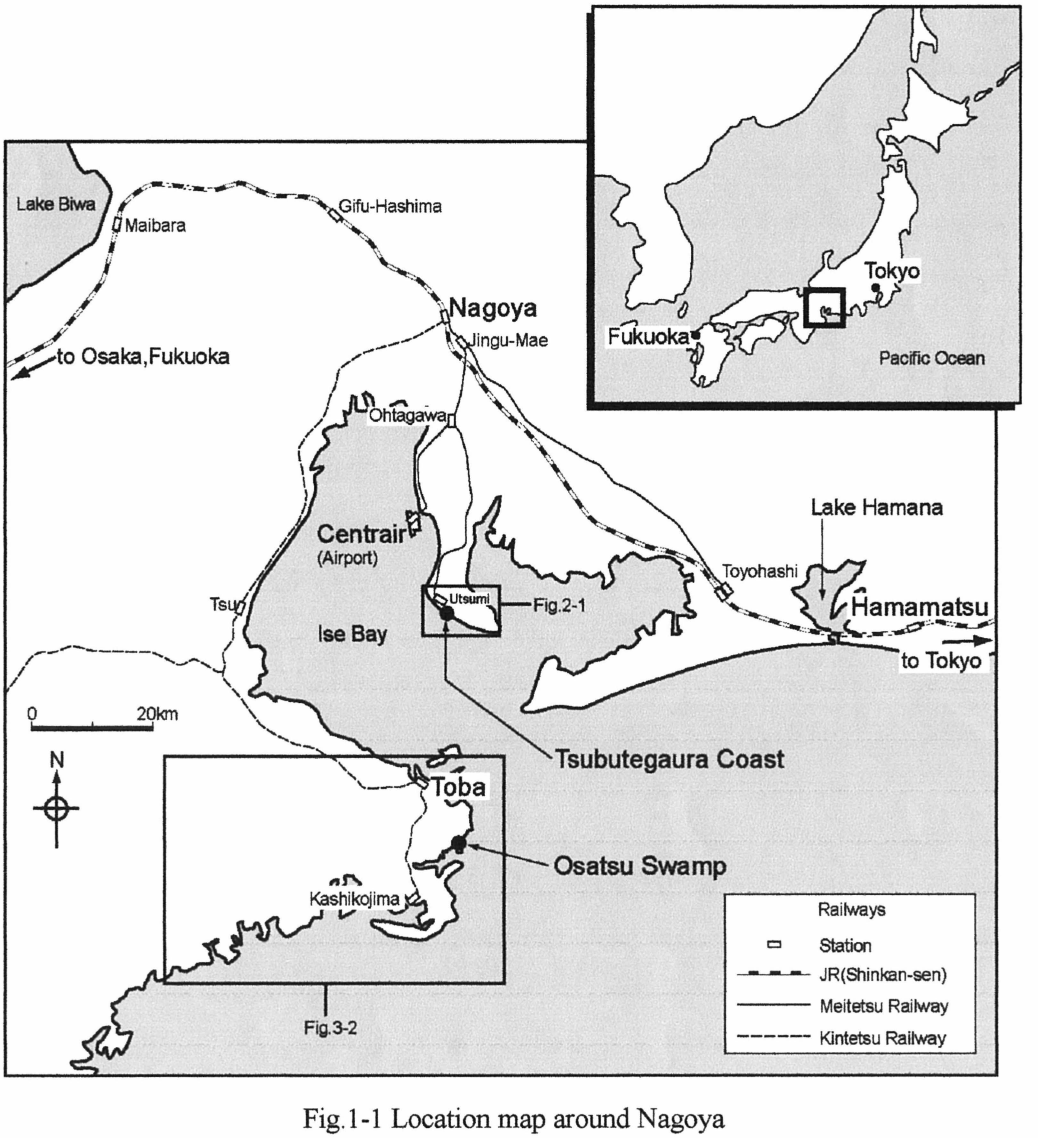

Fig.1-1 Location map around Nagoya

2. Tsubutegaura tsunamiites

Tsubutegaura is situated in the western coast of Chita Peninsula at a distance of 50km from Nagoya City. The Miocene tsunamiites accompanied with seismites occur in the middle section of the Miocene storm-induced sand-silt alternation system which developed over the southern half of the peninsula (Fig.2-1, 2-2 and 2-3). The upper bathyal depositional environment of the system including the middle section has been clarified based on various kinds of fossils (Yamazaki et al., 1989).

