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NEW GAME CHANGER: MARINE GAS HYDRATES

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Summary. Gas Hydrates (Methane Hydrates) are ice-like crystalline solids formed by the trapped entrapment of gas molecules in a lattice by water molecules. They are formed under high pressure and low-temperature conditions. They usually contain methane gas, which is the main component of natural gas. Water molecules surround the methane molecules trapping them in a 'cage' of water molecules to form gas hydrates (GH). They are commonly found in the continental margin (continental slope), seafloor sediments, and near-polar frost (permafrost) areas also includes the Black Sea and Caspian Sea. GH are important for earth sciences and economics; the methane leaks that occur in these zones are a direct indicator of the presence of hydrocarbon reserves in the depths, behaves for the accumulation of methane gas. GH themselves are also an important source of energy. They are called "zipped gas, burning ice" because they contain 164 times more gas than its volume.

Introduction

Today, Marine Gas Hydrates deposits, which can be defined as a type in economic terms as a "relatively clean energy source of the near future". When the near-future scenarios in the energy are researched, it is understood that coal based energy/electricity production will reach its maximum level in a short time, particularly when power plants to be installed are taken into. By the 2040s, it is predicted that natural gas-based energy production will out perform a rapidly increased share of renewable energy resources. Shale gas and Gas hydrates both are an alternative in natural gas production. "these two unconventional energy sources have been investigated in recent years and production technologies have been developed. As a result, since the 2000s, Shale Gas has taken its present place in the oil industry and has become "game-changer" energy source in terms of countries' policies. Now turn is on Gas Hydrates in the new plays as the unconventional hydrocarbon revolution. Gas Hydrates are a potentially huge worldwide resource in the form of natural gas trapped in the ice in permafrost ocean sediments. Due to the large volume of methane they contain, it seems Gas hydrates reserves will stand out as the main alternative/ Unconventional energy Resource in near future.

GH occurs at high-pressure and moderate temperatures in the Marmara, Mediterranean, and Black Sea. To carry out work in those areas, the Geophysical seismic laboratory established within Dokuz Eylul University with the support of the State Planning Organization (DPT) served as a focal point in many research activities and carried out exploration studies between 2005 and 2018 by mapping GH and taking samples from the seafloor for the first time. Among these studies, the first phase of the National Gashydrate projects were been completed and a priceless discovery with a national team has generated decades of energy potential.

Method and / or theory

What are Gas hydrates or methane hydrates? Gas hydrate refers to dirty white color crystalline ice-like substance, which formed under high pressure and low temperature by combining lattice-bearing water molecules and natural gas molecules. The formation of the ice-like, crystalline GH composed of hydrocarbon gas molecules and water molecules surrounding them under the seafloor in high pressure and low-temperature environments depends on the combination of four factors: low temperature, high pressure, water, and which mainly consists of methane. These are the conditions required for the formation of gas hydrates and some parameters that control the gas hydrate formation process. Stationarity condition of gas hydrate represented by the high pressure and low temperature conditions, and this situation is called "thermobaric conditions". If temperature increases and/or pressure drops, structure of the gas hydrate passes two phases that is gas and

water. Gas hydrate is in earth sciences and economically important for several reasons: (1) Gas hydrates are good cap rocks for oil and natural gas. A volume of gas hydrate can store up to 164 times per volume gas, and that gas hydrate occurs almost all around the world, (2) The methane hydrate itself is an important energy source (3) Methane seepage may indicate the existence of a deeper oil and gas reservoir, and (4) The methane production and migration in the slope sediments may cause massive slides. Last but not at least Methane gas has 22 times more global warm absorption capacity compared to carbon dioxide if it is released into the atmosphere. In other words, greenhouse gas due to its contribution to climate change.

