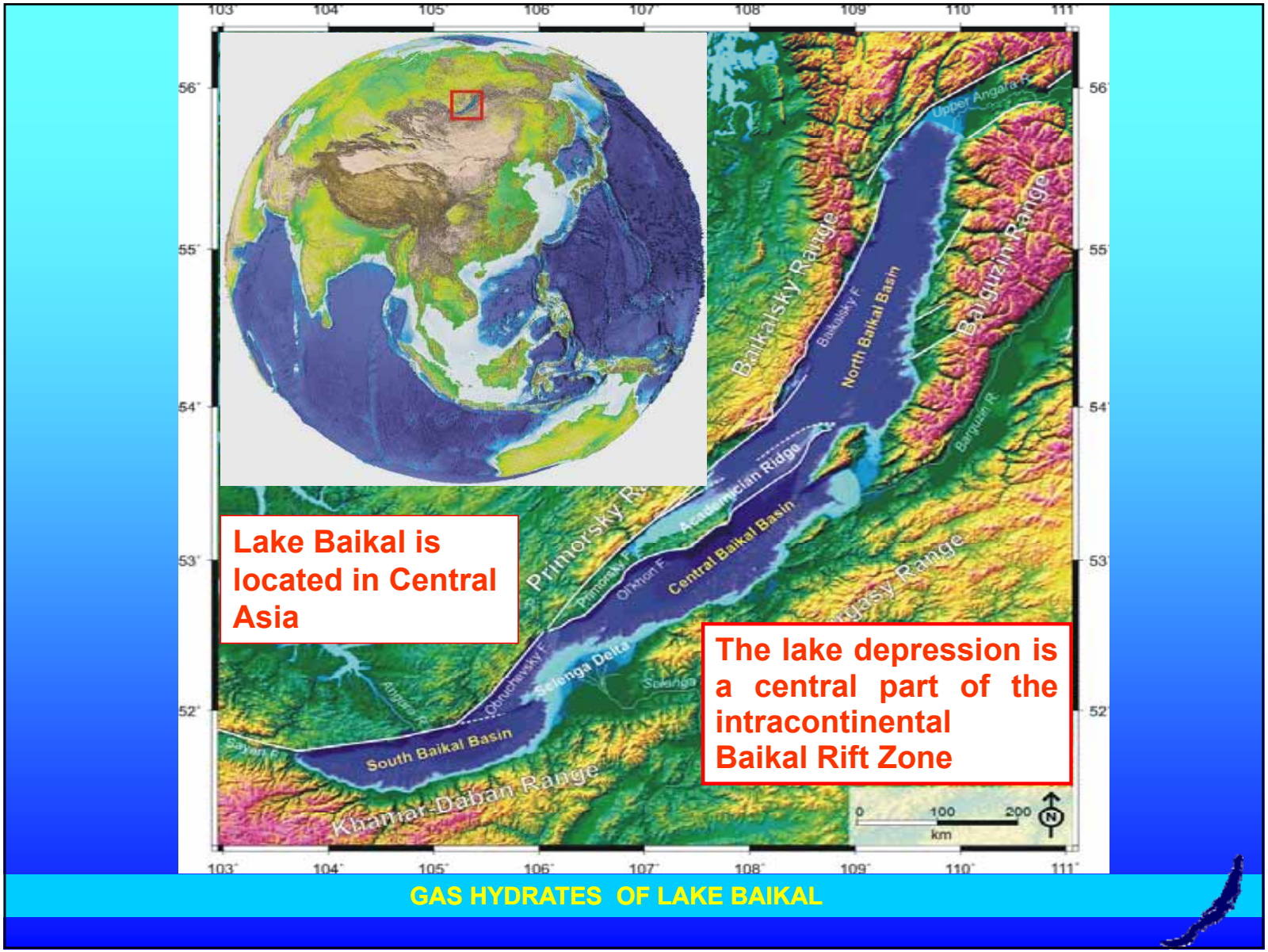

Results and perspectives of search and research of the Baikal gas hydrates
Khlystov O.M.
Limnological Institute SB RAS, Irkutsk, Russia
Niigata, 2009


Lake Baikal is located in Central Asia
The lake depression is a central part of the intracontinental Baikal Rift Zone
Baikalsky Range
North Baikal Basin
Central Baikal Basin
South Baikal Basin
Khamar-Daban Range
Selenga Delta
Upper Angara F.
Barguzin R.
Academician Ridge
Primorsky F.
Olkhon F.
Obruchevsky F.
Angara R.
Sakyan F.
Sakunga
0 100 200
km
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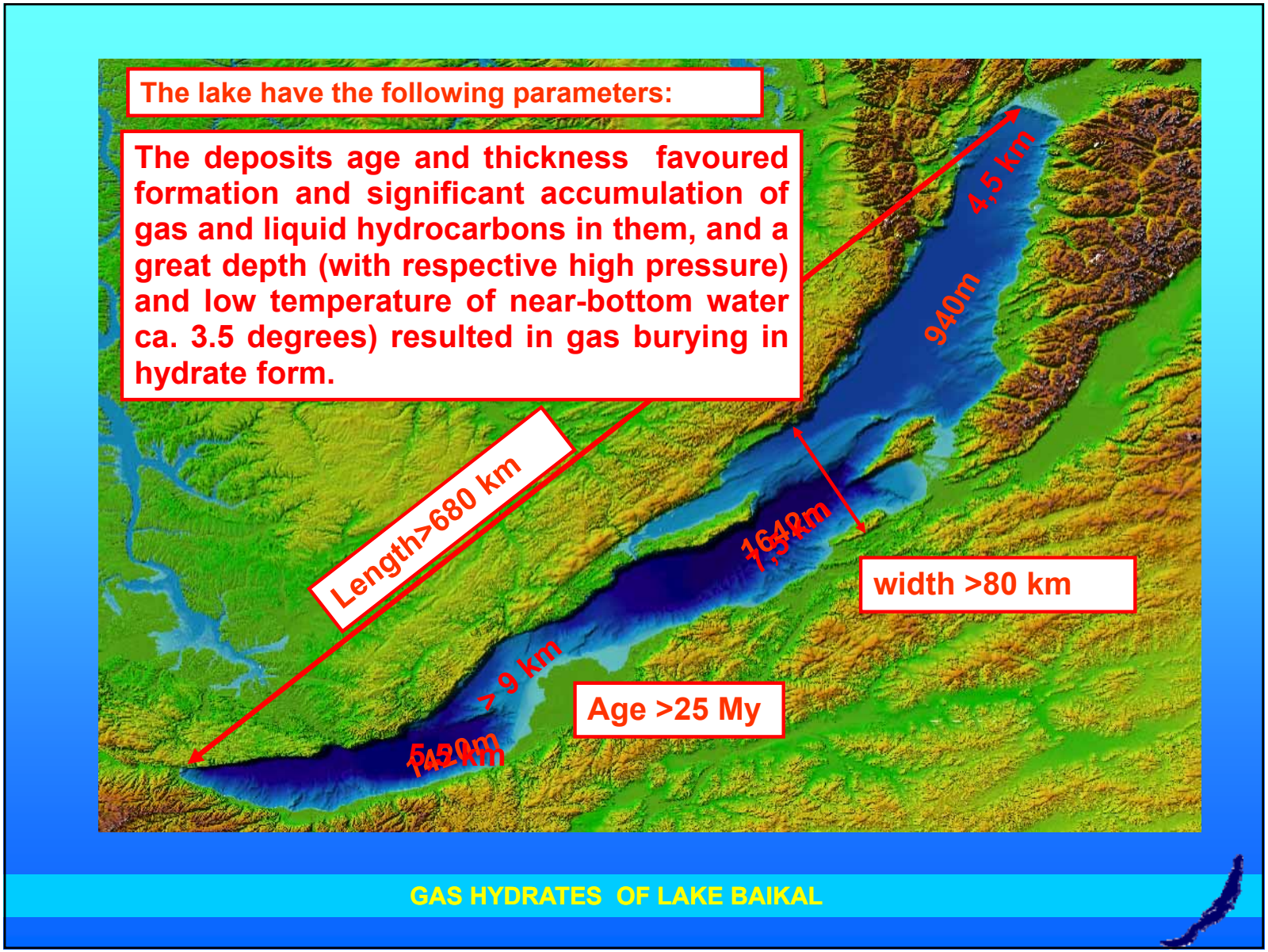
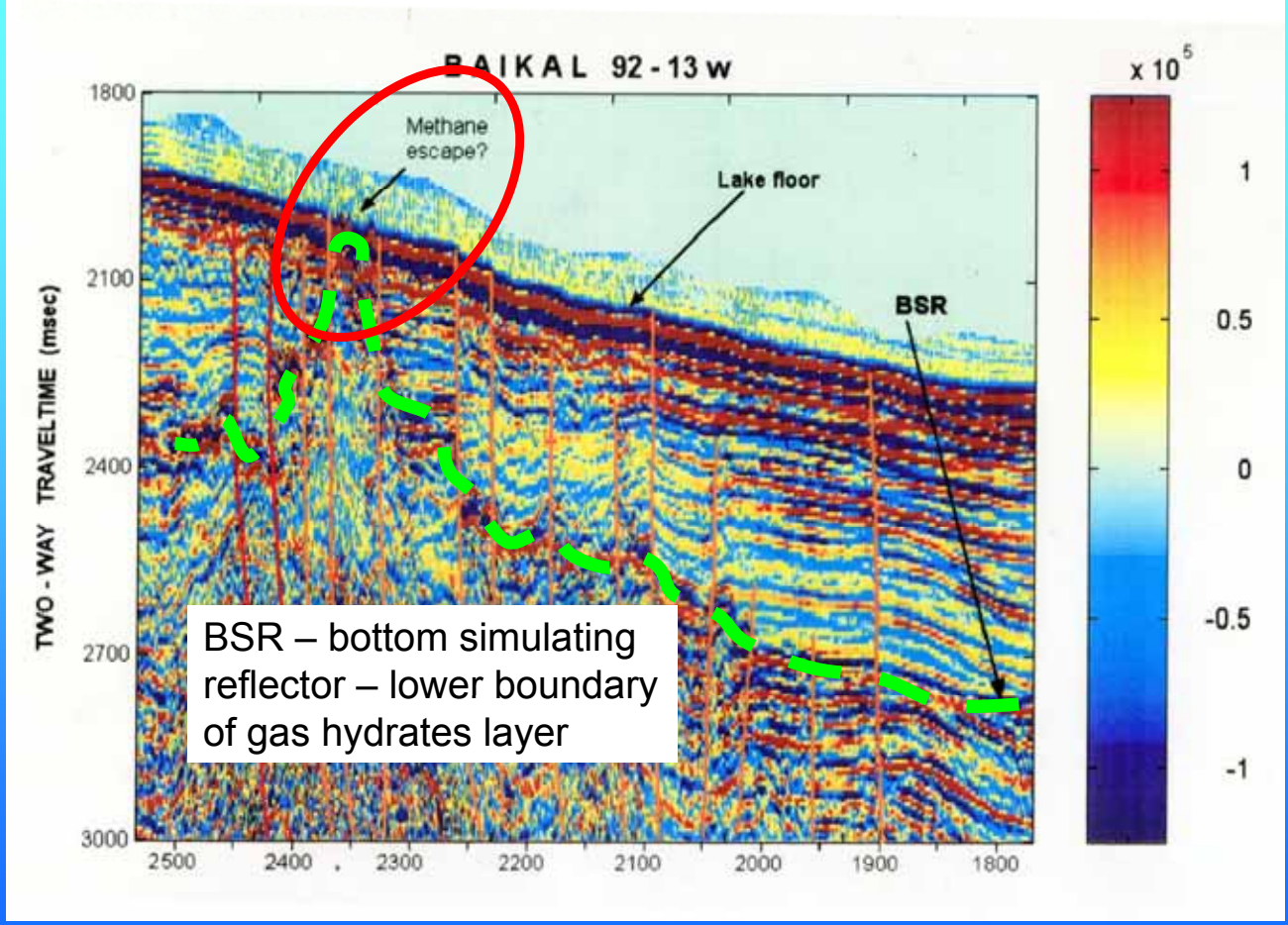
GAS HYDRATES OF LAKE BAIKAL


