

A field guide to the geology of **MADEIRA**

Supplement 01/2016

Since publication in 2008 the need has arisen to update some of the information contained in the above Guide. The great storm of February 2010 changed some of the topography, including the area of Porto da Cruz and in the same year a new geological map of the island was published along with a revision of the stratigraphy. These and other alterations and additions are reflected in the following information which was up to date in June 2016. The authors would be grateful for additional information relating to the Guide; they can be contacted at the address at the bottom of page 8.

1. In and around Funchal

Locality 1.2 Garajau page 44

A path (Fig. 1.) constructed below the Christo Rey statue, provides safe access to the dyke that cuts the Garajau cone. A cable car descends 200 m to the beach where there is a small café and scuba diving facilities in a protected area, the Garajau Marine National Park.



Fig. 1. Path at Punta de Garajau

2. New Itinerary from Ponta da Cruz to Camera de Lobos

This route traverses a variety of lava flows, volcanic cones and sediments (epiclastic rocks) derived from the erosion of volcanic rocks. These are products of the most recent division (Funchal Unit) of the youngest period of volcanic activity in Madeira.

Ponta Da Cruz is on the urban bus route No.1. Prepaid bus tickets can be purchased from a kiosk at Avenenido do Mar opposite Fuchal Marina. Take the bus to **locality 1** (Fig.2), close to the Centromar Shopping Centre. Steps opposite the Shopping Centre give access to a path leading to a fish restaurant built on the side of the thick basaltic lava flow that forms the cliff at the promontory. The lava flow has a thick rubbly top and a massive lower part in which a tunnel has been excavated to provide access to the Praia Formosa beach.

Beyond the tunnel exit a wooden slatted footpath leads along the boulder beach backed by cliffs of lava topped by bedded ash. Immediately past the Pastana hotel complex the path has been washed away by wave action so take the road past the hotel entrance to **locality 2 (Fig.4)** taking care to avoid traffic going to and from the hotels. Cone deposits including ash, lapilli and scoria interbedded with mudflows crop out in the cliff section at the side of the road.

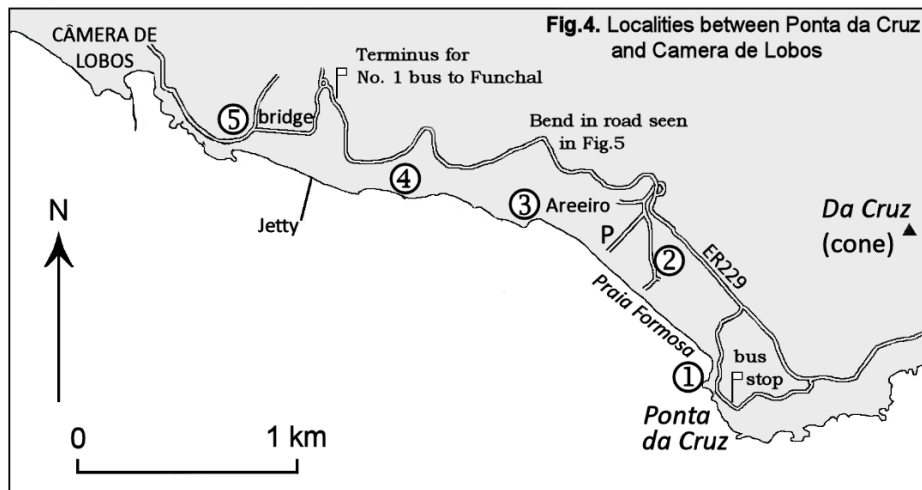


Fig.2. Bedded basaltic ash interbedded with mudflows at Locality 2. Rain has washed mud from the upper flow down the face of the bedded ash.

A little farther up the road a lithic clast, is embedded in ash and lapilli. The groundmass texture is characteristic of deposit from a collapsing eruptive column. The large lithic clast would have been torn from the side of the vent. It landed in the ash and lapilli cascading down the side of the vent. See how it disturbed the bedding that has piled up in front of it (Fig.3).



Fig.3. Angular basaltic lithic clast of microporphyritic lava. (1 Euro coin for scale)



To return to the beach take the first turning to the left. At the bottom of the road is car parking and access to the concrete esplanade leading to Câmara de Lobos. Cafés occur at the NW end of Praia Formosa (Fig.6) as far as the kink in the coastline marked by an outlier of black basalt lava at locality 3.



Beyond locality 3 a complex of lava flows and ash beds crops out in the cliffs backing the shoreline (locality 4) as far as the jetty at the fuel storage facility.

