5. Distribution and sedimentary facies of tsunami deposits

During the survey from April 13th to 18th, 2007, three of the group members, Nakamura, Nishimura, and Woodward, mainly investigated tsunami deposits in four villages (Titiana, Suva, Pailongge, and Vorivori) in Ghizo Island. They also measured tsunami flow directions based on damaged plants and buildings in Ghizo and Simbo Islands in order to interpret the sedimentary facies of the tsunami deposits.

5.1. Tsunami flow directions on Ghizo and Simbo islands

5.1.1. Ghizo Island

Flow directions of the tsunami wave in Titiana and Suva, on the southern coast of Ghizo Island (Fig. 5.1.1), were estimated from 42 indicators such as damaged trees, grasses, and buildings (Photo 5.1.1). 81% of them fell down indicating landward-directed flow, whereas grasses and shrubs indicated seaward-directed flow. The former seems to be affected by up-flow, and the latter by return-flow.

Directions of the up-flow were mostly perpendicular to the shoreline (Fig. 5.1.1). However, on the southeastern and northwestern edges of Titiana lowlands, flow was strongly affected by hill slopes and was directed obliquely to the shoreline (Fig. 5.1.1, right). Return-flow directions were significantly affected by microtopography and aligned toward local topographic lows.

5.1.2. Simbo Island

By the same methods, tsunami flow directions on Simbo Island were measured. Field observations were made in Tapurai, Riguru, and Lengana, on 16th April (Fig. 5.1.2). Orientation of damaged trees and grasses showed the up-flow toward the west in Tapurai and Riguru. Flow directions were nearly perpendicular to the shoreline in Riguru, but they were directed obliquely to the shoreline in Tapurai. In Tapurai, a large amount of coral fragments was brought inland by the tsunami (Photo 5.1.2). The orientation of the long axis of coral fragments showed the northwestern direction, suggesting the return-flow direction, whereas grass stems buried by the coral fragments indicate the initial flow direction, nearly west. In Lengana, west coast of Simbo, up-flow evidence was not significant.

5.2. Distribution and facies of tsunami deposit

5.2.1. Titiana, Ghizo Island

The tsunami generated sheet-like deposits (Photo 5.2.1) of coral beach sand on the flat plain in Titiana. Fig. 5.2.1 shows thickness (cm) of the tsunami deposit in Titiana. Deposit thickness seemed to be strongly affected by microtopography, vegetation, and distribution of buildings. Fig. 5.2.2 shows topographic profile elevations and thickness (cm) of tsunami sand between the shore and inundation limit. Near the beach, the tsunami wave eroded ground surfaces and formed small scarps at 30 m from the sea (hachured line in Fig. 5.2.1, Photo 5.2.2 and 5.2.3). Photo 5.2.3 shows full-sized palm trees leaning to the sea, affected by soil erosion from the tsunami. Just landward of the scarps, tsunami deposits up to 9 cm thick accumulated (Loc.51). The thickness decreased with distance from the sea and was also affected by microtopography. At the limit of sand deposition (Loc. 57), only sparse sand grains were barely observed on the soil surfaces. In an inland area more than 170 m from the shoreline, no sandy tsunami deposits were observed. The upper boundary of tsunami inundation, as defined by accumulation of driftwood and floating debris, was 210 m from the shoreline.

Fig. 5.2.3 shows stratigraphy of the 2007 tsunami deposits in Ghizo Island. The tsunami deposits consisted primarily of structureless sand layers with no graded bedding, in Titiana (Photo 5.2.4). However, their surface seemed to be weathered. The contrast between the 2007 tsunami deposit and the underlying sediments, containing humic materials or plant fragments, made identifying the deposit easy and allowed investigation of the contact between the tsunami deposit and the underlying soil layer. At Loc.48, the sand layer contained finer materials, suggesting return flow deposit.

Some coastal landforms changed as a result of sedimentation by the tsunami, as well as erosion. For example, 1 m thick sandy deposits formed a small sand bar (Photo 5.2.5) at the northwestern coast in Titiana. This sand bar dammed up a small channel at its mouth.