The most marked sediments of the tsunamiites are conglomeratic bodies with gigantic boulders which attain up to a few meters in size (Fig. 2-4). Sedimentary features of some conglomerate bodies such as boulder cluster (Fig. 2-5) and imbrication of cobbles (Fig. 2-6) show evidence of transportation by water movement of a tractive current nature. A number of tsunamiite sandstone layers are also distributed in the area alternated with back ground fine-grained sediments (Fig. 2-7). Occurrence of soft fine-grained rip-up clasts and fossils of feasible body such as starfish reveal the nature of tsunami water movement (Shiki and Yamazaki, 1996).

Three kinds of dykes are well observed in the Tsubutegaura field. The component sediments of two relatively big dyke systems fill ruptures of conjugate faults. One is conglomeratic. And the other is sandy. Dykes of another type evidently intrude from underlying sand layers liquefied by earthquakes. A number of small dykes which have been reported as diastasis cracks are of rupture origin although their real genetic mechanism is still under discussion.

The collapse of a submarine fault scarp by faulting, falls of rocks and generation of some weak hyperpycnal flow with the rock fragments of various sizes, as well as transportation of the fragments in the flow overlapped by the effect of tsunami energy, followed by the ensuing wash by pulses of tsunami-induced currents are the depositional scenario for the generation of the conglomeratic tsunamiite bodies. This scenario was supported by the recent hydro-dynamical studies by Tachibana (in preparation). As for the sandy tsunamiite layers, transportation by ebb currents from beach is very likely. The sign of frequency change of seismic activity and tsunami genesis during the time period of geohistorical scale is new and interesting sedimentological information which is hard to obtain in the Modern sediments because of limited survey method.

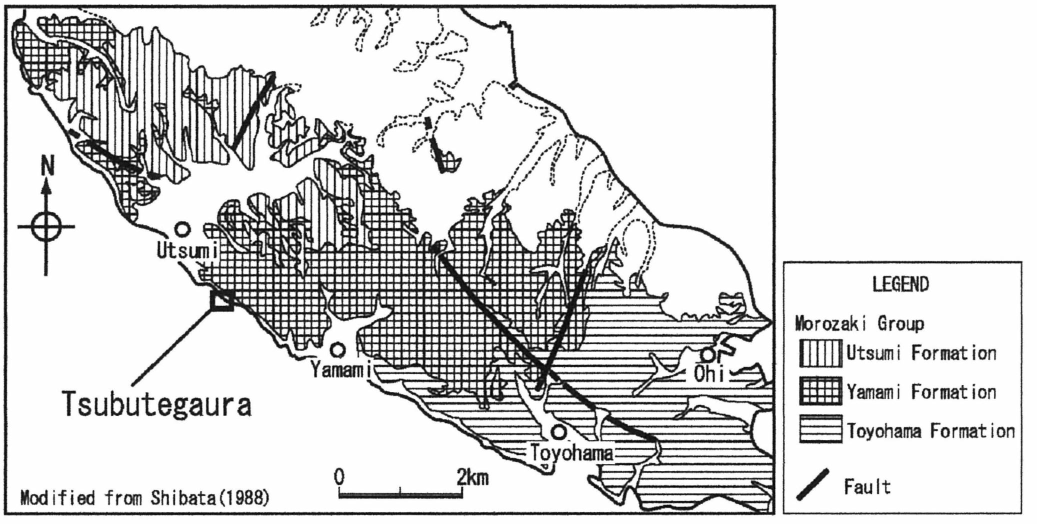

Fig. 2-1 A geological map of the Miocene formations in the Chita Peninsula.

Fig. 2-2 View of lined several conglomerate bodies and overlying sandy alternation. The conglomerates, named "Tubutegaura conglomerates" occur along the Tubutegaura beach over a distance of about 150 meters and form many hemi-lenticular or bunch-shaped bodies 10 to 50 meters across and a few meters high.

