The 2006 Earthquake Swarm in the Sulu Range, Central New Britain, Papua New Guinea

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Summary

On 6th July 2006, an intense swarm of earthquake activity began in the Sulu Range, Central New Britain, Papua New Guinea. The earthquakes were felt almost every one to two minutes, 24 hours a day, with modified Mercalli intensities of MM1 to MM4. They were accompanied by unusual vigorous activity in the hot springs southwest of the Sulu Range. Fearing a possible eruption and tsunami, about 1000 locals were evacuated.

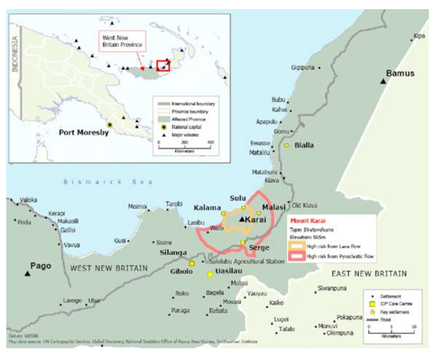

Figure 1. Locality Map showing areas likely to be affected by an eruption of Mt Karai, as well as the evacuation centres

Figure 2. Unusual activity of the hot springs in the Silanga area

Geological and Tectonic Setting

The Sulu Range consists of a cluster five small partially overlapping volcanoes which are part of the Bismarck Volcanic Arc resulting from the subduction of the Solomon Sea plate beneath the South Bismarck plate. There are no known recent eruptions in the Sulu Range.

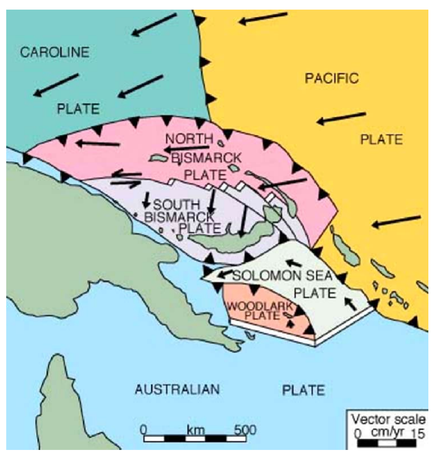

Figure 3. Tectonic setting of the Bismark Volcanic Arc

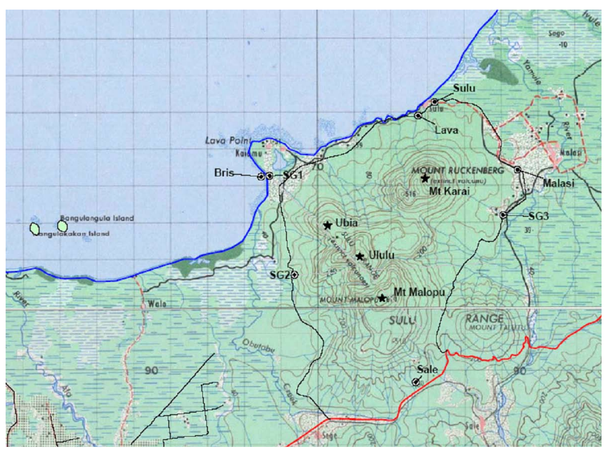

Figure 4. Detailed map of the Sullu Range

Instrument Deployment and Data Analysis

Five Kelunji Echo digital seismographs were deployed with 3-component seismometers and data were downloaded every one to three days.

More than 2000 earthquakes per day were recorded by station KAI at Kaiamu during the first 3 days of the installation.

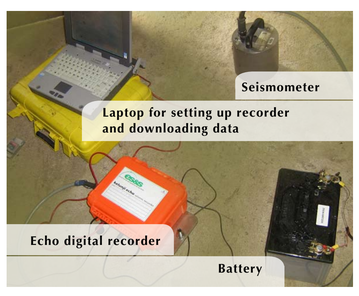

Figure 5. Digital seimograph

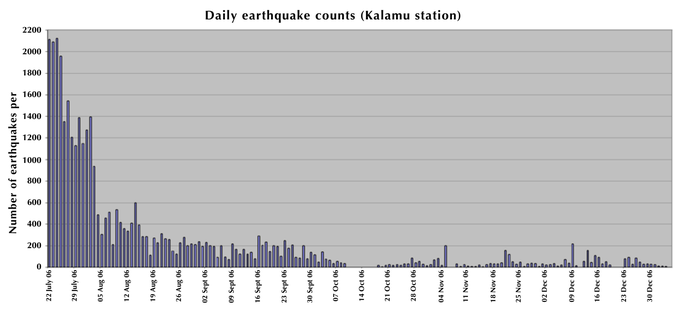

Figure 6. Daily earthquake counts at Kaiamu

The Magnitude 6.4 Earthquake of 19 July 2006

Two weeks after the activity commenced a magnitude 6.4 earthquake occurred 40km northwest of the Sulu Range followed by a magnitude 5.9 a few hours later, causing damage to houses and cracks in the ground surface.

Figure 7. Surface cracking at Tarobi near the epicenter and damage to houses

Observations and Results

A sample of the earthquake locations were reviewed and plotted in a 3D volume. The majority of the events are concentrated in a cylindrical cluster about 2 km wide, extending southwest from the Sulu Range for a distance of about 13 km, and at a depth between about 4 and 9 km. They are shallowest beneath the Sulu Range.

The earthquakes are confined to the northeast of a plane passing through the location of the magnitude 6.4 event. This plane is also evident in a second, deeper and more diffuse cluster of earthquakes which lies below the main swarm and extends northwestwards as far as the coastline. It is inferred that this demarcation marks the location of a major strike-slip fault trending northwest-southeast.

