Indicators of methane hydrates occurrence in the deep Adriatic Sea

J. Obhodas[1*], U. Tinivella[2], M. Giustiniani[2], T. Durn[3], A. Vinkovic[1], D. Sudac[1]

[1]Ruder Boskovic Institute, Bijenicka c.54, Zagreb, Croatia

[2]Istituto nazionale di oceanografia e di geofisica sperimentale – OGS, Grotta Gigante 42C, 34010 Sgonico (TS), Italy

[3]Croatian Hydrocarbon Agency, Miramarska 24, 10000 Zagreb

Corresponding author:
Phone: +385-(1)-468-0101
E-mail: jobhodas@irb.hr

Introduction: Methane hydrates (MH) are crystalline compounds in which methane molecules (CH_4) occupy the water ice lattices. The first natural sites were discovered in the 1960s in Siberian permafrost. Today we know that MH are globally widespread in permafrost (5%) and in deep sea sediments (95%) [1]. They are stable under high pressure and low temperatures. At the ocean seafloors, where temperatures are 1-7°C, MH deposits form in sediments at depths ~ 400 to 1000 m [2]. The assumed amounts of MH range from $2x10^{14}$ m^3 to $3x10^{18}$ m^3 [3]. Although MH exploitation is currently considered too expensive, they are investigated as a potential future source of energy. Of particular interest are technologies that investigate CH_4 exploitation by pumping warm pressurized CO_2 into the sediment layers containing MH. The deposited CO_2 liberates the trapped CH_4 forming even more stable form of hydrate. In this way the hydrate material does not melt and stability of the geological formation remains intact, yet another greenhouse gas is sequestered. MH can be destabilized by a slight change in salinity, temperature (1-2°C) or pressure, thus instability of MH can be induced by climate changes and be their accelerator.

This study focuses on the evaluation of the potential of the Adriatic Sea to produce MH. Seismic profiles obtained by the Croatian Hydrocarbon Agency and published geophysical and geological datasets will be examined to determine the possible presence of a bottom-simulating reflector (BSR) and to evaluate the Gas Hydrate Stability Zone (GHSZ) in the Adriatic Sea.

Methods: The existence and depth of a hydrate deposit is often indicated by the presence of the BSR. A BSR is a seismic reflection of reversed polarity that approximately parallels the sea floor and crosscuts the acoustic bedding structure of the sediments [1]. The parameters of importance for calculation of BSR in the Adriatic Sea are: Sea bottom temperature of 7°C; Geothermal gradient of 10-30 °C/km, 17°C/km in average; and Salinity of 3.5%.

Results and Discussion: In order for MH to be within the GHSZ the conditions of the sea depth, geothermal gradient, pressure gradient, salinity, etc. have to be satisfied. BSR indicates the lover limit of hydrate stability in sediments. It is only visible if below BSR there are sediments containing free gas, which significantly reduce the seismic wave velocity. At the same time sediments containing MH increase the velocity of the seismic waves. This is not always the case as the sediments bellow the BSR can also contain free water, permeable or impermeable shale or clay zones, or MH are distributed in sea floor with low hydrate saturation and there are no geologic strata [1]. Therefore, the BSR is not a necessary condition for the presence of hydrates as it was proved by collection of gas hydrate samples on different locations in the Mediterranean sea, however the only BSR observed was in the Nile Deep Sea Fan in the Eastern part of the Mediterranean Sea [1].

Compared to other investigated Mediterranean Sea zones, the Adriatic is less worm and less salty because of fresh water supply which is larger than the sea evaporation. The maximum depth is 1233 m, and zone bellow 400 m is cca 100 km^2 in diameter. Large quantities of organic rich sediments originated by the river Po are washed into the deep sea Adriatic. In addition, the geothermal gradient is ≤ 30 °C/km. This makes the Adriatic Sea a good candidate for the occurrence of BSR and thick GHSZ.

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