2015 Torishima tsunami earthquake: Tsunami observation at short distances by an array of ocean bottom pressure gauges

*Yoshio Fukao[1], Hiroko Sugioka[2], Aki Ito[3], Hajime Shiobara[4], Osamu Sandanbata[4], Shingo Watada[4], Kenji Satake[4]

1.CEAT/JAMSTEC, 2.Science/Kobe Univ., 3.D-EARTH/JAMSTEC, 4.ERI/Univ. Tokyo

The 2015 May 02 Torishima earthquake generated tsunamis with heights as large as 60 cm at Hachijo Island, 180km to the north of the epicenter, yet the seismic magnitude was only 5.7 and there was no report of seismic intensity of 1 or more. The earthquake can be regarded as a tsunami earthquake. The epicenter is located closely near the Smith Caldera and the focal mechanism is of CLVD-type. The seismic and tsunami waves were recorded by our pressure gauge array deployed at the bottom of the open sea about 100km to the NNE from the epicenter. Here we report the results of our observation.
(1)The array consists of 10 ocean bottom pressure gauges using ParoScientific quartz resonators which can measure absolute water pressure at 7000m depth with nano-resolution. The array configures equilateral triangles with minimum and maximum lengths of 10 and 30km, which was in operation for a year from May 2014 to May 2015. Sampling rate was set at 4Hz, with which the response to pressure disturbance is almost flat below 0.2Hz.
(2)The tsunami trace at each site starts with positive onset (pressure increase) and reaches a maximum amplitude of about 200Pa (≈2cm in tsunami height). Records of ordinary thrust earthquakes with similar magnitudes at similar epicentral distances show comparative amplitudes of seismic waves but no visible tsunamis (Fig.1).
(3)Tsunami slowness vector is measured under the plane wave approximation. The measured slowness varies as a function of frequency in a consistent way with the linear dispersion theory. The slowness vector orientation deviates clearly from the great circle path and changes slowly as a function of frequency as expected from the frequency-dependent ray tracing (Sandanbata et al., 2016, JpGU). This ray tracing also demonstrates strong ray focusing towards Hachijo Island and no such focusing towards the array, explaining qualitatively the marked contrast in tsunami height between the array (~2cm) and Hachijo Island (~60cm).
(4)The tsunami spectrum at each station shows consistently a broad peak around 3.5mHz and sharp double peaks around 8mHz. We interpret the first broad peak as due to the primary tsunami source associated with seafloor uplifting and the sharp double peaks as due to wave resonance inside the Smith Caldera.

Keywords: tsunami earthquake, tsunami observation, water pressure gauge