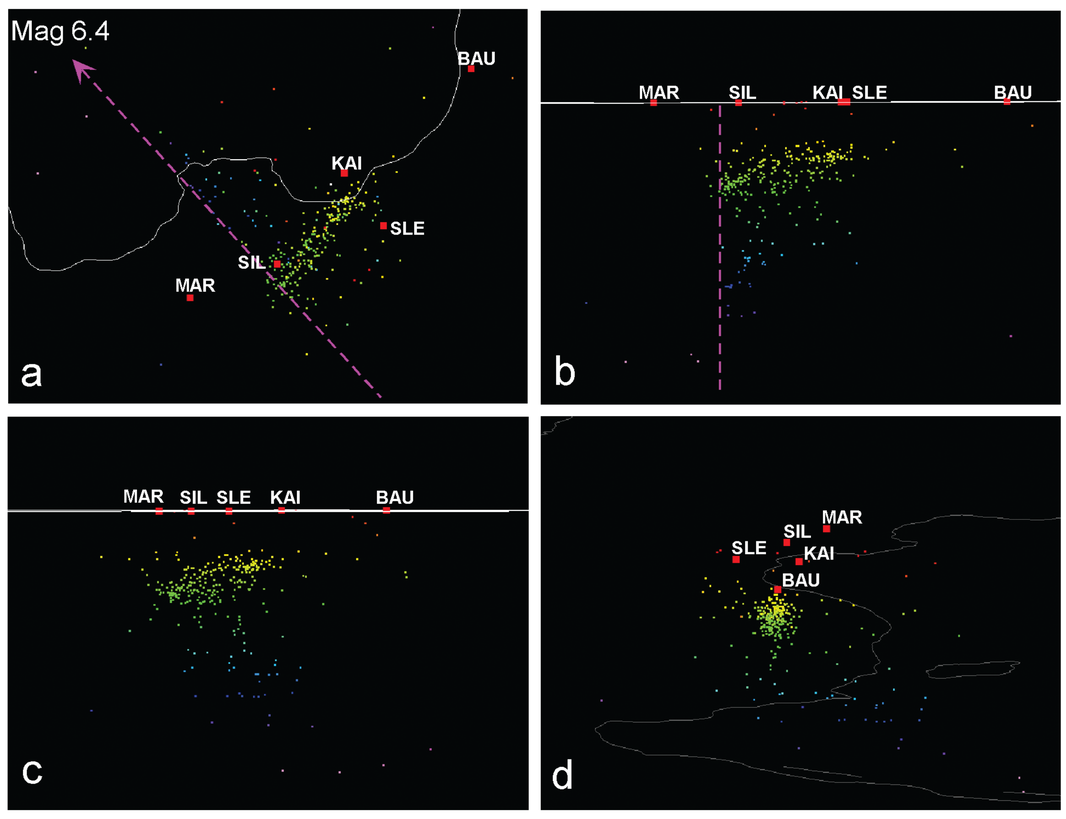

Figure 8. A small sample of the earthquakes in the swarm, coloured by depth. a) Viewed from the top, with seismic recording stations; dashed line passes through location of magnitude 6.4 earthquake and edge of swarm activity; b) From the southeast, looking along the northwest-southeast vertical plane through the magnitude 6.4 earthquake; c) From the east; d) Elevated view from the northeast, looking down the axis of the earthquake swarm.

Evidence of deformation due to a possible intrusion of magma is apparent in InSar radar interferometry images derived by the US Geological Survey, and supported by evidence from repeat leveling by RVO. Elevation of the ground surface occurred above the shallow earthquakes of the swarm and subsidence occurred to the northwest along the coast. Photographs taken in October 2007 show evidence of subsidence along the coastline north of the Sulu Range and the geothermal area.

Figure 9. Vegetation killed by inundation of the sea along the coastline, west of Kaiamu and north of the geothermal field, where the Insar radar interferometry indicates subsidence

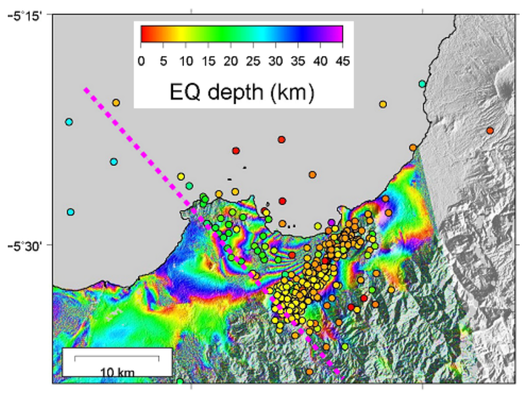

Figure 10. Radar interferometery (InSar) image and earthquakes overlain on the topography. Earthquakes are coloured by depth. Dashed line passes through location of magnitude 6.4 earthquake and edge of swarm activity (InSar Image from Wicks and others, 2007)

Discussion

The earthquake swarm beneath the Sulu Range was comprised of volcano-tectonic (VT) events. Volcanic tremor, a direct indicator of magma movement, was not observed. However, intrusion is inferred from InSar, leveling and photographic evidence. The occurrence of volcanic earthquake swarms commonly precedes an eruption, but this did not eventuate. Determining the most probable depth at which the magma stalled is an objective of the current work. The vast geothermal area southwest of Sulu Range, which lies directly above the earthquake swarm, may have influenced the progression of the magma intrusion and resulted in the decline of the activity.

Further work will be undertaken to investigate the development of any intrusion and its relationship to the regional tectonics. An outcome of this research will be a better understanding of the causes and behaviour of any future swarms in the Sulu Range, so that appropriate emergency management measures can be emplaced. The findings may also be applicable to other volcanic regions in Papua New Guinea, and areas with a similar tectonic setting.

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