

**GEODIVERSITY ROUTE ON
LIDO ↔ SOCORRIDOS SEASIDE PROMENADE**

The Geodiversity Route of Lido ↔ Socorridos Seaside Promenade, located between the Lido Bathing Complex and the mouth of the Ribeira dos Socorridos, aims to the geological, historical and cultural heritage dissemination and, also, the physical activity and well-being promotion to all age groups.

The route is situated on São Martinho parish where the coastal erosion caused by the Atlantic Ocean has a special impact on the coastal morphology and on the alteration of the geological formations, from which result the typical pebble beach.

Along the route is raised awareness of the insular people history, the meaning of several toponyms and, also, the geological formations and respective evolution that occurred in the last two million years. The volcanic landscape is marked by the scoria cones of Ponta da Cruz and São Martinho, by subaerial lava flows with basaltic composition and by lava strings and associated deltas that were very important to the construction of the ancient military fortifications, the Cais do Carvão, the hotel units and the bathing complexes.

On the route the geodiversity and biodiversity occur in perfect harmony, considering that can be observed several endemic species of Madeiran flora which, have grown up spontaneously, or were planted, on several types of geological materials.



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SEASIDE PROMENADE**

2018

GENERAL INFORMATION
The Geodiversity Route of Lido ↔ Socorridos Seaside Promenade route is developed along the coastline of São Martinho parish in an extension of 5 km and, has 24 stopover points to observe and obtain information about the geological sites as well as others interesting places from the point of view of history, culture and science.

In addition, the nature of the multidisciplinary information, the low difficulty level as well as the good accessibility, make this route an appropriate choice for a walk, during the morning or afternoon, that reconciles the physical activity promotion in natural habitat with sociocultural enrichment provided by scientific dissemination.

RECOMENDATIONS

Use of hat and sunglasses, sunscreen, as well as suitable clothes and footwear.

USEFUL CONTACTS

Funchal City Hall (291 211 000), Dr. Nélio Mendonça Hospital (291 705 600)
Public Security Police (291 208 400) and Firefighters (291 22 122 / 291 225 067)

WORKING GROUP

Câmara Municipal do Funchal
Departamento de Economia e Cultura

Madeira Rochas – Divulgações Científicas e Culturais

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GEOLOGICAL FORMATIONS OF FUNCHAL WESTERN CENTRAL SECTOR

The geological formations that occur in western central sector of Funchal responsible for the relief forms, the fitting of the water courses and the human occupation of the territory. Based on the Geological Map of the Madeira island (Brum da Silveira *et al.*, 2010) and in the respective Explanatory Text presented in a simplified manner the main formations and deposits existent here (Figure A) formed during the geological time that goes since Plio-Pleistocene age, between 5,57 Ma and 1,8 Ma, passing through Pleistocene and Holocene, between 1,8 Ma and 7 ka, where Ma and Ka mean million years and thousands of years, respectively.

The Plio-Pleistocene age deposits belong to the Intermediate Volcanic Complex (CVM), namely to the formations of Penha de Águia (CVM2) and das Freiras (CVM3) and, consist of subaerial lava flows of basaltic composition.