5.2.2. Suva and Pailongge, Ghizo Island

In Suva and Pailongge, the outline of the sand-sheet distribution was the same as that in Titiana. The tsunami had a maximum thickness of 10 cm, and two or three sand layers were separated by thin humic sand layers (Fig. 5.2.3, Photo 5.2.6). These humic layers were likely supplied from hillslopes eroded by the tsunami and transported by return-flows. These successions of deposits suggest that tsunami waves inundated at least two times. This was consistent with the number of large waves reported by eyewitnesses. According to them, the tsunami began as an ebbing phase, and then three tsunami waves occurred intermittently.

5.2.3. Vorivori, Ghizo Island

A thin (<5 mm) sand-sheet covered the coastal area of Vorivori, western Ghizo. Most of the sand layers seemed to be massive and already weathered. At Loc.12, the sand layer had a maximum thickness of 1.5 cm.

5.2.4. Simbo Island

The tsunami layers had a maximum thickness of 10 cm in Tapurai, northern Simbo Island. The upper half of the layer contained a large amount of coral fragments (Photo 5.1.2) as well as sand grains, whereas the lower half contained only sand grains. The tsunami layer directly covered humic soil layers and small rooted grass.

In Riguru lowlands, the sandy tsunami layer was deposited about 5-20 m from the shoreline. This sediment formed small topographic highs along the coast, so that inland became a local depression. As a result, water could no longer drain from the inland (Photo 5.2.7).

5.3. Sediment preservation

In the Solomon Islands, plentiful rainfall causes erosion and re-sedimentation of tsunami deposits. Furthermore, the sedimentary structures will be destroyed easily by chemical weathering in the warm and moist environment, bioturbation by plants and animals, and human activities. The sedimentary structures had been preserved until the end of June 2007, but had already been penetrated by plant roots and sandpipes of crabs (Photo 5.3.1, 5.3.2, 5.3.3). We believe that the knowledge of weathering process of tsunami deposits is important for interpretation of sedimentary structures of paleo-tsunami deposits.

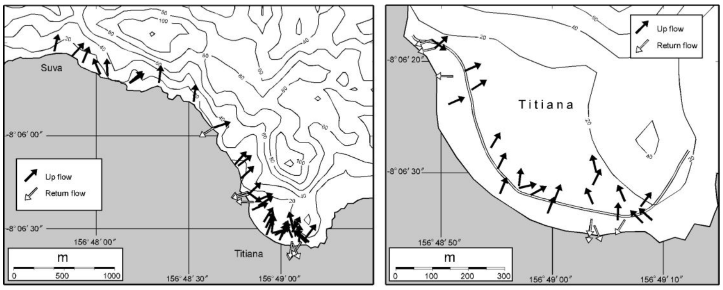

Fig. 5.1.1 Flow directions of the tsunami wave on the southern coast of Ghizo Island (left), Titiana (right).