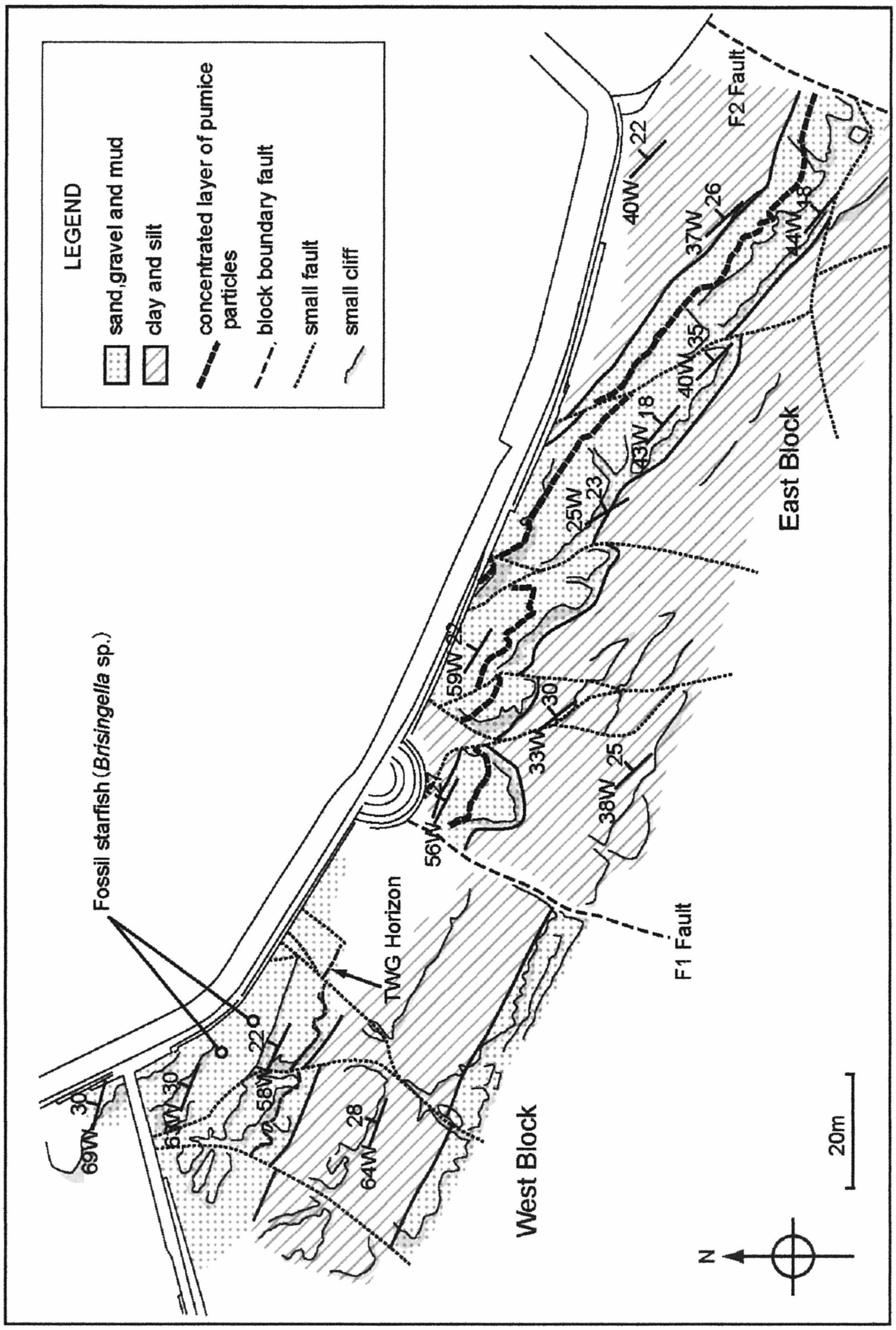

Fig. 2-3 Geological map showing distribution of the coarse-grained facies dominated divisions (dotted) in which tsunamiite layers are developed, and a fine-grained back ground sediments dominated division (shadowed by inclined lines). Tuffaceous key beds, location of fossil starfish occurrence are also indicated.

