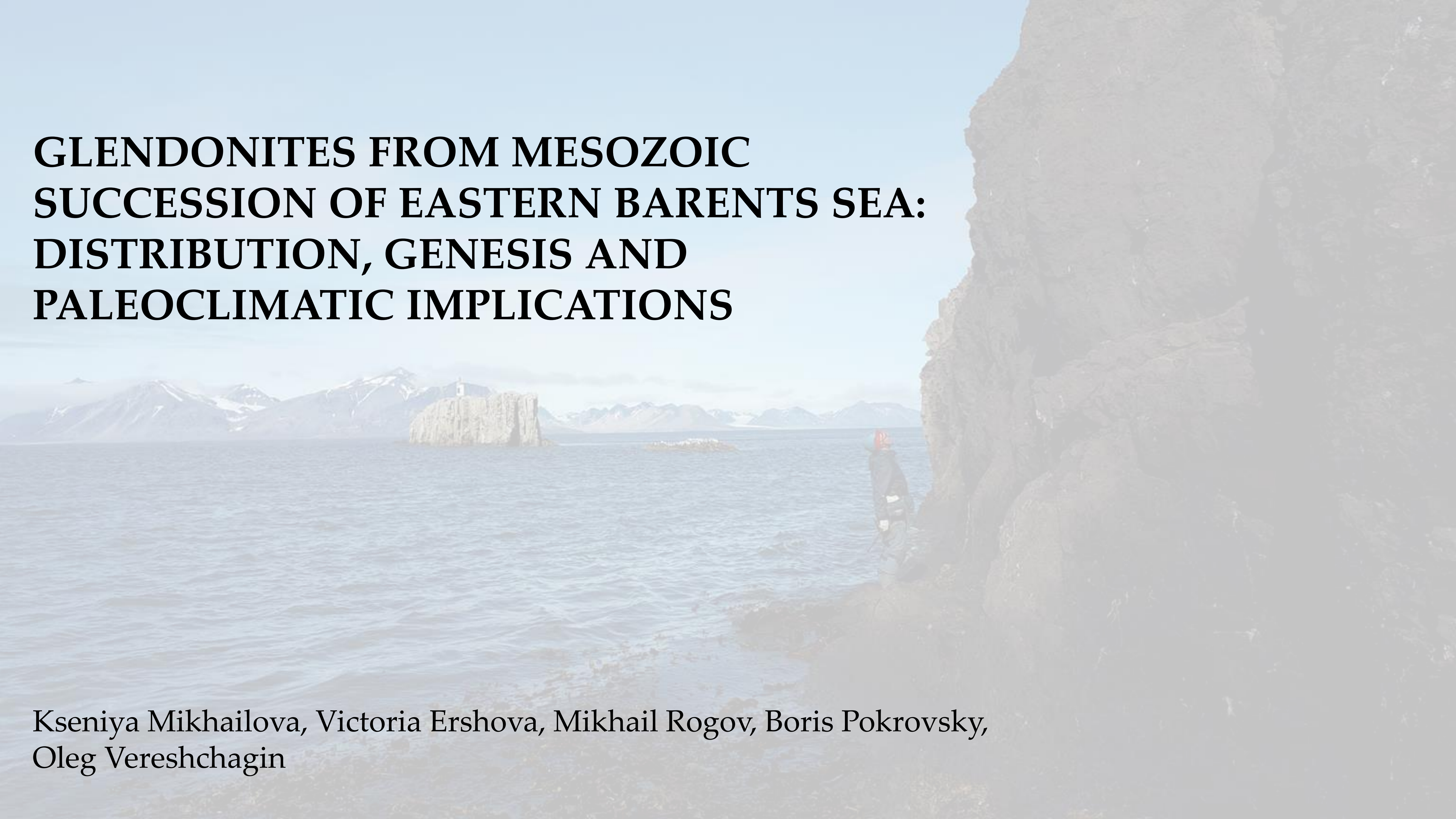


GLENDONITES FROM MESOZOIC SUCCESSION OF EASTERN BARENTS SEA: DISTRIBUTION, GENESIS AND PALEOCLIMATIC IMPLICATIONS

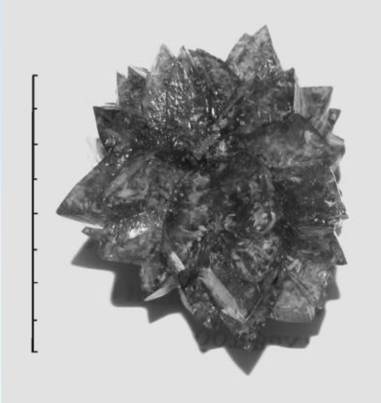
Kseniya Mikhailova, Victoria Ershova, Mikhail Rogov, Boris Pokrovsky,
Oleg Vereshchagin

