Sediment geochemistry and diatom assemblages of the Chukchi Sea: application for bioproductivity and paleoceanography

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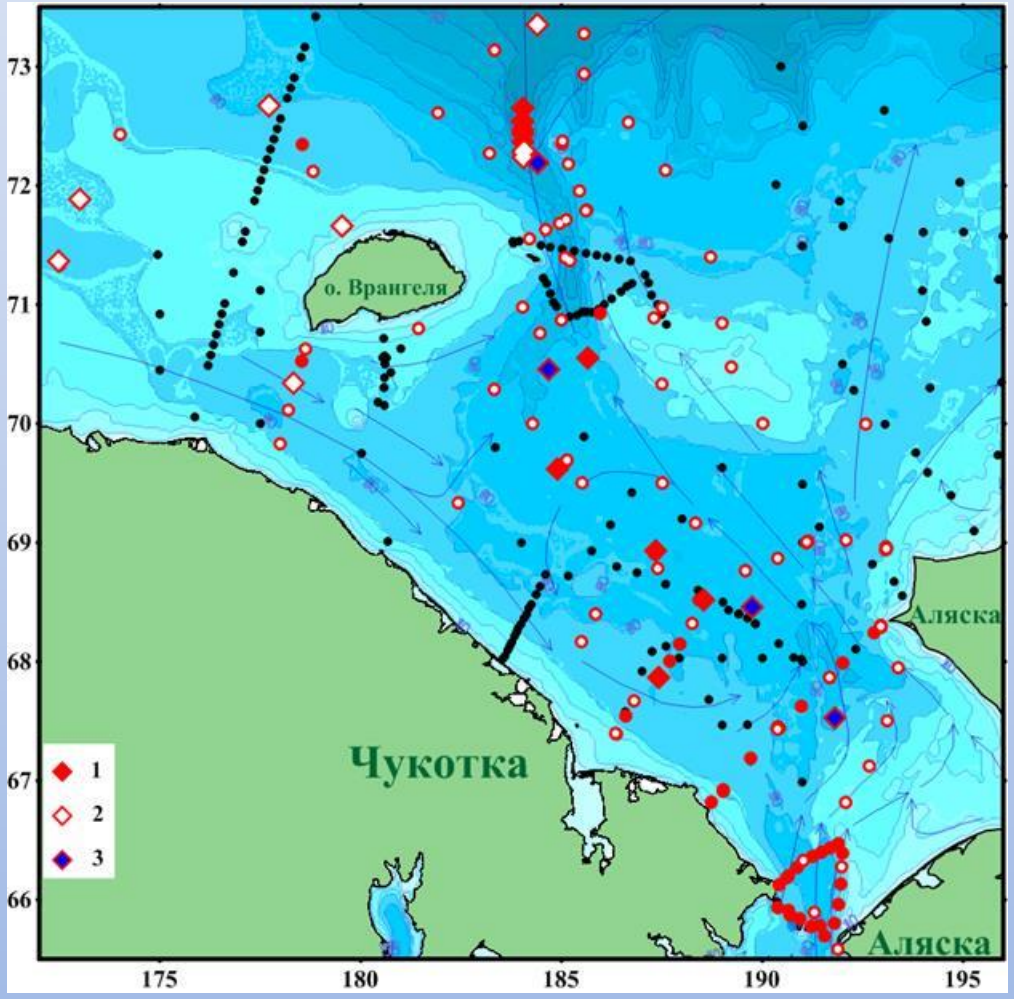
Main goals are:

- investigation of preservation conditions of biogenic elements produced by phytoplankton in the Chukchi Sea sediments,
- studying specifics of forming general chemical composition of the sediments
- revealing the indicators of certain environmental characteristics

Preservation of biogenic elements and microfossils in the shelf sediments depends on phytoplankton and benthos productivity as well as sedimentary conditions such as sediment composition, seafloor relief, geological structure of the basin and so on.

