Всероссийский научно-исследовательский
геологический институт им. А.П. Карпинского

Geology and coastal processes of Eurasian Arctic Marginal Seas

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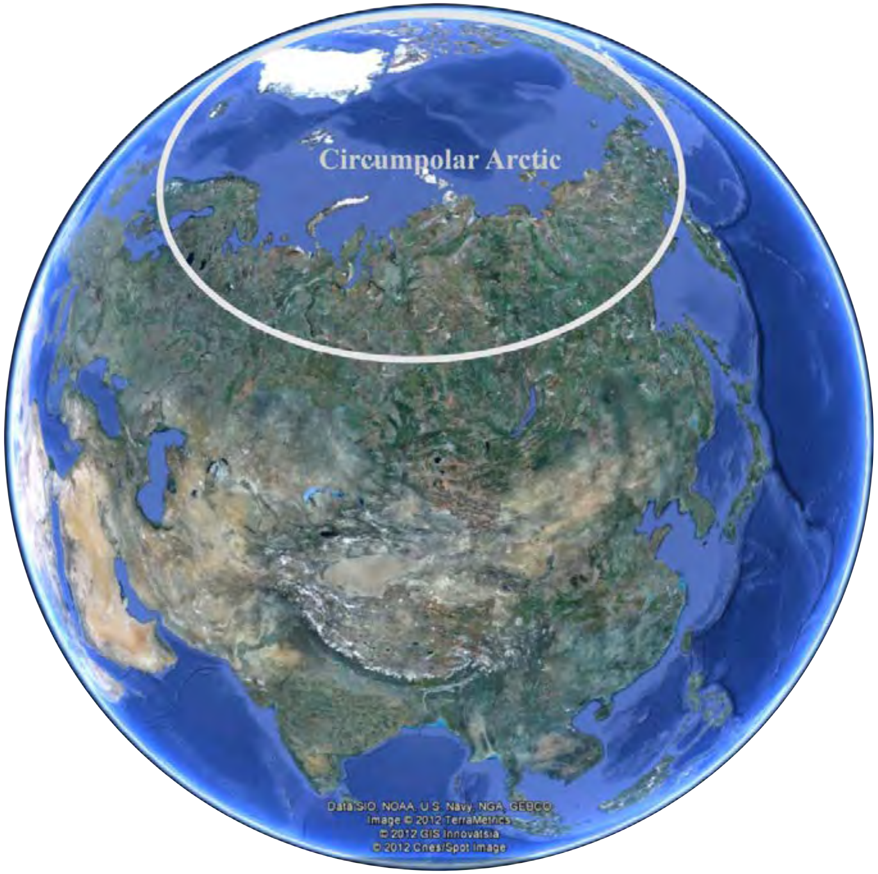
A.P.Karpinsky Russian Research Geological Institute (VSEGEI)

Evgeniy Gusev

VNIIOkeangeologia

Geology and coastal processes of Eurasian Arctic Marginal Seas



Barents Sea 1 424 000 км², shoreline - 6645 km (5930 km – islands)

White Sea 90 800 km² shoreline – 3215 km (120 km – islands)

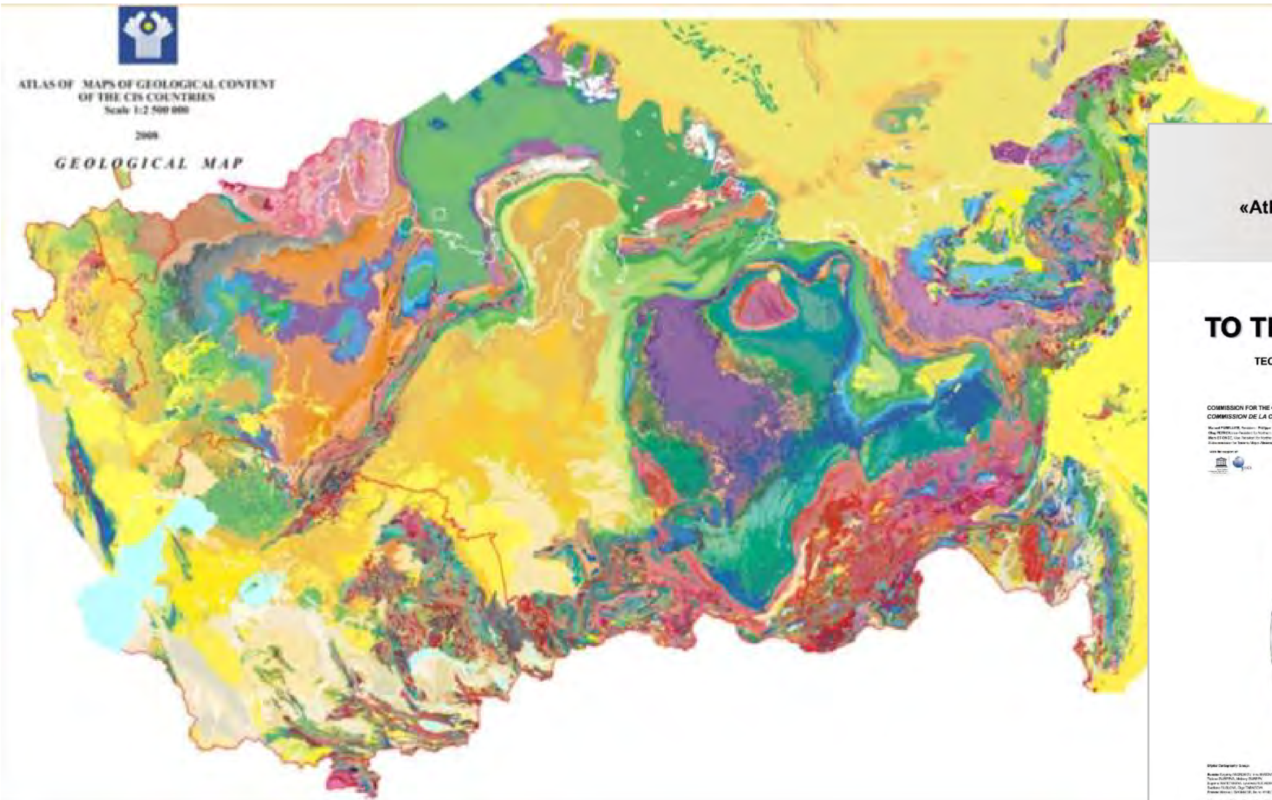
Kara Sea 893 400 км² shoreline - 6025 km (3765 km – islands)

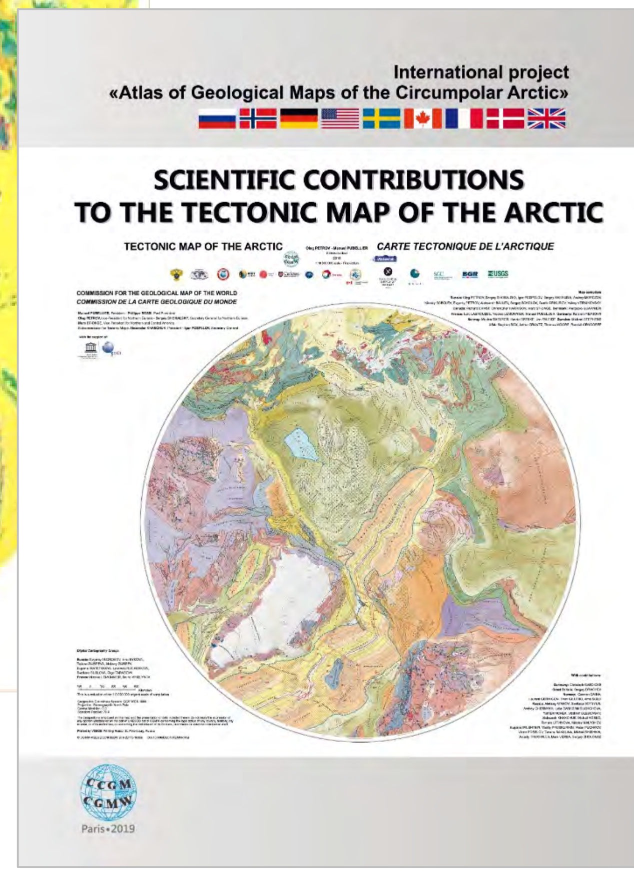
Laptev Sea 672 000 км² shoreline 3880 km, 2020 km – islands

East Siberian Sea - 944 600 км², shoreline - 3145 km (1945 km – islands)

Chukchi Sea - 595 000 км², shoreline - 1300 km (405 km – islands)

Geology and coastal processes of Eurasian Arctic Marginal Seas





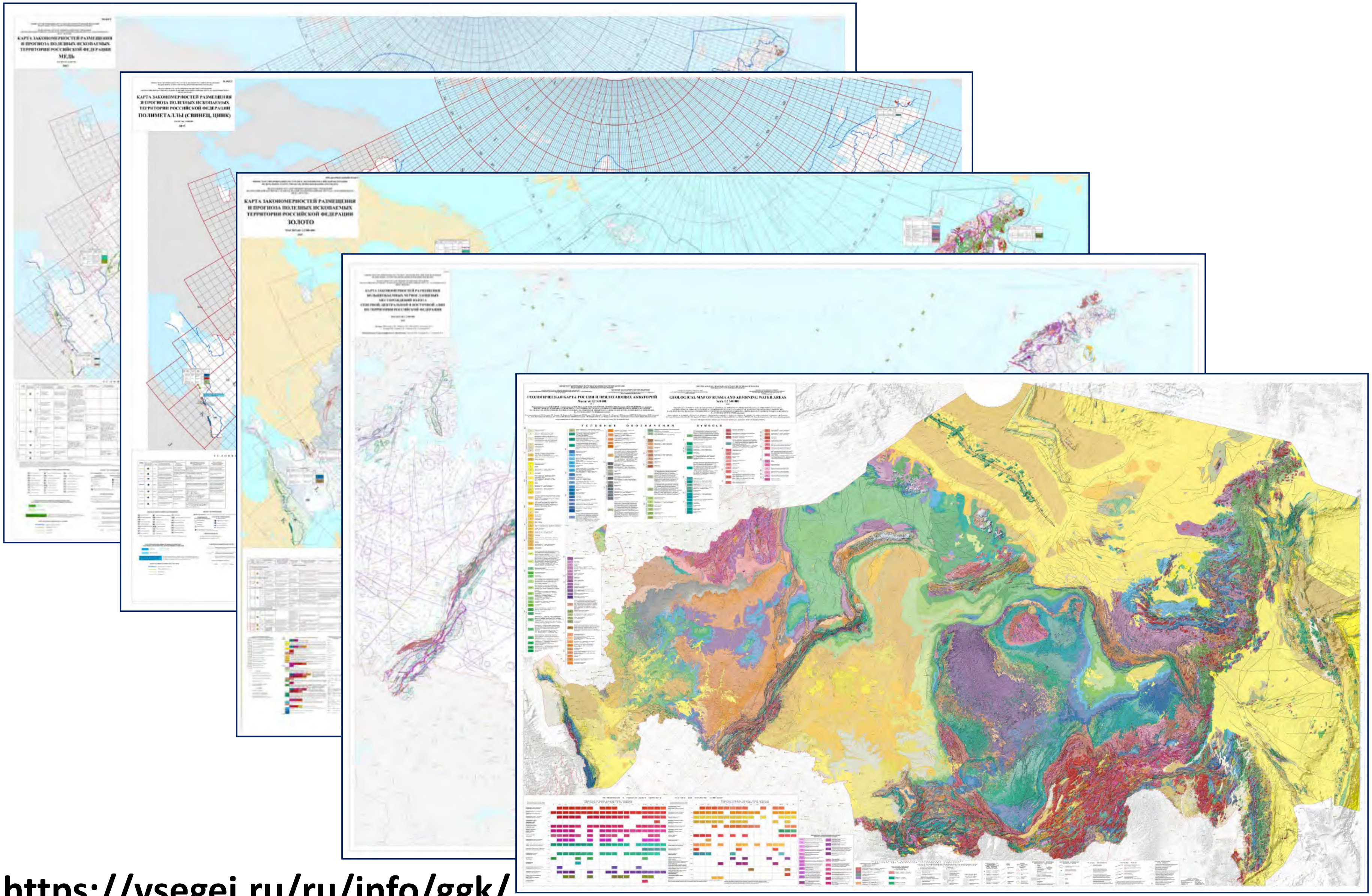
Huge area differ in geology, tectonics, geological history

“Eurasian Marginal Seas – Past and Future”

1. Available data about Quaternary geology, geomorphology and coastal processes of Eurasian Arctic Marginal Seas

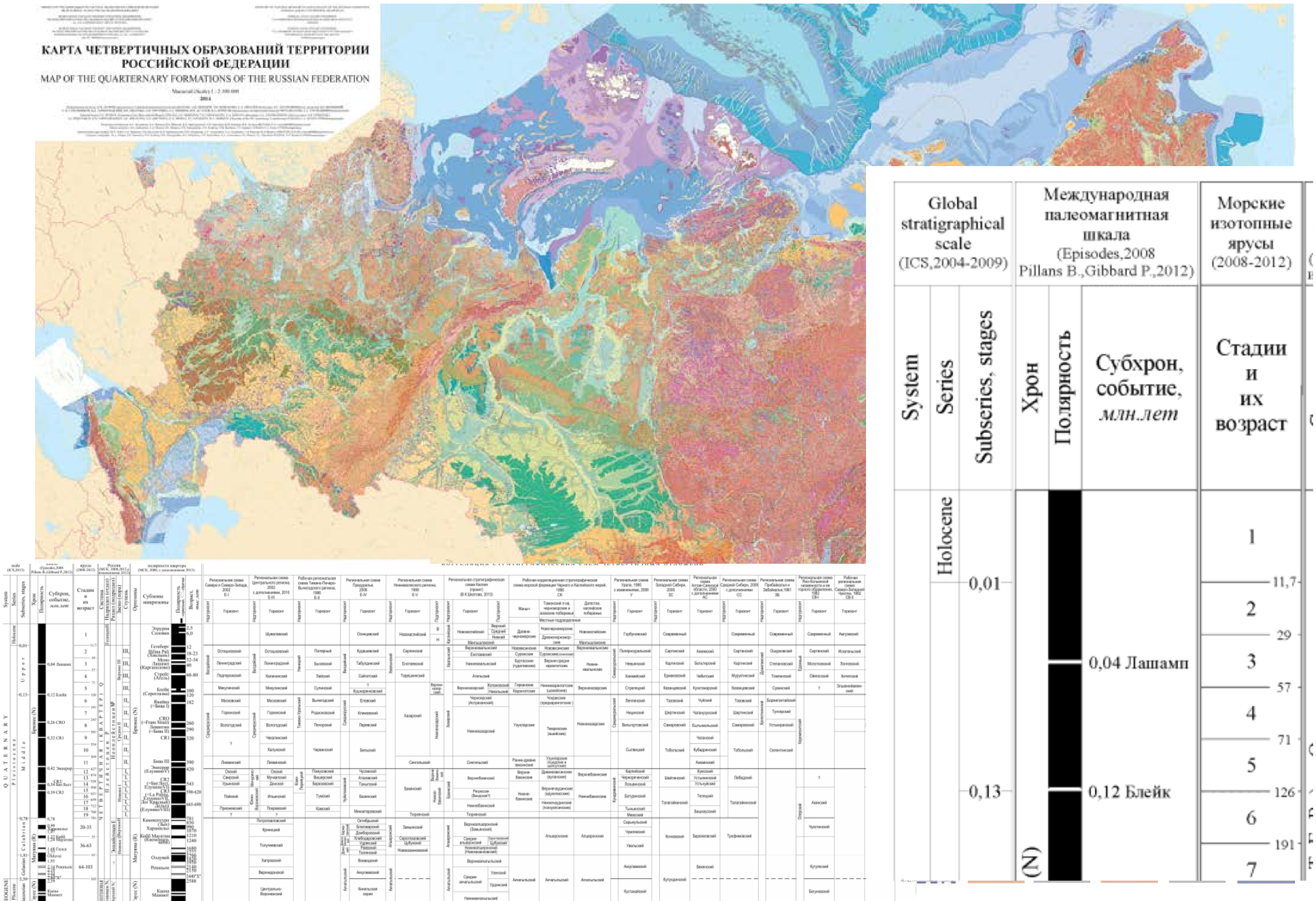
2. Disputable questions, unsolved problems and possible project outcomes

Multiscale State Geological Mapping (1:2.5M, 1:1M, 1:200000)