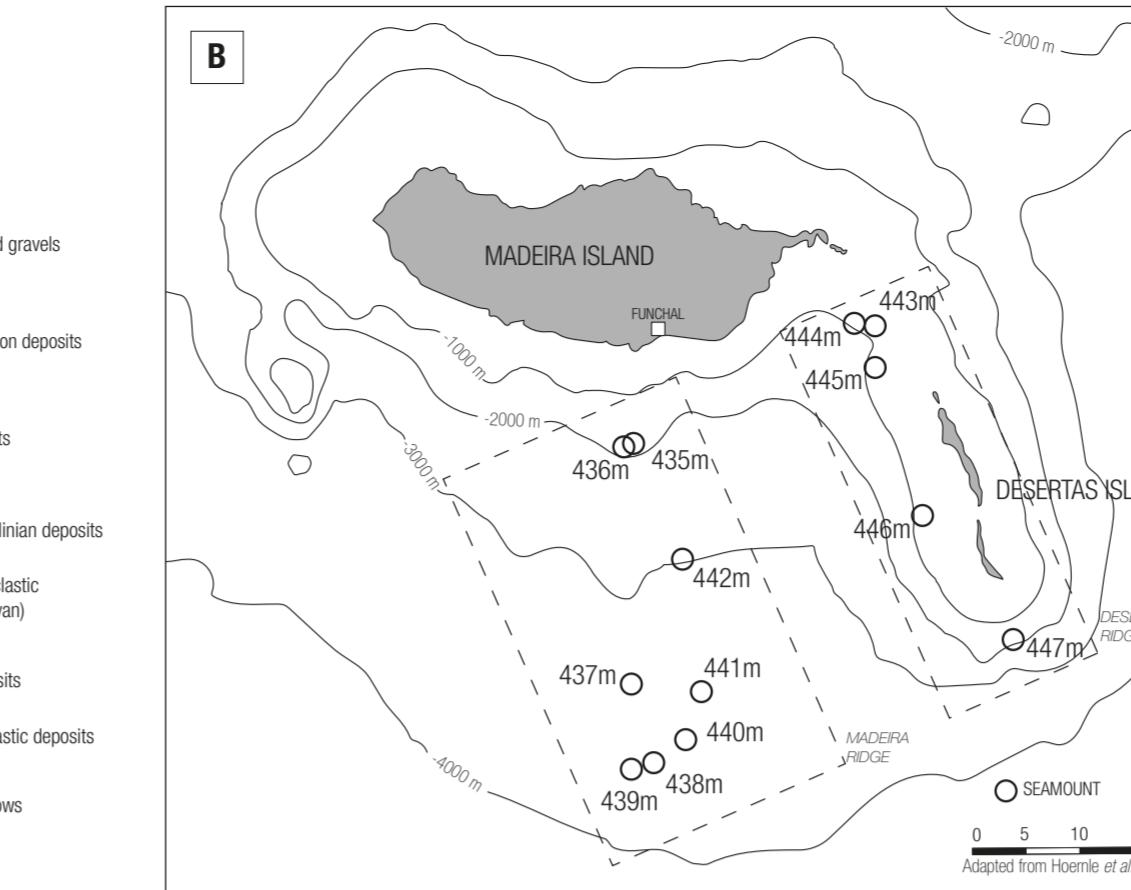
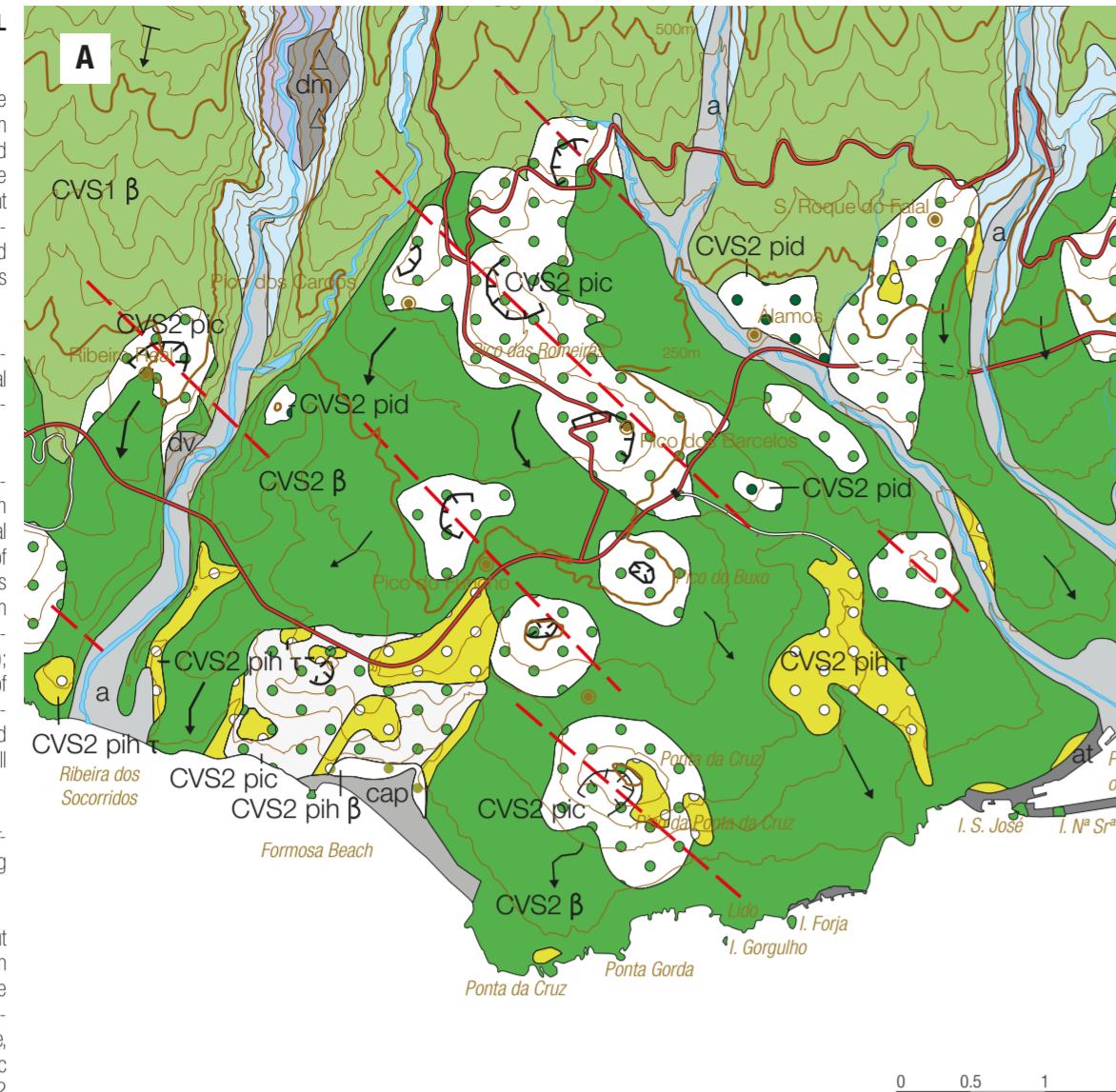
The Pleistocene and Holocene age deposits belong to the Upper Volcanic Complex (CVS), and correspond to two formations: Lombos formation (CVS1) and Funchal formation (CVS2). In these, are represented several types of lava flows and pyroclastic deposits, namely: subaerial lava flows

