# SEAFLOOR FLUXES OF METHANE AND MARINE GEOLOGICAL OPERATIONS

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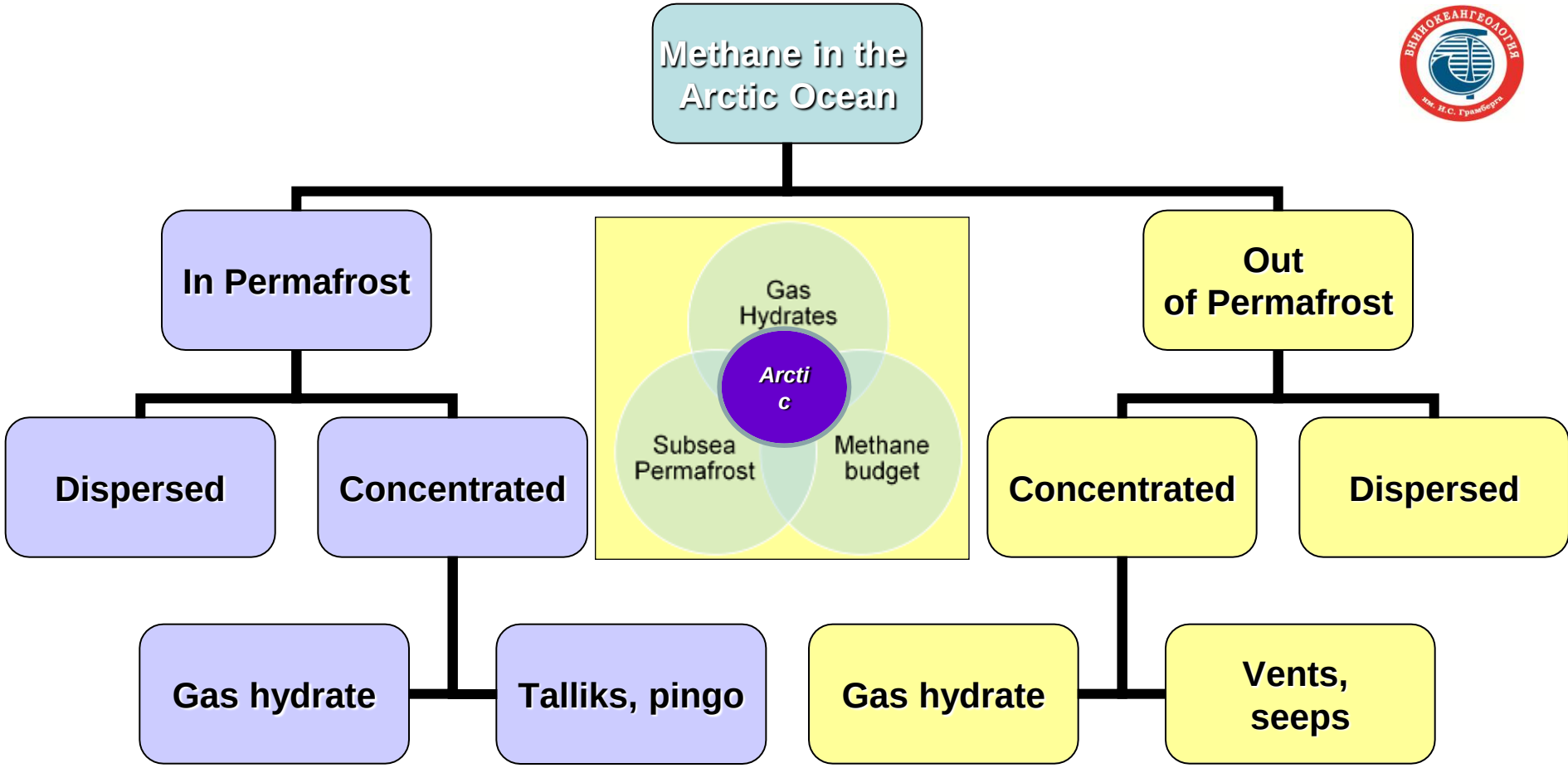
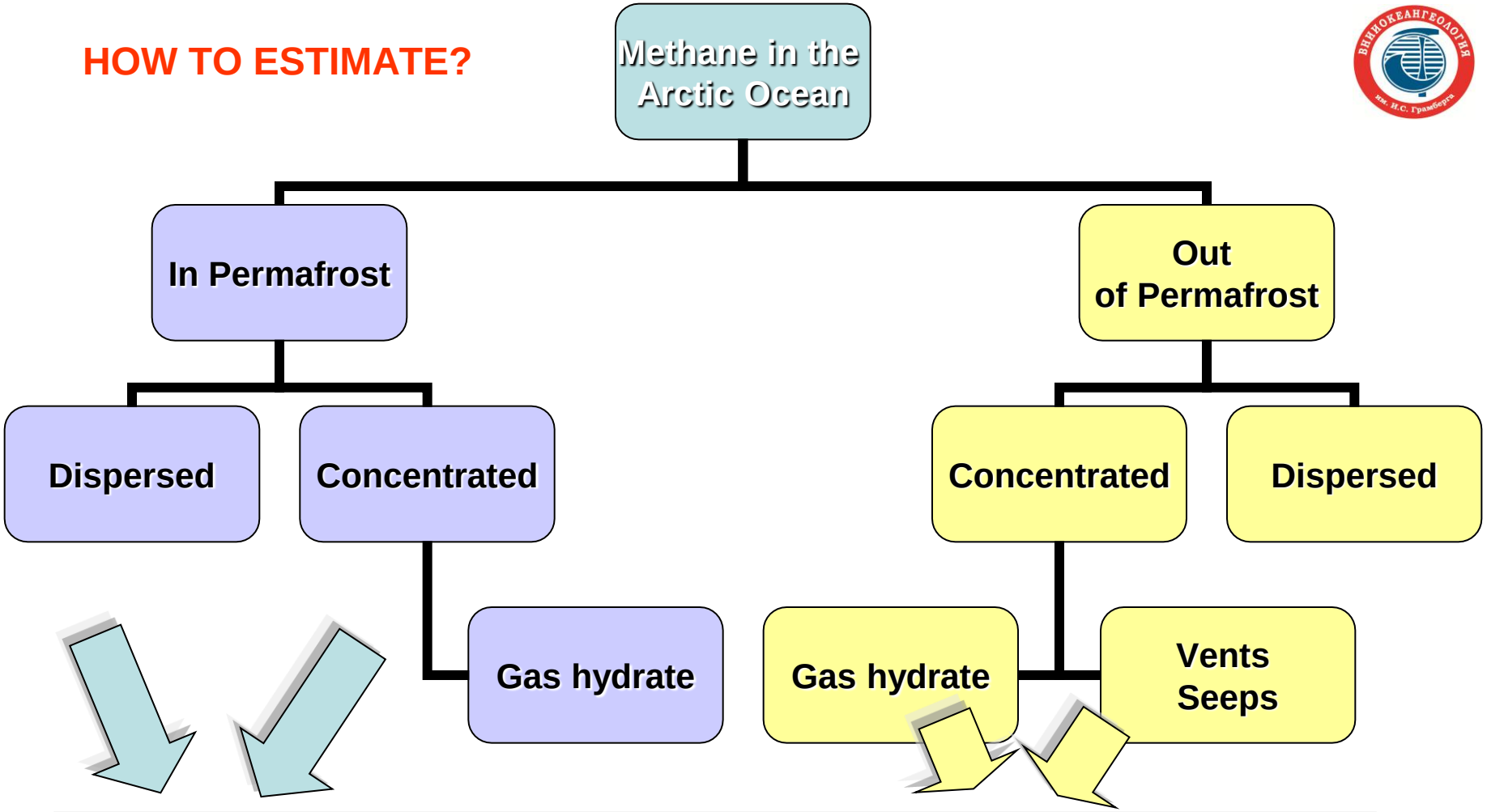



**In order to estimate possible methane input to Arctic environment we first need to know how much methane is really there?**

## HOW TO ESTIMATE?

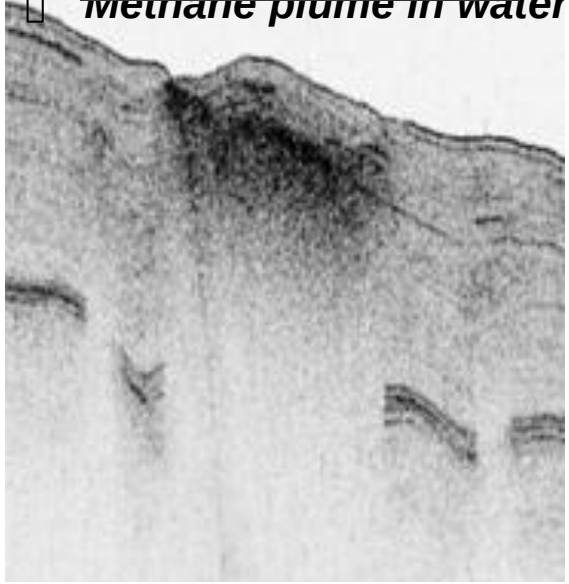



**<u>Concentrated methane[1]</u> = (average number of gas hydrate accumulations per unit area) x (average amount of methane in single accumulation)**
**<u>Concentrated methane[2]</u> (seabed flux)= (flux per area x area) or (flux per seep x number of seeps)*)**