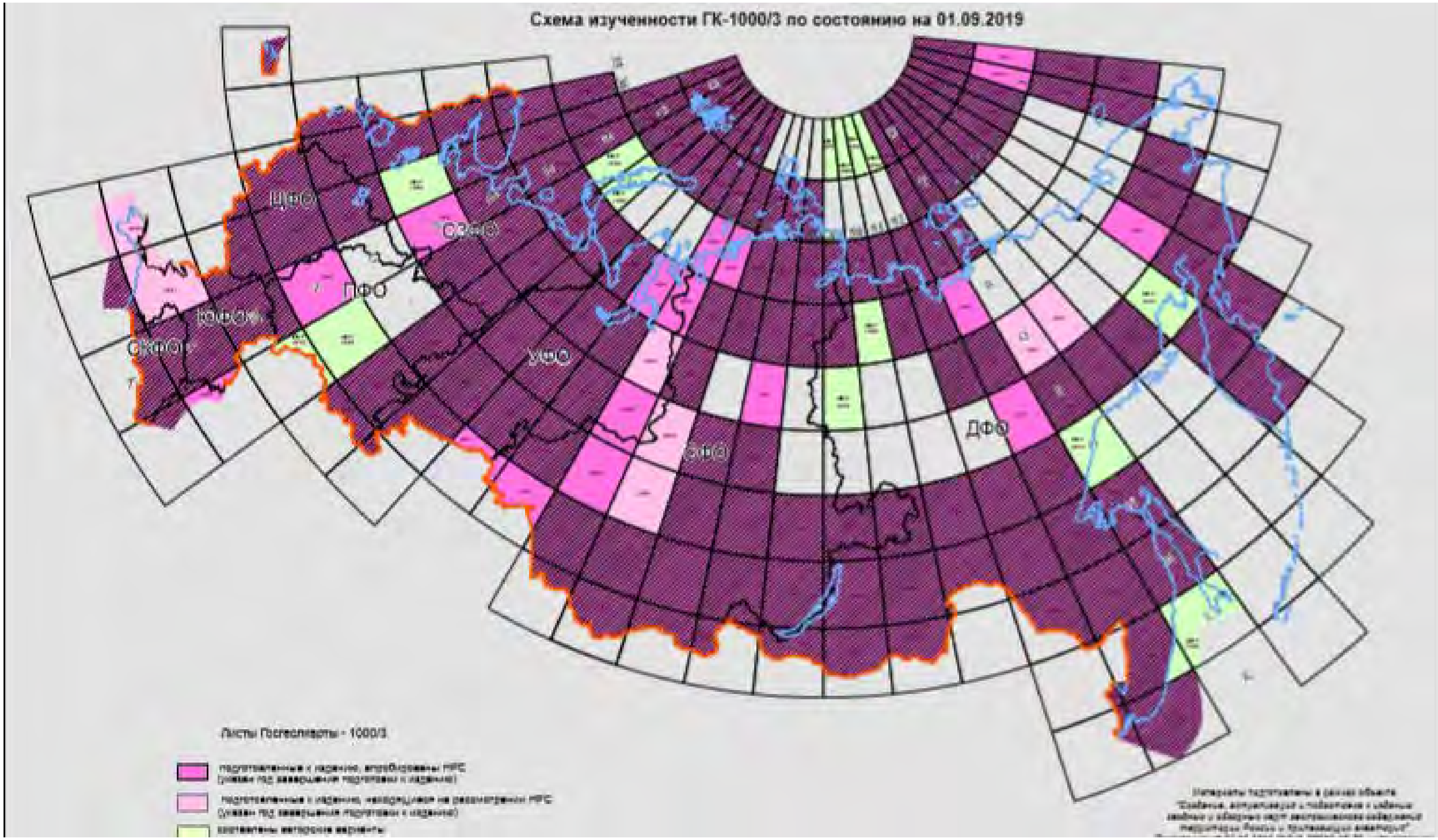


https://vsegei.ru/ru/info/ggk/

Seamless Map of Quaternary Geology 1 : 2.5M



Geological mapping of 1:M scale will be completed by 2024



Geological Map (preQuaternary deposits)
Quaternary Deposits
Environmental geological
Sea-bed substrate
Mineral Resources

Ministry of Natural Resources and Environment
Federal Agency on Mineral Recourses
State geological mapping:

VNIIOkeangeologiya (St.Petersburg)

VSEGEI (St.Petersburg)

Marine Arctic Geological Expedition MAGE (Murmansk)

Polar Marine Geological Expedition PMGE (Lomonosov)

SevMorgeo (St.Petersburg)

Scientific Research:
Russian Academy of Science

P.P.Shirshov Institute of Oceanology (Moscow, with branches in Kaliningrad, St.Petersburg, Gelendzhik, Arkhangelsk),

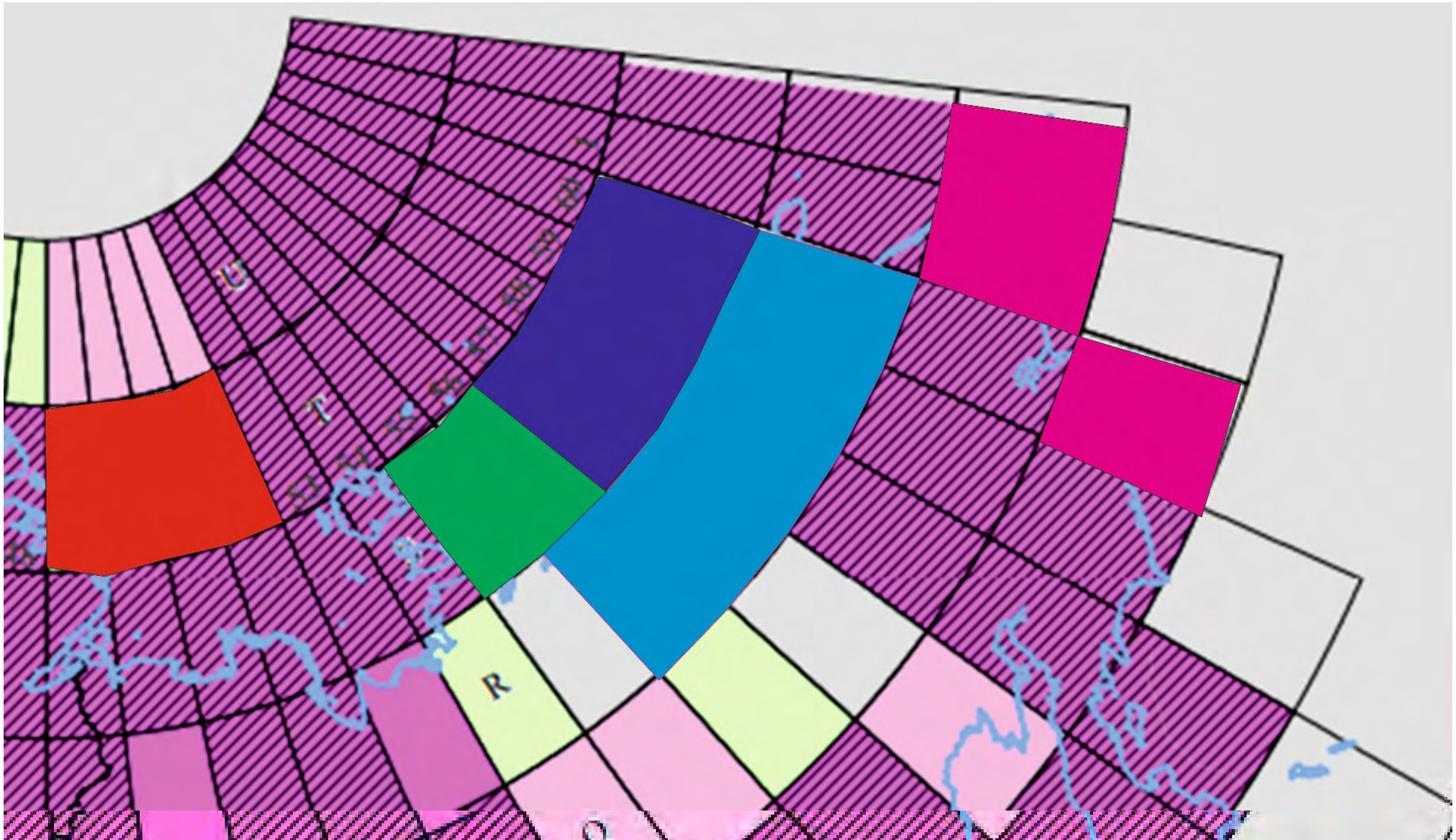
Moscow University

Geological Institute RAS

Hydrometeorological survey:

Arctic and Antarctic Reseaarch Institute (St. Petersburg)

Geological mapping of 1:M scale will be completed by 2024



- R56-60 - VSEGEI, 2018-2020
- T49-53 - VNIIO, 2019-2021
- P60, Q1-2 - VSEGEI, 2020-2022
- S55-56 - VSEGEI, 2019-2021
- S57-60 - VNIIO, 2020-2022

МИНИСТЕРСТВО ПРИРОДНЫХ РЕСУРСОВ И ЭКОЛОГИИ РОССИЙСКОЙ ФЕДЕРАЦИИ
ФЕДЕРАЛЬНОЕ АГЕНТСТВО ПО НЕДРОПОЛЬЗОВАНИЮ

ГОСУДАРСТВЕННАЯ ГЕОЛОГИЧЕСКАЯ КАРТА РОССИЙСКОЙ ФЕДЕРАЦИИ масштаба 1 : 1 000 000

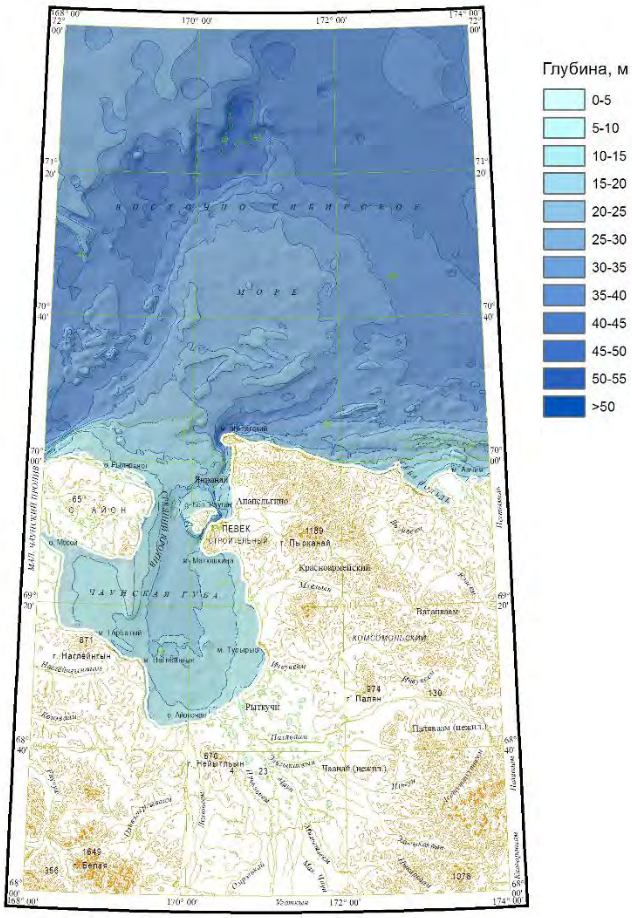
Третье поколение

ЧУКОТСКАЯ СЕРИЯ

КАРТА ЧЕТВЕРТИЧНЫХ ОБРАЗОВАНИЙ (авторский вариант)

R-59 (Певек)

Батиметрическая схема
Масштаб 1 : 2 500 000



МИНИСТЕРСТВО ПРИРОДНЫХ РЕСУРСОВ И ЭКОЛОГИИ РОССИЙСКОЙ ФЕДЕРАЦИИ
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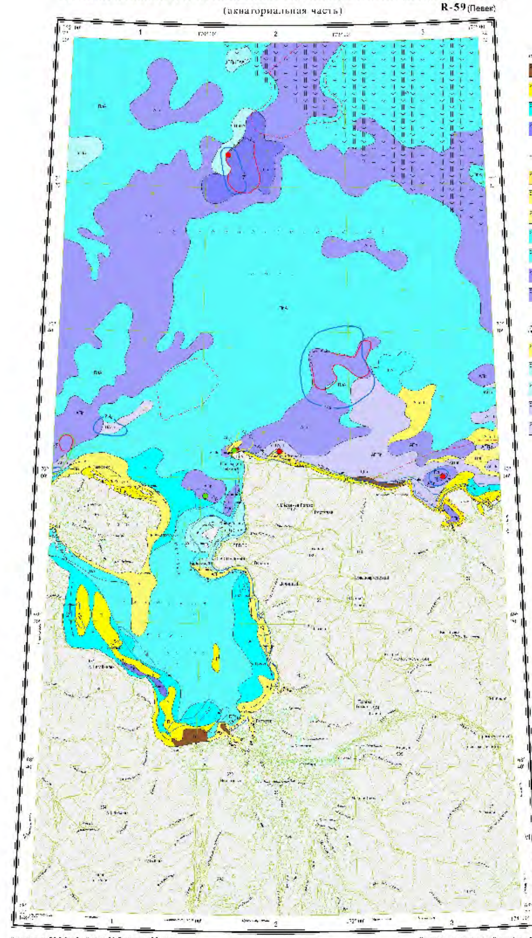
Третье поколение

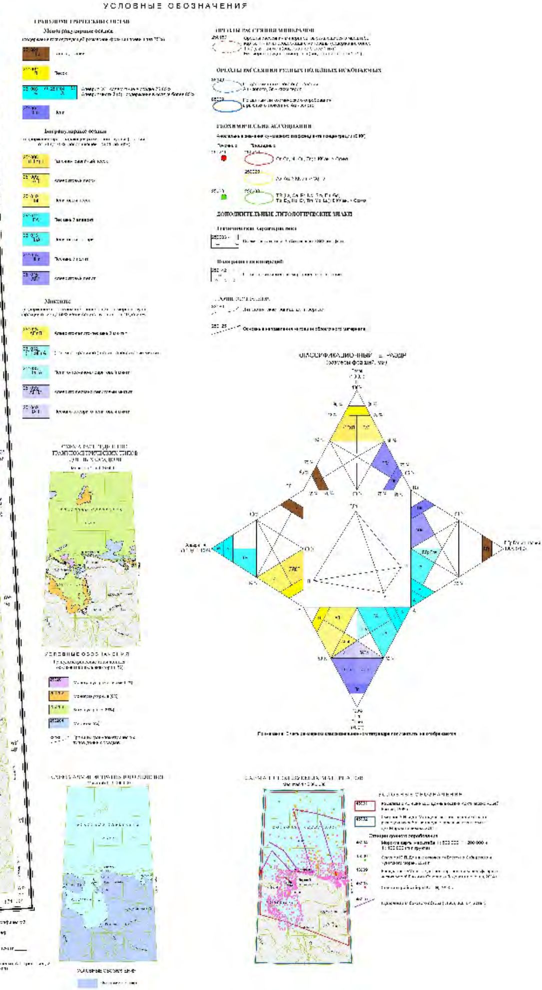
ЧУКОТСКАЯ СЕРИЯ

ЛИТОЛОГИЧЕСКАЯ КАРТА ПОВЕРХНОСТИ ДНА АКВАТОРИИ (авторский вариант)
(акваториальная часть)

R-59 (Певек)



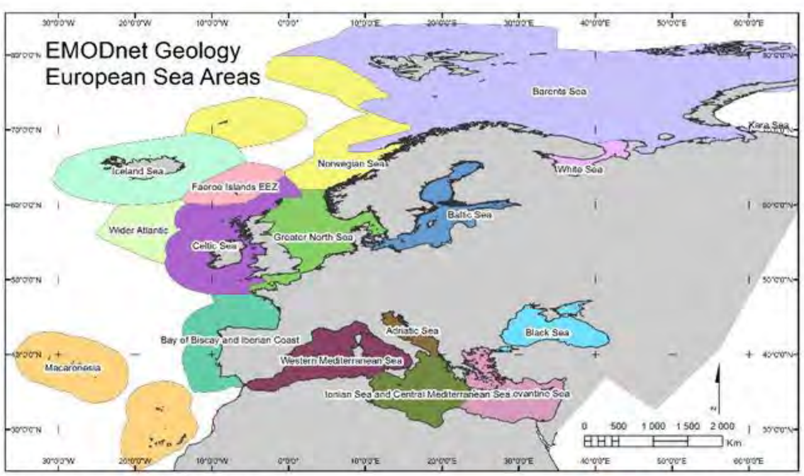
УСЛОВНЫЕ ОБОЗНАЧЕНИЯ



Карта четвертичных образований (авторский вариант) листа R-59 (Певек) (акваториальная часть)

EMODnet – geology project

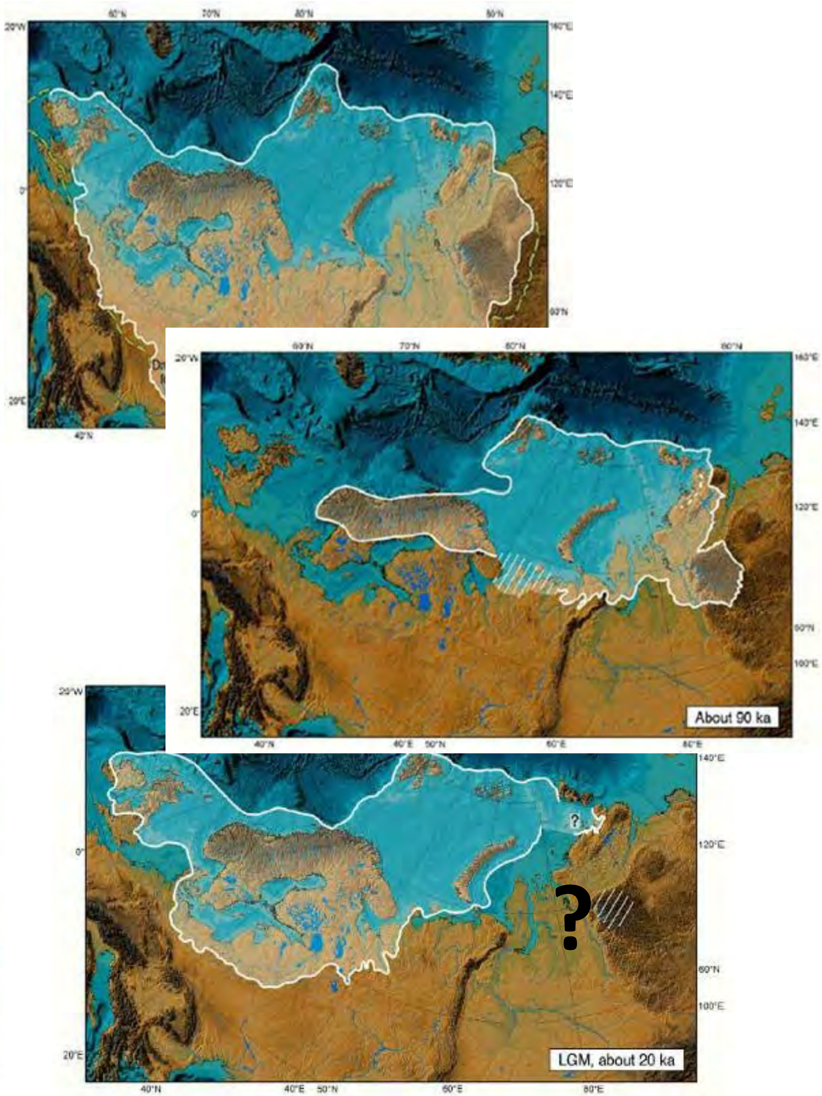
WP. Geological data specification and sourcing
WP. Sea-floor geology
WP. Sea-bed substrate
WP. Coastal behaviour
WP. Geological events and probabilities
WP. Minerals
WP. Data management, web portal and services