GLENDONITES = CALCITE PSEUDOMORPHS OF IKAITE

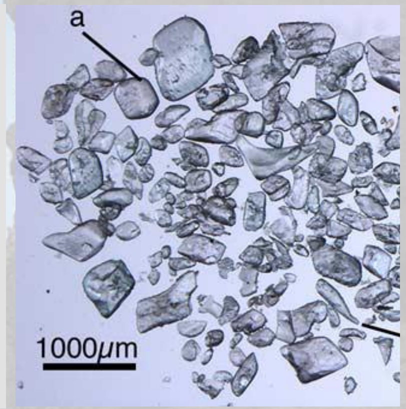
Stellate

Single crystal blade

Remnants of dissolved glendonites



Druse (Krylov et al., 2015)



Crystalls in sea ice (Dieckmann et al., 2008)

Tufa tower (Seaman, 2006)

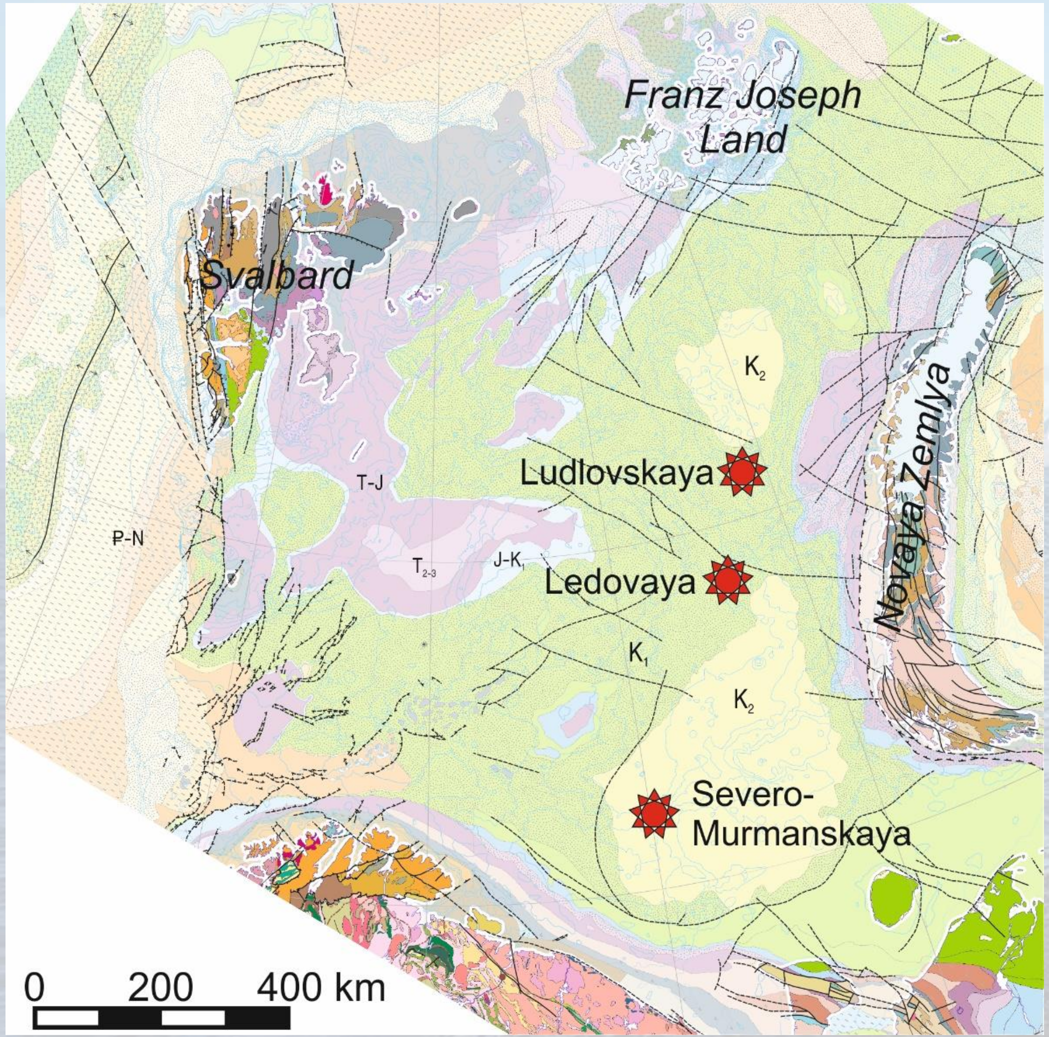
Glendonites

- Also called: pseudogaylussite, jarrowite, thinolite
- Varied morphology
- Age: Mesoproterozoic to modern
- Host rocks: mainly - sandstone, siltstone, shale, carbonate concretions; may include glacial deposits
- Depth of formation: 5-5000 meters
- No specific facies and tectonic setting association

