GEO Grid volcanic gravity flow simulation system for the next-generation real-time hazard mapping: an application to the recent 2011 eruption at Shinmoedake, Kirishima Volcano, Japan

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1. GEO Grid Project

GEO Grid is an infrastructure to accelerate GEO sciences related information retrieval, storage and processing based on the concept of virtual integration of all data related to earth observation, with certain access management. The GEO Grid system using a set of Grid and Web service technologies would be easy to handle by the end users. Numerical simulation of volcanic gravity flows on volcanoes is one of the major applications of the GEO Grid project.

http://volcano.geogrid.org/applications/energycone/

2. Next-Generation Real-time Hazard mapping

Volcanic disaster mitigation maps (volcanic hazard maps) are available for most major active volcanoes in Japan. A web-based GIS system combining various types of information with real-time numerical simulations are necessary for the next generation of volcanic hazard mapping system.

3. GEO Grid Volcanic Gravity Flow Simulation

Volcanic gravity flow simulations using the energy cone model are currently implemented on the GEO Grid system. An interactive user interface to evaluate the probability of an area to be affected by volcanic gravity flows is available on the GEO Grid website. Presently, the volcanic gravity flow simulations are available for 14 volcanoes, such as Kirishima, Unzen, Uzu, Mokara and St. Helens. It is also possible to update the digital elevation model (DEM) during the eruptions by taking new ASTER satellite data. Runtime of the simulation is very fast, taking 10-15 seconds to 3 minutes, due to the speed of grid computing system. The OGC’s Web Coverage Service (WCS) and Web Mapping Service (WMS) are used in the system. The simulation results could be downloadable as shape and KML files. It is thus possible for users to evaluate potential affected area by volcanic gravity flows using Google Earth or GIS system, overlaying evacuation route and various important facilities such as schools and hospitals.

4. Application to the 2011 Kirishima Eruption

The GEO Grid simulation system was used on these eruptions to evaluate the potential pyroclastic flows to the surrounding area from these volcanoes. The GEO Grid energy cone simulation system is useful to evaluate the potential danger zone in this area. We assumed losenous-type pyroclastic flows derived from the column collapse based on the occurrence of the 1718-17 pyroclastic flow deposits. The column collapse height (Hc) was changed from 160 to 1000 m. The equivalent friction coefficient of pyroclastic flows was estimated from 0.2 to 0.4 based on historical data. The best-fit case was Hc=400-500 m and Hc=300m compared to the distribution of the 1718-17 pyroclastic flow deposits. This result suggests that relatively higher mobility pyroclastic flows (Hc=200-300 m) may occur from a column collapse even if the collapse height is only 100-200 m above the crater rim.

5. Future Plan

The ASTER Global DEM (O-Dem, 30m resolution), STRM (30m) and GSI 18m DEMs are planned to be installed on the GEO Grid system in the near future. With this information, users could simulate any volcanic gravity flow for any volcanoes in the world on the GEO Grid simulation system. The energy cone simulation of the GEO Grid system could be applied to other geological hazards such as debris avalanches and landslides. The gravity flow simulation is open to all scientists in the world. More sophisticated simulations such as Titan 2D and LAMARZ and the usage of ALOS satellite data such as PALSAR and PRISM (2.5m resolution) should be installed on the GEO Grid system in the near future. Collaboration between the GEO Grid and the V-Web projects is another important target.