Abstract The latest cycle of volcanism on Tenerife has involved the construction of two stratovolcanoes, Teide and Pico Viejo (PV), and numerous flank vent systems on the floor of the Las Cañadas Caldera, which has been partially infilled by magmatic products of the basanite–phonolite series. The only known substantial post-caldera explosive eruption occurred ∼2 ka BP from satellite vents at Montaña Blanca (MB), to the east of Teide and at PV. The MB eruption began with extrusion of ≈0.022 km³ of phonolite lava (unit I) from a WNW–ESE fissure system. The eruption then entered an explosive subplinian phase. Over a 7–11 hour period, 0.25 km³ (DRE) of phonolitic pumice (unit II) was deposited from a 15 km high subplinian column, dispersed to the NE by 10 m/s winds. Pyroclastic activity also occurred from vents near PV to the west of Teide. Fire-fountaining towards the end of the explosive phase formed a proximal welded spatter facies. The eruption closed with extrusion of small volume domes and lavas (≈0.025 km³) at both vent systems. Geochemical, petrological data and Fe–Ti oxide geothermometry indicate the eruption of a chemically and thermally stratified magma system. The most mafic and hottest (≈875 °C) unit I magma can yield the more evolved and cooler (755–825 °C) phonolites of units II and III by between 7 and 11% fractional crystallization of an assemblage dominated by alkali feldspar. Analyses of glass inclusions from phenocrysts by ion microprobe show that the pumice was derived from the water-saturated roof zone of a chamber containing 3.0–4.5 wt.% H₂O and abundant halogens (F ≈ 0.35 wt.%). Hotter, more mafic tephritic magma intermingled with the evolved phonolites in banded pumice, indicating the injection of mafic magma into the system during or just before eruption. Reconstruction of the event indicates a small chamber chemically stratified by in situ (side-wall) crystallization at a depth of 3–4 km below PV. Although phonolite is the dominant product of the youngest activity of the Teide–PV system, there has been no eruption of phonolitic magma for at least 500 years from Teide itself and for ∼2000 years from the PV system. Therefore there could be a large volume of highly evolved, volatile-rich magma accumulating in these magma systems. An eruption of fluorine-rich magma comparable with MB would have major damaging effects on the island.

Key words Phonolite stratovolcanoes · Subplinian eruptions · Tenerife

Introduction

The geology of the central part of Tenerife affords a spectacular view of the evolution of a long-lived alkaline volcanic system. The active system is the latest of four cycles of central magmatism. Each cycle erupted products which became increasingly felsic with time and terminated with caldera collapse events (Marti et al. 1994). The active system has entered a phase of felsic magma eruption and recently produced a substantial explosive eruption which forms the subject of this paper. The ∼2 ka eruption provides an insight into the evolving magmatic system beneath the Las Cañadas caldera. This study is part of the European Laboratory Volcanoes project and has the objective of assessing the future potential for explosive eruption from a detailed study of the system’s most recent history. As the most substantial explosive eruption of the current cycle it is important for the assessment of future volcanic risk on Tenerife.

The ∼2 ka eruption occurred from vents on Pico Viejo (PV) and Montaña Blanca (MB). These struc-
Fig. 1 Location and geological map of the Las Cañadas Caldera. The main map shows the geographical distribution of post-caldera volcanic rocks. Products from Teide, Pico Viejo, caldera floor vents and Montaña Blanca are shown. The MB complex is divided stratigraphically as shown in Fig. 2. Note that the distribution of the MB pumice (unit II A) shows the approximate extent of total coverage. Dotted lines signify the margins of AB lava flows partially buried by the MB pumice. AB, Arenas Blancas; MR, Montaña Rajada; ET, El Tabonal; MM, Montaña Majua; and S, Teide satellite vents. Map from photogeological and 1:10000 field data.

Geological setting

Tenerife is constructed almost entirely of volcanic rocks. Its early history involved the eruption of voluminous basanites and alkali basalts and the construction of a lava shield now exposed as massifs in the extremities of the island (Fig. 1, inset). About 3.0 Ma ago, a change in the geometry of eruptive centres, associated with an increase in the volumes of felsic magmas, occurred (Ancochea et al. 1989). A large central edifice, the Las Cañadas volcano, then developed, which was modified by continued eruptive activity and caldera collapse to produce the Las Cañadas Caldera (LCC), a large multiple collapse structure of at least three partially overlapping depressions created between 1.6 and 0.175 Ma ago (Marti et al. in press; Mitjavila and Villa in press).

Since the last phase of collapse, the LCC has been partially filled by volcanic products of the basanite-phonolite suite, erupted from numerous intra-caldera vents (Fig. 1). Activity has been particularly persistent in the northern part, resulting in the growth of two overlapping stratovolcanoes: Pico Teide (PT) (3718 m) and PV (3103 m). Stratigraphic studies indicate that for the latter part of their history they have been simultaneously active (G. J. Ablay, unpublished data). Other vents have erupted thick trachy-phonolitic flows and minor pumiceous fallout within the central part of the caldera.

Recent activity of the PT-PV (T-PV) magmatic system can be contrasted with pre-LCC activity. The upper pre-caldera succession is dominated by phonolitic pyroclastic deposits comprising repeated packages of voluminous, proximally welded ignimbrites and fallout horizons separated by subordinate basaltic and tephritic rocks. Three cycles of basaltic to phonolitic magmatism have been recognized (Marti et al. 1994), which young toward the east. The most voluminous explosive phonolitic eruptions correlate with episodes of caldera collapse. In contrast, the products of the post-LCC T-PV system comprise only a minor pyroclastic component. Montaña Blanca produced the only substantial known explosive eruption since the formation of the LCC.