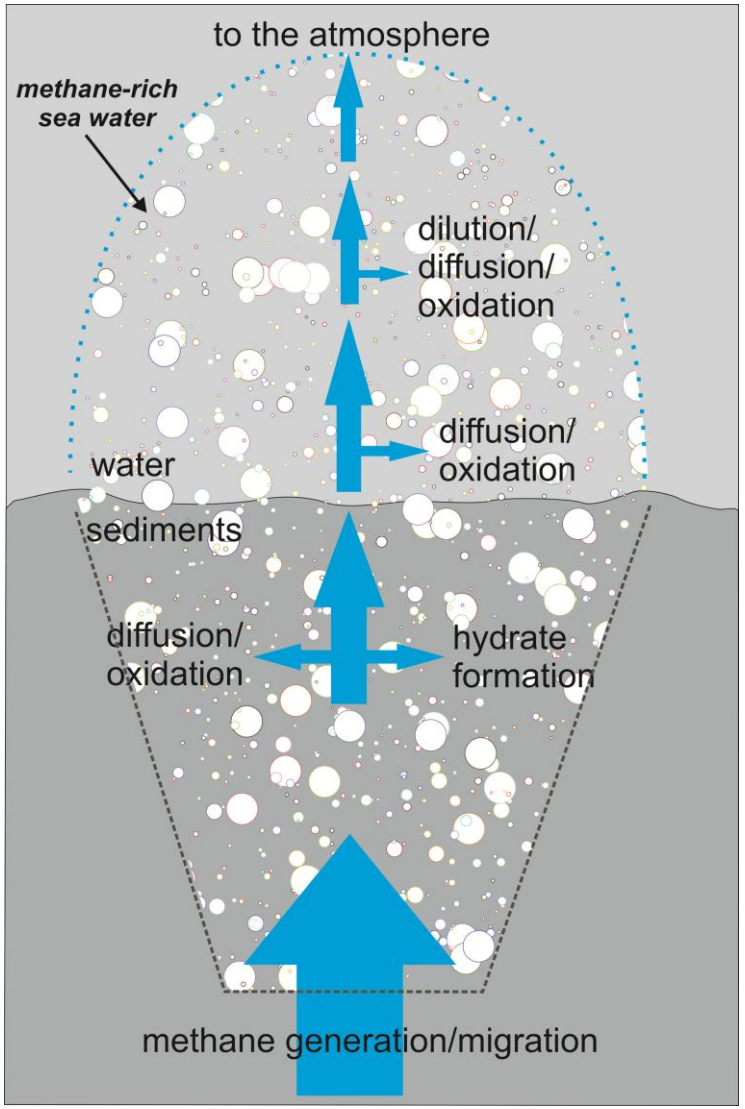
* *Requires estimation of methane consumption on diffusion, oxidation, dilution, and hydrate formation*

# METHANE SEEPAGE: WHAT DO WE HAVE TO LEARN?

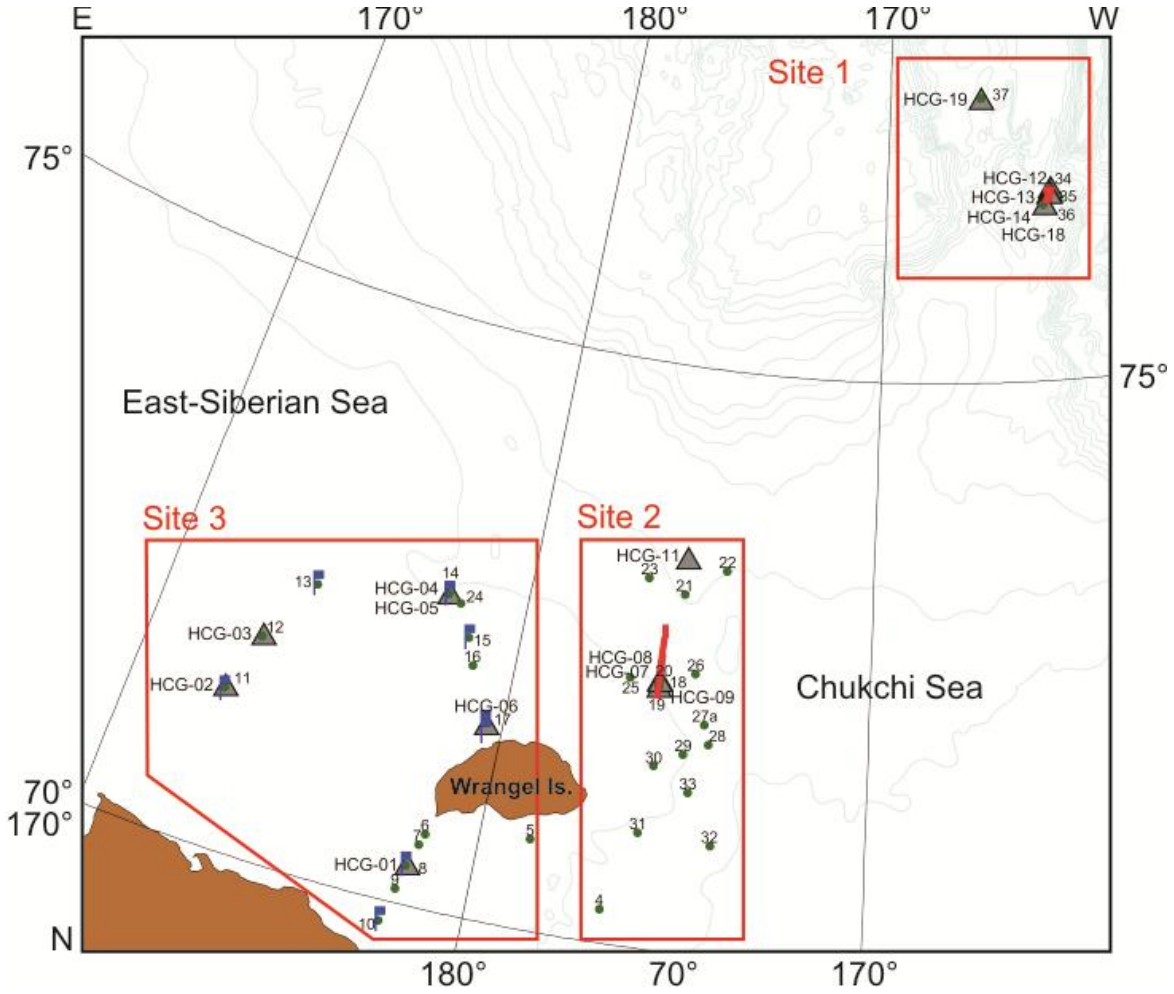
⇧ *Methane plume in water*

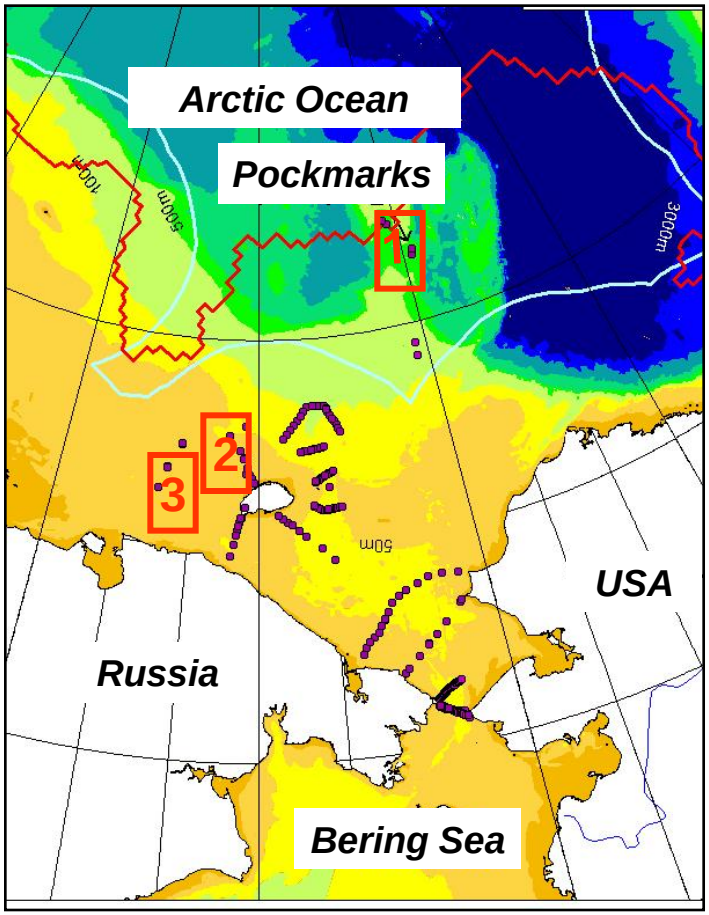


***The fate of methane at a single gas seep*** ⇨



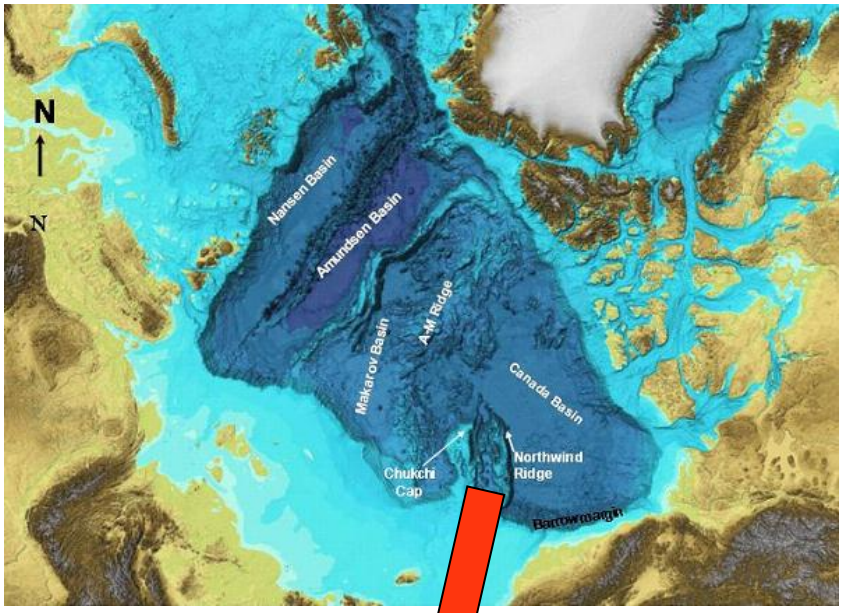
# RUSALCA-2009 GEOLOGICAL SAMPLING STATIONS

