Volcanic Geomorphology in El Hierro Global Geopark

Cayetano Guillén-Martín and Carmen Romero

Abstract

Few oceanic islands express their geomorphological history in such a marked way as the island of El Hierro. Indeed, on El Hierro, its geomorphology goes hand in hand with the evolution of its insular geology. In fact, seventy percent of places of geological interest in El Hierro's Geopark have geomorphological features as their main or secondary interest, which is indicative of the importance of geomorphology in the configuration of the island's relief. However, there are few studies that have addressed the processes or features of the island's geomorphology. In this study, the first geomorphological characterization is carried out in which the island is considered as a whole unit.

Keywords

Volcanic geomorphology • Monogenetic volcanism • Geopark • El Hierro • Canary Islands

1 Introduction

With a maximum age of 1.2 Ma (Guillou et al. 1996), El Hierro is the youngest island of the Canary Archipelago. It is an oceanic volcanic island formed by the fusion of the Tiñor (1.12–0.88 Ma) and El Golfo-Las Playas (545–176 ka) volcanic edifices, as well as by the Holocene volcanic fields that developed later. Several structures can be identified in the island's morphology that have been interpreted as the scars of giant gravity landslides of Tiñor (0.8–0.5 Ma), Las Playas (~ 545–176 ka and 176–145 ka), El Julán (> 158 ka), and El Golfo (~ 87–39 ka) (Carracedo et al. 1999, 2001; Gee et al. 2001; Longpré et al. 2011; Masson 1996; Masson et al. 2002). The youngest of these landslides corresponds to a broad amphitheatre open to the NW and bounded by a large 27 km long arcuate escarpment that gives the island its distinctive crescent shape. From about 158 ka ago, monogenetic volcanism has developed on the flanks of the previous structures and in the interior of the depressions generated by landslides, and whose distribution is controlled by an apparent triaxial system of volcanic rifts (Carracedo et al. 2001; Guillou et al. 1996).

From a climatic point of view, the island of El Hierro has an oceanic subtropical climate, with temperatures ranging between 19 and 23 °C and rainfall concentrated from October to March. In addition, rainfall varies by slope depending on the slope's exposure to the prevailing winds, though it can exceed 1000 mm per year in windward areas.

The climate of El Hierro results from the interaction between the general climatic conditions of the whole archipelago and the island's steep mountainous relief. The dominant trade winds on the island reach El Hierro via the eastern flank of the Azores anticyclone of moderate speed (20–25 km/h) (Marzol 2006), which brings humidity and are present in the archipelago for almost two thirds of the year.

The combination of these elements gives rise to a relatively complex mosaic of microclimates, with different predominant morphodynamic processes, ranging from those typical of temperate-humid climates (areas between 800 and 1500 m asl. on the N and NE slopes of the island) to those associated with semi-arid climatic contexts (coasts and slopes of the S, SW and W of El Hierro).

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The cartography that accompanies this study was conducted taking into consideration the fieldwork carried out on the island in recent years, a high resolution DEM analysis, as well as the interpretation of the aerial photographs of the island from recent decades, available through the IdeCAN WMS server (https://www.idecanarias.es/). The different geographical features were mapped and classified according to their volcanic, erosive or sedimentary genesis.

The delineation of the riverbeds has been carried out manually in a GIS environment following the method of Strahler (1964), since important areas of the island characterized by lava surfaces are structured in slight and central channels and areas of interlavic and intralavic contact gave very high errors in their automated digital delineation. Nevertheless, the delimitation of the proposed mapping of the basins is based on the information derived from slope models, high resolution DEM and the runoff accumulation map.

The study of erosive forms has been based on the morphometric analysis of the hydrographic network. This not only provides a quantitative description of the drainage system, but also constitutes one of the tools that gives most information for the morphological study of volcanic territories. Basins and talwegs effectively express the existing relationships between the lithological, structural, geomorphological and climatic characteristics of the territory (Romero et al. 2004, 2006).

The study of volcanic forms has been carried out through the mapping of volcanic vents and cones and the morphometric analysis of some of their most relevant parameters, such as the elongation of craters and direction of volcanic fissures (Dóniz 2004, 2008). For the morphological classification of the cones, the taxonomy of Bishop (2009) has been followed. In his morphometric and geomorphological study, surtseian cones (Romero 2016; Guillén, in press) or those highly disfigured by erosion or landslides have not been included.

2 Physiographic Features

The island of El Hierro has an abrupt and vigorous relief of marked orographic contrasts. Twenty percent of the island's surface is characterized by an open depression to the NNW, closed to the south by a steep escarpment with slopes of up to 600 m in height, and where the highest altitude of the island is reached (1501 m at the Pico de Malpaso). This great amphitheatre is one of the island's most characteristic features. From this cliff, the altitude of the island descends quite steeply in all directions, forming ramps that extend fundamentally towards the interior of the depression, and towards the NE, S and W (Fig. 1a).

