

Cruise Report

Poseidon Cruise POS270

Exploring and sampling submarine volcanoes and collapse deposits off
the western Canary Islands (El Hierro and La Palma)

Date of the cruise: 02.03. - 15.03.2001

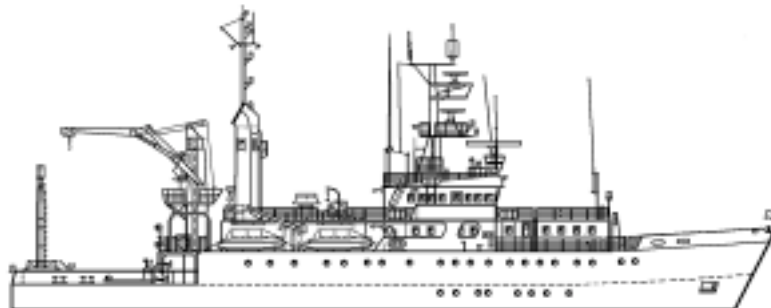
Port calls: Las Palmas de Gran Canaria / Las Palmas de Gran Canaria

Chief scientist: Dr. T.H. Hansteen, GEOMAR, Kiel

Co-chief scientist: Dr. Andreas Klügel, Universität Bremen

Number of scientists: 10

Project: "Beprobung und Untersuchung von submarinen Vulkaniten und Kollapsablagerungen
im Bereich der westlichen Kanaren" (DFG: Ha 2100/6-1, Kl 1313/3-1)



1. Scientific crew

Name	Nationality	Institution	Job on board
Dr. Thor H. Hansteen	Norwegian	GEOMAR	Chief Scientist / Shift leader
Dr. Andreas Klügel	German	GeoB	Co-Chief / Petrology
Beate Wenskowski	German	GEOMAR	Shift leader
Burkhard Schramm	German	GeoB	Shift leader
Valentin Troll	German	GEOMAR	Rock descriptions
Silke Steph	German	GEOMAR	Protocol writer / Geology
Thomas Walter	German	GEOMAR	Protocol writer / Structural geology
Jörg Pfänder	German	MPI	Protocol writer / Petrology
Kai Neufeld	German	GEOMAR	Protocol writer
Dr. Juan Carlos Carracedo	Spanish	EVCT	Sample coordination

GEOMAR: GEOMAR Forschungszentrum, Abt. Vulkanologie und Petrologie, Kiel, Germany

GeoB: Universität Bremen, Fachbereich 5 – Geowissenschaften, Germany

MPI: Max-Planck Institut für Chemie, Mainz, Germany

EVCT: Estación Volcanológica de Canarias, Tenerife, Spain

2. Research program

The westernmost and youngest Canary Islands La Palma (2.0 Ma) and El Hierro (1.1 Ma) are presently in their shield stages. The subaerial and submarine morphology of both islands is characterized by one or three elongated ridges, respectively, interpreted as volcanic rift zones [1]. High-resolution bathymetry shows that dozens of small cones occur not only along the submarine extensions of these rift zones but also in a dispersed manner at the island flanks [2,3]. Most of these cones appear to be relatively young volcanoes although some could represent slump blocks as well. Some presumably young cones are located on the scars and deposits of recent landslides such as the giant El Julán collapse of El Hierro.

The main objective of cruise POS270 was a detailed sampling of these morphologically young cones along the submarine rift zones and flanks of La Palma and El Hierro. Sampling was performed by pulling a chain or drum dredge precisely over the cone flanks (on the basis of a 1:50.000 bathymetric map) such that only in-situ material was collected. Most of the sampled cones had a base diameter of 1 to 2 km and an elevation of 300 to 500 m. In addition, some flank collapse deposits at the submarine flanks of La Palma were sampled. After preliminary investigations on board (petrography and cutting of cubes for thin sections), a number of samples was selected for petrological investigations, geochemical analyses and Ar/Ar rock dating.

The aim of the research project is a better understanding of the temporal, structural and geochemical evolution of the western Canary Islands. Only if samples from the volumetrically dominant submarine part of a volcanic island (>95%) are included in the investigations can the actual extent of recent volcanic activity be assessed. In addition, only the submarine sections can provide samples from extreme localities such as the end of rift arms or the distal volcano flanks. Major questions addressed are:

- Reconstruction of the volcanic evolution of the islands' rift zones. What is the extent of recent volcanic activity along-rift and off-rift?
- Comparison of petrological (thermobarometrical) data of submarine and subaerial rocks. Do samples from the distal flanks or near the end of rift arms indicate distinct levels of magma stagnation or depths of magma reservoirs? What are the implications for the magma plumbing systems?

