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Effect of the storm waves on the distribution of sediments on the reef at northern Ryukyu Islands

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Coral reefs form dynamic wave-resistant structures built by the skeletons of living organisms, and absorb the energy of breaking waves that are produced by storms and tsunamis. Because the most active growth is in the wave-breaking zone, reefs form linear structures facing waves, often parallel to shorelines, protecting them from erosion. Only scleractinian corals are able to build these structures. Storm surge in the Ryukyu Islands is the abnormal rise in water level caused by wind and pressure forces of a typhoon. Coral reefs are subject to mortality from a variety of wave erosion whose impact is most serious at reef edges, and removed reef blocks are transported them as boulders to the reef flat by shoring currents.

Coral boulders or cobbles without mechanical abrasion and smoothing are generally found on reef flats in the Ryukyu Islands. No large tsunamis have attacked the northern Ryukyu Islands for the last 200 years and hence they were highly likely deposited by the storm waves. Although previous works focused on the distribution of boulders (Goto et al., 2009) or cobbles (e.g. Kan et al., 1994), there is no systematic study that investigated the characteristics and distribution of the reef sediments (sand to boulder size) transported and deposited by storm waves. Thus, we investigated the sediment distribution on the reef and compared to the distribution of the storm wave forces.

Field work was conducted in the Yo coast, north-eastern Amami-Oshima Island of Kagoshima Prefecture. Boulders deposited on the reef crest, distributed within 200 m from the reef edge as an exponentially fining landward deposit. Although Amami-Oshima Island is about 300 km far from Okinawa Islands, central Ryukyu Islands, the boulders were commonly deposited on the similar distribution trend. This suggests that storm waves which have attacked to these islands on the Pacific Ocean side were similar in the maximum intensities, and that the landward limit of boulders might be estimated as the maximum transport force of storm waves. The bottom sediments at the landward half of the moat were composed of coral sands, whereas offshore half of the moat is composed of Sargassum, rubbles and gravels. Reef rocks were exposed on the floor of the reef crest, and many coralline boulders with $>$1 m in long axis were deposited. We found that maximum sizes of the sediments on the reef of Yo coast shows exponentially fining trend with distance landward from the reef edge. This trend is well consistent with the distribution of the storm wave force on the reef. Therefore, we infer that the storm wave force is one of the major factors to determine the sediment distribution on the reef.

Keywords: Amami-Oshima, coral reef, boulder, reef sediments, storm wave