Data: European Sea areas VLIZ (2014), MSFD Areas v1.
Coastline: EEA, upload 4th July 2013.
Both datasets modified in EMODnet geology
based on seabed substrate data
(e.g. Faeroe EEZ, Wider Atlantic Sea included in sea areas)
Coordinates: WGS84

Research questions: ice-sheets extent and deglaciation

Hughes et a., 2016



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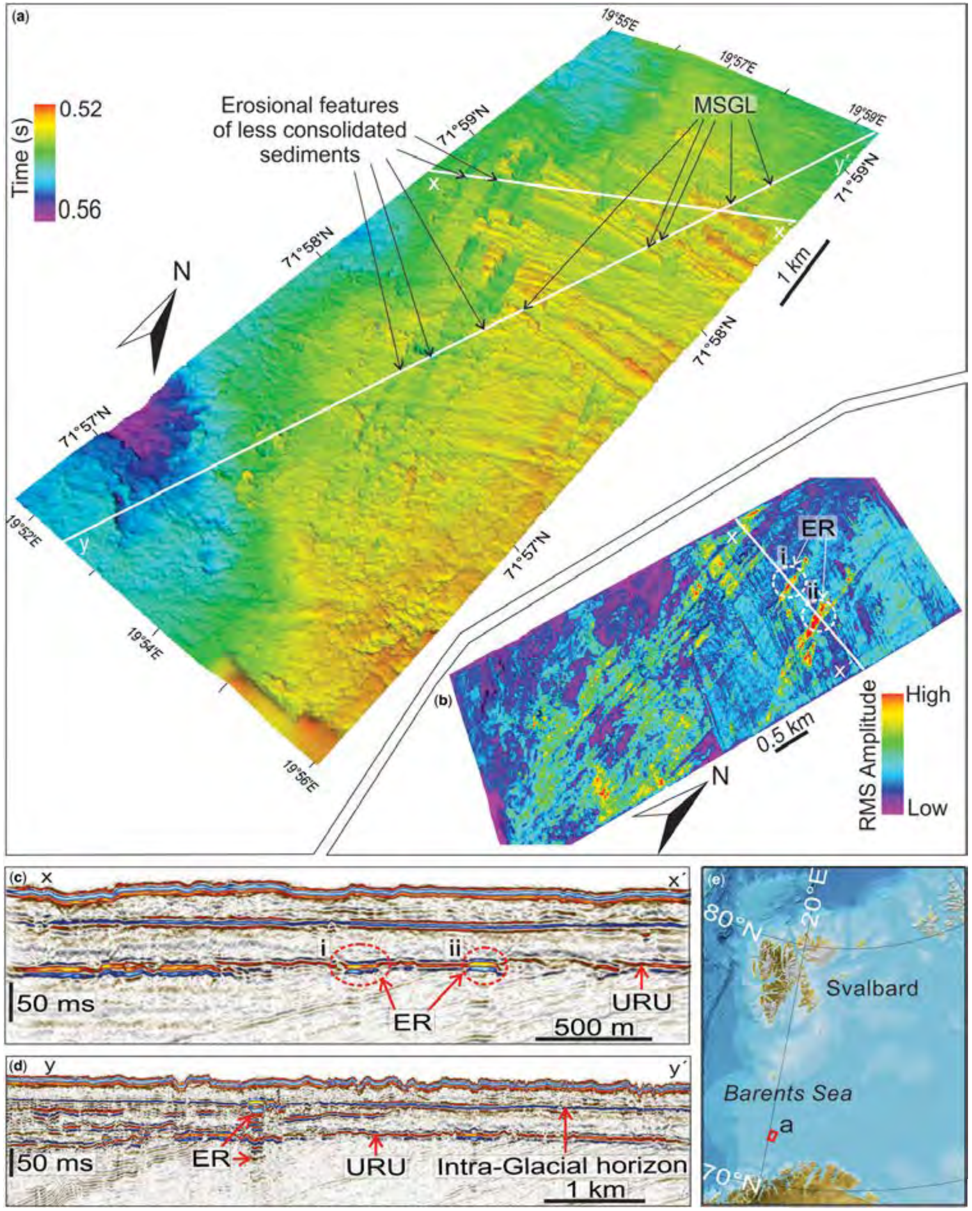
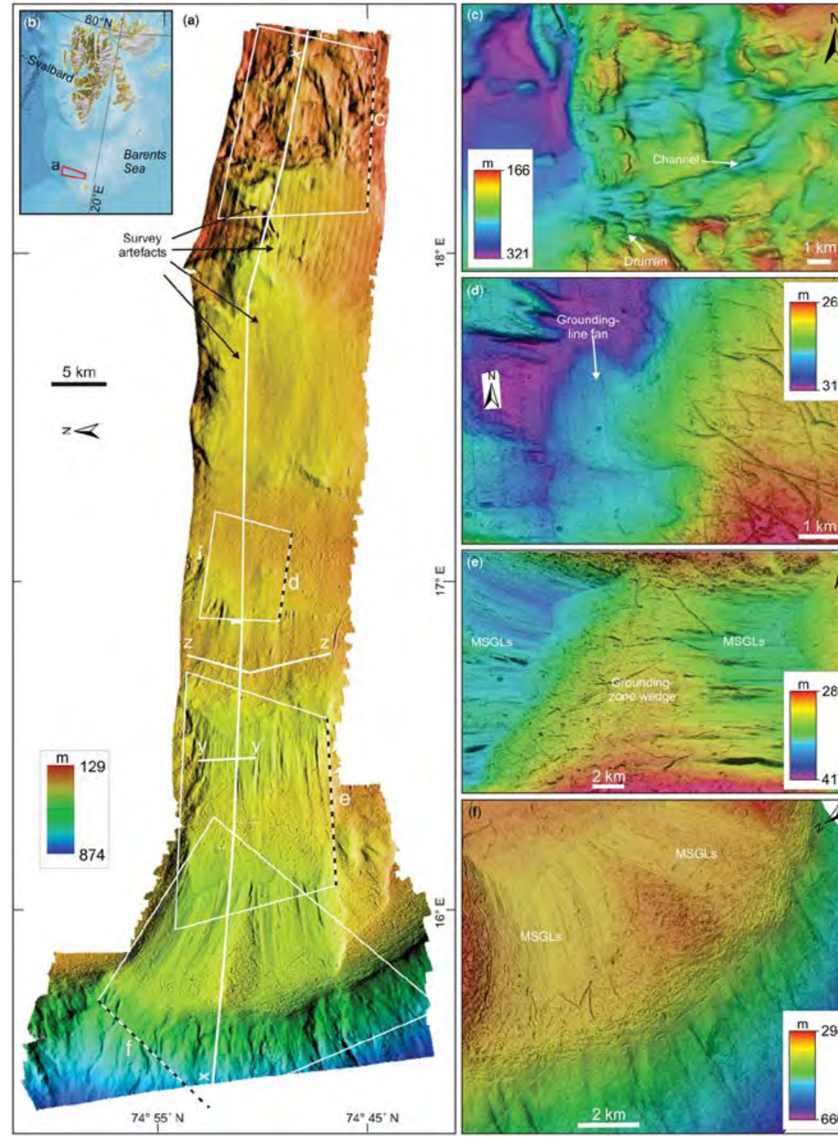
Tasianas et al., 2017



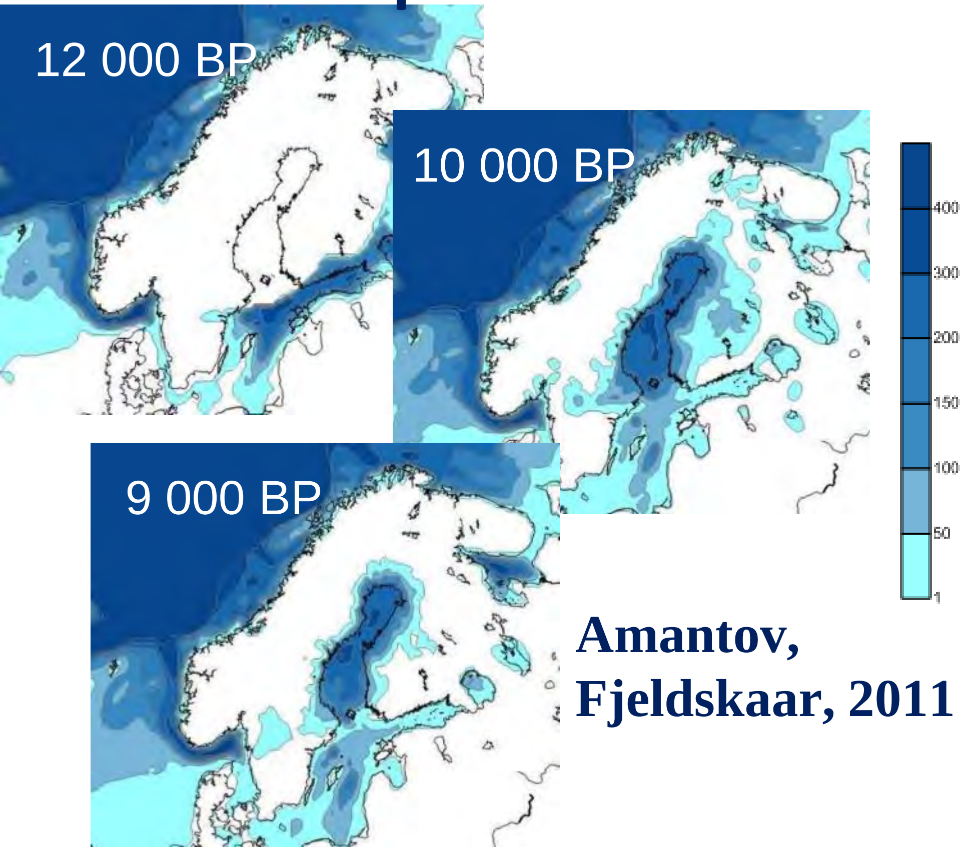
Buried subglacial landforms in the SW Barents Sea imaged using high-resolution P-Cable seismic data.

Bjarnado & Andreasen, 2017

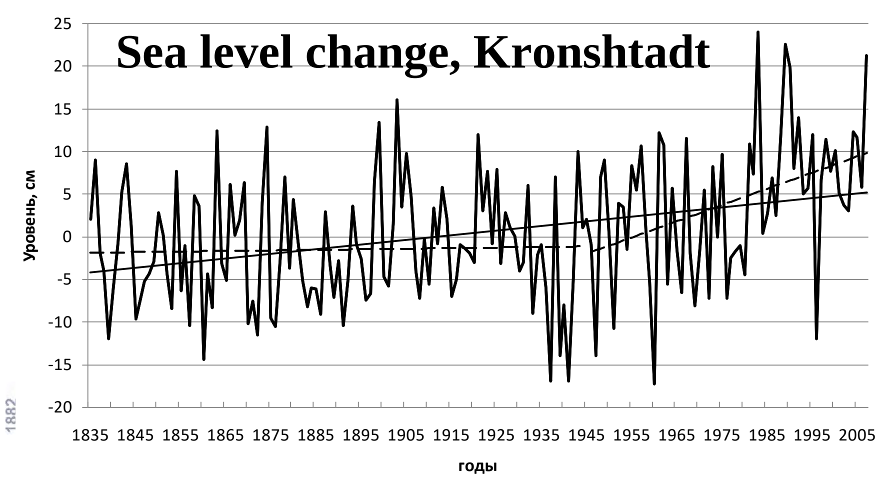


Multibeam swath bathymetry from Kveithola Trough, western Barents Sea. (a) Swath-bathymetric image showing trough geomorphology.