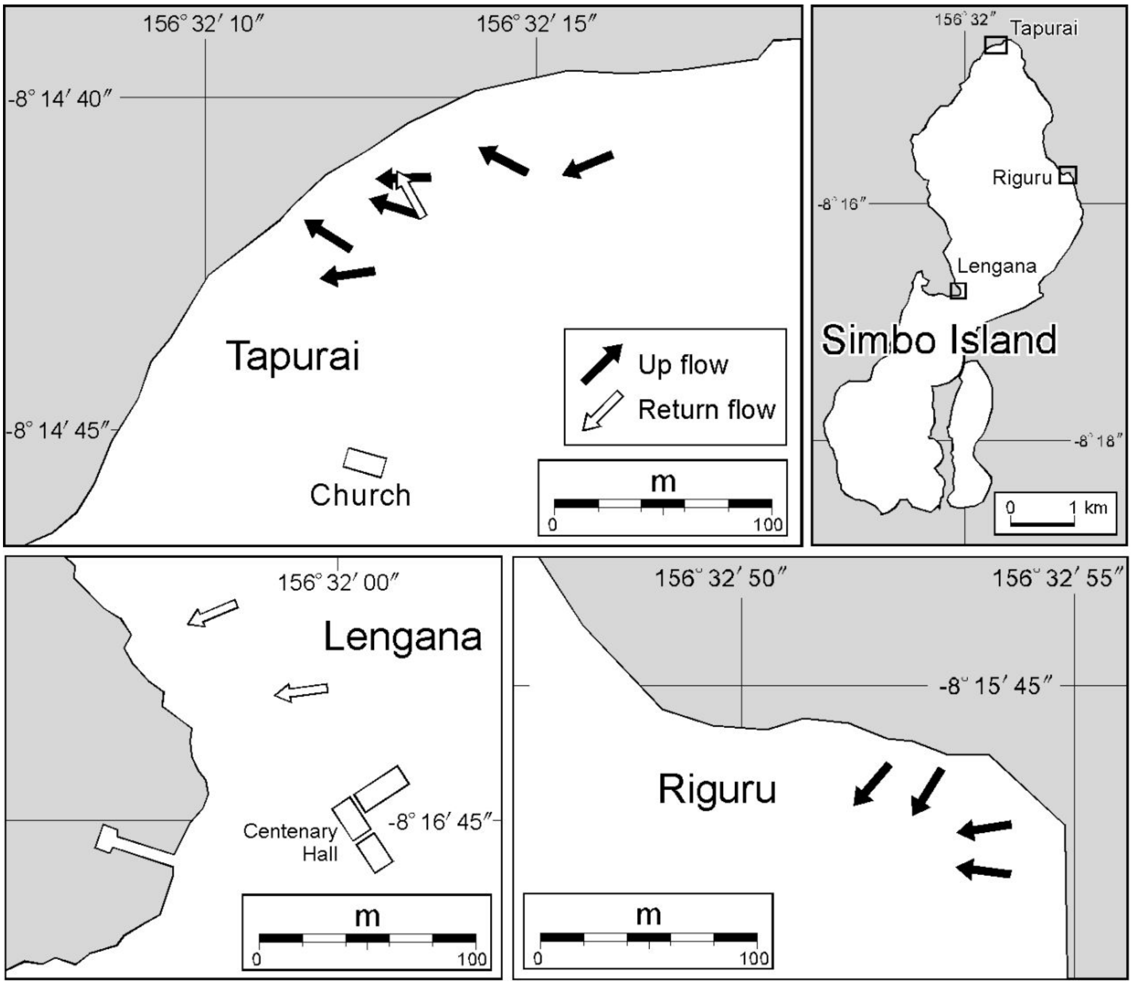

Fig. 5.1.2 Flow directions of the tsunami wave on Simbo Island.

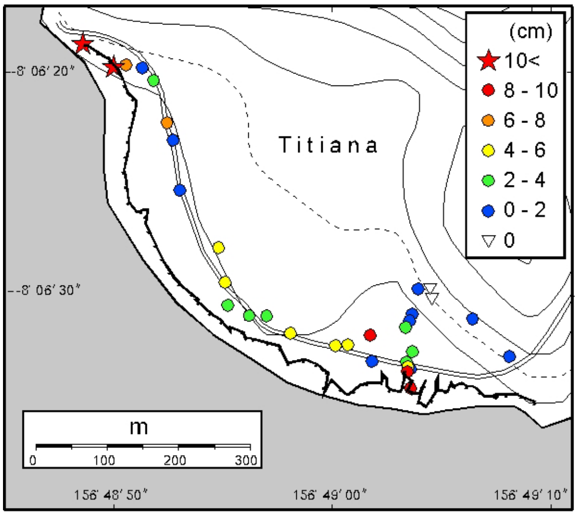

Fig. 5.2.1 Thickness (cm) of tsunami deposits. The hachured line shows the eroded scarp.