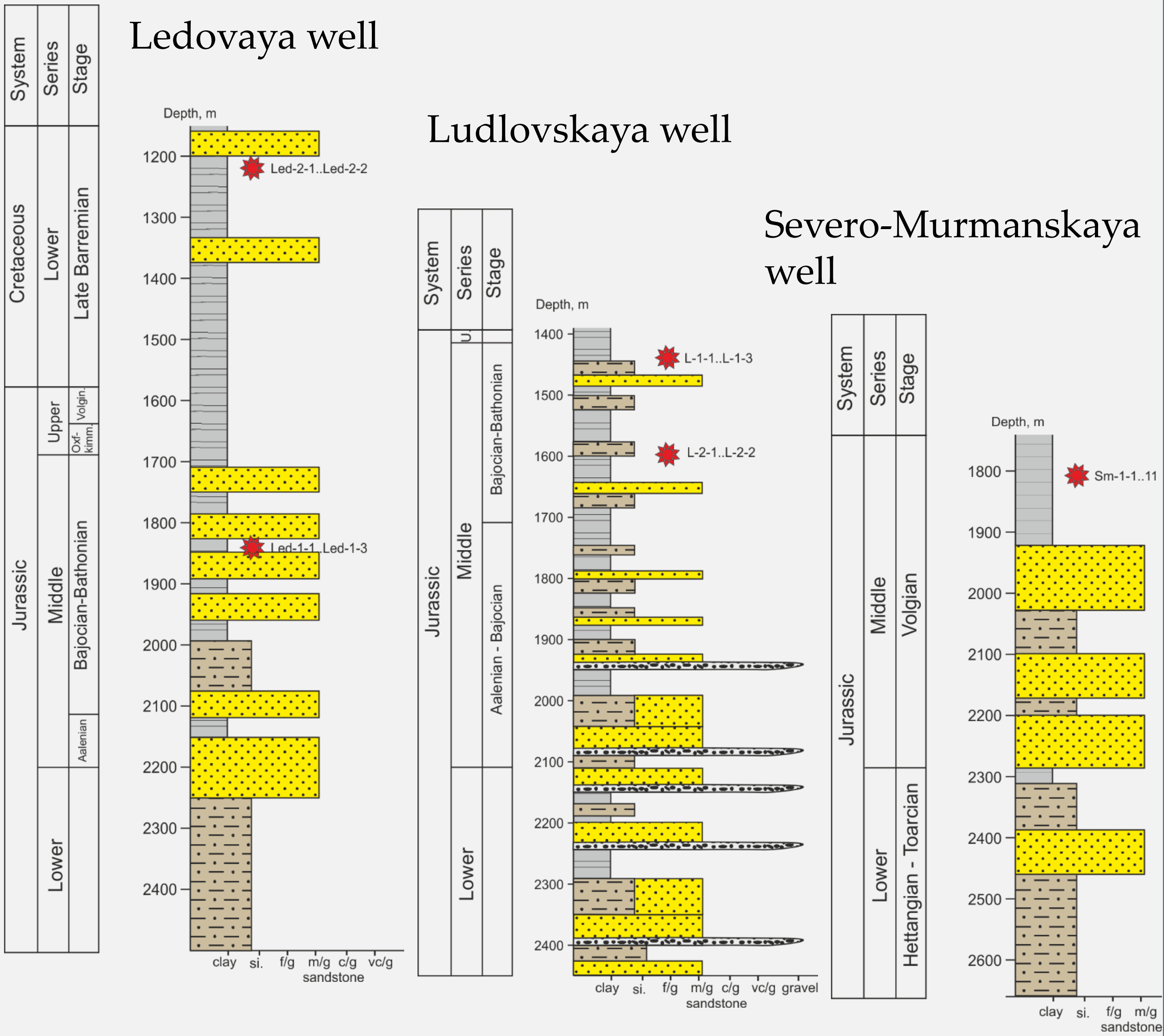
Ikaite

- Metastable hexahydrate of calcite - $CaCO_3*6H_2O$
- Forms under low temperature: mainly 0-4^{o}C
- Stabilized by high $[PO_4]^{3-}$, Mg^{2+}, $[SO_4]^{2-}$, anaerobic oxidation of methane and/or organic matter; dissolved organic carbon, amino acid

