

Exploring and Monitoring of Methane Hydrate Deposits

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Abstract— Relatively recently, in the last 20 years, it was discovered that methane hydrate (MH) deposits are globally distributed in the permafrost and oceans. Before 1965 when first deposits were discovered in nature, it was believed that MH can occur only in laboratory conditions or in vast parts of the Universe. Presently it is presumed that this solid crystalline compounds in which CH₄ molecules occupies the water ice lattices (nominal chemical formula of MH is C₄H₆₂O₂₃) can serve as an energy source favorably to the all of the world remaining conventional hydrocarbon sources. The worldwide estimates of MH deposits range from 2x10¹⁴ m³ to 3.053x10¹⁸ cubic meters. This uncertainty partly results from our limitations in geological understanding of the MH deposits, which is due to the relatively bad quality of data obtained by presently available seismic and electromagnetic techniques. Moreover, MH deposits can become vulnerable to climate changes, which were already occurring in geological past with tremendous consequences for the global life on Earth. Thus, further development of advanced techniques is needed to enhance our abilities to better characterize, quantify and monitor the MH deposits. In the work presented 14 MeV neutrons and associated alpha particle imaging (API) were used to quantify the amount of MH in the sample. Samples were prepared from sea sediment, quartz sand and MH simulant. MH simulant with chemical formula C₄H₄₆O₂₃ was made from sucrose (25 % by mass) and water. MH quantity was measured by measuring the carbon content in the sample [1-8].

Index Terms—associated alpha particle imaging, fast neutrons, methane hydrate and hydrocarbon energy sources

I. RESULTS

Measurements were done in the empty basin and in the basin filled with the water. In total six samples were prepared:

- Samples of sea sediments/ quartz sand with pores filled with air
- Samples of sea sediments/quartz sand with pores filled with water
- Samples of sea sediments/quartz sand with pores filled with MH simulant

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- Samples of sea sediments/quartz sand with pores filled with MH simulant

Detection probability of MH simulant was determined in the sea sediment/quartz sand with respect to the pores filled with air/water in dependence on the measuring time. Figure one shows the gamma ray spectrum of sea sediment which pores are filled with MH simulant.

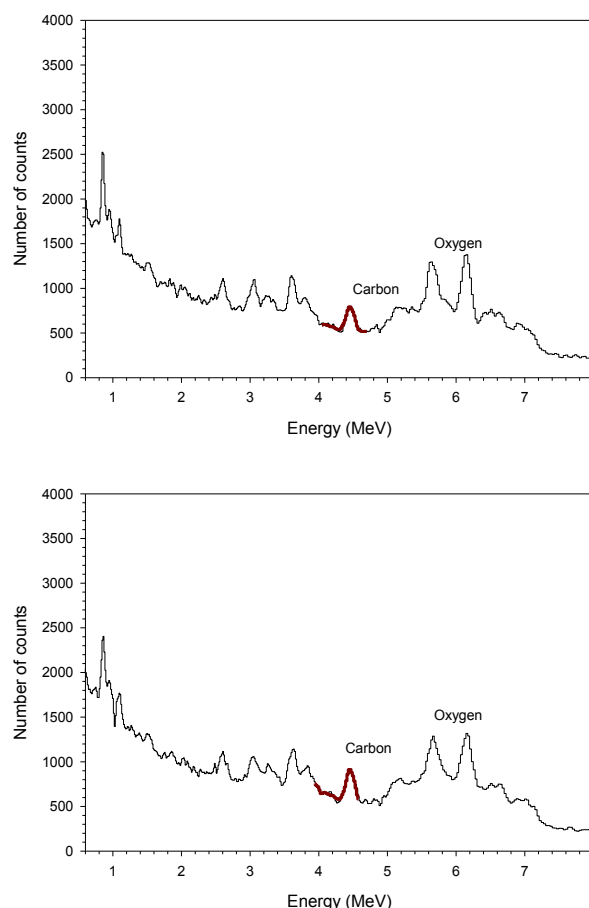


Fig. 1. The gamma ray spectra of sea sediment saturated with water (up) and saturated with MH simulant (down).

According to the data 2.5 h of measurement time is needed for 100% detection probability. Detection probability decreases with decrease of measuring time. For half an hour of

measurement time detection probability drops to 70%. There are no measurable influence of water on detection probability, at least for a given measurement accuracy. For potential commercial applications at least one order of magnitude more intense neutron beam is needed together with at least four gamma ray detectors placed around the sample. Nevertheless, our investigation shows that MH rich deposits can be detected and investigated by API method.

TABLE I
 DETECTION PROBABILITY OF MH SIMULANT IN QUARTZ SAND
 (WATER IN THE BASIN)

Measuring Time	Detection Probability with respect to pore filled with air (%)	Detection Probability with respect to pore filled with water (%)
2.5 h	100	100
1.25 h	94 ± 4	89 ± 7
50 min	85 ± 5	81 ± 7
37 min	66 ± 8	76 ± 8
30 min	65 ± 7	68 ± 7
25 min	66 ± 5	62 ± 6

TABLE II
 DETECTION PROBABILITY OF MH SIMULANT IN SEA SEDIMENT
 (WATER IN THE BASIN)

Measuring Time	Detection Probability with respect to pore filled with air (%)	Detection Probability with respect to pore filled with water (%)
2.5 h	-	100
1.25 h	-	94 ± 3
50 min	-	89 ± 4
37 min	-	69 ± 8
30 min	-	69 ± 7
25 min	-	64 ± 6

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