However, altitudes, slope breaks and slope distribution allow us to divide the island into eight different areas (Fig. 1b). Each of these areas has specific physiographic features and represent, in relation to their orientation towards the trade winds, and their more or less marked altitude, specific bioclimatic and morphoclimatic units. The north-facing units of Valverde (VA), Tiñor (TI), Nisdafe (ND) and El Golfo (EG) (Fig. 1b, nos. 1, 2, 3 and 5) are open slopes to the NE and N, more humid, with higher rainfall and lower insolation, where weathering processes predominate. The leeward areas of Las Playas (LP), El Pinar (EP), El Julan (EJ) and La Dehesa (LD) (Fig. 1b, nos. 4, 6, 7 and 8) are characterised by a warmer climate, with less rainfall and cloud cover and fewer mechanical erosion processes.

3 Erosive and Accumulation Forms

Even though the ravines do not seem to be one of the outstanding features of the relief of El Hierro, given the youth of the island, the island has a well-established hydrographic network, consisting of 270 basins and 3683 channels, with an average density of 5 km/km^2. The low rainfall, high evaporation rates and the predominance of very permeable materials, determines that there is no water regime with permanent flows on the island. These are intermittent and ephemeral watercourses, usually with sporadic torrential flows, associated with the development of high intensity rainfall episodes (Marzol 2006; Arroyo 2009). Figures 1 and 2 summarize the most salient features of drainage on an island scale.

The orographic and geological setting of the riverbeds and basins means that 72.4% of the island's basins are radially distributed with respect to the EG escarpment and are cataclysmic, running down the dip of the layers. Forty-one percent of the basins have their headwaters on the EG ridgeline, which acts as the main watershed of the island. This watershed extends to the NE following the ridge line established around the Ventejís volcanic vent (1238 m) (Fig. 3a–c).

As on other islands of the Canary archipelago (Romero et al. 2006), the control imposed by the lithology in combination with the age of the materials conditions the existence of a very significant surface without drainage network, which extends 78 km^2. In addition, at least 31% of the island's basins have no direct outlet to the sea and can be considered endorheic basins. Although surface without drainage network and endorheism affect the whole island, they are fundamental features of the eastern area of the EG amphitheatre and the volcanic fields of EP and LD (Fig. 2d). The presence of these relict and endorheic spaces is not directly linked to environmental factors but is determined by the inhibition of runoff in areas of more recent volcanism, caused by the high porosity and permeability of the volcanic materials (Romero et al. 2006).

The number and shape, order and area of the river basins show spatial variations and define very diverse hydrographic

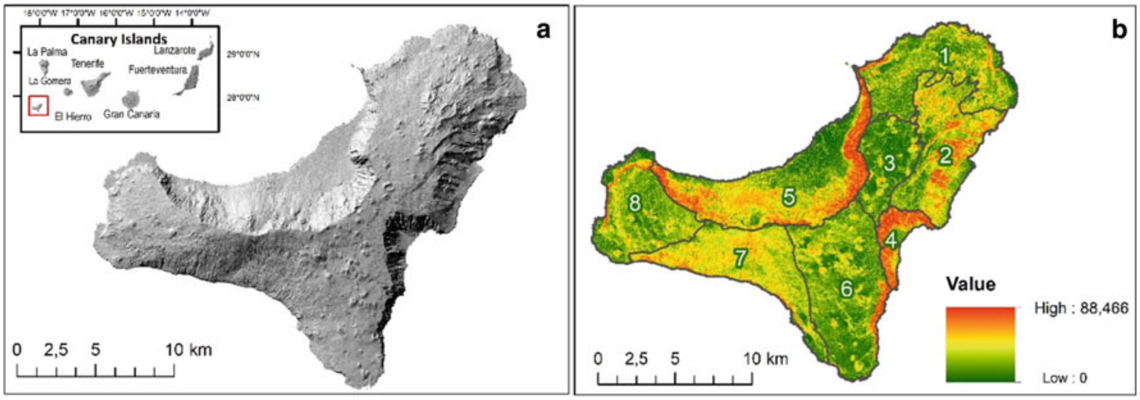

Fig. 1 Digital shadow model of the island of El Hierro (**a**) and slope map (**b**), with the delimitation of the physiographic units, 1: Valverde (VA); 2: Tiñor (TI); 3: Nisdafe (ND); 4: Las Playas (LP); 5: El Golfo (EG); 6: El Pinar (EP); 7: El Julan (EJ) and 8: La Dehesa (LD)

	km2	Stream Order 1	Stream Order 2	Stream Order 3	Stream Orderr 4	Stream Order 5	Talwegs Length km	Density km /km^2
Island	**268**	2659	745	184	45	5	1348,3	5,0
Valverde	45	198	44	10	3	-	134,0	3,0
Tiñor	42	427	129	28	6	1	225,0	5,4
El Golfo	55	477	143	38	6	-	184,4	3,4
Las Playas	19	466	117	31	6	1	165,7	8,7
El Pinar	41	248	71	12	3	-	128,1	3,1
El Julan	42	680	193	53	17	3	394,7	9,4
La Dehesa	25	163	48	12	4	-	116,5	4,7

	Basins	Basin order 1	Basin order 2	Basin order 3	Basin order 4	Basin order 5	Endorheic basin
Island	270	76	98	60	32	5	85
Valverde	19	8	6	2	3	-	1
Tiñor	37	10	11	11	4	1	6
El Golfo	74	18	31	19	6	-	55
Las Playas	31	4	12	11	3	1	-
El Pinar	26	8	12	3	3	-	13
El Julan	63	20	20	11	9	3	2
La Dehesa	20	7	6	3	4	-	8

Fig.2 Data relating to the hydrographic network and watersheds of the island of El Hierro

units that adapt to the different geological units, coinciding roughly with the physiographic units mentioned above. Although topographically ND is an area with its own characteristics, hydrographically it is part of the TI and VA areas, as the headwaters of their watercourses are located in this sector.