Location of studied wells



Geological map of Eastern Barents Sea



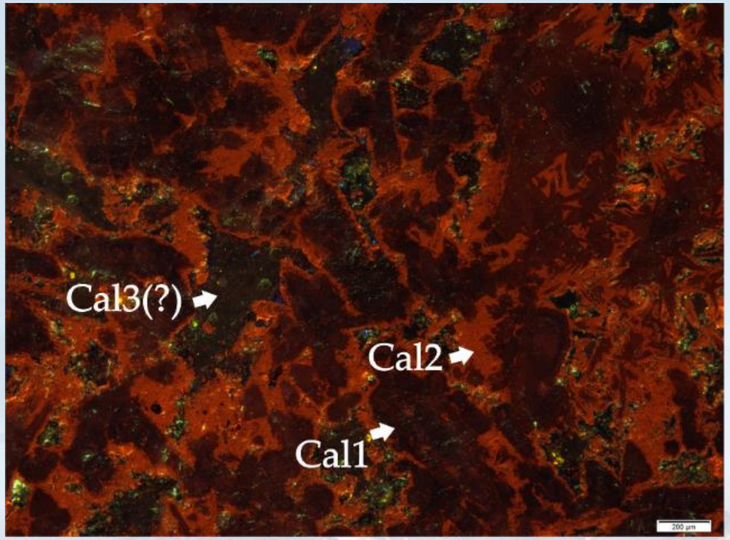
Stratigraphic section and levels with glendonites

METHODS

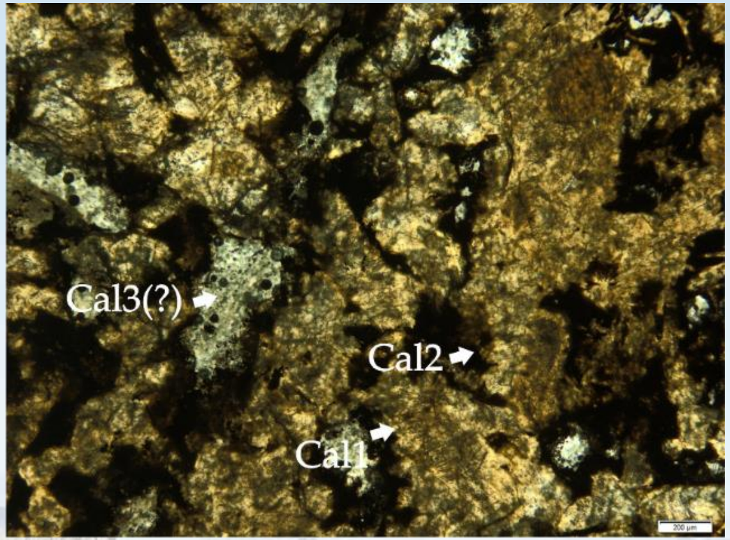
- Cathodoluminescence microscopy (CL)
- Carbon and oxygen isotope analysis
- X-ray diffraction

