



Maria S. Merian Cruise 1 leg 3

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Station work of the entire last week was dedicated to the investigation of the deep mud volcanoes in the western Gulf of Cadiz (Fig. 1). We surveyed three MVs: Carlos Ribeiro MV (2200m), Bonjardim MV (3150m) and Porto MV (3850m).

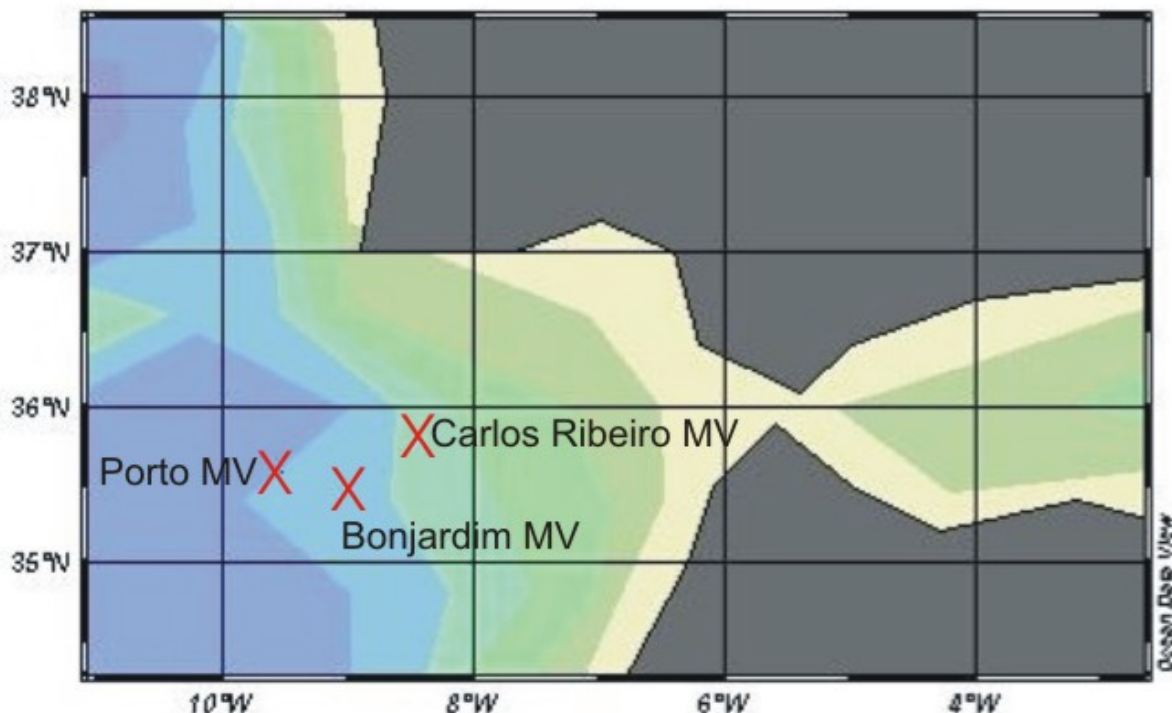


Fig. 1: Working area with positions of the three investigated mud volcanoes

All three MVs were mapped with multi-beam. Based on the multi-beam maps we set out OFOS profiles to identify sediment patterns and megafauna biocoenoses with special attention to organisms indicating chemosynthetic activity driven by geosphere-surface sediment coupling. Sediments were sampled at all three MVs with the TV-MUC, gravity corer and box grab for geochemical, biogeochemical, microbiological and benthos biological investigations. The Fluid Flux Observatory Lander (FLUFO) and the Deep Sea Observatory Lander (DOS) were deployed at Bonjardim MV and Porto MV. CTD/Ro casts for physical oceanographic and water chemical investigations were performed at all three MVs.

Megafauna exhibits a quite distinct zonation at Bonjardim MV. The lower flanks show low density of animals and are characterised mainly by enteropneust burrows and feeding marks. The upper flanks are dominated by hexactinellid sponges and holothurians accompanied by a rather high density of worm burrows. The top of Bonjardim MV is asymmetrical with an elevation at the south-eastern side where some patches of Pogonophora occurred among areas of disturbed sediment with exposed breccia and some bivalve shells. This area is surrounded by coarser

sediments populated mostly by Ophiuroidea and Holothuria, the latter forming dense aggregations at the rather flat north-western area of the top. The box grab sample from Bonjardim MV contained a mollusc fauna of at least 17 species in a well oxygenated environment. A high amount of species were of planktonic origin. The sediment was also very rich in Foraminifera, most of them planktonic species.

