

# Volatile budget of the 2011 Cordón Caulle eruption, Southern Volcanic Zone, Chile

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**Abstract.** Cordón Caulle, a basaltic to rhyolitic volcanic complex that hosts diverse monogenetic volcanic centres, started to erupt 4 June 2011 producing ~11 km eruptive column above the crater. Subsequently, a permanent ash plume (2-7 km altitude) has been emitted, decreasing considerably in ash content and altitude (< 2 km). Three different approaches (melt inclusions, microprobe analysis and satellite imagery) have been used to assess the volatile budget. Melt inclusions and microprobe analysis in pumice samples (72 wt% SiO<sub>2</sub>) gave consistent results for S, Cl and F. Similar volatile concentrations were estimated both melt inclusions and satellite data (OMI and AIRS), suggesting that ~0.2Mt of SO<sub>2</sub> were released from the initial explosive phase.

**Key Words:** Melt Inclusion, Satellite Data, Microprobe analysis, Cordón Caulle

## 1 Introduction

Estimates of volatile budgets for volcanic eruptions are often based on volatile concentrations measured in melt inclusions (MIs) versus groundmass glass (e.g. Gurenko et al., 2005, Moune et al., 2007) and on measurements made by direct sampling and remote sensing techniques (e.g. Aiuppa et al., 2004).

The eruption from the Cordón Caulle volcanic complex began on 4 June 2011 and produced a 5-km-wide ash-and-gas plume that rose to an altitude of ~11 km above the crater. Subsequently, the eruption produced an ash plume which altitude has varied between 7 and 2 km above the crater. Since February 2012 the activity has decreased considerably, with columns characterized by less ash contents and an altitude that range between 2 and 0.4 km above the crater.

We used three different approaches to assess the volatile budget (MIs, microprobe analysis and satellite imagery), how the volatile content of the magma controls the explosivity of such an eruption.

## 2 Geological setting

Cordón Caulle – Puyehue (40.590°S – 72.117°W, 2,236 m a.s.l.) is a Late Pleistocene to Holocene NW-SE elongate (13 km long and 6 km wide) volcanic chain that hosts a series of monogenetic volcanic centres (pumice cones, lava-domes and fissure vents) (Fig. 1). A wide composition of lava and pyroclastics products is present, ranging between basalts to rhyolites (48–72% SiO<sub>2</sub>; Gerlach et al., 1988). Along the southwestern border, the so-called Cordón Caulle Fissure (Moreno, 1977), historic fissure eruptions occurred in the years 1921–1922 and 1960. Among of thermal manifestations occur along Cordón Caulle (Fig. 1), characterized by presence of fumaroles, steaming ground, boiling pools, bubbling pools, mud pools, geysers and springs.

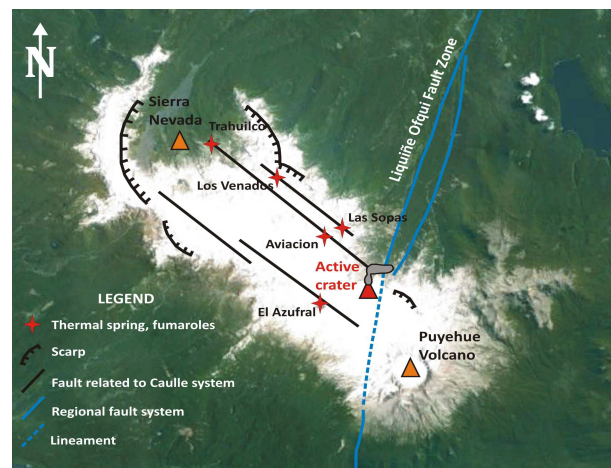


Figure 1. Location map of the study zone.

## 3. Results and discussion

Pumice samples were collected on June 18<sup>th</sup> along Puyehue international road, located ~25 km SE from eruptive centre. Volatile (S, Cl, F) and major element

concentrations were measured in MIs trapped in plagioclase (An<sub>54-56</sub>) and pyroxene (Mg<sub>#39-44</sub>) phenocrysts and also in groundmass. Homogeneous dacitic to rhyolitic compositions were observed in the MIs with maximum concentrations up to 160 ppm S, 2,600 ppm Cl and 800 ppm F. Consistently, microprobe analysis of glass from pumice samples indicate a rhyolitic composition (72 wt% SiO<sub>2</sub>) with maximum concentrations of volatiles up to 255 ppm SO<sub>3</sub>, 2,205 ppm Cl and 163 ppm F.

The difference between the maximum volatile concentrations in the MIs and those measured in the groundmass indicates that ~0.2Mt SO<sub>2</sub>, 0.5Mt HCl and 0.3Mt HF were released into the atmosphere during the Cordon Caulle eruption. Similarly, satellite remote sensing data from instruments in NASA's A-Train spacecraft constellation, including the Ozone Monitoring Instrument (OMI) on Aura and the Atmospheric Infrared Sounder (AIRS) on Aqua, indicate a total SO<sub>2</sub> emission of ~0.2 Mt from the initial explosive phase of the 2011 Cordon Caulle eruption.

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