Tsunami sediment deposition on coastal lowland over a sand dune: Examples from present and historical deposits in Japan

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Many studies have discussed the onshore tsunami deposits on coastal lowland, which have reported since the great Chilean tsunami of 1960. The sediments can provide new insights into those from a spatial distribution of the paleo-tsunami, landward grain size, and changes in composition of the deposits. The relationship between the distance from coast, grain size properties, or the thickness of tsunami deposits are particularly well clarified by many studies on the present and paleo-tsunami deposits. Those studies show that tsunami deposits generally decrease in grain size and thickness further inland, with minor variations affected by small-scale topographic inequalities of the ground. However, there are fewstudies based on sedimentary analysis that infer the direction of paleo-current, which could provide very important information with which to reconstruct the behavior of the paleo-tsunami. One of the reasons for this is that onshore tsunami deposits often have parallel or very low-angle cross laminations, or massive facies, as primary sedimentary structures; therefore, it is considered that the direction of the paleo-current could not be obtained from sedimentary structures. Although a few studies did try to understand the behaviors of the onshore tsunami, which inundated coastal sand dunes, using gravel fabric or the magnetic fabric of tsunami sands, the depositional model of tsunamis in coastal lowland over sand dunes are still debated.

In this study, the characteristics of the deposits from a tsunami were determined from two tsunami deposits (Takashimizu et al., 2012a, b). One is a seventeenth-century tsunami deposit on the eastern Iburi Coast, in Hokkaido, northern Japan, and the other is from deposits of the 2011 Tōhoku-oki tsunami on the central Sendai Coast in Miyagi, northeastern Japan. The sedimentological analysis clarifies that both deposits show the same characteristics, as follow;

- ✓ The distance of the distribution limit of the sands is around two kilometers from the coastline.
- ✓ Faint parallel laminations are observed commonly in the deposits.
- ✓ The thickness of the bed and the average grain size are seen to decrease and become finer farther inland.
- ✓ Both tsunami deposits include marine diatom species.
- ✓ Erosional contacts at base, including rip up clasts, are common features.
- ✓ The direction of the paleo-current, estimated from grain fabric, shows that the beds were deposited from inflow only.

It is considered that these represent generic features of tsunami depositions on coastal lowland caused by a tsunami inundating a coastal sand dune. After the tsunami floods up to several kilometers inland, most of the remaining seawater did not drain away to the sea due to the high coastal beach ridges, which were probably several meters high. The stagnating seawater did not drain quickly and some water bodies remained on the coastal lowland. Finally, the water bodies might have disappeared due to seepage underground or evaporation.

In contrast, differences between both tsunami deposits have also been discovered, as follows;

- ✓ The seventeenth-century tsunami deposit simply becomes finer farther inland; however, the deposit from the 2011 Tohoku-oki tsunami becomes finer inland but also coarsens suddenly in two zones.
- ✓ The seventeenth-century deposit doesn't include a mud layer; however, the deposit from the 2011 Tohoku-oki tsunami is covered with thick mud.
- ✓ The frequency of the marine water diatom species in the 2011 Tohoku-oki tsunami deposit is quite low compared to that in the seventeenth-century tsunami deposits.
- ✓ Both tsunami deposits do not have the same number of units. The seventeenth-century deposit has three, but the 2011 deposit has only one.

Two sudden coarsening zones in the grain size of the 2011 tsunami deposits were controlled by local topologic factors: older beach ridges on Sendai Plain. The average grain size of the tsunami deposits increased at those topologic highs due to the fact that the inundation eroded sand on beach ridges. The thick, well-developed muddy section and the low level of marine water diatoms are interpreted as showing abundant muddy fractions had been taken into the tsunami from the surface of rice paddy fields during the. In other words, the differences between the two tsunami deposits were considered differences in the geomorphological features and the rate of influence of artificial changes on the land. The difference in the number of units suggests the height of the tsunami following after the first. If the height of the latter was greater enough than the coastal sand dune, the deposit formed multiple units. However, if the height of the tsunami was low, it did not overtop the coastal dune and only one unit can be observed (Fig. 1).

