GAS HYDRATE STRUCTURES IN THE EASTERN BLACK SEA BASIN

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Abstract

Methane hydrate is a methane-bearing, ice-like material that occurs in marine sediments and in permafrost regions. They are normally formed under low temperature and high-pressure conditions. The amount of methane contained in hydrate deposits is enormous. Hydrate deposits are estimated to contain a much greater amount of natural gas than conventional accumulations. Since 1991, UNESCO/TREDMAR Training-Through-Research (TTR) studies have shown that the Black Sea has an important potential for the gas hydrates. Structures bearing gas hydrates are distinguished on the subbottom profiler records as strong acoustic reflections.

Key Words: The Black Sea, Seismics.

Intoduction

Oceanic hydrate system deposits, which include both methane hydrate and associated methane gas, are very large, but relatively low grade when compared with conventional hydrocarbon deposits. Near surface gas hydrate zones in several water depths can be predicted to some extent by side scan sonar, profiler, single, multichannel high resolution seismic, and exploration 3D seismic data. Gas hydrates could be formed by natural gas vents and other oil and gas seepages. They indicate a potential for shallow gas accumulations, and formations of hydrates could present geohazard problems at the offshore installations and operations. Methane hydrates are found in high pressure-moderate temperature in sediments of the Black Sea. Hydrate is now widely recognized on continental slopes, where they are well developed, because of their unique appearance on profiler and seismic reflection records. Structures which contain gas hydrates are present on the profiler records as strong acoustic reflections in the Black Sea basin. Hydrate formation can strengthen sediments through both pore filling and cementation and retard compaction. Hydrate provides a mechanism for concentrating methane both in hydrate itself and in associated trapped gas. These formations indicate gas charged layers covered by the gas hydrate shield, preventing the escape of gas where there is a contact between hydrate and gas, a strong impedance contrast termed the bottom simulating reflector (BSR) forms (1).

Gas hydrates and the potential in the Black Sea basin

Methane hydrate is a mixture of methane and water that is frozen into an ice. The crystalline structure of the frozen water molecules forms a cage-like lattice inside of which is trapped high concentrations of methane molecules. Methane hydrates form in generally two types of geologic environments, in permafrost regions (where cold temperatures dominate) and beneath the sea in sediments of the outer continental margins (where high pressures dominate). Methane hydrates can form at temperatures above the freezing point of water (2).

Studying and the understanding of the gas hydrates in the slope areas and deep basins are important for several reasons. Sea floor stability and safety are two important issues related to gas hydrates. Sea floor stability refers to the susceptibility of the sea floor to collapse and slide as the result of gas hydrate disassociation. The safety issue refers to petroleum drilling and production hazards that may occur in association with gas hydrates in both offshore and onshore environments. Throughout the world, oil and gas drilling is moving into regions where safety problems related to gas hydrates may be anticipated. Oil and gas operators have recorded numerous drilling and production problems attributed to the presence of gas hydrates, including uncontrolled gas releases during drilling, collapse of well casings, and gas leakage to the surface. These problems are generally caused by the dissociation of gas hydrate due to heating by either warm drilling fluids or from the production of hot hydrocarbons from depth during conventional oil and gas production. Subsea pipelines may also be affected by loss of sea floor support from hydrates destabilized by warming. Hazards arise because gas hydrates are only quasi-stable; if the temperature is increased at a fixed pressure or the pressure decreased at fixed temperature, or both temperature increased and pressure decreased, it is easy to pass out of the stability regime of hydrates. The hydrate structure encases methane at very high concentrations. A single unit of hydrate, when heated and depressurized, can release 160 times its volume in gas. It is possible that both natural and human-induced changes can contribute to in-situ gas hydrate destabilization, which may convert an offshore hydrate-bearing sediment to a gassy water-rich fluid, triggering sea floor subsidence and catastrophic landslides. Evidence implicating gas hydrates in triggering sea floor landslides has been found along the Atlantic Ocean margin of the United States. These processes may release large volumes of methane to the Earth's oceans and atmosphere. Methane is a "greenhouse" gas, 10 times more effective than carbon dioxide in the process believed by many to cause climate warming. The hydrate accumulations in the world comprises of thousands of square kilometers. Therefore another importance of the gas hydrates is that they will probably become an energy source of the word in the future after running out of the existing oil and gas reservoirs (3).

The Black Sea is one of the most important areas having prospective geosources of the large gas hydrate accumulations. The most suitable geophysical methods used to investigate the large gas hydrate areas both in the seabed surface and near bottom sediments are sonar and high-resolution seismic methods. Hydrate formations can easily be determined on the subbottom profiler records, because the boundary between the hydrate formations and the underlying gas or water bearing sediments causes strong reflection packets (Fig. 1). Methane seeps are common features in the Black Sea Basin and they can also be defined by the mud volcanoes. The shelf and the continental slope regions are the areas in which high amount of methane accumulations occur.

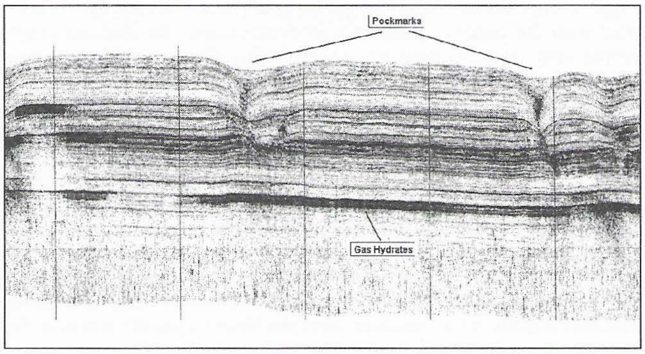

Fig. 1. Subbottom Profiler record example from Eastern Black Sea showing gas seeping zones (pockmarks) and gas hydrate layer as strongly acoustic reflectors.

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