Fig. 6. The view from the Esplanade looking NW towards locality 3. The headland in the distance is Cabo Girão.





Fig.7. Series of basaltic lava flows near locality 4. The flows are separated by layers of ash and rubble. They are about the same age as the cones, products of late Quaternary volcanic activity in post Glacial times.

Beyond the jetty the path leads up to locality 5 where it joins the ER-229 road to Câmara de Lobos. Here you have the option of crossing the bridge along the ER-229 towards the terminus where you can catch the No.1 bus back to Funchal or continue along the promenade towards Câmara de Lobos. Examples of lava and ash also occur at the roadside (Fig 8.) and beside the promenade. Another quaternary cinder cone forms the hill on the north side of Câmara de Lobos.

Travelling by bus along the ER-229 note how the road cuts through the cone at Areeiro, and lava flows farther west. Flows also crop out at the roundabout and at the roadside between the bus terminus and locality 5.



Fig.8. Promenade looking towards locality 5.

3. Major changes in the vicinity of Porto da Cruz

The storm in February 2010 led to flash floods in several parts of Madeira. At Porto da Cruz the main road into the town from the east was swept away and the graveyard severely damaged. A major collapse on the seaward side of Rochão Hill destroyed the pillar of mugearite lava (Fig 10) that formed a feature at Locality 3.10 (Burton & MacDonald, page 70). The old Baixo road below the cliff face of mugearite lava (A in Fig.9) was upgraded to improve access to the east.

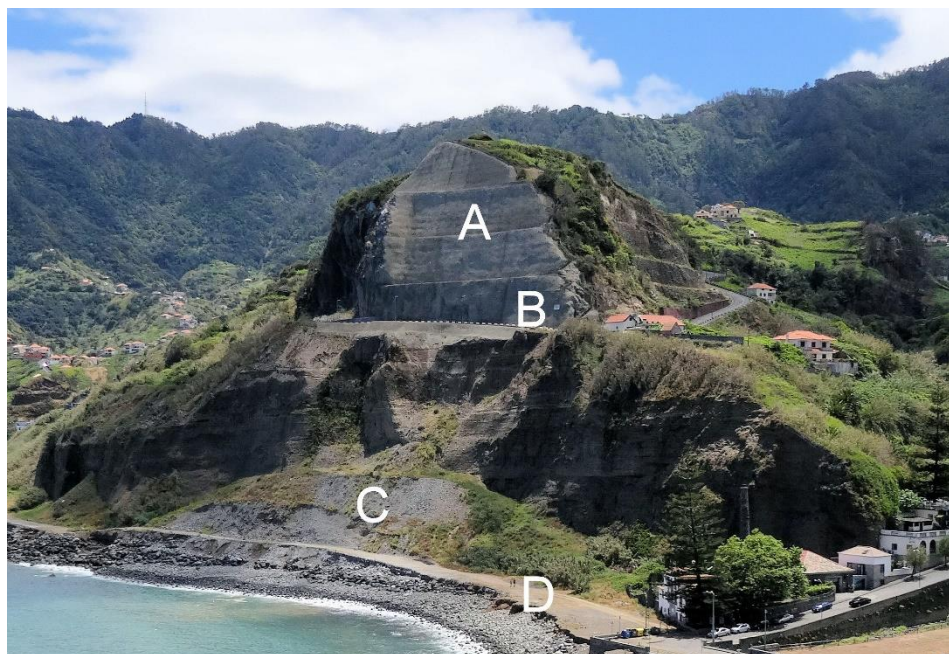


Fig.9. View of Rochão Hill from the summit of the Cais peninsula in June 2016. Prior to the publication of the guide in 2008 the ocean lapped the foot of the cliff at the lower left-hand side (see plate 7a in the Madeira Guide). Subsequently a road was constructed (D) close to sea level with rock debris from the construction of the new trunk road between Machico and Santana. A pillar of mugearite (Fig.10) stood at B but had already partially collapsed before the major cliff collapse at the time of the storm in 2010. C is the fan of sediment resulting from the collapse of the cliff. The mugearite cliff above the road at B has been stabilised by a cement rendering (A) to protect the reconstructed road below it from further rock falls.

To obtain copies of the Guide refer to the website of the Geological Society of Glasgow at www.geologyglasgow.org.uk. The Guide also may be obtained from the book shop, Livraria Esperança, 155 Rua Dos Ferreiros, Funchal, Madeira (the street that runs NW from the north corner of the Municipal Square (PRACA DO MUNICÍPIO)).



Fig. 10.