- What is the compositional range (major and trace elements, radiogenic isotopes) of the submarine rocks, are there systematic differences to the subaerial volcanic edifices? What are the implications for mantle sources and plume dynamics?

3. Report of the cruise

The cruise track is shown on Figure 1. The POSEIDON left Las Palmas de Gran Canaria at 08:00 on the morning of March 2nd, 2001. The transit to the first station took less than a day and was accompanied by strong wind resulting in a rough sea and unfavourable dredging conditions during the entire first week. On the early morning of March 3rd work began at the first dredge location off the northeast rift zone of El Hierro. The dredge program was guided by 1:50.000 bathymetric maps kindly compiled and provided by Dr. S. Krastel (Universität Bremen) based on data from GEOMAR and from Dr. D. Masson (Southampton Oceanographic Center). The dredge program continued in this area until the evening of March 5th and then moved on to the area of El Hierro's northwest rift zone. Here we carried out many successful dredge hauls during the next two days. We then moved on to the western coast of La Palma where we dredged the western flank of the Cumbre Vieja ridge and the Cumbre Nueva landslide deposits for two days. After a short transit during the night, the eastern flank of the Cumbre Vieja ridge was dredged on March 10th and 11th and the southeastern submarine ridge on March 12th. The transit back to El Hierro was accompanied by a heavy storm that lasted for two days. Although the POSEIDON had moved to a presumably calm site southwest of the island ("mar de tranquilidad"), the strong wind and heavy sea required termination of the dredging work after only one station in the morning of March 13th. On the evening of that day, course was taken for Las Palmas. After almost 1 1/2 days of transit we arrived in Las Palmas on the morning of March 15th, when the cruise ended.

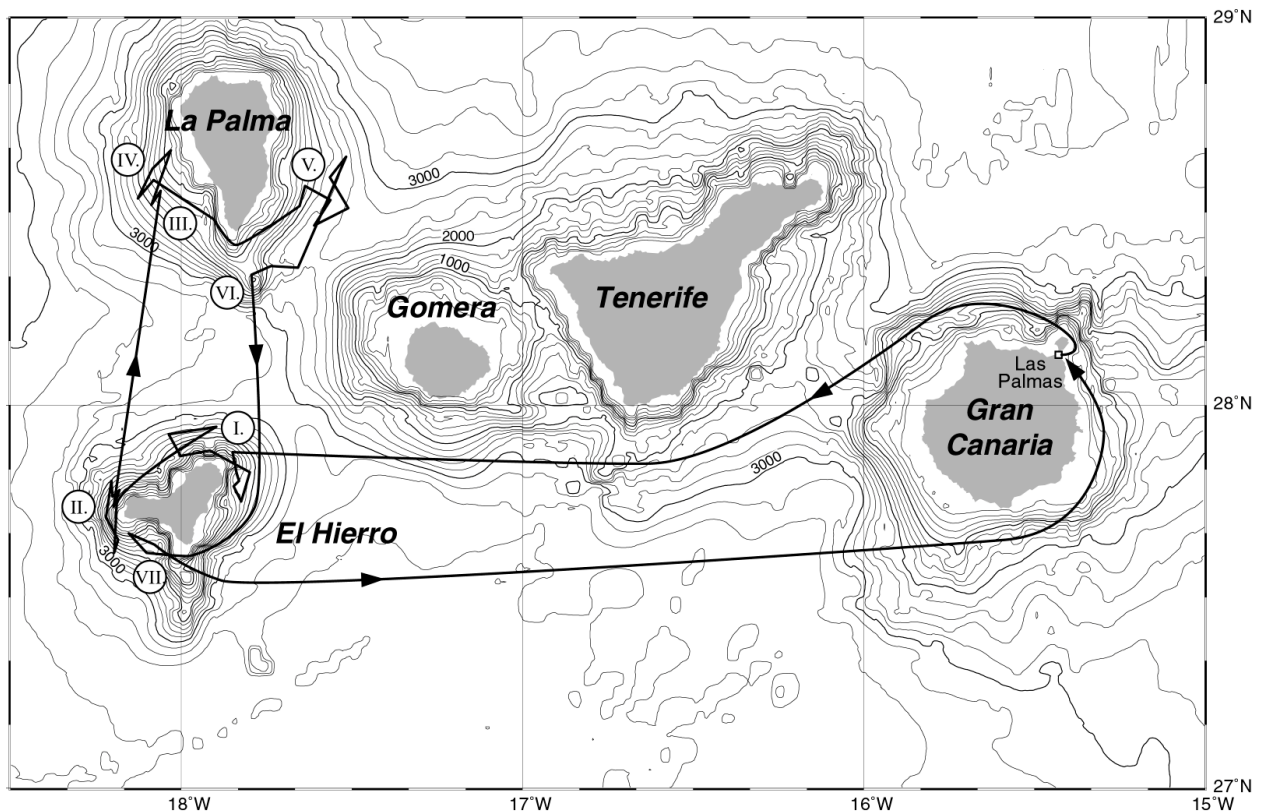


Fig. 1: Cruise track of POS270. Numbers in circles indicate working areas (see 6. Station List).