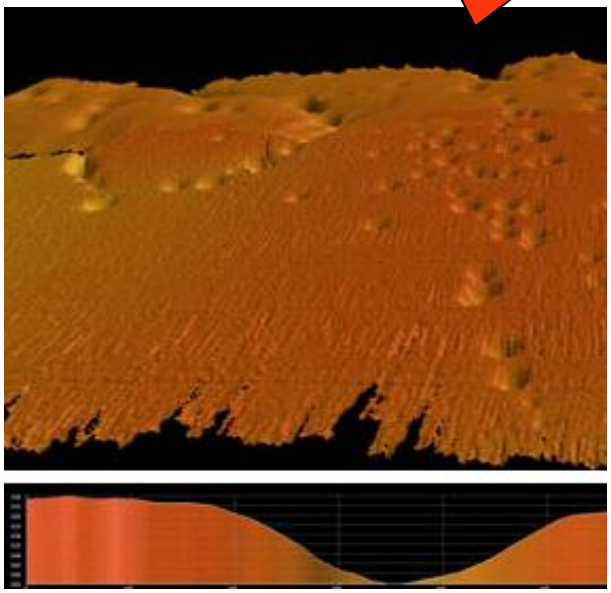


# SITE 1 Pockmarks area

**Water depth - 400-500 m**

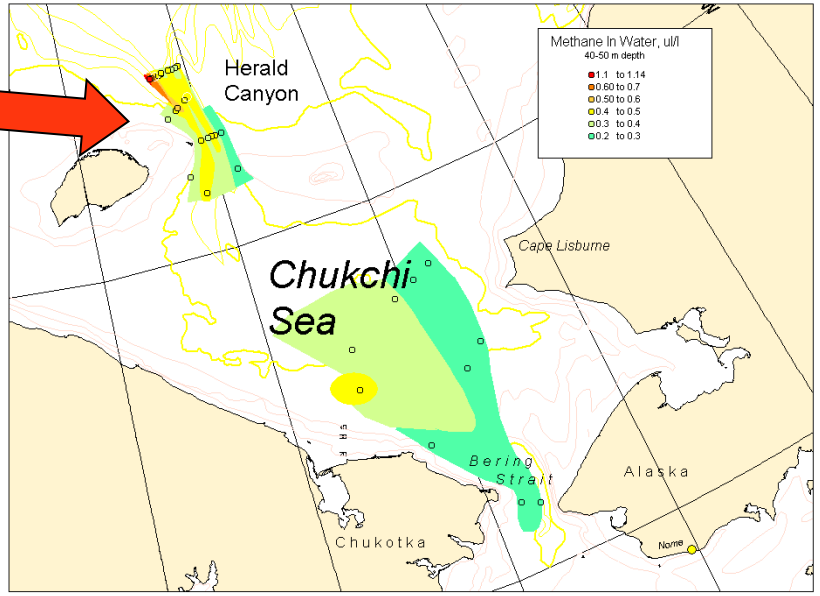


Mayer et al., 2009

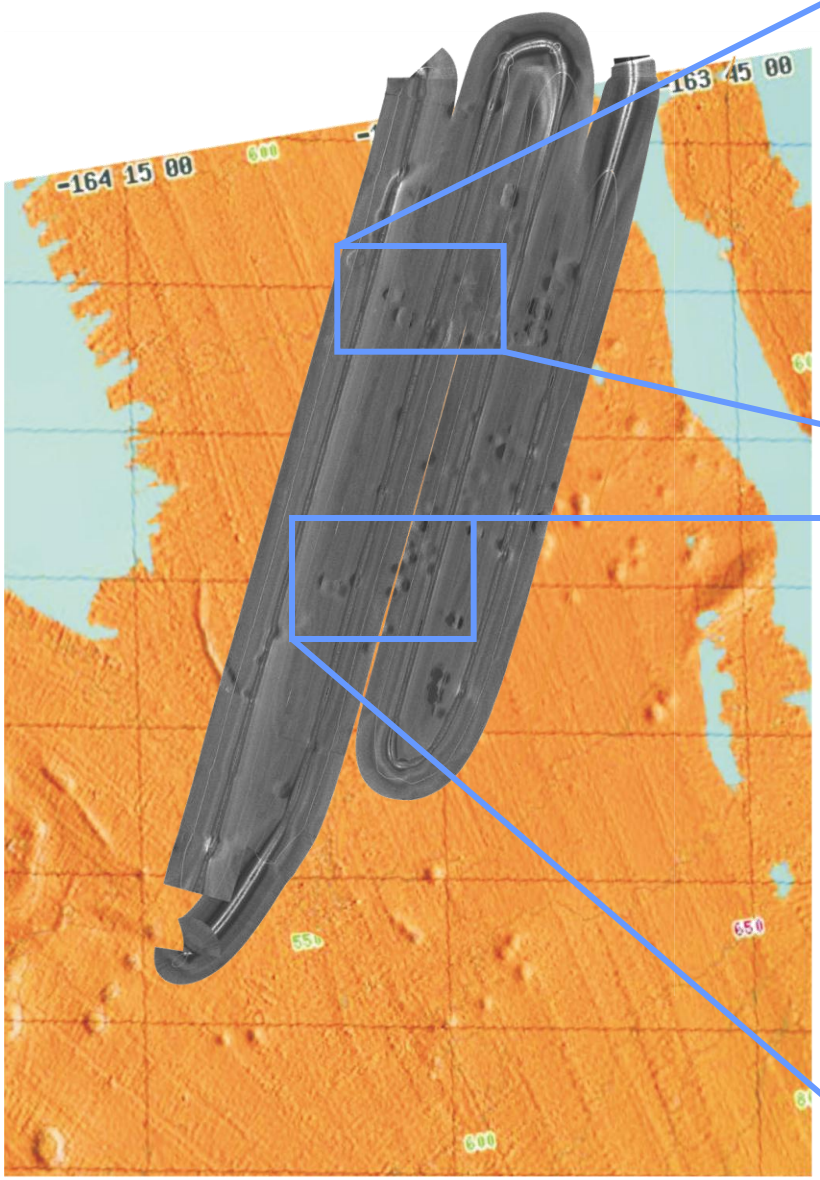
# SITE 2 An extension of the Herald Canyon

