

A resonance frequency map of Japan: Does the crust resonate?

*Atsuko Namiki¹, Naoki Uchida²

1. Graduate School of Integrated Arts and Sciences, Hiroshima University, 2. Graduate School of Science, Tohoku University

A medium with a certain length usually has a resonance frequency. If this is true, the crust as an outermost layer of the Earth may have a resonance frequency. For a medium with a wave velocity of V_s and a length of L , the fundamental mode of the resonance frequency is $V_s/(2L)$. The Earth's crust has the thickness of approximately 30 km and the S-wave velocity of 3km/s, thus the resonance frequency becomes 0.05Hz. Such a low frequency oscillation is excited only by a megathrust, so the resonance of the crust does not appear usually.

We analyze the oscillation after the Tohoku-Oki earthquakes to test occurrence of the resonance of the crust. We use the 300s data recorded by velocity type seismometers (1Hz) after the arrival of the S-wave, correct the instrument response, and then calculate the power spectra. Some spectra show peaks in the frequency range between 0.01-0.1Hz. We pick the peaks up, when the peak values exceed the twice of the fitting line between 0.01-1Hz, and plot the frequencies at the peaks in the map.

The appearance of the peak frequency between 0.01-0.1Hz depends on oscillation direction. In up-down direction, the peak signal is observed in most of Japan except for the East Tohoku and Kyushu regions. The East Tohoku region may be too close and the Kyushu region is too far from the source region to distinguish the resonance signals. The peak signals also appear in the East-West horizontal oscillation but the appeared region is restricted comparing to that in the up-down direction. In the North-South direction, the region further restricted. This may be because the shape of the source region of the Tohoku-Oki earthquake elongates in the North-South direction, which generates difference in the typical frequency components of the originally excited wave by the earthquake in East-West and North-South directions.

The widely observed peak frequencies in up-down direction are approximately 0.05Hz. We thus consider that these peaks show the resonance of the crust. Interestingly, the peak frequencies are slightly slower on the Median Tectonic line, suggesting that the resonance frequency represents the heterogeneities in wave velocity or thickness variety of the crust.

Acknowledgments:

We used seismic data from the networks of National Research Institute for Earth Science and Disaster Resilience (Hi-net), Hokkaido University, Tohoku University, University of Tokyo, Nagoya University, Kyoto University, Kochi University, Kyushu University, Kagoshima University, Tokyo Metropolitan Government, Shizuoka Prefecture, Hot Springs Research Institute of Kanagawa Prefecture, Japan Meteorological Agency and National Institute of Advanced Industrial Science and Technology.

Keywords: Resonance, the Median Tectonic line