BSR is bottom of gas hydrate accumulation follows the topography of the sea floor and on seismic sections they called Bottom Simulating Reflector in marine geophysics seismic sections. BSR reflections follow isothermal surface, the depth is determined by the geothermal gradient (Figure 1). The amount of methane gas captured/stored in GH all over the world is estimated to be twice the total carbon held in all fossil fuels in the World and more than fifty times the oil and natural gas resources. Existing GH deposits have been determined with up-to-date technology, only a small part of them have commercial potential, the real reserve and its contribution to the country's economy are much higher. Currently only a small fraction of existing gas hydrate deposits have commercial potential. Even that alone is the incredible size of the available resource.

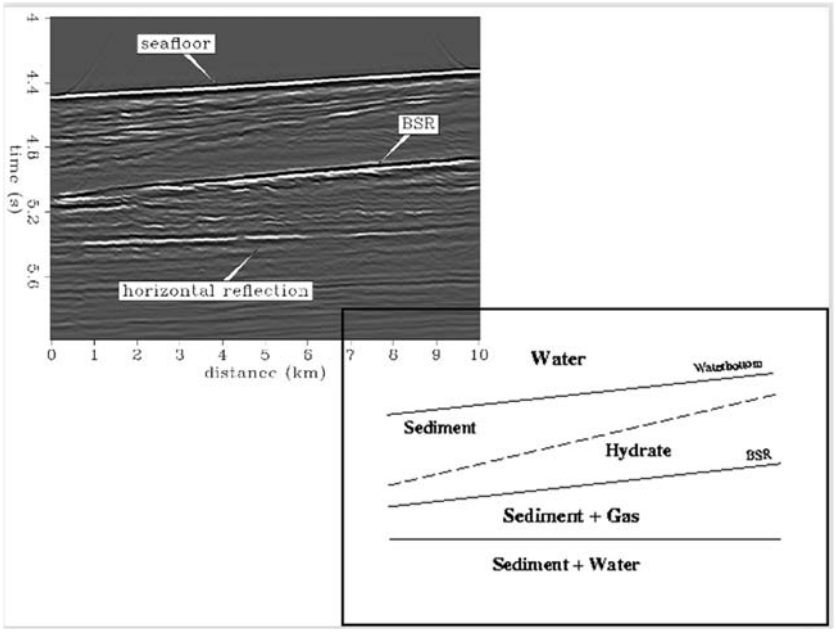

Fig. 1. BSR-that is bottom of gas hydrate accumulation follows the topography of the sea floor and on seismic sections they called Bottom Simulating Reflector

The areas within potentially show the Messoyakha area which is the first land production area in the world, GH areas in oil and gas fields such as Alaska, Gulf of Mexico, Angola Bay, and the Eastern Mediterranean, and GH areas such as the Nankai Trough where the first production was realized in the sea and the South China Sea. We are lucky with the gas hydrate resources as we know with Azerbaijan is also lucky it as oil and natural gas. Many countries, such as oil and gas-non existing China, Japan, South Korea, India, and Germany, as well as the oil- and gas rich United States, Brazil, Norway, and Iran have invested in this area. The first production test study has been carried out successfully in 2013 by Japan, and the second stage production test study was conducted in 2017. Within the scope of the 3rd phase, it targeted production works on a commercial scale starting already and continued to work towards uninterrupted production. China, which is the first country to continuous and stable gas production, carried out the same techniques in different areas. China has also come to the fore with the most patents among other gas hydrate countries. This was a big step towards making gas production from gas hydrates feasible.

The Hydrate Ridge located on the coast of Alaska, the Atlantic Ocean, the Pacific Continental Margin, Southern Mexico, the Central American Trench extending from Mexico to Costa Rica, the Atlantic Continental Margin, the Blake Outer Ridge, the southeastern and western active margin of the United States shows that GH is spreaded in sediments. On the Blake Plateau on the southeastern continental slope of the USA, only one area of approximately three thousand km^2 has methane reserves equal to approximately 30 times the annual gas consumption of the USA. In 2018, it was combined with an expanded gas hydrate production test with

stratigraphic testing in the western part of the Hydrate-01 well in the Prudhoe Bay area. The final goal of this project is a long-term (12-24 months) gas hydrate production test (Collet, 2018). After many projects such as the northern slope of Alaska, the US has planned and started a new drilling and pressure coring project in the Gulf of Mexico in early 2022 and 2023 (Collet T., personal communication 2023).