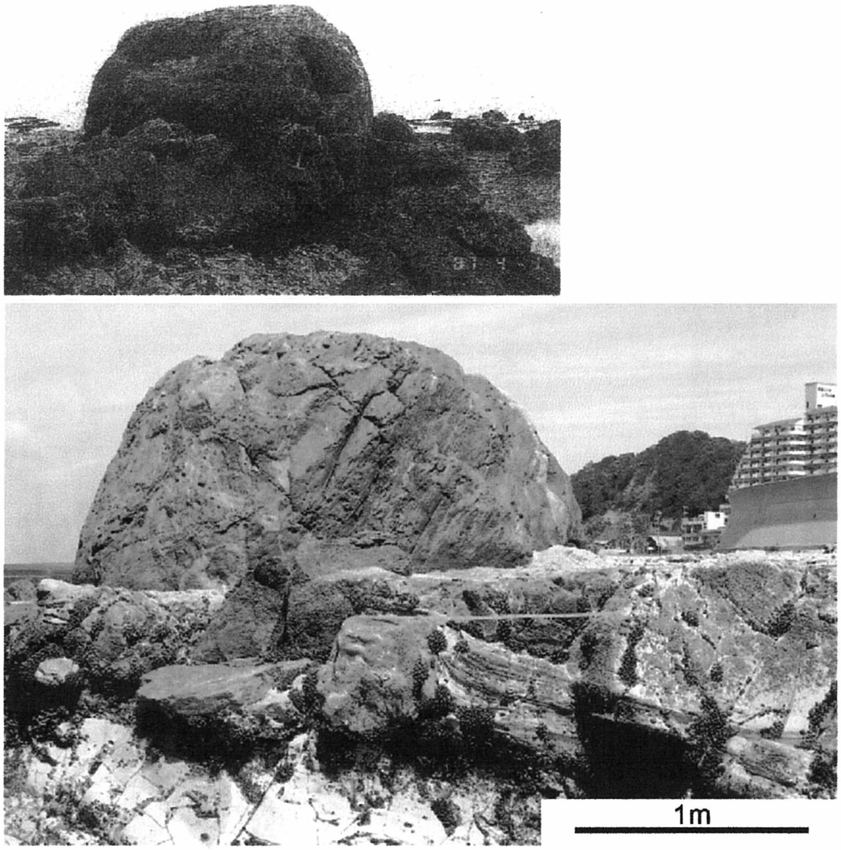

Fig. 2-4 The largest and exceptionally rounded boulder in a conglomerate body sticking out into the overlying tuffaceous sandstone layer.

