GEOPHYSICAL DATA OF THE BLACK SEA MUD VOLCANOES

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Abstract

Mud volcanoes exist in the deep eastern Western Black Sea sub-basin within rather limited areal distribution. Morphological and structural characteristics of the Black Sea mud volcanoes were investigated during several Unesco-ESF "Training-Through-Research (Floating University)" cruises (1991-1996). These mud volcanoes were formed usually under an extensional regime with high terrigenous input. They generally have mushroom or cone-like shape and rise 20-150 m above the surroundings, relatively flat seafloor. In sonar records they are indicated with strong backscatters. All seismic sections across them show bending down reflectors towards the feeder channel(s) and bright spots between 400 and 600 ms (TWTT) below the seafloor.

Key-words : mud volcanoes, seismics, Black Sea

Introduction

Black Sea is one of the largest enclosed marine seas occupying an area of 432000 km^2 and having depths greater than 2 km. It is clear that the Caspian-Black Sea region is, at present, tectonically active (1). The very recent subsidence characterize not only the abyssal Black Sea, but also a series of more-or-less elongated basins extending westward to Italy. The mechanism of immense subsidence has given way to the deposition of thick sedimentary sequence reaching up to 14-15 km. From detailed seismic investigations (2, 3), the lower part of the southern Black Sea basin generally preserves the extensive tectonics associated with the rift processes, whereas the Middle upper margin is affected by compressive tectonics accompanied by overthrusts.

Mud volcano features (Fig. 1) were observed in the abyssal plain of the Mid-Black Sea Basin towards the southern and southeastern margins of Crimea (4, 5). Mud volcanoes and diapirs have been studied by the Russian scientists and the institutions over a long period in the Black Sea and the Sea of Azov. Mud volcanoes were discovered in the deep Black Sea during the joint geological/geophysical in 1988 cruise (5). Besides these large volcanoes, some others were mentioned by Ivanov *et al.* (6). The distribution of the mud volcanoes is given in Fig. 1. The works of Konyuhov *et al.* (7), Kruglyakova *et al.* (8) and Limonov *et al.* (9) have shaded more light into the knowledge about the geological, geophysical and geochemical aspects of these features.

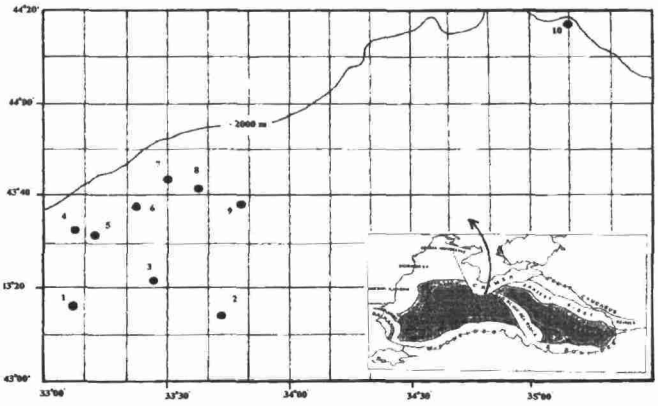

Fig. 1: Distribution of the large mud volcanoes in the deep Black Sea basin: 1-TREDMAR, 2 Kovalevskiy, 3-Vassoevitch, 4-MSU, 5-Yuzmorgeologiya, 6-Malyshev, 7-Kornev, 8 Stakhov, 9-Goncharov, 10-Kazakov.

The second leg of the Sixth Unesco/Tredmar Training-Through-Research Floating University (TTR-6) cruise was carried out in the Sorokhin trough area during July-August 1996 on board the R/V *Gelendzhik* that belongs to the Russian Federation. The following data were collected in the Sorokhin trough near the Crimean continental slope and the deep Black Sea Basin: (i) Multibeam swath mapping (as well as reflectivity) with the SIMRAD EM 12S; (ii) Single channel high resolution seismic data; (iii) Data of the deeptow combined system of side-scan-sonar and subbottom profiler (MAK-1); (iv) Sampling with gravity corer.

Swath bathymetric (SIMRAD EM 12S) surveys were carried out in the area in 1996 during the TTR-6 cruise at the first time. In the context of this paper, some information shall be given for the mud volcano features in the deeper abyssal plain of the Black Sea and to describe the seafloor features related to the mud volcanoes and identify their origin with respect to the neotectonic processes.

Data collection systems and the technical details

Swath Bathymetry

During the expedition of TTR-6, a SIMRAD EM 12S low frequency (13 KHz) multibeam echosounder was used to make both high resolution bathymetric and reflectivity maps of the seafloor. The basic model of the echosounder EM 12S, which has an angular coverage sector of 120°.

Seismic System

A single channel seismic system was used during the works. The seismic source is comprised of 3 liters air-gun source (Pulse-5 system) at the working pressure of 130 atmospheres. The streamer is composed by 100 m of active section towed behind the vessel by 500 m of distance. The data were recorded by an IBM PC based seismic station for duration of 3000 msec.

Marine acoustic deep-tow system (MAK-1)

The MAK-1 system is designed by Yuzmorgeologiya Co. (Russian Federation) to obtain acoustic images of both the seafloor surface (side scan sonar) and subbottom sediments (subbottom profiler). This system makes it possible to obtain acoustic images of the seafloor surface with the sidescan sonar system for a swath of up to 1500 m per side in long range (LR) mode (30 kHz) and up to 500 m per side in high resolution (HR) mode (100 kHz). The subbottom profiler works at 6 kHz frequency. This system has to be operated at low speeds of 1 to 2 knots.

Results of the bathymetry, sonar and seismic data

Three parallel swath bathymetric profiles with a SW-NE strike were made in the deep Black Sea basin within the coordinates of 43°31 N and 33°01 E; 43°51 N and 33°30 E; 43°42 N and 33°39 E; 43°23 N and 33°10 E. The whole area is almost flat, except the isolated mud volcano cones (Fig. 2). There is a gradual increase of seafloor relief towards to the NE. Water depths decrease from 2190 m down to 2060 m here. Therefore there is only 130 m difference for about 70 km. This means the approximate gradient of 0.002 m/km.

Five large mud volcanoes which were known before, were reconfirmed as the Moscow State University (MSU), Yuzhmorgeologiya, Malyshev, Kornev and Gocharov (5, 6, 9, 10). The main geomorphological features for these mud volcanoes are summarized in Table (1). The largest mud volcanoes are the Yuzhmorgeologiya and Malyshev ones by height and size. The diameters of the bases and the heights of these volcanoes are about 4 km and 110 m respectively with slope gradients of approximately 7°. The Goncharov mud volcano is the smallest but with the sharpest gradient which was calculated to be about 11°.

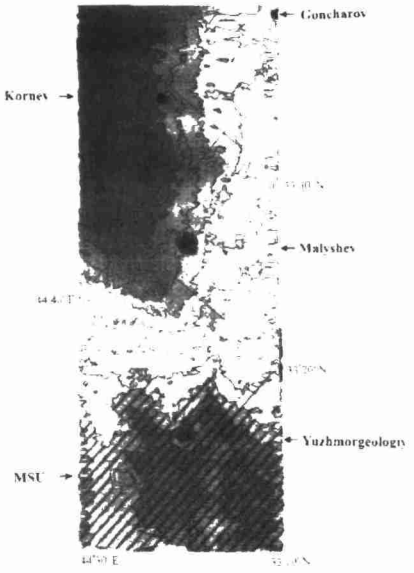

Fig. 2: The bathymetric map of the deep Black Sea prepared from the SIMRAD EM12S data (TTR-6, R/V *Gelendzhik*, 1996).