4. Scientific report and first results

The sampling program during cruise POS270 was very successful and yielded abundant fresh volcanic rocks from all dredge localities. A majority of the samples are optically very fresh and well suited to carry out petrological and geochemical analyses and in some cases Ar/Ar age dating. Details of the samples recovered during the cruise are given in the station list in section 6. Highlights of the sampling include the recovery of fresh basalt from a recent cone 30 km east of the La Palma rift axis and of extremely vesicular and fresh basalts with well developed pahoehoe-like flow textures from several localities off El Hierro.

On the submarine flanks of El Hierro, we recovered fresh basalts from 21 young volcanoes at depths from 800 to 2300 m. Another 25 volcanic cones can be tentatively identified from morphologies similar to the dredged ones. These submarine volcanoes off El Hierro occur in a dispersed manner on the blunt noses representing the extensions of the postulated subaerial northeast and northwest rift zones [1, 2] but also off the rift axes. Young volcanoes also occur within the Las Playas and El Julian landslide scars, testifying to renewed volcanic activity following large landslides.

On the east flank of La Palma off the active Cumbre Vieja volcano, we recovered submarine basaltic rocks from 8 volcanic cones at depths between 850 and 2200 m and at a distance of up to 30 km off the rift axis, recognizing another 20 possible volcanoes in the same area from high-resolution bathymetric data. Remarkably, young submarine volcanoes are comparatively rare on the western flank and the submarine extension of the Cumbre Vieja rift zone. Morphologic data also indicate the existence of several tens of volcanoes in the strait between La Palma and El Hierro and the older La Gomera island to the east. The high density of apparently young volcanoes on the NE and NW slopes of El Hierro is comparable to that on land at first sight, supporting the view that submarine volcanism is volumetrically important during subaerial growth stages of the Canary Islands [5].

The results of cruise POS270 indicate that young submarine volcanic activity off the islands of La Palma and El Hierro is not confined to the extensions of these rift zones, but is also dispersed along the island flanks. This highlights two important features of volcanism on the western Canary Islands: a) eruptions during the shield stage occur both subaerially and on the distal submarine flanks; b) synchronous basaltic eruptions both on neighbouring islands and in the straits between islands leaves two possibilities for the geometries of magmatic plumbing systems: a) dominantly vertical magma pathways from small-scale source domains, or b) widespread lateral transport of several km during magma ascent. In any case, a broad melting anomaly must occur in the mantle beneath La Palma and El Hierro to account for these observations.

5. Scientific equipment, instruments etc.

The POS270 cruise was aimed purely at dredging the submarine flanks of El Hierro and La Palma. The instruments deployed were two types of chainbag dredges of different size and a small, cylindrical drum dredge. A sediment tube was connected to the dredges to sample mud and eventually small glass or ash fragments. A total of 49 dredge hauls, of which 46 were successful, were performed without loss of any equipment.

6. Station List

The following station list includes short petrographic descriptions of the samples recovered. Coordinates and water depths given are those of the ship at first bottom contact (on bottom) and end of bottom contact (off bottom). CD = chainbag dredge, DD = drum dredge.