The island's watersheds show elongated shapes and lack, except in the steep sectors of EG and LP and TI, reception areas with clear topographic limits. The highest density of watercourses corresponds to EJ and LP, with values of 9.4 and 8.7 km/km^2, respectively. The lowest values characterize the VA, EP, LD and EG sectors (with 3, 3.1, 4.7 and 3.4 km/km^2 respectively). TI has average drainage densities of 5.4 km/km^2.

In general, lithostratigraphic variations, discontinuities in the rocks (joints and internal structure of the lava flows), dips of the layers in relation to the direction of runoff, tectonic features, age of the materials, morphoclimatic environment, and degree of interference between volcanic and erosive processes act in an interrelated way to give rise to valleys and ravines of very diverse morphology.

In the areas corresponding to the old massif of TI or in the sliding escarpments of EG and LP, where the oldest outcrops of basalts are on the island, the most important levels of network encasement are reached. In the TI area, where interference with later volcanism has been practically nil, erosion has dismantled the original structures and has generated the presence of abrupt reliefs, with steep slopes and deep torrential incisions separated by interfluves on ridges. These are inverted reliefs, which characterize the middle and lower sections of the basins, carved at the expense of the piles of the lava flows of the lower sequence of the IT edifice. The upper sections of these basins show, however, significantly lower levels of wedging when adapting to the tabular piles of the intermediate sequence. The transition between the two geological units is marked by the presence

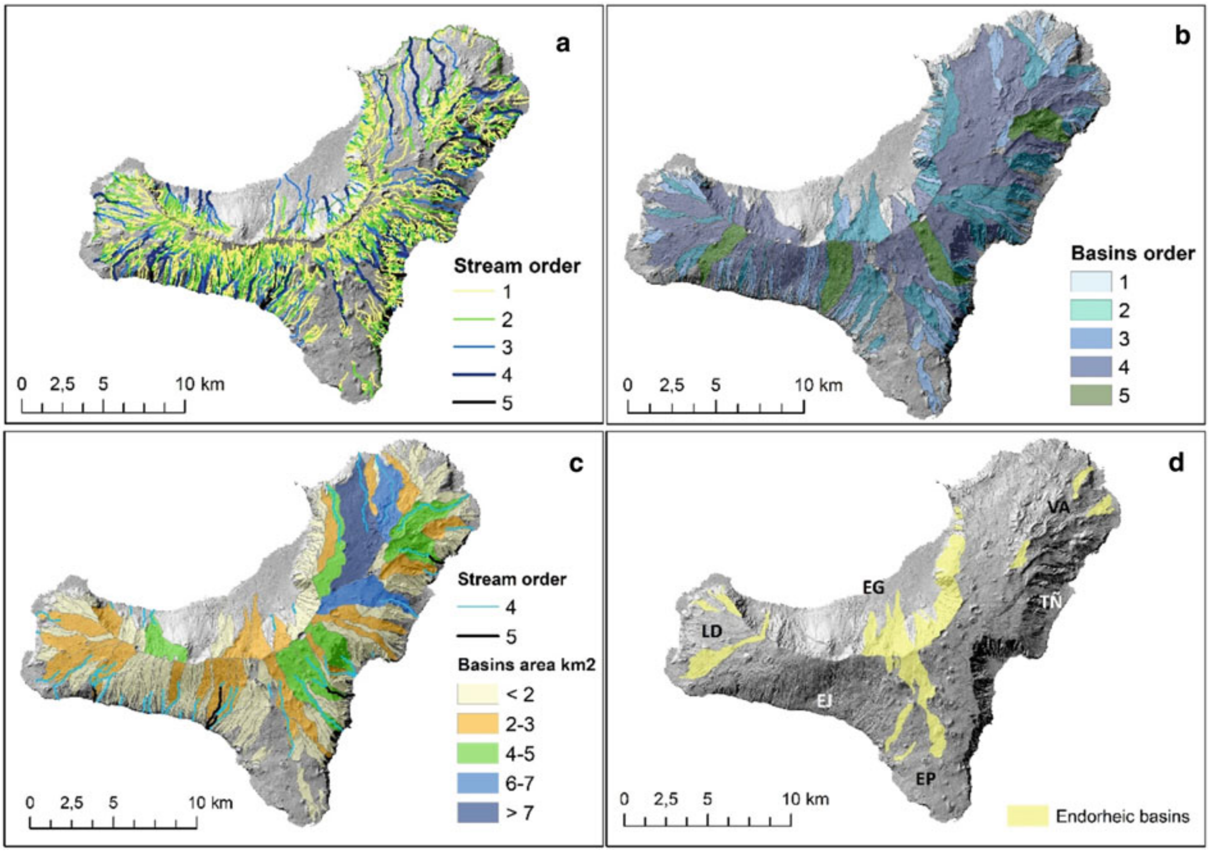

Fig. 3 Distribution of watercourses (**a**) and basins (**b**) according to their order. Classification of the basins according to their area in km^2 (**c**). The areas without colour in maps **a**–**c** correspond to reef sectors, without an organized drainage network. Map **c** shows the basins that do not flow into the sea and can be considered endorheic

