A 6500 year old paleotsunami deposit at Ohga marsh facing Beppu Bay

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Acoustic and coring surveys conducted in the Beppu Bay have revealed that the submarine active faults in the bay have been active at least four times before the 1596 CE Keicho-Bungo earthquake (e.g., Shimazaki et al. 2000; Oita Prefecture 2002). The recent tsunami deposit study was conducted at a coastal marsh located on the south coast of the bay and reported four tsunami deposits in the sediment cores during the last 7300 years (Yamada et al. 2021). However, the tsunami history of the bay has still been incomplete due to a lack of the recent 2800 years record in the sediment cores. In addition, since we only studied one small site, we cannot estimate earthquake magnitude or determine which fault rupture produced the tsunami deposits. Therefore, this study aimed to complement geological data with a tsunami deposit survey at a coastal marsh located on the north coast of the bay. This result could make progress in understanding the earthquake and tsunami history of the bay.

We collected seven sediment cores at 10 m intervals along a shore-perpendicular transect using a 2 m long geo-slicer. The approximately 85 m wide and 150 m long marsh is protected from the sea by a 5 m high sandbar. The present elevation is about 4 m a.s.l. throughout the marsh. Reed grass now grows naturally in the marsh, although the marsh was used for rice paddy fields in the past. The up to 180 cm long sedimentary sequence constitutes of four units: the lowermost gray muddy sand layer, light brown organic-rich mud layer, dark brown to black organic-rich mud layer, and the top agricultural soil. The 0.3–22.0 cm thick sand layer exhibits in the organic-rich mud in all sediment cores. This sand layer is bounded by sharp upper and lower contacts with the surrounding muds, implying that this layer was deposited by a sudden event. We infer that this layer was formed by a tsunami inundation since the sand layer thins and fines toward the inland and is geochemically distinct with peaks in S, K, Ca, and Sr reflecting marine influence.

The depositional age of the sand layer was constrained by two radiocarbon ages obtained from immediately above and below the sand layer. Constrained age is 6440–6620 cal. yr BP for the sand layer based on conventional ages from 0–1 cm above and below the layer (5701±23 ^{14}C yr BP and 5773±25 ^{14}C yr BP). Yamada et al. (2021) reported four tsunami deposits at a coastal marsh located on the south coast of the bay. One of them was estimated to be deposited 5750–6750 cal. yr BP. This wide age range is due to the problem of the radiocarbon dating location used for age constraint. The limiting-maximum age used for the modeling was from 0–1 cm below the tsunami deposit, whereas the limiting-minimum age was from 39–40 cm above that, indicating that the actual depositional age should be close to the limiting-maximum age. A same tsunami probably formed the tsunami deposit in this study and one of the tsunami deposits on the south coast. This implies that a 6500 year old earthquake was accompanied by a tsunami that attacked north and south coasts of the bay. The accumulation of geological data over the bay will be helpful for estimating the rupture area of past intraplate earthquakes. This study also did not provide data for the last 2800 years –the top of the organic-rich mud layer was dated to 5660–5900 cal. yr BP. Therefore, further tsunami deposit surveys are needed to clarify the earthquake and tsunami history of the Beppu Bay submarine active faults.

Keywords: Tsunami deposit, Submarine active fault, Beppu Bay

