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The next-generation real-time volcano hazard assessment system

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Many approaches have been employed to mitigate volcanic hazards. Next-generation approaches will focus on real-time volcano hazard assessment, which is useful for volcanic eruption prediction, risk assessments, and evacuation at the various stages during the volcanic eruptions. Development of a real-time hazard assessment system is a priority effort for the near future.

1. Volcanic eruption scenarios

Defining volcanic eruption scenarios based upon precursor phenomena leading up to major eruptions at active volcanoes is quite important for the future prediction of volcanic eruptions. Important datasets to use include precursor phenomena such as dates of minor eruptions, distribution of tephra fall deposits, amount of essential materials, chemical composition variations, volcanic tremors, and GPS measurement. Compiling volcanic eruption scenarios after the major eruptions is also important. For prehistoric volcanic eruptions, detailed geological field work and dating are essential. Eruption dates, vent positions, and distributions of each volcanic deposit should be examined. Eruption volumes of each deposit should be reevaluated using a standard estimation method based on the more precise distributions. Well-constrained volumes and eruption age data are important inputs in making a high-quality volume-age diagram for the probabilistic analysis of future eruptions.

2. Volcanic eruption database

A high-quality volcanic eruption database, which compiles eruption age, eruption volume, and eruption styles, is important for the next-generation volcano hazard assessment system. The Global Volcano Model project is an ongoing effort, which includes the compilation of volcanic eruption database and makes risk assessment worldwide. Distributions of deposits should be stored in a GIS-based format.

3. Simulations

The volcanic eruption database is made based on past eruption results, which only represent a subset of possible future scenarios. Hence, different distributions from the previous deposits are mostly observed due to the differences, such as vent position, volume, eruption rate, wind directions and topography. Therefore, numerical simulations with controlling parameters are needed for more precise volcanic eruption predictions. Numerical simulations of pyroclastic flows, debris avalanches, lava flows, tephra falls, ballistic, and lahars should be done for major past eruptions at the major active volcanoes, and key parameters should be evaluated. Currently, many numerical simulations, such as Energy cone, LaharZ, PDAC, Titan2D, and VolcFlow are used for volcanic gravity current assessments. Appropriate simulation model should be selected with the consideration on the model's merits and demerits and on the purpose of the assessment. Online numerical simulations are provided by the GEO Grid volcanic gravity flow system and the V-Hub project.

4. Volcanic hazard assessment system

The next-generation real-time volcano hazard assessment system is should be developed based on volcanic eruption scenario datasets, volcanic eruption database, and numerical simulations. The use of next-generation system should enable the visualization of past volcanic eruptions datasets such as distributions, eruption volumes and eruption rates, on maps and diagrams using the timeline and GIS technology. In the system, prediction of arrival time and area affected by volcanic eruptions at any locations near the volcanic area should be possible, using numerical simulations. The system should estimate the volcanic hazard risks by overlaying the distributions of the volcanic deposits on major roads, houses and evacuation areas using a GIS enabled systems. Probabilistic volcanic hazards maps at active volcanoes sites should be made based on numerous numerical simulations. The next-generation real-time hazard assessment system would be implemented as a user-friendly interface, making risk assessment system accessible online anywhere in the world.

Keywords: volcanic hazard, real-time, next-generation, volcanic eruption scenario, volcano eruption database, simulation