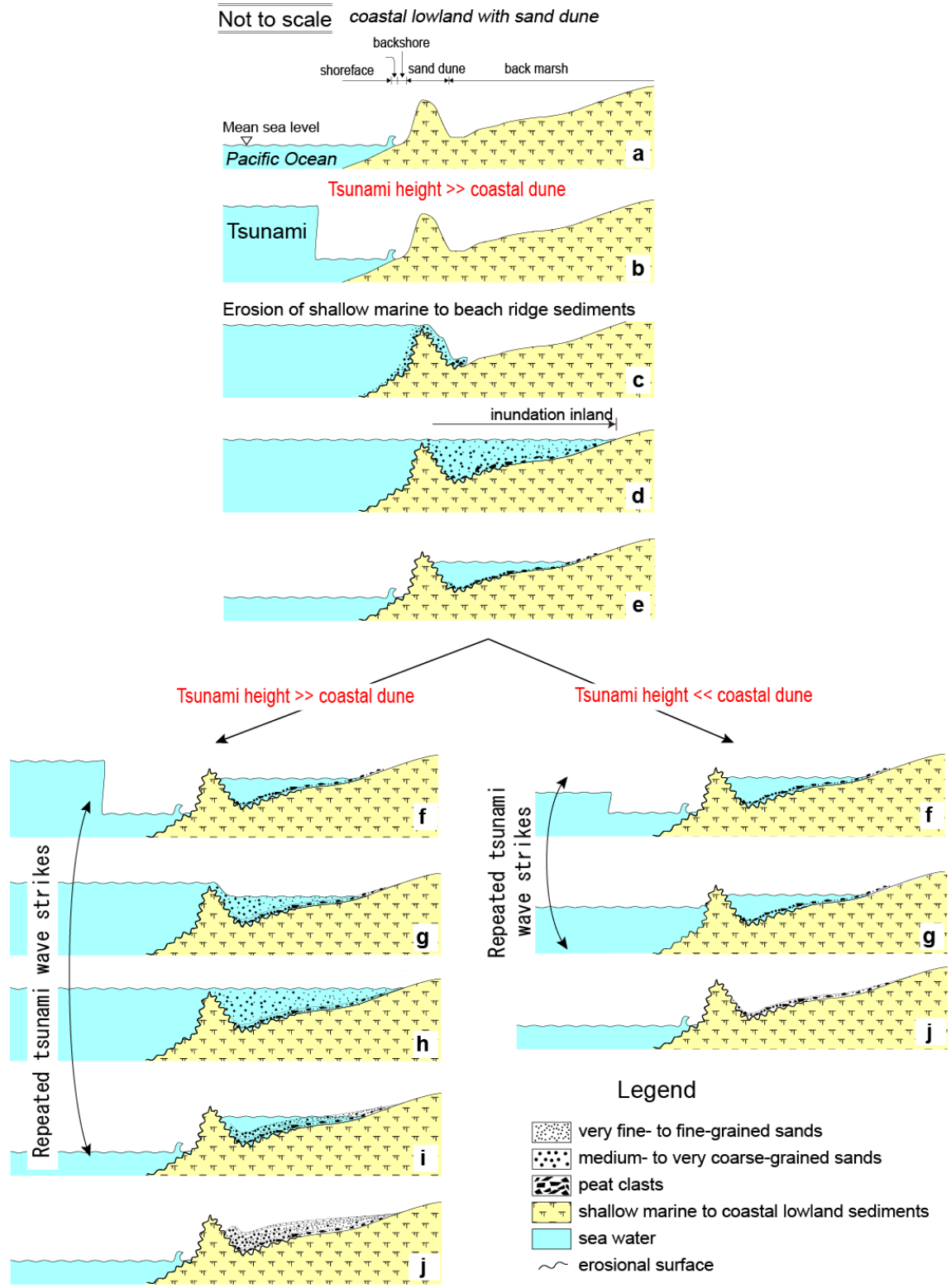

Fig. 1. A tsunami depositional model on coastal lowland over sand dune (modified from Takashimizu et al. 2012a)

References

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