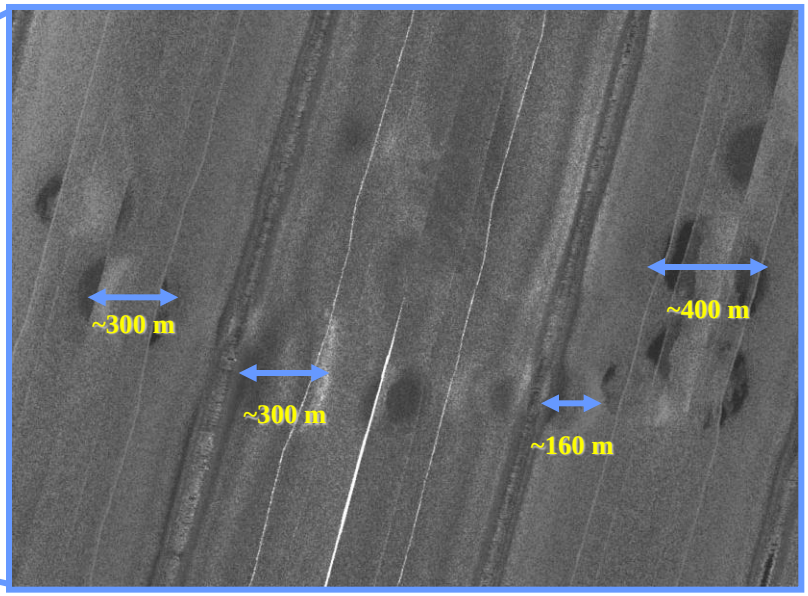
**Water depth - 50-150 m**

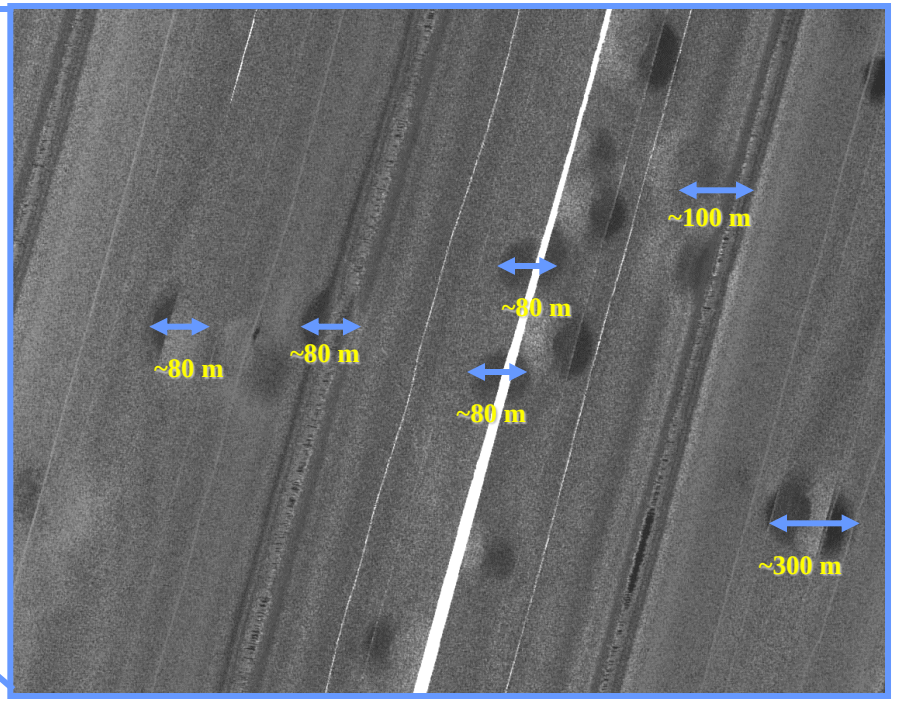



Savvichev et al., 2004

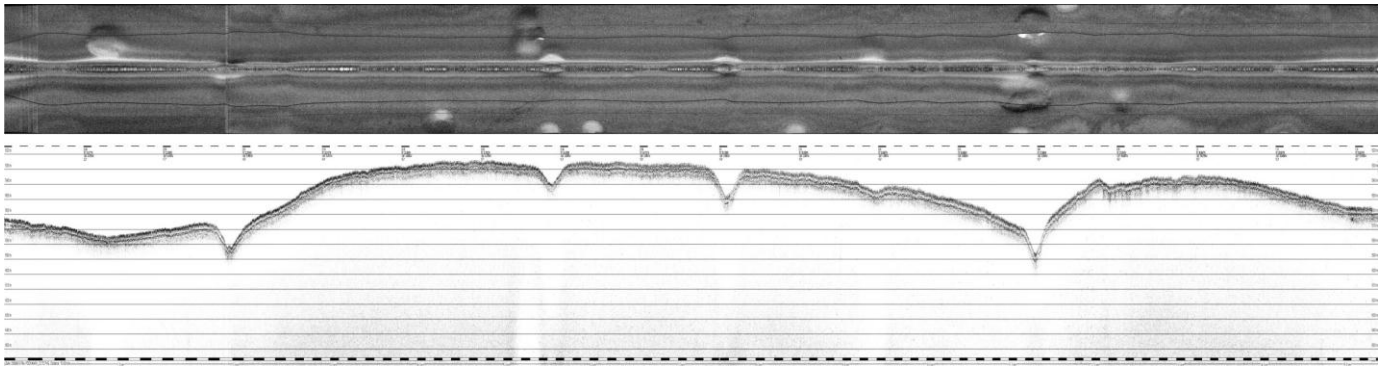
# SITE 1 Pockmarks area

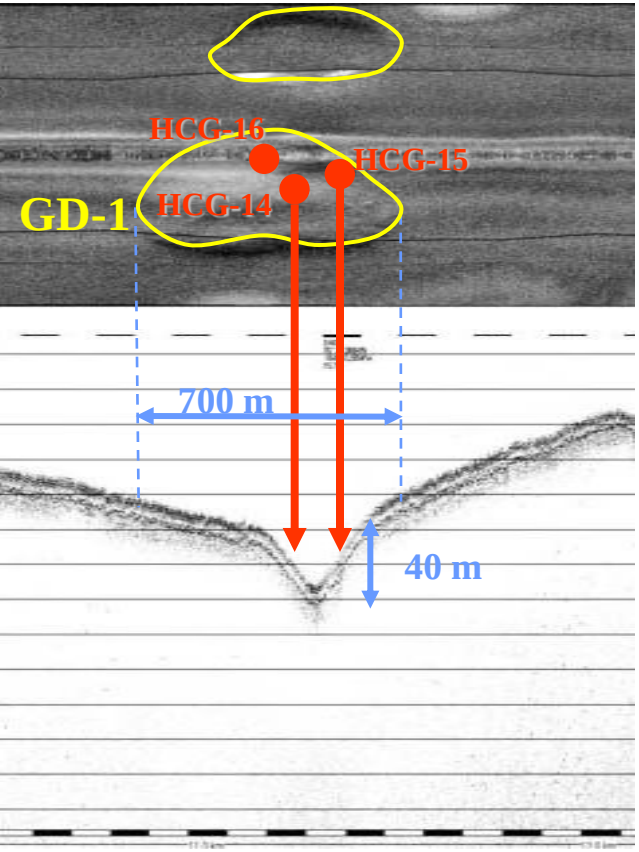


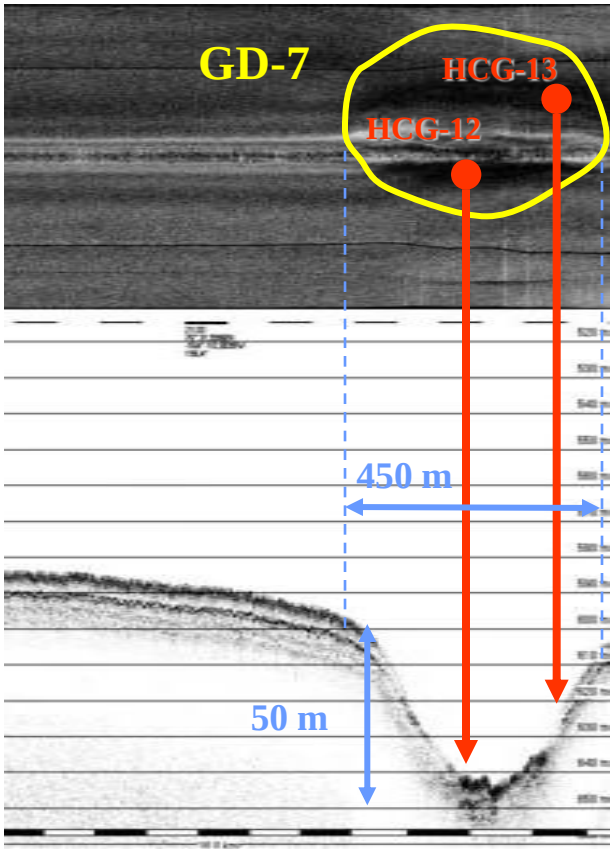



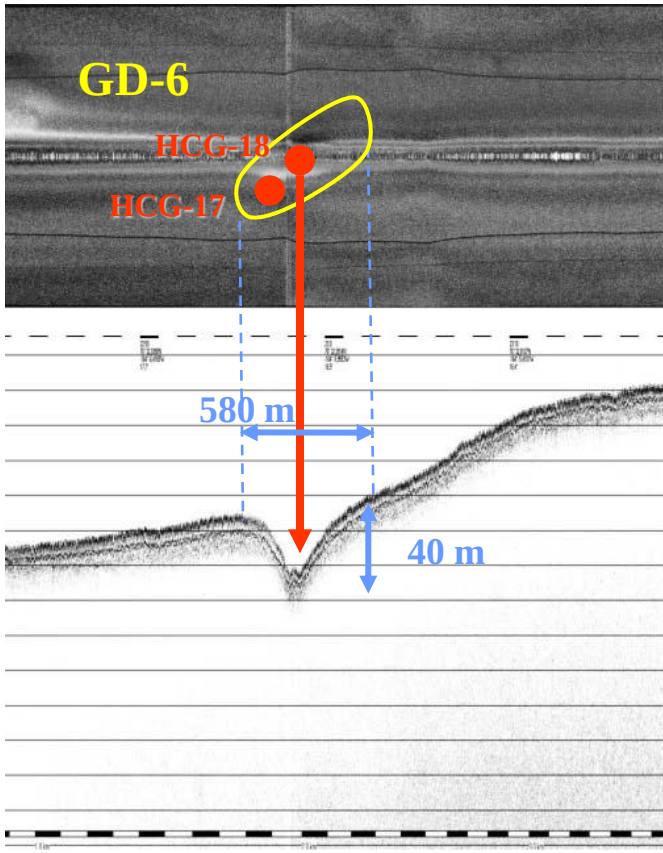



# SITE 1



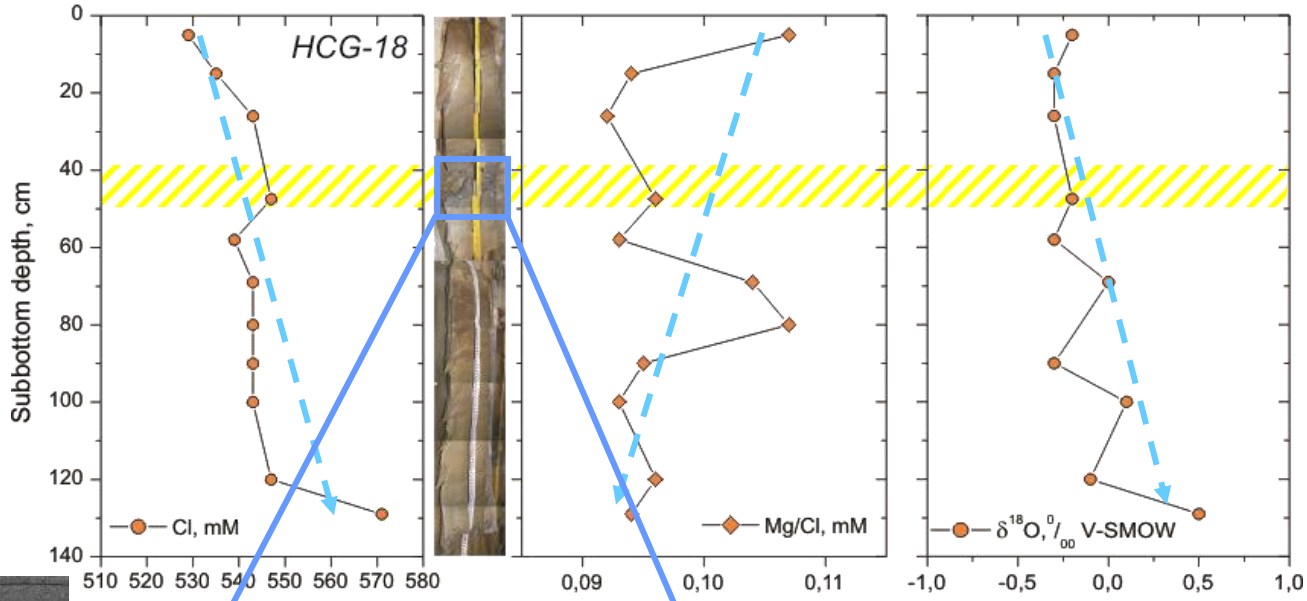

HCG-16
HCG-15
HCG-14
GD-1
700 m
40 m

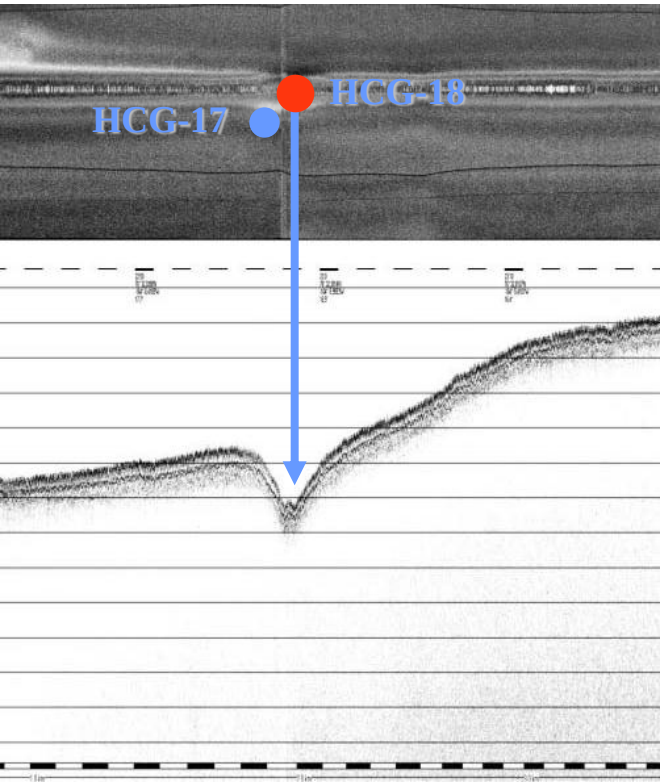

GD-7
HCG-13
HCG-12
450 m
50 m


GD-6
HCG-18
HCG-17
580 m
40 m

# Results:

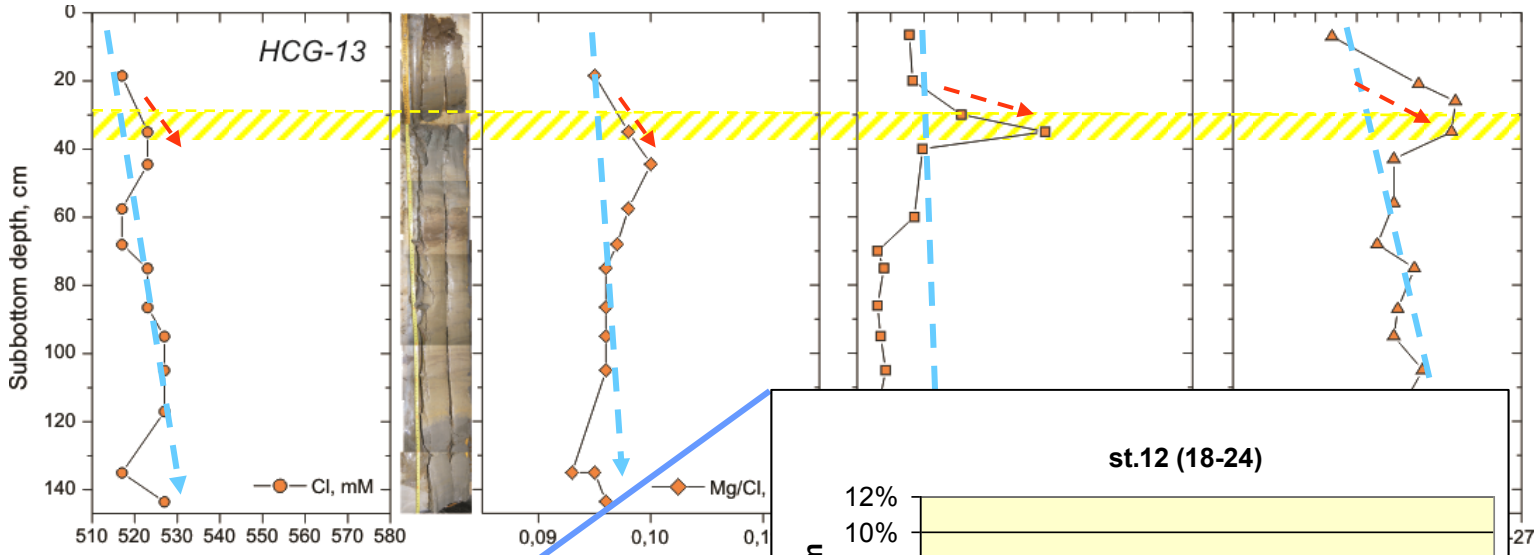
## Geochemical and isotope studies: GD-6 structure

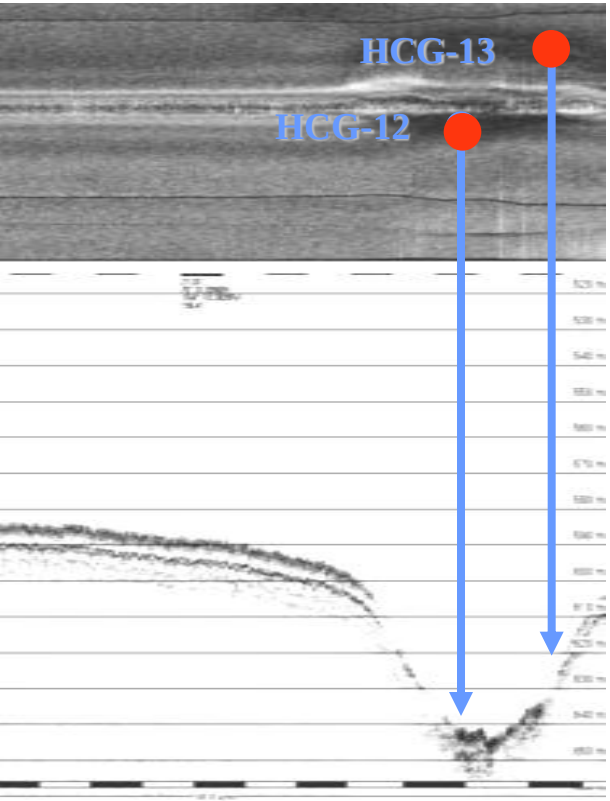


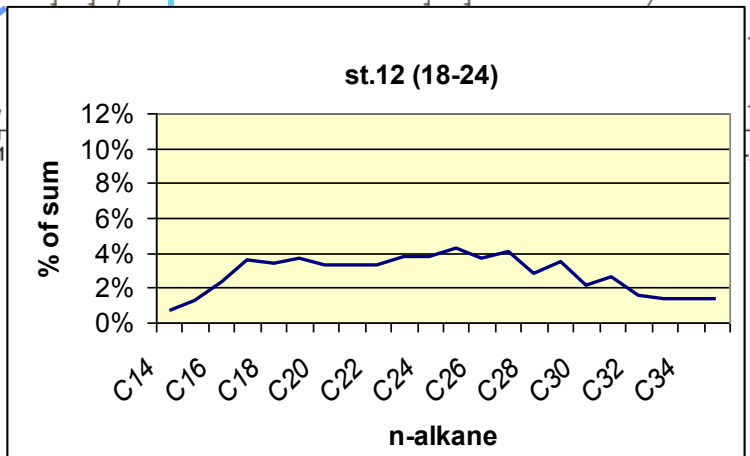




# Results:

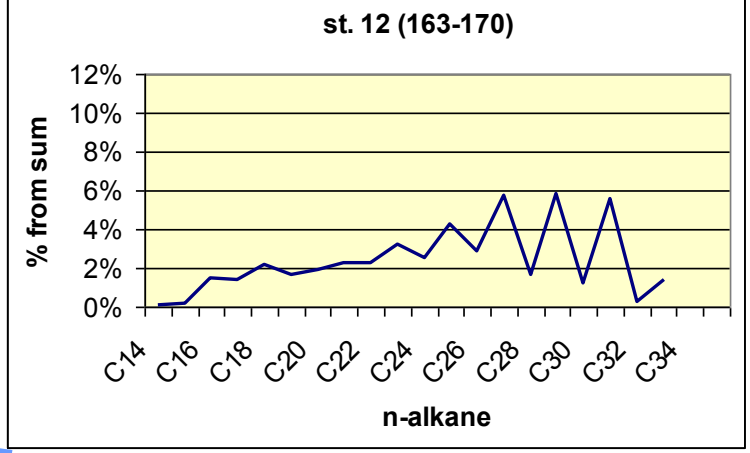
## Geochemical and isotope studies: GD-7 structure




**Determination of hydrocarbon biomarkers**



## Implications:

### Pockmark sediments at the Chukchi Cap

- Anomalies in major-ions content distribution
- Variations of Mg/Cl ratio
- Enhanced values of oxygen-18 isotopes

→ ***Upward water infiltration***

- Sterane indexes of the maturity (20S/20S+20R C29)
- Specific character of composition and distribution of HC biomarkers

→ ***Post- diagenetic stage of DOM transformation***

- Increase of the Corg content and decrease of the $C^{13}$ values
- Aromatic HC markers represented mostly by phenanthrene and its alky-homologies and characterize by anomalously high content (> 3000 ng/g) at the uppermost sediments

