GROWTH OF LAVA DELTAS ON THE SEA FLOOR AT THE WESTERN FLANK OF LA PALMA DURING THE 2021 ERUPTION, CANARY ISLANDS

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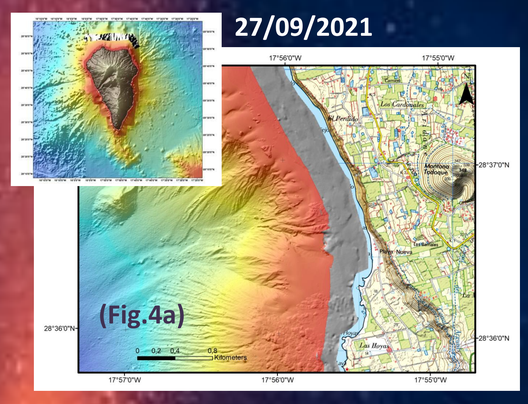
On September 19, 2021, a volcanic eruption began on the island of La Palma. To control the changes caused on the seabed and the water column during the eruption, three oceanographic cruises were carried out on board the research vessels Ramón Margalef (VULCANA-III-LP- 0921) and Ángeles Alvariño (VULCANA-III-EH-LP-1021, VULCANA-III-LP-1221) (Fig.1), both from the Spanish Institute of Oceanography, to carry out an exhaustive multidisciplinary oceanographic study of the southwest area of the island of La Palma with special attention to the analysis of the morphological changes in the seabed and coastline, as well as to the possible outflow of gases of volcanic or hydrothermal origin, in addition to studying the effects of the lava flows on the morphology of the seabed. A fourth control cruise was carried out in 2002 (VULCANA-III-0222). Throughout them high resolution multibeam bathymetric data (EM710, Kongsberg) and ROV transacts (LIROPUS, Fig. 2) were carry out to identify and characterize structures associated with active processes, analyze the morphology terrain deformation and the evolution and submarine advance of the lava.

The lava flows reached the western shores of this island on September 28 at 23:00 UTC (Fig. 3) and later reached the coasts in three other sites. Finally, they formed a southern lava delta attached to the north of the lava delta generated during the 1949 eruption and a second delta located to the south of Tazacorte port.

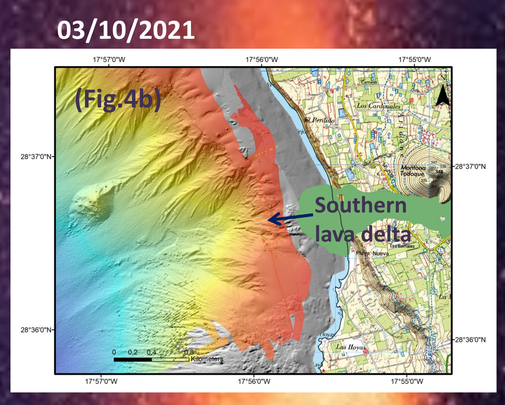


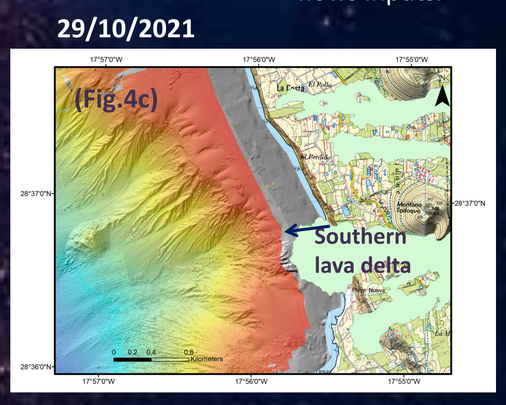
A complete mapping and characterization of the seabed in the western part of the island of La Palma before (Fig. 4a) and after (Figs. 4b, 4c and 4d) the arrival of the lava was carried out, mapping about 24,000 hectares.

First, a bathymetric survey was carried out in the probable arrival zone to the sea of lava flows to establish the pre-eruption characteristics of the seafloor (Fig. 4a). This first study has served as the base for determining the changes caused by the arrival of lava flows on the seabed. Blue arrows in Figs.4a, 4b, and 4c correspond to detected lava flows inputs.

Mainly, the deep part of the lava flows emplacement on the shelf and slope of the island has been studied. It was observed that these materials advanced along the seabed both as block flows (aa) (Fig. 5a) and as pillow lavas flows (pahoehoe) (Fig. 5b and 5c), preferentially occupying the insular shelf and upper slope, and filling a series of previous depressions on the outer shelf and submarine gullies on the slope (Figs. 4b, 4c, 4d and Fig. 6).

