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Huge boulders scattered at Hashigui-iwa, pacific side of central Japan - transported by tsunamis or not?

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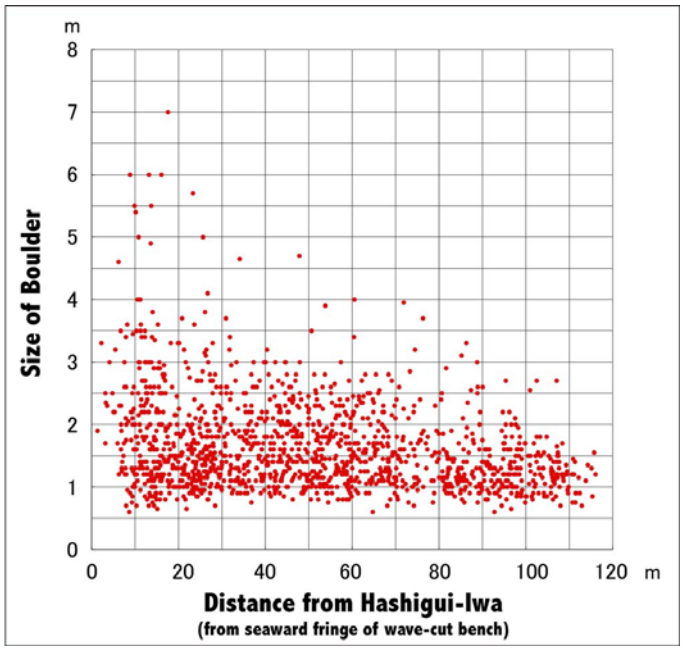
1) Introduction

Hashigui-iwa located 6 km northeast from the Shiono-misaki cape, which faces subduction zone of the Nankai Trough, is well known as a sightseeing spot, (Fig. 1) . It looks like natural bridge pier composed of 25 individual large rocks aligned along Neogene volcanic rock dike. The rocks poke up from a sea surface, and line up about 850 m striking N15W direction. This unique topography is considered to be formed by differential erosion between easily eroded sedimentary rock and relatively hard volcanic rock.



In the western side of Hashigui-iwa, wave -cut-bench is well-developed with dimensions of 100 m in east-west and 300 m south-north directions. The bench has been formed by erosion of shale and sandstone due to combination of sea waves and wet-dry weathering (e.g. Toyoshima, 1968; Takahashi, 1975 Maemoku and Tsubono, 1990). Several hundreds of boulders are scattered on the bench, and the longest major axis exceeds 7 m. Because these scattered boulders are composed of volcanic rock which is different lithofacies to the bench, origin of them are obviously derived from the rocks of Hashigui-iwa. Some causes of transportation of the scattered boulders are inferred to be such as storm or tsunami, but it is not yet specified how such large boulders were transported.

To clarify the cause of the scattered boulders, we are studying by field survey, air-photograph analysis and its numerical analysis. In this symposium, we will make a presentation about provisional results and about future plans.

2) Characteristics of boulders

We carried out field surveys around Hashigui-iwa in 2007 to measure dimensions and locations of the boulders whose major axis exceeds 1 m (Nagai et al, 2008). Relationship between the major axis of the boulders and orthogonal distance from the line of Hashigui-iwa is also shown in Fig. 1. This strongly indicates negative correlation. When the distance from Hashigui-iwa becomes larger, the maximum amount of major axis decreases. We divided the distance from Hashigui-iwa into 6 sections with interval of 20 m (0-20 m, 20-40 m, 40-60 m, 60-80 m, 80-100 m, and more than 100 m), and counted a number of the boulders in each section. As a result, the large number of the boulders is counted in section of 20-40 m.

3) Causes of the transportation of the boulders
To judge horizontal movement of boulders during several ten years, we treated two aero photographs which were taken at the same area in 1975 and 2007 (the same year at our field survey) from altitudes of 1600 m and 3000 m high, respectively. Two photographs were overlapped with each other, and each boulder with major axis of more than 1-2 m can be recognized from these photographs. We visually checked whether the boulders were moved in the period during 1975 and 2007. The results indicate that almost all the boulders were not carried except a few small ones. Especially the boulders with the major axis of more than 2 m completely stayed at the same positions.
During the period, no large tsunami attacked, but many severe storms struck around Hashigui-iwa, and the largest significant wave height was recorded to be 10.22 m (period: 15.7 sec) at Shiono-misaki cape at 18:00, October 20th, 2004 due to typhoon 0423. We thus consider that the possibility of that storms scattered the boulders would be low, and inferred that the cause is higher -energy waves like tsunamis.

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Keywords: tsunami, Hashigui-iwa, Kushimoto, bench, boulder