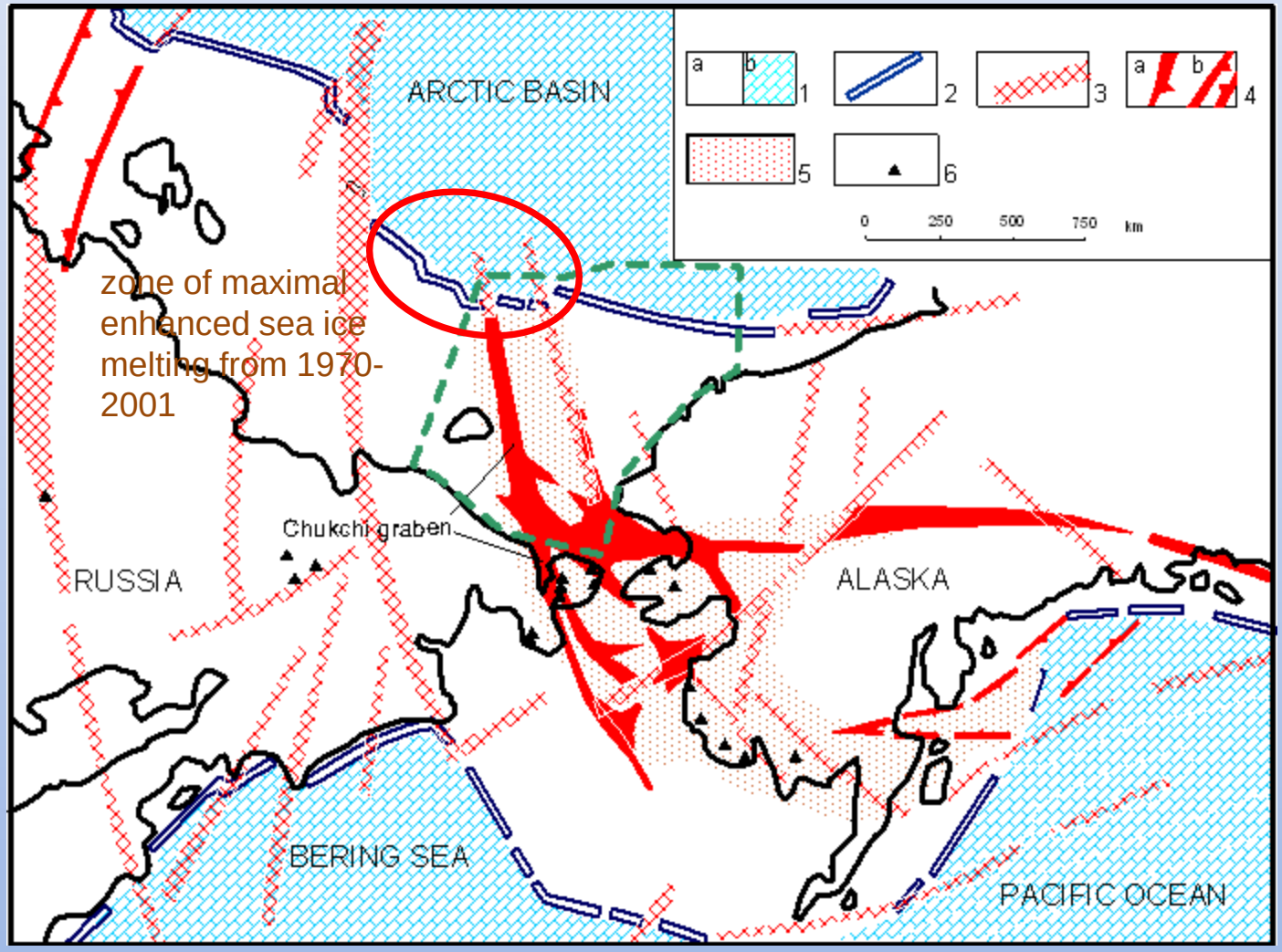
Sediment Sampling Map



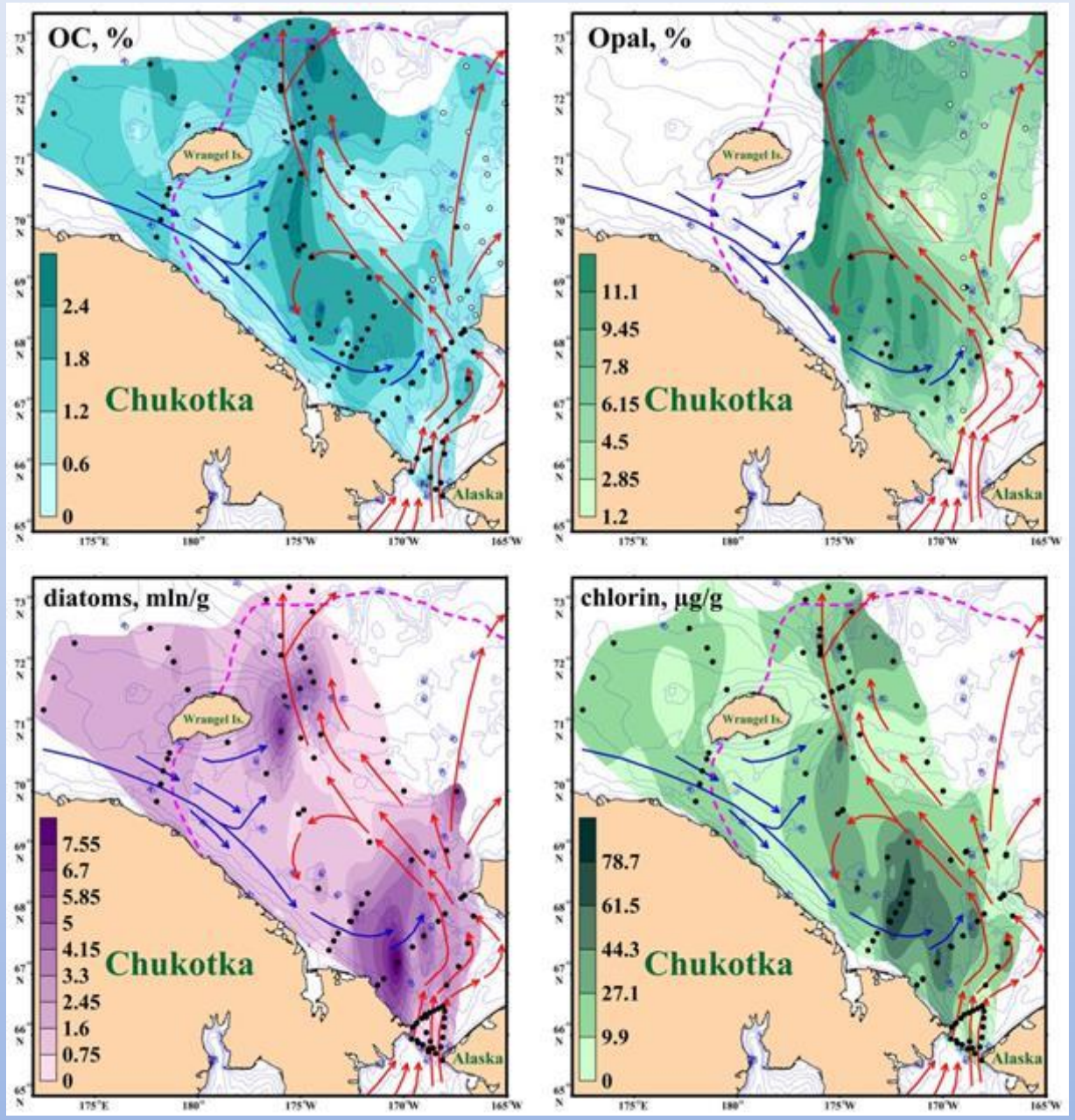
1 - 2012 sediment cores
2 - 2009 sediment cores
3 - 2009 grabs
◦ - 2012 grabs
• - non-RUSALCA stations

Bosin et al, 2014

The Mesozoic graben-rift system of the Chukchi Sea in the area of interaction of the Arctic and Pacific transitive zones (Senin et al., 1989)



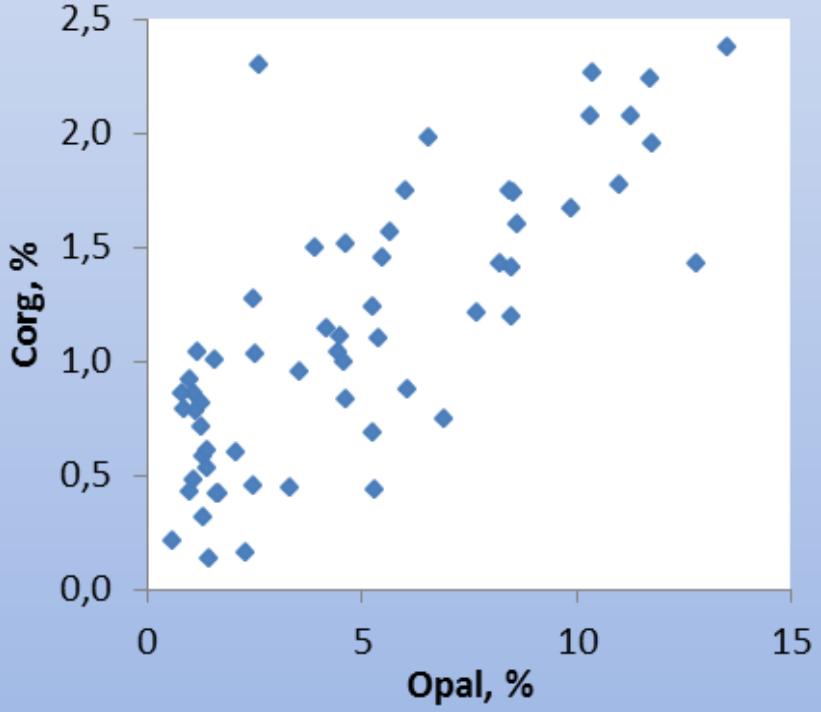
1 - areas with continental and subcontinental (a) and oceanic and suboceanic (b) crust; 2 - a continental flexure; 3 - the largest fault belts of the shift-extension nature; 4 – global extensional structures (a – Chukchi-Bering seas graben - riftogenic system, b - riftogenic zones of the Laptev Sea and Alaska Bay); 5 - areas of direct interaction of transitive zones; 6 – manifestations of Cenozoic volcanism on land beyond the limits of the island-arc systems.