The lake have the following parameters:
The deposits age and thickness favoured formation and significant accumulation of gas and liquid hydrocarbons in them, and a great depth (with respective high pressure) and low temperature of near-bottom water ca. 3.5 degrees) resulted in gas burying in hydrate form.
4,5 km
940m
Length>680 km
1642m
width >80 km
> 9 km
Age >25 My
GAS HYDRATES OF LAKE BAIKAL

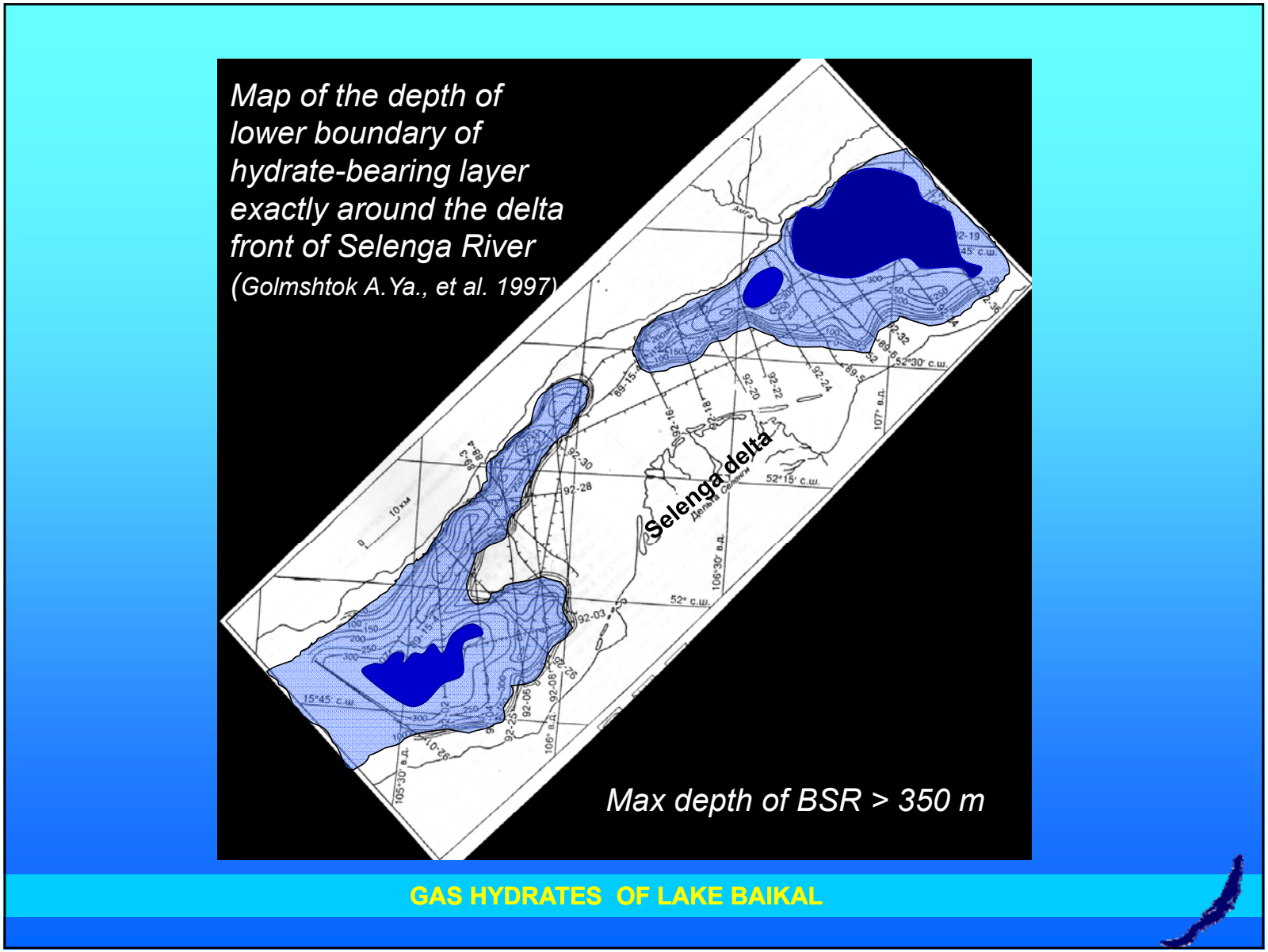

*Efremova A.G., et al. 1980*

**GAS HYDRATES OF LAKE BAIKAL**

Multi-channel seismic survey 1992 *MC92_01 [ch.10]*

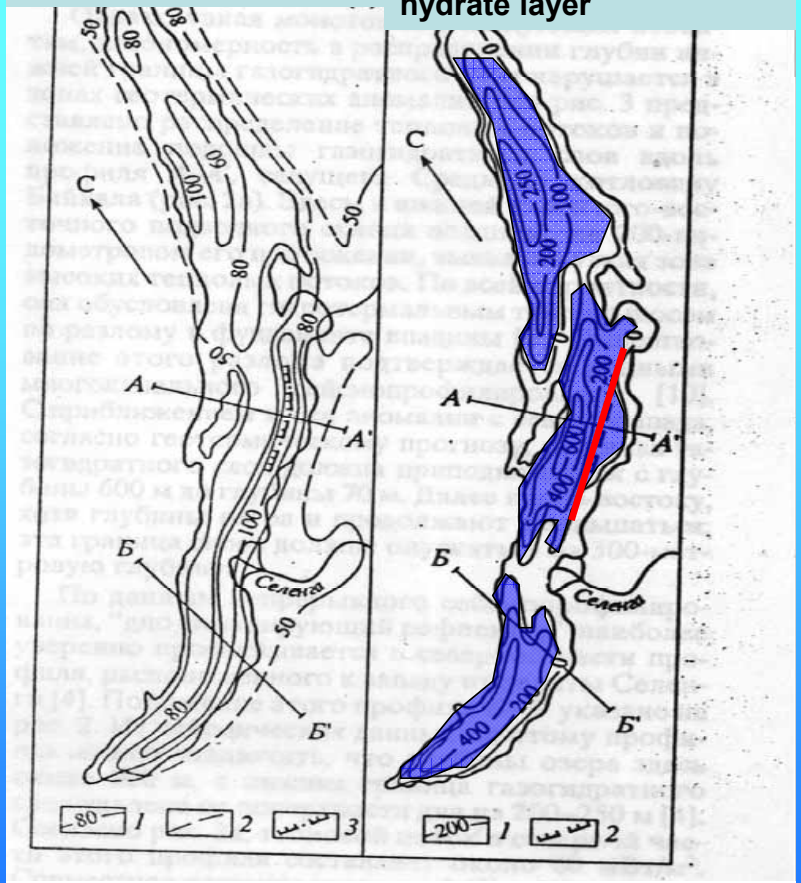



GAS HYDRATES OF LAKE BAIKAL


Map of the depth of lower boundary of hydrate-bearing layer exactly around the delta front of Selenga River
(Golmshtok A.Ya., et al. 1997)
Selenga delta
Max depth of BSR > 350 m
GAS HYDRATES OF LAKE BAIKAL