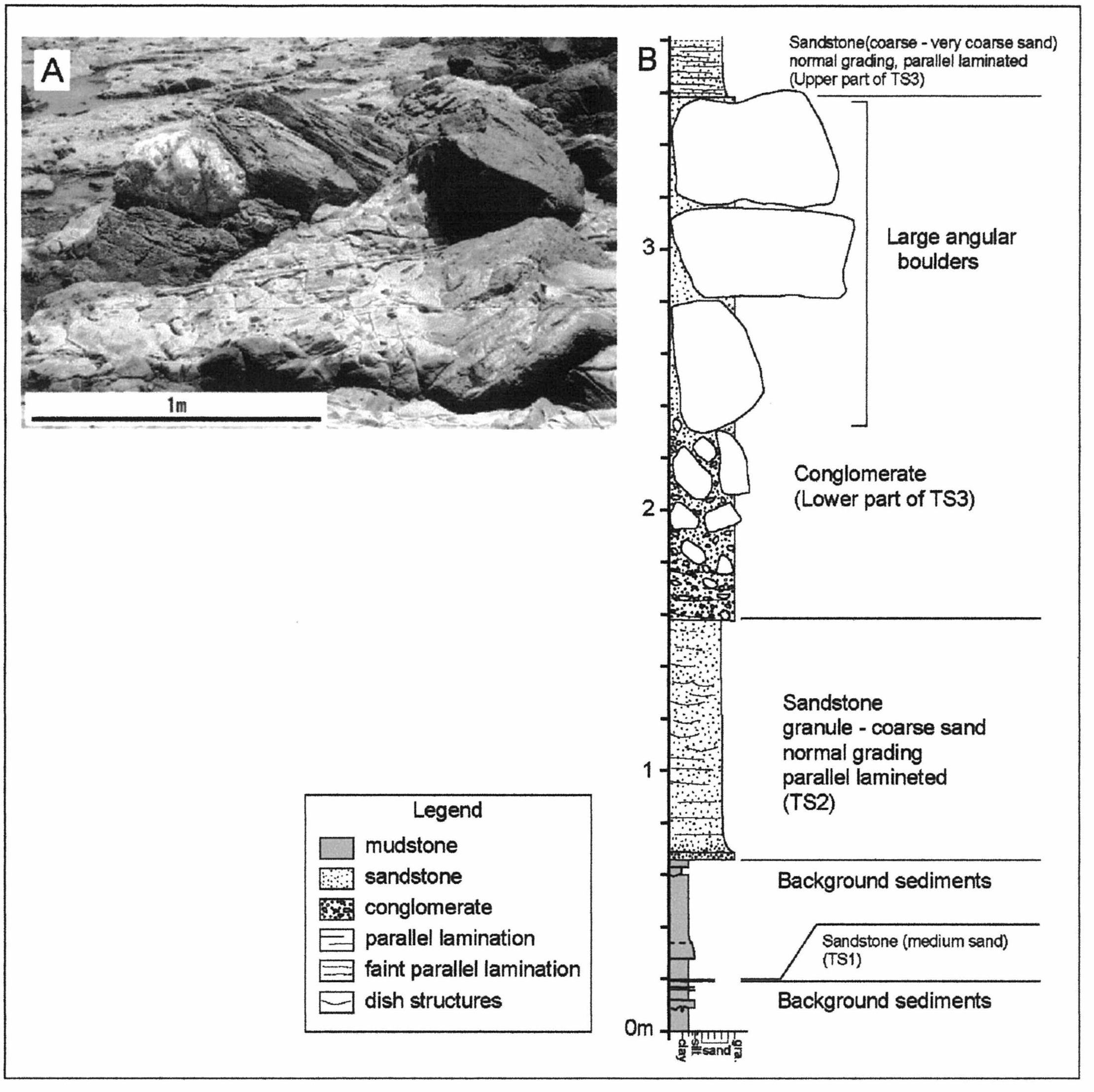

Fig. 2-5 A cluster of extremely angular boulders overlain by a pebble conglomerate, and a sandstone bed. (A) : and a columnar section of tsunami-genetic sediments including a boulder conglomerate and a sandstone bed. (B)

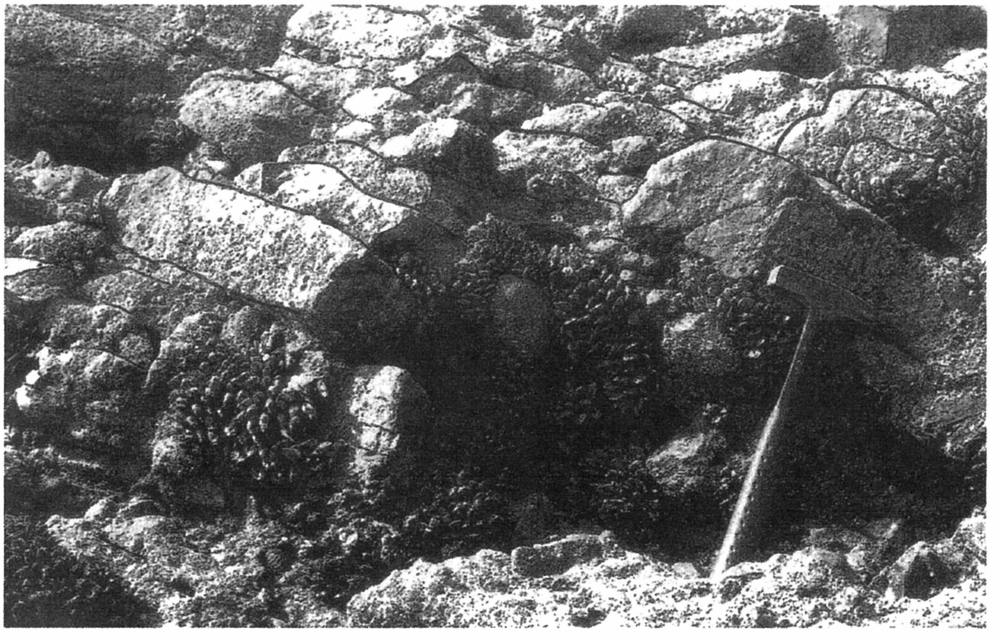

Fig. 2-6 Imbricate cobbles of the upper unit in a conglomerate body. Paleocurrent is from northeast. Note the very angular shapes and sorting of the pebbles.

