Journal of Volcanology and Geothermal Research 302 (2015) 199–210

Contents lists available at ScienceDirect

Journal of Volcanology and Geothermal Research

journal homepage: www.elsevier.com/locate/jvolgeores

Magma extrusion during the Ubinas 2013–2014 eruptive crisis based on satellite thermal imaging (MIROVA) and ground-based monitoring

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ARTICLE INFO

Article history:
Received 24 February 2015
Accepted 3 July 2015
Available online 15 July 2015

Keywords:
Ubinas
MIROVA
Thermal anomalies
Extrusion rate
Iquique earthquake

ABSTRACT

After 3 years of mild gases emissions, the Ubinas volcano entered in a new eruptive phase on September 2nd, 2013. The MIROVA system (a space-based volcanic hot-spot detection system), allowed us to detect in near real time the thermal emissions associated with the eruption and provided early evidence of magma extrusion within the deep summit crater. By combining IR data with plume height, sulfur emissions, hot spring temperatures and seismic activity, we interpret the thermal output detected over Ubinas in terms of extrusion rates associated to the eruption. We suggest that the 2013–2014 eruptive crisis can be subdivided into three main phases: (*i*) shallow magma intrusion inside the edifice, (ii) extrusion and growing of a lava plug at the bottom of the summit crater coupled with increasing explosive activity and finally, (iii) disruption of the lava plug and gradual decline of the explosive activity. The occurrence of the 8.2 Mw Iquique (Chile) earthquake (365 km away from Ubinas) on April 1st, 2014, may have perturbed most of the analyzed parameters, suggesting a prompt interaction with the ongoing volcanic activity. In particular, the analysis of thermal and seismic datasets shows that the earthquake may have promoted the most intense thermal and explosive phase that culminated in a major explosion on April 19th, 2014.

These results reveal the efficiency of space-based thermal observations in detecting the extrusion of hot magma within deep volcanic craters and in tracking its evolution. We emphasize that, in combination with other geophysical and geochemical datasets, MIROVA is an essential tool for monitoring remote volcanoes with rather difficult accessibility, like those of the Andes that reach remarkably high altitudes.

1. Introduction

The Andes, one of Earth's highest subaerial mountain ranges, host more Holocene active volcanoes than any other volcanic region in the world (Tilling, 2009) but less than 25 of the ~200 potentially active volcanoes are continuously monitored (Stern, 2004). Within the last decades, population growth and economic development within the Andean countries drastically increased volcanic risk within the areas surrounding active volcanoes.

The highly elevated (>4000 m) region of southern Peru is a unique example because it hosts seven active volcanoes located at less than 160 km from Arequipa, the 2nd most important city of Peru (with nearly 1 million inhabitants). The same area was also the site of largest

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http://dx.doi.org/10.1016/j.jvolgeores.2015.07.005
0377-0273/