

Maria S. Merian Cruise 1 leg 3

Third weekly report: 26. 04. - 02. 04. 2006

Station work of the entire last week was transferred to the realm of the mud volcanoes occupying the depth range 1300m to 1000m. Our activities focused on a detailed sampling at Captain Arutyunov MV (CAMV, Fig. 1). This MV located in 1320m depth has been previously known for intense subsurface biogeochemical activity and the occurrence of gas hydrates.

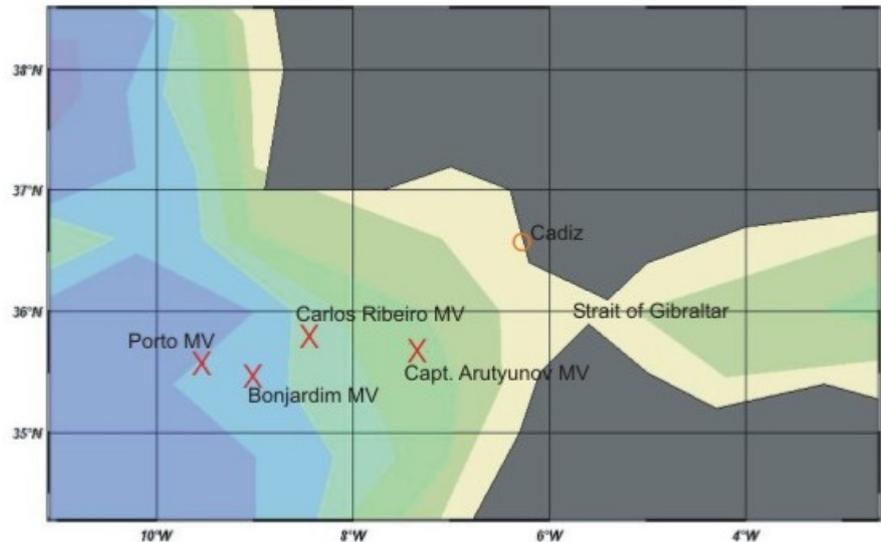


Fig. 1: Working area with positions of the mud volcanoes so far investigated.

A highlight of our CAMV survey was the finding of hand sized gas hydrates, which were sampled with a box corer from quite shallow sediment depth of 10-20cm. In contrast to other sites with surficial gas hydrates such as in the Gulf of Mexico or at Hydrate Ridge no bacterial mats (*Beggiatoa*) indicated the presence of the hydrates. Only dense occurrence of *Thyasira* shells and a peculiar grooved sediment surface morphology covered with a network of brownish polychaete aggregations pointed to the presence of enhanced biological activity. Thus the sampling of substantial gas hydrate deposits in such shallow depth came as a surprise to us although it was already indicated by the large gas bubbles escaping from the box grab when it came to the water surface. Due to the rapid destabilization of the hydrates the water in the sampling box seemed to boil when opened (Fig. 2). We could recover a quantity of gas hydrates which were stored in liquid nitrogen for further analysis at home.



Fig. 2: "Boiling" water indicating the presence of gas hydrates in a box corer sample. Ten minutes after taken on board gas hydrates of substantial size were picked from the mud.

Steep geochemical gradients close to the sediment-water interface could be detected at CAMV, indicating strong fluid advection rates at this site (Fig. 3). In comparison to the deep-water mud volcanoes investigated earlier on this cruise the fluids are obviously more enriched in ammonium and depleted in bromine. The strong exponential decrease in bromine, which can be regarded as a conservative tracer within the sampled depth interval, can be used as a measure for the upward advection of deeply mobilized fluids. Another major difference is that chloride concentrations slightly increase with depth and indicate the dissolution of halite in the subsurface. High-resolution geochemical analyses of surface sediments (retrieved from multicorer and lander deployments) indicate a high efficiency of the benthic filter, which is responsible for generally low rates of fluid expulsion into the bottom water in the vicinity of the whole mound structure. At some places, active pumping of seawater and H₂S consumption by dense populations of Pogonophora maintain almost zero H₂S-levels in the pore water even within the zone of anaerobic methane oxidation.