Research questions: ice-sheets extent and deglaciation

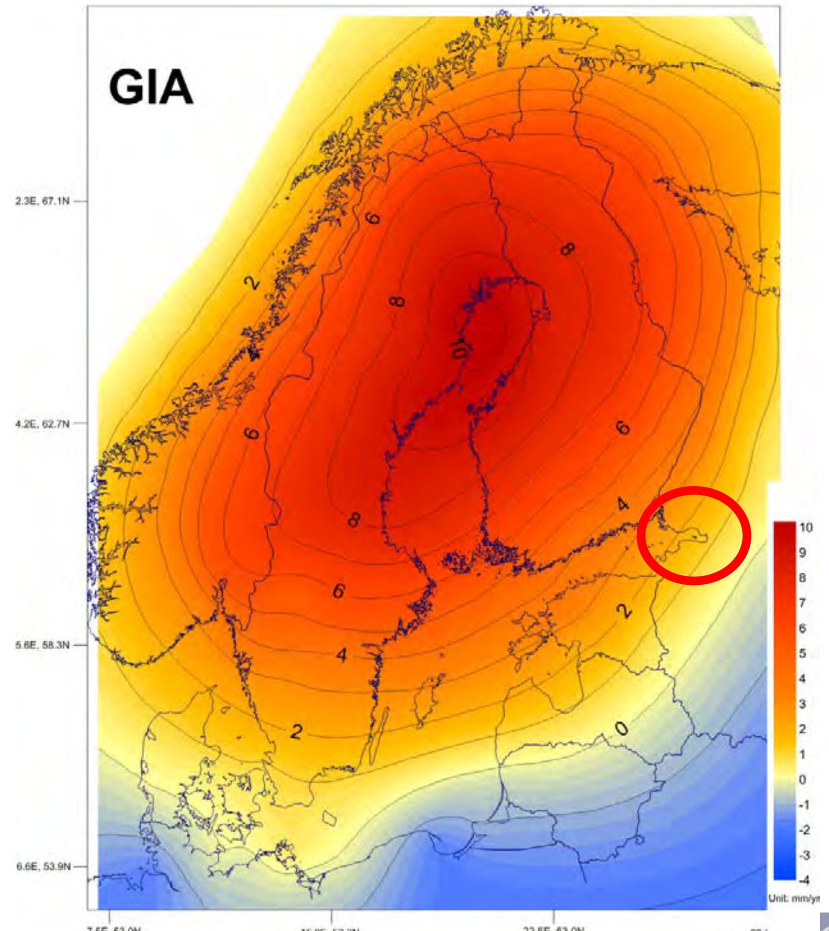


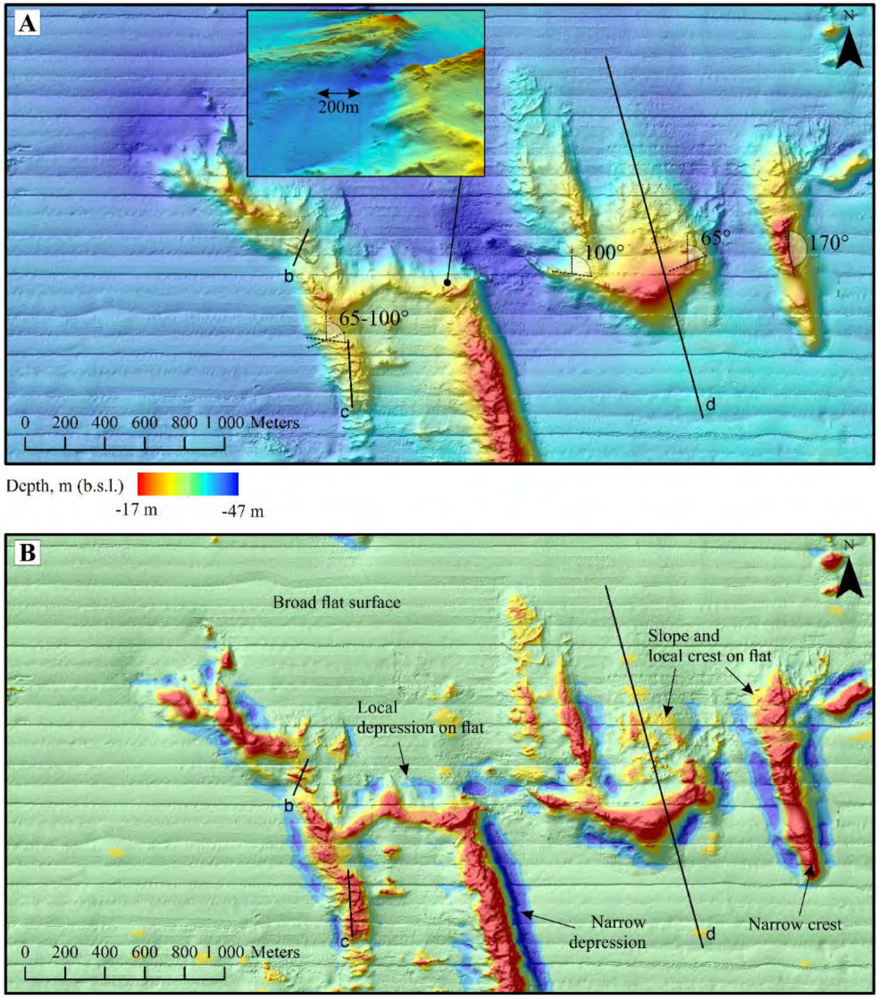
Amantov, Fjeldskaar, 2011



Eastern Gulf of Finland

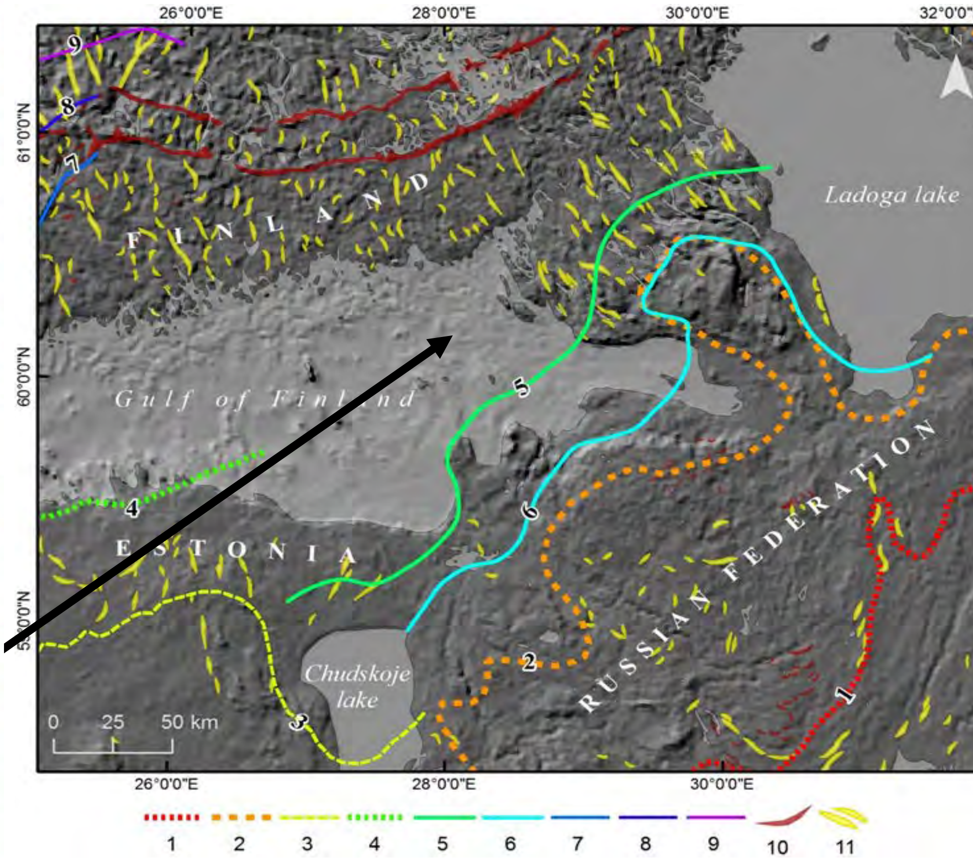
Harff, 2017





Amantov, Amantova, 2017

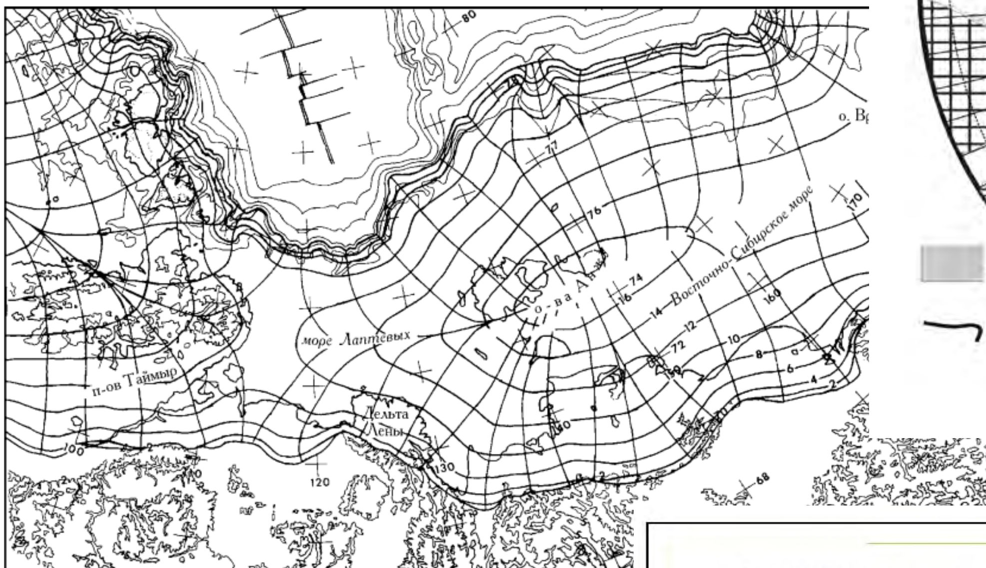
Salpausselkä I (12.25-11.5 ka BP (Saarnisto & Saarinen 2001; Hang 2003; Kalm 2006; Subetto 2009; Hang & Kohv 2013)

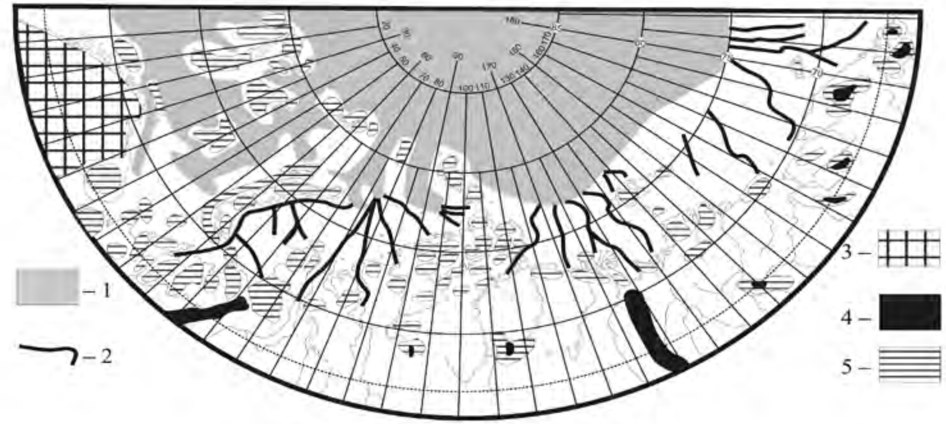


13.3-13.5 ka BP (Vassiljev et al., 2013) or 12.7 ka BP (Vassiljev et al., 2011)

14.5 ka BP or 13.8-13.3 ka BP (Kalm 2006; Vassiljev et al., 2011Vassiljev et al., 2013)

Research questions: ice-sheets extent and deglaciation



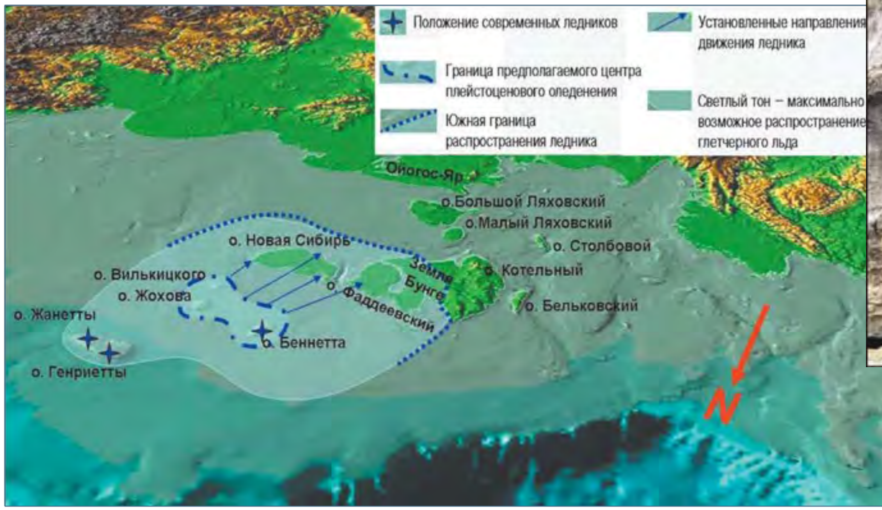


Bolshiyanov, 2004-2011

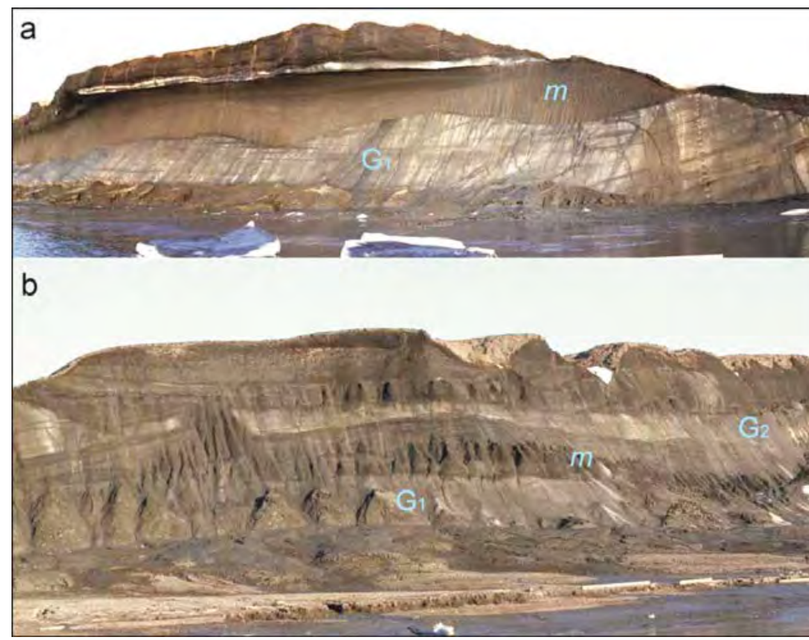
Hughes, 1998
Grosswald, 2009

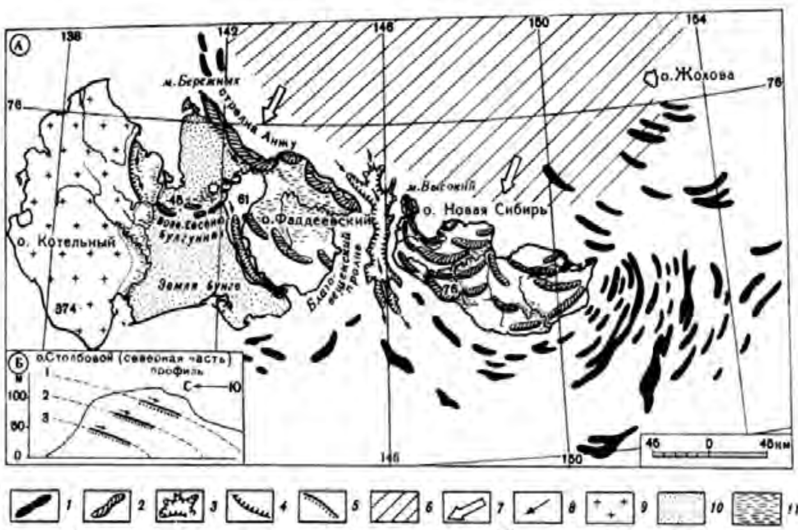
Zastrozhnov (VSEGEI), 2020

Novaya Sibir' Island



Basylian, Nikolsky, 2007

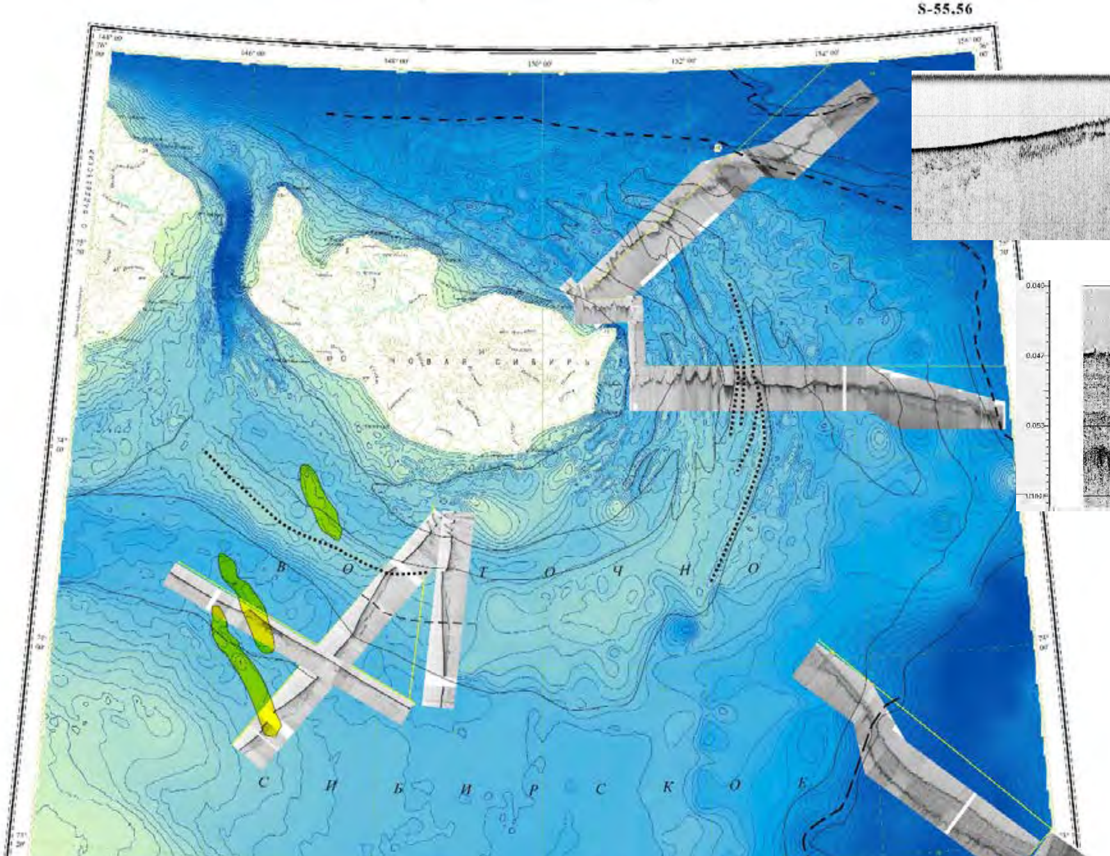


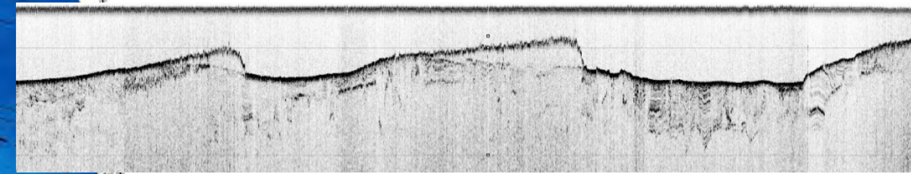


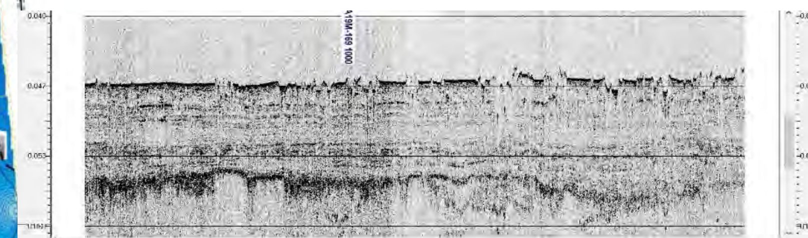
Nikiforov, 1985

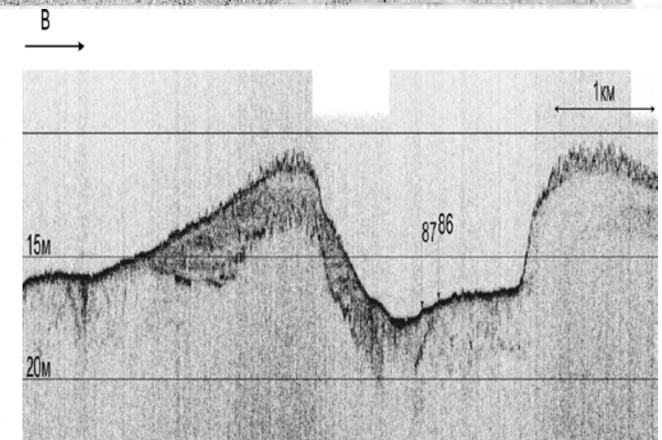
Tumskoy, 2009

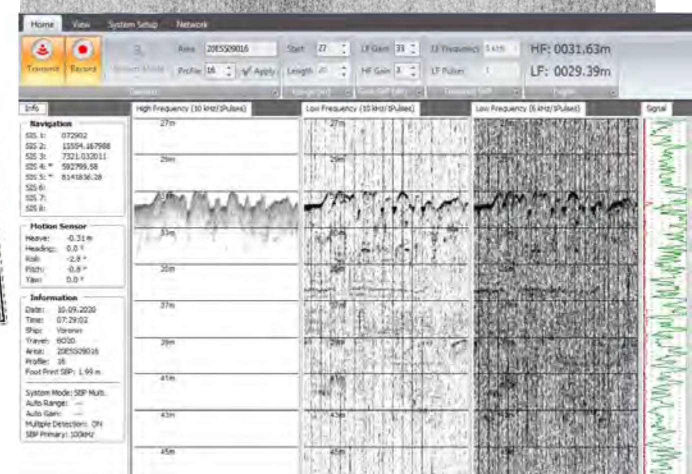
VSEGEI, 2020)



