P4-6 SEISMIC SIGNATURES OF GAS SEEP FEATURES ON THE NORTH-WESTERN SHELF OF THE BLACK SEA

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The northwestern shelf of the Black Sea is the most prospective hydrocarbon region of the Ukraine. It is still studied by various methods that even include those which only can help to evaluate opportunities for further exploration.

During the expedition on R\V "Kyiv" (June-July 1997) echo-sounding and continuous seismic profiling were carried out in the transitional zone between the Scynthian plate and deep sea basin of the Black Sea.

The lines used in this study provide 6 crossings of gas seepage from sediments. The study area is bounded by 44°39′,7 - 44° 51′,9 N and 31° 08′,5 - 31° 46′,9 E.

For the first time geometrical pattern of the upper portion of sediments in this area was simultaneously documented by 3 acoustic systems up to 550 m thick, with they being run at frequencies of 38 Khz 200 and 30 Hz respectively. This approach resulted in obtaining accurate and reliable data that make it available very clear acoustic signature of geological bodies because of mapping them in fine details.

Prominent gas seep features were located on the bathymetric soundings and seismic reflection records in two geomorphologically different surveying sites.

The first of them occurs on generally smooth sea bed in a shallow water depth of 20-50 m. The distinct places of loss integrity in horizontal reflectors up to a depth of 550 m are seen on the 30 Hz frequency records of the gas seeps. These places are characterized by crumpling some layers, up-doming subsurface parallel reflectors in the middle of the gas seep features and occurring of faults on the periphery of these features resulted in depressions beneath them.

The higher frequency records (200 Hz) indicate that immediately below the Quaternary sediments the gas seep features have haystack-shaped appearance bounded by the structurally non-uniform crumpled deposits that act as a strong reflector. Acoustically homogeneous bodies of the sediments are suspected to be located within the gas seep features, because strong attenuation of sound waves are observed. As a rule, such seismic shadows are resulted from enriching with a gas of soft silts.

The gas seep features of the second survey site appear on the echograms and seismic reflection records as remarkably diapir-like structures which produce small topographic cone-shaped knolls. As these seabed mounds have associated moats, the bathymetric pattern demonstrates the alternating of highs and lows. The outer form of the knolls is the symmetrical one. Their height is 40-70 m above the base on the sea floor where an average depth varies from 250 to 280 m.

Tectonic deformation of the deposits is widespread. It is marked by vertical discontinuities up to a depth of several hundred meters, being manifested as subvertical minor faults.

Gravitational sliding downslope of the deposits and vertical channels occur on the knolls. The channels are believed to be filled in with crumpled and vertically microfaulted silty deposits.

The vertical zones of large scatter in sound velocity are distinctly seen on the echograms from both sites mentioned. They have a torch-shaped appearance. The separate torches or the groups of them produce clouds of different sizes.

On the basis of available data the torches can be only interpreted as intermittent methane flows from the sediments. A possible model for developing gas seeps is as follows.

Gases are generated at a depth in the sedimentary basin. They leak upward through the faults and fissures to the shallow layers occurring at 10-20 m beneath the sea floor. The gases are here trapped in the silts producing local gas rich bodies in the form of cones and lentils. Periodically the gases begin to escape to seawater because of the loss of sedimentary integrity after reaching a state when the gas pressure in the capillary system of the bodies exceeds the overburden pressure.

The crucial condition of the model that faulting and fracturing occur at depths beneath penetrating sound waves in this study. The supporting evidence for this condition is provided by the tectonic framework of the gas seep basin (1,2). Within the study area the presence of a large deep fault trending roughly N-S across the northwestern shelf of the Black Sea is inferred from regional considerations based on multidisciplinary information. This Pre-Riphean fault had a profound effect on stress pattern giving rise to numerous minor faults and offsets. Some of them were recognised on seismic reflection sections deeper than in this study.

The present day tectonic entity is due to the development of the Black Sea deep basin. The role of the faults was enhanced by deep-seated physical-petrological processes and subsidence of the central part of the Black Sea from the Late Cretaceous to the modern Late Quarternary. By nature of these faults they were subject to recurrent variable displacement over a considerable period of time. Such a long-lived tectonic activity produced pathways for gas migration to the shallow layers.

References

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