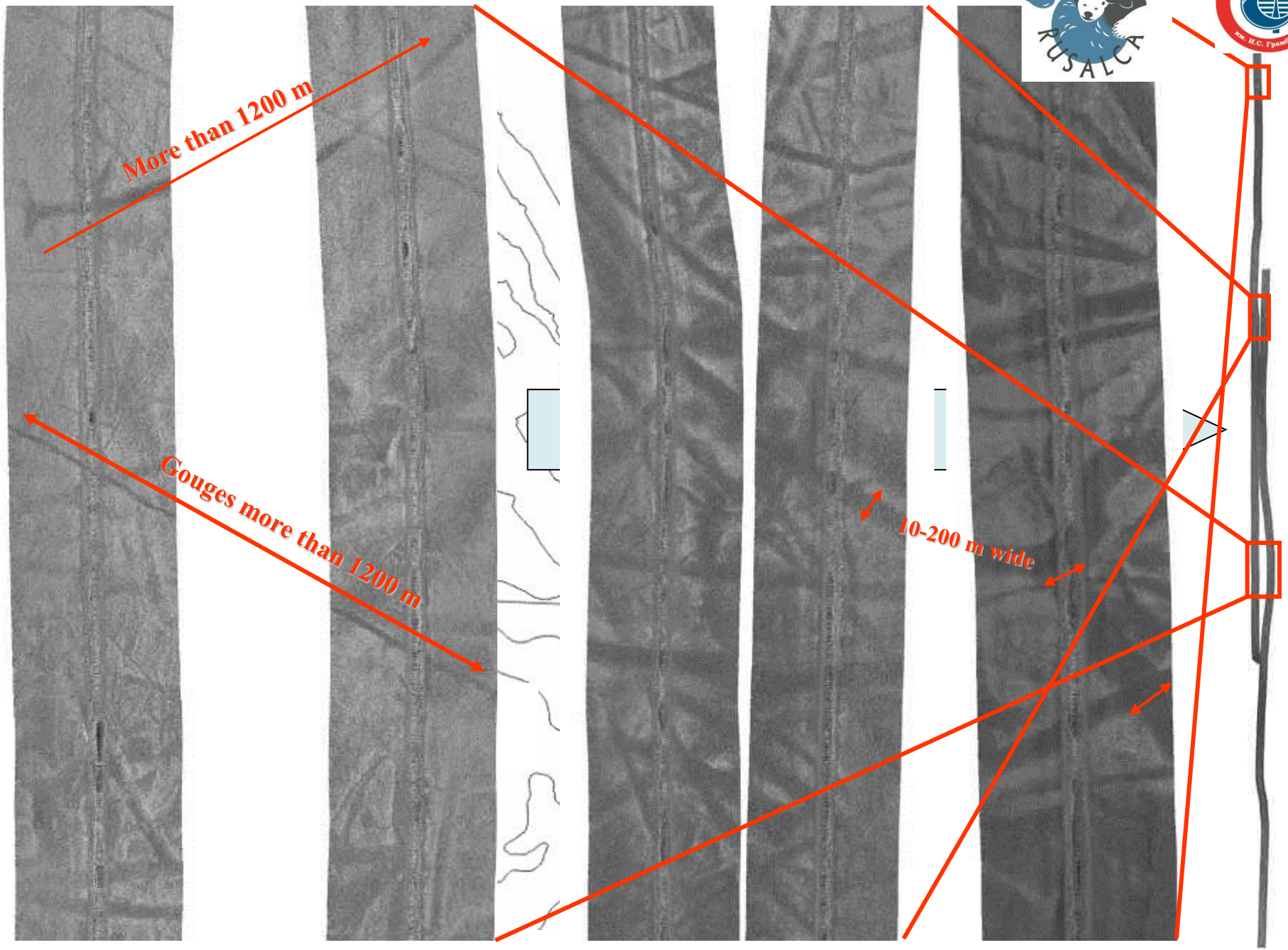
→ ***High level of OM maturity***

→ ***Mixed OM origin***

***The source of the high maturated OM supply may be resulted from: (1) ice rafting, (2) suspended organic material transported by river run-off or (3) mud flows from deeply buried sediments.***

**We need to learn more about this ...!!!**

# Site 2: *continuation of the Herald Canyon*



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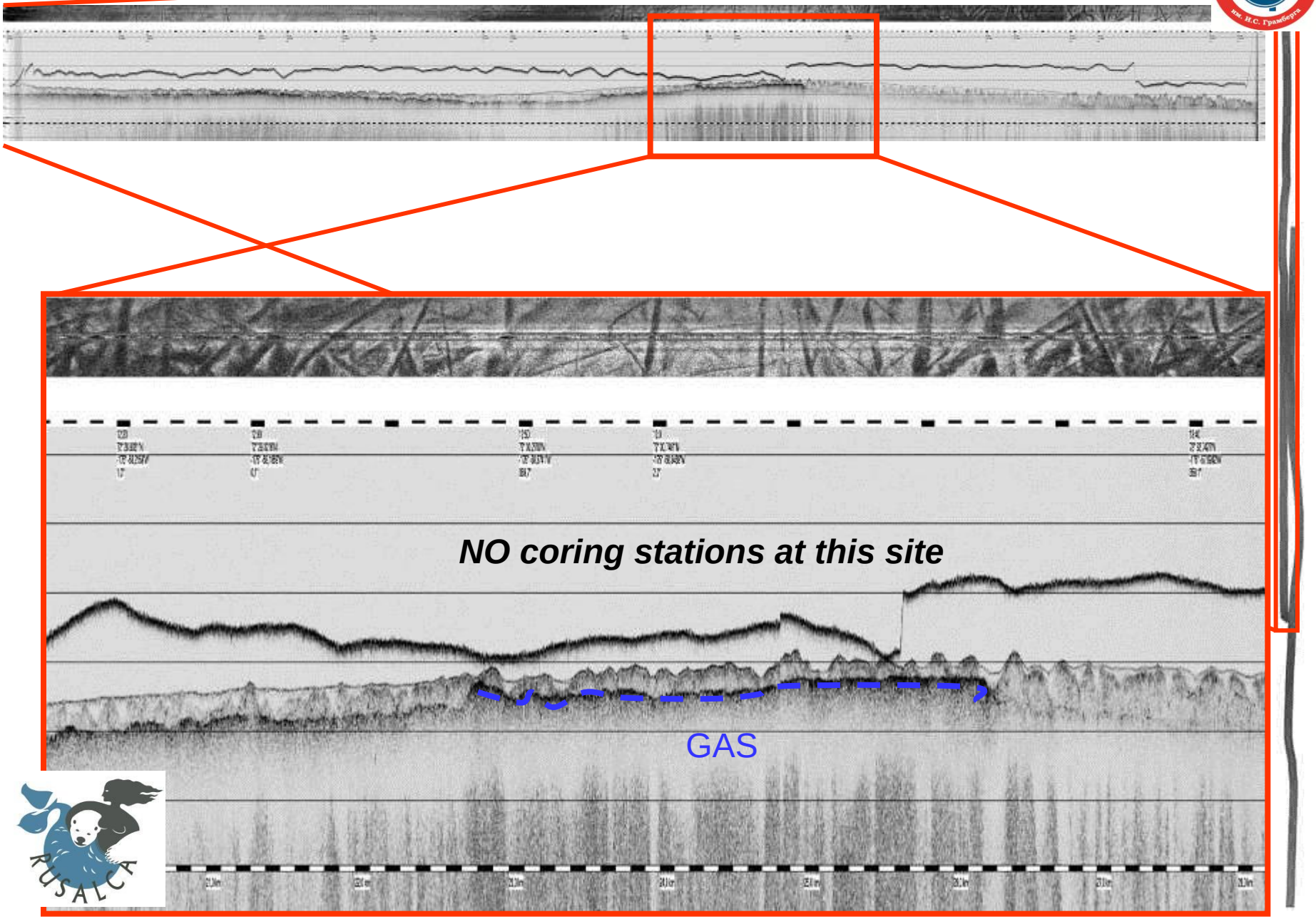

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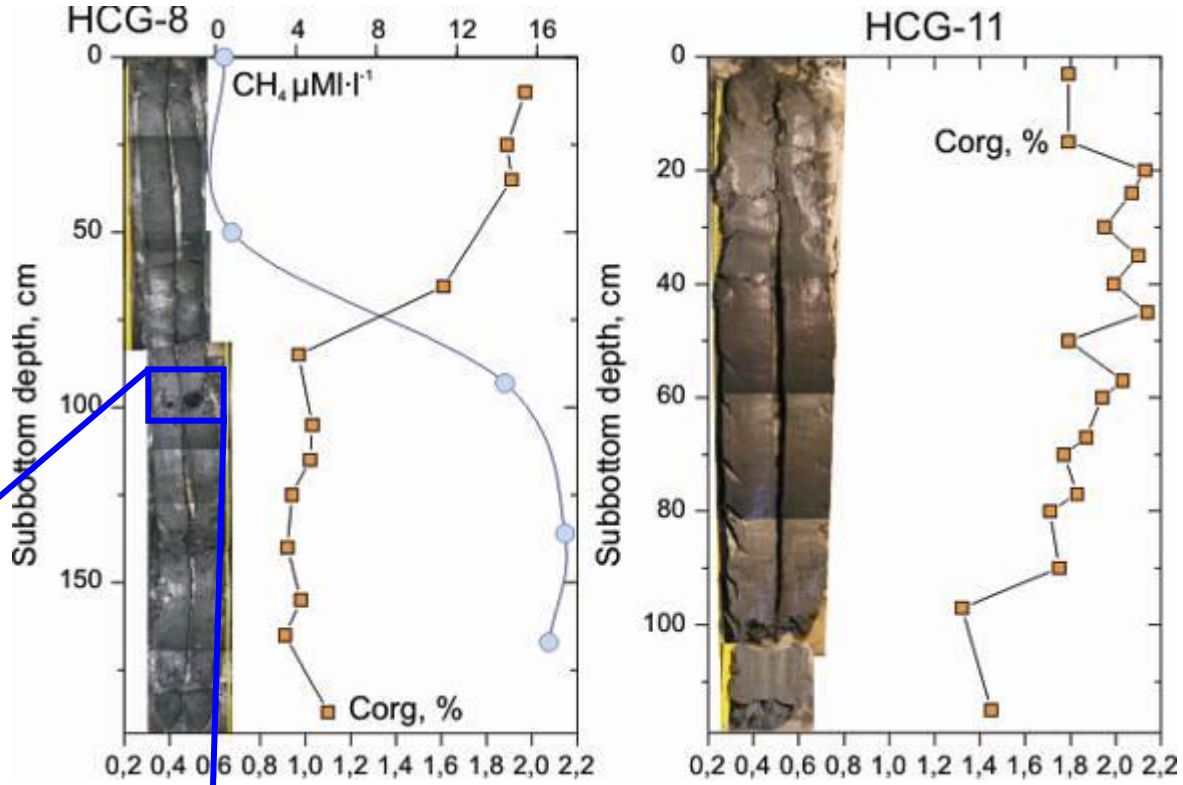



**$C_{org}$ values vary widely ranging from 0.1-2.8%, average - 1.21% (Stein, 2008).**

**Max $CH_4$ content is 17.4 μM/dm$^3$ - 30 times higher than the average methane content in the sediment of the southern Chukchi Sea (0.2-0.8 μM/dm$^3$).**