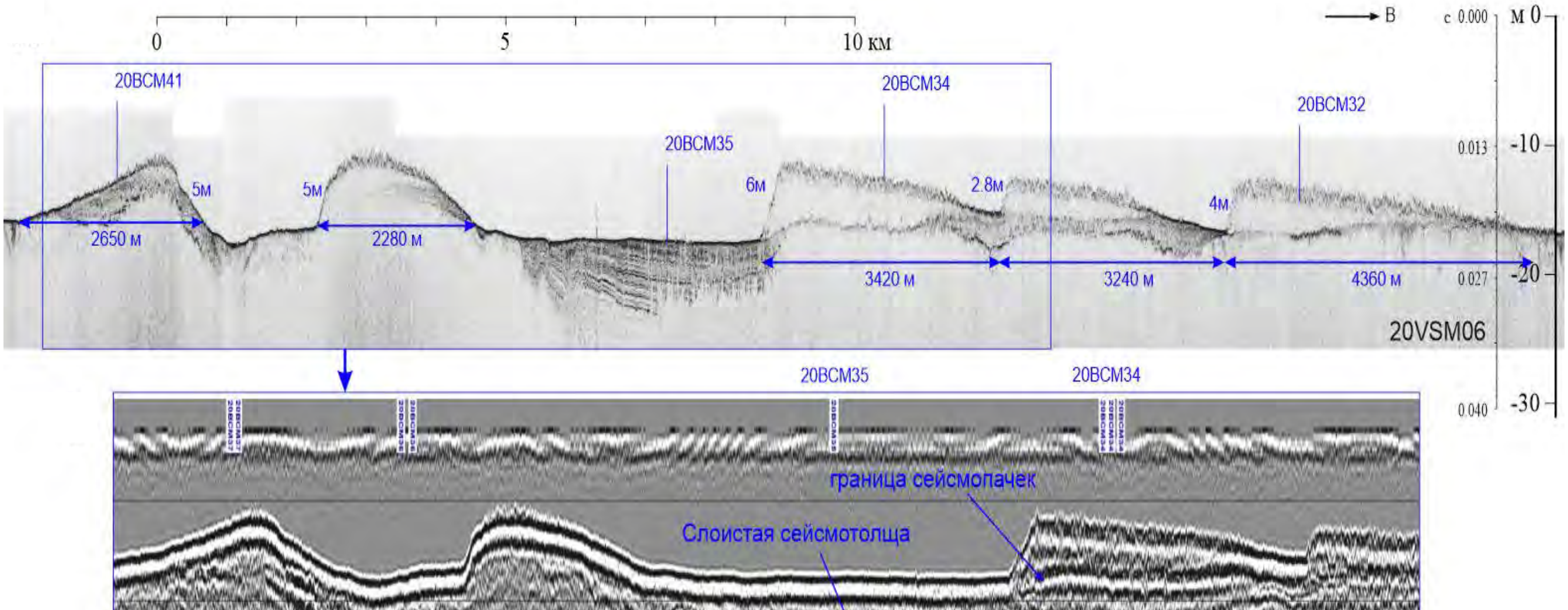






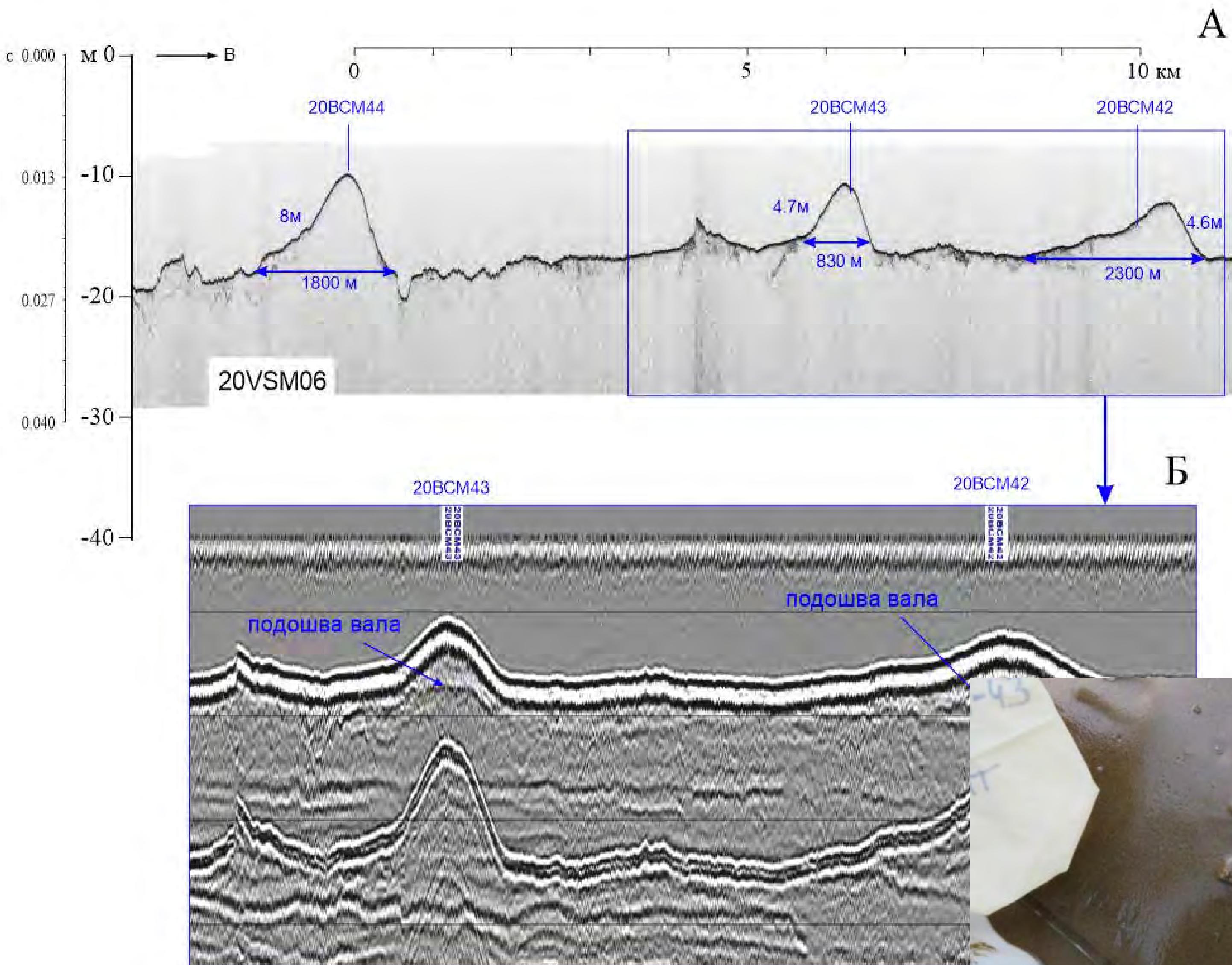


R/V "Capitan Voronin" (Moscow University)
Cruise leader Igor Neevin (VSEGEI)



Interpretation by Alexander Sergeev, Leonid Budanov

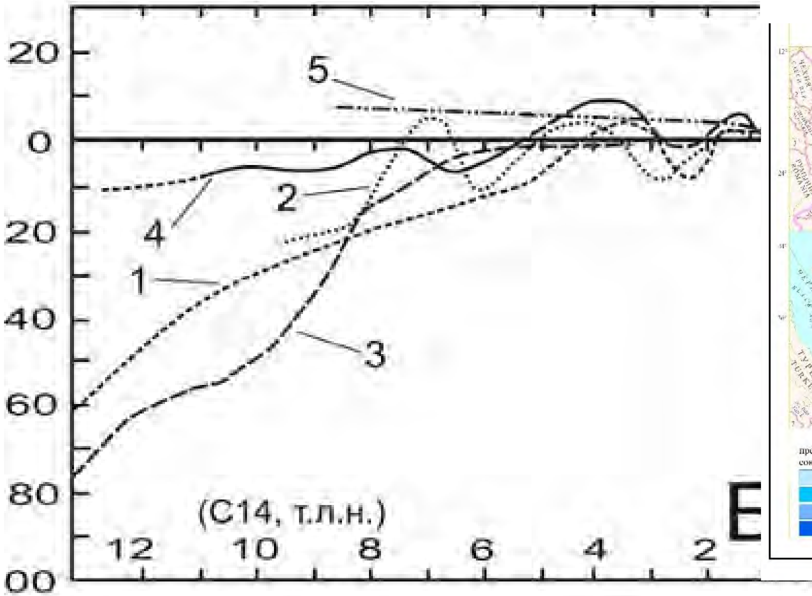
Dense clay (core depth50-60 cm), site 20-BCM-32



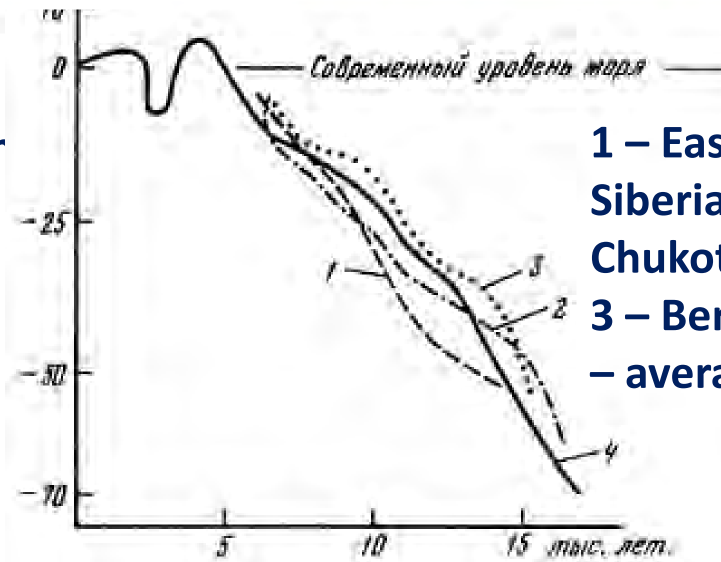
Interpretation by Alexander Sergeev, Leonid Budanov

Box-corer, site 20-BCM-43

Research questions: Holocene sea-level change

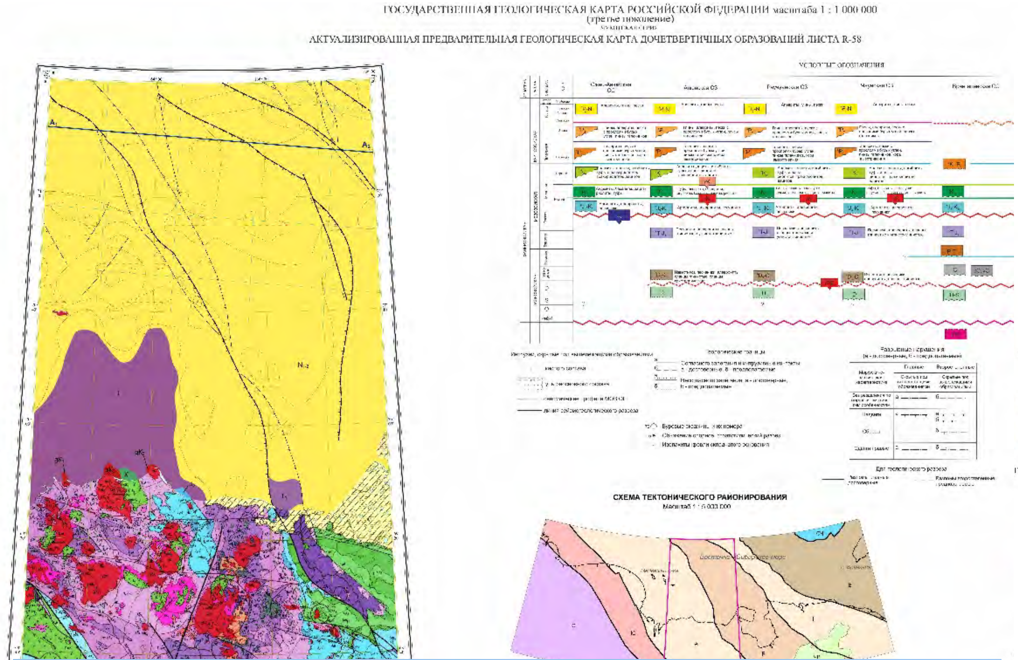


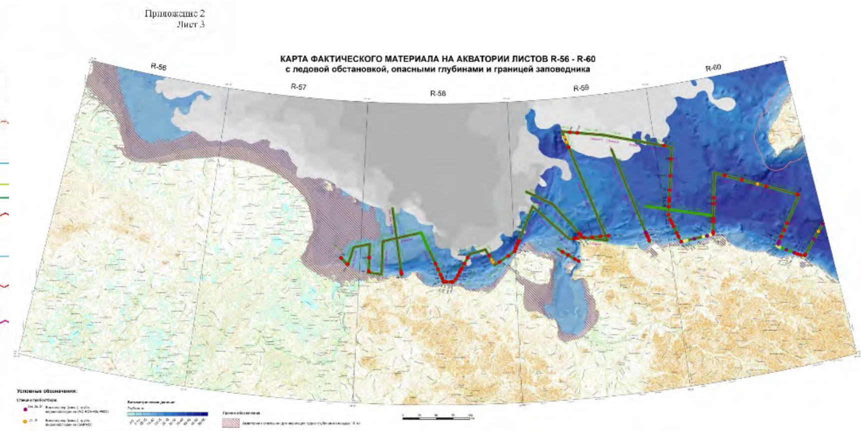
1 – seas of the Eastern Arctic and Bering Strait (Дегтяренко и др., 1982); 2 – Eastern Siberian Sea (Селиванов, 1995); 3 – Laptev Sea (Bauch et al., 2001); 4 – Eastern Siberian Sea (near Zhokhov Island) (Анисимов и др., 2009); 5 – south-eastern part of Bunge Land (Anisimov et al., 2014).

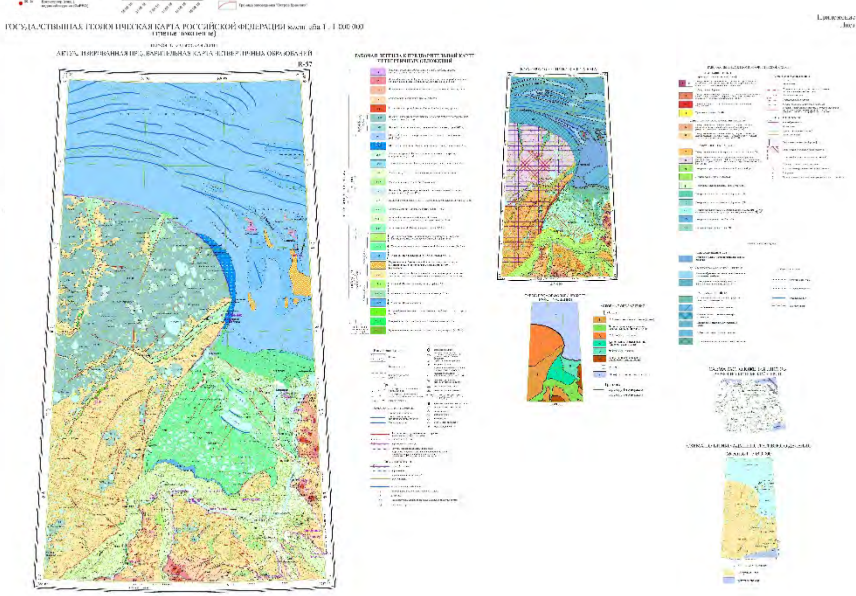


1 – Eastern Siberian Sea; 2 – Chukotskiye Sea; 3 – Bering Sea; 4 – average

State Geological Map 1:1000000, Sheets R56-R60
Eastern Siberian Sea (2018-2020, VSEGEI)







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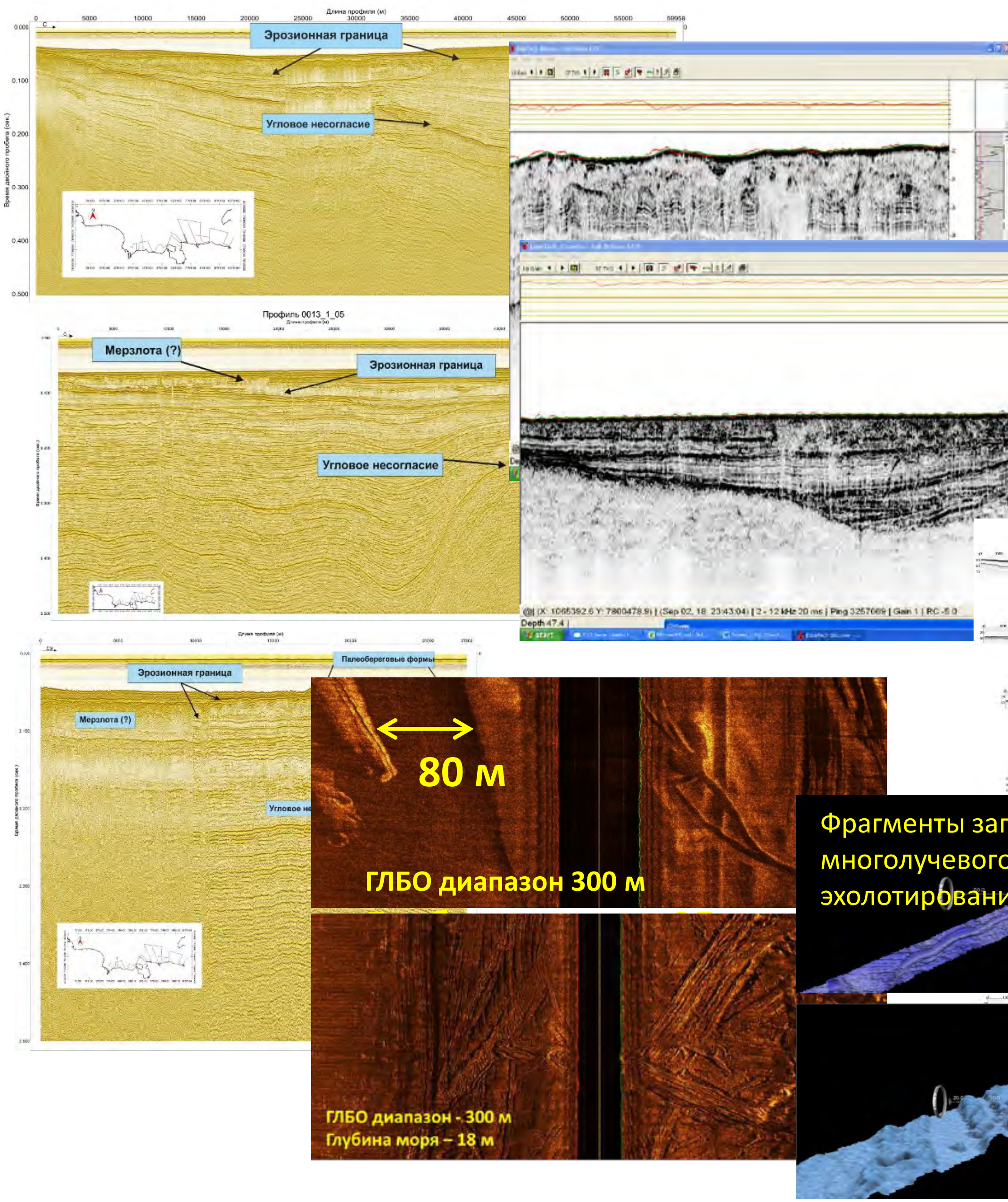
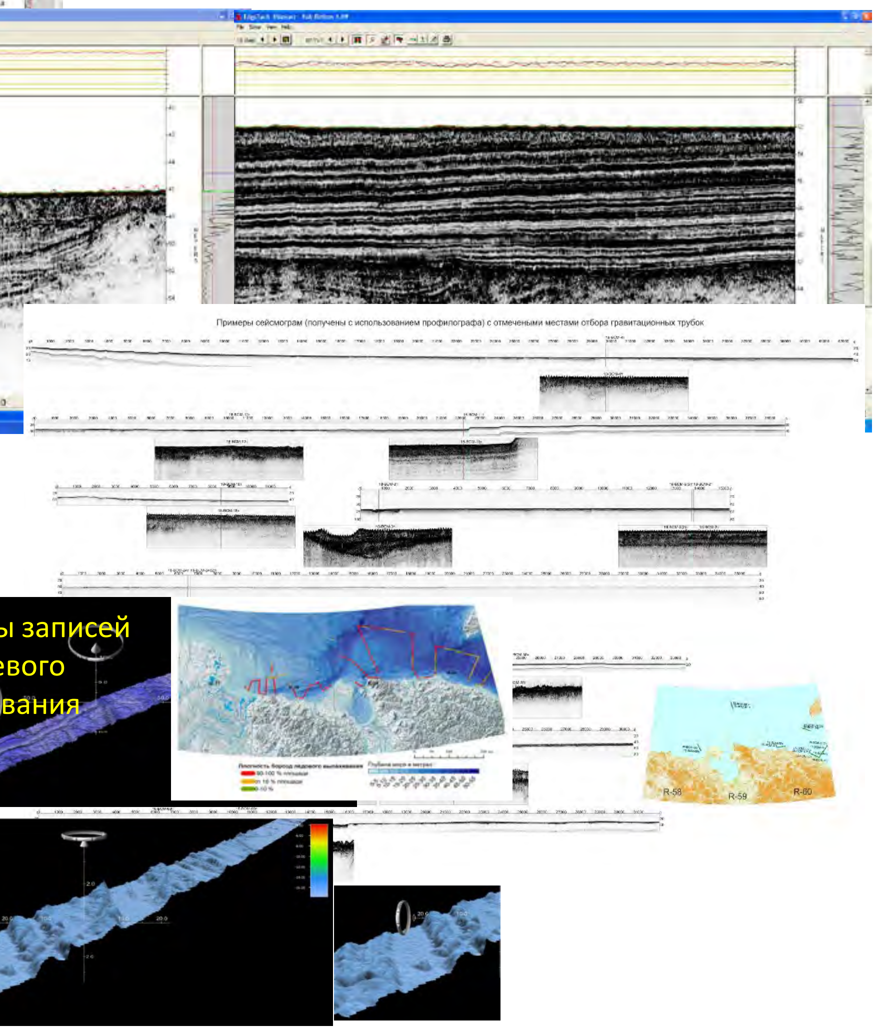
геологический институт им. А.П. Карпинского