**Heat flow map**

**Map of thickness gas hydrate layer**



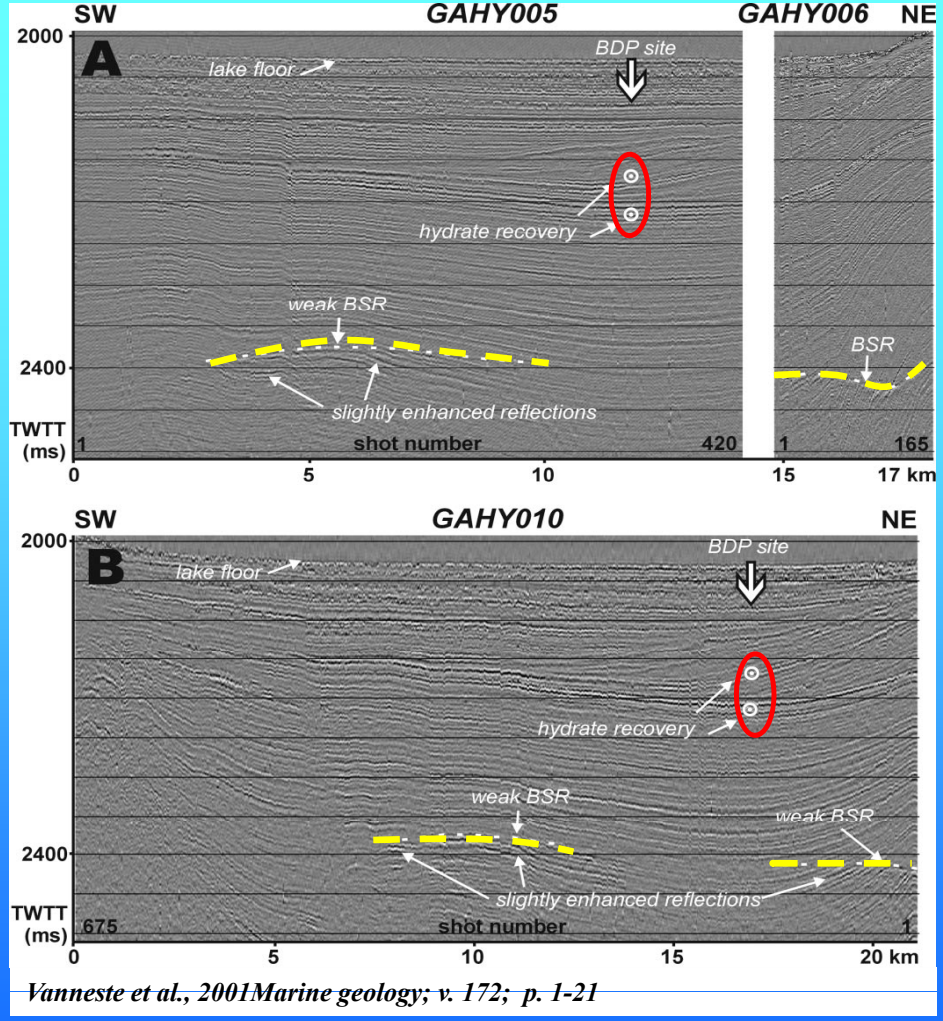

*Golubev V.A. Doklady RAN, 1997,*

*v. 352, No 5, p. 652 – 665.*

## GAS HYDRATES OF LAKE BAIKAL

BDP-97, first samples of depths gas hydrate

**GAS HYDRATES OF LAKE BAIKAL**




*Vanneste et al., 2001Marine geology; v. 172; p. 1-21*

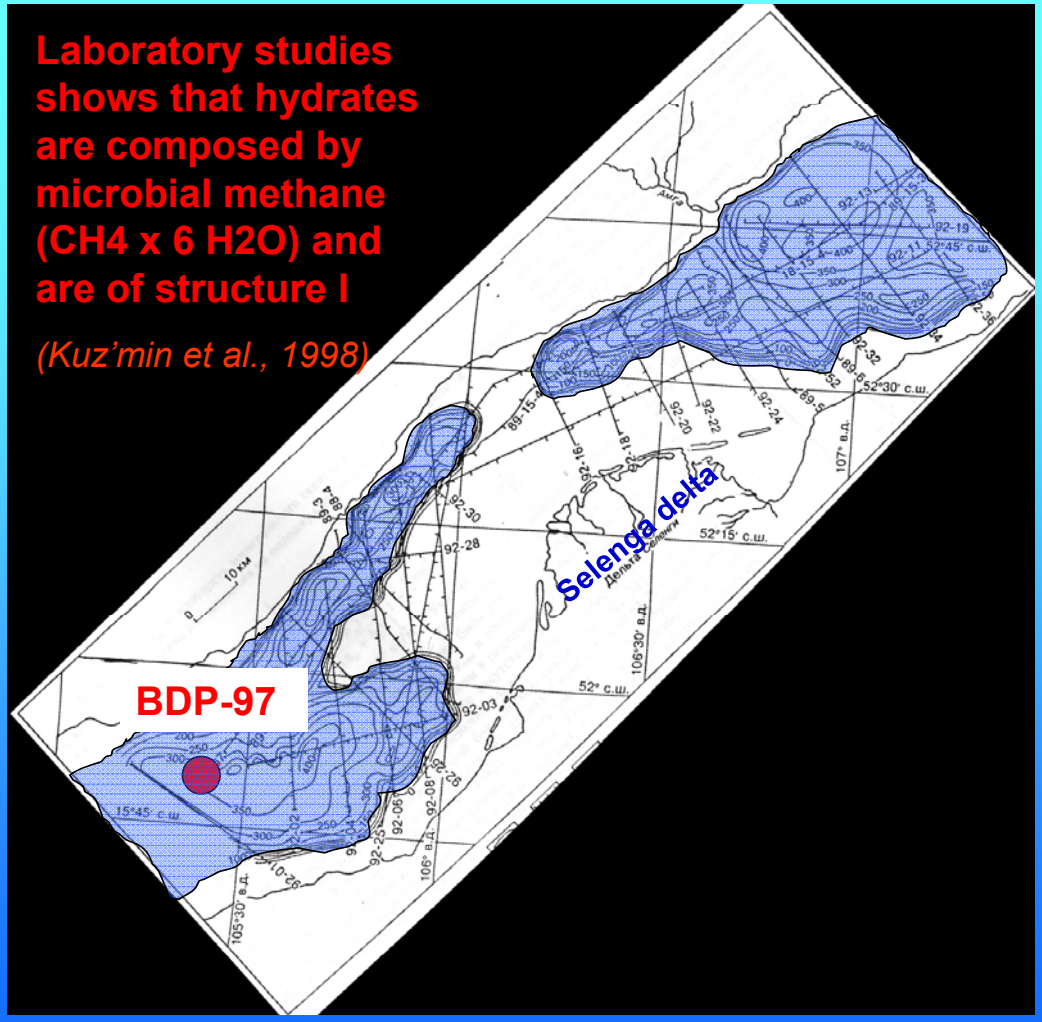
**Water depth drilling point – 1420 m**

**A gas hydrate in the form of frozen sand and silt layers was discovered at the depth of 121m and 161 m in the sediment core.**

**GAS HYDRATES OF LAKE BAIKAL**

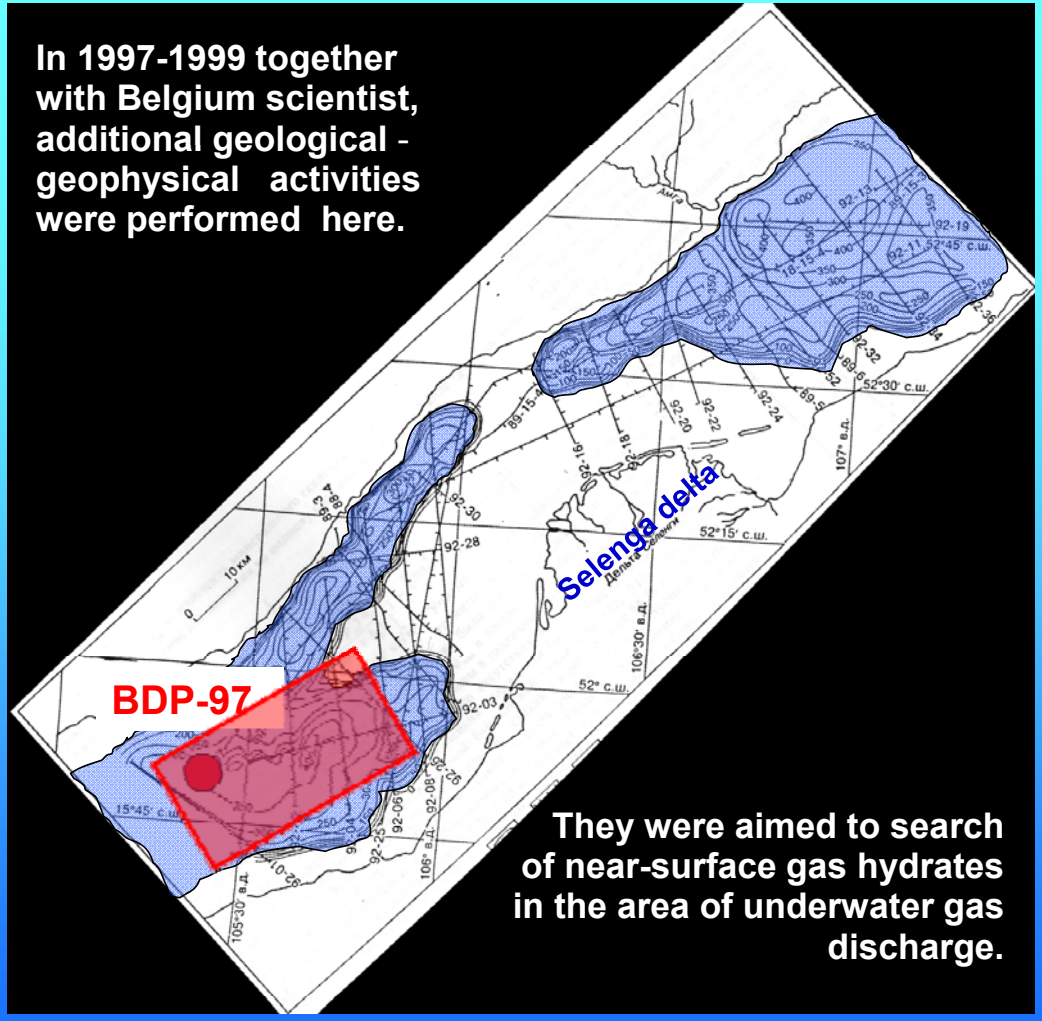
**Laboratory studies shows that hydrates are composed by microbial methane ($CH_4 \times 6 H_2O$) and are of structure I**

*(Kuz'min et al., 1998)*




**GAS HYDRATES OF LAKE BAIKAL**

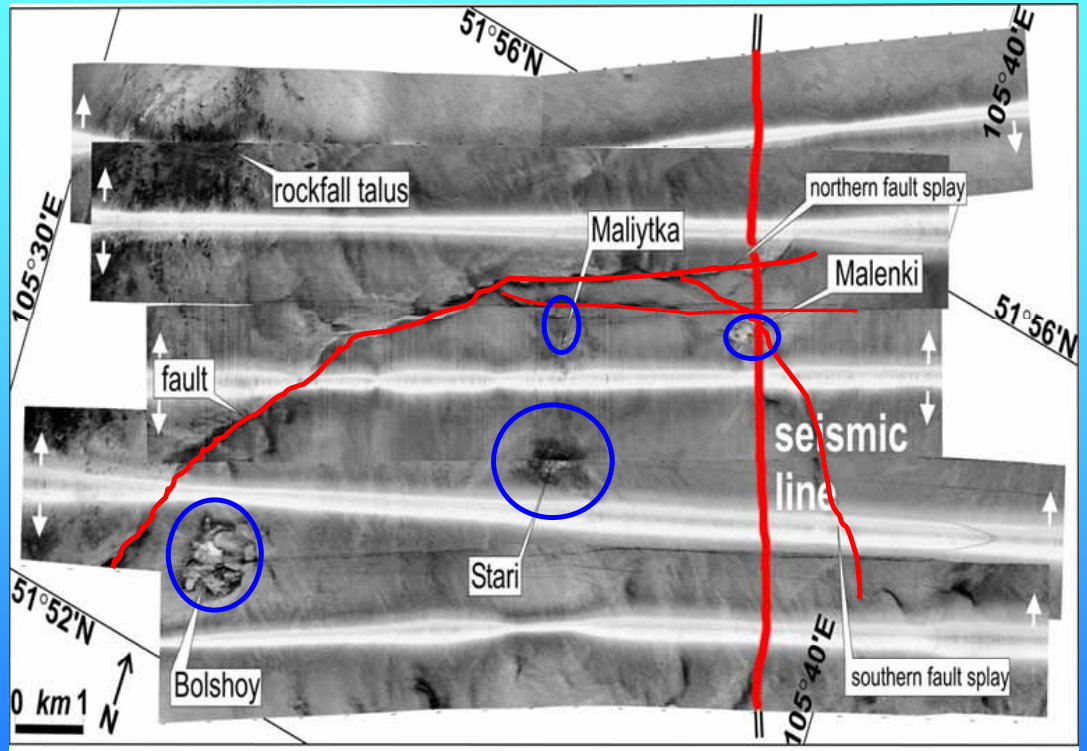
In 1997-1999 together with Belgium scientist, additional geological - geophysical activities were performed here.