Station, Date	On bottom	Depth	Off bottom	Depth	Dredge
Area I. El Hierro, northeast rift zone					
Station 130 03.03.2001	27°52.170'N, 17°49.382'W	1998	27°51.390'N, 17°49.291'W	1775	CD
Around 20 pieces (4 kg) of fresh, vesicular (20 to 35 %) basalt. Group 1 ("bomb type") is aphyric, group 2 ("lava type") is ol-phyric, group 3 ("scoria type") is aphyric. Fragments are irregularly shaped, possibly pieces of submarine lava flows. Thin (mm) Mn crusts are common. 15 samples and 2 groups of extra material.					
Station 131 03.03.2001	27°51.296'N, 17°49.409'W	1825	27°51.286'N, 17°49.765'W	1577	CD
Dominantly corals with Mn coating, plus 1 piece of fresh, highly vesicular, aphyric basalt, interpreted as submarine lava.					
Station 132 03.03.2001	27°51.258'N, 17°48.497'W	2231	27°51.390'N, 17°49.030'W	1803	CD
Several pieces of basalt recovered (20 kg), 10% vesicles, moderately altered (Mn crust, calcite), minor cpx and ol. Sample 132-1-1 is a block of about 10 kg. 3 samples plus extra material.					
Station 133 03.03.2001	27°49.065'N, 17°48.918'W	1871	27°49.630'N, 17°49.620'W	1237	CD
About 12 pieces (10 kg) of very fresh basalt, either aphyric or ol-phyric (1-10%). Highly variable vesicularity (5% to >35%). 8 Samples; sample 133-8 is a large block.					
Station 134 03.03.2001	27°49.835'N, 17°49.139'W	1591	27°49.730'N, 17°49.501'W	1260	DD
About 10 pieces (10 kg) of very fresh, vesicular (20-25%), ol- and cpx-phyric (5%) basalt. Probably fragments of submarine lava flows. Samples are well suited for geochemistry and microprobe. 3 samples plus extra material.					
Station 135 04.03.2001	27°48.080'N, 17°49.560'W	1500	27°48.062'N, 17°50.188'W	1223	DD
First dredge haul lost on board. Second haul yielded around 20 pieces (10 kg) which include: fine-grained sediments; strongly altered hyaloclastite breccias with carbonate + clay; moderately vesicular submarine basalt with moderate (calcite + clay) or minor (calcite) alteration. 5 samples (135-2 consists of 4 and 135-3 of 5 specimens).					
Station 136 04.03.2001	27°47.978'N, 17°48.430'W	2108	27°47.434'N, 17°49.195'W	1807	DD
About 10 pieces (5 kg) of fresh, glassy, highly vesicular (35-65%) submarine basalt. Contains up to 5% of phenocrysts (plag and cpx). Could be an intermediate composition. 5 samples plus extra material; sample 136-1 is a soft, muddy sediment possibly containing small glass fragments.					
Station 137 04.03.2001	27°47.145'N, 17°50.369'W	1481	27°46.520'N, 17°50.730'W	1113	DD
About 30 pieces (15 kg) of very fresh, highly vesicular (50%), glassy submarine basalt which contains about 1 % phenocrysts that are difficult to recognize (probably cpx + plag). 6 samples plus extra material (20 pieces of 1-3 cm size); sample 137-6 is a muddy sediment with small rock fragments.					
Station 138 04.03.2001	27°44.225'N, 17°48.819'W	2196	27°43.830'N, 17°49.054'W	1740	DD
10 small pieces (1-2 cm) of fresh, glassy, aphyric basalt with 10-20% of vesicles. Well suited for microprobe or glass picking.					
Station 139 04.03.2001	27°43.695'N, 17°48.023'W	2276	27°43.780'N, 17°48.680'W	1920	CD
Full dredge (about 150 kg) of mostly fresh basalt from submarine lava flows. Two groups: A) Pillow fragments with very fresh and intact glassy rims up to several mm thick, vesicularity varies from almost massive to >50 %; vesicles often heterogeneously distributed. Some lavas are aphyric, others contain up to 10% of phenocrysts, some slightly altered, and up to 5 % cpx. B) As A, but slightly rounded (abraded). Several small ultramafic xenoliths (up to 1 cm).					
Station 140 05.03.2001	27°53.027'N, 17°54.265'W	1300	27°52.838'N, 17°54.811'W	1000	CD
Full dredge (about 200 kg) of dominantly fresh basalt from submarine lava flows. Three groups: A) Pillow fragments with very fresh and intact glassy rims up to several mm thick, vesicularity varies from 10 to 50 %; vesicles often heterogeneously distributed. Up to 10% of phenocrysts, and up to 5 % cpx. B) As A, but slightly rounded (abraded). C) Clastic basalt/ carbonate sediment mixture (partly lapillistone).					
Station 141 05.03.2001	27°52.580'N, 17°57.970'W	1250	27°52.240'N, 17°58.740'W	960	CD
Full dredge (about 200 kg) of very fresh basalt mainly from one submarine lava flow which disintegrated on deck. Most fragments have very fresh and intact glassy rims up to several mm thick, vesicularity varies from 20 to 40 %, vesicles are often heterogeneously distributed and range in size from <1mm to several cm. 3 to 10% of phenocrysts, lesser amounts of cpx.					
Station 142	27°52.063'N, 18°00.354'W	1150	27°51.761'N, 18°01.320'W	1050	CD

05.03.2001

Full dredge (about 200 kg) 17 samples. Mostly fresh basalt from submarine lava flows. Four groups: A) Pillow fragments with very fresh and intact glassy rims up to several mm thick, vesicularity varies from 10 to 50 %; vesicles often heterogeneously distributed, <1 to 5% ol, and 1 to 5 % cpx. B) As A, but slightly rounded (abraded). C) Dense (<2% vesicles) cpx+plag-phyric basalt; D) Clastic basalt/ carbonate sediment mixture (partly lapillistone), one piece with contact to glassy lava or dyke (chilled margin).