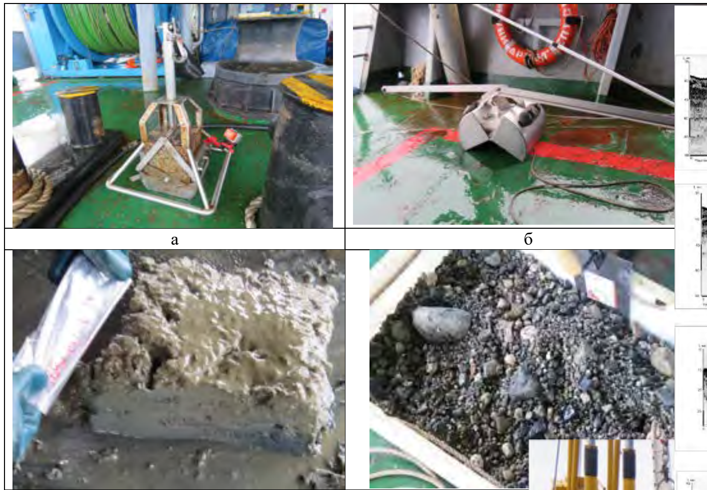
2200 km
of SBP, SSS and MB

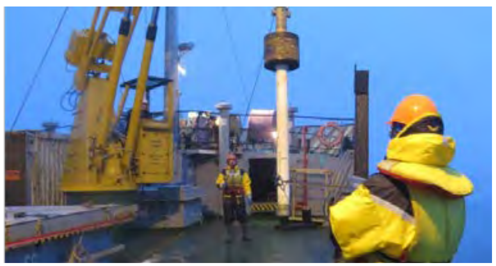


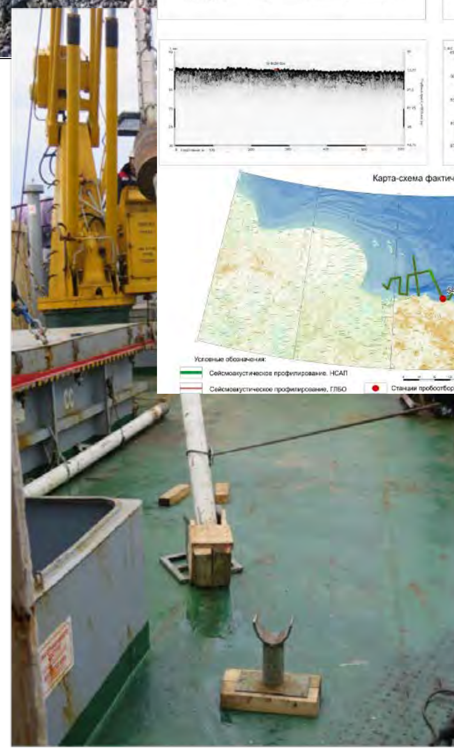


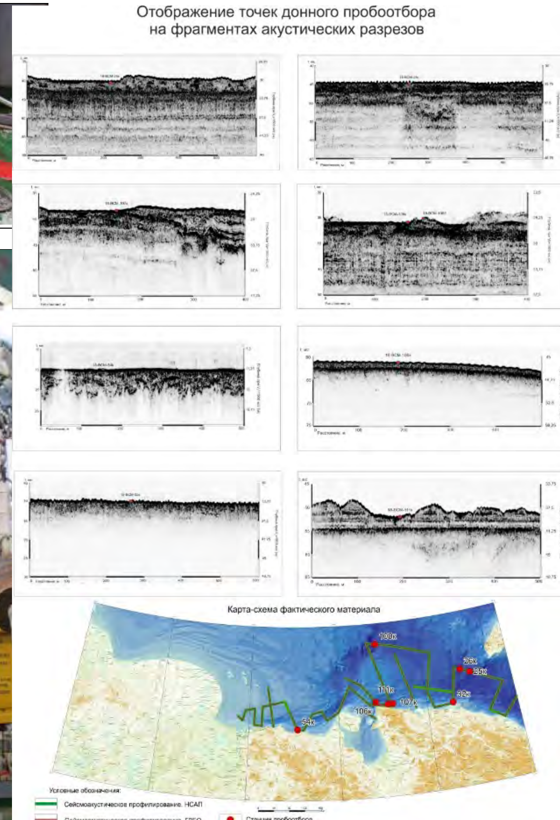
10 cores (up to 2.5 m)

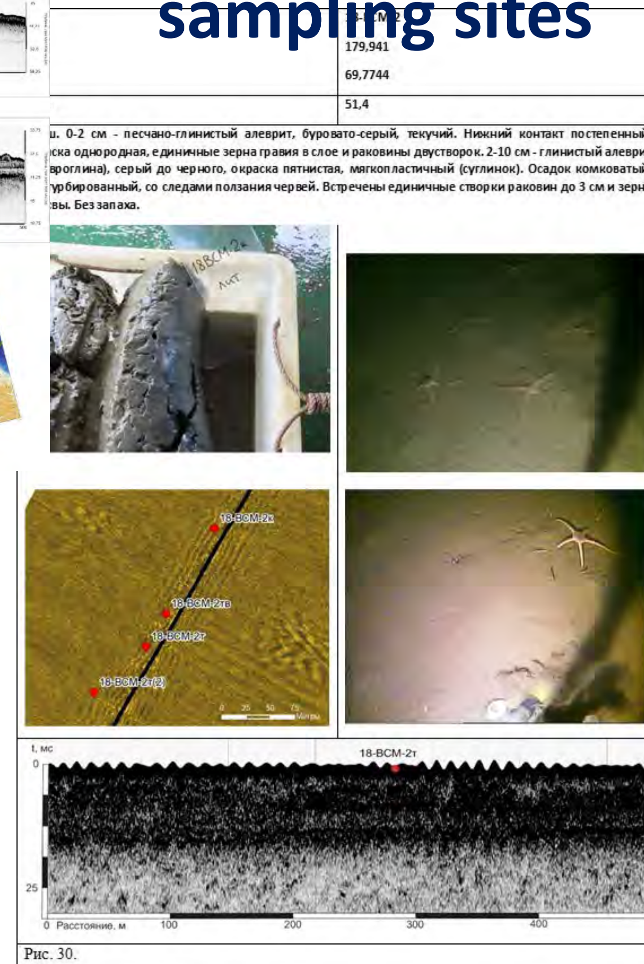
130 surface sampling sites





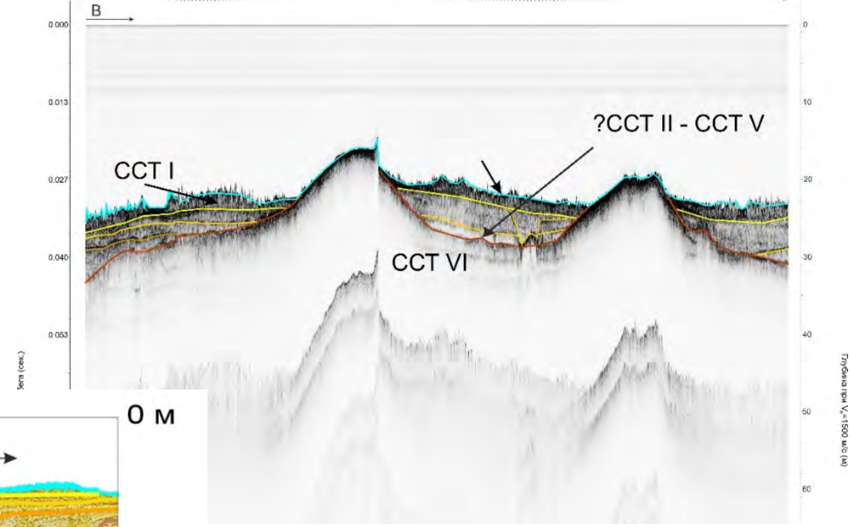


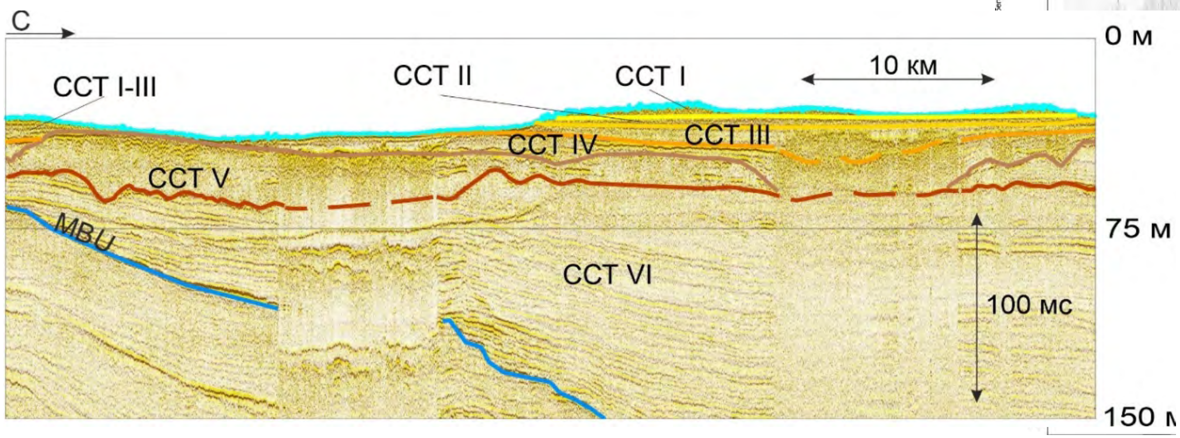


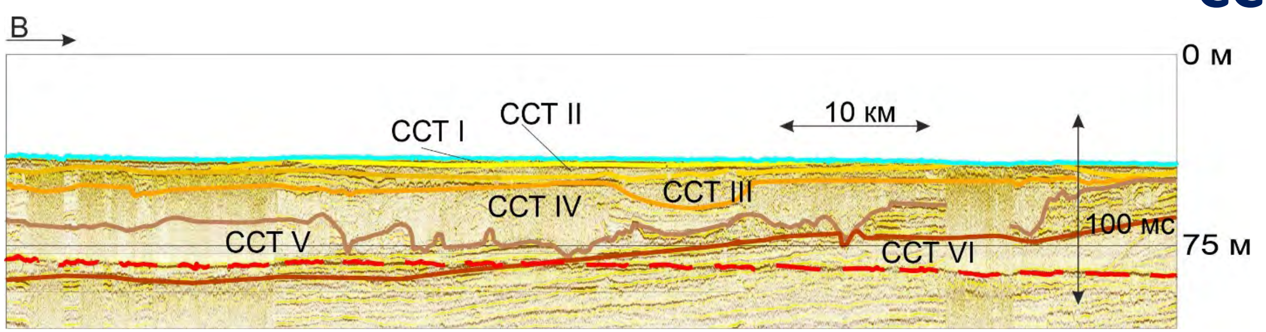


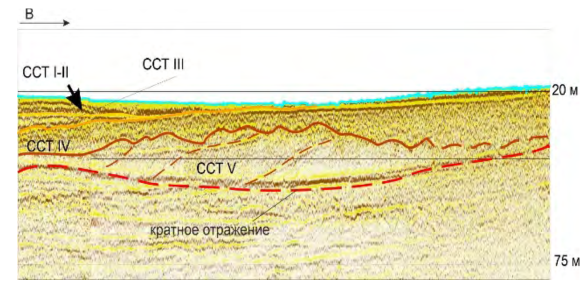
Eastern Siberian Sea

Samples of acoustic-seismic profiles









CCT VI- Ng-Pliocene
CCT V – Pliocene-Calabrian (up to MIS 20)
CCT IV – MIS19-MIS6

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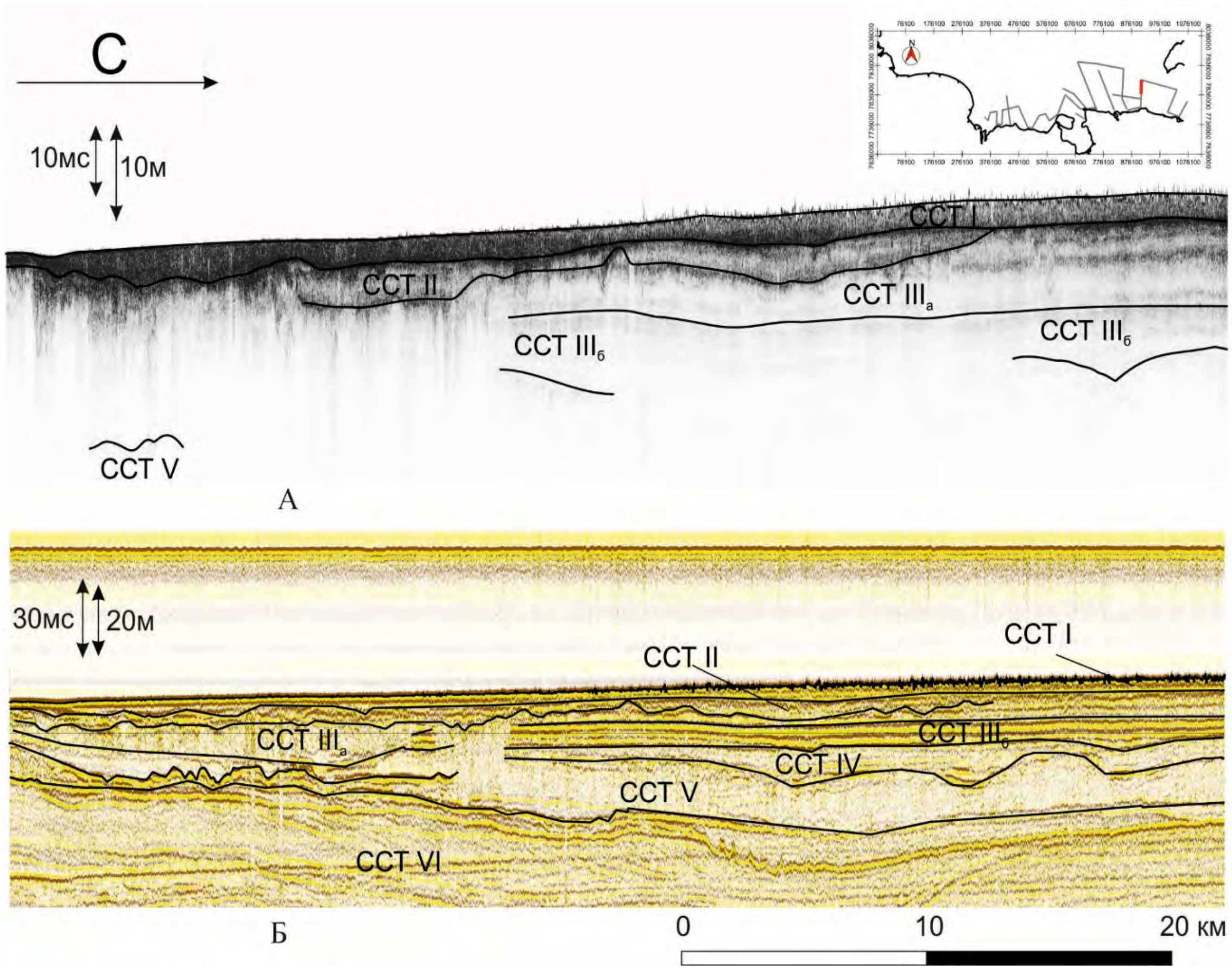
Eastern Siberian Sea

