Detection of Strombolian Activity in Satellite Data

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Strombolian activity across the remote volcanoes of the Aleutian Islands and Kamchatka Peninsula cannot be monitored easily or safely by direct methods. Satellite remote sensing offers a useful means to routinely monitor these volcanoes.

In order to model the expected time-dependent thermal signal recorded by the satellite/sensors, we carried out laboratory-based experiments and collected field data for cooling spatter and bomb fields. Preliminary laboratory work was focused on finding an acceptable lava analog, as well as appropriately scaled pressures and vent sizes. Honey emitted from 0.5-3.8 cm diameter vents by explosions with pressures of around 0.05 MPa seemed to work the best. Scaled explosions were recorded with a FLIR thermal camera and a digital video camera. Explosions at Stromboli Volcano in Italy were also recorded with the same thermal camera over a period of days in May and June, 2010, and were compared to the scaled explosions. In both the modeled and actual explosions, vent diameter directly dictates the type of explosion and deposit distribution ranging from intense jetting from small vents to diffuse spattering from larger vents. The style of emission controls the area of, and distribution of bombs within, the resulting bomb field. This, in turn, influences the cooling rate of the bomb field.

The cooling rate of spatter and bomb fields (most likely the source of thermal anomalies in satellite data) for both modeled and actual explosions compared well, and is on the order of seconds to minutes. For a single explosion of average size, the thermal signal is detectable by satellite for a time period in terms of tens of seconds. Thus, in order to see a thermal signature related to a strombolian explosion, a satellite must pass over the volcano (with acceptable geometries) within about a minute of an explosion. A volcano with 70 explosions per day would produce roughly an hour of detectable thermal anomalies. With about a dozen possible NOAA and NASA satellite overpasses daily, dependent on weather and viewing geometry, an anomaly would be seen every couple of days and almost certainly once a week. Satellite images from Stromboli volcano in Italy, Mt. Chuginadak (Cleveland) and Shishaldin volcanoes in Alaska, and Karymsky volcano in Kamchatka are analyzed to detect thermal anomalies likely associated with strombolian explosions and determine the relative frequency of activity. By calibrating events observed by satellite with events recorded in infrasonic, seismic, and FLIR data a tool can be developed to gauge increasing or decreasing strombolian activity at remote volcanoes.