

# **Short report of METEOR cruise 62/4**

Tim Reston  
and shipboard scientists

2004

Leibniz-Institut fuer Meereswissenschaften - IFM-GEOMAR

Kiel

Germany

## Short report on cruise M62-4

Mid-ocean ridges are first order plate tectonic features. Here, the plates are pulled apart, the asthenosphere wells up to fill the gap and by a combination of pressure release melting and cooling creates new lithosphere. However the process is not two-dimensional as mid-ocean ridges are not only the sites of divergent plate boundaries but also of nearly all transform faults where the plates slide past each other, dividing the spreading ridge into segments.

Ridge segmentation is particularly important at slow-spreading ridges such as the Mid-Atlantic Ridge (MAR), where it is controlled not only by true transform faults, but also by non-transform ridge axis discontinuities. Individual segments occur between such ridge axis discontinuities and exhibit several characteristics.

- magmatic activity increases towards the centre of the segment
- crustal thickness increases towards the centre of the segment
- lithospheric thickness increases towards the end of the segment
- importance of faulting increases towards the end of the segment
- increasing amounts of mantle serpentinites within the crust at the end of the spreading segments.

It is however also clear that faulting and tectonic processes do play an important role in controlling structure within a segment. Microseismicity studies in particular have been used to map out the distribution of brittle deformation near the centre of the segment, but have been hardly used to explore the mechanics of faulting at the end of a segment. Seafloor imaging has shown that the size of the faults increases towards the end of the segments. However, here the style of spreading is in places strongly asymmetric. The "inside corner" - the region bound by the active transform or other ridge-axis discontinuity - commonly displays large massifs, in contrast to the lower "outside corner" (adjacent to the inactive fracture zone). The inside corner (IC) massifs have been shown to consist of peridotite and gabbros, lithologies that are largely unexposed at the outside corners (OCs) where basalts dominate.

Some inside corner massifs are topped by domal surfaces, characterised by pronounced transform parallel lineations. Good examples are found north of the Atlantis transform, south of the Kane transform, south of the 5°S transform, and at the Ascension transform, the subject of the study. The corrugated domal surfaces are interpreted as the exhumed footwall and slip surface of large "detachment" faults. It is the movement along these faults that is thought to have brought the deep crustal and even mantle rocks to the surface; the direction of slip indicated by the corrugations shows that these rocks were pulled out from beneath the median valley rather than from the transform fault. However the geometry of detachment faulting at depth beneath the median valley is not understood.

The aims of M62-4 were thus to investigate the tectonics and structure of the Ascension transform inside-outside corner pair and to constrain the processes of segmentation occurring at the Mid-Atlantic Ridge just south of the Ascension FZ. The main targets of the cruise with the RV Meteor are:

- an oceanic core complex developed between the NAFZ and the SAFZ, marked by a corrugated surface. This is one of the longest (in a transform-parallel direction) corrugated surface (~ 120 km long between 11.8°W-13°W) that has been observed anywhere in the oceans and as such is probably the oceanic core complex that has actively developed for the longest time (~13 million years). As

such, the Ascension Transform provides an ideal place to study an active detachment fault as it passes to depth beneath the median valley.

- the structure of the segment (A-BV 1) immediately south of the SAFZ. This is a classic "tectonic segment", characterised by teleseismic activity and a well-developed median valley. By determining the crustal structure in this segment, and comparing the results with the extant gravity data the importance of mantle upwelling beneath a segment characterised by a median valley and active faulting can be investigated.
- the structure of segment A-BV 3 further south. This is characterised by a well-developed axial high that is probably the site of voluminous volcanism and as such may be underlain by an axial magma chamber. If so, determining the depth and structure of this magma chamber will constrain the thermal structure of the spreading segment. Furthermore, by determining the crustal structure along this segment, it will be possible to assess the contribution of crustal thickness variations and mantle upwelling in causing the well-developed bull's eye MBA gravity low beneath this segment.