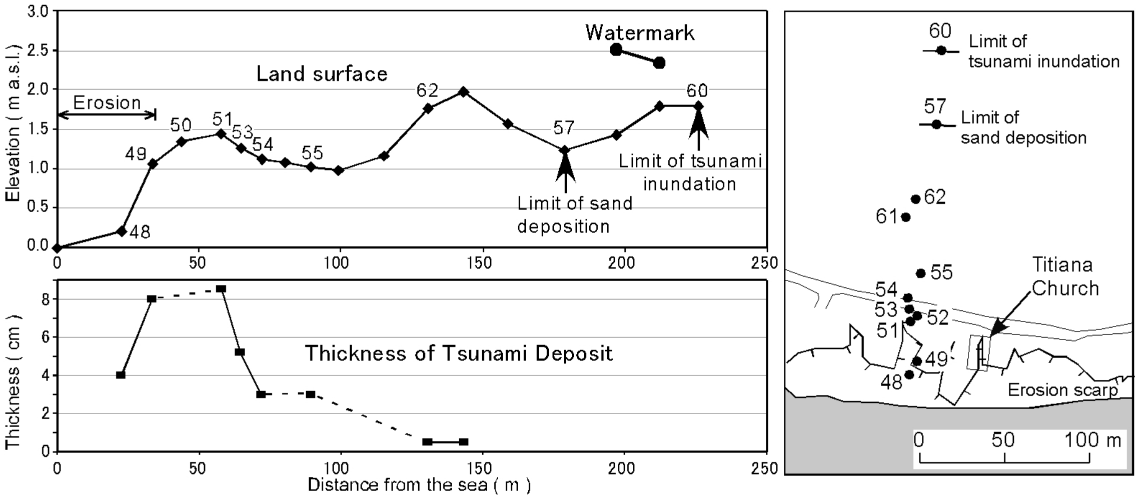

Fig. 5.2.2 Topographic profile elevations, thickness (cm) of tsunami sand, and locality of the transect.

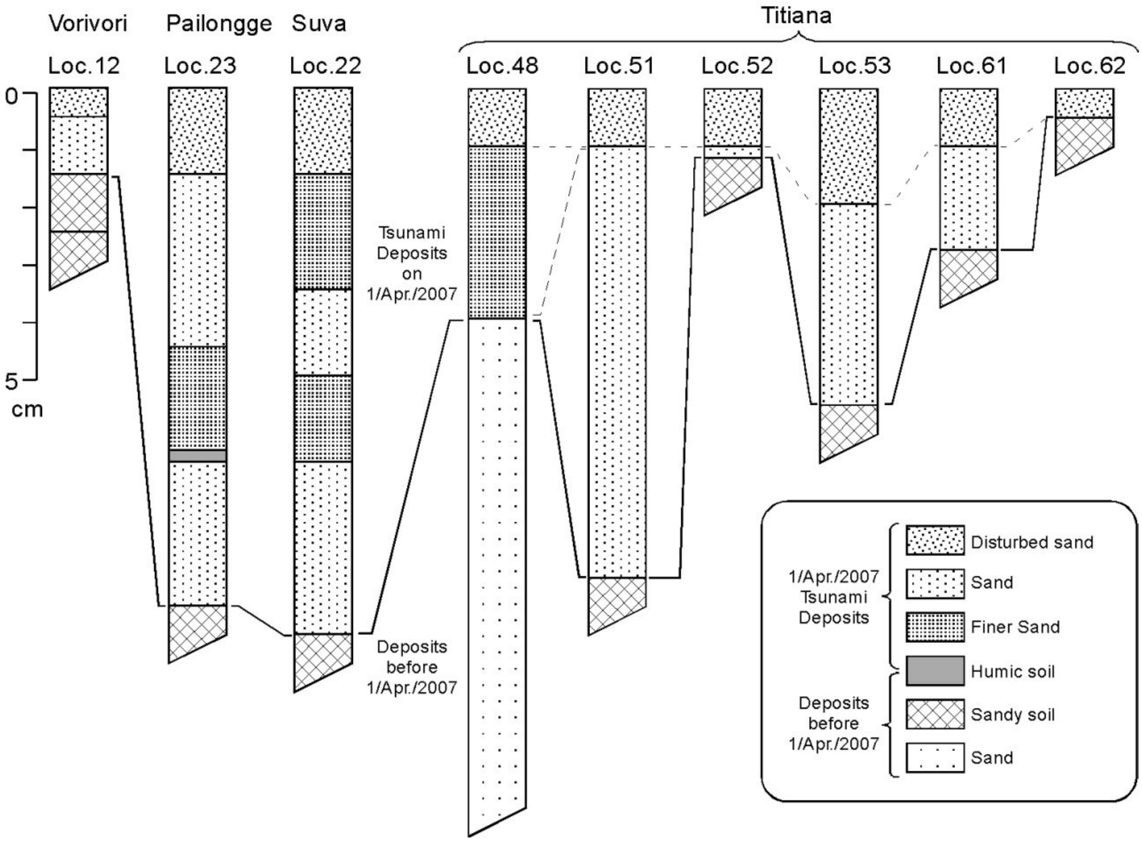

Fig. 5.2.3 Stratigraphy of 2007 tsunami deposits in Titiana, Ghizo Island.

Photo 5.1.1 In many places, the tsunami waves destroyed and moved wooden houses. Remaining timber or concrete piles indicate the flow direction of the tsunami (Titiana).

Photo 5.1.2 Coral fragments aligned nearly parallel with the return-flow direction toward northwest, whereas buried grass stems show the up-flow direction toward west (Tapurai, Simbo).

