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Activity of crustal earthquakes in and around the Kirishima volcano synchronizing and activating with ground inflations

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Crustal earthquakes in and around volcanoes may become active by static stress changes caused by magma stores at the major reservoirs beneath the volcanoes. We detected the numbers of the earthquakes in and around the Kirishima volcano increased in 2002, 2006, and 2009. The timings of the increase nearly agree with the timings of inflation of the magma chamber beneath the volcano shown by temporal changes of a baseline length between 2 stations of GEONET. In this study, we discuss the relation between increases of the earthquake and crustal deformation.

A seismic network of Nansei-Toko Observatory for Earthquakes and Volcanoes, Kagoshima Univ. (NOEV) has observed the earthquakes around southern Kyushu. The network can locate earthquakes in and around the volcano larger than or equal to M0.8 since October, 2000 incorporating data from Kyushu Univ., JMA, and Hi-net (Mori, 2001). Therefore, we can follow the seismicity in and around the volcano on equal condition for 11 years long from 2001 through 2011. The authors compared the cumulative number of these earthquakes with the length change of the GPS baseline between Ebino (960714) and Makizono (950486) of GEONET (GSJ, 2011) in time domain. Also we calculated the numbers per day (NPD) of the earthquakes every month through the period. The increases of the average NPD (ANPD) synchronized with the relaxations of shortening or distinct extension of the baseline. The ANPD increases from 0.1-0.2 at the first half year in 2002 to 0.8-1.0 in 2003, and changes from 0.3 at the first quarter in 2006 to 0.7 after the period. The ANPD also increase from 0.8 in December, 2009 to 1.3 through 2010. Previous studies reported the slight changes of Coulomb failure stress (only 0.01-0.1MPa) caused the increase or decrease of the earthquakes (e.g. Reasenberg and Simpson, 1992; Toda et al., 1998). Changes of static stress with the inflations of the main magma chamber beneath the volcano may cause the changes of the seismicity (ANPD).

Crustal earthquakes also may arise tectonically by the plate motions. We hope the earthquakes mainly caused by the magma pressure increase can be distinguished. We therefore calculated z values (e.g. Habermann, 1983; Wiemer and Wyss, 1992) to extract the earthquakes with inflating the volcano edifice. The positive and negative numbers of the z value show decreases and increases of the seismicity rate of interesting areas, respectively. We compared the z values between the first and second half year of 2010 when the most distinct extension of the GPS baseline has been observed. We got negative z values beneath the southwest, northeast, and northwest flank of the Kirishima volcano. The static stress changes by magmatic inflations cause the earthquake activities in these areas. The authors also analyzed the source mechanisms of the earthquakes to examine whether the temporal change of the main principal stress axis exists or not. As a result, we observed no obvious change of the axis. The crustal earthquakes around the area of negative z value may occur on existing faults with static stress changes produced by magma accumulations in the chamber (Morita and Ohminato, 2005).

Keywords: Kirishima Volcano, seismicity