

Ocean-bottom pressure disturbances around Japan due to the 2022 Tonga eruption observed by S-net and DONET

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An explosive volcanic eruption occurred at the Hunga Tonga-Hunga Ha'apai volcano on January 15, 2022, and produced atmospheric pressure waves and ocean waves that traversed the Pacific Ocean. Ocean-bottom pressure gauges of ocean-bottom observation networks in Japan, S-net and DONET of NIED, observed ocean-bottom pressure changes due to the Tonga eruption. We investigated their waveform records to clarify the nature of the arriving ocean waves, and found two significant disturbances between 20:00-21:00 and after 22:00. The first disturbance with a positive-polarity pulse dominated by long-period components of 1000-3000 s arrived at S-net and DONET stations between 20:00-21:00 from the southeast. This direction corresponds to the direction of the great circle between Tonga and Japan. This arrival was much earlier than expected for a direct tsunami from the volcano and can be explained by assuming the propagation along the great circle path between Japan and Tonga at a velocity of approximately 300 m/s. After 22:00, significant phases dominated by relatively shorter period components (< 1000 s) arrived from the southeast direction in both observation networks. In DONET, another phase arrived from the south-southeast direction at approximately 23:30 with shorter period components (approximately 500 s). Most of the near-trench S-net stations recorded a peak amplitude during the first disturbance, whereas the near-coast S-net stations and DONET stations observed their peak after 22:00. The amplitudes of ocean-bottom pressure change were amplified as the water depth decreases. This amplification behavior differed between the first and second disturbances, which may be attributed to differences in the dominant period of the arriving ocean waves and in their generation mechanisms. We also investigated atmospheric pressure records of V-net, NIED and Soratena, Weather Incorporated, and compared them with ocean-bottom pressure data. We found several phases of atmospheric pressure that were correlated with the ocean-wave phases, which implies that the multiple disturbances of ocean-bottom pressure were generated by the interactions of several disturbances of air waves following the 2022 Tonga eruption with ocean waves.

Keywords: 2022 Tonga eruption, Ocean-bottom pressure disturbances, Ocean-bottom pressure gauge observation around Japan, Relationship with atmospheric pressure disturbances