of abrupt jumps and pronounced slope breaks in the profile of the main valleys. Between the main interfluves of these basins, parallel ridge interfluves develop, with summit-to-slope gradients of 200–300 m difference between the summit and interfluves. To the south of TI, later lava flows completely flooded the channels and partially clogged the basins, leaving the ridge interfluves as isolated remnants, causing the appearance of channels with a lesser degree of embedding in contact areas with other geological units. This determines that TI is the only area of the island where differentiated incision levels and the development of quadrangular-shaped basins can be defined, with a drainage pattern with dendritic trends and morphological evidence of recent landslide (Klimeš et al. 2016), with pulses linked to climatic events (Blahut et al. 2018).

The combination of high slopes and the structure of the EG and LP landslide escarpments has favoured very effective erosion action. The configuration of the escarpments in layers with different mechanical properties (Isidro et al. 2015), with numerous discontinuity planes (alternation of lava and pyroclastic layers, joints and internal levels of the lava layers, degree of weathering and presence of subvertical dykes) has favoured the presence of rocky channels vertically embedded in the walls, locally called "*fugas*". These channels are characterised by high hypsometric gradients, short but very pronounced longitudinal profiles and frequent cornices and breaks in the slope. They show funnel morphologies that favour the channelling of landslides and the accumulation of sediments at the foot of the most vertical escarpments.

The difference in age and dip of the layers in relation to the direction of the runoff, fundamentally anaclinal in EG and cataclinal in LP, determine variable degrees of remodelling between the escarpments of both depressions. These variations are evident in the different degrees of channel embedding, the topographic definition of the interfluves and the catchment basins and the lobulated character of the general outline of the escarpments, more accentuated in the case of LP than in EG. The degree of erosive remodelling of these escarpments has been established by calculating their sinuosity index, which is the result of dividing the total length of the escarpment by the straight line length of its starting and end points. Thus, while the LP escarpment has a sinuosity index of 2.38, in EG it is only 0.72. These data are indicative of the greater degree of erosive evolution of the LP escarpment compared to that of EG, which fits with the chronology of both depressions. The ruiniform character of the relief of the LP amphitheatre is also associated with the development of an anaclinal hydrographic network with its catchment areas on the upper slopes and the absence of subsequent monogenetic volcanism in the interior of the depression.

The gullies developed in the areas of monogenetic volcanism (volcanic fields of the NE, S, W) or in the EJ landslide arc are usually characterized by their low degree of embedding, and by generating elongated and narrow basins, usually with slightly lobulated headwaters and with surfaces of less than 4 km^2. In these sectors, the pyroclasts that characterize the summit areas favour the formation of very dense networks in the headwater areas, with a multitude of small length channels of order 1 and 2. On the other hand, the steep slopes, essentially formed by lava flows structured in channels and lateral levees, favour the development of radial or parallel networks, with a tendency to be embedded in lava channels or in the contact areas between different lava units. These networks are not very hierarchical and have areas of less than 2 km^2, where long and narrow basins of orders 2 and 3 predominate.

The anomalies of the drainage network in the size and shape of the basins and in the layout of the network show a close relationship with tectonic processes, as well as the closing and blocking of the valleys associated with the emplacement of cones and lava flows. The role of tectonics can be observed especially in two points of the island: in LD, in the transit zone towards EJ and in some areas of TI. The influence of tectonics is reflected in the existence of breaks in the profile of the channels and in the design of their layout. In these sectors, there are frequent abrupt changes in the course of the channels, with zigzag or staircase traces and steps in the profile that allow the different fault breaks to be bridged. These features can also be observed in the network around the Caldera de Ventejís, where the talwegs with the most severe boxed are associated with the presence of faults.

The processes of closure and obturation of valleys and basins cause processes of confluence and difluence of the ravines that determine significant changes in the layout of the network and in the size of the basins, favouring the presence of basins with surfaces greater than 6 km^2 and the existence of plains and endorheic type areas.

The products of erosion are preserved as spatially discontinuous sedimentary units, characterizing the mouth areas of the steepest ravines, or those with abrupt breaks in slope in their lower sections, where a range of detrital fans are formed (Fernández-Pello 1989). Many of these deposits, however, lack the typical morphology of fans as they adapt to the irregular surface of recent lava flows, where they generate the appearance of irregular fluviotorrential fans. Also, at the foot of the large escarpments of the LP and EG depressions, or at the bottom of the larger cliffs surrounding the island, there are detrital fans of mixed origin, the result of both gravity processes and small debris-flow processes.

In the deposits at the foot of the slope of the LP and EG escarpments, it is possible to distinguish two or three generations, with topographic locations that are lower in altitude, the more recent they are. In general, the oldest deposits are relicts and appear to be dissected by boxed channels, which have ended up disconnecting the apexes and bodies of the fans from the current escarpments, while being topographically disconnected from their source areas. When they are located on the coast, their bases are cliffed by the sea, so their formation must have taken place at a lower sea level than the present one. These deposits are flanked and covered at their base by the most recent deposits of the second or third generation, so they have more gradual average slopes.

