

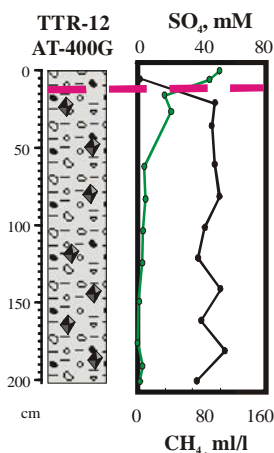
SOME GEOCHEMICAL CHARACTERISTICS OF RELATIVELY ACTIVE AND PASSIVE MUD VOLCANOES (GULF OF CADIZ AND ALBORAN SEA)

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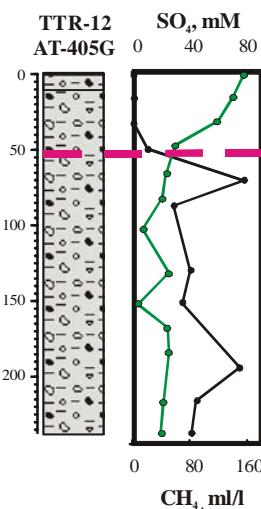
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During the TTR-12 cruise on board R/V *Professor Logachev* several gravity cores were taken from different mud volcanoes in the Gulf of Cadiz and the Alboran Sea. Pore water from the

CAPTAIN ARUTYUNOV MUD VOLCANO



GEMINI MUD VOLCANO



KALININ MUD VOLCANO

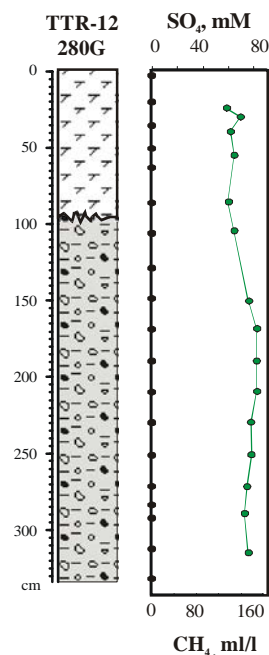


Fig 1. Position of SRZ in mud volcanoes with different intensity of fluid flow

mud volcano deposits were analysed for its principal element composition. Hydrocarbon gases were collected from the same intervals as pore water and analysed for molecular and isotopic composition. A number of anomalies in concentrations and distribution of the hydrocarbons and principal elements of pore water samples were observed.

Three types of mud volcanoes were recognized basing on their activity at present:

- (1) the Captain Arutyunov mud volcano is one of the most active among the known mud volcanoes in the Gulf of Cadiz. Sediments recovered from this mud volcano are represented by mousse-like breccia with small crystals of gas hydrates along the core. Methane concentration is extremely high (up to 126 ml/l) and $\delta^{13}\text{C}$ of methane varies from -48 to -49.2‰ PDB along the core and reaches -56.9‰ PDB in the uppermost part;
- (2) the Kalinin mud volcano is an example of a relatively passive volcano. It is covered by hemipelagic sediments and concentration of hydrocarbons is very low (CH₄ is about 0.01 ml/l);
- (3) the Gemini mud volcano has a very complex structure. It has one feeder channel and two craters of different generations. The crater of the first generation is covered by hemipelagic sediments and several layers of mud breccia are observed under the sediments cover. Hydrocarbons (C₁ – C₅) slowly increase with depth and methane concentrations reach 50 ml/l.

The second crater is younger and more active. Mud breccia comes to the sea bottom and methane concentration reaches 87.5 ml/l. Concentration of the higher hydrocarbons is extremely high (C_1/C_{2+} ratio is about 15). Moreover, carbon isotopic composition varies from -41.1 to -37.2‰ PDB for methane in the younger crater whereas in the older one it is more depleted (from -44.4 to 42.2‰ PDB).

Pore water analysis shows the same difference. Chloride content is in the range from 564 to 376 meqv/l in active mud volcanoes and from 554 to 612 meqv/l in passive ones.

Sulphate content gradually decreases with the depth from 80 to almost 0 meqv/l. But this decreasing in concentrations is different from one mud volcano to another. It means that sulphate reduction zone (SRZ) migrates due to differences in the fluid flow. In the Captain Arutyunov mud volcano SO_4^{2-} decreases very fast along the first 10 – 30 cm. At the same time on the Kalinin mud volcano SRZ was not observed along 3 m depth, which has been penetrated by gravity corer. In the Gemini mud volcano SRZ locates upper in relatively active crater than in inactive one. SRZ in the active crater situated approximately at the depth of 50 cm and in the inactive one – at about 80 cm or deeper (fig 1). The chemical characteristics of the samples suggest that SRZ migrates due to intensity of the fluid flow i.e. activity of a mud volcano.

MUD VOLCANOES, CORALS AND CARBONATE CRUSTS OF THE AL ARAICHE MUD VOLCANO FIELD, GULF OF CADIZ. RESULTS FROM THE BELGICA CADIPOR AND LOGACHEV TTR-12 CRUISES.

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The Al Araiche mud volcano field is situated on the Atlantic Moroccan margin. About 8 small to giant mud volcanoes are clustered around two sub-parallel thrust ridges, the Vernadsky and Renard ridges, the latter with steep fault escarpments. The ridges rise up in water depths of about 700 m and stretch to the shelf edge. Most mud volcanoes occur on top of the Renard ridge (Lazarillo de Tormes mv, Gemini mv, Don Quichote mv and Fiúza mv). The Kidd mud volcano is situated on top of the Vernadsky Ridge. Isolated mud volcanoes occur between the ridges (Adamastor mv, Mercator mv), or at their junction (Al Idrissi mv). The largest mud volcano, Al Idrissi, is situated at the shelf edge and is almost 250 m high, 5.3 km wide at the base and 1.4 km at the top. The smallest mud volcano (Lazarillo de Tormes) is 500 m wide and 25 m high. This area in the Gulf of Cadiz is especially interesting since it is a geologically dynamic region with variable oceanographic conditions, and characterized by a rich fauna.

The upslope mud volcano cluster was discovered during a R/V *Belgica* cruise in May 2002 and further surveyed during a R/V *Logachev* follow-up cruise in July 2002. The surveys yielded detailed swath bathymetry over the entire area, dense grids of high-resolution seismic data, a few very high-resolution deep-tow sub bottom profiles, side scan sonar mosaics over the major structures, selected TV-lines, TV-grabs, dredge samples and gravity cores. Integration of data sets allows to reconstruct the structure of active mud volcanoes in detail, and moreover, it allows to zoom at selected places from the regional structures gradually down to microscopic scale.

The mud volcanoes are all, regardless of their size, well developed conical hills with a crater and crater rim at the top. The structure of the mud volcanoes consist of a feeder pipe flanked with stacked outflow lenses. The mud volcanoes are flanked by erosional moats that are regularly filled in by extrusive mud flows and sediment from slope instabilities. At present the outflow events of different mud volcanoes are being correlated in a mud flow stratigraphy to analyse the mud volcano activity in the area.