Station 143	27°54.847'N, 18°02.144'W	2350	27°54.585'N, 18°02.498'W	2100	CD
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05.03.2001

Dredge almost empty. One 10 cm piece of semi-angular, fresh glassy submarine basalt with 10% vesicles and 10% ol + cpx (143-2). Sample 143-1 is a muddy sediment.

Station 144	27°56.742'N, 17°54.095'W	2450	27°56.449'N, 17°54.637'W	2150	CD
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05.03.2001

Dredge empty.

Area II. El Hierro, northwest rift zone

Station 145					CD
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06.03.2001

Start at 27°35.500'N, 18°11.680'W, 2650 m depth. Dredge haul terminated because of insufficient cable length and strong waves.

Station 146	27°40.393'N, 18°10.908'W	1600	27°40.795'N, 18°11.338'W	1250	CD
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06.03.2001

Full dredge (>200 kg); about 30 samples. Dominant rock type is very fresh submarine, vesicular (10 to 40 % basalt with olivine (5 to 15 % including megacrysts) and cpx (5 to 15%; megacrysts rare). Probably glassy groundmass and excellent sideromelane rims. Vesicles from <1 mm to several cm; often interconnected and surrounded by sideromelane. Also aphyric varieties.

Station 147	27°41.486'N, 18°11.247'W	1350	27°42.350'N, 18°11.810'W	1120	CD
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06.03.2001

Full dredge (>200 kg). about 20 samples. A) Mainly very fresh vesicular (20 to 50 %) basalt with cpx (2 to 10%) and olivine (0 to 5 %). Probably excellent sideromelane rims. Several small ultramafic xenoliths (up to 1 cm). Gradational vesicles sizes from <1 mm to several cm, often interconnected and surrounded by sideromelane. Also aphyric varieties. B) Angular basaltic clasts in carbonate sediment. C) Soft sediment sample.

Station 148	27°42.852'N, 18°13.572'W	1750	27°43.703'N, 18°13.805'W	1700	CD
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06.03.2001

Full dredge (>200 kg). 11 samples. Types: A) Very fresh glassy basalt mostly with sideromelane crusts, highly vesicular (20 to 45%; including micro-vesicular varieties), either aphyric or ol (2-7%) and cpx (2-15%-)phyric; B) comparatively dense (up to 15 % vesicles) and blocky to subrounded nearly aphyric basalt; C) Subrounded picritic basalt with 15-20 % ol and 5-10 % cpx and 15% vesicles.

Station 149	27°42.091'N, 18°14.384'W	2070	27°42.606'N, 18°14.847'W	2000	CD
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06.03.2001

Half a dredge (ca. 110 kg). 7 samples. A) Most pieces are very fresh highly vesicular (35 to 50 %) pillow basalt, nearly aphyric with minor cpx and olivine. Probably excellent sideromelane rims. Gradational vesicles sizes from <1 mm to several cm; often interconnected and surrounded by sideromelane. B) Blocky type pillow fragments with typically 20 % vesicles and subordinate ol and cpx.

Station 150	27°49.471'N, 18°13.208'W	2050	27°49.068'N, 18°12.626'W	1880	CD
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07.03.2001

Dredge a quarter full (ca. 80 kg). 10 samples. Fresh to slightly altered (decolouration and vesicles filled with clay minerals), moderately to highly vesicular (20 to 35 %) pillow basalt, some rocks nearly aphyric with minor cpx and olivine, others with up to 10 % cpx and 8 % olivine. Several pieces have sideromelane rims. Gradational vesicles sizes from 1 mm to 1 cm.

Station 151	27°46.880'N, 18°12.860'W	1664	27°46.950'N, 18°12.059'W	1366	CD
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07.03.2001

Full dredge (>200 kg). 10 samples. Very fresh to slightly altered (decolouration and vesicles filled with clay minerals), moderately to highly vesicular (20 to 35 %) pillow basalt, some rocks nearly aphyric with minor cpx and olivine, others with up to 10 % cpx and 8 % olivine. Several pieces have sideromelane rims. Gradational vesicles sizes from 1 mm to 1 cm.

Station 152	27°46.221'N, 18°13.238'W	1520	27°46.015'N, 18°12.697'W	1240	CD
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07.03.2001

Dredge very full (ca. 250 kg). 10 samples. Two rock groups: A) Very fresh submarine basalt fragments with intact glassy rims up to several mm thick, vesicularity varying from 15 to 60 %, vesicles often heterogeneously distributed, <1 to 5% ol, and 1 to 5 % cpx. Gradational vesicles sizes from 1 mm to 10 cm. B) as A, but slightly to moderately rounded and moderately to slightly altered (decolouration and vesicles partly filled with carbonate and clay minerals).