The mugarite pillar (Pinnacle) beside the old Baixo road prior to 2008. It was poised on top of a succession of poorly cemented sediments extending down to sea level. Major cracks in the pillar led to its partial collapse by 2009.

4. Roto da Cal, São Vicente



Fig. 11. Lime kiln at Roto da Cal museum

The Miocene Reef Complex locality (page 76) now features a museum complex, Roto da Cal, illustrating the history of extraction of limestone at Lameiros. As well as a restored lime kiln there is a display of fossils found at the limestone quarry featuring specimens of a sea urchin (*Clypeaster*), a bivalve (*Gigantopecten*) and a colonial coral. A kiosk provides light refreshments. Before visiting Rota de Cal it is as well to check opening times at the tourist information office in Avenida Ariaga in central Funchal opposite the Fortress.

5. Revised stratigraphy

In 2010 a new geological map of Madeira at the scale of 1:50 000 was published by the Regional Secretariat for the Environment and Natural Resources of the Autonomous Region of Madeira, and the University of Madeira. A detailed description of the revised stratigraphy used in the preparation of this map was also published in 2010 by the authors, António Brum da Silveira, José Madeira, Ricardo Ramalho, Paulo Fonseca and Susana Prada.

Volcanic Stratigraphy of Madeira – A. Brum da Silveira et al. 2010

*Equivalent
Stratigraphy of
Zbyszewski et al.*

SUPERIOR VOLCANIC COMPLEX (CVS) –
Pleistocene to Holocene (1.8 – 0.007 Ma)

Lombos/Fuchal units undifferentiated (CVS1-2)

Funchal Unit (CVS2) Post-erosional activity;
represented in the contemporary geomorphology.

Late stage β^6

Lombos Unit (CVS1) Isolated activity, flows tending
to fill valleys

Late stage β^5

INTERMEDIATE VOLCANIC COMPLEX (CVM)

Plio-Pleistocene (5.57 – 1.8Ma)

Curral das Freiras Unit (CVM3) Third stage of
subaerial activity. Essentially Hawaiian in character
from vents probably in the Paul da Serra area.

Mature Stage β^4

Penha D'Águia Unit (CVM2) Second stage of shield
construction, increased strombolean and Hawaiian
activity producing vast quantities of lava.

Main Shield
Building stage β^3

Encumeada Unit (CVM1) First stage in the
construction of the subaerial shield. Strombolean,
vulcanian and fissural activity aligned along an
E-W rift zone

Main Shield
Building Stage β^2

INFERIOR VOLCANIC COMPLEX (CVI)

Basal Complex β^1

Miocene (>5.57 Ma)

Lameiros Unit (CVI 2) A sequence of submarine
carbonates with an unconformable relationship
with CVI 1

Porto da Cruz Unit (CVI 1) Probably represents the
final phase of submarine shield activity; highly
altered rocks including hyaloclastites and
submarine lavas cut by a dense network of dykes

6. Possibility of volcanic hazards

Mention has been made (Brum da Silveira et al. 2010, 38) of the possibility that a submarine volcanic eruption took place on the 31st March 1748, east of Ponta de São Lourenço. It is also noted (*op. cit.*) that hydromagmatic (Surtseyan) fall deposits occur on the top of the SE extremity of the islet of Desembarcadouro (also known as Cevada or Metade) the larger of the two islands at the eastern end of Cabo São Lourenço. Very fresh-looking agglutinated spatter and bombs occur at Estreito (Burton & MacDonald 2008, 55). Emanations of carbon-dioxide gas have been encountered extensively in many of the road and water supply tunnels throughout Maderia although not normally in quantities that are considered to be hazardous. The youngest radiometric age dates obtained from the Paul da Serra area suggest that volcanic eruptions took place there about 6 or 7 thousand years ago (Geldmacher et al. 2000). It cannot be assumed that volcanic activity on Madeira is extinct but in the absence of significant seismic activity it is considered that the volcanic hazard level is very low.

7. References

António Brum da Silveira, José Madeira, Ricardo Ramalho, Paulo Fonseca and Susana Prada. 2010. *Notícia Explicativa da Carta Geológica da Ilha da Madeira*. Secretaria Regional e Recursos Naturais, Região Autónoma da Madeira e Universidade de Madeira.

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Geldmacher, J., Bogaard, P. v D., Hoernle, & Schminke, H.-U. 2000. $^{40}\text{Ar}/^{39}\text{Ar}$ age dating of the Madeira Archipelago and hotspot track Eastern North Atlantic) *Geochemistry, Geophysics, Geosystems*. 1. 1008

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