At the rim of Porto MV megafauna is scarce but the seafloor is highly bioturbated with Enteropneust burrows and feeding marks and different kinds of Lebensspuren. Siboglinids (Pogonophera) were first recorded when approaching the north-western area of the MV and appear to be covering the entire top of the MV (Fig. 2) where some *Acharax* shells were also spotted. Living specimens of *Acharax* and Siboglinidae were recovered with a box core. The latter belong to a species different from the others previously recorded in the Gulf of Cadiz. The siboglinids are accompanied mainly by hexactinellid sponges (tubular and stalked) and ophiuroids as well as a few galatheid crabs.

The box grab samples proofed the existence of a relatively small oxygenated surface zone and the occurrence of H₂S in deeper strata. Characteristic for this environment is the presence of the solenomyid bivalve *Acharax* sp., a deep burrowing species living in endosymbiosis with sulphide oxidizing bacteria. The finding of shells of the epifaunal carnivorous gastropod species *Mohnia abyssorum* in the deeper part of the core shows that the ancient surfaces were previously oxidized.

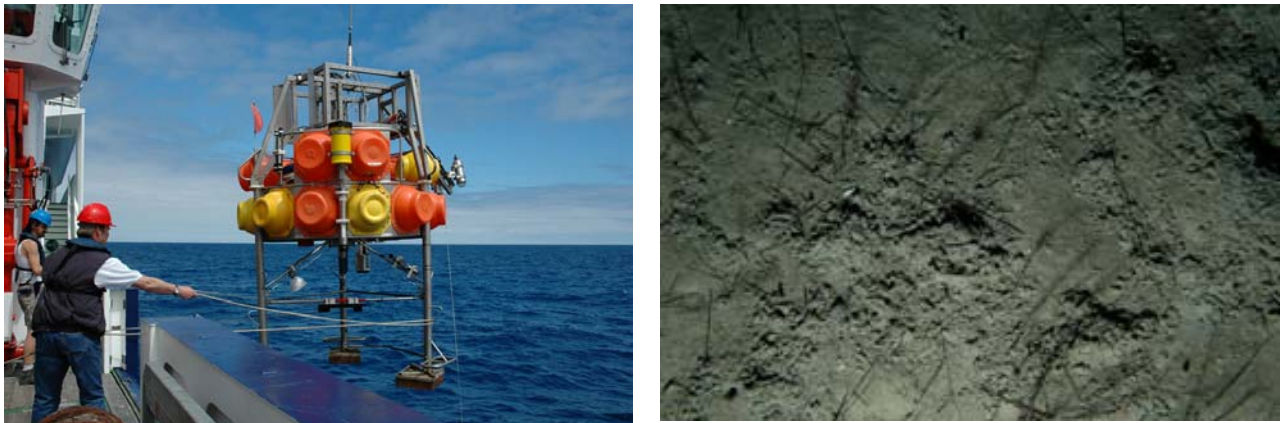


Fig. 2: Deployment of the Deep Sea Observatory (DOS Lander) at Porto MV. The time lapse camera confirmed the placement of the DOS on a Pogonophora assemblage.

At Carlos Ribeiro MV the megafauna assemblage is dominated by echinoderms, mainly Ophiuroidea accompanied by stalked Crinoida at the flanks and some aggregations of Holothuria. There are numerous burrows of different shapes and sizes, sometimes arranged in clusters. Hexactinellid sponges are also frequent and there is a rather high diversity of Cnidaria especially at the north-eastern flank. The top of the MV is almost devoid of megafauna with the exception of a few borrows and scattered ophiuroids and thyasirid shells at the surface of the sediment. The presence of living Thyasiridae was confirmed by a box-core sample retrieved from the MV top.

A second box core from the flank of the Carlos Ribeiro MV consisted of well oxygenated pelagic mud and clay. The abundance of different pteropod species and other planktonic gastropods was striking. The impoverished endobenthic community

comprised of *Bentharca* sp. and some other mollusc species. Planktonic foraminifers were abundant. Only a few clasts originating from the mud volcano were observed.