basaltic composition (CVS1 p and CVS2 β), subaerial pyroclastic deposits of basaltic nature, composed of blocks and bombs, lapilli and volcanic from strombolian/hawaiian cones (CVS2 pic); distal subaerial pyroclastic posits, composed of volcanic ash and lapilli, generally weathered (CVS2 submarine pyroclastic deposits of basaltic nature (surseyan), composed volcanic ash tuffs, lapilli, blocks and bombs (CVS2 pih β); hydroplinian pyroclastic deposits of trachytic nature composed of volcanic ash tuffs, lapilli pumice interspersed with hydromagmatic pyroclasts of basaltic nature subaerial pyroclasts, and tuff levels (CVS2 pih τ).

The subaerial pyroclastic deposits of basaltic nature (CVS2 pic) stands in the landscape being represented by the volcanic cones, locally known as peaks and hills, observable in the west sector of Funchal city, which are implanted on fractures with a general orientation of northwest-southeast (Figure A). On the route (Figure D), on LS 17 stopover, deposits of this nature, showing dark tonality, are easily observed. The distal subaerial pyroclastic deposits, geographically dispersed, are for the most part weathered (CVS2 pid). In the case of submarine pyroclastic deposits of basaltic nature (sunyan), they are easily identified in stopover LS 14 (CVS2 pih β). With regard to hydroplinian pyroclastic deposits of trachytic nature (CVS2 pih τ), they show a yellowish tonality, a geographical dispersion and can be observed on the route (Figure C).

The sedimentary deposits of quaternary age correspond to sedimentary formations and are represented by scree and colluvion deposits (dv), landslides

The beach sands and gravels (cap) takes up all the area of Formosa beach between the exit of the Poças do Gomes tunnel and the Areeiro beach (12-LS 18). The alluviums (a) are identified on all the lower floodplain of Ribeira dos Socorridos and, in the north, on its east slope, can be seen



FUNCHAL RIDGE AND SUBMARINE CANAL

The submarine region of Funchal coast presents an alignment of volcanic cones in the form of a volcanic mountain range that is designated by Funchal Ridge Rift (Figure B). According to Klugel & Klein (2006), this ridge is characterized by presenting 60 km long and 20 seamounts with a conical morphology with diameters in the range of 1,5 km to 3 km and different depths. In Figure B it is clearly evidenced this volcanoes cluster in the south and, also, the parallelism between

In more detail, the Funchal Rift lies between Câmara de Lobos and Funchal submarine canyons (Figure C), on the continuation of the respective terrestrial fluvial valleys (Gierman, 1967). This rift extension reaches the volcanic structure base, in other words, the transition zone to the surrounding abyssal plains at 4000 m deep (Figure B).

