Intensifying Seismicity beneath Mount Teide: Assessing the Probability of an Imminent Eruption on Tenerife

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Abstract

Recent seismic swarms in the western sector of the Las Cañadas Caldera (Tenerife, Canary Islands) have raised concerns regarding the potential for renewed eruptive activity at Teide. Although the earthquakes were of small magnitude and occurred at depths of around 6-12 km, their detection and media coverage generated public concern on an island visited by millions of tourists each year. Teide forms part of the Teide-Pico Viejo volcanic complex, located within the Las Cañadas Caldera. According to the national agency responsible for volcanic monitoring and early warning in Spain, the Instituto Geográfico Nacional (IGN), numerous small earthquakes have been recorded at depths of around 10 km beneath the central part of the island. Seismic swarms at such depths are relatively common in volcanic regions and usually reflect stress adjustments within the crust or the movement of fluids rather than magma ascent toward the surface. The absence of clear precursory signals indicates that the current seismicity represents typical volcanic unrest rather than an imminent eruption, highlighting the importance of clear communication of monitoring data in regions where active volcanoes coexist with dense populations and major tourist activity.

Keywords: seismicity, volcanic unrest, Teide, Tenerife

The Teide volcanic system

The Teide-Pico Viejo volcanic complex forms the youngest volcanic centre of Tenerife in the Canary Islands. It rises within the large Las Cañadas Caldera, a 16-km-wide depression produced by major volcanic collapses (≥ 200 Kyr ago), during the geological evolution of the island.

At 3,718 m above sea level, Teide is the highest peak in Spain and one of the largest volcanic edifices on Earth when measured from its submarine base. The present stratovolcano developed within the Las Cañadas caldera after a large landslide c. ~200,000 years ago. Together with the neighbouring Pico Viejo, Teide and its peripheral vents form the present-day central volcanic complex of Tenerife.

The eruptive history of this system includes both effusive basaltic eruptions along the island's rift zones and more evolved phonolitic eruptions from the central complex (Fig. 1). Several historical eruptions have occurred along the NW rift zone near the Teide-Pico Viejo complex, the 1909 eruption of Chinyero being the most recent one on the island. In contrast, the latest eruption associated with the central volcano corresponds to a medieval eruption of Teide, as described in detail by Carracedo and Troll in 2016, and was dated to about 1150 years before present (BP) from radiocarbon ages obtained on charcoal beneath the Lavas Negras flow.