Station 153	27°47.661'N, 18°10.891'W	1200	27°47.400'N, 18°10.600'W	906	CD
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07.03.2001

Half full dredge (100 kg). 7 samples. A) Very fresh moderately to highly vesicular (15 to 45 %) submarine basalt, some rocks nearly aphyric with minor cpx and olivine, others with up to 3 % cpx and 8 % olivine. Several pieces have sideromelane rims. Gradational vesicle sizes from 1-10 mm. B) Some basalt blocks are moderately rounded and slightly altered (decolouration and vesicles filled with clay minerals), otherwise as A.

Station 154	27°44.759'N, 18°12.013'W	1270	27°44.320'N, 18°11.580'W	1050	CD
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07.03.2001

Half a dredge (100 kg). 9 samples. Very fresh and glassy submarine basalt with excellent sideromelane rims. Moderate to high vesicularity (15 to 35 %), vesicles sizes from 1 mm to several cm. Some rocks nearly aphyric with minor cpx and olivine, others with up to 6 % cpx and 5 % olivine.

Area III. La Palma, west flank of Cumbre Vieja

Station 155	28°31.662'N, 17°58.440'W	1467	28°31.193'N, 17°57.933'W	1501	CD
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08.03.2001

20 kg rocks in the dredge. 8 samples. Two main types of rocks: A) slightly to moderately altered (decolouration and vesicles filled with clay minerals), moderately to highly vesicular (15 to 35 %) submarine basalt with formerly glassy rinds, varying from nearly aphyric to 10 % cpx and 3 % olivine; B) Moderately to highly altered rounded basalt pieces, dense to slightly vesicular (<4 %), with fresh cpx and minor ol, interpreted as subaerial lavas.

Station 156	28°28.695'N, 17°59.839'W	2090	28°29.200'N, 18°00.050'W	1750	CD
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08.03.2001

15 kg rocks in the dredge. 12 samples, comprising three rock types: A) rounded, slightly to moderately altered (decolouration and vesicles filled with clay minerals), low vesicularity (1 to 5 %) basalt with abundant phenocrysts (10-20 % cpx, 3-10 % ol) interpreted as subaerial lavas; B) Rounded, moderately to highly altered basalt pieces, with moderate vesicle contents (5-10 %), fresh cpx (5-15 %) and ol (2-5 %), interpreted as submarine lavas; C) clastic sediments with carbonate matrix containing variably altered basaltic clasts.

Station 157	28°39.013'N, 18°00.775'W	830	28°39.421'N, 18°01.218'W	530	CD
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08.03.2001

15 kg rocks in the dredge. 8 samples, comprising two rock types: A) Rounded, slightly to moderately altered (decolouration and vesicles partly filled with clay minerals) basalt, variable vesicularity (10 to 40 %), 1 to 4 % olivine and cpx, interpreted as submarine lava; B) Altered lapillistone with carbonate matrix.

Station 158	28°36.369'N, 18°03.816'W	1610	28°36.940'N, 18°03.748'W	1300	CD
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08.03.2001

2 kg rocks in the dredge. 3 samples comprising two rock types: A) Rounded, moderately altered low vesicularity (1 to 5 %) basalt with >20 % olivine (iddingsitized) and 5 % cpx interpreted as a subaerial lava; B) Dense, rounded and moderately altered basalt with 0-1 % ol and 1-2 % cpx, interpreted as subaerial lavas.

Station 159	28°35.750'N, 18°04.553'W	1610	28°36.298'N, 18°04.400'W	1350	CD
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08.03.2001

10 kg rocks (15 pieces) in the dredge. 6 samples, comprising three rock types: A) Angular to sub-rounded slightly to moderately altered (decolouration and vesicles partly filled with carbonate and clay minerals), vesicle-rich (10 to 30 %) basalt with 2-3 % cpx and 1-3 % ol interpreted as submarine lavas; B) Lapillistone with carbonate matrix, partly rounded moderately to highly altered clasts up to 5 cm with vesicle contents of 20-30 %; C) Carbonate-rich sediment containing variably altered basaltic clasts.

Area IV. La Palma west flank, Cumbre Nueva landslide deposit

Station 160	28°31.800'N, 18°04.501'W	2160	28°32.235'N, 18°04.151'W	2000	CD
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09.03.2001

Just mud in dredge. One mud sample, possibly with glassy fragments.

Station 161	28°31.142'N, 18°04.105'W	2250	28°31.450'N, 18°03.471'W	2004	CD
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09.03.2001

20 kg rocks in the dredge. 8 samples. Two main types of rocks: A) Almost fresh to moderately altered (decolouration and vesicles filled with carbonate and clay minerals), moderately to highly vesicular (10 to 35 %) submarine basalt with formerly glassy rinds, varying mineral contents from 3-10 % cpx and 1-7 % olivine; B) Dense, slightly to highly altered rounded basalt pieces, with fresh cpx and minor ol, interpreted as subaerial lavas.