The Funchal Ridge (Figure A and B) also stretches to the north, to the interior of the island, defining a cluster of several monogenetic volcanic cones implanted along four eruptive fractures, with a north-northwest-south-southeast direction and, parallel to each other. From the volcanic structures specified stands out the peaks

In the last few years, the bathing complexes and the referred beach areas have been developed.

During 600 years of settlement several places maintain their centenary names. However, in several cases, they have acquired new designations according to historic events, eminent persons, geological phenomena and characteristics, industrial and commercial activities, among others. Along the route (Figure D) several places came to be known: by personalities names and nicknames, like the cases of Poças do Gomes and Doca do Cavacas, that are located between LS 8 and LS 10; by historical events, as in the case of the Ribeira dos Socorridos (LS 24) and the Formosa beach, which Gaspar Frutuoso (1998) described and praised "... by her comeliness and fit, (...) because there are no similar in all the island, that will have

The fortifications were only used to intimidate the intruders, as several of them were useless in terms of defense, fact mentioned in the reports of military engineering from XIX century. As a consequence, several fortifications were sold to private individuals, mostly of english families, while others were abandoned. Such cases are the Cais do Carvão (LS 4) as well as the Fábrica and Conservas sites (LS 7-LS 8, where tuna fish was processed, transformed and canned in olive oil).



LS 1 - LIDO BATHING COMPLEX



On Madeira island, the Lido designation as a different meaning from the one used in Aveiro and Algarve coast, where the Lido term result from the accumulations transported by currents, situation that leads to the formations of sandbars and islets groups separated by sea branches.

In the case of Lido Bathing Complex, its formations result from a subaerial lava flow of basaltic composition (CVS2 B, Figure A) which, going down the cliff, advanced through the sea, in shallow waters, and lead to a lava delta formation (or lava "Fajá"). Over time the ocean erosion in the front side of the lava delta let the prevalence of several islets (for example, Gorgulho and Fajá islets), and several coastal recesses, lows and flaps on the rock of the lava delta that were used as a connecting element, on the construction of the swimming pools and the solarium platforms.



LS 2 - REGIÃO AUTÔNOMA DA MADEIRA SQUARE ▾



The current headquarters building of Funchal Naval Club, Quinta Calaça Bathing Complex, was in first place a fort in the XVIII century, designated as Calaça or Arôvel Artillery Battery and, later, was the place where have been built the summer houses of the British Consul in Madeira, Henrique Gordon Vetch.

The Funchal Ridge (Figure B) extends to the interior of the island, defining a cluster of several monogenetic volcanic cones, resulting from strombolian/hawaiian eruptions. The scoria cones of basaltic nature take root along four eruptive fractures, with north-northwest-south-southeast direction, parallel to each other (Figure A). In the foreground is the imposing Ponta da Cruz peak (261 m) with a estimated age of 25 000 years. On top of the cone are installed a range of telecommunications towers and, along the southern slope, were built a range of infrastructures, for instance: Regimento de Guardiões nº 3 (RG3), Ajuda Urbanization and several hotel units (Altô Lido, Meliá Madeira Mare Hotel & Spa and Entel Lido Resort Conference & Spa).

The Gorgulho Fort, also known as Lido Fort, was built in 1618, and refurbished in the XVIII century by the Engineer Inácio Joaquim de Castro. In 1987/1988, the fort was restored, and its space is used, nowadays, by the "Fortim do Lido" Snack Bar.



LS 3 - GORGULHO BEACH



The small subvertical cliff, located near the solarium and the Gorgulho beach, is composed of hydrolipian pyroclastic deposits of trachytic nature (tuff of volcanic ash and pumice) interspersed with hydromagnetic pyroclasts of basaltic nature, subaerial pyroclasts (common scoria) and tuffite levels. This is, therefore, a polygenetic cliff formed by different volcanic products, associated to different magma compositions (felsic, in the case of trachytic materials and mafic in the case of scoria of basaltic nature), resulting from different eruptive types, including subaerial eruptions (or terrestrial) and eruption that had contact with water (namely, hydromagnetic eruptions, hydrolipian/felsic or surseyan /basaltic). While the pumice deposits present a yellowish brown tonality, the pyroclasts deposits of basaltic nature exhibit a darkish tonality.