4 Monogenetic Mafic Volcanism

The monogenetic basaltic volcanism of El Hierro characterizes the last stage of construction of the island, concentrating along three zones identified as volcanic rifts (Carracedo 1994; Balcells et al. 1997, Aulinas et al. 2019). The 541 mapped emission centres depict an essentially radial pattern with respect to the EG arc (Becerril 2014; Becerril et al. 2015, 2016) with an average density of 2.02 vents km^2. The ND, EP and LD areas (areas 3.6 and 8 in Fig. 1) show values above the island mean, with 3.7; 3 and 5.6 vents/km^2 respectively. By contrast, some areas, such as TI and EJ, have very low vent densities, with 0.54 and 0.49, respectively (Fig. 4).

Each of these areas presents a predominant orientation around one or two preferred directions that help to delimit the volcanic fields on the island. Thus, the volcanic field of LD can be structurally divided into two sectors according to the number of emission centres, their spatial distribution and the greater or lesser predominance of specific directional lines. On the one hand, the WNW sector has a significantly lower number of vents (54 compared to 115 in the WSW sector). There are, however, many very marked eruptive fissures aligned following the predominant NW–SE and WNW-ESE directions. This sector forms a group of volcanic cones spatially separated from the rest of the cones in the western sector of the island. The WSW sector, on the contrary, shows not only a greater number of eruptive centres, but also its organization is via the preferential fractures of ENE, WSS. However, NW–SE and WNW-ESE orientations are also present in a less representative way.

Something similar occurs in the NE part of the island, where the distribution and geometry of the cones and fissures define at least two sectors with different features. On the one hand, the areas of VA and TI (Fig. 1, zones 1 and 2),

Morphological units	Km^2	Nº Vents	Density vents/km^2	Nº Cones	Density cones/km	Nº vents/cones	Simples	% with respect to total cones	Compounds	% with respect to total cones	Complex	% with respect to total cones
TOTAL ISLAND	**268**	**541**	**2,02**	**230**	**0,86**	**2,35**	**68**	**34,87**	**99**	**50,77**	**28**	**14,3589744**
Valverde	37	66	1,78	36	0,97	1,83	13	6,67	13	6,67	5	2,56
Tiñor	37	20	0,54	12	0,32	1,67	2	1,03	3	1,54	4	2,05
Nisdafe	18	68	3,78	26	1,44	2,62	7	3,59	13	6,67	2	1,03
El Golfo	54	54	1,00	25	0,46	2,16	5	2,56	12	6,15	5	2,56
Las Playas	9	-	-	-	-	-	-		-		-	
El Pinar	48	147	3,06	65	1,35	2,26	21	10,77	28	14,36	7	3,59
El Julan	35	17	0,49	12	0,34	1,42	-		-		-	
La Dehesa N	11	54	4,91	14	1,27	3,86	5	2,56	9	4,62		0,00
La Dehesa S	20	115	5,75	41	2,05	2,80	15	7,69	21	10,77	5	2,56

Fig. 4 Parameters for the characterization of monogenetic edifices

where the cones seem to be arranged following a marked NE-SW direction. On the other hand, the area of ND, where the cones are articulated in an arched shape with respect to the EG escarpment. This arcuate configuration is also evident around the EJ arc, the preferential orientations seem to be arranged in an arc following its east and west limits. This affects the WSW and S volcanic fields, which lose their radial distribution and do not configure well-defined volcanic rifts structurally.

A total of 230 monogenetic volcanic edifices have been mapped, in different locations. They have a range of ages, morphologies, sizes, materials and geometries. All of them are associated with mafic basaltic magmas, show accentuated fissural features (with an average of 2.3 vents per volcanic cone) and have eruptive mechanisms that vary from typically Hawaiian and Strombolian to violent Strombolian, and eventually with the development of phreatomagmatic pulses. They correspond to spatter, slag and lapilli cones that emitted abundant lava flows.

Volcanoes have been grouped, following the taxonomy established by Bishop (2009), into three categories: *simple, compound and complex*. Some 34.8% are simple cones, characterized by being unique and discrete edifices, spatially isolated and without interaction with other cones. Their morphology can be annular or horseshoe-shaped, with a simple ground plan. There are 54.7% that correspond to compound cones in which two or more cones of the same type are merged, so they usually show coalescent or multiple craters (Tibaldi 1995; Corazzato and Tibaldi 2006) and lobulated and irregular plans. Finally, 14.3% are complex edifices, resulting from the combination or superposition of two or more types of volcanoes with differentiated eruptive mechanisms. This last category includes mainly those cones built by slag, lapilli or spatter volcanic edifices associated with basal effusive vents of composite pahoehoe flows. These effusive emission centres have given rise to small lava shields (scutulum type) (Walker GPL, 2000), some of which seem to correspond to rootless secondary lava edifices built on volcanic tubes. An outstanding feature of these small lava shields is their high average slope, as the lavas are usually in areas with steep pre-slopes. These features are particularly characteristic of the monogenetic edifices of Holocene platform-forming volcanism, but they can correspond to volcanic assemblages of very different ages. These features can be found in VA (Montaña del Tesoro), in TI (such as in WSW (Montaña de Orchilla, Montaña de Lomo Negro, Montaña de Las Calcosas, Montaña Tenaca, Montaña Quemada de Allá), or in the S rift (Montaña de El Julan, Montaña de La Empalizada, etc.) and even within the EG depression (Montaña de Sabinosa, Tanganasoga). The volumes of these lava edifices are generally higher than those of the cones from which they originate.