Photo 5.2.1 Tsunami sand sheet in Titiana.

Photo 5.2.2 Tsunami eroded scarp in New Manra, east of Titiana.

Photo 5.2.3 Palm trees leaning to the sea, affected by the soil erosion (New Manra, east of Titiana).

Photo 5.2.4 Tsunami sand layer in Titiana (Loc. 51). The sand layer has the maximum thickness of 9 cm. A few cm at the top is weathered.

Photo 5.2.5 Sand bar formed by the tsunami, northwestern Titiana. The top of the sand bar is at about one meter above sea level. A small channel, on the left of this photograph, was dammed up here.

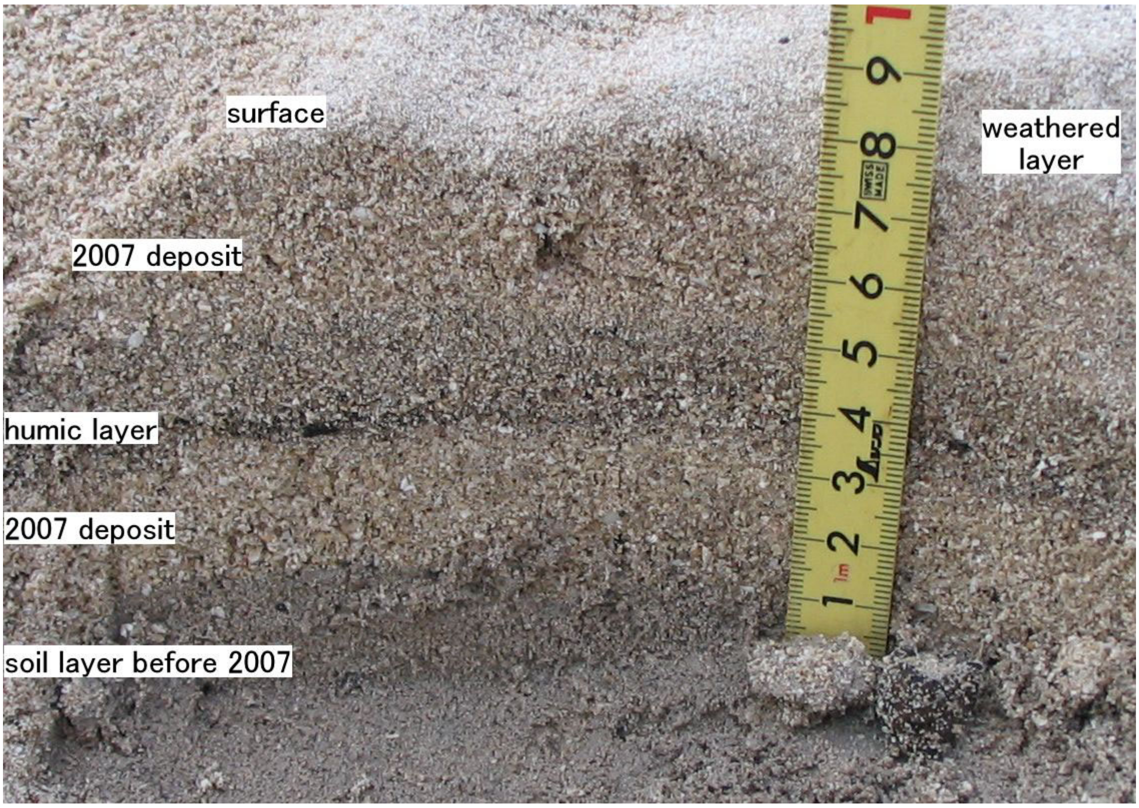

Photo 5.2.6 Tsunami sand layer in Pailongge (Loc. 23). Two (or three ?) sand layers were separated by a humic sand layer.

Photo 5.2.7 Wetland formed after the tsunami (Riguru, Simbo). A ruined building shows that the area was inhabited before the tsunami devastation.

Photo 5.3.1 Tsunami affected area in Tapurai, Simbo Island in April 2007 (upper: two weeks after the tsunami) and in July 2007 (lower: three months after the tsunami).

Photo 5.3.2 Tsunami deposit in Titiana, Gizo Island in July 2007.

Photo 5.3.3 Tsunami deposit in Tapurai, Simbo Island in April 2007. The deposits are significantly reworked by crabs.