In several deposits layers (a), located under the promenade bridge, it's possible to identify, with the naked eye, xenoliths ("foreign rocks fragments", b) which were brought from the magmatic chamber, as well as pre-existing corals and seashells fragments, ripped from the bottom of the ocean, facts that attest the violence of the volcanic explosions and eruptions.



LS 4 - CAIS DO CARVÃO

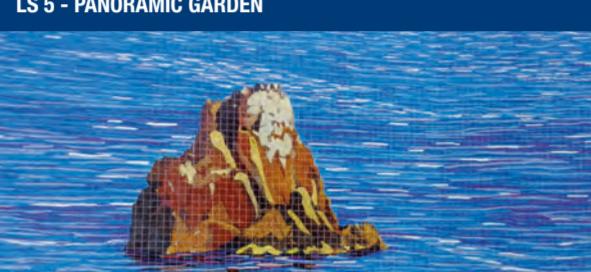


The Marine Biology Station of Funchal, opened on 28th September 1999, was based on a project signed by the architect Gonçalo Byrne, that defend the "architecture in service of life".

The Cais do Carvão, used since 1903 by Wilson Sons & Company Limited (Weira, 2017), had a crucial role in the supply of mineral coal, namely the anthracite type, mainly imported from England. Among the several coal applications, deserves to be highlighted the application in boilers of the Monte train, steamboats, as well as in the sugar cane thermoelectric and processing industry.

The pier was built on several flaps from the subaerial lava flow (CVS2 B, Figure A), which extend to south, towards the sea. Along the coastal cliff, between the Cais do Carvão and the Funchal Naval Club, the lava flow presents differential erosion and different morphological characteristics, including a smooth surface and a form similar to coiled ropes (pahoehoe lava), and very irregular surfaces constituted of loose, angular and scoria fragments (namely, material of clinker type), typical of aa lava, that sometimes form small cavities, due to the removal or fall of the loose materials.

LS 5 - PANORAMIC GARDEN



The tile panel, placed near the access staircase of the Panoramic Garden, is the handwork of the Maderian plastic artist Rigo 23. The sculptor aimed to illustrate the scenic importance of the Gorgulho Islet (Lido), an icon in the coast landscape.

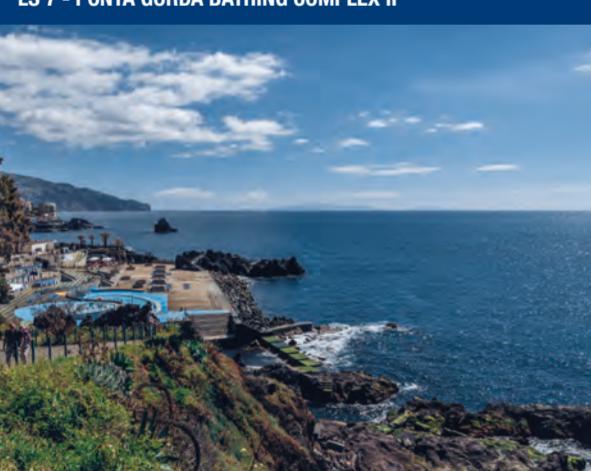
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LS 6 - PONTA GORDA BATHING COMPLEX I



The Ponta Gorda designation is associated to the fact that its geological formation is very thick and prominent on the coast line. On the route that cross the bathing complex, the subaerial lava flow (CVS2 B, Figure A) has a considerable thickness (>10 meters), showing at the top a columnar jointing. The construction of several infrastructures on the lava flow, associated to the steep subvertical inclinations, required the execution of stabilization works. These involved railing, wire mesh netting system, and shotcrete. However, most part of the adopted geoenvironmental solutions go currently unnoticed due to the range of planted trees along the seedbed and the garden that form a kind of vegetation curtain.

LS 7 - PONTA GORDA BATHING COMPLEX II



The Dighton Rock replica, placed on the promenade in 2005, marks the American Independence, which took place in July 4, 1776, where the Madeira wine was chosen to celebrate this historic date.

On the Funchal city 500 years celebrations (1508-2008) it was placed on this site a bronze sculpture of João Gonçalves Zarco, authored by Augusto Cid. The sailor position and its look have at prospect the Cabo Girão, remembering the first complete recognition of Madeira island.