***CH4 content by Alexander Savvichev, IO RAS***

# Implications

## HYDROCARBONS INDICATIONS WITHIN THE CHUKCHI AND EAST SIBERIAN SEAS

### Site 1: pockmark-like structures at the Chukchi Cap

**Further studies: heat flow, high resolution seismic, coring, lipid biomarkers**

### Site 2: An extension of the Herald Canyon

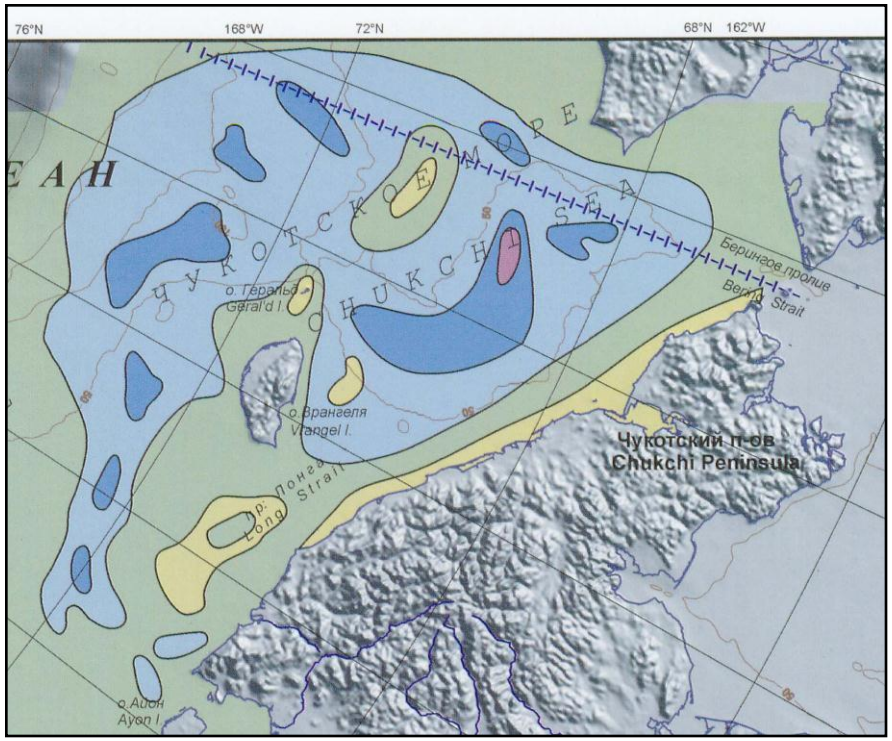
**Further studies: mapping the methane-reach sediments by seismic methods, reinterpretation of RUSALCA-2004 seismic data, coring, AOM**