They were aimed to search of near-surface gas hydrates in the area of underwater gas discharge.

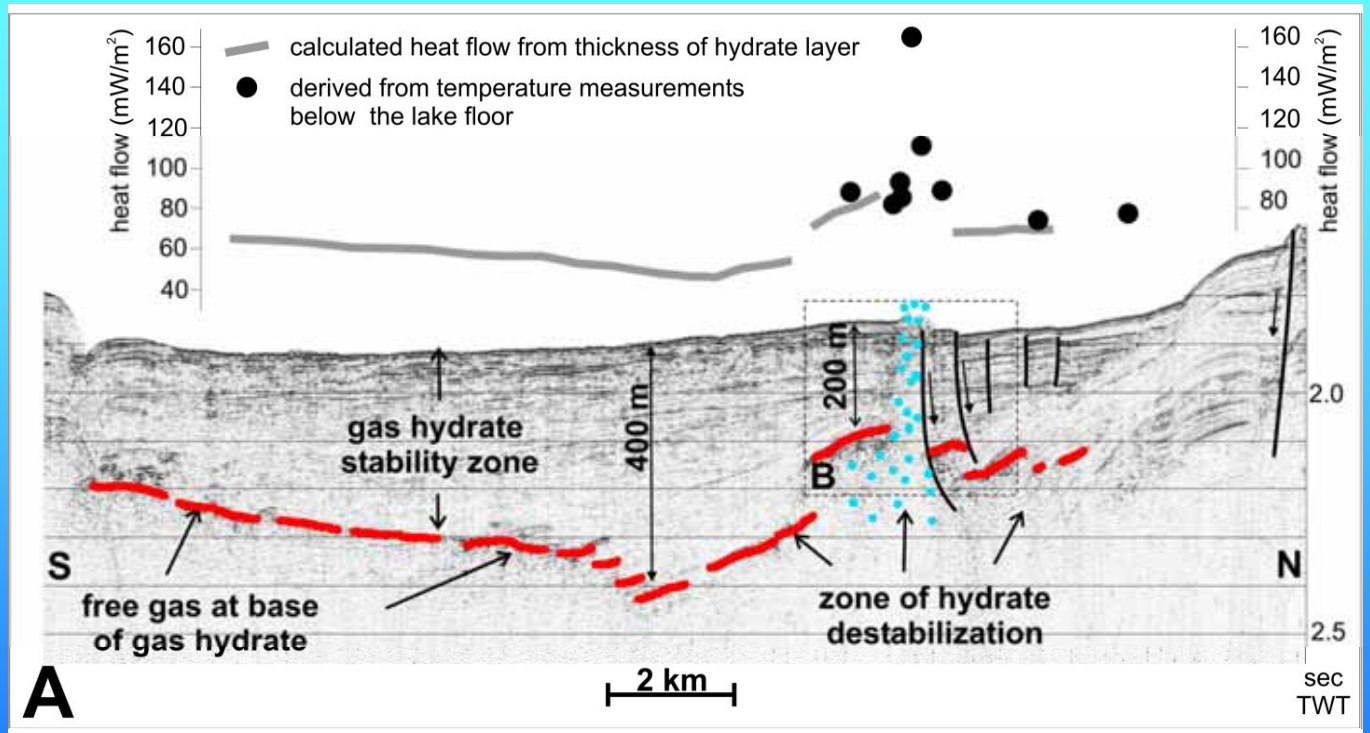
GAS HYDRATES OF LAKE BAIKAL

## *Side-scan sonar mosaic*




P. Van Rensbergen* et. al. 2002 Geology; v. 30; no. 7; p. 631-634;

**GAS HYDRATES OF LAKE BAIKAL**

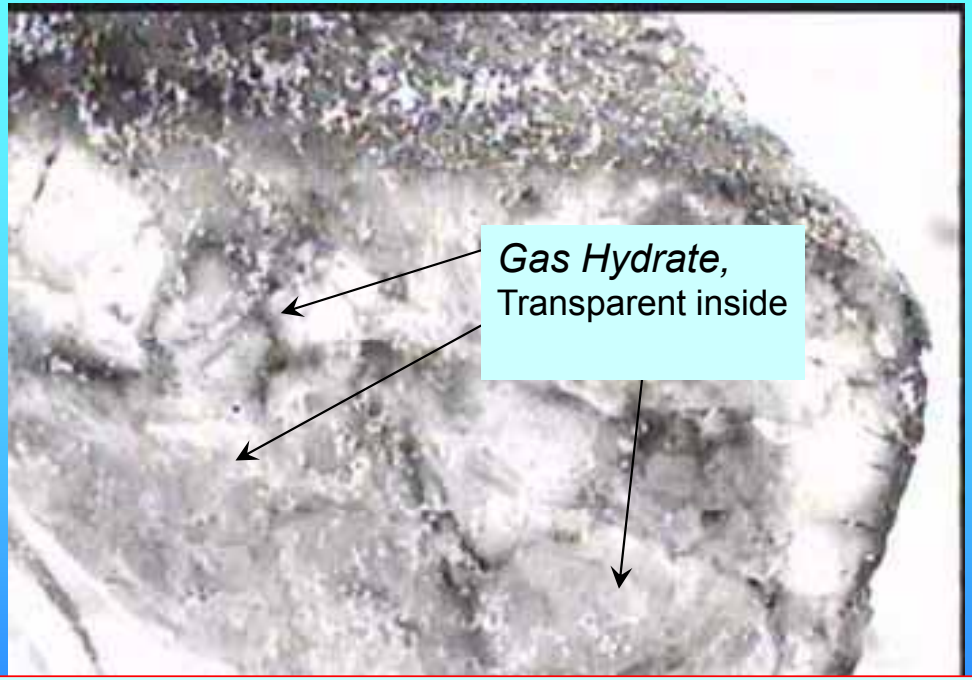



P. Van Rensbergen* et. al. 2002 Geology; v. 30; no. 7; p. 631-634;

GAS HYDRATES OF LAKE BAIKAL

***Gas hydrates samples in march 2000***

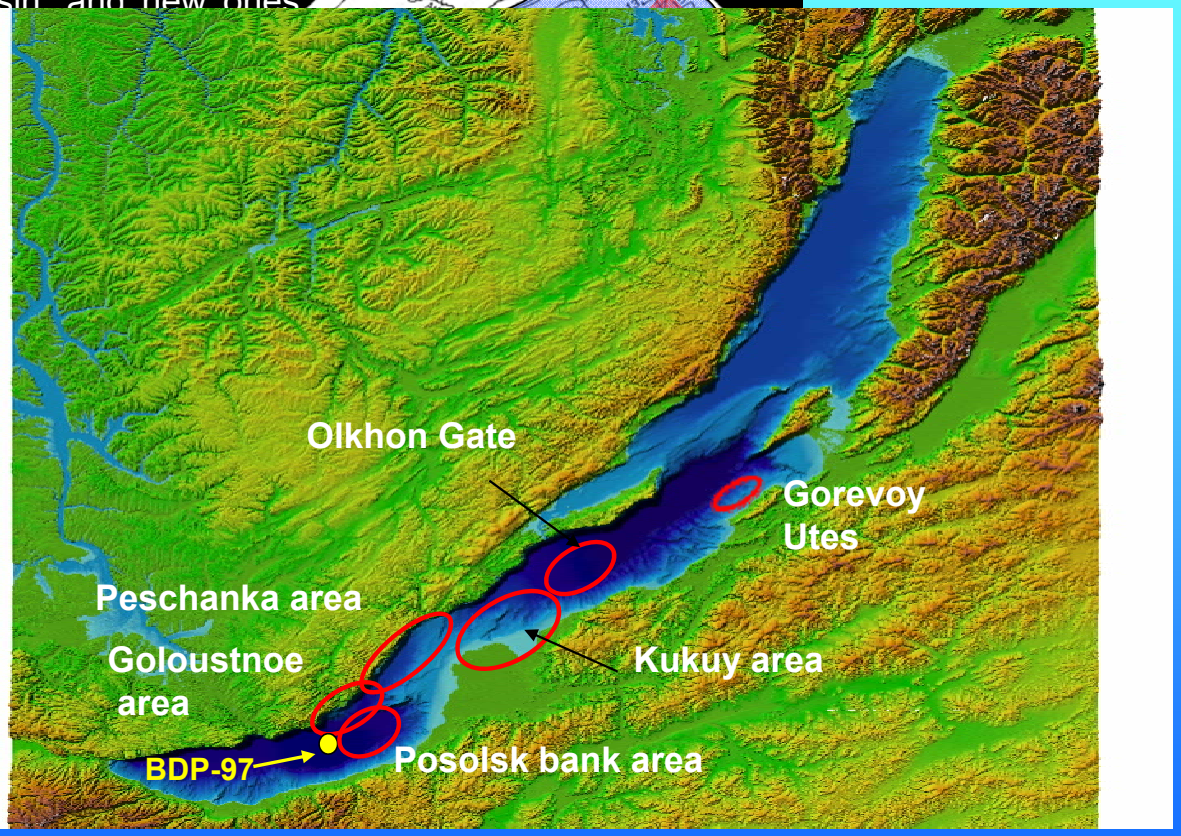
***Water depth 1280 m, under bottom depth 40 cm***




