THE STRUCTURE OF THE SEDIMENTARY COVER AND ACTIVE FLUID VENTING IN THE SOROKIN TROUGH (NORTHERN BLACK SEA)

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Abstract

The structural trends of clay diapiric ridges and folds in the Sorokin Trough south of the Crimea radically differs from those earlier assumed. The diapirs and folds are interpreted as being the result of a lateral tectonic compression. New geological-geophysical data obtained in the trough provide much evidence for active hydrocarbon fluid flux through the seafloor, including mud volcanoes, different seismic and acoustic anomalies, gas hydrate accumulation, etc.

Key-words : tectonics, diapirs, mud volcanoes, Black Sea

Introduction

In summer 1996, during leg 2 of the 6 th UNESCO-IOC Training-through-Research Cruise of the Russian R/V *Gelendzhik*, geological-geophysical investigations were carried out in the Sorokin Trough south of the Crimea. The methods applied included seismic profiling with a 3 litre air-gun, Simrad EM-12S multibeam echosounder swath-mapping, deep-towed survey with the MAK-1 sidescan sonar equipped with a subbottom profiler, and bottom sampling with a large diameter gravity corer. The seismic profiles were run in the direction approximately parallel to the Sorokin Trough trend and spaced closely enough (4.5 km apart on the average) allowing us to make a confident correlation between the structural features. The MAK-1 lines were placed between the seismic ones, and thus the surficial and shallow subbottom acoustic data complemented the deeper seismic information. The bottom sampling was based on the preliminary sidescan sonar and profiler data interpretation, providing a real ground-truthing.

Geological setting

The Sorokin Trough is located on the Crimean continental margin, at waterdepths of 800 - 2100 m (Fig. 1). The trough, about 150 by 50 km in size, is considered as the Crimean fore-deep [1]. It is filled with the more than 5 km thick clayey Maikopian Formation (Oligocene-Lower Miocene), overlain by Middle Miocene to Quaternary sediments, totally 3-4 km thick [2]. The Quaternary sediments largely belong to the paleo-Don/paleo-Kuban fan accumulation that covers the entire northeastern part of the Black Sea floor. The northern flank of the trough is a steep, faulted escarpment of the Triassic-Jurassic basement of the Crimean Mountains, and to the south it is bordered by the Cretaceous-Eocene Tetyaev Rise and Shatskii Ridge, on the top of which the thickness of the Maikopian Formation decreases by 1-2 km.

Since the first seismic investigation in the trough in the 1970s it was widely accepted that the Maikopian Formation forms several zones of clay diapirs aligned in accordance with the general trend of the trough. However, any details of the trough structure remained unknown.

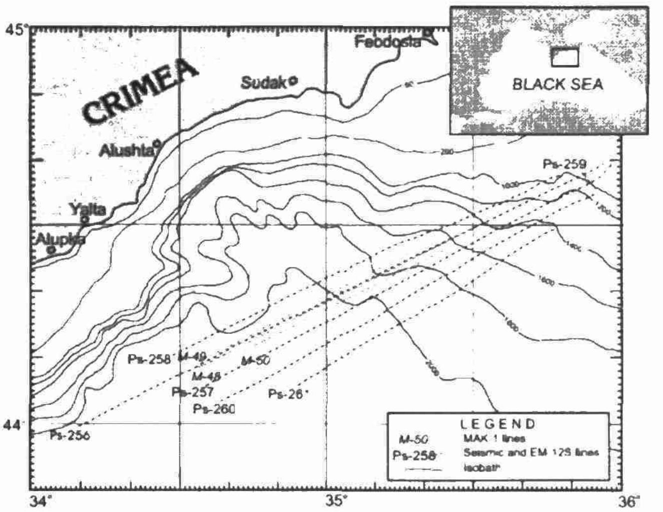

Fig. 1. Location map of seismic, multibeam echosounder, and sidescan sonar lines in the Sorokin Trough.

The data analysis

Two seismic members can be distinguished in the seismic sections. The upper one is identified as Quaternary hemipelagic and turbiditic sediments [2]. Its observed thickness varies between 100 and 1300 ms TWTT (90-1200 m). This member appears as acoustically layered, with some acoustically transparent units, each 70-80 m thick, whose abundance and thickness increase northeastward. The peculiar feature of the upper seismic member is well-defined, negative polarity bright-spot acoustic anomalies at different subbottom depths : from 230 to 800 m. The tectonic disturbance of the upper member is completely determined by the dislocation in the lower one. The latter can be dated by the Pliocene to the upper part of the Maikopian Formation [2]. It is generally acoustically semitransparent or transparent and is disturbed by numerous folds and faults. The boundary between the lower and the upper members sometimes is difficult to pin-point in the seismic profiles.

The seismic profiles show that the deformation in the lower seismic member has a complex pattern. Both diapiric structures and fault-related folds were observed in it within the study area (Fig. 2). They are grouped in 9 linear zones, 6 of them (southwestern) clearly being of diapiric origin, and other 3 zones (northeastern) representing faulted folds. The Maikopian Formation is deeply buried in the northeastern part of the study area and is not seen in our seismic profiles, hence it is not excluded that the faulted folds could develop above clay diapirs. Each diapiric zone consists of 1 to 4 diapiric ridges. In turn, some of these ridges produce individual diapirs or mud volcanoes that rise from their tops and slopes. Three diapiric zones are characterized by mud volcanoes. On the MAK-1 sonographs and the seafloor reflectivity map, totally 16 mud volcanoes were distinguished, all of them at waterdepths of 1600-2100 m. They vary in morphology form regular cone-shaped structures, through "mud pies" and collapsed features, to fissure eruptions of the mud breccia. The average sea bottom diameter of the mud volcanoes is about 800 m. Their craters are poorly expressed. The fissure eruptions are related to a system of parallel faults oriented in a sublatitudinal direction. Some pockmarks were observed in the high-resolution sonographs as well.

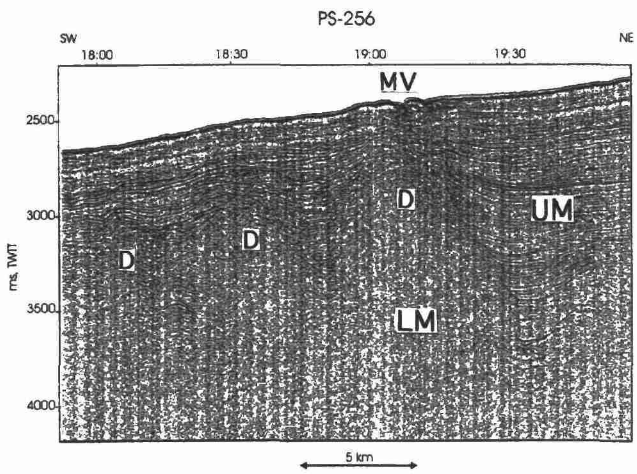

Fig. 2. Part of seismic profile PS-256. UM - upper seismic member, LM - lower seismic member, D - clay diapir, MV - mud volcano.