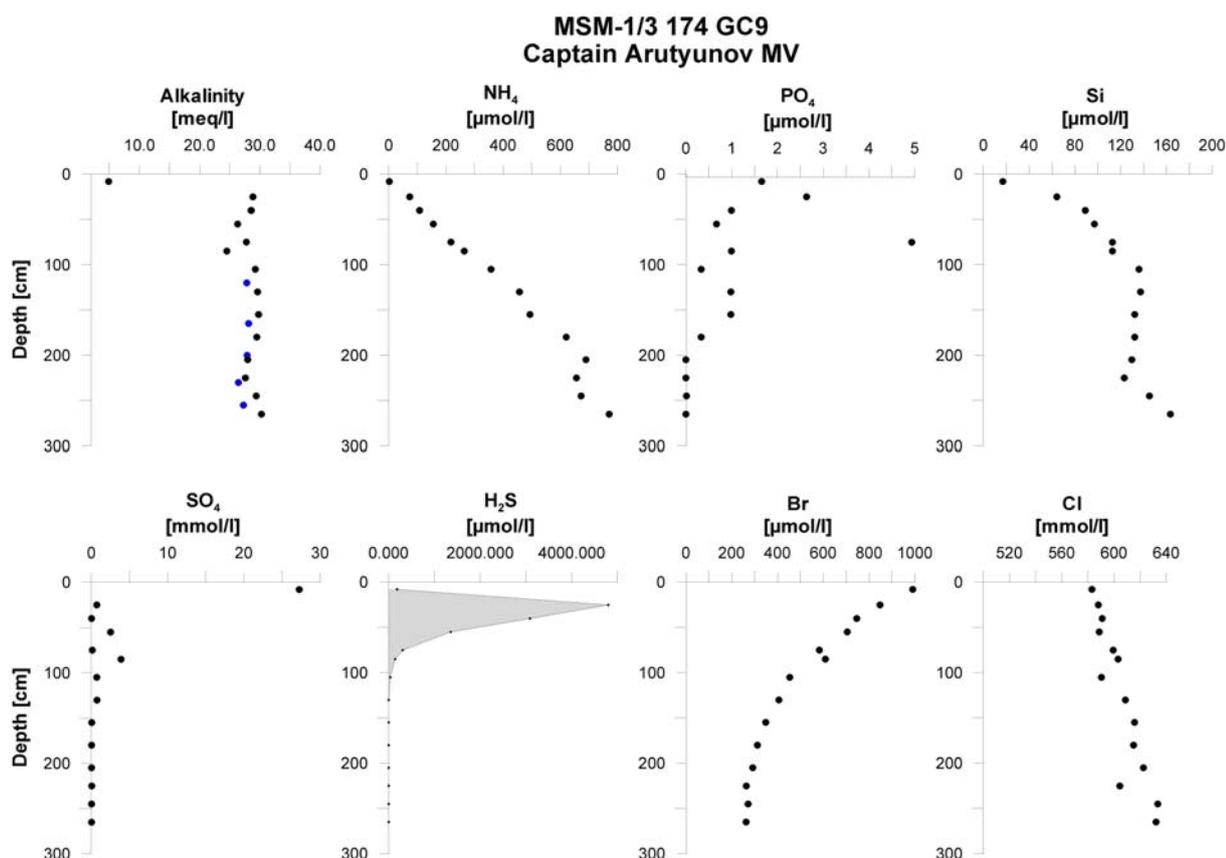


Fig 3: Pore water profiles of a gravity core at Captain Arutyunov MV.

Outflow breccias from the investigated mud volcanoes contained a varying proportion of erratic clasts. They are enriched in layers forming indurated breccias as revealed by sediment cores. On the sea bed, the clasts may be enriched in stripes probably depicting the margins of different mudflows. These stripes are moulded by the lower Mediterranean Outflow Water to starved ripples of subangular gravel on the top plateau of Captain Arutyunov mud volcano. Every mud volcano is characterised by a unique lithological composition of the xenolithic clasts. Outflow breccias from Bonjardim mud volcano contained green clay pebbles and a substantial proportion of dark, indurated claystone. Porto mud volcano yielded pebbles of green clay, chalk, and tectonised yellowish sandstones with vein fillings. Sediments from Carlos Ribera mud volcano contained dark green claystones. They showed evidences for brittle and ductile deformation, in particular cleavage faces and slickensides. The claystones were of Eocene age as revealed by numuliths while the clay matrix contained *Globorotalia inflata* and *G. tumida* indicating that Pliocene or Pleistocene sediments were liquified and thus contributed to the mud flow formation. Captain Arutyunov yielded tectonised grey marls and green claystones, sandy siltstones and quartz sandstones. In particular the siltstones showed vein fillings of sparry calcite, and open cracks filled with mud breccia probably formed during fluidisation. Pelagic sediments in the vicinity of the mud volcanoes were yellowish to dark grey clays with a prominent contouritic fine sand layer of approximately 10 cm thickness at 154 cm depth in core MD01/3-183. This bed is widely distributed in the Gulf of Cadiz

and was formed by an extraordinary strong Mediterranean Outflow activity at depths during Heinrich E.