**This gas hydrate was found out for the first time in the near-bottom sediments of Lake Baikal.**
**Laboratory studies shows that hydrates from Malenkiy are composed by methane and has the structure I**

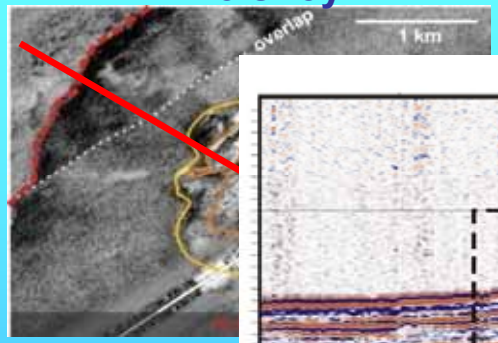
**GAS HYDRATES OF LAKE BAIKAL**

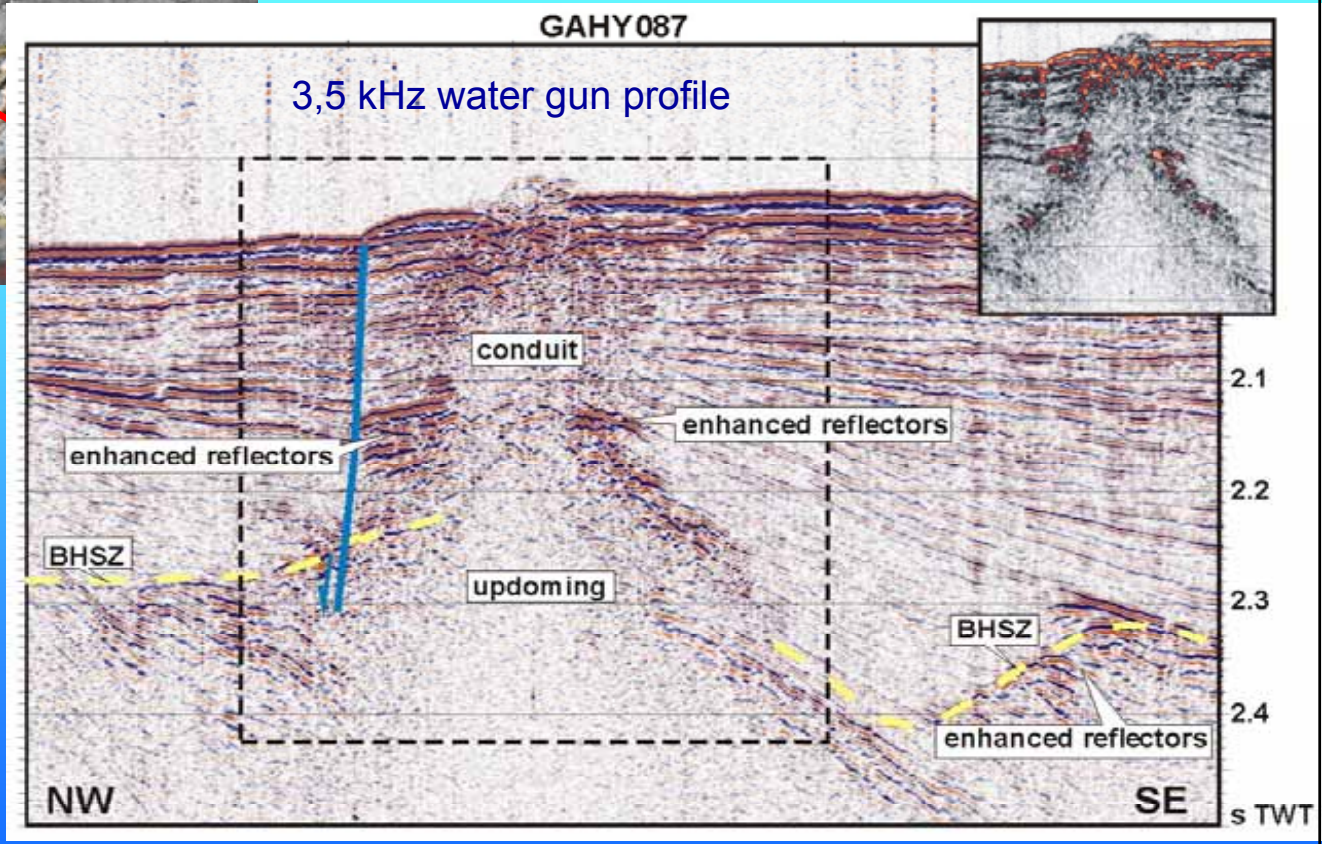
In 2002-2008 together with Belgium, Indian and Japanese scientist additional geophysical works were performed in the Southern basin and new ones — in t