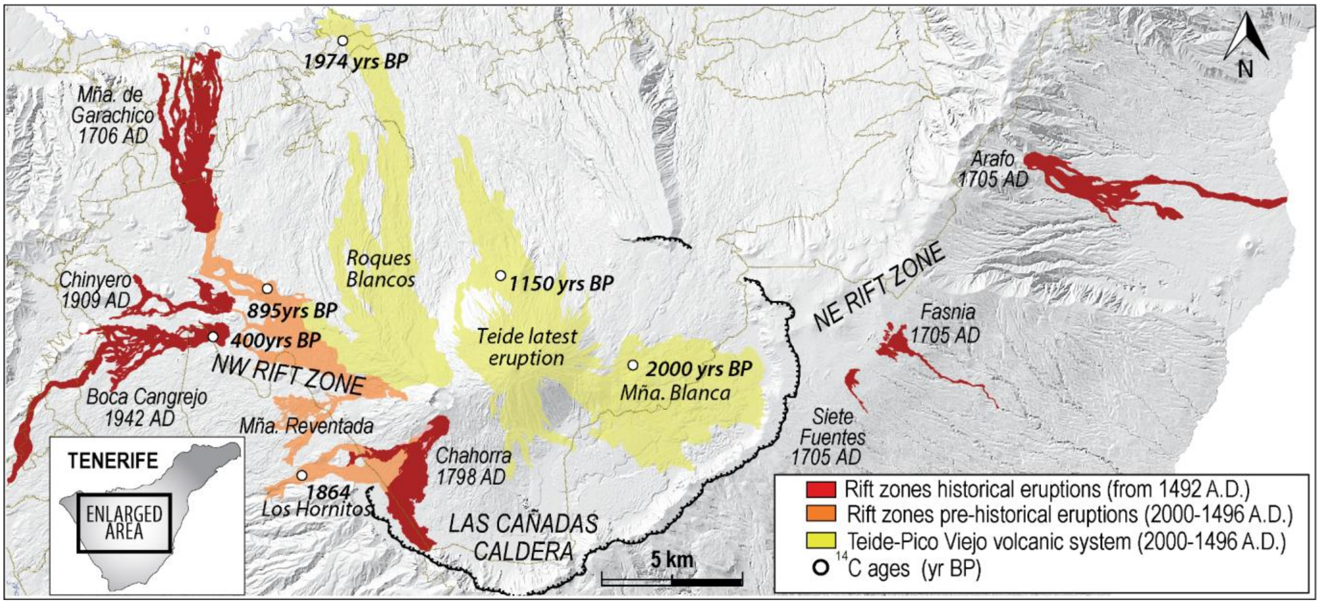

Fig. 1. Holocene volcanism in central Tenerife (Canary Islands, Spain). Two coexisting volcanic systems are evident: basaltic fissure eruptions (red) along the NW and NE rifts, and evolved phonolitic volcanism of the central Teide-Pico Viejo volcanic System (yellow).

Considering the recent volcanic history of Tenerife, the probability of future eruptions is considerably higher along the rift zones, particularly the western rift. There, seven eruptions have occurred during the last 2,000 years, four of them in historical times.

The central volcanic system followed a different evolutionary path. After a major flank collapse removed a large part of central Tenerife and deposited enormous volumes of debris on the ocean floor north of the island, the resulting depression began to refill with volcanic products. This initiated construction of the Teide edifice, first dominated by dense basaltic lavas but later dominated by more silica-rich phonolitic compositions.

As the volcanic edifice grew taller, the ascent of magma towards the summit became increasingly difficult. The pressure that the magma column must overcome increases with both the height of the conduit and the density of the magma, effectively imposing a density filter that inhibited the eruption of dense basaltic magmas from the central volcano and favoured lighter phonolitic lavas.

By about 30 ka the main stratovolcano had already reached an elevation of about 3,500 m, but continued activity led to the development of the Pico Viejo stratovolcano on the lower western flank and to the emplacement of several phonolitic domes and lava flows around the base of the complex. The youngest of these is the Roques Blancos dome and flows, dated to 1974 years BP (approximately the late first century BC).

Finally, the summit cone of Teide was built by highly evolved phonolitic obsidian lavas that raised the volcano to its present elevation of 3,718 m. The dome formed during the medieval eruption that produced the Lavas Negras flows, dated to about 1150 years BP (around AD 800). Given that this eruption predates the European colonisation of Tenerife, no historical records exist.

Overall, eruptive activity within the central volcanic system is relatively limited compared with that of the rift zones, particularly the western rift, where most recent eruptions on the island have occurred.

Despite the long repose intervals between eruptions, recent seismic unrest beneath central Tenerife indicates that the magmatic system beneath the island remains active at depth.

Historical eruptions on Tenerife

Historical volcanism in Tenerife has been relatively limited and is restricted to flank eruptions associated with the island's rift systems (shown in red in Fig. 1 and green in Fig. 2A). Since the European conquest in the late 15th century, only a few eruptions have been documented. These include the eruptions of Siete Fuentes, Fasnia, and Arafo (1704-1705) along the NE rift, the eruption of Mña. de Garachico Volcano (also known as Trebejos Volcano) that destroyed the port of Garachico in 1706 along the NW rift, the eruption of Narices del Teide (also known as Chahorra Volcano) on the western flank of Pico Viejo in 1798 (Fig. 2B), and the eruption of Chinyero Volcano in 1909 along the NW rift, the latest in Tenerife.

All these eruptions were basaltic and characterized by Strombolian activity and lava flows. In contrast, no historical eruptions have occurred at the summit of the central complex dominated by Teide Volcano, highlighting the predominant role of the rift zones in recent volcanism on the island.