The finding of living reef building cold water corals at CAMV was another highlight of the last week. Patches of corals were observed around the 1400m depth contour at the base of CAMV in several OFOS surveys. Many of them were partly buried or nearly covered with sediment, but we still found living specimens on larger reef structures. Due to the extraordinary manoeuvrability of M. S. MERIAN we were able to sample such a structure with the large TV grab and prove for the first time the existence of living coral patches in such water depth in the Gulf of Cadiz (Fig. 4).



Fig. 4: Coral reefs at the base of Captain Arutyunov MV; sampling with the large volume TV-grab; close up of a living stone coral (*Caryiophyllia* sp.).

The three OFOS Surveys at CAMV showed a diverse range of microhabitats. At the flanks the fauna is scarce but there are numerous burrows arranged in clusters at the lower flanks and forming small mounds of bioturbated sediment (mud breccia) up slope. Patches of semi-buried corals were observed especially around the depths of 1400m. The larger structures of coral, mainly occurring at the southern flank, show abundant epifauna (eg., Octocorallia, Ophiuroidea, Arcidae, Cirolanidae) and are often accompanied by a higher density of shrimps (*Pandalidae* and others) and fish. The top of the MV appears highly active with a rim of disturbed sediment and numerous *Buccinidae* shells and clasts. A few living specimens of *Neptunea contaria* were sighted in this area. Towards the centre the seafloor is rippled, covered by numerous clasts and shells and has a patchy appearance. The most conspicuous animals were *Cidaridae* echinoids clustered at the centre of the MV. Several samples taken at the top showed that some areas are densely covered by *Siboglinum* aggregates while other areas have fewer *Siboglinidae* but a high abundance of other *Polychaeta*. In the most active areas these *Polychaeta* are accompanied by *Thyasiridae* bivalves.

The molluscan thanatocoenoses of the CAMV was studied from van Veen grab, box core and a TV-grab sample, taken in areas representative for the variety of different sediment facies as seen from the OFOS investigations. Samples from muddy areas showed the lowest mollusc diversity. They were almost completely built by bivalves (e.g. *Limopsis minuta*, *Yoldiella* sp., *Katadesmia* sp. and *Cuspidaria cuspidata*).

Pebbly habitats, as the detected fields on the top and the north-western part of the Captain Arutyunov MV were dominated by *Limopsis minuta* and *Bathyarca pectunculoides*. Gastropods settling on stones as *Emarginula* sp. and small carnivorous gastropods of the family Turridae or *Amphissa acuticostata* were present.

A biodiversity hotspot was sampled at the coral built ups. Although the corals were mainly dead a very rich reef-associated fauna was found. From a representative sample a highly diverse mollusc fauna was extracted with more than 100 species. Highest diversity with at least 15 species was found within the family Turridae (e.g., *Spirotropis modiola*, *Gymnobela* spp., *Mangelia* spp.), furthermore many Trochidae (e.g., *Calliostoma* sp., *Putzeysia wiseri*, *Solariella* sp.). Other families included were Turbinidae, Rissoidae, Epitonidae, Eulimidae, Architectonicidae, Bullidae. The gastropod fauna is dominated by *Amphissa acuticostata*. It includes all feeding types as grazers, deposit feeders and carnivores.

The bivalve fauna is clearly dominated by *Asperarca nodulosa*, a suspension-feeding species attached to the corals by byssus. Other suspension feeders as pectinids are also common, dominated by species also attached by byssus. It is worthwhile to mention that even bivalve families adapted to a life in unfavourable deep-sea conditions show a much higher diversity here than in other habitats investigated. The carnivorous Cuspidariidae are represented by at least 6 species in the reef association, while only 2 species (*Cuspidaria cuspidata* and *C. inflata*) were found in the other samples.

On Monday evening we stopped our station work at CAMV, leaving the DOS- and BIGO-Lander deployed and steamed to Cadiz where we docked on Tuesday morning. At Cadiz a part of the scientific crew is changed and a multitude of repairs and guarantee works are undertaken by various contractors.

An Bord sind alle wohlauf.
Es grüssen.

O. Pfannkuche und alle Fahrtteilnehmer