The beach materials extend towards the cliff base that correspond to the ancient coastline, however they become unnoticed due to the hotel units, Pestana Bay and Pestana Gardens. The petrous materials that form the referred beaches, of several sizes/dimensions (boulders, cobbles, pebbles, sands), where explored for several decades and used in the construction industry and public works sector, on the hot stone massage and, also, in Madeiran pavement. The paving art used on Madeiran pavement constitute a unique heritage, if considering the composition of geological materials and the variety of patterns, geometrical and floral, which embellish Madeira streets, atriums, churches, palaces, houses, courtyards and gardens.



LS 8 - POÇAS DO GOVERNADOR



The Poças do Governador are shallow depressions that form small natural swimming pools filled with seawater according to the tide, highly sought and appreciated by the bathers. These natural swimming pools are installed between "coastal strings", in other words, rocky crests resulting from the cooling of front side of the lava flow, which advanced to the sea.

On the portuguese pavement, along the promenade, the white and black limestones were used to identify the Poças, Buraco do Fojo, Fábrica, Ponta da Cruz and Conservas sites, as well as to represent a set of designs allusive to the local activities.

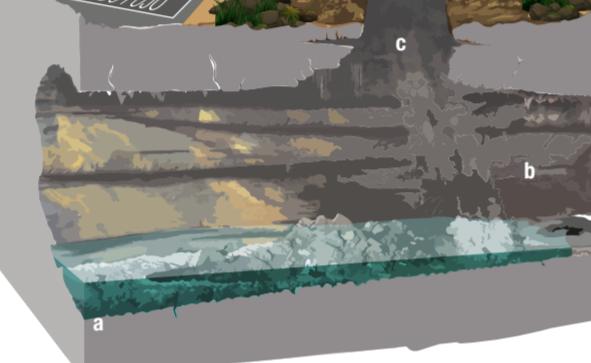
LS 9 - BURACO DO FOJO

The Poças do Gomes tunnel opened on 1st October 1999, and integrates the Ponta da Cruz - Praia Formosa sea-side promenade. The tunnel, hewn out of the basaltic rock, present variable section, an irregular shape and contour, with several cracks, marks from the drillings (for rock breaking and tunnel opening) and, also, a geological fault that compartmentalizes all the structure. This fault extends until the cliff giving rise to a coastline cave, since the cliff provide less resistance to coastal erosion by effect of this tectonic accident. The seawater entering the cavity creates an unusual phenomenon, known as "bufaduro": the sound produced and the released aerosol result from compressed air in the crack and in the cavity interior by the waves action.

In the 1930s were extracted, from the east cliff and the Formosa beach, blocks of stone and sand that were applied as construction materials in the port of Funchal (or Pontinha, Figure A).

Note that the tunnels are volcanic cavities associated to effusive basaltic volcanism, typical of pahoehoe flows, in which the formation mechanism has several stages, namely: whilst the lava flows move over a slope the surface, the base and the edges of the lava flow solidify faster than their interior which continue liquifying and flowing; when the lava supply by the eruptive center is finished and, after, the drainage of the flow central part, it is formed a tunnel fully or partially opened. When the tunnel roof is too thick, or in the cases that are subject to heavy loads and great stresses (natural or anthropic), it can collapse and originate skylights.

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LS 10 - PONTA DA CRUZ

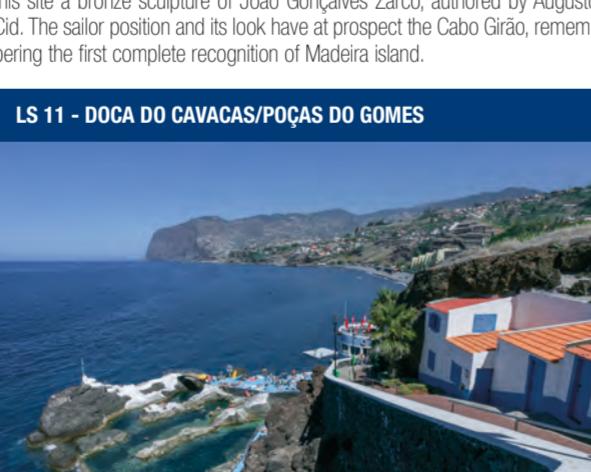


The Ponta da Cruz site is the southernmost point of Madeira island. The erosive action of the seawater over the geological formation, composed by materials with different resistances, carved on the cliff a shape similar to a dog head (back side view). On the top of the salient side of the lava flow it was put an iron cross to identify the place.