The southern and northern lava deltas sub-aerial surface extends along 43 ha and 5.4 ha respectively. On the seafloor new volcanic materials have been located at least to a depth 300 m approximately at 1.2 km from the initial shoreline occupying an estimated area of 30 ha. A thickness of up to 40 m lava accumulations have been measured inside the pre-existing gullies (Fig. 7).





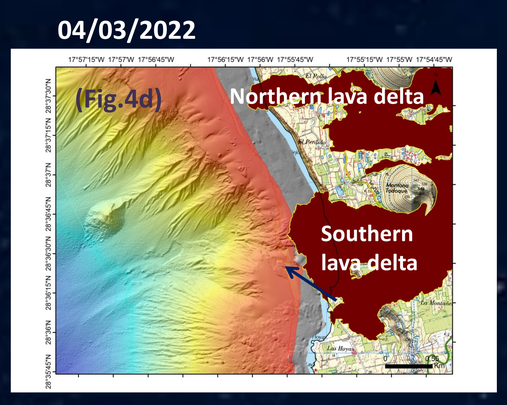


Fig. 5 – Lava flow facies interpretation from ROV images and bathymetric mosaics.

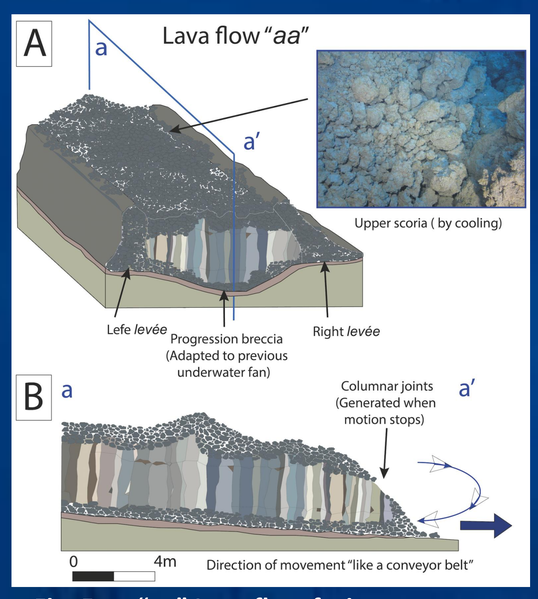


Fig. 5a – "aa" Lava flow facies

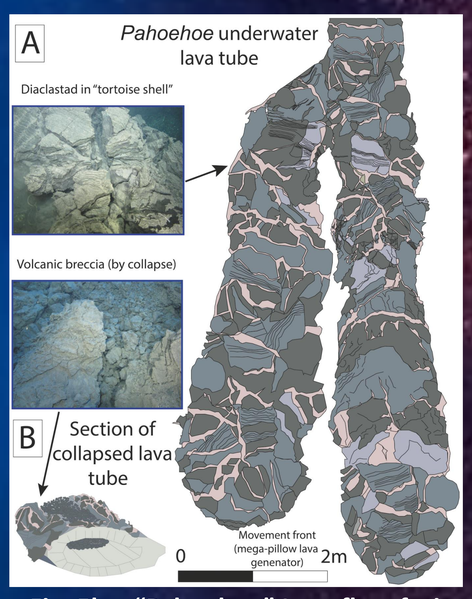


Fig. 5b – "Pahoehoe" Lava flow facies

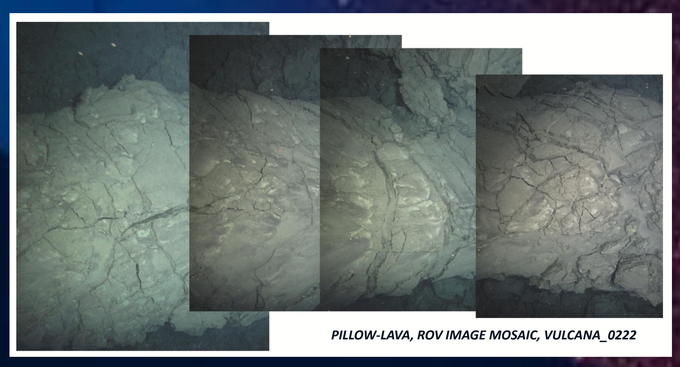
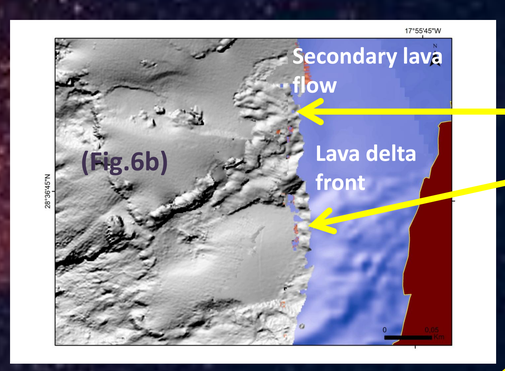
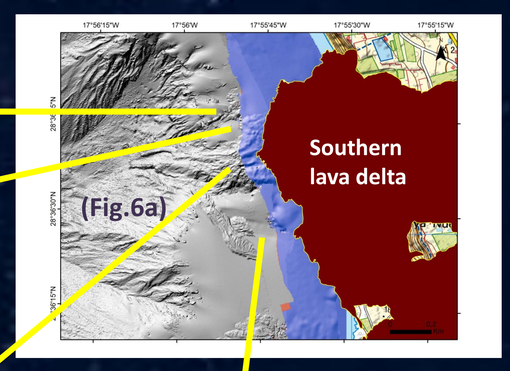
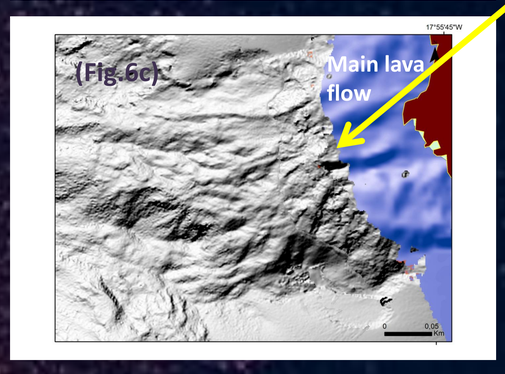