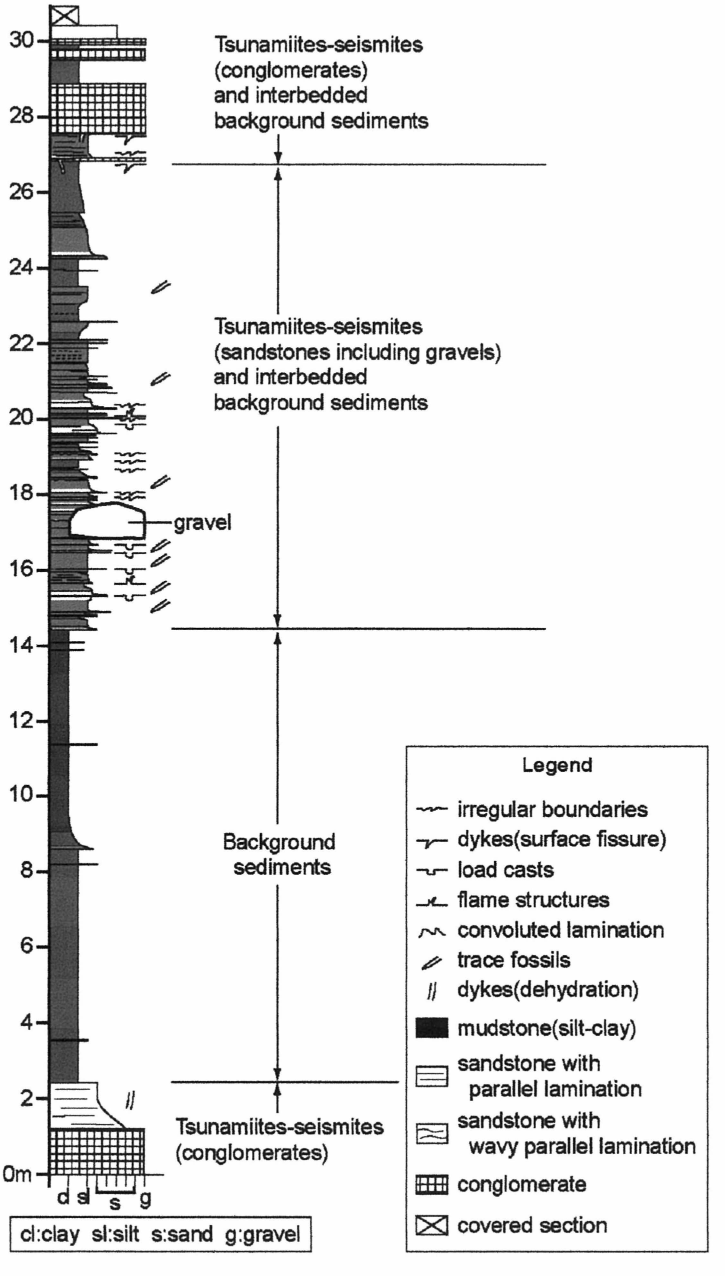

Fig. 2-7 A columnar section of tsunamiite layers and back ground fine-grained sediments observed in the western part of the Tubutegaura coast where a number of sandy tsunamiite layers are distributed.

Sedimentary structures including earthquake-induced convolution, sedimentary dykes, and trace fossils observed in the section are also shown in the column. Take note that the tsunamiites, especially a number of fine-grained tsunamiite layers alternated with thin back ground sediments, record high tsunami frequency periods. On the contrary, a thick succession of back ground sediments in the column indicates a low frequency period of tsunami generation.

3. Stone monument and Geological traces of Past Tsunamis on the Ise-Shima Peninsula

The Ise-Shime Peninsula is located in the central part of Mie prefecture, about 100 kilometers SSW of Nagoya (Fig.3-1). It is well known that a series of gigantic earthquakes called "Off Tokai Earthquakes" took place in the south Sea region of the Tokai District where the 1707 Hoei and 1854 Ansei Tokai earthquakes occurred and huge tsunamis hit the coast of this district. Fig.3-1 shows the distributions of the heights of the tsunamis of 1707(left) and 1854(right). There is a stone monument on which the description "Sea water rose up to the height of 75 feet (=22.5 meters) in the time of the tsunami of the 1854 Ansei Tokai Earthquake" in the garden of Jofukuji Temple, Kuzaki, Toba City.