Station 162	28°34.600'N, 18°01.265'W	1590	28°35.253'N, 18°00.929'W	1430	CD
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09.03.2001

3 samples in the dredge. Two pieces of silty carbonate sediment with very finegrained rock fragments; one sample of soft finegrained sediment.

Station 163	28°34.250'N, 18°00.247'W	1450	28°34.832'N, 17°59.986'W	1300	Big CD
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09.03.2001

15 kg rocks recovered. 6 samples. Three rock types: A) Dense, slightly to moderately altered (decolouration and vesicles filled with clay minerals) basalt with fresh cpx (1-3 %) and ol (1-3 %), interpreted as subaerial lavas; B) Fresh to slightly altered vesicular (15 to 20 %) submarine basalt with 3-4 % cpx and 2-3 % olivine; C) Silty sediment with small basaltic fragments.

Area III. La Palma, west flank of Cumbre Vieja

Station 164	28°29.677'N, 17°54.249'W	1200	28°29.735'N, 17°53.796'W	840	CD
09.03.2001 Dredge about 15 % full (35 kg). 7 samples. Two rock types: A) Fresh to slightly altered (decoloured) basalt, moderately vesicular (10 to 20 %) submarine lava with formerly glassy rinds, with 2-3 % cpx and 3-4 % ol. Some rocks contain ultramafic cumulate xenoliths up to 1 cm; B) Fresh to slightly altered basalt pieces with glassy rinds and low to moderate vesicularity (3-10 %) containing cpx (2-3 %) and ol (2-3 %), interpreted as submarine, nearly degassed lava.					
Area V. La Palma, east flank of Cumbre Vieja					
Station 165	28°31.344'N, 17°40.682'W	1930	28°31.810'N, 17°40.248'W	1550	DD
10.03.2001 10 kg rocks in the dredge. 6 samples. Three rock types: A) Fresh to slightly altered (decolouration) moderately to highly vesicular (20 to 45 %) submarine basalt fragments and bombs with formerly glassy rinds, containing about 2 % cpx and 1 % olivine; B) Clastic basalt breccia with internal layering, moderately to strongly altered, basalt pieces moderately vesicular with fresh cpx and minor ol; C) Hyaloclastic basalt breccia with moderately vesicular clasts, moderately to strongly altered.					
Station 166	28°32.900'N, 17°39.128'W	2020	28°33.285'N, 17°38.716'W	1639	DD
10.03.2001 Dredge recovery about 30 kg. 12 samples. Four rock types: A) Fresh to slightly altered (decolouration) highly vesicular (30 to 55 %) submarine basalt fragments and bombs with glassy rinds, containing about 2 % cpx and 1-2 % olivine; B) Angular moderately to strongly altered (microcracks and pervasive groundmass alteration) basalt pieces with 10 - 20 % vesicles, 2-3 % cpx and 1-2 % ol (moderately altered; decolouration and iddingsite formation). Most pieces contain mm to cm-sized peridotite nodules; C) Dense, moderately rounded and slightly altered basalt with 1-2 % ol and 1-2 % cpx; D) Moderately altered (strong decolouration) and vesicular (10 - 15 % vesicles) basalt containing plagioclase (4 %), cpx (5-6 %) and accessory ol.					
Station 167	28°30.505'N, 17°35.581'W	2350	28°31.102'N, 17°35.242'W	2108	DD
10.03.2001 Dredge recovery about 10 kg. 7 samples. Mainly A) fresh to slightly altered (decolouration) variably vesicular (10 to 50 %) submarine basalt fragments, partly with glassy rinds, containing about 1-2 % cpx and 0-2 % ol; and B) rounded, dense and strongly altered (microcracks and pervasive groundmass alteration) basalt pieces containing former ol and cpx.					
Station 168	28°34.246'N, 17°39.163'W	1680	28°34.514'N, 17°38.824'W	1608	DD
10.03.2001 Dredge recovery 20 kg. 10 samples. Three rock types: A) Fresh to slightly altered (decoloured) highly vesicular (20 to 55 %) submarine basalt fragments with glassy rinds, containing about 2-7 % cpx and 2-3 % olivine; B) Rounded, moderately to strongly altered (partly microcracks and pervasive groundmass alteration) basalt pieces with 3- 10 % vesicles and typically 1-2 % ol 2-3 % cpx. Some pieces contain >10 % cpx megacrysts; C) Semi-consolidated finegrained calcareous sediment containing ol and cpx grains.					
Station 169	28°28.059'N, 17°39.987'W	2250	28°28.665'N, 17°39.227'W	2200	DD
11.03.2001 Dredge recovery about 45 kg. 14 samples. Two rock types: A) Fresh to slightly altered (slight decolouration) highly vesicular (30 to 50 %) submarine basalt fragments and bombs with glassy rinds, containing about 1-3 % cpx and 0-2 % olivine. Vesicle sizes range from >1 mm to several cm. Large vesicles have smooth surfaces well suited for micro-analysis; B) Finegrained semi-consolidated calcareous sediment containing basalt clasts.					
Station 170	28°30.800'N, 17°31.752'W	2576	28°31.629'N, 17°31.104'W	2500	DD
11.03.2001 Dredge recovery about 40 kg. 9 samples of fresh to slightly altered (slight decoloured) highly vesicular (20 to 40 %) submarine basalt fragments with glassy rinds, containing 3-10 % cpx and 2-6 % ol. Vesicle sizes range from >1 mm to several cm. A couple of rocks contain peridotite nodules up to 8mm in diameter.					
Station 171	28°33.971'N, 17°35.526'W	2056	28°34.04'N, 17°35.47'W	2027	CD
11.03.2001 Dredge recovery about 40 kg. 9 samples of four rock types: A) Angular pieces of moderately altered (clay minerals in groundmass) submarine basalt (vesicle contents 10-15 %; partly filled with carbonate and clay minerals) with variable mineral contents from 2 % each of cpx, ol and plag to 15% cpx, 7 % ol and 20 % plag; B) Sub-rounded pieces of moderately vesicle rich (10-20 %) moderately altered submarine basalt containing 3-15 % cpx (some megacrysts) and 1-10 % olivine; C) Dense, nearly aphyric basalt with minor plag; D) Volcaniclastic sediments with basaltic clasts, former glass shards and carbonate-rich groundmass.					
Station 172	28°37.876'N, 17°32.846'W	2360	28°38.312'N, 17°32.558'W	2222	CD
11.03.2001 Dredge empty.					
Area VI. La Palma, east flank of the submarine South La Palma Ridge					
Station 173	28°21.005'N, 17°41.677'W	2350	28°21.624'N, 17°41.067'W		CD
12.03.2001					