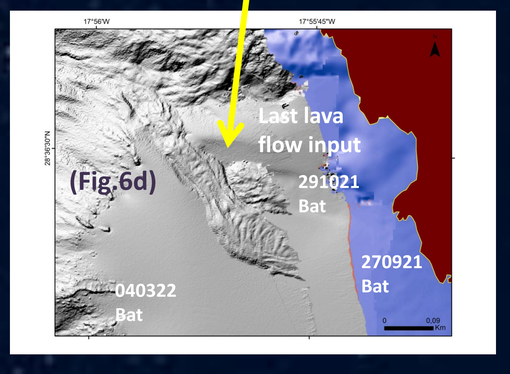
Fig. 5c – Mega-pillo-lava example from ROV images

Fig. 6 – Seafloor changes related to the growth of southern lava delta.



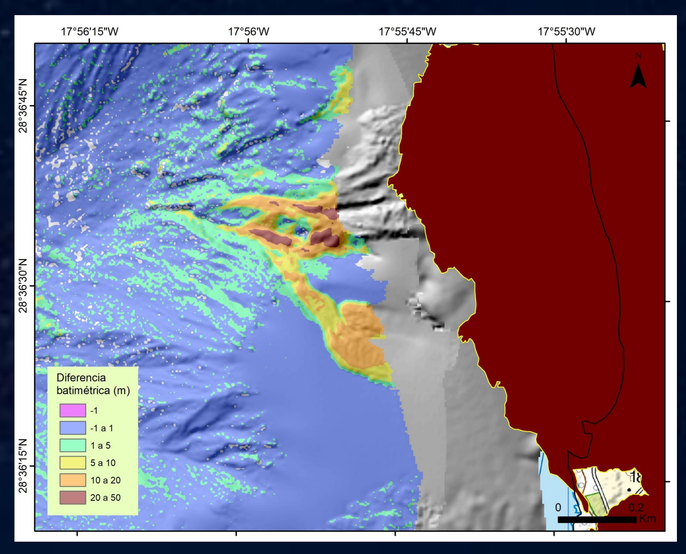






It can be seen the insular shelf would be occupied by the lava delta or its submarine front (Figs. 6a and 6b), except in the southern area where it has been channeled into a previous depression (Fig. 6d), while on the slope it has taken advantage of the presence of pre-existing gullies to channel its flow (Fig. 6c).

Map of differences in the Southern Lava Delta sector between the bathymetric data prior to the eruption (September 27, 2021) and the data obtained in the 2022 cruise. The map (Fig. 7) is projected in transparency on a hillshade of the bathymetry carried out throughout the eruption (gray), and the bathymetry prior to the eruption (blue). The main accumulations are located on the position of previous gullies, surface morphology of lava flows simulate in some cases previous morphology. There are also eroded areas related to slides around the emplacement of submarine lava flows. The approximate lava volume calculated for the submarine part is at least 3 Mm^3, assuming an average thickness of 13 m.



Conclusiones:

The high-resolution mapping obtained will now make it possible to detect very accurately changes in the morphology of the terrain.

This study, which has been a great milestone for science by having the opportunity to study in real time the arrival of a lava flow to the sea and the modification of the coast and seabed it generates.

In addition, it will provide additional information on the development of the eruptive episode on the island of La Palma, allowing a more complete picture of the functioning of the volcanic system.

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