

The effect of the 1611 Sanriku earthquake on volcanic activity in Hokkaido, Japan

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After several thousand years dormancy, three active volcanoes in southwestern Hokkaido (SW Hokkaido), Hokkaido-Komagatake, Usu and Tarumai volcanoes, started their eruptive period with large eruptions of VEI=5 during AD 1640 to 1667. It has been discussed that these could be caused by the 1611 Sanriku earthquake ($M > 8$). It has been recently proposed that the source of the earthquake was distributed widely from off the eastern coast of Hokkaido to the Sanriku area. In this research, I compile the eruptive history of active volcanoes in Hokkaido to clarify the regional difference of the eruptive activity around 17th century. In addition, I also compile the structure and eruptive processes of magma plumbing system of these three volcanoes to discuss the relationship between earthquake and volcanic eruption. Relatively large eruptions occurred in Hokkaido during end of Pliocene to early Holocene. In E Hokkaido belonging to Kuril arc, two large eruptions of Me-Akandake (VEI=5) and Mashu volcanoes (VEI=6) occurred 13 and 7 ka, respectively. Nigorikawa and Tarumai volcanoes in SW Hokkaido belonging to NE Japan arc occurred a large eruption of VEI=5 9 and 7 ka, respectively. Since then, volcanoes in E Hokkaido, such as volcanoes in the Shiretoko peninsula, Masu, Atosanupuri, Me-Akan and O-Akan volcanoes, had been active until ca. 1000 years ago. On the other hand, in SW Hokkaido, although a large eruption of VEI=5 occurred in Tarumai volcano, smaller eruptions of VEI<3 sporadically occurred in other volcanoes. In summary, eruptive activity in SW Hokkaido had been quite lower than that of E Hokkaido since ca. 5000 years ago. In contrast, the eruptive activity of volcanoes in central Hokkaido belonging to the boundary between the two arcs has been relatively low. A large eruption of VEI>4 has not occurred in the region. In 17th century, as mentioned above, three volcanoes in SW Hokkaido started vigorous eruptive activity and has continued their activity until now. Other volcanoes adjacent these three volcanoes have also started their activity since then. In contrast, although two relatively large eruptions occurred in Mashu and Me-Akandake volcanoes ca. 1ka, and Rausu volcano ca. 0.7ka, eruptive activity of volcanoes in E Hokkaido has been quite weak since then. Although small magmatic eruption have sporadically occurred in Tokachidake volcano in central Hokkaido, no magmatic eruptions have occurred in E Hokkaido at least since 17th century. Considering temporal change of eruptive activity of active volcanoes in Hokkaido during Holocene, if 1611 Sanriku earthquake affected the volcanic activity, it should be emphasized that the earthquake had reduced eruptive activity in E Hokkaido, whereas it had caused sequential eruptions in SW Hokkaido. In other word, the earthquake caused distinct influences to southwestern and eastern part of Hokkaido, respectively.

Eruptive history, the structure of magma plumbing system and its eruption processes of these three volcanoes in SW Hokkaido are summarized as follows. 1) Each volcano started its eruptive activity after a long dormancy. 2) Although whole-rock chemistry of major eruptive magma is silicic, ranging from dacitic andesite to rhyolite, whereas their melt compositions are similar rhyolite. 3) Each initial eruption had been caused by the injection of mafic magma into the above silicic magma less than several years before eruption. These features suggest that enough volume of silicic magma had been accumulated in each volcano. Thus, a large earthquake could affect the activity of a volcano to cause mafic injection and/or activation of a voluminous silicic magma chamber. However, there existed the interval of 30 years between the earthquake and the initial eruption in AD 1640. This would not be consistent with the 1611 Sanriku explanation that the earthquake caused sequential large eruptions in SW Hokkaido.

Keywords: volcanic eruption, earthquake, Hokkaido, 1611 Sanriku earthquake, magma chamber