The link between the cones and their corresponding lava flows is not always visible. The intensity of the degradation processes determines that the connection between the older flows, and the edifice is difficult to establish, as it is diffuse in morphoclimatic environments of high humidity, where weathering processes predominate over erosive ones, and where there is also a high degree of anthropization of the territory (Fig. 5).

Many of these flows are partially shaped by erosion and sedimentary processes, so that it is possible to group them into at least four categories. The first category consists of lava flows with a very low degree of preservation and whose surface morphology has been lost and cannot be mapped. However, in this category, we have also differentiated from those which, although showing very low degrees of preservation, can be mapped thanks to the existence of coastal platforms and the erosion carried out in the areas of contact with older materials. Next, there are lava flows with a medium degree of preservation still maintain well-defined morphological elements, such as slight laterals and fronts, pressure arches, etc., though their surface shows evident signs of erosion. They are located at the bottoms of ancient channels, as well as in the contact zones between different lava flows. The surfaces of these lava flows are often covered with detritic materials that blur their original surface morphology, showing highly variable degrees of transformation. In the third category, there are flows with a high degree of preservation belonging to Holocene eruptions on

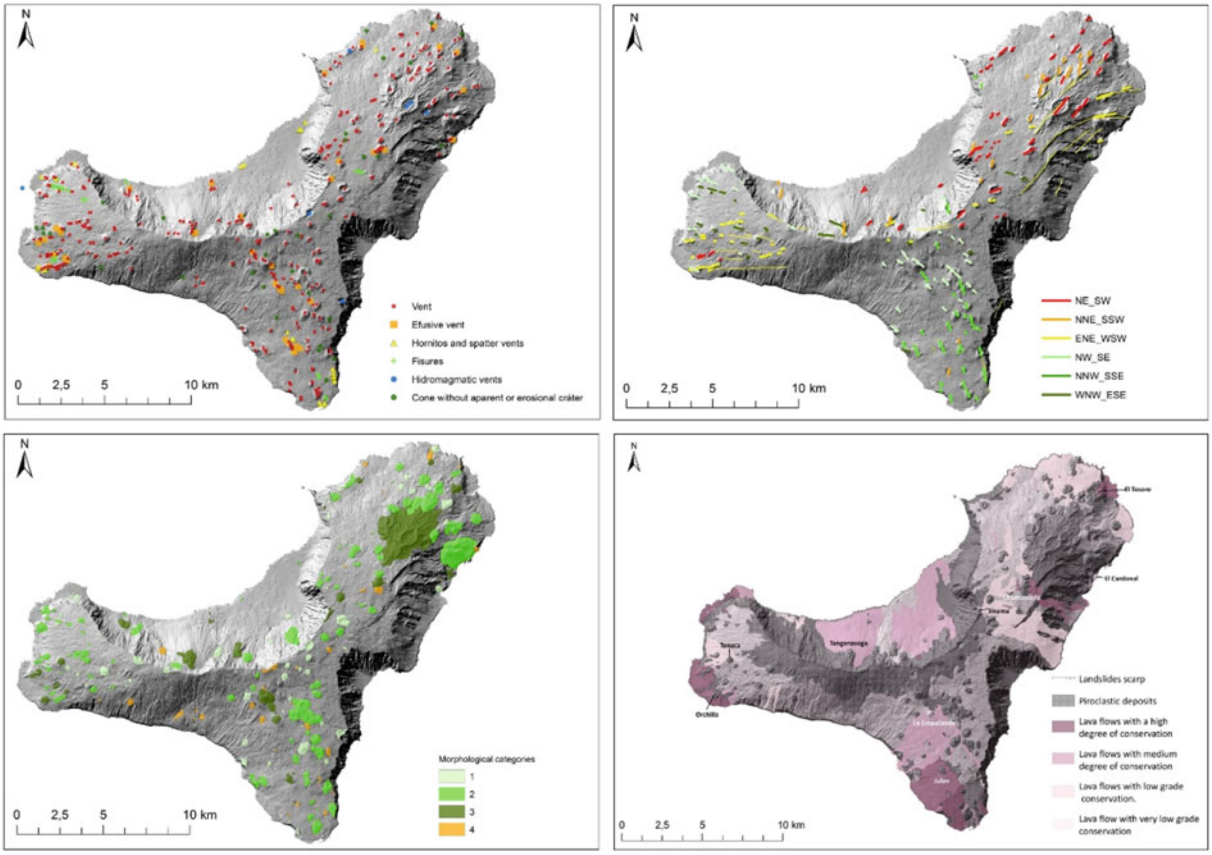

Fig. 5 Monogenetic volcanism on El Hierro. **a** Type and distribution of vents. **b** Lineaments of the vents according to directions. **c** Morphological types of volcanic cones. **d** Degree of preservation of the main lava units on the island

the coast of the northern humid and southern dry climatic environments, typical of the lava platforms and deltas of these areas. Their location at the foot of pre-coastal escarpments, however, favours an intense partial covering with detrital materials that are transported from talwegs established on the upper slopes and spill down to reach the coast. Finally, the best-preserved lava fields are located in the western and southern areas of the island, where xeric climatic conditions have led to the best preservation of the original forms.

