Identification of tsunami boulders in the Ryukyu Islands, Japan and their potential use for long-term risk assessment
Kazuhisa Goto (Tohoku University)

Numerous coastal boulders are deposited on the fringing reef and along the coastline of the Ryukyu Islands, Japan. Past few decades, many researchers explored whether they were deposited by the tsunamis or storm waves. One important advantage studying boulders in this region is that there is a historical description that many boulders were transported by the 1771 Meiwa tsunami at the southern end of the Ryukyu Islands (Sakishima Islands). Moreover, series of aerial photographs are useful to know the movement of boulders by the storm waves.

Based on the sedimentological research, Goto et al. (2010) differentiated boulders deposited by the tsunami and storm waves. Namely, storm wave boulders are concentrated on the reef crest with the maximum landward limit of about 300 m from the reef edge. On the other hands, there are many coralline boulders along the coast of Sakishima Islands and those were deposited far beyond (~1.5 km from the reef edge) the possible distribution limit of the storm wave boulders. Thus, Goto et al. (2010) interpreted that these boulders were of tsunami origin. This interpretation was supported by the numerical modeling by Watanabe et al. (2014) that storm waves in this area can’t transport huge boulders to the coast.

It is important to note that these boulders were not necessarily be transported only by the 1771 tsunami but might have also been deposited by prehistoric tsunamis. Radiocarbon dating of tsunami boulders by Araoka et al. (2013) revealed that these boulders were deposited every 150-400 years which may reflect the tsunami recurrence interval in the Sakishima Islands. Among them, tsunami event at 2000 BP might have been large equivalent to the 1771 event (Hisamatsu et al., 2013) and it is probable that another large tsunami were occurred in between the 2000 BP tsunami and the 1771 tsunami according to the paleomagnetic analysis (Sato et al., 2013). In this way, together with the recent work on sandy tsunami deposits (e.g., Kitamura et al., 2014), it is now relatively well understood the paleotsunami histories at the Sakishima Islands and probably 3 large tsunamis were occurred during past 2000 years including the 1771 event.

On the other hand, little is known about the paleotsunamis at central and northern Ryukyu Islands (Okinawa and Amami Islands). Goto et al. (2013) suggested the absence of tsunami boulders in these island groups nevertheless that there are many boulders that can be explained by the storm wave activities. Based on the observation that a boulder deposited at 2300 BP in the Amami Islands was still deposited within the distribution range of storm wave boulders, Goto et al. (2013) suggested that no tsunami that was sufficiently large to transport the storm-wave boulders on the reef to further inland beyond the storm-wave transport limit struck these reefs at the Amami Islands at least during the past 2300 yr.

If this is the case, there may be a significant difference of paleotsunami histories between the southern (Sakishima) and central to northern (Okinawa to Amami) Ryukyu Islands. One possible explanation is that extremely large tsunamigenic earthquake might have occurred only along the Ryukyu Trench near the Sakishima Islands but was not occurred near Okinawa and Amami Islands. Alternatively, it is also probable that tsunami size near the Sakishima Islands were sometimes unexpectedly enlarged due to the local submarine landslide, nevertheless that the magnitude of earthquake were not extremely large.

Comprehensive researches based on geology, seismology, and tectonics are required to better understand the paleotsunami and earthquake histories along the Ryukyu Trench.

Reference