The most concrete step for GH studies in Turkey was an advanced research project supported by the State Planning Organization in 2003 (Çifci et al., 2003). With this project, a Geophysics Seismic Laboratory was established within Dokuz Eylül University, the laboratory activated by the author as project coordinator and supported several funds.

Fig. 2. Marine geophysical laboratory was run several cruises to research the gas hydrate mapping and sea bottom sampling between 2005 and 2018 to collect, process and interpret the geophysical and geological data using several thousands km data. The laboratory's infrastructure was been strengthened the laboratory is became only one in Turkey and international level in the world. With additional knowledge and experience, they have acquired staff and researchers who have served within, taking part in research projects with Turkey's research, exploration and drilling vessels and making important and valuable contributions

Results and discussion

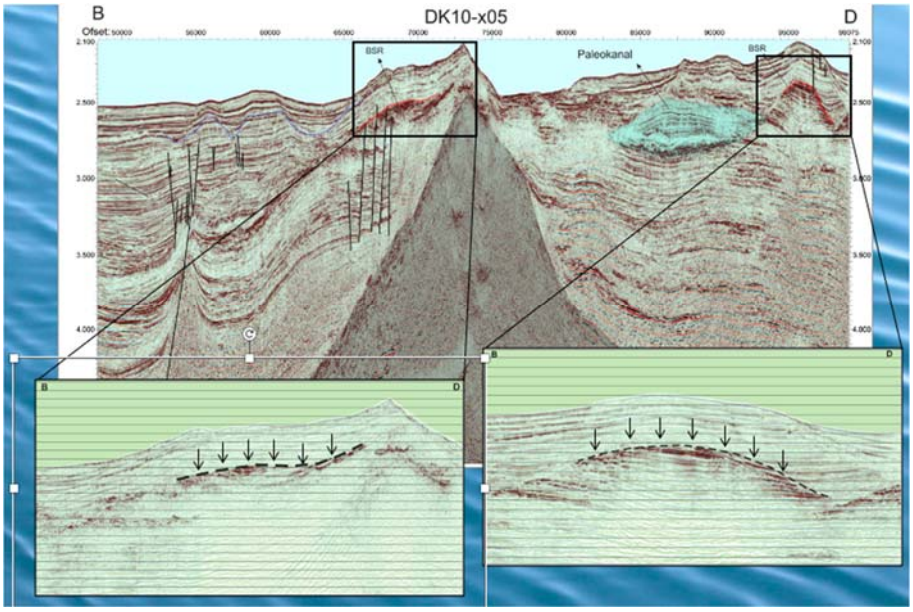

Fig. 3. The Bottom Simulating Reflector (BSR) mimics the sea floor on the seismic sections. The BSR reflections follow isothermal surface, the depth is determined by the geothermal gradient. At the BSR reflection level, sudden amplitude changes can be observed. Sometimes it extends to reflections and here BSR disappear. BSR is not real geological reflections that comes from interfaces, they cross the real sedimentary units on seismic sections. Free gas accumulation can be observed under the BSR reflections. BSR may indicate the presence of a deep reservoir of HC

Conclusion

Gas-hydrates are Game Changer. Gas-hydrates are most probably the near future energy sources of the World. The Black Sea and Caspian Sea are two of the richest waters having immensive hydrate accumulations. Considering that energy resources are very limited; such a very important reserve discovery has the strategic importance that can change the fate of any country. A "game-changer" energy source in terms of countries' policies towards energy sources to recover unconventional hydrocarbon resources changed everything.

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