GAS HYDRATES OF LAKE BAIKAL

***Side-scan sonar mosaic***
**«Bolshoy»**

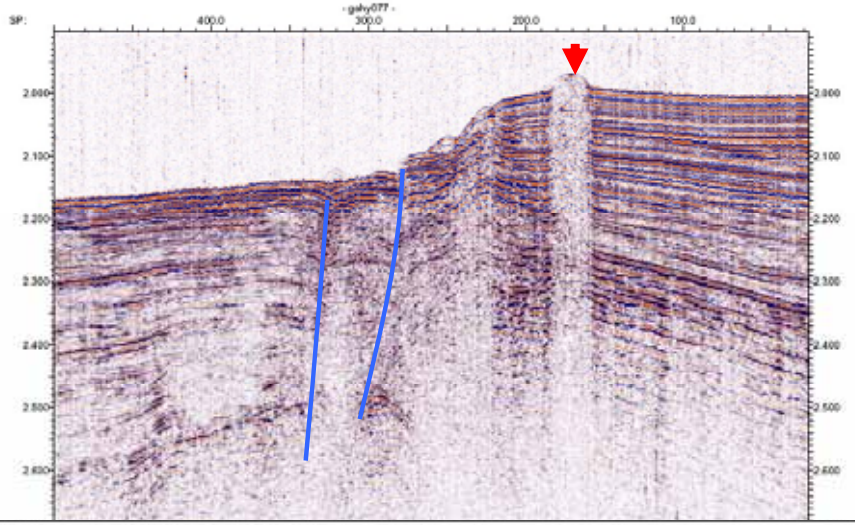


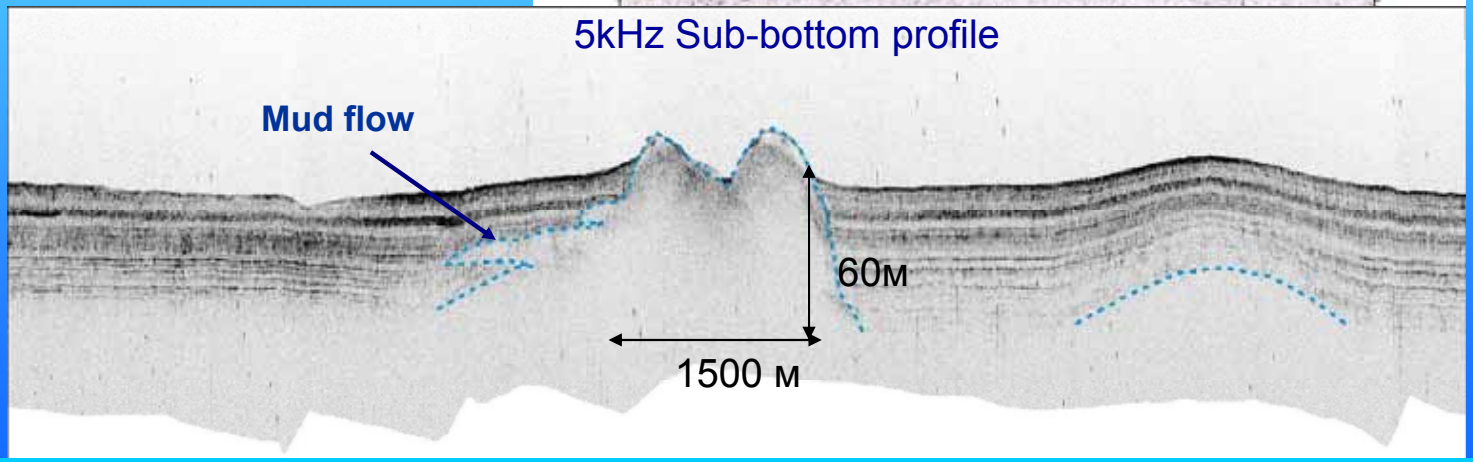

**GAS HYDRATES OF LAKE BAIKAL**

***Side-scan sonar mosaic***
**«Novosibirsk»**

3,5 kHz water gun profile

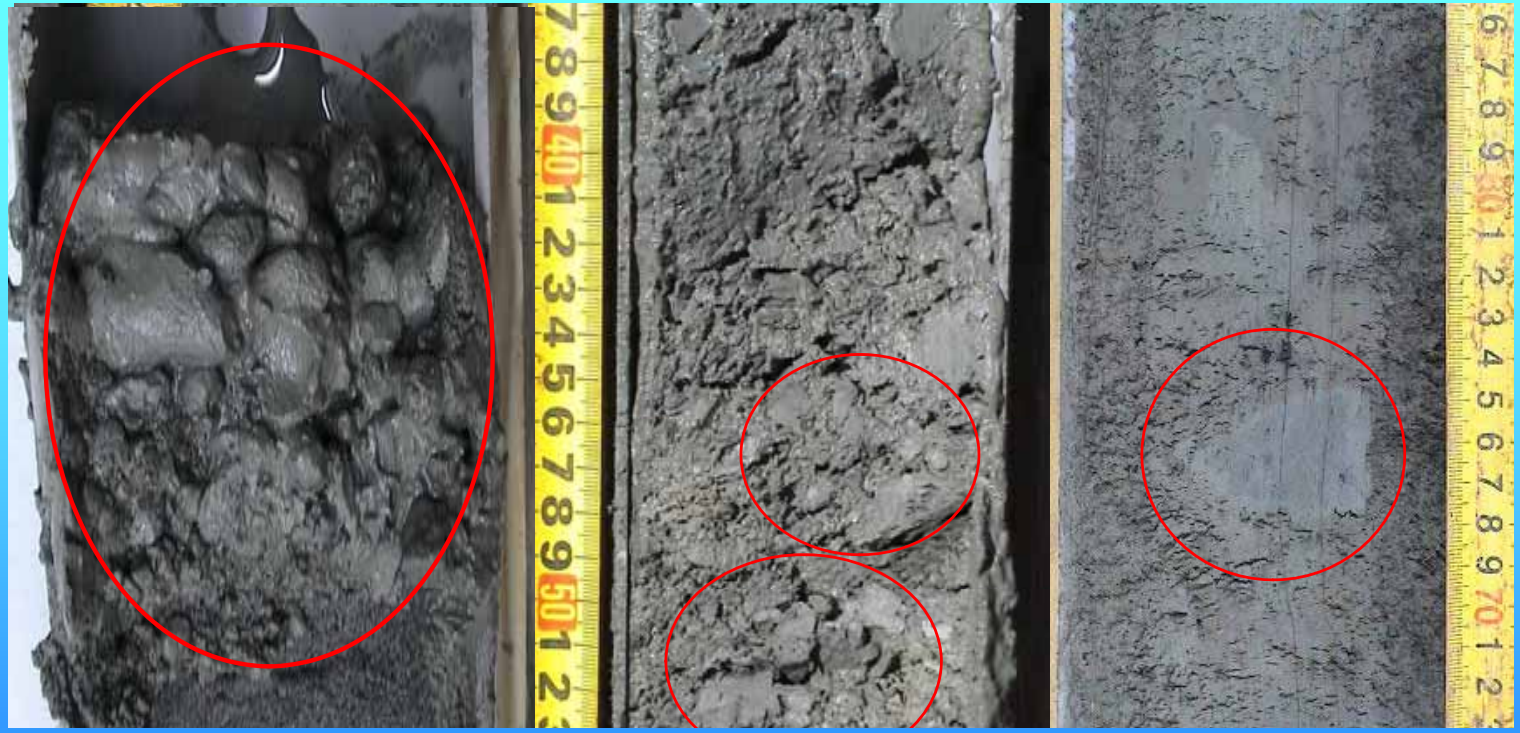


5kHz Sub-bottom profile



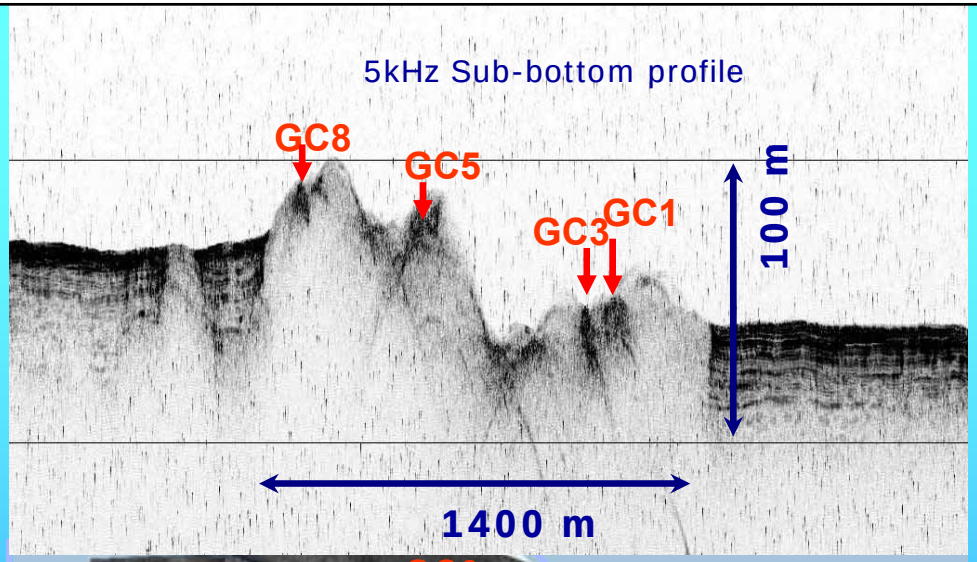

**GAS HYDRATES OF LAKE BAIKAL**

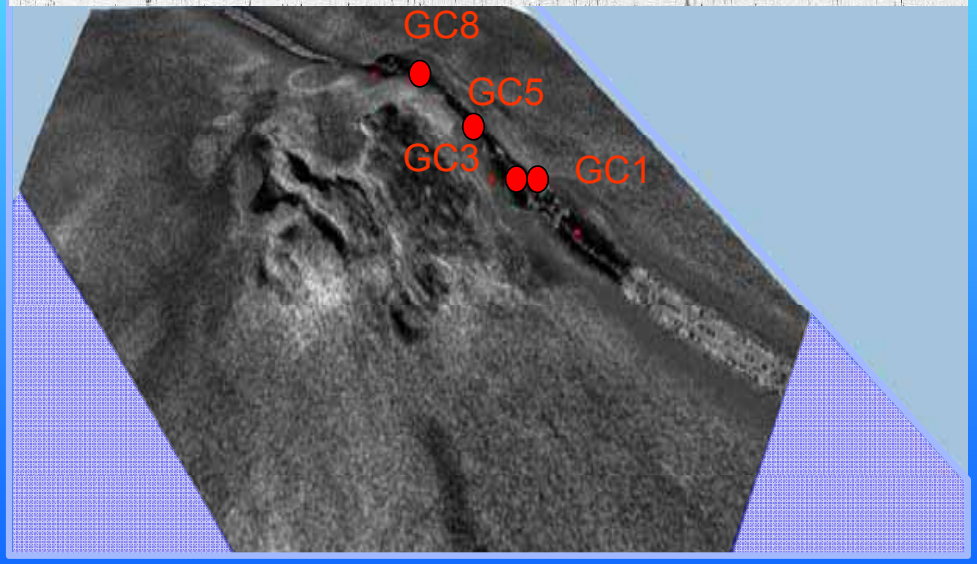
## mud volcanic breccia



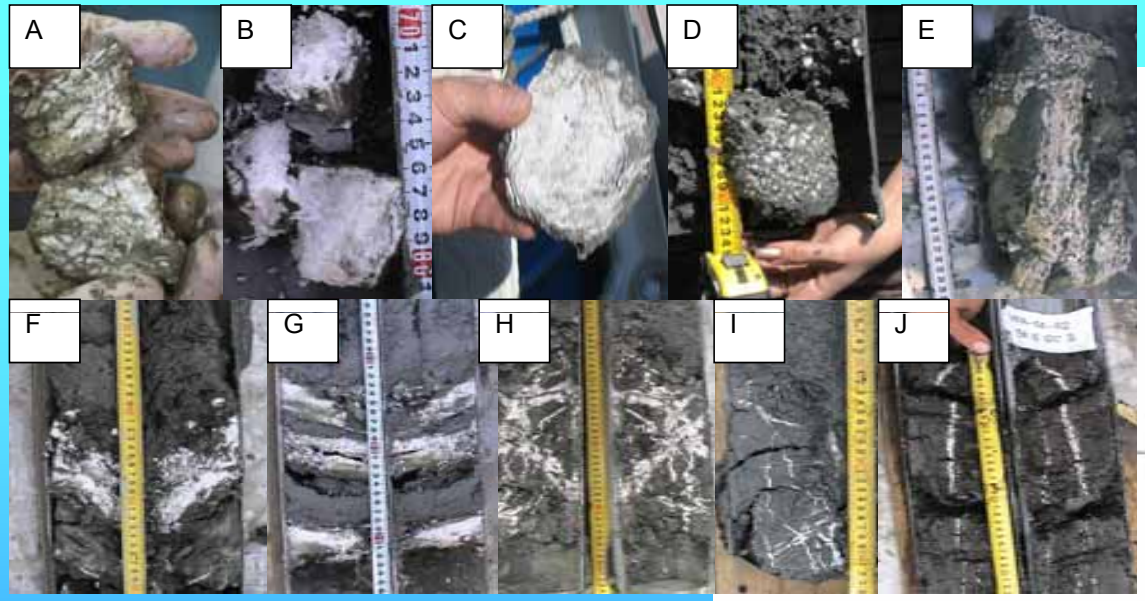
Its presence in the surface sediment instead of diatom ooz and argillaceous strata interchange typical for the Lake became a main geological prospecting indicator of gas hydrates occurrence whereas the structures themselves were ascribed to be mud volcanoes.

GAS HYDRATES OF LAKE BAIKAL

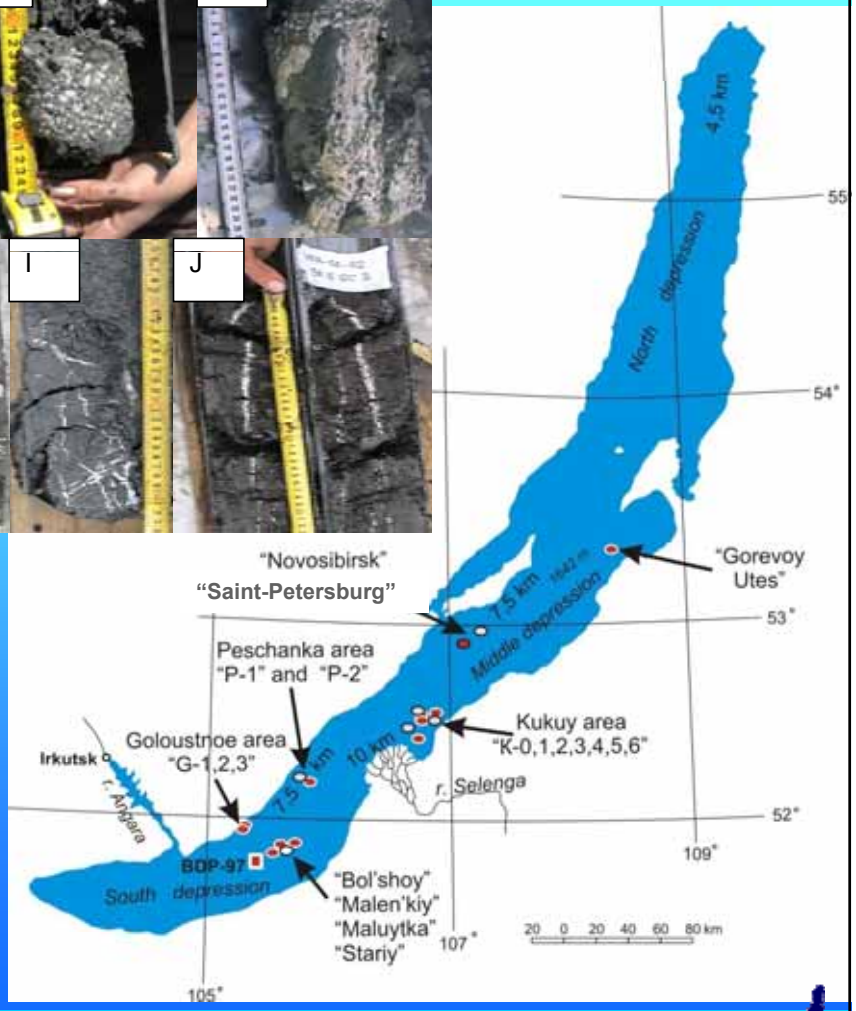



As well geophysical prospecting indicators characterized by **dark points on the background of transparent record**. Hydrates have been selected only there where 5 kHz sub-bottom profile has same reflectors