5 Discussion and Conclusions

The delimitation of geomorphological units is one of the key factors in the geodiversity of a territory (Serrano and Ruiz-Flaño 2007). This study establishes at least eight geomorphological units on the island of El Hierro that result from the combination of topographic, structural, geological and geomorphological elements and factors. The temporal and spatial relationships between the processes of volcanic construction and those linked to their erosive dismantling, or the formation of detrital deposits are also relevant.

Traditionally, the essential geomorphological features of El Hierro have been described using a simple model based on the three volcanic rifts that concentrate and organize the volcanic activity of the island around a triaxial scheme. This approach leads to structures with relatively simple topographic and geomorphological features, in whose interior the emission centres are concentrated in the central axis of these structures, giving rise to volcanic lineaments and obvious crater elongations, coinciding in orientation with a well-defined main structural orientation. However, it has been pointed out that the geometry of the volcanic fields on the island of El Hierro shows radial patterns that are a reflection of the local stress fields related to the formation of megathrust landslides that mask the general radial patterns of the EG edifice (Fig. 6).

This work contributes to define the geometry of the volcanic fields of the island of El Hierro, understood as the result of complex patterns and temporal interactions between the relative location of the different volcanic edifices that

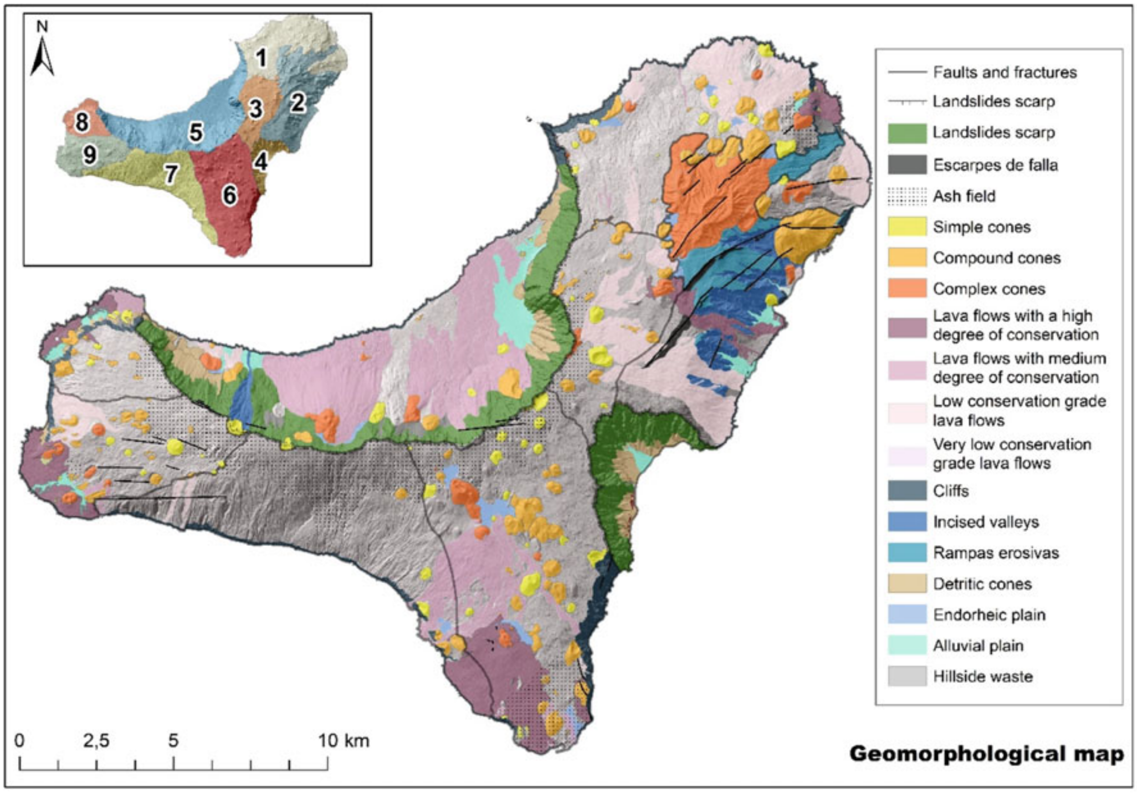

Fig. 6 Synthesis morphological map with geomorphological units

make up the island. Their morphological evolution and the regional geodynamics of the volcanic province are also relevant factors, as has been previously highlighted by authors for other Canary Islands (Márquez et al. 2018).

Structurally, the volcanic rifts of the Canary Islands have been defined as polygenetic edifices generated by the preferential emission of magma through persistent tectovolcanic fissures and associated with swarms of feeder dykes, whose density increases towards the rift axis and at depth (Carracedo 1994). Morphologically, these types of structures are characterized by the presence of narrow and longitudinally developed volcanic ridges orientated around a preferential directrix, with a well-defined line of summits located on its axis and with slopes built essentially by piles of lava flows with a generalized dip perpendicular to the axis. This gable roof configuration is palpable in the volcanic rifts of the islands of Tenerife and La Palma, although with nuances depending on the geological history of each edifice, its age and the greater or lesser degree of interaction between volcanic and erosive processes.

