Eruption History and Future Scenario of Sinabung volcano, North Sumatra, Indonesia

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Sinabung volcano is an andesitic stratovolcano located 40 km northwest of Lake Toba, North Sumatra. It is characterized by multiple thick lava flows/domes, and their collapsed materials (block-and-ash flow and associated surge deposits). The latest lava spine is located at the southern end of one of the summit craters which trend in N-S. Historical eruptions have not been reported prior to the phreatic eruptions of August-September 2010. The latest eruption caused panic among the people living around the volcano. We conducted geological survey, geochemical analyses and dating of charcoal samples to establish the future eruption scenario based on the eruption history.

The activity of Sinabung volcano began after the last caldera-forming eruption of Toba Lake (ca. 74ka). The volcanic history of Sinabung volcano can be divided into two stages (old and young stages), based on the topographical and geochemical features. The old stage is the activity of lava flows of porphyritic, two-pyroxenes andesite with/without hornblende, which are exposed in the dissected western area. The young stage is the activity of lava flows and pyroclastic deposits of porphyritic, two-pyroxene basaltic-andesite to hornblende two-pyroxenes andesite, which are distributed in the eastern part of edifice including summit domes. The youngest block-and-ash flow and associated surge deposits on the southeastern flank were emplaced at ca. 1.1 ka, based on the radiocarbon ages of charcoals (1145±20 and 1155±20 years BP). Mafic enclaves are commonly found in lavas, suggesting common magma mixing or mingling before eruption in this volcano. Pyroclastic fall deposits of plinian- to subplinian eruptions were not found, implying no occurrence of large explosive explosions in this volcano throughout its history.

One of the plausible scenarios for future eruption is a dome-forming eruption or lava flowing from near the summit. During dome growth, partial collapse of the lava dome will generate block-and-ash flows and surges. If a large lava dome grows at the summit crater, the most serious scenario is a failure of the old and weak volcanic edifice due to the load of the dome or deformation by lava intrusion. Relatively large-scale collapse of the volcanic edifice may generate a lateral blast preceding the pyroclastic avalanche, as observed in the 1997 event at Soufrière Hills volcano, Montserrat, where the crater wall overridden by the growing lava dome collapsed together with a part of the overlying dome.

If magma is less viscous due to low SiO2 content or higher temperature driven by a high effusion rate, lava will flow down on the flank from the summit crater, being associated with minor pyroclastic flows from the flow front.

Evolution of scenarios may be forecastable by continuous monitoring of volcanic earthquakes and ground deformation.