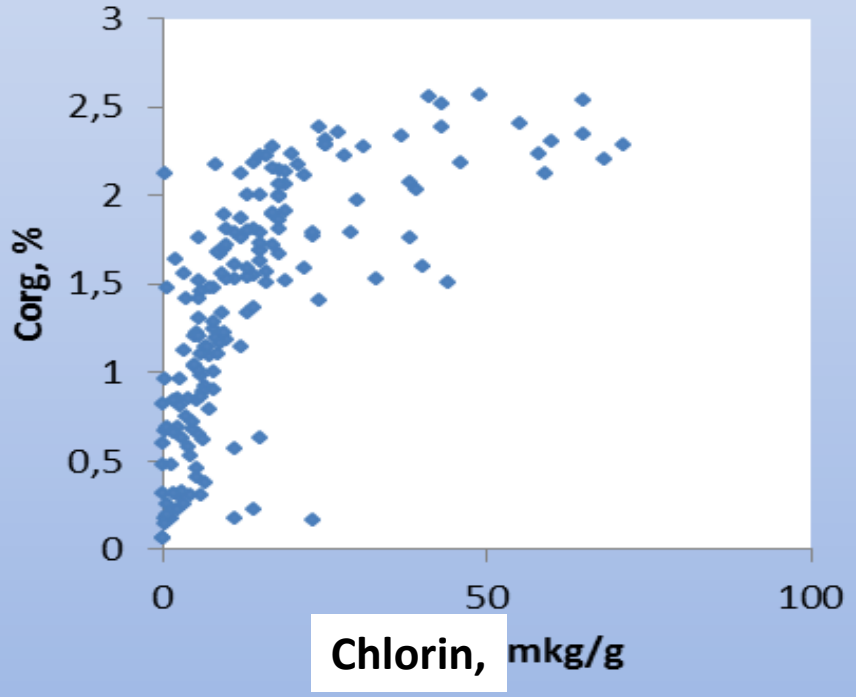


Content of biogenic elements and diatoms in the Chukchi Sea surface sediments.

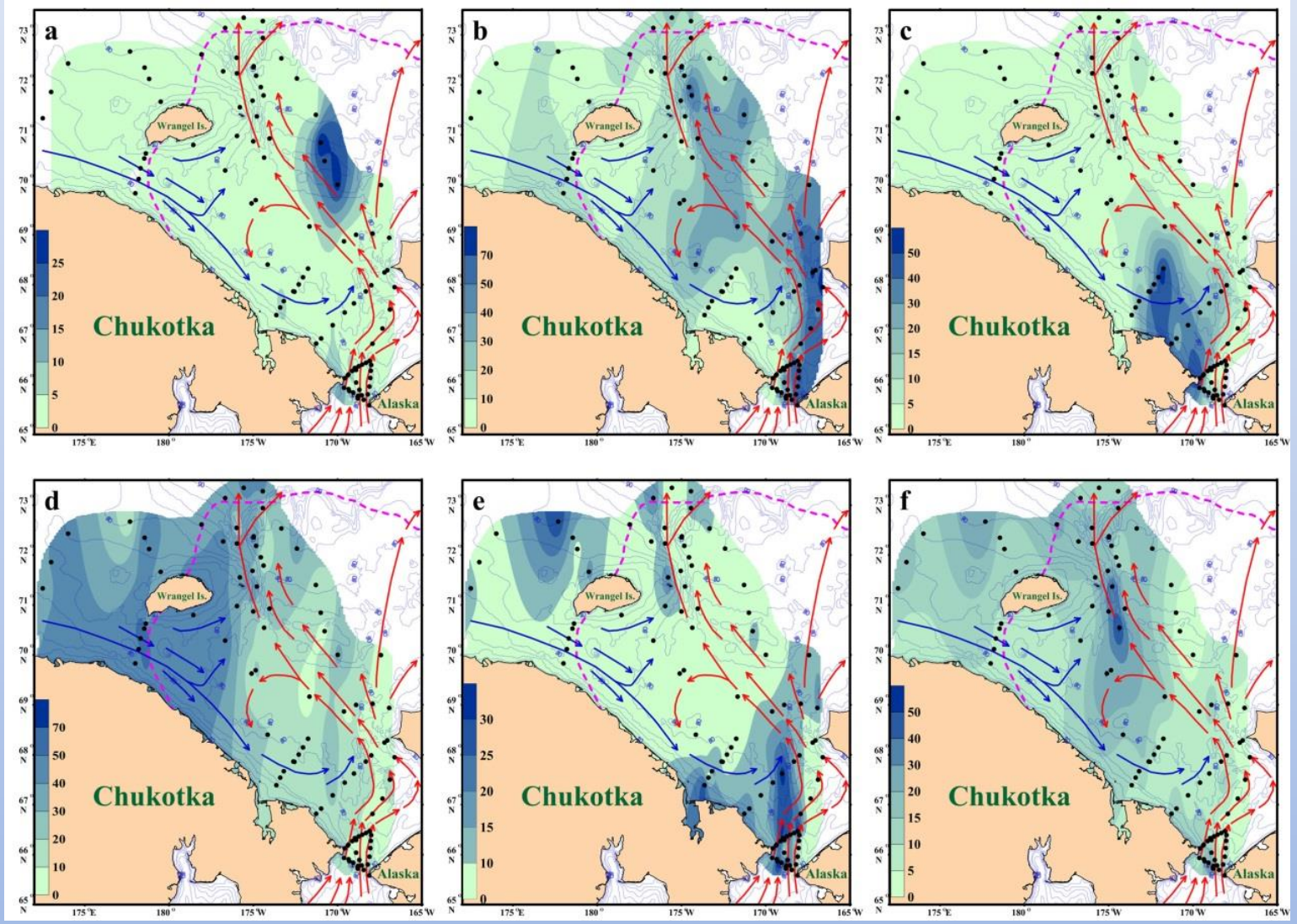
Red and blue arrows mark warm and cold currents accordingly; dashed line –50 % ice concentration line for September 1979-1983 (Frolov, 2008).