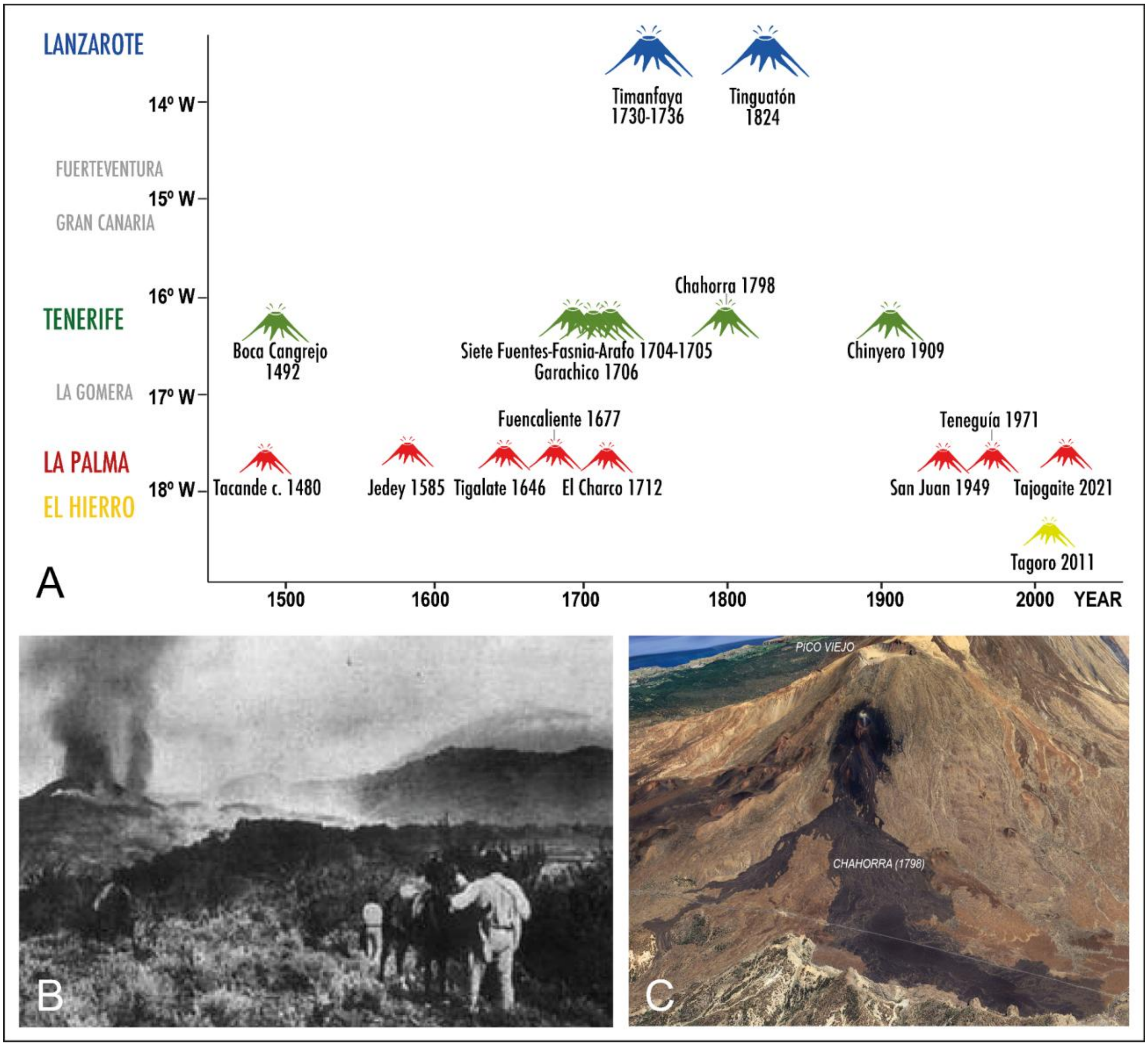

Fig. 2. **(A)** Holocene volcanism and inter-eruptive intervals in the Canary Islands. The latest eruptive activity of the central volcanic system (Teide-Pico Viejo) predates the Holocene interval shown here. **(B)** The 1798 Chahorra (Narices del Teide) eruption along the NW rift, Tenerife. **(C)** Contemporary photograph during the eruption of Chinyero volcano (Centro de Fotografía Isla de Tenerife).

Recent seismic unrest at Teide

Episodes of seismic unrest have been detected beneath central Tenerife in recent years. These episodes typically consist of swarms of small (low magnitude) earthquakes occurring at depths of several kilometres beneath the island. Most of the earthquakes have been interpreted as volcano-tectonic events produced by crustal fracturing, reflecting changes in the stress field within the volcanic system rather than the immediate ascent of magma toward the surface.