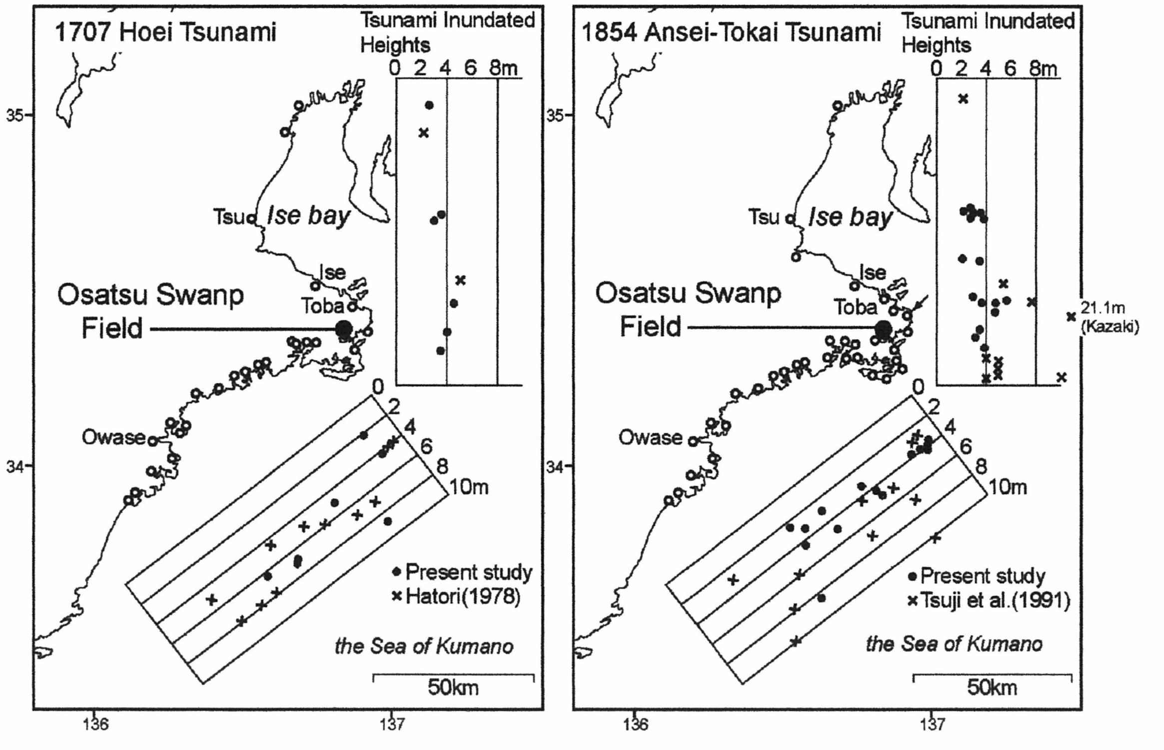

Fig.3-1 Distributions of the heights of the 1707 Hoei (left) and the 1854 Ansei-Tokai Tsunamis on the coasts. Black Circles show the location of Osatu Swamp where geological sample cores were gathered.