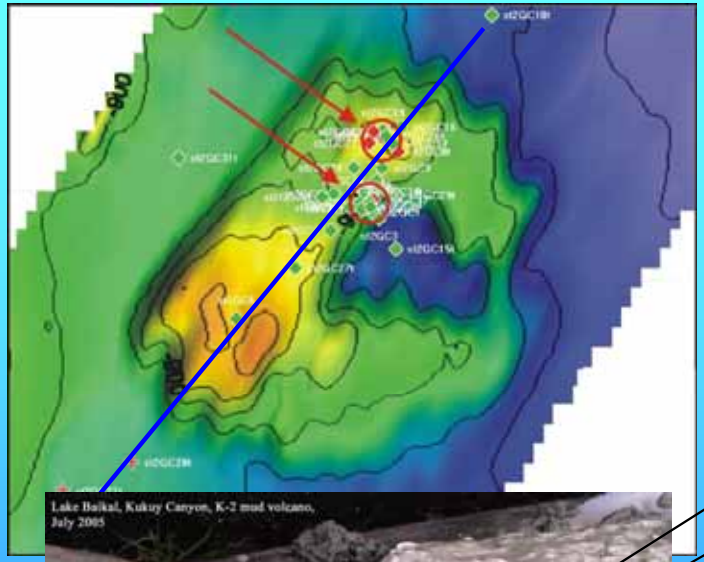


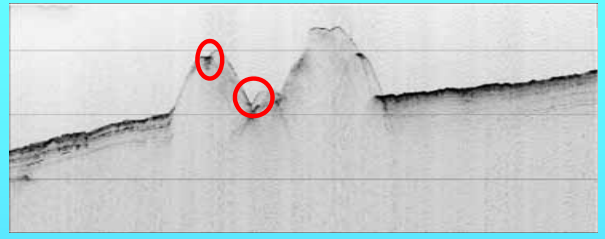

**14 mud volcanoes and a few cold seeps are found and investigated, practically from every one samples of gas hydrate are obtained.**




**GAS HYDRATES OF LAKE BAIKAL**

## Mud volcano K-2





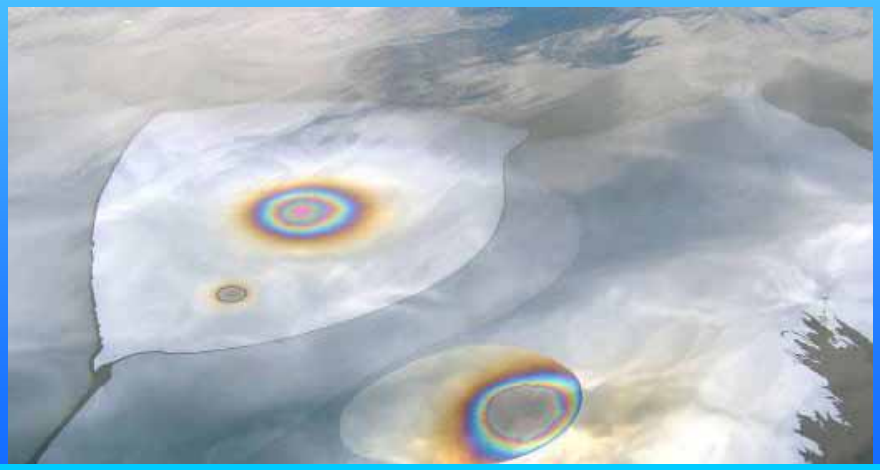

**In the same core: hydrate deposits of two different structures**

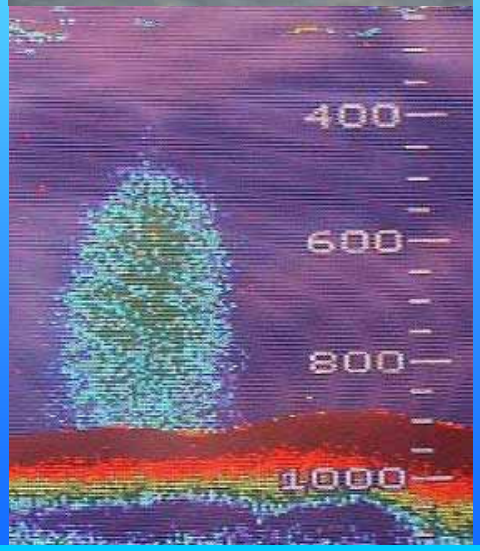
1. Structure I: ethane < 4%
2. Structure II: ethane = 13,8 %, CH4/C2H6= 5,7

(Kalmichkov et al., 2005, Khlystov, 2005, Kida et al., 2006)

**GAS HYDRATES OF LAKE BAIKAL**

## Oil seep and gas hydrate






GAS HYDRATES OF LAKE BAIKAL

# Samples of gas hydrates with oil

GAS HYDRATES OF LAKE BAIKAL

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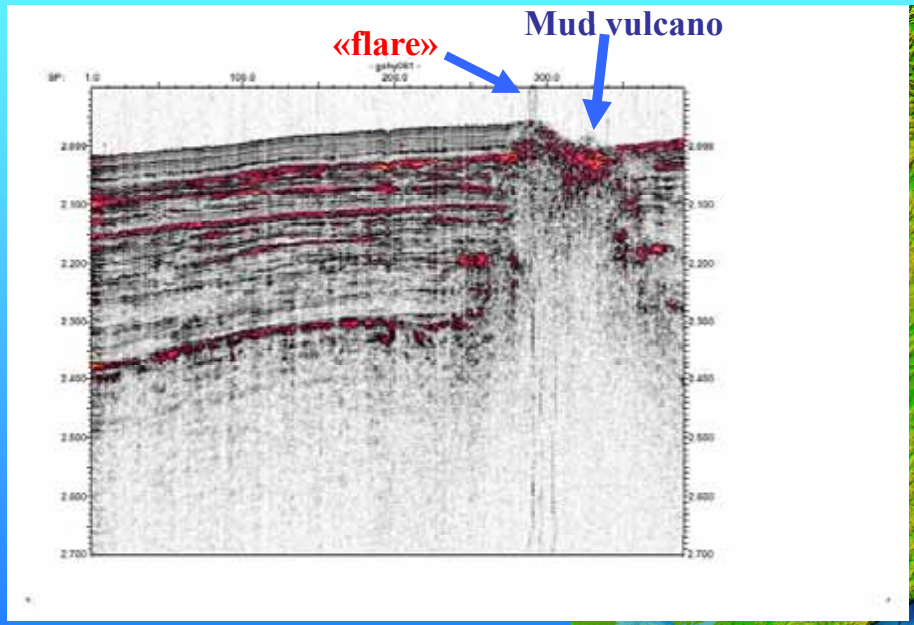
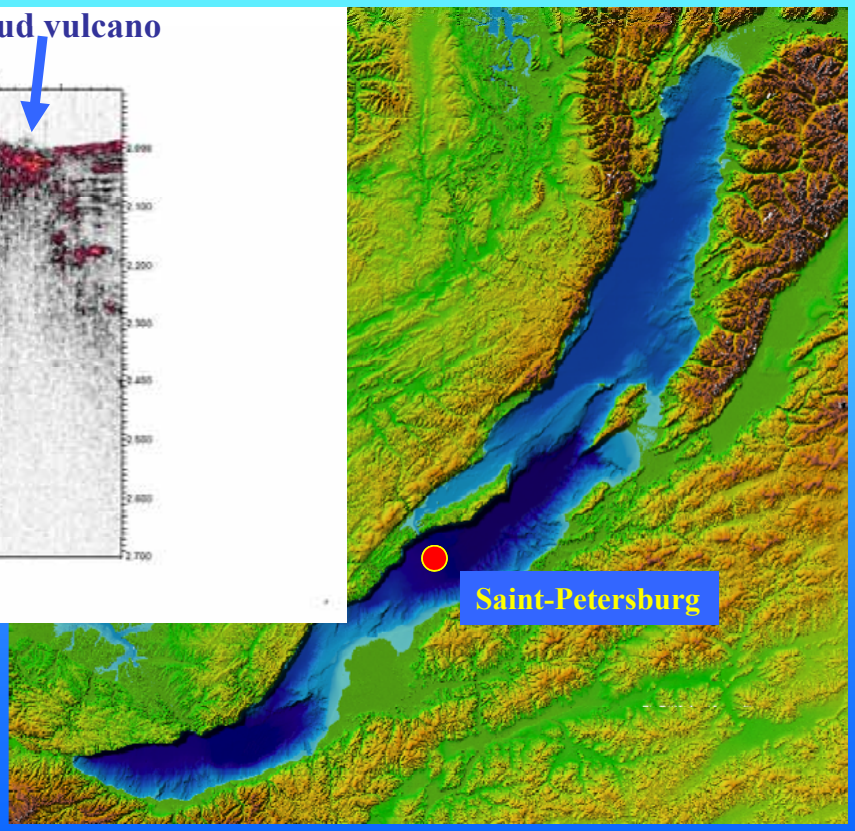
**In 2009 with submersible «MIR», near the «flare» «Saint-Petersburg» we found a gas hydrates accumulation in a slope part of an underwater hill.**



**Using the «MIR», we could investigate one gas hydrate outcrops on bottom surface, to take samples and to do video survey of its destruction while lifting.**

**It is found out that hydrates are more transparent on the bottom than we saw them on the surface after sampling.**




Photo from DMA «MIR»