Significantly improved instrumental seismic monitoring (Fig. 3), carried out by the Instituto Geográfico Nacional (IGN), has greatly enhanced detection capabilities and led to a substantial increase in the number of recorded microseisms in the Canary Islands, most of them with magnitudes below 2 and therefore previously undetected.

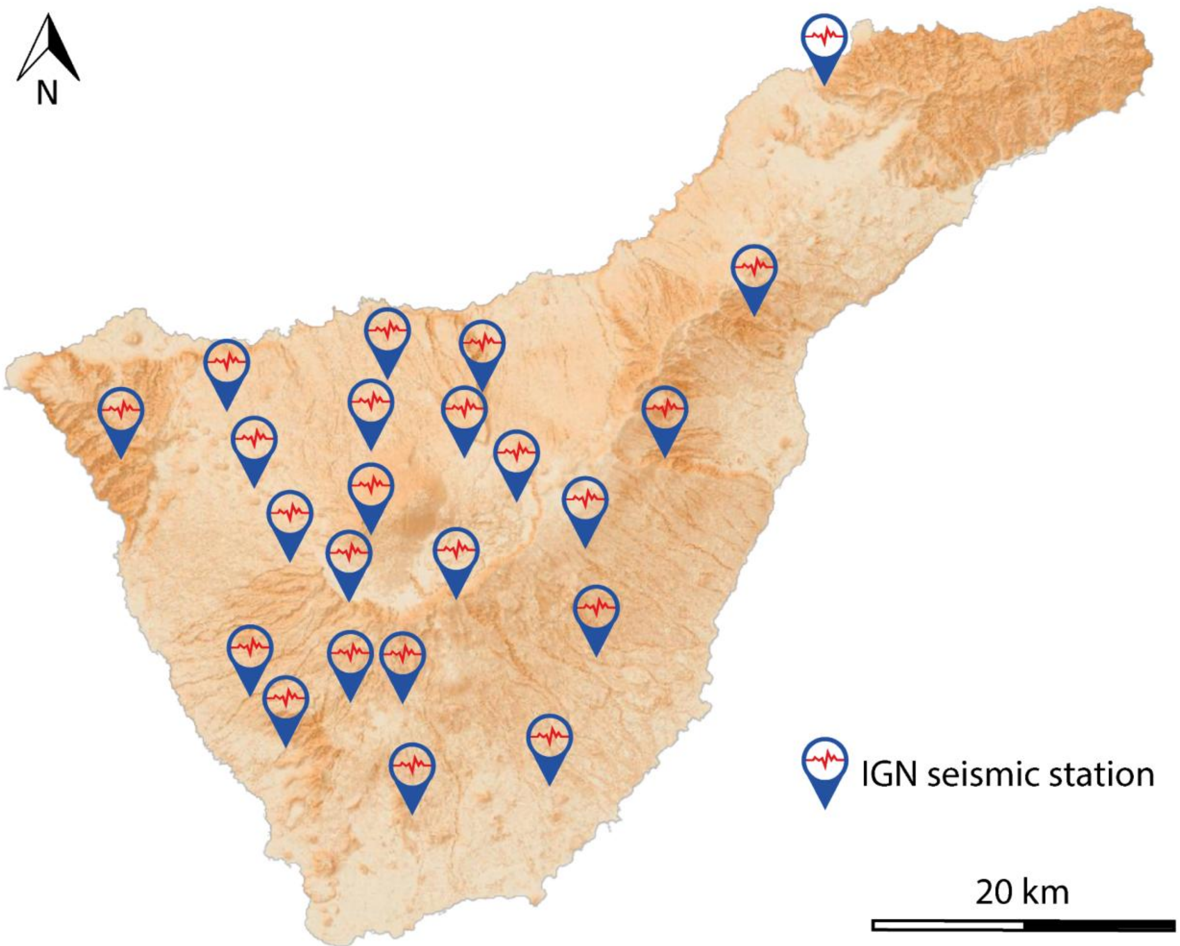

Fig. 3. Distribution of the seismic monitoring stations of the Instituto Geográfico Nacional (IGN) on Tenerife.