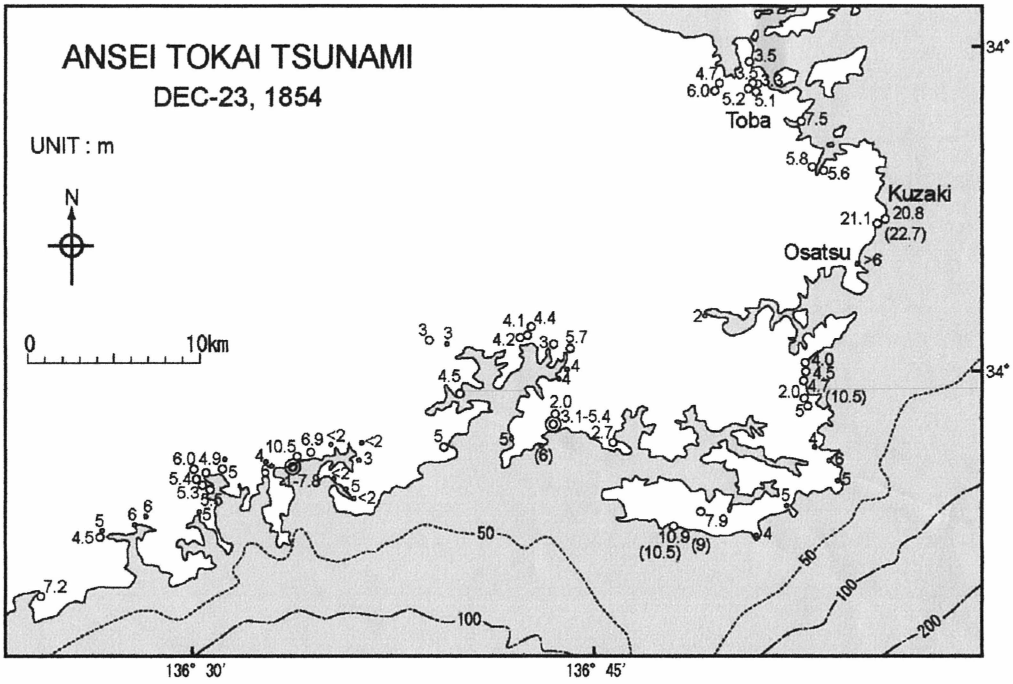

Fig. 3-2 Detailed map of Ise-Shima Peninsula. Numbers show the height of the tsunami run-up of the 1854 Ansei Tokai earthquake.

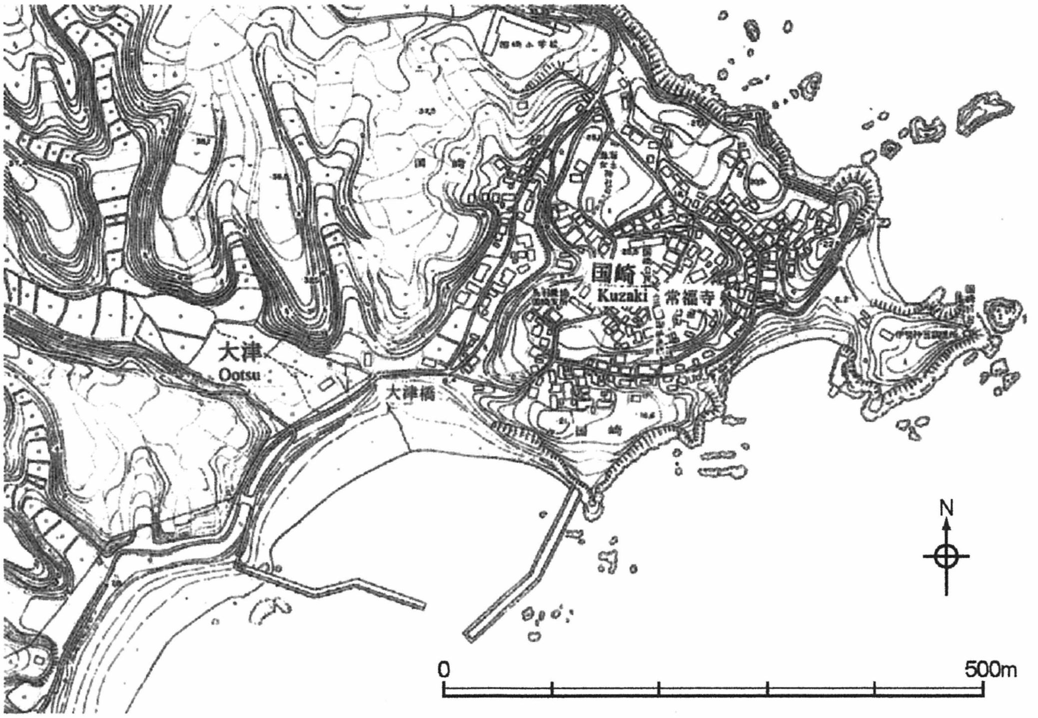

Fig. 3-3 Detailed map of the residential area of Kuzaki Village in Toba City.