Samples of acoustic-seismic profiles



CCT IIIb – MIS 5
hyathus – MIS 4
CCT IIIa – MIS 3

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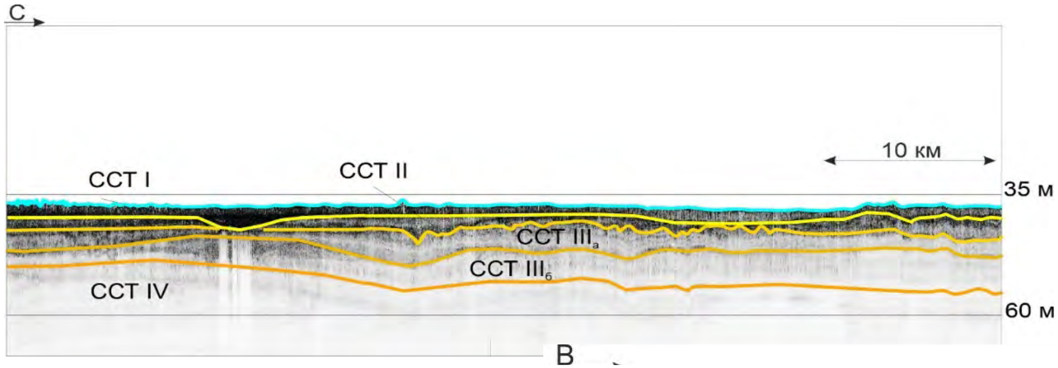
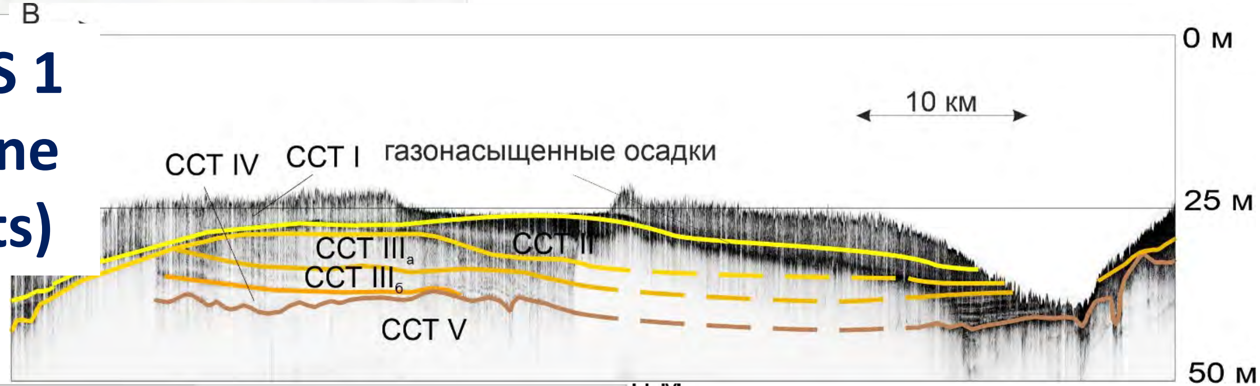
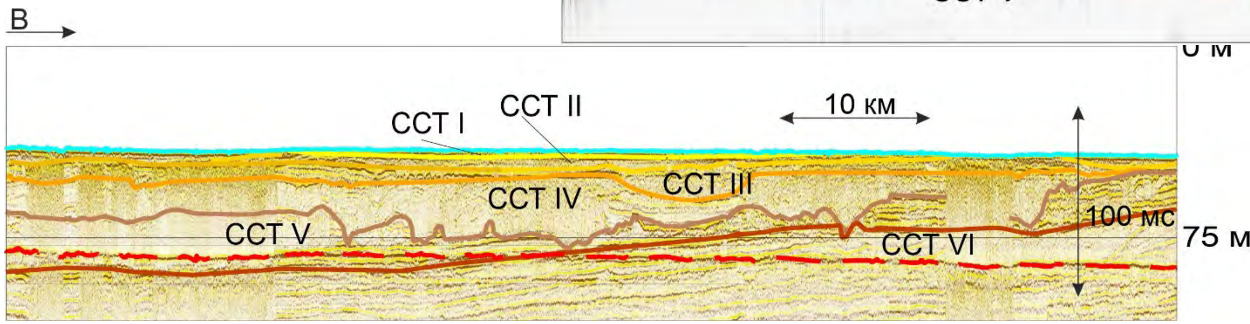
Eastern Siberian Sea

Samples of acoustic-seismic profiles



CCT II – MIS 2 – MIS 1
CCT I – MIS 1 (marine Holocene sediments)





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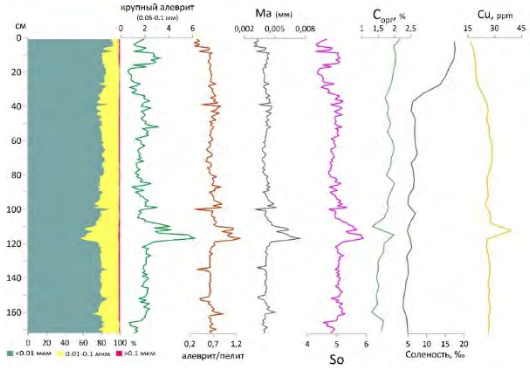
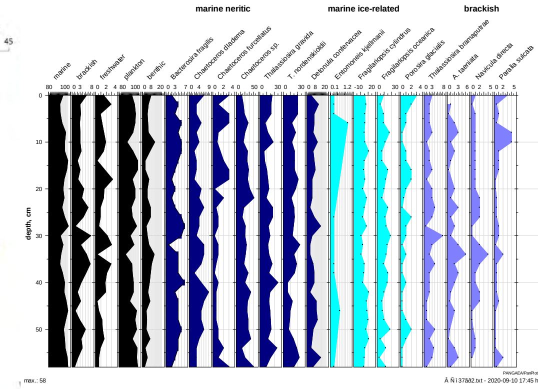
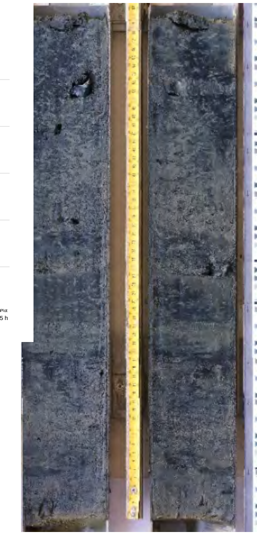
Sediment cores

18-BCM-3





18-BCM-37



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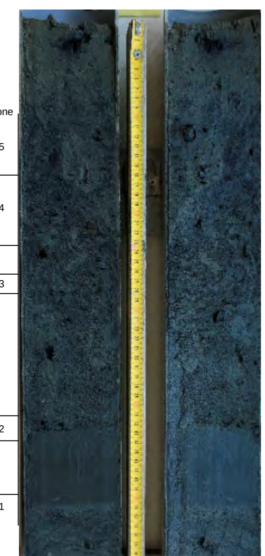
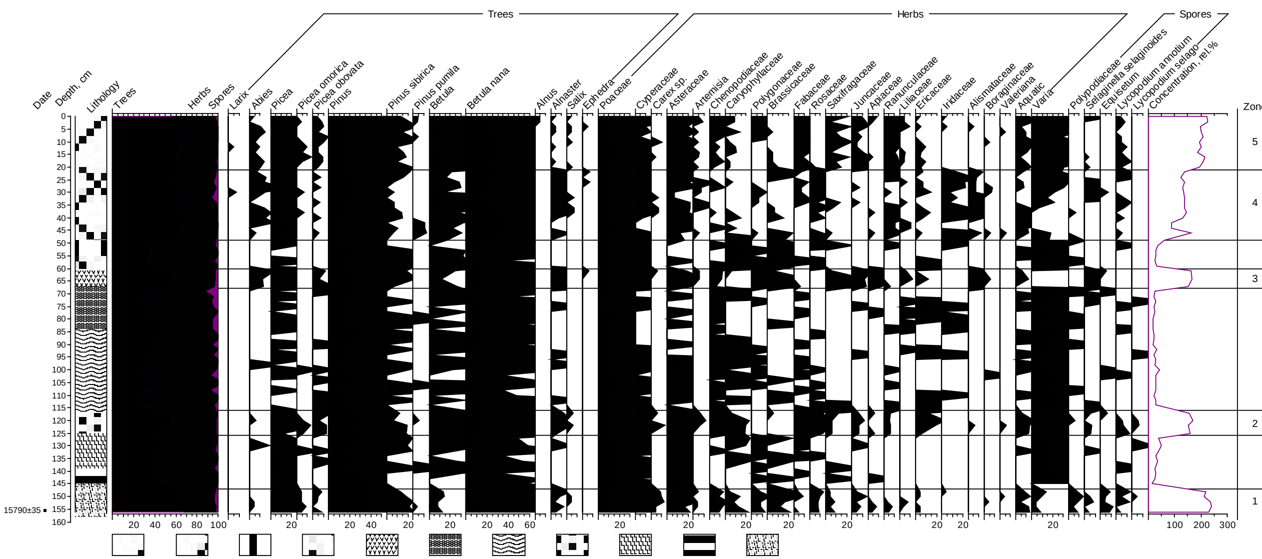
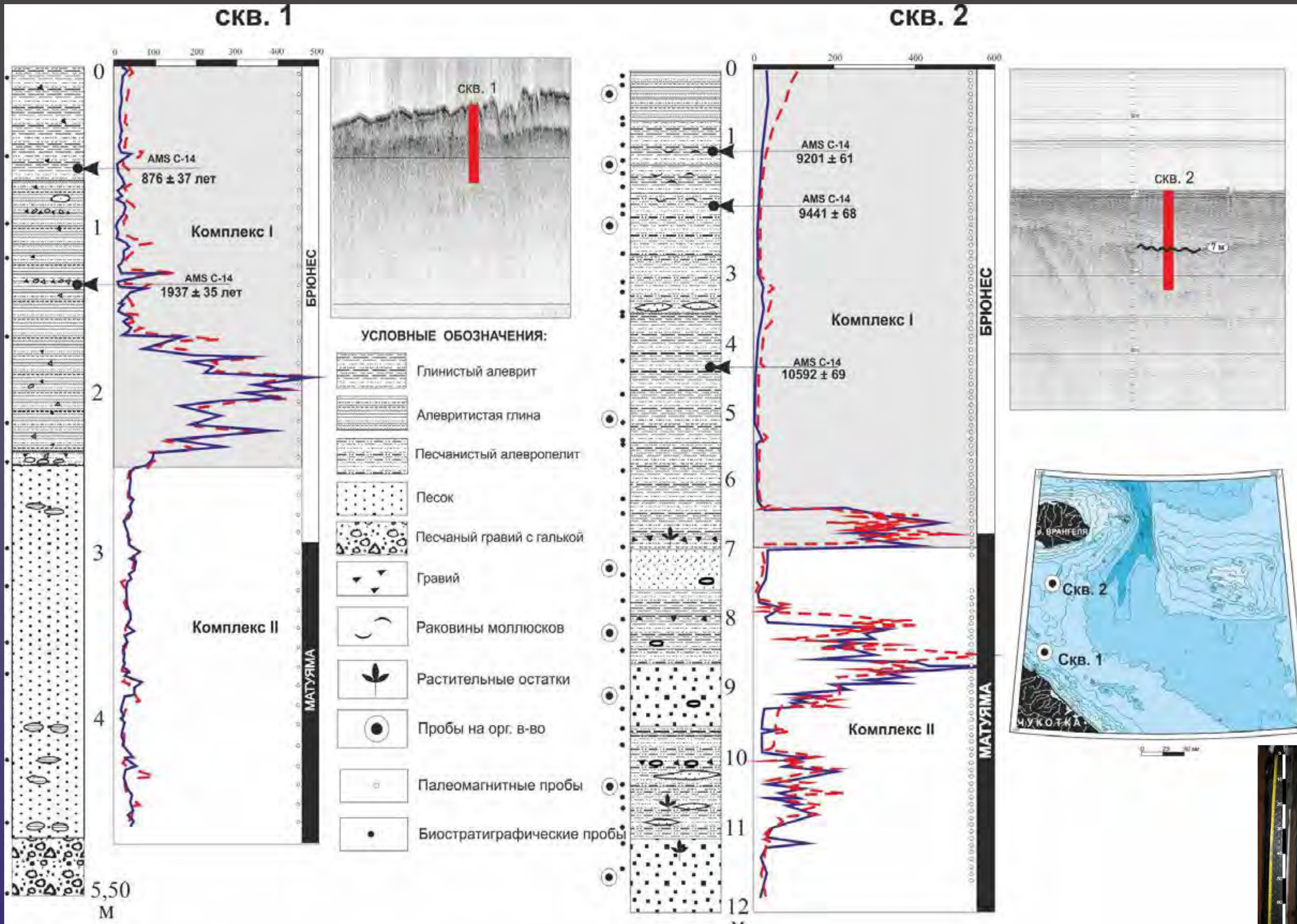
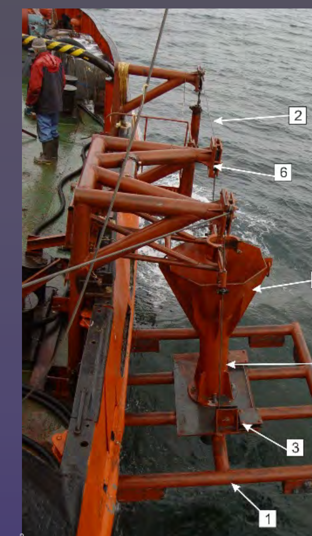




Shallow boreholes in Chukchi Sea.





Coastal processes. Barents Sea (Kola Pennincula)

Teriberka Bay

Norway

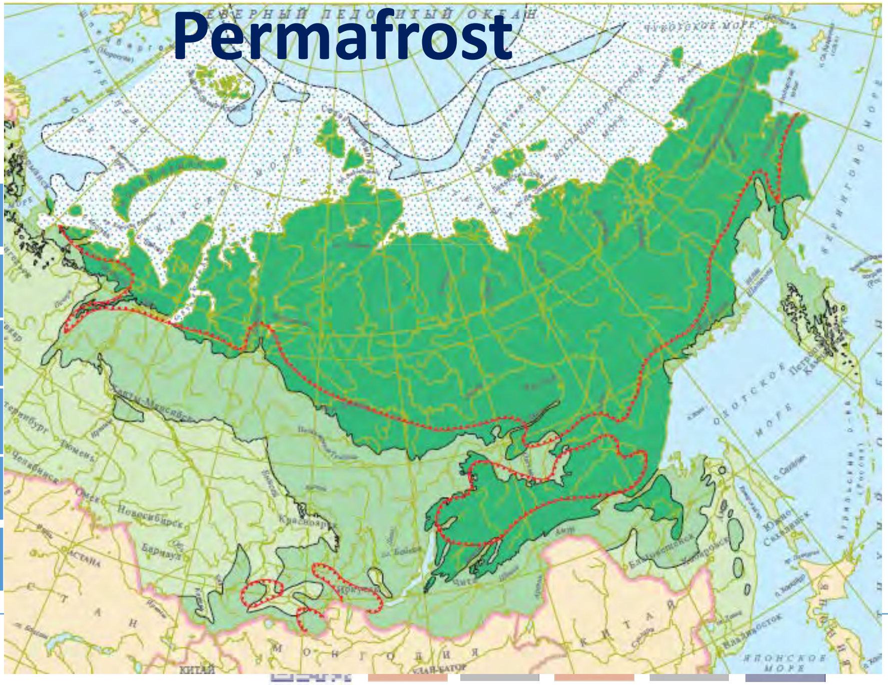
Main features of Russian Arctic coasts development

- coastal erosion in the main source of sediment material;
- sea-ice blocked wave impact during 6 months or longer;
- floating ice can cause temporary accretion processes;
- freezing of beach sediments can protect coast from active erosion;
- permafrost in unconsolidated sediments leads to very fast denudation caused by thermal erosion;
- high development of barrier costs (very changeable).

Ice-free period

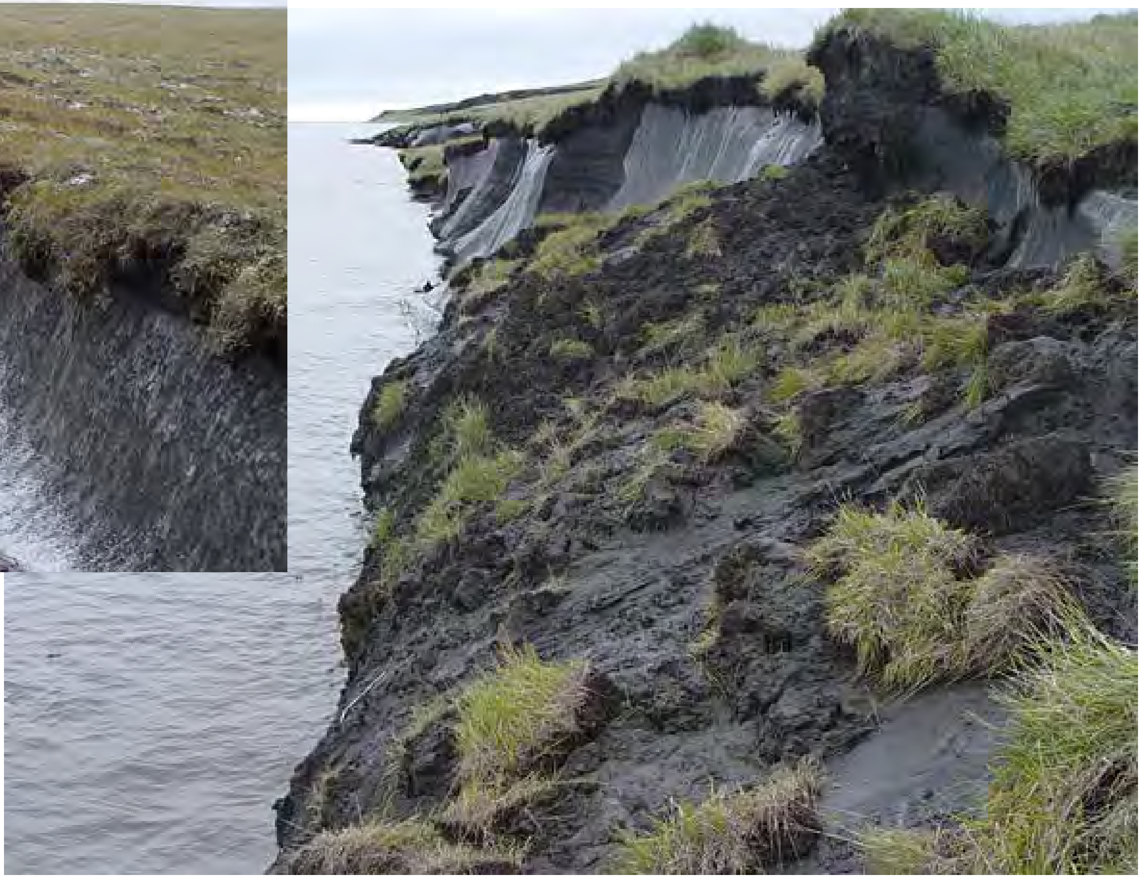
White Sea	June-November (6)
Barents Sea	July-October (4)
Kara Sea	July-September (3)
Laptev Sea	July-September (3)
East-Siberian Sea	August-September (2)
Chukchi Sea	June-October (5)