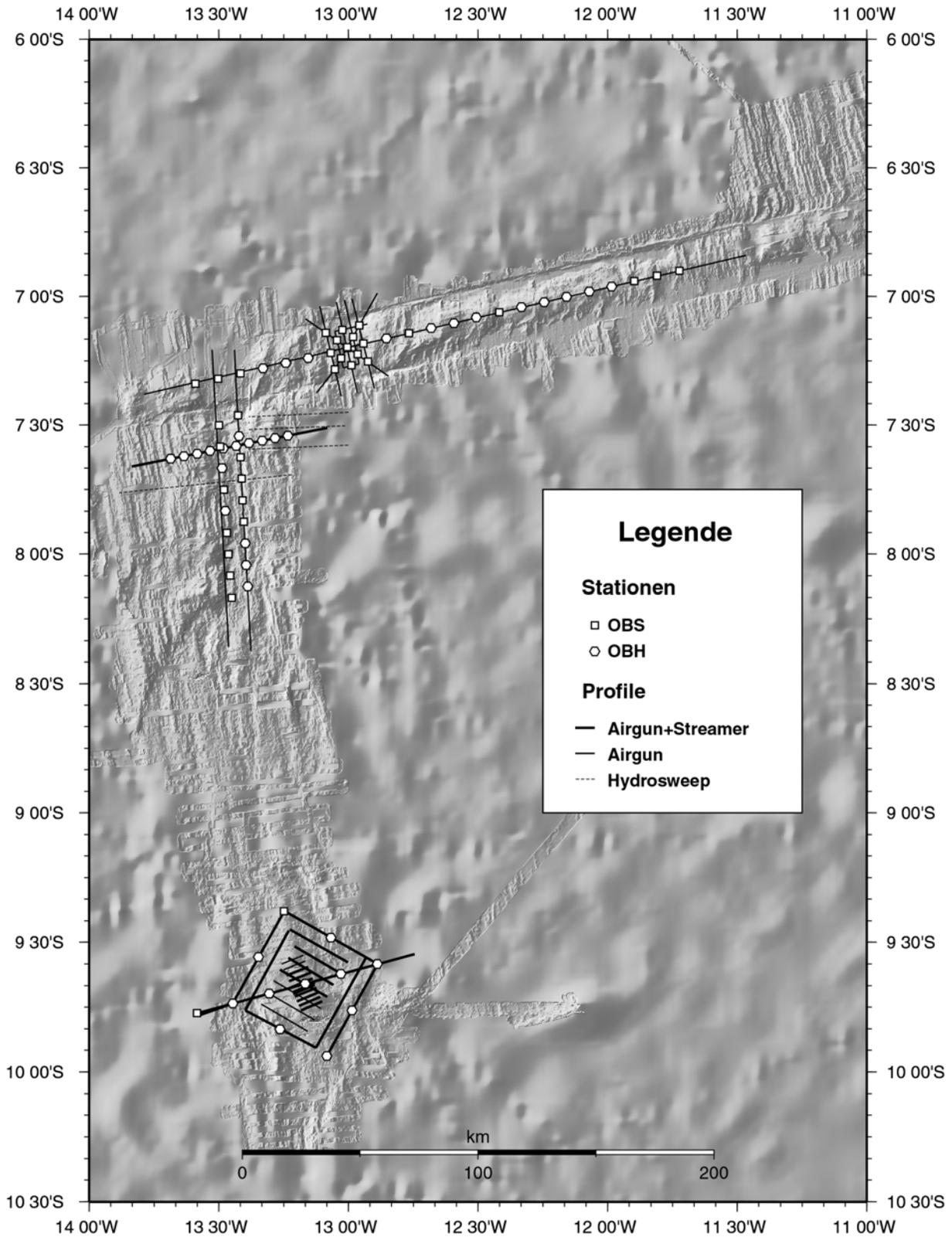
To achieve these aims we collected the following data during M62-4:

- a series of magnetic profiles in international waters near 5°S to complement the wide-angle seismic data collected during M47-2.
- a long wide-angle profile (9) using 23 ocean bottom hydrophones and seismometers (OBH and OBS) between the two Ascension Fracture Zones
- a grid of short profiles (using 13 OBH or OBS) across the spreading segment between the two Ascension Fracture Zones
- a microseismicity grid across the same active spreading segment (recorded with 11 OBH)
- a wide-angle seismic (10 OBS) profile (10) across the spreading axis in the segment immediately south of the Ascension Fracture zones
- a broad grid of wide-angle profiles across spreading centre in segment A-BV3 – the third segment south of the Ascension Fracture zones
- a deep-tow seismic survey here, as an attempt to image the magma chamber that is thought to underlie this segment (pronounced axial high)
- two wide-angle seismic profile oriented parallel to the spreading segment ABV1 (immediately south of the Ascension fracture zones) to determine the variation of crustal structure along this segment. These instruments were subsequently left deployed as an elongated microseismicity grid to record the active tectonics of the spreading segment and were recovered during Leg M62-5.