The variations between some volcanic fields and others and the comparative synthetic analysis of the morphological features that characterize the volcanic rifts of Tenerife, La Palma and El Hierro show that only the NE volcanic field seems to correspond to a developed and persistent volcanic rift over time (Fig. 7, profile A–A′), although influenced by the stress field of the EG edifice in the ND zone (Fig. 7, profile B–B′). The WNW volcanic field corresponds to the volcanism controlled by the EG system directly on its flanks, without the construction of a well-defined axis. The S and WSW alignments have complex patterns that show the high influence of the stress field of the EG edifice and, above all, of the landslide effect. Some of these volcanoes are distributed by drawing arcs with respect to the EG landslide scarp or the EJ slopes, following approximately arcuate fractures towards the interior of both sectors. All these factors determine that the volcanic rifts do not have the morphological features in plan and elevation of other volcanic rifts of the Canary Islands, such as those of La Palma or Tenerife. This lack of morphological regularity of El Hierro's rifts cannot be linked to the age of the structures since the S rift of the island of La Palma has a similar age to the volcanism of the volcanic fields of El Hierro.

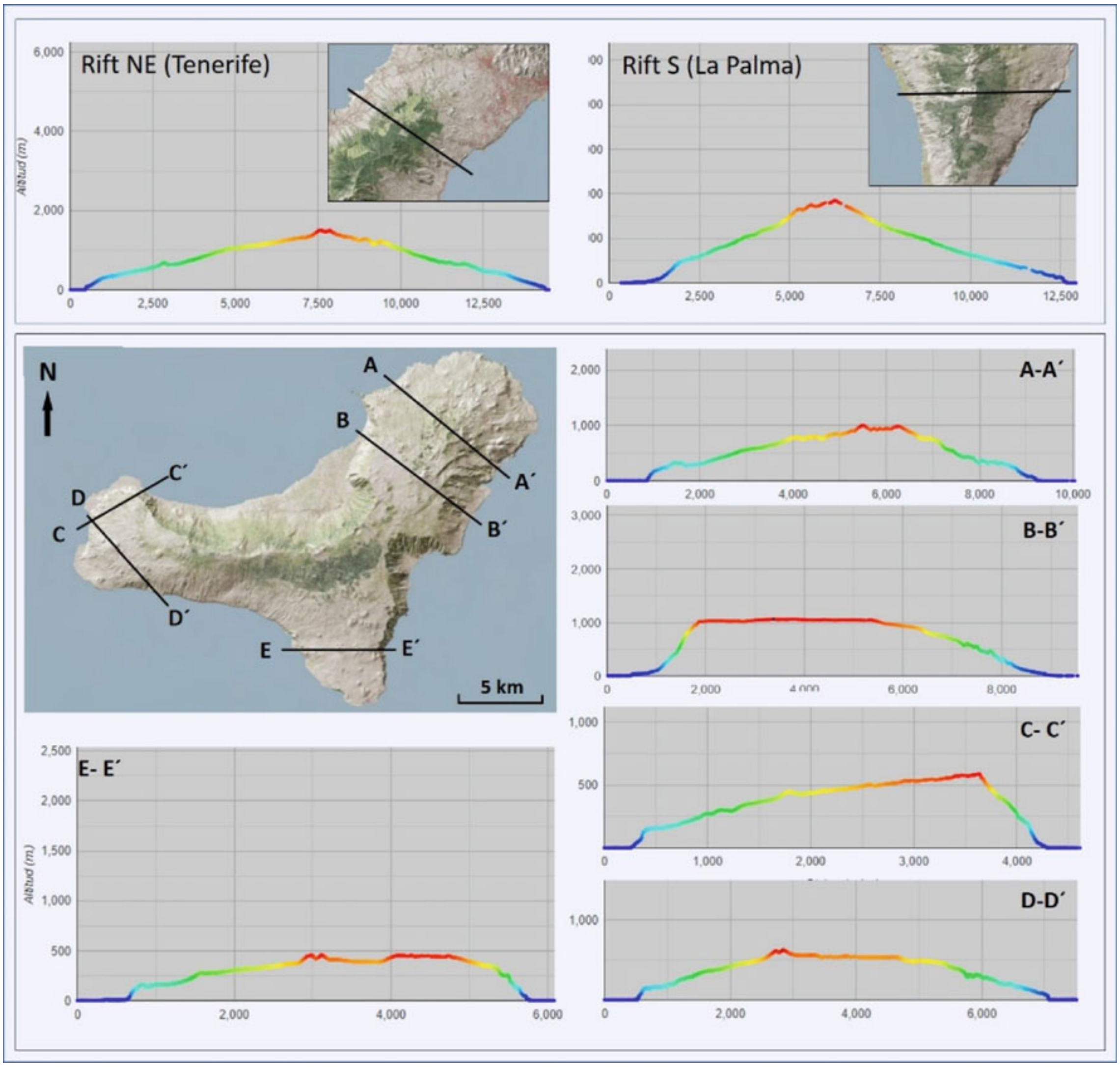

Fig. 7 Standard cross-sectional profiles of the volcanic fields of the island of El Hierro

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