Records from the last 90 days (Fig. 4A) and the last two decades (Fig. 4B) show that most of this seismicity is clustered beneath the islands of La Palma, El Hierro and Tenerife, as well as in the area between Tenerife and Gran Canaria. In this region, a submarine volcanic edifice was identified during the German cruise M43/1 by the research vessel Meteor in 1998, and was informally referred to as the "Son of Tenerife" during early surveys, but is now known as the "Enmedio volcano".

Earthquake locations reported by the Instituto Geográfico Nacional (IGN) indicate that seismicity in Tenerife over the last three months (Table 1) has consisted mainly of numerous small earthquakes, most of which have not been felt by the population. Seismicity is concentrated in central Tenerife, within the Teide-Pico Viejo volcanic complex, at depths of approximately 6-12 km. This behaviour may represent a typical pattern during inter-eruptive periods in Tenerife that has previously gone unrecognized, either because the monitoring network has only been in place for a relatively short time (about 20 years), or because such patterns recur over longer time intervals (>20 years).

These depths suggest mid-crustal seismicity associated with crustal fracturing and deeper magmatic adjustments, possibly involving fluid migration, rather than magma ascent. Smaller seismic clusters have recently also been detected beneath El Hierro and La Palma, although with fewer events during the same time.

Due to the fact that the seismic network on Tenerife (see Fig. 3) is relatively young (only fully established in 2004), the apparent scarcity of earthquakes beneath the Teide prior to ~2004, compared with the larger number detected afterwards, should not necessarily be interpreted as a real increase in volcanic activity. For example, a similar rise in seismicity occurred in 2017 without leading to a volcanic eruption. While it does of course reflect increased seismicity, it also to a large degree reflects improvements in density, sensitivity, and detection capability of the seismic network on the island in the last fifteen years, which yields a far higher data resolution than in earlier efforts.

The absence of a longer instrumental record precludes the establishment of a reliable baseline level of seismicity, and therefore this behaviour may represent a common pattern during inter-eruptive periods in the island.

Table 1. Seismicity in Tenerife during late 2025 and early 2026 as reported by IGN.

Period	No. of events	Magnitude (ML)	Depth (km)
Dec 2025	tens	<1-2	8-10
Jan 2026	~100	<1-2	8-10
Feb-Mar 2026	several hundred (swarms)	mostly <1	8-10