Correlation of the Corg in the southern Chukchi Sea sediments with phytoplankton productivity indicators

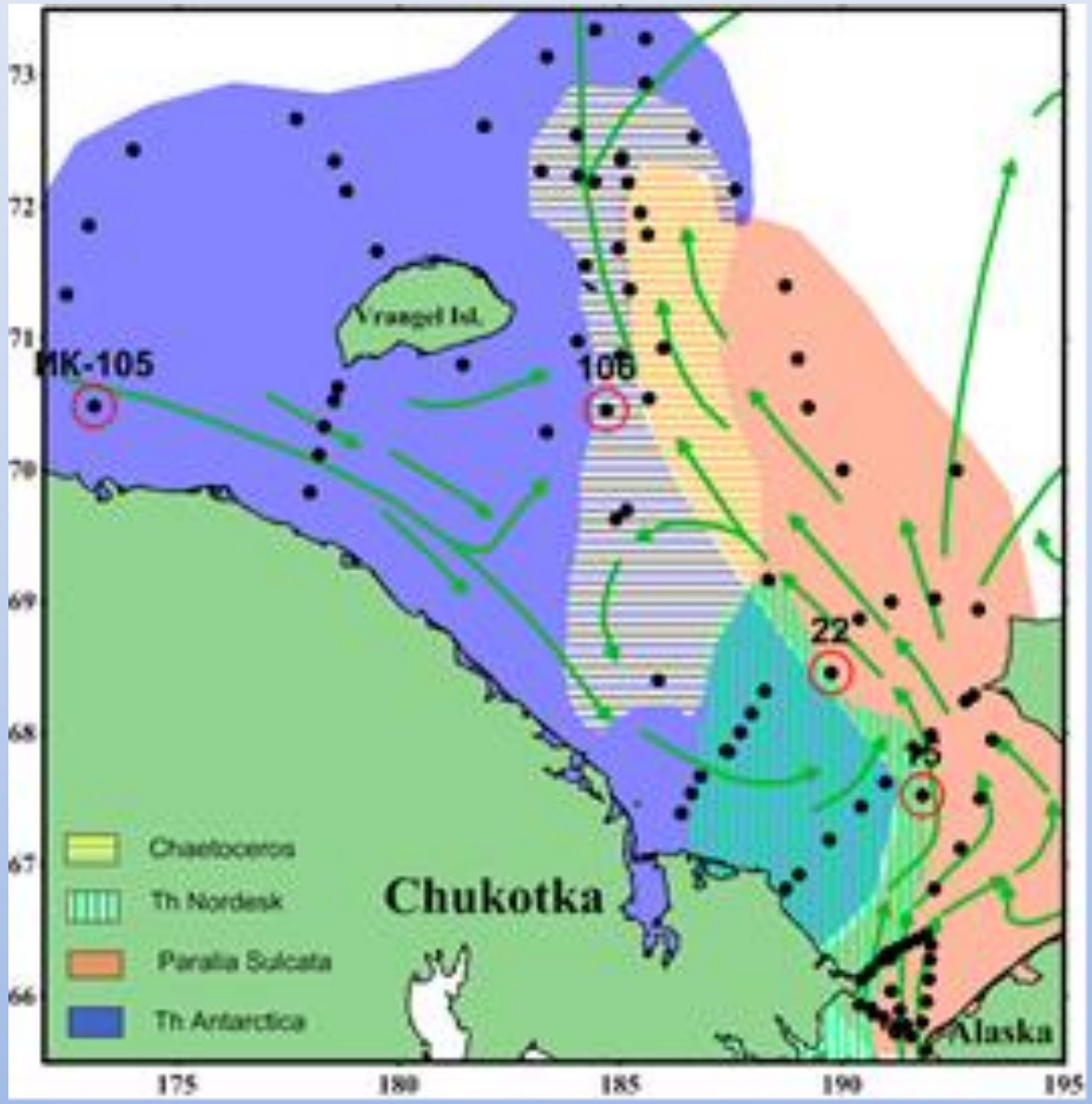




Distribution of dominant diatom species in surface sediment of Chukchi sea



a – *Odontella aurita,* b – *Paralia sulcata,* c – *Thalassiosira nordenskioeldii,* d – *Thalassiosira antarctica,* e – cryophilic species, f – *Chaetoceros* species.

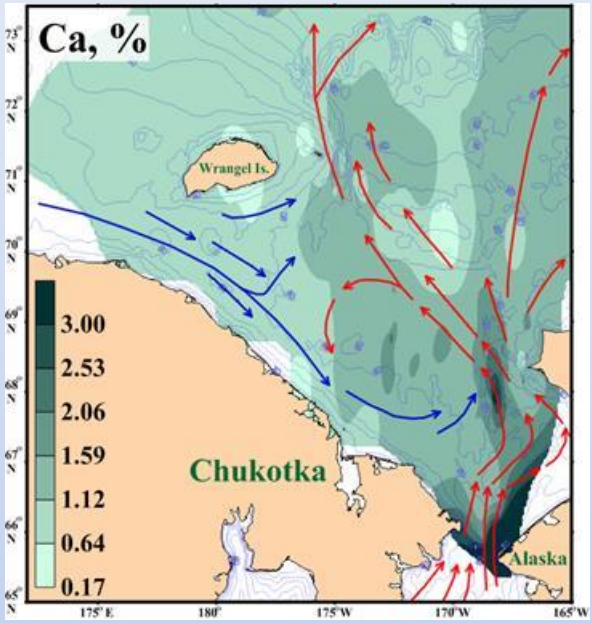


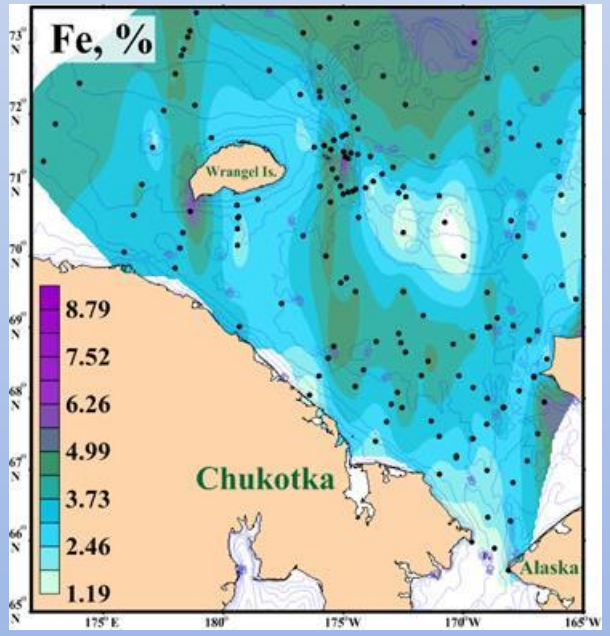
Dominant diatom assemblages in surface sediments of the Chukchi Sea

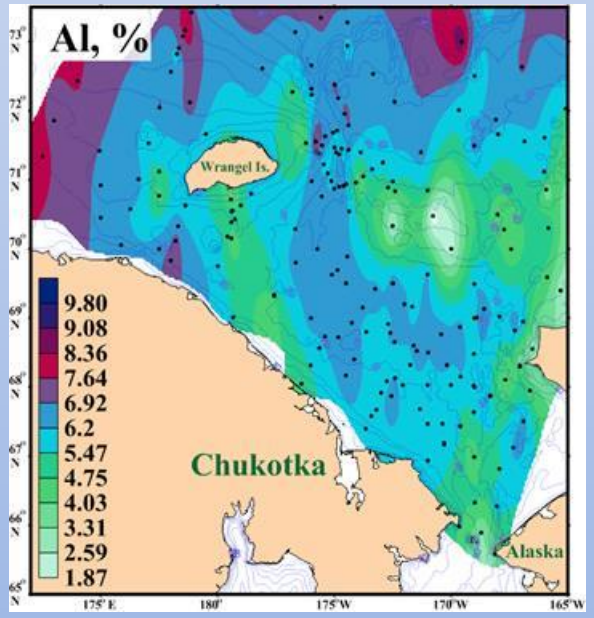
Geochemical sediment composition in the Chukchi Sea

