Recent Earthquake Activity in Northern Hokkaido, Japan

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In order to understand the future earthquake potential damage in northern Hokkaido, we examined the current seismic activity from the perspective of plate tectonics. An earthquake swarm, with largest earthquake of M_{JMA} 4.3, starting on July 15, 2012 in the town of Nakagawa in northern Hokkaido, Japan, where residents felt the earthquakes of seismic intensity IV three times in 3 days (The Seismological Bulletin of Japan, JMA, 2012). At the same time, a slow earthquake was also detected nearby during the swarm (M. Ohzono et al., 2015; S. Ikeda, 2016). It is inferred from the results that the source area is associated with almost horizontal E-W compressional tectonics. Den and Hotta (1973) first proposed the paleo-tectonic movement of the Okhotsk plate in the Mesozoic to Paleogene time along western Hokkaido and the island of Sakhalin to the north. Nakagawa is located at the western margin of the Okhotsk paleo-plate. The present tectonic movement of the island of Hokkaido is controlled by the triple interaction among the Pacific, the North American and the Eurasian plates. The current activity of an earthquake swarm and slow earthquake near Nakagawa suggests that the tectonic movement on the remnant boundary zone has not completely vanished. Further, according to the geodetic imaging by Loveless and Meade (2010), the slip rates across the corresponding area were estimated as 13.0±2.1 mm/y ~ 8.4±2.1 mm/y of E-W closing or shortening. In order to shed light on the current earthquake behavior in the western boundary of the Okhotsk paleo-plate, we study seismic activity in northern Hokkaido centered on Nakagawa using earthquakes of magnitude 2 or more in the JMA unified catalog from January 1, 1996 to October 30, 2018. The map of epicenters indicates that almost all are inland earthquakes within a western coastal zone extending 40km east-west and 200km north-south with very few earthquakes located in the east side of the Sea of Okhotsk. Here we focus on the earthquake activity in the northern half of the zone (44.2˚N - 45.5˚N; 141.5˚E - 142.5˚E). The topical earthquake swarm and slow earthquake near Nakagawa occurred when the general earthquake activity was at its highest. We apply the Gutenberg-Richter frequency-magnitude formula (G-R law) to our earthquakes set and obtain a b-value of 0.87 that is somewhat small but almost normal. This current seismic activity is also useful in considering future potential damages in northern Hokkaido. The largest earthquake magnitude from the G-R relation is estimated to be about $M_{JMA}5$ consistent with the fact that few moderate to larger earthquakes with magnitude (M_{JMA}) greater than 5 have occurred in the research region. Our results are limited by the number of earthquakes in the region since the installation of the high density network in late 1990. In 2007, the Headquarters for Earthquake Research Promotion, an office of Japanese government estimated the magnitude of the biggest earthquake of $M_{JMA =}$ 7.6 if the Sarobetsu fault zone in northern Hokkaido fails over its entire zone. Since we have a catalog for a certain time interval (2.7 years) the straight line projection to higher magnitudes gives an estimate of the probability of having a larger earthquake. Projecting the line to say M_{max} =7.6 expected gives a value of 0.0055, implying that we could expect one M_{max} =7.6 in 183 years. We are aware that such a long term projection based on a relatively short data interval is subject to significant error. As earthquake data are added in the future, this aspect should be reexamined.

Keywords: Earthquake activity in northern Hokkaido, Earthquake zone in the western margin of Okhotsk sea plate, Earthquake swarm, Slow earthquake, Gutenberg-Richter law, b-value

