Henry Seamount, western Canary Islands: Old Structure or recently active volcano?

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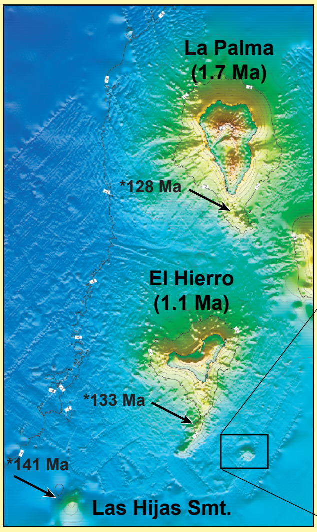
1. Introduction

Henry Seamount is 8 km wide, 660 m high and rises from 3700 m deep seafloor southeast of El Hierro, the youngest of the Canary Islands (Fig. 1). Mapping during Charles Darwin cruise CD108 in 1997 revealed that Henry Seamount is dome-shaped with radiating gullies and ridges and shows a sharp break-of-slope with the surrounding flat seafloor (Gee et al., 2001). Because of these characteristics and because low backscatter indicates several meters of sediment coverage, the seamount was interpreted as an extinct volcanic edifice possibly some 100 ka old. A similar minimum age was inferred for the southern submarine ridge of El Hierro further to the west.

These interpretations are consistent with high radiometric Ar/Ar ages of submarine samples from the westernmost Canary Archipelago (P.v.d. Bogaard, unpubl. data), which suggest that volcanic activity of the Canary hotspot began much earlier than thought previously. In order to test this hypothesis, we sampled Henry Seamount by six dredge hauls during Meteor cruise M66/1 in 2005.



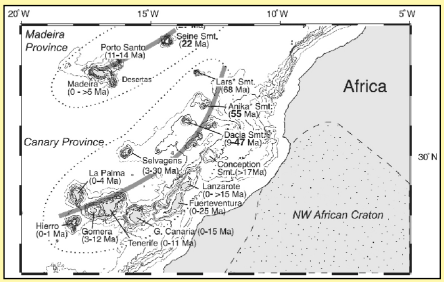


Fig. 1a: Bathymetric map and age progression of the Canary hotspot track after Geldmacher et al., 2005). Radiometric ages are given in Ma. There is an age progression from Lars Seamount in the northeast (68 Ma) to El Hierro in the southwest (1 Ma).

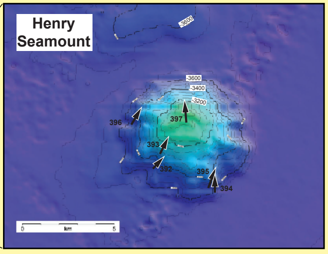


Fig. 1b: Left: Bathymetric map of the western Canary Archipelago. Numbers in brackets indicate oldest subaerial ages of the islands, and numbers with asterisk are maximum ages of submarine rocks and seamounts (P.v.d. Bogaard, unpubl. data). **Right:** Detailed map of Henry Seamount with arrows indicating dredge hauls. Maps are based on data from Masson et al. (2002).

2. Dredged samples

Dredging bites were extremely scarce and two drum dredges were full of soft sediment, which confirms the inferred meter-thick sediment coverage. Samples from two successful dredges include:

- Trachytic rock fragments and pebbles with few phenocrysts (plagioclase, amphibole, titanite). The samples range from fresh to strongly altered and are covered by thin Mn-crusts (Fig. 2).
- Vesicular fragment of glassy basalt.
- Volcaniclastic sandstones with abundant Globigerina foraminifers.
- Fragments of cm-thick layered Mn-crusts.
- Abundant shell fragments of vesicomyid clams up to 15 cm in size that are mildly corroded (Fig. 3).
- Small fragments of porous biogenic or abiogenic carbonates. One sample associated with trachyte has $\delta^{13}C$ = -11.3 and $\delta^{18}O$ = 4.2.
- Fresh porous barite fragment underlying a deep-sea coral stem (Fig. 4). XRD analysis indicates that the rock consists of

Fig. 2: Trachyte fragment with thin Mn crust.