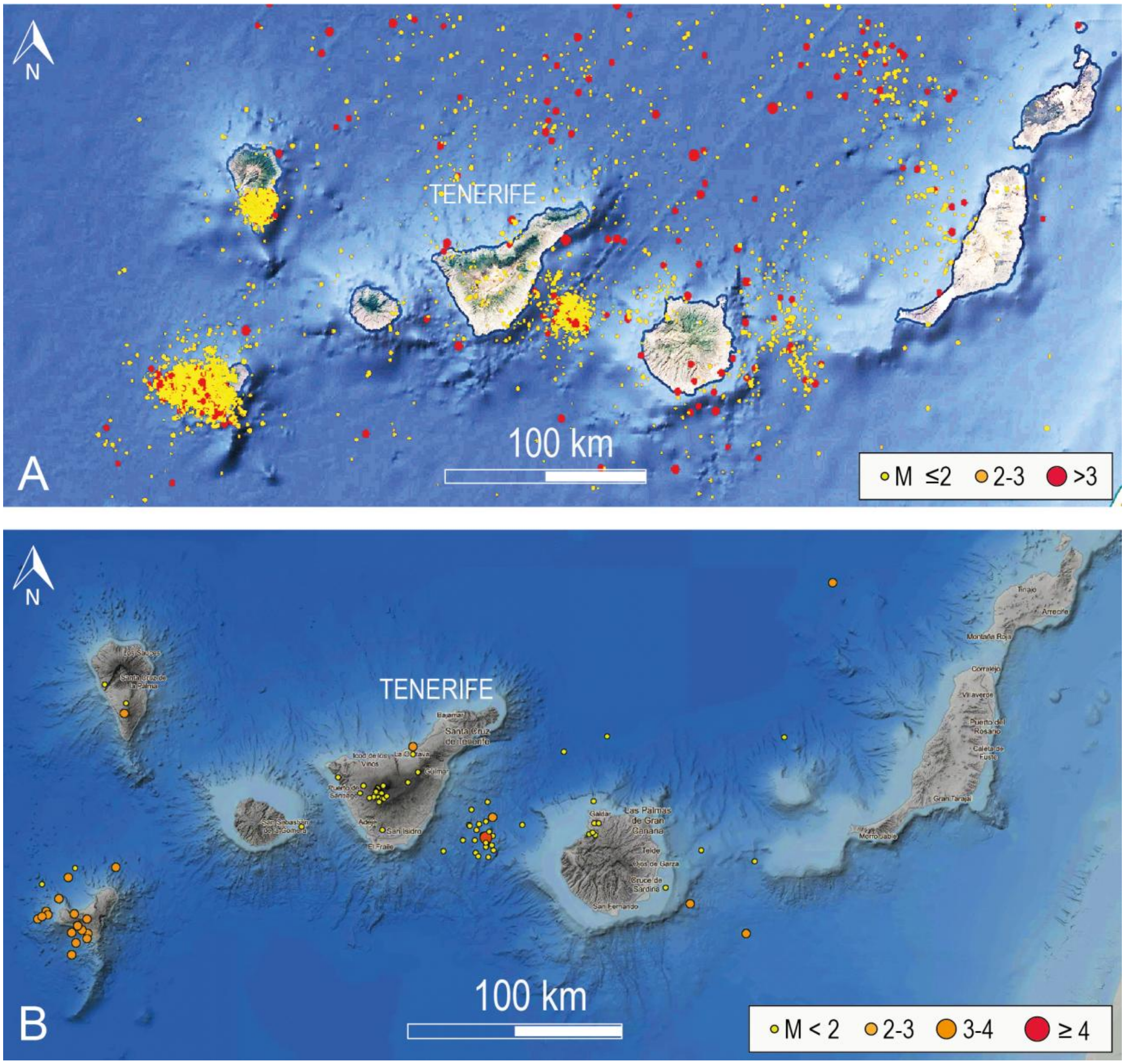

Fig. 4. **(A)** Seismicity in the Canary Islands during the period 2006-2026. In the figure, the total number of instrumentally recorded seismic events, reaching hundreds and even thousands, has been filtered to include only earthquakes that have been reliably located and catalogued. The monitoring network currently deployed by the Instituto Geográfico Nacional (IGN) detects large numbers of very small seismic signals. However, only those events that can be reliably located are included in the official catalogue, such as those shown in the figure. As a result, reported totals of hundreds or thousands of recorded events often include numerous microseismic signals that remain unlocated and imperceptible. This important issue should be clearly emphasised when communicating with the public. **(B)** Seismicity in the Canary Islands over the last 90 days (IGN data).

Possible eruptive styles in Tenerife

Geological studies and geochronological data from Tenerife indicate that Holocene volcanism occurs in two main settings: along the island's rift zones and within the central volcanic complex dominated by Teide and Pico Viejo, each characterised by distinct eruptive styles and associated hazards.

Activity along the rift zones is typically basaltic and relatively frequent on geological timescales, producing Strombolian eruptions that form small cinder cones and lava flows, such as the 1909 eruption of Chinyero, the most recent eruption in Tenerife, but also those of 1704-06 and 1798.

In contrast, eruptions from the central volcanic complex are much less frequent but may involve evolved (> 60 % of silica) magmas, including phonolitic compositions. These generate viscous lava domes, lava flows, and occasionally explosive activity.

On the basis of historical eruptions on Tenerife and the other islands, the most likely scenario for a future volcanic event in Tenerife would be a basaltic fissure eruption along one of the rift zones, particularly the western rift. Although such eruptions are typically effusive and not especially dangerous, the island's high population density and extensive infrastructure mean that even this type of event could pose a significant risk, as exemplified at the recent eruption on La Palma (2021), as described by Carracedo and co-workers in 2022.