Along the east cliff can be identified a sharp change on tonality of geological formations, that corresponds to the transition from the subaerial lava flows of basaltic composition, with dark tonality, to the hydrolipian pyroclastic deposits of trachytic nature (tufts and pumice ash), with brownish yellow tonality (Figure F).

The beach materials extend towards the cliff base that correspond to the ancient coastline, however they become unnoticed due to the hotel units, Pestana Bay and Pestana Gardens. The petrous materials that form the referred beaches, of several sizes/dimensions (boulders, cobbles, pebbles, sands), where explored for several decades and used in the construction industry and public works sector, on the hot stone massage and, also, in Madeiran pavement. The paving art used on Madeiran pavement constitute a unique heritage, if considering the composition of geological materials and the variety of patterns, geometrical and floral, which embellish Madeira streets, atriums, churches, palaces, houses, courtyards and gardens.

LS 11 - DOCAS DO CAVACAS/POÇAS DO GOMES



The swimming pools and the solariums of Ponta Gorda Bathing Complex, were built on the front surface of an old lava delta, taking advantage of the several rock outcrop flaps of the subaerial lava flow (CVS2 B, Figure A) constituted by rocks with a dark tonality.

On the lava flow base can be seen an ancient contact surface (a), with irregular contours, between the lava flow and an ancient soil (i.e., paleosol, b). This contact surface also corresponds to a "cooked area" (a) as a result of the heat action from the lava flow on the clay soil conferring a strong reddish tonality given the presence of iron oxides and hydroxides on the soil. This clay material that contains, punctually, small fragments of snail shells, is locally known as "giz de pedreiro" or "giz de alfaiate" (c) based on its use, to mark and/or scratch several kinds of surface, including textiles.

In several deposits layers (a), located under the promenade bridge, it's possible to identify, with the naked eye, xenoliths ("foreign rocks fragments", b) which were brought from the magmatic chamber, as well as pre-existing corals and seashells fragments, ripped from the bottom of the ocean, facts that attest the violence of the volcanic explosions and eruptions.



LS 12 - POÇAS DO GOMES TUNNEL



The Poças do Gomes tunnel opened on 1st October 1999, and integrates the Ponta da Cruz - Praia Formosa sea-side promenade. The tunnel, hewn out of the basaltic rock, present variable section, an irregular shape and contour, with several cracks, marks from the drillings (for rock breaking and tunnel opening) and, also, a geological fault that compartmentalizes all the structure. This fault extends until the cliff giving rise to a coastline cave, since the cliff provide less resistance to coastal erosion by effect of this tectonic accident. The seawater entering the cavity creates an unusual phenomenon, known as "bufaduro": the sound produced and the released aerosol result from compressed air in the crack and in the cavity interior by the waves action.

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LS 13 - FORMOSA BEACH (FO2 GEOSITE)

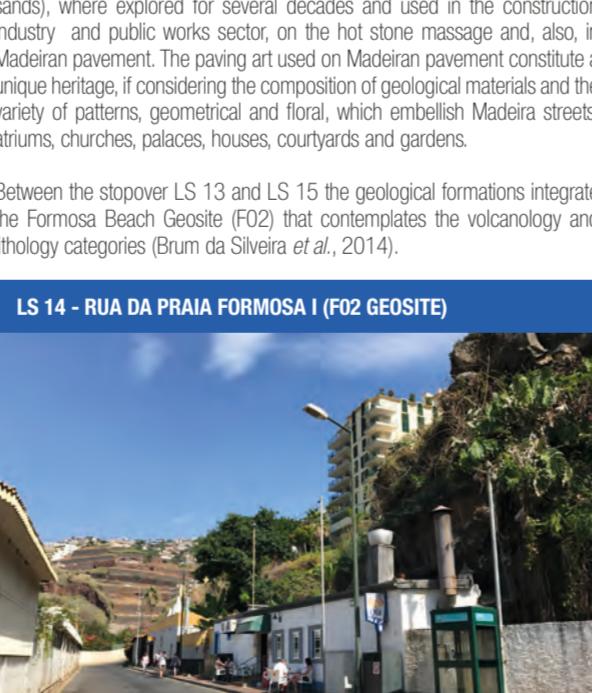


On the coastline that extends along 1.5 km, between the Pestana Gardens Oceans and the Orca Praia Hotel, there are six contiguous beaches: East Formosa, Central Formosa, West Formosa, Nova, Namorados and Areeiro. All of them, presently constituted by rolled pebbles and cobbles, have free access and comprehend several structures, that include blind or reduced mobility bathers support.