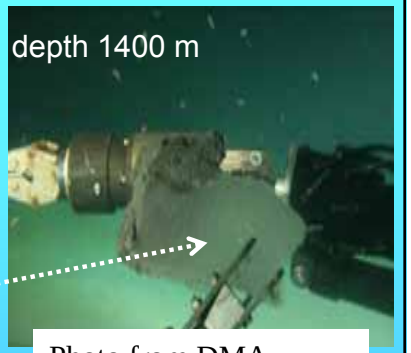
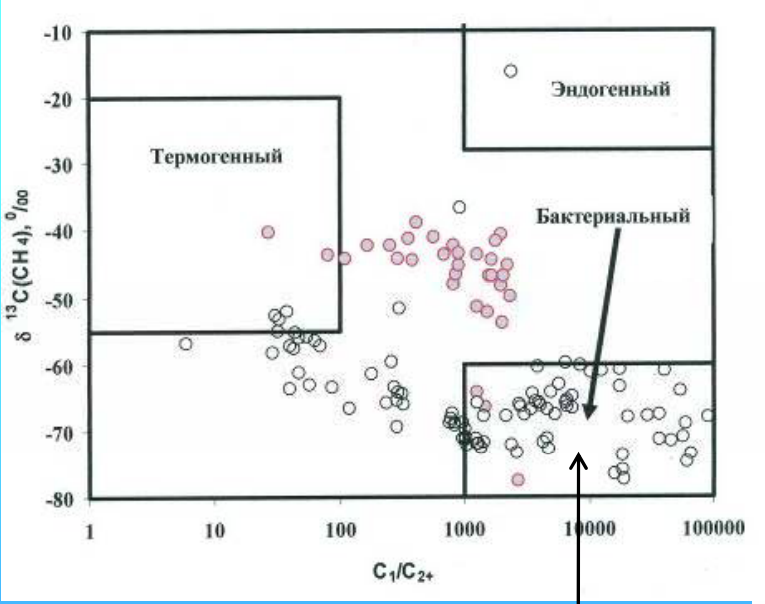



Photo from DMA «MIR»

The same sample on lake surface

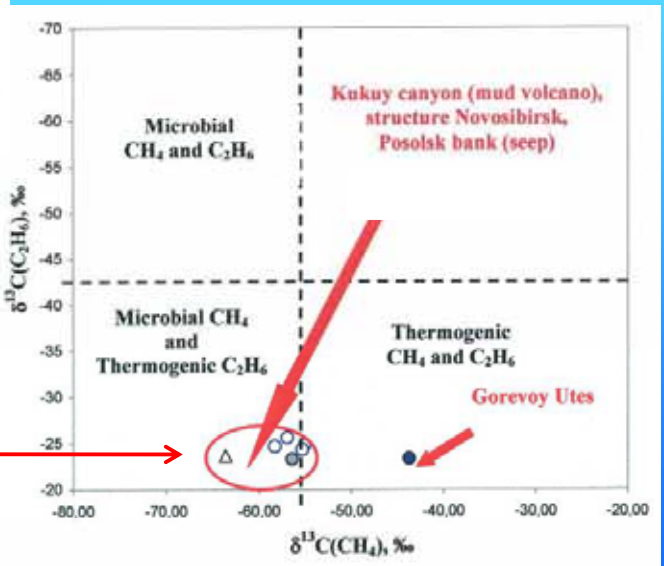
**GAS HYDRATES OF LAKE BAIKAL**




**Gas from gas hydrates and sediment of oil and gas ingress (Gorevoy Utes) has a quite thermogenic origin**

**Gas from hydrates of the** Posolsk Bank area **consists of only microbial methane.**

**Gas from hydrates of the** Goloustnoe, Kukuy, Olkhon Gate areas **consists of thermogenic ethane mixed with local microbial methane**




GAS HYDRATES OF LAKE BAIKAL

## Conclusion

- By the moment, 4 mud volcano provinces are discovered on Lake Baikal ( 14 mud volcanoes);
- In the sediments of 7 mud volcanoes, of gas and oil ingress near-surface accumulations of gas hydrates forming different textures of hydrate-bearing sediments are found;
- Samples of simultaneous coexistence of hydrates of different cubic structures I and II are obtained ;
- Lake Baikal is an natural laboratory and polygon where it is easy and accessibly to perform integrated studies of gas hydrates in freshwater sediments. This work can be performed not only for basic research, but also for development and testing of technologies for gas exploration from near-surface accumulations of gas hydrates.

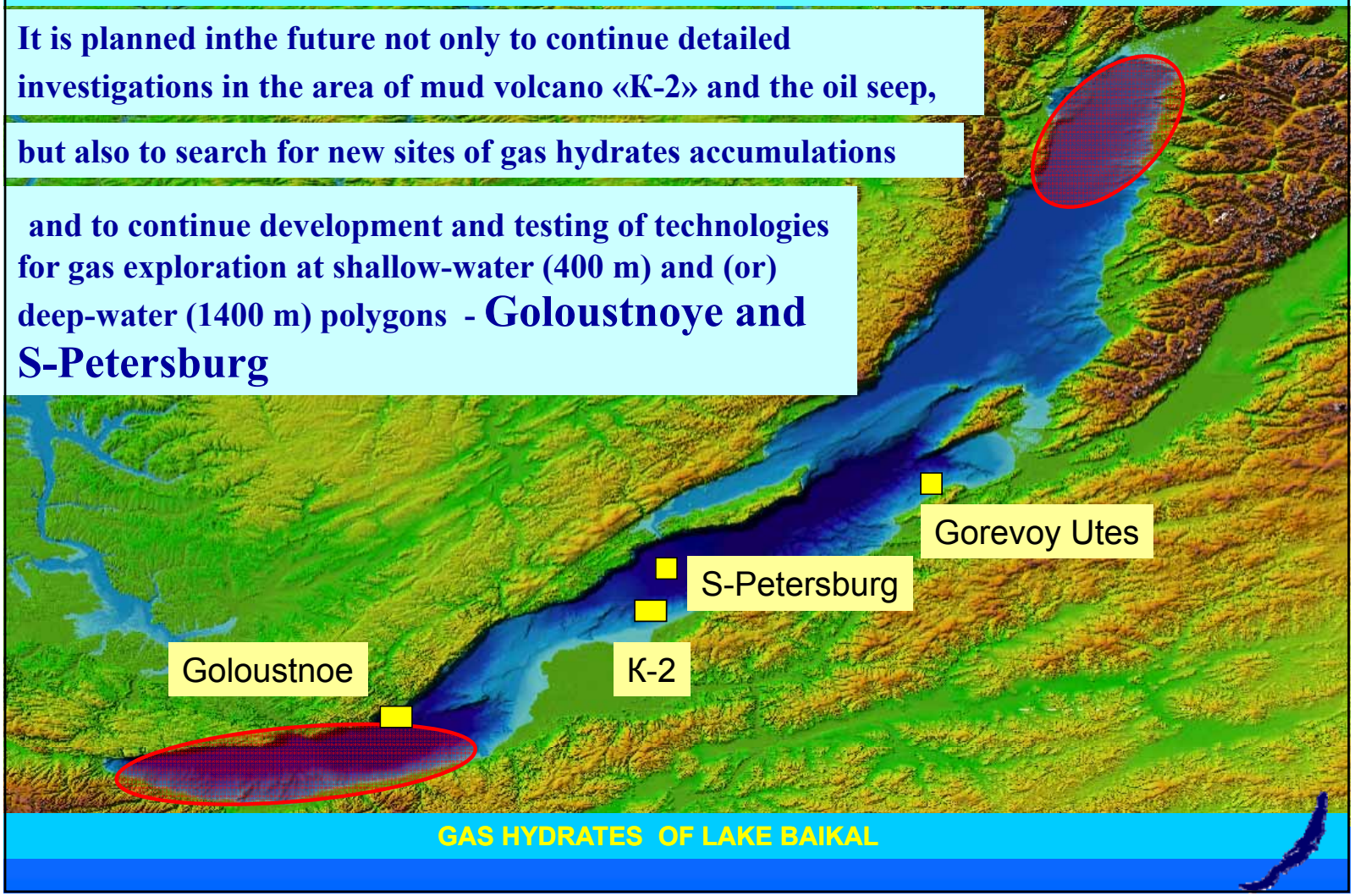
GAS HYDRATES OF LAKE BAIKAL

## Perspectives

It is planned inthe future not only to continue detailed investigations in the area of mud volcano «К-2» and the oil seep,

but also to search for new sites of gas hydrates accumulations

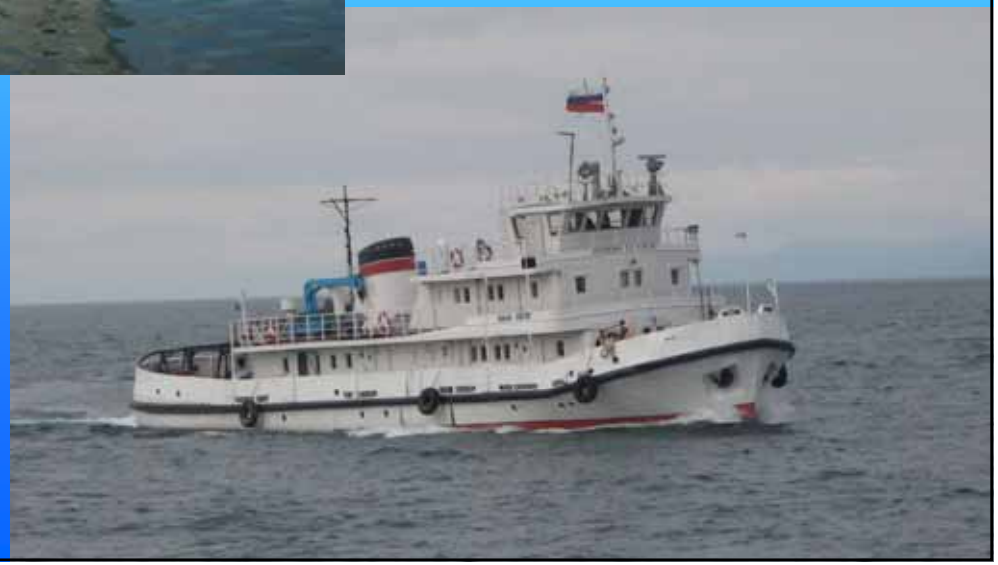
and to continue development and testing of technologies for gas exploration at shallow-water (400 m) and (or) deep-water (1400 m) polygons - **Goloustnoye and S-Petersburg**



The work was performed in open water in May-December from R/V

*R/V «Academician Koptyug»*

*R/V «G.Yu. Vereshchagin»*



As well as from ice

in February and March