Pandalid shrimps and fishes were frequently sighted at all MVs but without a clear pattern in their distributions.

Geochemical analyses of pore waters were conducted at a number of cores from the three MVs in order to determine their present state of activity and decipher the origin of the fluids. The results indicate the advection of strongly methane enriched fluids, which causes an upward shift of the zone of anaerobic-oxidation of methane (AOM) to less than one meter below the sediment surface (indicated by the depletion of sulphate and the simultaneous increase in alkalinity and hydrogen sulphide (Fig. 3). At all sites the advecting fluids are significantly depleted in chloride with respect to normal seawater. This chloride depletion is already known from earlier studies at Bonjardim MV and is most likely caused by mineral dehydration processes at a few kilometres depth. In addition, the fluids are characterized by elevated levels of ammonium, accompanied by low concentrations of other nutrients (phosphate and silicate). Ongoing activities aim at a deeper understanding of fluid mobilization processes and their specific control mechanisms in this tectonically active region.

Gas hydrates were sampled at Porto MV with the gravity corer and preserved in liquid nitrogen. Traces of gas hydrates destabilized during the sampling procedure were found at Bonjardim (gravity corer sample) and Carlos Ribeiro (box grab and gravity corer sample).

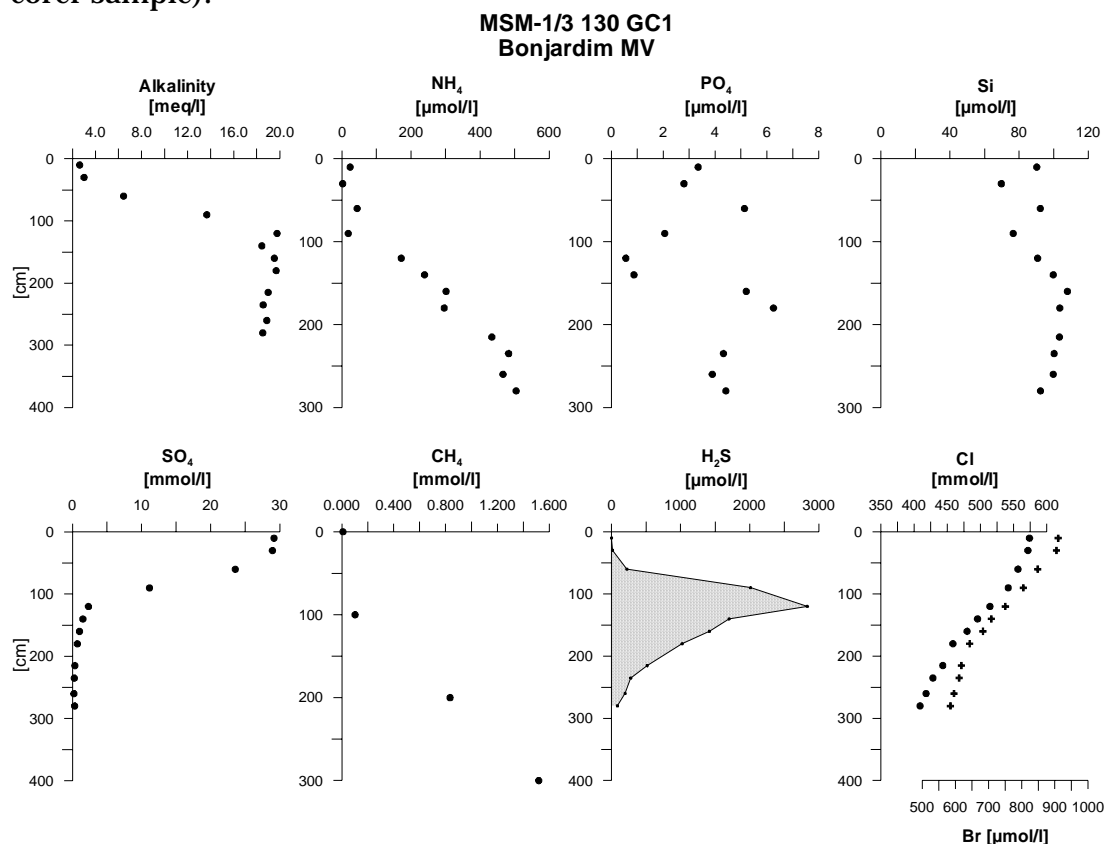


Fig 3: Pore water profiles of a gravity core at Bonjardim MV.