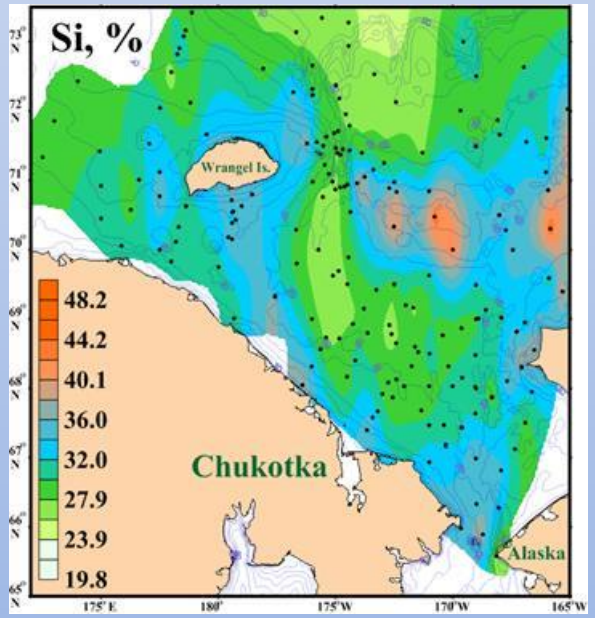
- grain-size composition;
- mineral content;
- on near-bottom hydrochemical conditions

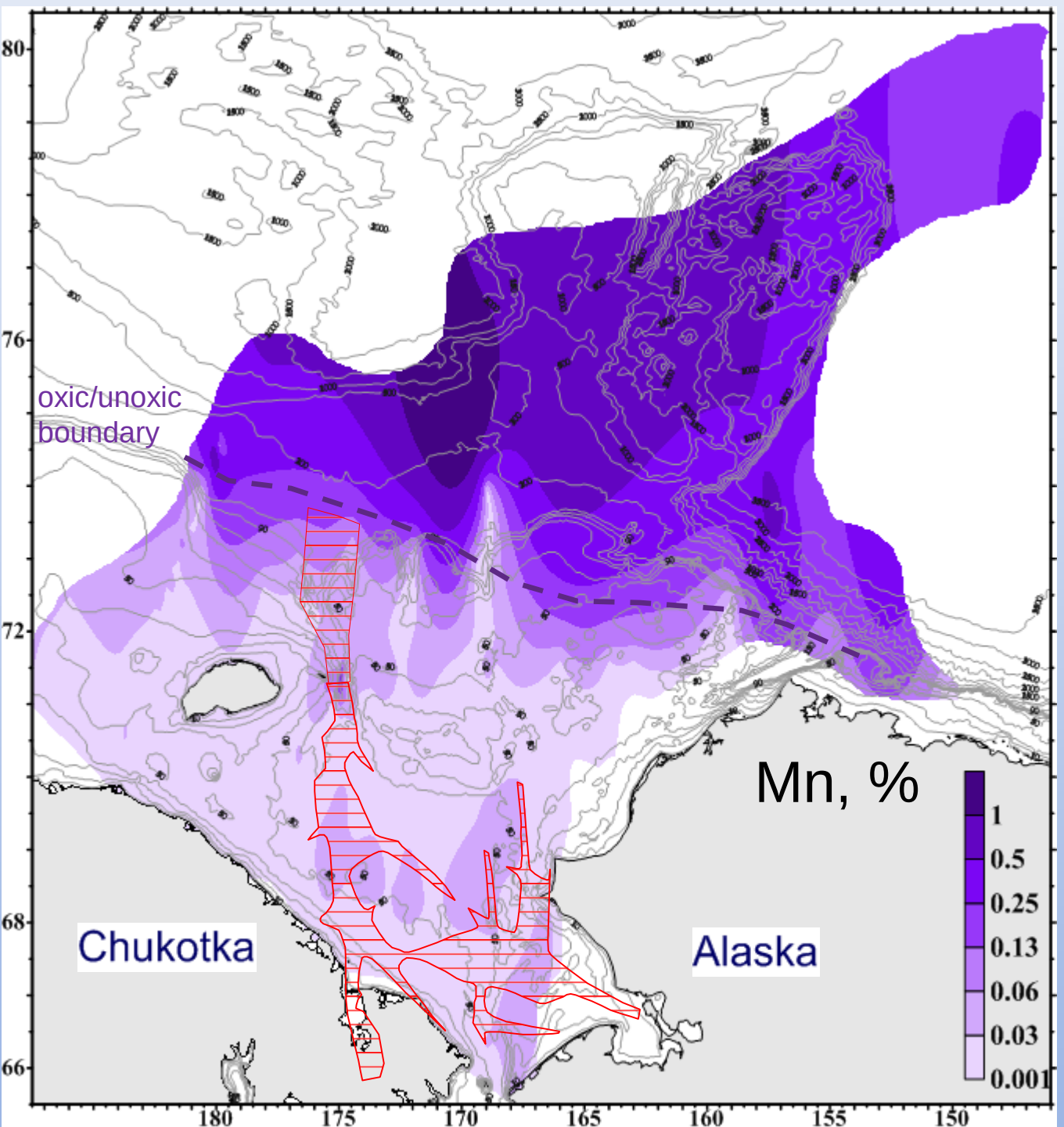
Distribution of Ca, Fe, Al and Si in the surface sediments