Fig. 3: Shell of vesicomyid clam.

Fig. 4: Fresh porous barite fragment with coral stem.

3. Preliminary interpretation

The presence of shells from vesicomyid clams is surprising since this species is always associated with active hydrothermal vents or seep areas. To our knowledge, this is the first reported finding of vesicomyid clams within the Canary Archipelago and also the first direct or indirect evidence of venting activity. Their preservation state suggests that the shells are not very old, possibly less than 100.000 years.

Texture, porosity and extreme freshness of a barite fragment recovered from the summit plateau (Fig. 4) also indicate a recent origin. The fragment is considerably larger than other marine or diagenetic barites suggesting that it originated by some focussed fluid flow.

It is therefore possible that Henry Seamount is a recently active volcanic system related to the present location of the hotspot near El Hierro. This interpretation is supported by the small degree of alteration of the freshest dredged trachytes. Alternatively, fluid discharge at the seamount could be related to aquifer recharge at the neighbouring island of El Hierro and lateral fluid flow in the crust.

4. Forthcoming work

Geochemical and petrological investigations as well as age determinations of the rocks and shells are on the way to resolve the following questions:
How can recent venting and possible volcanic activity be reconciled with the presence of some meters of sediment drape and gullied flanks? What is the nature of the inferred venting fluid? Does Henry Seamount currently show some kind of rejuvenated activity? Is there any evidence for a high, possibly Cretaceous, age of the seamount?

References:

Devey, C.W., K.S. Lackschewitz, D.F. Mertz, B. Bourdon, J.L. Cheminée, J. Dubois, C. Guivel, R. Hékinian, and P. Stoffers, Giving birth to hotspot volcanoes: Distribution and composition of young seamounts from the seafloor near Tahiti and Pitcairn islands, Geology, 31, 395-398, 2003.

Gee, M.J.R., D.G. Masson, A.B. Watts, and N.C. Mitchell, Offshore continuation of volcanic rift zones, El Hierro, Canary Islands, Journal of Volcanology and Geothermal Research, 105, 107-119, 2001.

Geldmacher, J., K. Hoernle, P. Bogaard, S. Duggen, and R. Werner, New 40Ar/ 39Ar age and geochemical data from seamounts in the Canary and Madeira volcanic provinces: Support for the mantle plume hypothesis, Earth and Planetary Science Letters, 237, 85-101, 2005.

Klügel, A., and F. Klein, Complex magma storage and ascent at embryonic submarine volcanoes from Madeira Archipelago, Geology, in press, 2006.

Masson, D.G., A.B. Watts, M.J.R. Gee, R. Urgeles, N.C. Mitchell, T.P. Le Bas, and M. Canals, Slope failures on the flanks of the western Canary Islands, Earth-Science Reviews, 57, 1-35, 2002.

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5. Other work on seamounts

One of the most significant evolutionary stages in the life of oceanic intraplate volcanoes is the formation of magma chambers. There is however little information about the earliest magma chambers because the volcanoes' pre-shield stage is hard to access. We are therefore planning geobarometric studies at small seamounts (e.g. Las Hijas seamount, Fig. 1) in order to learn about the evolution of their magma plumbing systems.

The recovery of predominantly trachytic lavas at Henry Seamount is consistent with the observation that small seamounts erupt more differentiated lavas during their earliest stages of growth when the lithosphere above the hotspot is still cool (Devey et al., 2003). On the other hand, depths and degree of crystal fractionation beneath small seamounts near Madeira resembles that of the island's subaerial shield stage (Klügel and Klein, 2006). It is possible that the different manifestations of early hotspot-volcanism are related to plate velocities controlling thermal gradients in the lithosphere. This hypothesis will be tested by further studies.