Managing volcanic unrest: lessons for the future

Public concern associated with seismic unrest in Tenerife is not unusual. Another notable episode occurred during the 2004-2005 seismic crisis (Fig. 5), when increased seismicity, felt earthquakes, and geophysical and geochemical anomalies were recorded in late 2004 and early 2005, although no magmatic eruption occurred. This episode marked a turning point in volcanic monitoring in the Canary Islands as outlined at the time by Carracedo and co-workers in 2006. The activity was concentrated beneath the central part of the island, close to the Teide-Pico Viejo volcanic complex and led to public concern of an imminent eruption in late 2005. However, while the seismicity was of course a real phenomenon, it was interpreted by scientists as the result of a deep magmatic intrusion and associated fluid migration within the volcanic system. In particular, the seismicity was considered to reflect stress redistribution due to deep magma emplacement and the movement of magmatic or hydrothermal fluids rather than magma ascent to the surface.

The crisis gradually declined during 2005 and led to significant improvements in volcanic monitoring and hazard assessment in the Canary Islands. Although the current seismic activity, owing to its low magnitude, is generally not perceived by the population, it shows notable similarities to the 2004-2005 seismic crisis, demonstrating that the volcanic system beneath Tenerife remained active at that time.

Episodes of seismic unrest beneath central Tenerife highlight the importance of effective volcanic monitoring and clear communication with the public. Volcanic systems may remain in a state of unrest for long periods without leading to an eruption, making the interpretation of monitoring data inherently sporadic and thus uncertain.