→ Paleoclimatic reconstruction of Middle Jurassic-Early Cretaceous

CATHODOLUMINESCENCE MICROSCOPY



Sample L-2-2, in CL



Sample L-2-2, plane-polarized photo

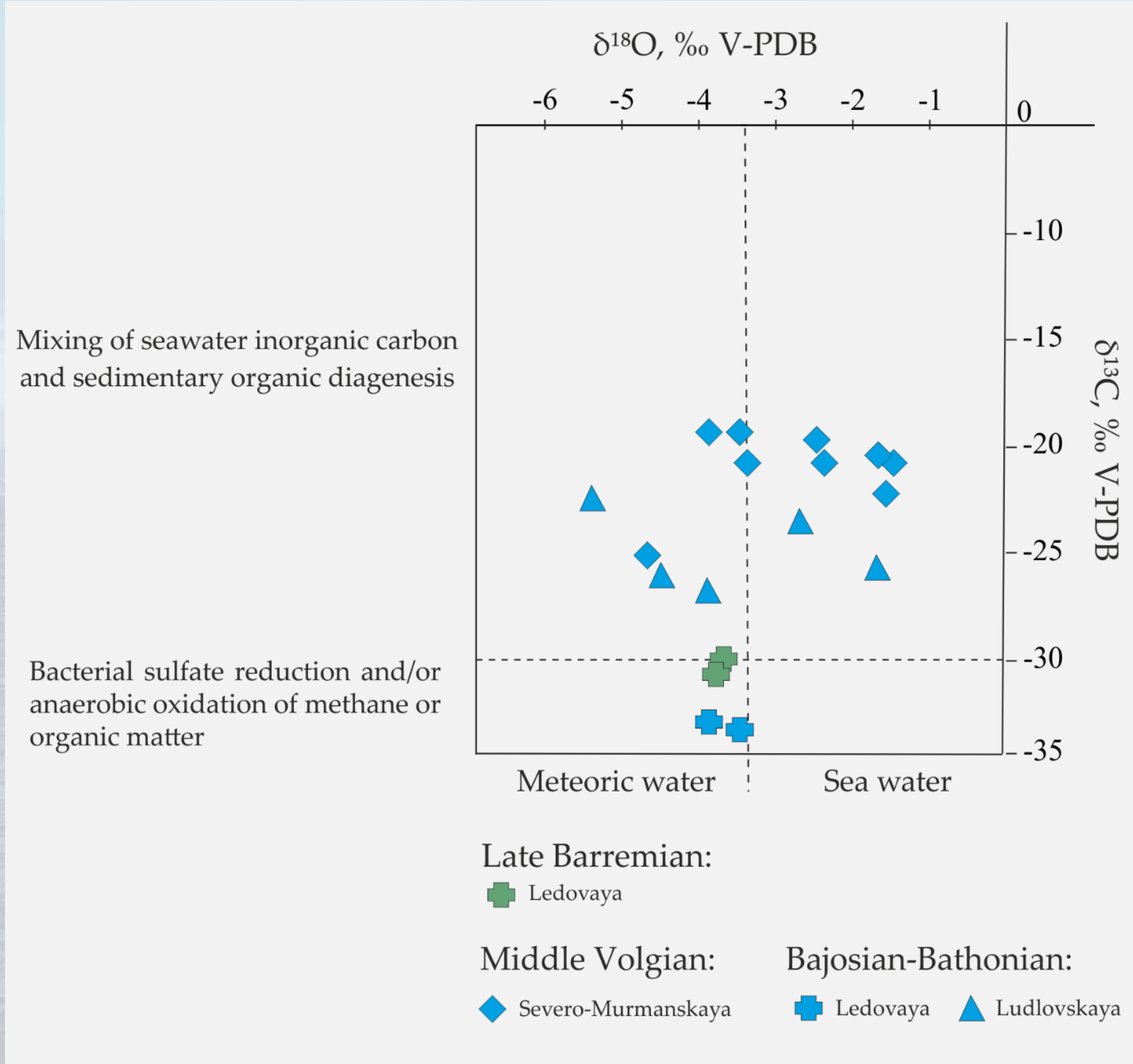
Barents sea glendonites are composed of three calcite phases:
Cal1 – calcite form elongated crystals up to 3 mm in size with concentric zonation; dark-brown CL-light. The most abundant phase (>50%)
Cal2 – calcite, bright orange CL-light (~15%)
Cal3 – calcite (?), blue CL-light

X-RAY DIFFRACTION

Sample	Calcite	Pyrite	Marcasite	Quartz	Kaolinite	Gypsum
CM-1-6	+	+	±	+	+	+
CM-1-8	+			+	+	+
LED-1-1	+			+	+	
LED-2-1	+				+	
L-1-2	+			+		
L-2-1	+			+		
L-2-3	+			+		

All studied glendonites consist of calcite, one sample includes pyrite and/or marcasite. Quartz, kaolinite and gypsum represent the remnants of host-bearing rocks.

