Review: Researches on detection of nuclear tests by seismic waves in Japan

*Noriko Kamaya¹

1. Earthquake Research Institute, the University of Tokyo

1. Introduction

In Japan, if the Japan Meteorological Agency (JMA) observes a seismic wave that may not be a natural earthquake with epicenters around North Korea, the JMA immediately contacts the Prime Minister's Office and have press conferences and announces the parameters of that event. Then, with showing both waveforms of the North Korea's underground nuclear test and a natural earthquake, based on the characteristics of the waveform such as the S wave being ambiguous, JMA states there is a possibility that it is not a natural earthquake. The materials of these press conferences will be published on JMA' s website. However, because the detection of nuclear tests is not the original task of the JMA, no more analysis is not published. In addition, Japan Weather Association, which is responsible for monitoring nuclear tests based on the waveform data of the CTBTO (Comprehensive Nuclear Test Ban Treaty Organization), analyzes data, but only simple report is published on the website. It is important for Japan' s security to study detection technology of nuclear tests by Japanese researchers. In this paper, we will review about Japanese researches on detection of nuclear tests by seismic waves which was published in Japanese papers.

2. Reports of observed events

The oldest paper would be written by Kubodera and Okano (1960). They reported long-period seismic waves with periods of 9 minutes to 1 minute were recorded at the same time that small atmospheric pressure change reached, when a hydrogen bomb test was conducted by the United States at Bikini Atoll in 1958. JMA (1972) published collection book of seismic waves recorded at underground nuclear test conducted by the US in the Amchitka Island on November 7, 1971.

3. Study on discrimination from natural earthquakes

Researches for discrimination nuclear tests from natural earthquakes were mainly conducted by using seismic waveforms at the Matsushiro Earthquake Observatory. Yamagishi et al. (1973) reported that the P wave of the nuclear tests were dominated by short-period waves. Also, they concluded that discrimination was possible by comparing Ms and mb. Seki et al. (1980) pointed out that S waves and surface waves were observed when large tests were conducted. Wakui and Kakishita (1986) pointed out that the discrimination method using the ratio of Mb and MS could only be applied to large-scale tests. Kamaya (1998) analyzed the waveforms of nuclear tests and natural earthquakes at Nevada and Xinjiang. She concluded the Complexity was the most effective method for discrimination. Okamoto and Kanjo (2007) analyzed waveforms of Matsushiro, Mudanjiang and Incheon of IRIS at the nuclear test by North Korea on October 9, 2006. They showed P wave radiation pattern had isotropic pattern. Koyama (2007) calculated the Complexity and the Spectral ratio of waveform in Matsushiro for the same test, and reported that the Spectral ratio was better than the Complexity for discrimination.

Kikuchi (1997) calculated the moment tensor for nuclear tests conducted by China and France from 1995

to 1996 by waveform of the IRIS. He showed that the combination of the three main values of the moment tensor were clearly different from those of the natural earthquake. In addition, he estimated that shape of epicenters of Chinese tests were acicular and French were disk-shaped.

4. Toward the Future

It is necessary for us to learn recent research in the world in cooperation with the CTBTO. In addition, our (Japanese researchers') continuous research on detection of nuclear tests by analyzing seismic waveforms around the world is important.

Keywords: Nuclear Test, Nuclear Explosion, Seismic waves, Complexity, Spectral Ratio, Moment Tensor