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The sub-volcanic system of El Hierro, Canary Islands

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The main volcanotectonic structures of El Hierro are three rift zones, trending northeast, west, and south. Most of the eruptions in El Hierro within these zones are basaltic fissure eruptions fed by subvertical dykes. The dykes appear as close to collinear or slightly offset segments, their surface expressions being clusters of cinder cones and eruptive vents. Three large landslides, referred to as El Golfo, El Julan, and Las Playas, have eroded the areas between rift axes and provide exposures that make it possible to provide a three-dimensional view of the uppermost part of the sub-volcanic system. Here we report the results of a structural study of the sub-volcanic system as obtained through the analysis of dykes and eruptive vents.

The data obtained from surface outcrops have been combined with data from subsurface water galleries. More than 600 eruptive vents and 625 dykes have been studied in detail to characterise the subvolcanic system of the island. Using cinder-cone and other eruptive-vent alignments it has been possible to infer 115 eruptive fissures with lengths that range from 40 m to 2200 m.

NE-SW trending volcanic fissures and dykes are common on the entire island and predominate in the northeast rift zone. The main strike of the dykes and fissures in the south and west rift zones are approximately NNW-SSE and E-W, respectively. However, in the west rift zone, eruptive fissures display a fan distribution with directions that range from N43ºE to N124ºE. Volcanic fissures within the El Golfo landslide valley trend parallel to the head scarp, except those that are close to the head of the valley, many of which are perpendicular to the scarp. Dykes show a radial distribution in the head scarp of the El Golfo landslide.

Three feeder-dykes directly connected with their lava flows have been identified in El Hierro. Feeder dykes are difficult to observe in the field but provide important information when their lengths and thicknesses can be measured. Through the study of these dykes we have estimated the magmatic overpressure at the time of their emplacement as from 5 to 15 MPa. These field data and analytical models allow us to estimate the depths of the associated magma reservoirs as between 8 and 25 km. These data agree with the estimated depths of the magma reservoirs associated with the 2011 and ongoing submarine eruption in El Hierro.