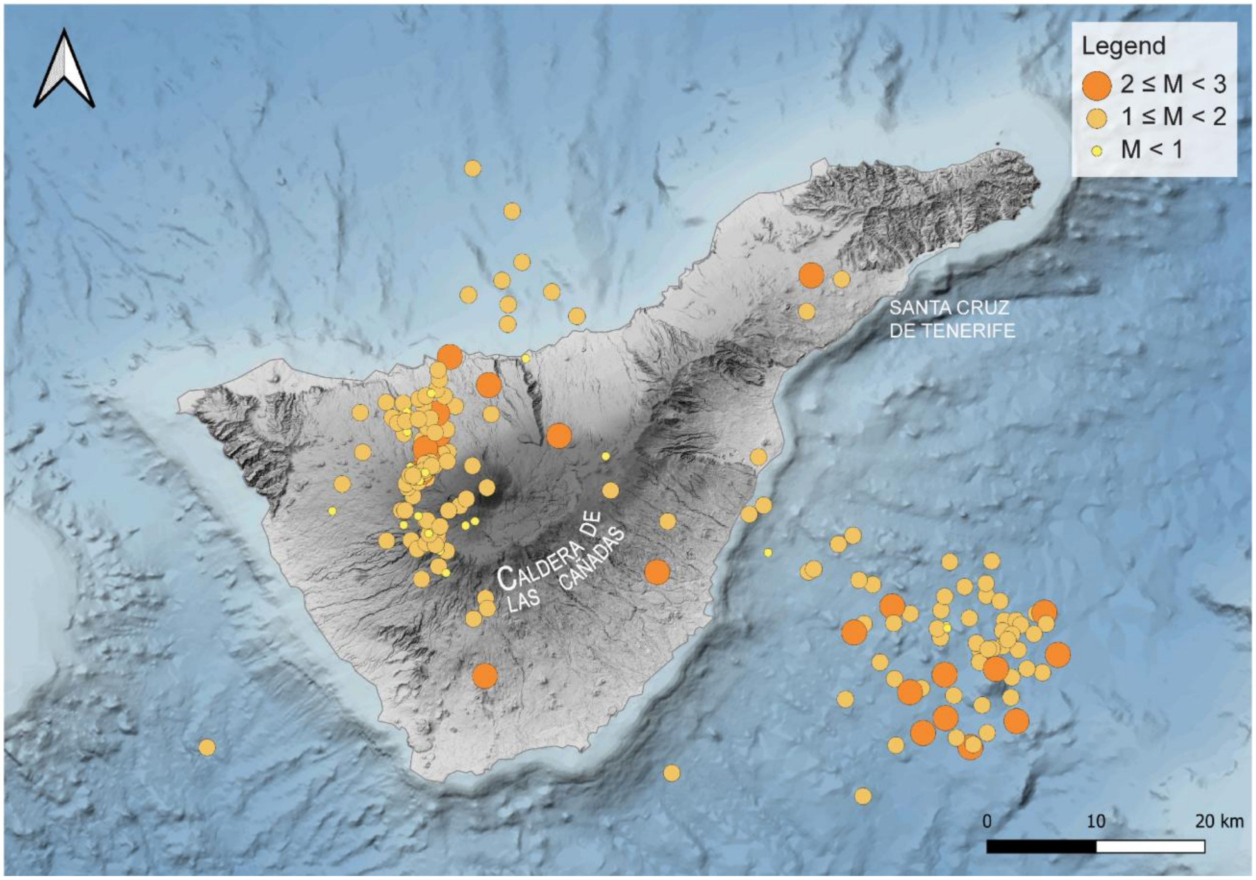

Fig. 5. Seismicity recorded in Tenerife in 2004 (IGN). Current seismicity on Tenerife shows similarities to this past crisis, characterised by swarms of small earthquakes at depth beneath the NW-central part of the island, interpreted as internal volcanic processes rather than signs of imminent eruption. Magnitude colour scale: yellow: $M < 1$, beige: $1 \leq M < 2$, orange: $2 \leq M < 3$.

In Tenerife, volcanic surveillance is carried out by the Instituto Geográfico Nacional (IGN), which operates seismic, geodetic and geochemical monitoring networks across the archipelago. These observations allow scientists to detect changes in the volcanic system and to evaluate whether an episode of unrest may evolve towards eruptive activity.

One of the key questions raised by recent seismic unrest is whether such information should be communicated to the public when there are no clear indications of an impending eruption. In volcanic systems, the approach of magma toward the surface is typically accompanied by a set of well-known precursory signals, including a clear increase in the frequency and magnitude of earthquakes, their progressive migration toward shallower levels, measurable ground deformation, and changes in the temperature and composition of volcanic gases emitted at the surface. Such multiparametric signals are commonly used in modern volcano monitoring to distinguish between background unrest and processes that may lead to eruptive activity.

None of these indicators are currently observed in central Tenerife. The recent seismicity consists mainly of very small earthquakes, most with magnitudes below 2 and many even below 1, occurring at depths of around 6-10 km. Such events are imperceptible to the population and would have gone largely unnoticed without modern instrumental monitoring.

This situation highlights an important communication challenge. Transparency in the dissemination of monitoring data is clearly positive, and making seismic information publicly available -as done by the Instituto Geográfico Nacional- represents a significant advance in public access to scientific data. However, when such information is released without a clear explanation of its geological meaning, it can easily generate unnecessary concern.

The use of terms such as “earthquakes” and references to Teide may evoke catastrophic scenarios for non-specialists, even though the events involved are extremely small and may just be the “normal” baseline of this active island. Although technically they are earthquakes, magnitudes well below 2 would be more accurately described as microseismicity, detectable only by sensitive monitoring networks. Moreover, referring simply to “earthquakes at Teide” may also be misleading, since the events are located at considerable depth and broadly within the central part of the island, making a direct relationship with the behaviour of the stratovolcano possible, but not certain.

Clear and contextualised communication is therefore essential to avoid misinterpretation of volcanic monitoring data, particularly in regions such as Tenerife where active volcanoes coexist with dense populations and intense tourism.

The recent seismic unrest beneath central Tenerife therefore provides an instructive example of the challenges involved in monitoring active volcanic regions. Although the magmatic system beneath the Teide-Pico Viejo volcanic complex remains active at depth, the current seismicity does not indicate the approach of magma toward the surface or an imminent eruption.

At the same time, these events highlight the importance of maintaining robust monitoring networks and communicating scientific information clearly and in its proper geological context. In volcanic islands such as Tenerife, where active volcanoes coexist with dense populations and major tourist activity, effective communication is therefore as essential as monitoring itself for the responsible management of volcanic risk.

In conclusion, the monitoring network currently deployed by the Instituto Geográfico Nacional (IGN) detects large numbers of very small seismic signals. However, only those events that can be reliably located are included in the official catalogue, such as those shown in Fig. 5. As a result, reported totals of hundreds or thousands of recorded events often include numerous microseismic signals that remain unlocated and imperceptible. It is also important to emphasize that the Instituto Geográfico Nacional (IGN) does not communicate directly with the public, although monitoring data from stations across all islands are openly available in the interest of transparency. A key challenge is improving public understanding of volcanic processes and ensuring high-quality communication from civil protection agencies and decision-makers, alongside controlled, verified online messaging from the scientific community to build public awareness and hazard resilience.

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