CTD measurements (SBE 9 *plus* - SBE 11*plus* V2 deck unit) in the Porto MV area show the expected water mass characteristics, including the typical occurrence of an upper and lower core of the Mediterranean Outflow Water (MOW, Fig. 4). The site

was visited twice, on April 22 and April 24. The measurements indicate variation of the MOW between 750m and 1250m. During our first visit the typical two tongues of high saline MOW, ~ 36.10 for the upper portion and ~ 36.30 for the lower portion were encountered. However, during the second CTD cast a different pattern emerged. Between 750m and 1250m the upper and lower core were less defined. Instead we detected one single core between 800m-1200m with varying salinities between 36.00 and 36.20.

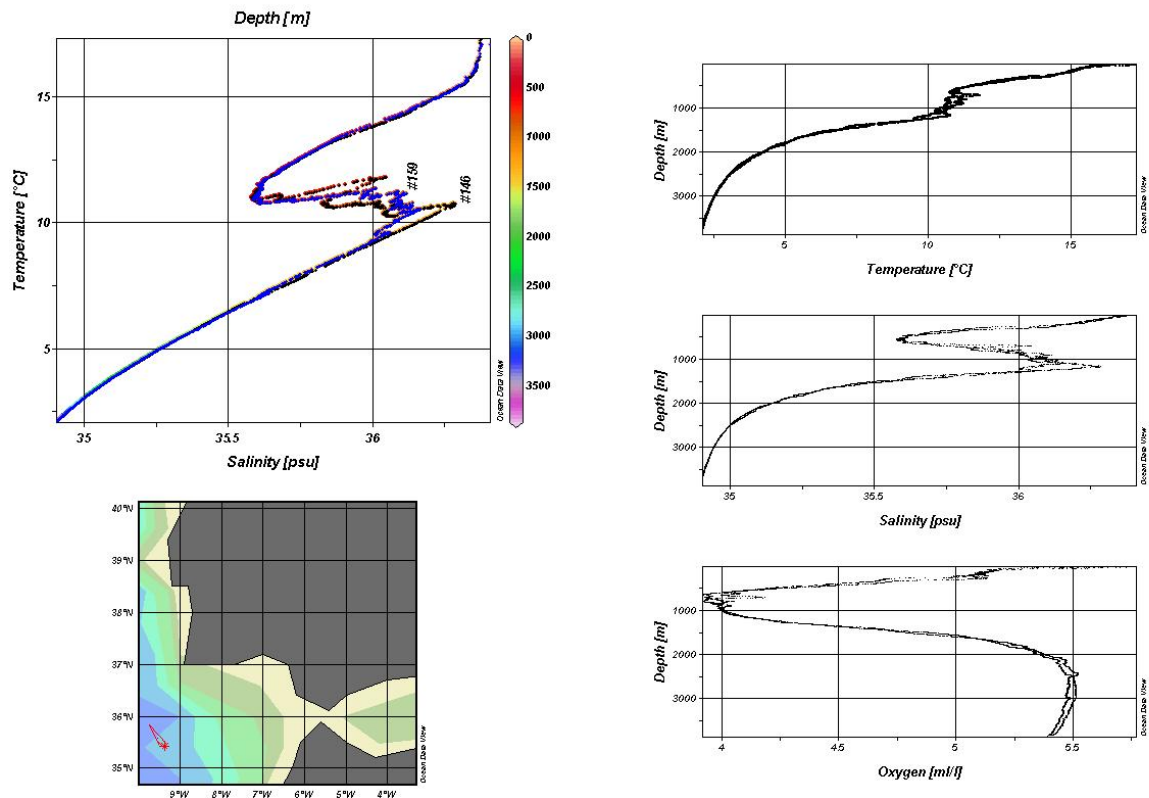


Fig. 4: CTD profiles and T/S plot from Porto MV.

An Bord sind alle wohlauf.
Es grüssen.

O. Pfannkuche und alle Fahrtteilnehmer