CARBON AND OXYGEN ISOTOPE ANALYSIS



Oxygen isotope composition for Middle Jurassic glendonite concretions range from – 5.4 to –1.7 ‰ Vienna Pee Dee Belemnite (VPDB);
for Upper Jurassic – Lower Cretaceous $\delta^{18}O$ values range from – 4.3 to –1.6 ‰ VPDB;
for Lower Cretaceous - $\delta^{18}O$ values range from – 4.5 to –3.4 ‰ VPDB.

Carbon isotope composition for Middle Jurassic glendonite concretions range from – 33.3 to –22.6 ‰ VPDB;
for Upper Jurassic – Lower Cretaceous $\delta^{13}C$ values range from – 25.1 to –18.4 ‰ VPDB;
for Lower Cretaceous - $\delta^{13}C$ values range from – 30.1 to –25.6 ‰ VPDB.

Based on $\delta^{18}O$ data we suppose that seawater had a strong influence on ikaite-derived calcite precipitation. Received data coincide with $\delta^{18}O$ values reported from other Mesozoic glendonites and Quaternary glendonites formed in cold environments. Values of $\delta^{13}C$ of glendonites are close to bacterial sulfate reduction and/or anaerobic oxidation of methane or organic matter.

PALEOTEMPERATURE ESTIMATION

$$t(^{o}C)=15.7-4,36(\delta^{18}O_{Cal}-\delta^{18}O_{water})+0,12(\delta^{18}O_{Cal}-\delta^{18}O_{water})^2$$ (De Lurio, Frakes, 2008)

$$\delta^{18}O_{seawater}= -1‰SMOW$$

Time	Sample	^{13}C, PDB	^{18}O, PDB	Paleotemperature	
Late Barremian	Led-2-1	-29,70	-3,36	16,17	
Late Barremian	Led-2-2	-30,10	-3,55	17,02	
Middle Volgian	Sm-1-1	-19,60	-3,07	14,90	
Middle Volgian	Sm-1-3	-22,30	-1,42	8,11	←
Middle Volgian	Sm-1-4	-21,30	-3,26	15,74	
Middle Volgian	Sm-1-5	-20,80	-2,58	12,83	
Middle Volgian	Sm-1-6	-20,00	-1,61	8,87	←
Middle Volgian	Sm-1-8	-18,40	-3,94	18,76	
Middle Volgian	Sm-1-9	-25,10	-4,33	20,53	
Middle Volgian	Sm-1-10	-20,10	-1,90	10,04	←
Middle Volgian	Sm-1-11	-19,90	-2,19	11,22	
Bajocian-Bathonian	Led-1-1	-33,30	-3,55	17,02	
Bajocian-Bathonian	Led-1-3	-32,60	-3,84	18,32	
Bajocian-Bathonian	L-2-1	-25,60	-4,52	21,43	
Bajocian-Bathonian	L-2-2	-26,10	-3,94	18,76	
Bajocian-Bathonian	L-1-2	-22,60	-5,39	25,60	
Bajocian-Bathonian	L-1-3	-24,20	-2,77	13,65	
Bajocian-Bathonian	L-2-3	-25,4	-1,71	9,26	←

- Arrows point to the samples with estimated temperatures close to ikaite formation
- Oxygen isotope composition of seawater in Mesozoic may vary from -1 to -1.9‰SMOW

CONCLUSIONS

- Studied glendonites were collected from Middle Jurassic-Early Cretaceous terrigenous successions (clay and siltstone) of Eastern Barents Sea
- It was defined that pseudomorphs consist of three calcite phases with minor admixture of pyrite, marcasite, quartz, kaolinite and gypsum
- Isotopic composition of oxygen was caused mainly by diagenetic processes. However we got the results close to oxygen isotope composition of Mesozoic seawater
- The source of carbon was organic matter decay
- Based on oxygen isotope composition we calculated paleotemperature that are quite favorable to ikaite formation
- Despite Mesozoic climate was warm studied concretions pointed to cold climate excursion in Bajosian-Bathonian, Middle Volgian ant Late Barremian

THANK YOU FOR ATTENTION!

The study is supported by RFBR, project number 20-35-70012.
The research project is being carried out in the SPSU Research Park