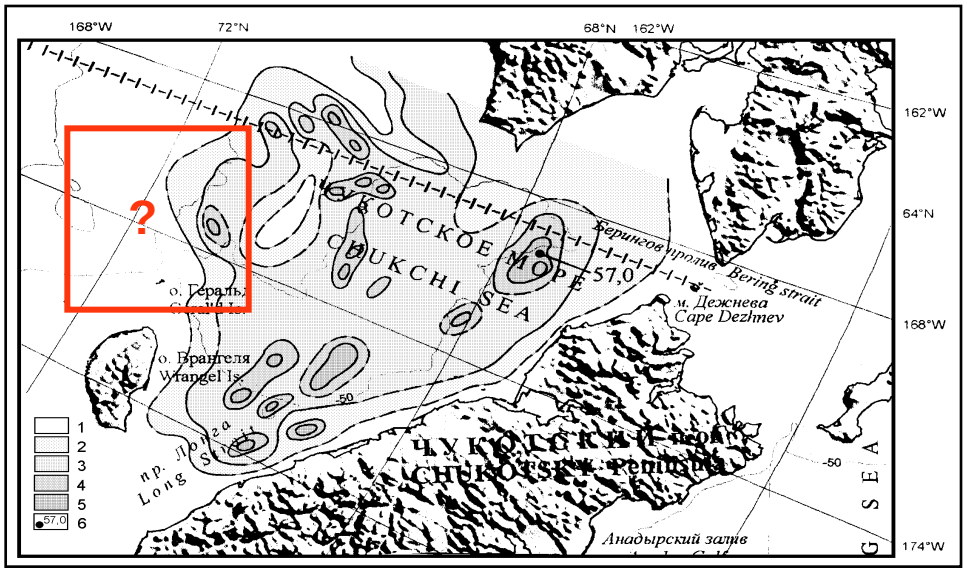
### Site 3: East Siberian Sea

***No strong hydrocarbons signature observed***

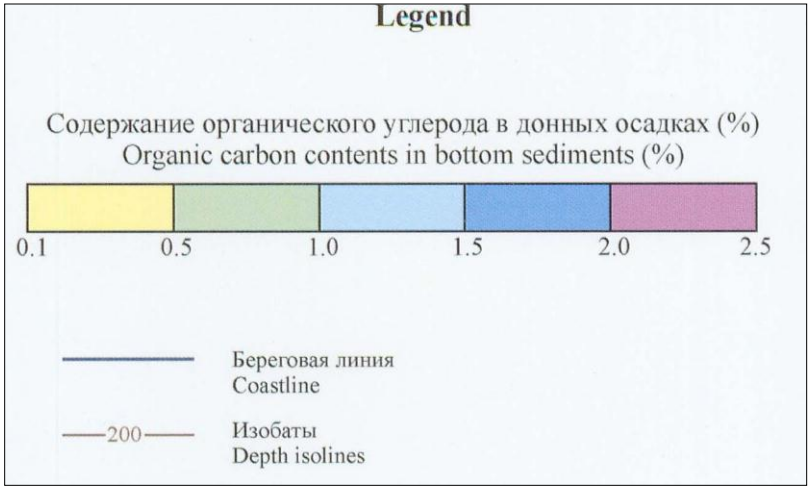
# SUGGESTIONS FOR RUSALCA-2012

# CHUKCHI SEA




## *Organic carbon content in bottom sediment (%)*

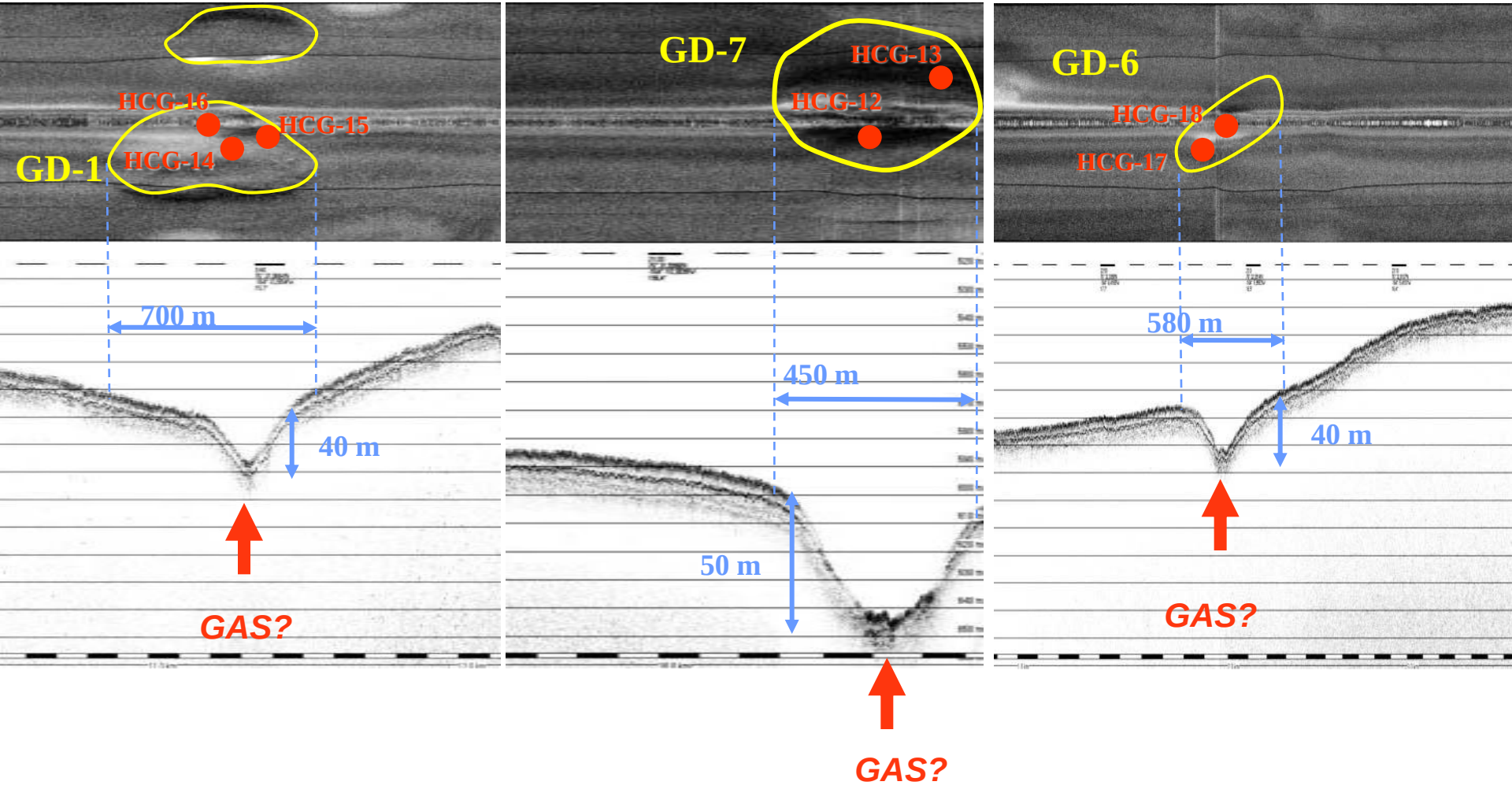



## *Anomalous hydrocarbon gases content in bottom sediment ($cm^3$/kg)*

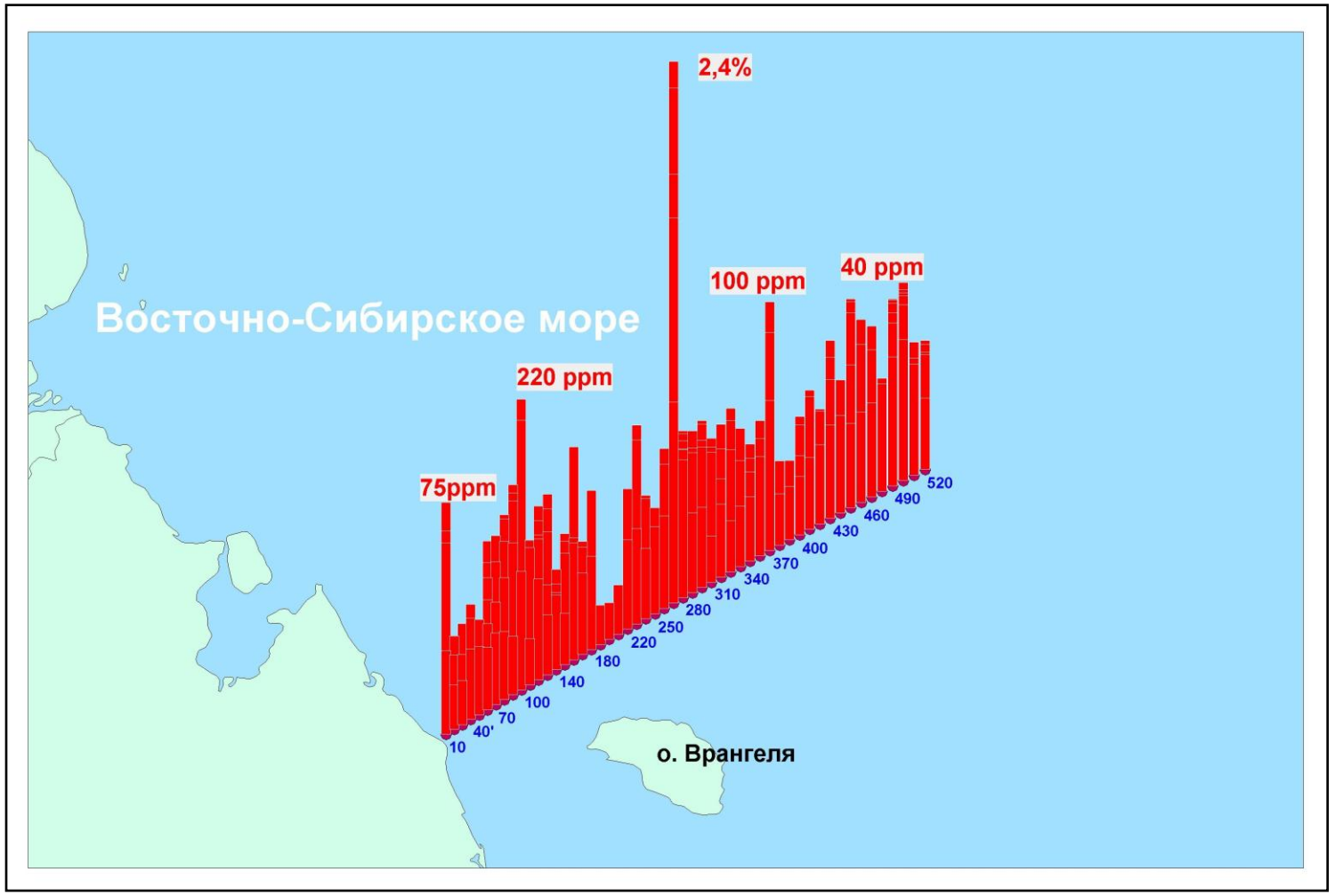
1 – less 0.005;
2 – from 0.005 to 0.01;
3 – from 0.01 to 0.05;
4 – from 0.05 to 0.1;
5 – from 0.1 to 1.0;
6 – > 1.0 $cm^3$/kg

*Yashin, Kim, 1994*

# Pockmarks area



## *East-Siberian Sea: methane in the bottom sediment*



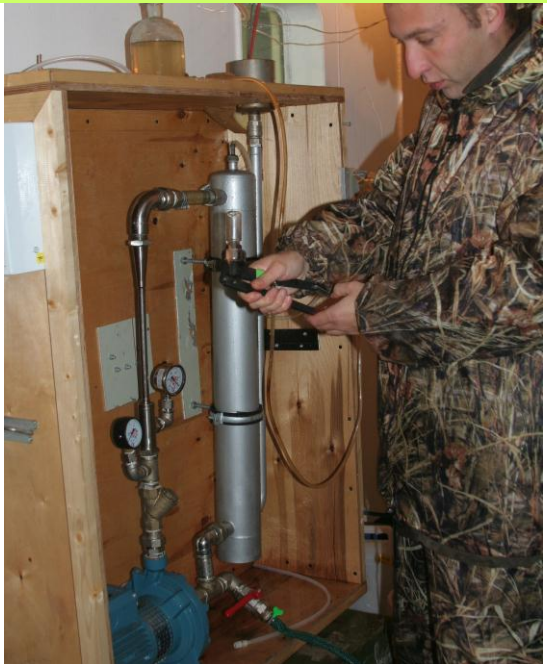

Data courtesy of A. Obzhirov (POI FEB RAS)

# Onboard geological operations

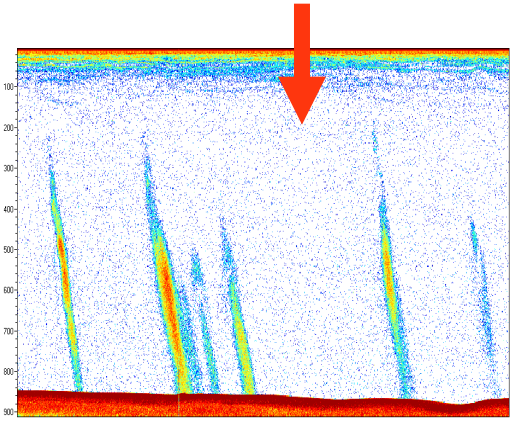
Sediment coring
(gravity corer and box-corer)

Heat flow measurements *in situ*
by GEOTHERM probe

Gas content determination in the water column
SUOK-DG degassing unit



***Echosounder!!!!***



# Geophysical methods?




SONIC-3M deep water Side Scan Sonar System
(SSS+profiler 5-10kH)

SONIC 4M High resolution seismic system
(sparker)


Shallow water SONIC-9L Side Scan Sonar System
(SSS+profiler 1kHz)

# *2012 Proposal from POI FEB RAS by A. Astakhov*

## Targets

1.Coring at the sites with different rates of sedimentation in order to further paleooceanographic and paleoclimate reconstructions at the Holocene time scale

2.Ecological investigations: mercury in the air and heavy metals in sediment determinations

3.Geochemical databases acquisition (silica and carbonate microplankton death assemblages

## Methods

Sediment coring by box-corer and gravity corer

1.Core description

2.Sediment physical properties deteermination

3.Subsampling for micropaleontological, X-ray fluorescent studies, sedimentation rates determination, dating by14C, 210P,137Cs

4.Mercury determination in the air and in sediments

## Participants

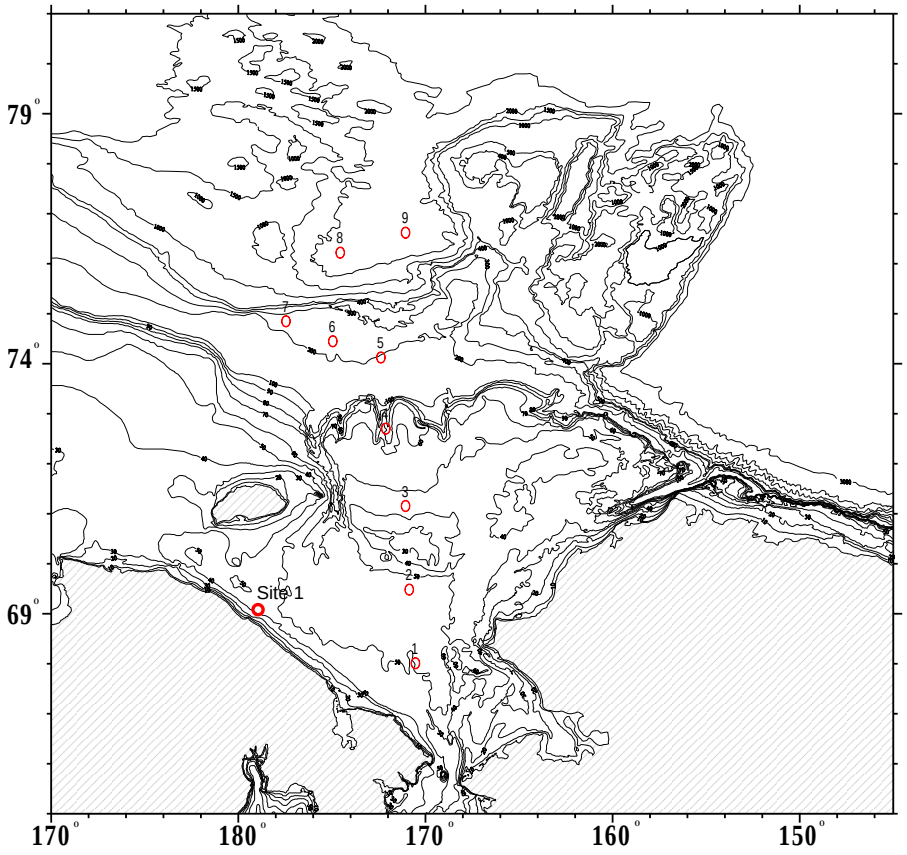
1. Колесник Александр Николаевич (***Kolesnik Alexander***) 1986 г., н.с, ТОИ ДВО РАН

2.Босин Александр Анатольевич, (***Bosin Alexander***) 1981, с.н.с., к.г.н, ТОИ ДВО РАН

***3.Reserve*** Сотрудник Института геологии и минералогии СО РАН, г. Новосибирск

4.Калинчук Виктор Васильевич, (***Kalinchuk Victor***) 1984, н.с, ТОИ ДВО РАН

# Study areas




## Sites location

| Station | Latitude N | | Longitude W | |
|---|---|---|---|---|
| | Degree | Minutes | Degree | Minutes |
| Site 1 | 69 | 53,0 | 179 | 19,20 |
| 1 | 68 | 2,50 | 171 | 36,89 |
| 2 | 69 | 30,46 | 171 | 17,45 |
| 3 | 71 | 10,34 | 171 | 5,78 |
| 4 | 72 | 42,77 | 172 | 3,55 |
| 5 | 74 | 7,75 | 173 | 47,99 |
| 6 | 74 | 27,13 | 175 | 16,29 |
| 7 | 74 | 50,98 | 178 | 48,49 |
| 8 | 76 | 12,98 | 175 | 39,63 |
| 9 | 76 | 36,83 | 171 | 5,78 |

## POI Equipment

1. Boxcorer 30x20x50 cm, 150 kg
2. Hydrostatic corer 3 m length, 200 kg with plastic liner
3. Mercury analyzer PA-915+
4. Computers
5. GPS

*THANK YOU!*