Spatial and temporal *b*-value distributions in and around Shinmoe-dake, Kirishima volcano, Japan

*Keita Chiba[1], Hiroshi Shimizu[1]

1. Institute of Seismology and Volcanology, Faculty of Science, Kyushu University

Kirishima Shinmoe-dake is an active volcano located in the southern Kyushu, Japan. Shinmoe-dake erupted from 11 to 17 October 2017 after six years of quiescence since 2011. In addition to the 2011 and 2017 eruptions, small phreatic eruptions occurred at Shinmoe-dake in 2008 and 2010. We thus examined spatial and temporal variations of *b*-values to clarify volcanic activities and the magma plumbing systems in and around Shimoe-dake, using catalog data of volcanic earthquakes in and around Kirishima volcano constructed by Japan Meteorological Agency (JMA). We used 2541 volcano-tectonic events that occurred between 1 January 2007 and 26 October 2017, and used the ZMAP software package (Wiemer 2001) for *b*-value calculations. As a result, it was found that a region with relatively high *b*-values (*b* ~ 1.5) was located at depths of -1.0 to 2.0 km in the sea level beneath the summit. It is considered that this anomaly region was generated by crustal heterogeneity since pressure sources were observed in this region. Next, referring to hypocenters distribution in and around Shinmoe-dake, we investigated temporal variations of *b*-values from January 2007 to October 2017 in the regions beneath the summit (region A) and about 7.0-8.0 km northwest of the summit (region B), respectively. An increase in the *b*-value (*b* ~ 1.4) in region A was observed beginning in early 2009, followed by a subsequent decrease (*b* ~ 0.9) immediately before and during the 2011 eruption. The 2010 phreatic eruption occurred during this increasing period of the *b*-values. Therefore, the increase of the *b*-values was likely attributed to the increasing of the density of smaller faults and cracks due to the penetration of hot fluids related to the 2010 phreatic eruption and a resultant reduction of effective normal stress in region A. Besides, the subsequent decrease of the *b*-values was attributed to growing of a dense network of crack related to the 2011 eruption in region A and subsequently producing higher magnitude earthquakes. On the other hand, decreases in *b*-values (*b* ~ 0.6) were observed in region B during the 2011 and 2017 eruptions, respectively. Region B where the temporal changes of the *b*-values were observed corresponds to the region above the magma chamber related to the 2011 and 2017 eruptions. Thus, it is possible that the decreases in *b*-value in region B result from the activation of small cracks and the development of these crack systems, producing higher magnitude earthquakes, and/or a change in the stress field near the magma chamber.

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