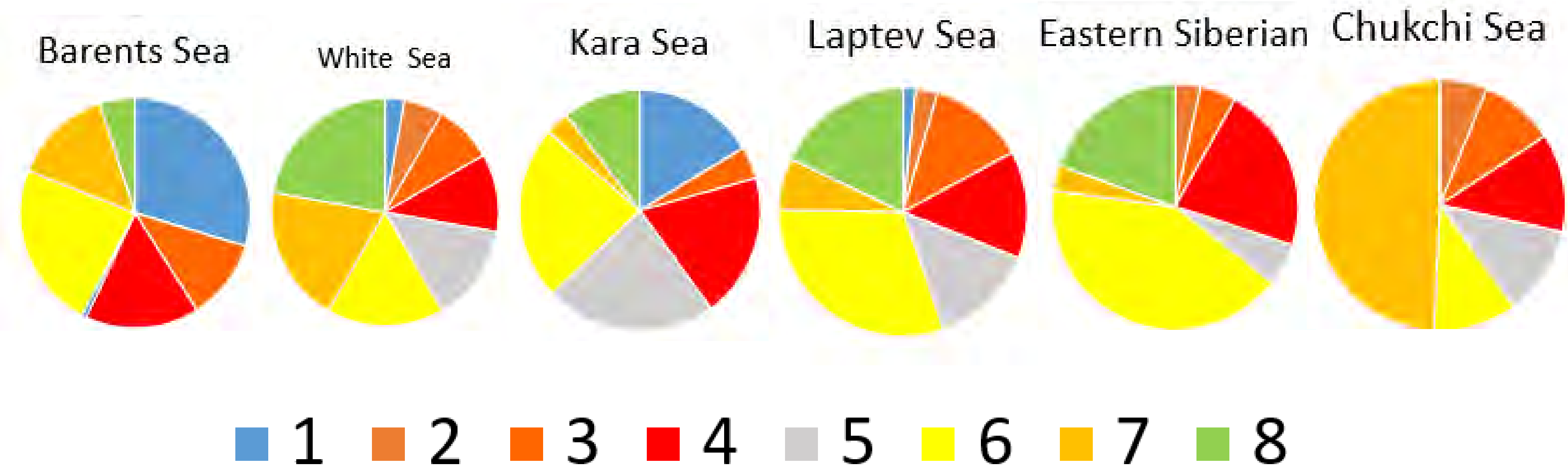
Permafrost



Thermal erosion erosion of unconsolidated permafrost rocks

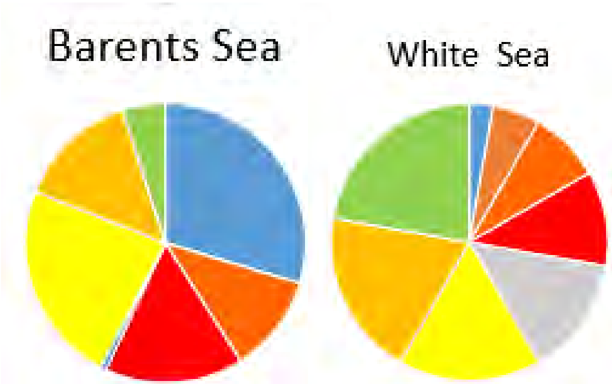
Up to 10-30 m/year

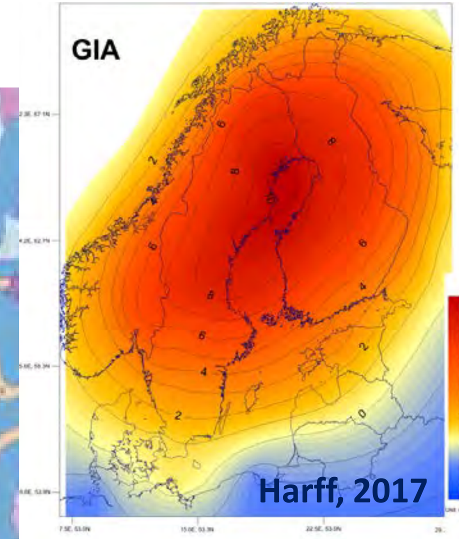




1	Primary coasts (fjords and other rock coasts)
2	Erosion of sedimentary rocks (cliff coasts)
3	Active erosion of unconsolidated sediments
4	Thermal erosion (eroding permafrost coasts)
5	Stable marine deposition/erosion coasts
6	Marine deposition (sand and gravel beaches, spits, bars)
7	Lagoon coasts
8	Delta coasts

Barents and White Seas





Barents Sea

Rates of coast retreat:

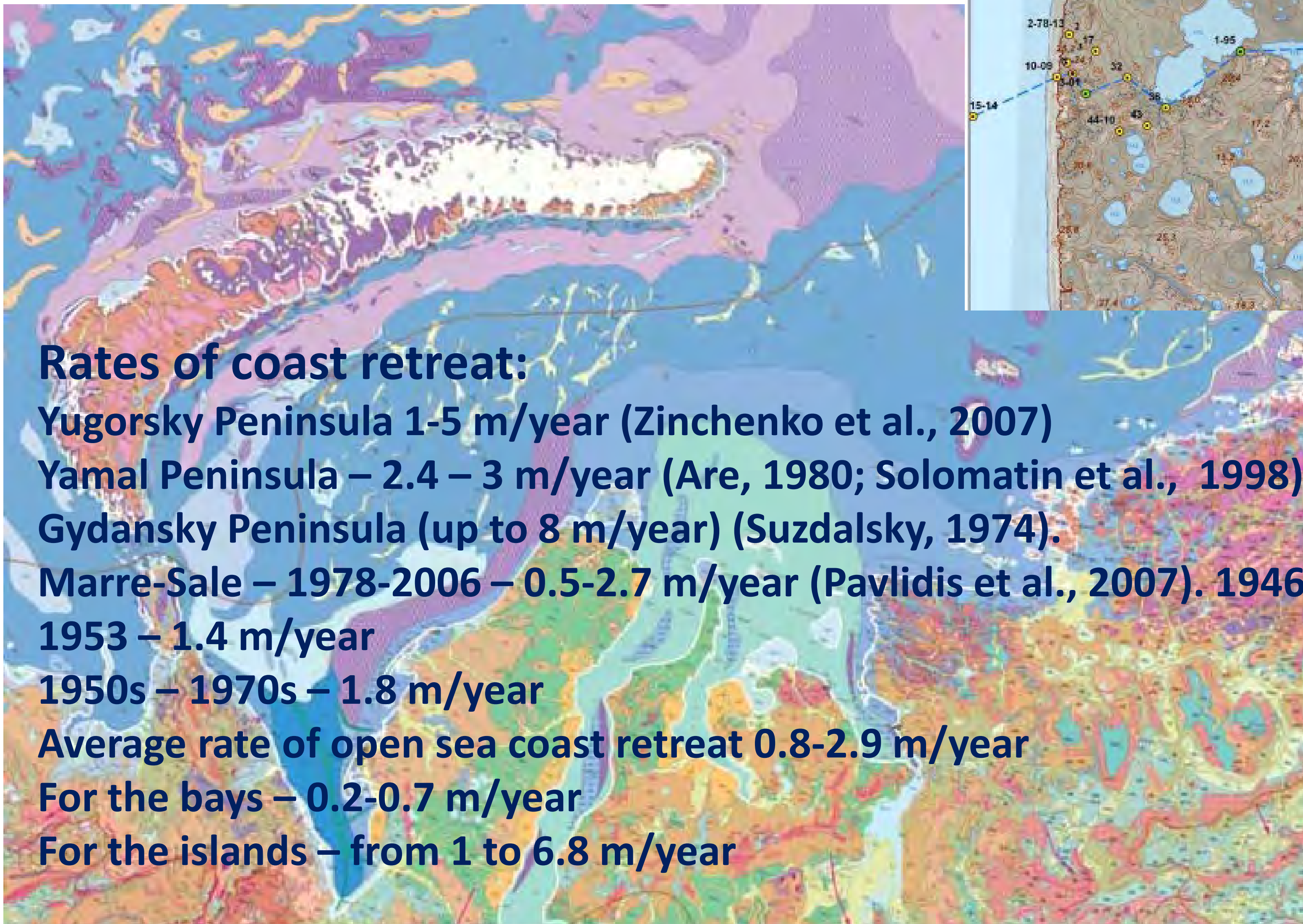
Kanin Peninsula: up to 2 m/year (Suzdalsky, 1974; Gorbatsky, 1970; Are, 1980)

Cheshskaya Bay (eastern coast) - 1.5-3 m/year.

Pechrskaya Bay (between Pesyakov isl. and Medinsky Zavorot Peninsula) - 0.5 – 2.5 m/year (Ogorodov, 2004).

Ice coasts of Victoria Isl. - 5-6 m/year (Kaplin et al., 1991).

Kara Sea



Rates of coast retreat:

Yugorsky Peninsula 1-5 m/year (Zinchenko et al., 2007)

Yamal Peninsula – 2.4 – 3 m/year (Are, 1980; Solomatin et al., 1998).

Gydansky Peninsula (up to 8 m/year) (Suzdalsky, 1974).

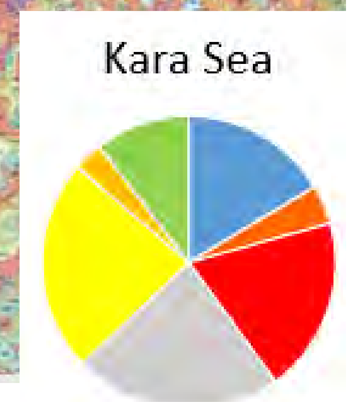
Marre-Sale – 1978-2006 – 0.5-2.7 m/year (Pavlidis et al., 2007). 1946-1953 – 1.4 m/year

1950s – 1970s – 1.8 m/year

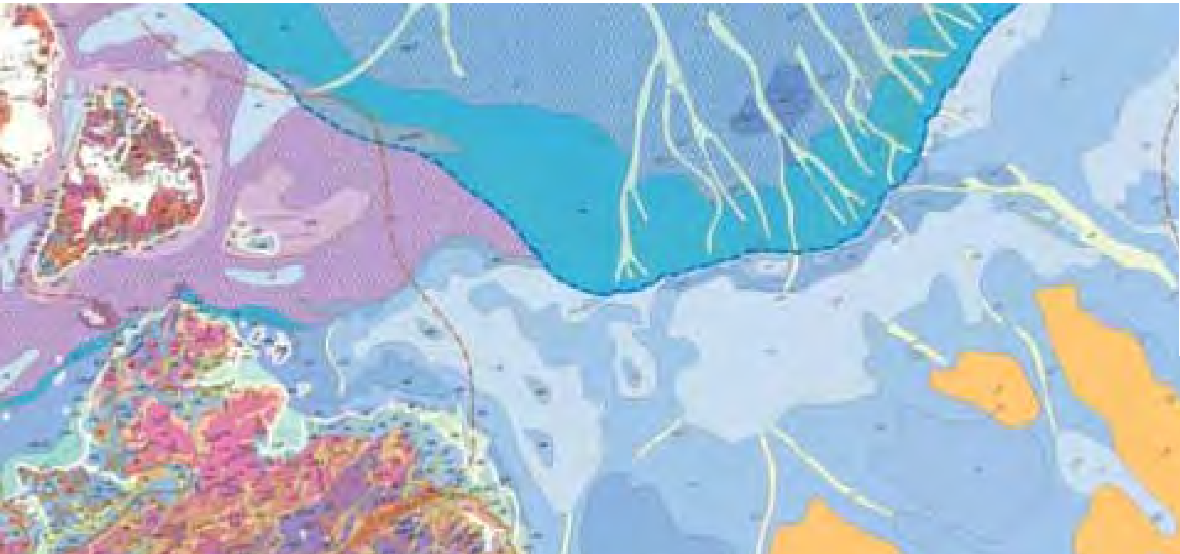
Average rate of open sea coast retreat 0.8-2.9 m/year

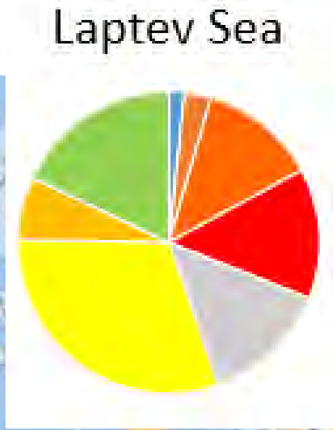
For the bays – 0.2-0.7 m/year

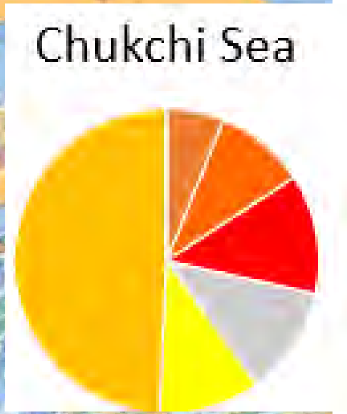
For the islands – from 1 to 6.8 m/year



Laptev Sea and Eastern Siberian Seas Chukchi (Chutotskoye) Sea







Rates of coast retreat:

Muostakch Isl. – up to 18 m/year (Pavvlidis et al., 2007)

Between capes Olenyok and Anabar (station of RAS - 10-20 m/year (Pavlidis et al.., 2007).

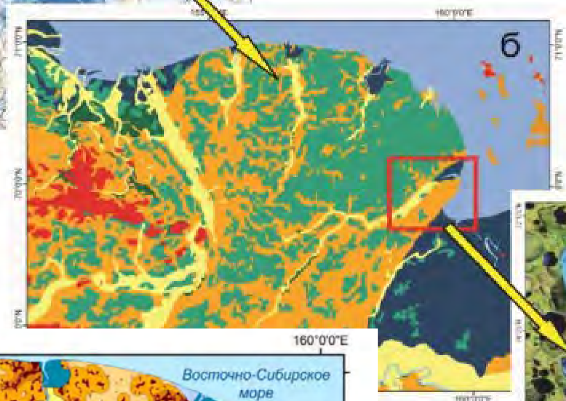
Terpyay Tumus (polar station) - up to 4 m/year) (Kaplinet al., 1991). Islands Vasilievsky and Semenovsky has disappeared since 1823 (erosion rate up to 55 m/year)

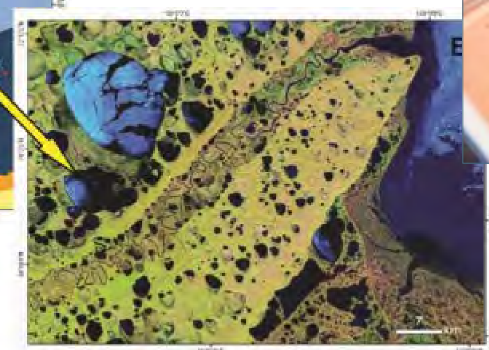
Eastern Siberian Sea from 1-2 m/year to 6.8-11 m/year (Pavlidis et al., 2007)

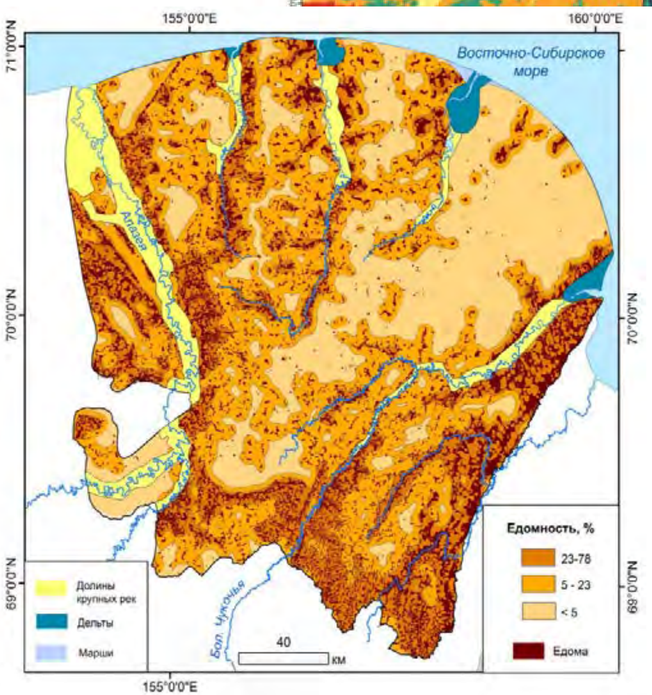
According to mathematical modeling (Leontyev, 2002; Pavlidis et al., 2007) during next 100 year Arctic coasts of Russia can retreated:

Eastern Barents sea – shoreline retreat up to 500 m (low coasts); up to 200 m (4-6 m high coastal terrace); 60-80 m (8-10 m high terrace)
Kara Sea – increasing of ice free time period by 4 months per year. Erosion rate will increase, coastal line retreat will locally reach from 50 m (for high coasts) to 80 m (for low coasts).
Eastern Siberian Sea - shoreline retreat up to 100 m to 200 m

Veremeeva, 2017







Basylian et al., 2007

Eurasian Marginal Seas – Past and Future
Background for the project. Russian Baltic and Arctic

Past

1. A huge amount of available information (e.g. different scale geological maps)
2. Many knowledge gaps, a lot of discussions and open questions (climate change e.g. sea-level change, glaciations/interstadials)
3. Scientific research of Quaternary stratigraphy in Eastern Arctic is needed
4. Broad-scale view and modeling can help to solve some problems

Future

1. Coasts of Eurasian Arctic Seas suffer from erosion and very sensitive to climate change
2. Modeling and prognosis of future development is a very important task

“Eurasian Marginal Seas – Past and Future”

project is a great idea

We hope for future cooperation

Thank you for attention!