All profiles were collected with coincident gravity and bathymetric data to further constrain the structure and evolution of the Mid-Atlantic Ridge.

The most immediate results come from the bathymetric mapping carried out. In particular while collecting deep-tow seismic data in segment ABV-3, believed to be magmatically very active as it is characterised by a pronounced axial high, we image numerous volcanic structures.

# M 62/4 ASTERICS RV METEOR



**Figure 1: Map showing deployments and profiles in the main working area**

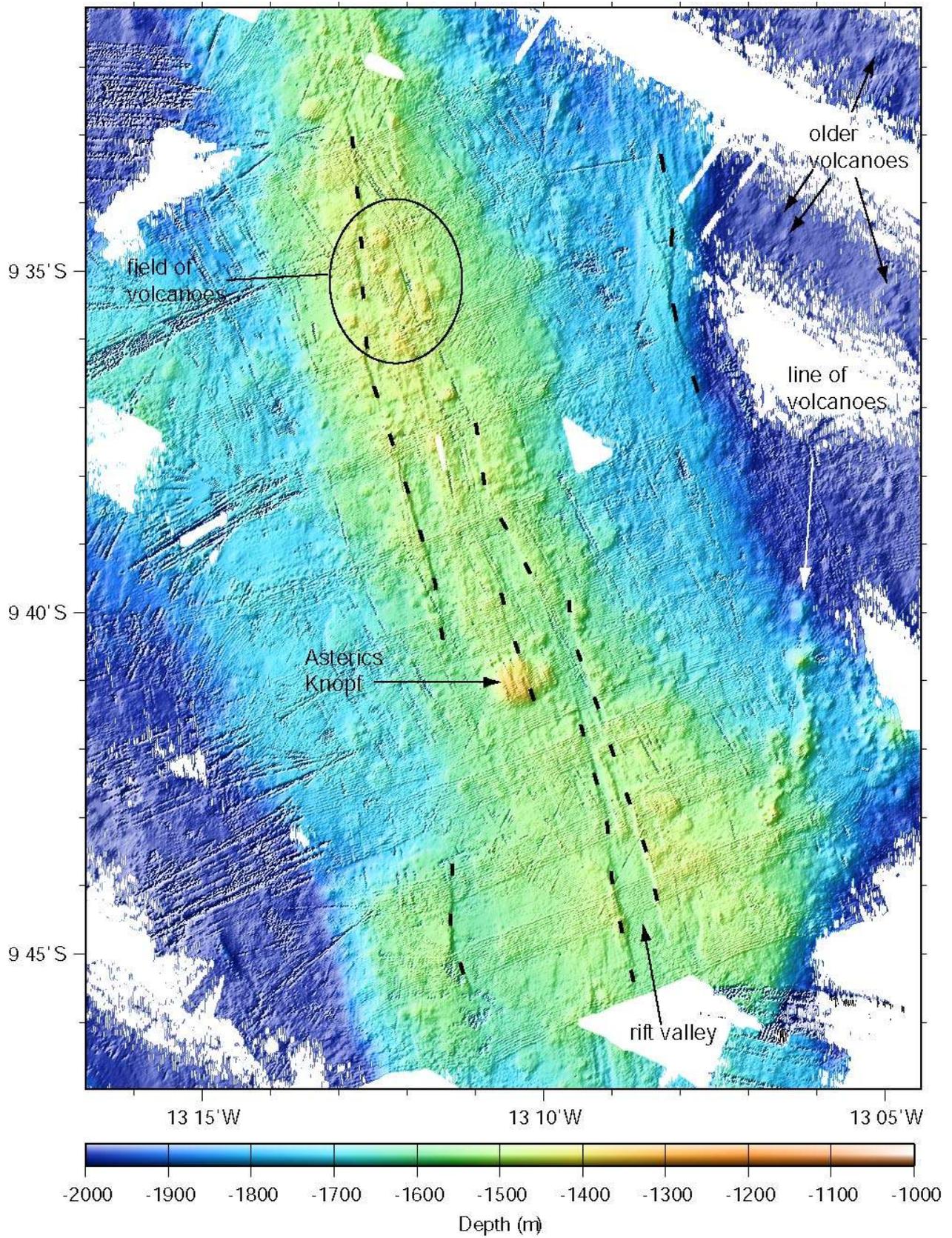


Figure 2: Detailed bathymetric map from segment ABV3 showing numerous volcanic structure.