Six samples comprising three rock types: A) Hyaloclastite with angular or rounded basalt fragments (altered) in carbonate-rich matrix; B) Dense aphyric basalt with carbonate fillings and Mn-crust; C) Qtz- and cpx-bearing plag-rich, well-sorted (0.5-1 mm grain-size) sediment.

Station 174	28°20.944'N, 17°41.690'W	2400	28°21.46'N, 17°40.997'W	2000	DD
12.03.2001					

Dredge half full, 70% corals and 30 % rocks. 13 samples comprising three rock types:A) Slightly to moderately altered (some clay minerals and carbonate in groundmass) submarine basalt with minor cpx and Mn-coating; B) Basaltic hyaloclastite/lapillistone with vesicular clasts containing variable amounts of cpx, olivine and plag and calcite fillings; C) Silty sediment with internal layering, probably fragments of turbidite sequences.

Station 175	28°22.062'N, 17°45.350'W	2180	28°22.670'N, 17°45.108'W	1950	DD
12.03.2001					

Dredge recovery about 10 kg rocks and lots of corals. 2 samples of moderately altered (some clay minerals and calcite in groundmass) submarine basalt with Mn-crust, moderate vesicularity (15 to 25 %), 1-2 % cpx and 1-2 % ol (partly iddingsitized).

Station 176	28°20.834'N, 17°49.469'W	1100	28°21.20'N, 17°49.30'W	850	DD
12.03.2001					

Five rock pieces in the dredge (10 kg). One fresh sample of fully consolidated, hard, carbonate-sediment with fossils and bioturbation.

Station 177	28°20.929'N, 17°49.462'W	1000	28°21.200'N, 17°49.310'W	850	DD
12.03.2001					

Dredge recovery about 4 kg. One sample of subrounded, moderately altered (microcracks, clay minerals and calcite in groundmass) moderate vesicularity (10 to 15 %) submarine basalt with 2 % cpx, 6 % ol and 2 % zoned plag.

Area VII. El Hierro, southwest flank in the El Julian landslide scar

Station 178	27°37.426'N, 18°05.254'W	1900	27°38.159'N, 18°04.746'W	1721	DD
13.03.2001					

Dredge 1/4 full (30 kg). 7 samples comprising two rock types: A) Fresh highly vesicular (25 to 40 %; vesicle sizes <1 mm to 5 cm) submarine basalt fragments with glassy rinds, containing 0-3 % cpx and 0-3 % ol; B) Fresh moderately vesicular (10-15%) basalt with 3% ol and 3 % cpx, also interpreted as submarine lava.

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