Along the east cliff can be identified a sharp change on tonality of geological formations, that corresponds to the transition from the subaerial lava flows of basaltic composition, with dark tonality, to the hydrolipian pyroclastic deposits of trachytic nature (tufts and pumice ash), with brownish yellow tonality (Figure F).

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LS 14 - RUA DA PRAIA FORMOSA I (FO2 GEOSITE)



Between the stopover LS 13 and LS 15 the geological formations integrate the Formosa Beach Geosite (FO2) that contemplates the volcanology and lithology categories (Brum da Silveira et al., 2014).

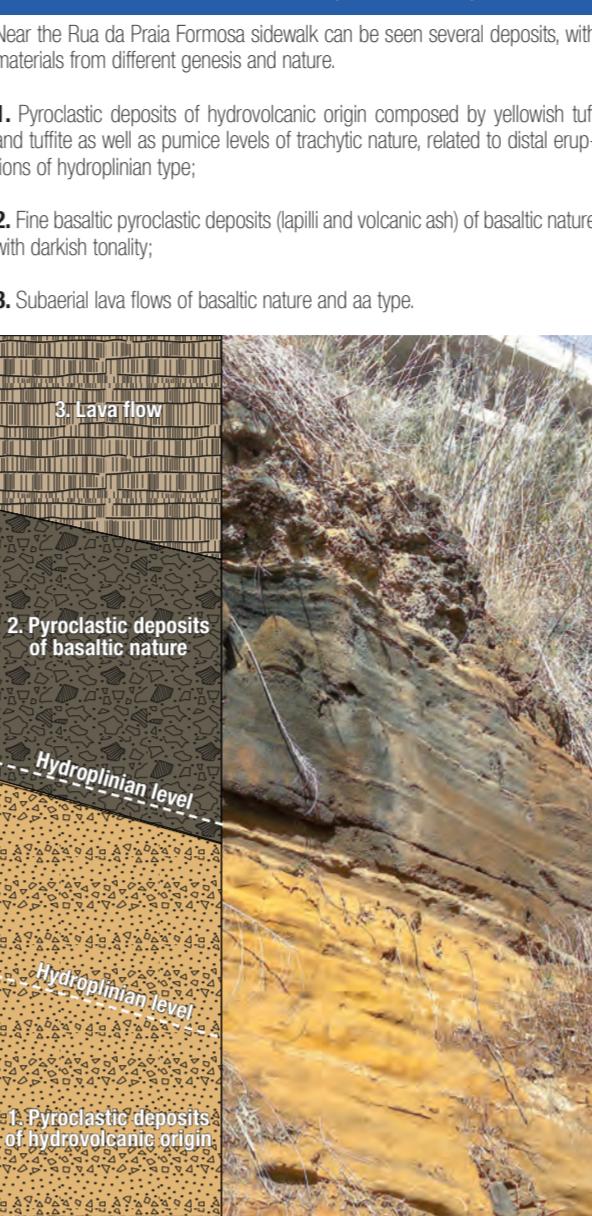
The cliff between the Nova beach and the Namorados beach presents three distinct lithostratigraphic units, described from bottom to top:

1. Pyroclastic deposits of basaltic nature with reddish tonality due to the weathering of ferromagnesian minerals;

2. Compound subaerial lava flows of basaltic nature deposited discordantly and horizontally, in which are individualized several flow units in the form of compact and massive levels interspersed with fragmented levels of clinker;

3. Pyroclastic deposits of hydrovolcanic origin composed by yellowish tuff and tuffite with pumice levels of trachytic nature related to eruptions of hydrovolcanic type;

LS 15 - RUA DA PRAIA FORMOSA II (GEOSITO FO2)



The Rua da Praia Formosa sidewalk can be seen several deposits, with materials from different genesis and nature.

1. Pyroclastic deposits of hydrovolcanic origin composed by yellowish tuff and tuffite as well as pumice levels of trachytic nature, related to distal eruptions of hydrovolcanic type;

2. Fine basaltic pyroclastic deposits (lapilli and volcanic ash) of basaltic nature with darkish tonality;

3. Subaerial lava flows of basaltic nature and aa type.

Hydrolipian level

Hydrolipian level

1. Pyroclastic deposits of hydrovolcanic origin

2. Pyroclastic deposits of basaltic nature

3. Lava flow

Hydrolipian level

LS 17 - NAMORADOS/AREEIRO BEACH