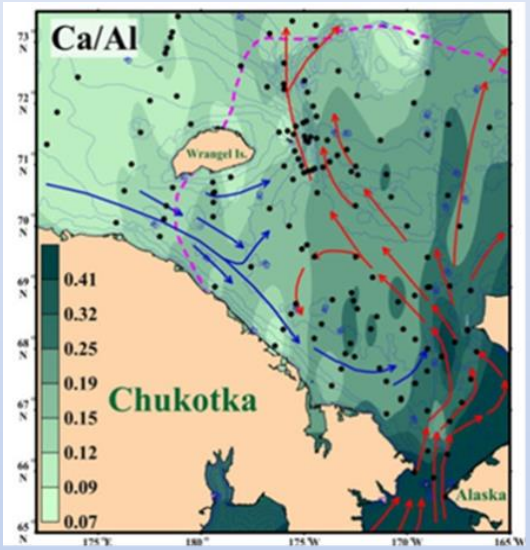


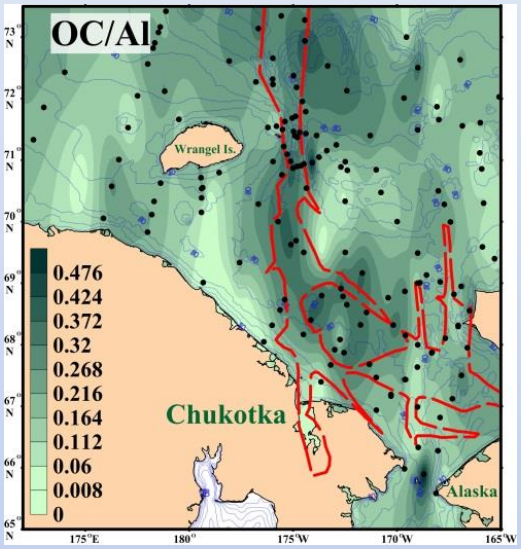


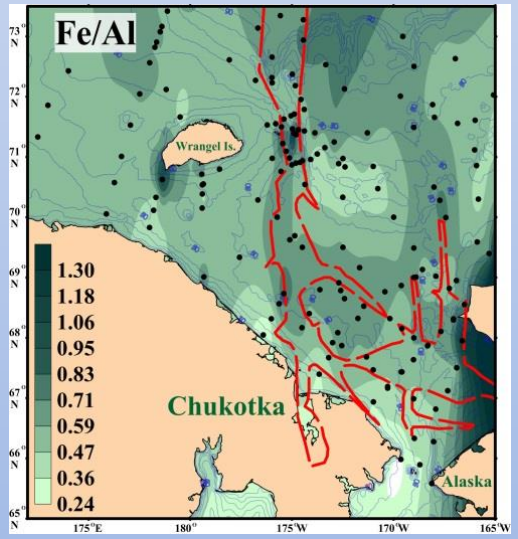


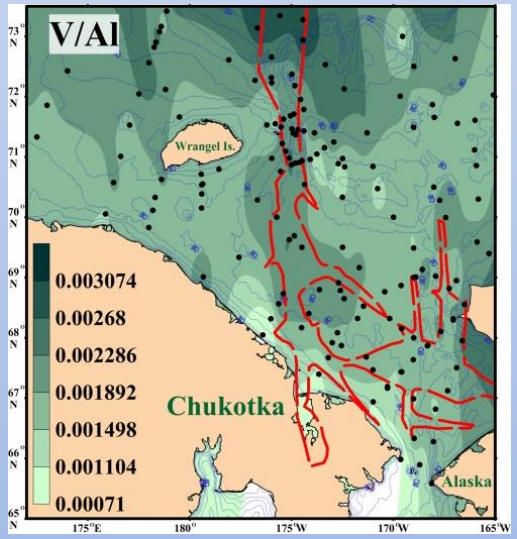


The Mn content in bottom sediments of the Chukchi Sea and adjacent Arctic Basin compare with cold and warm currents, ice conditions, redox condition and geological structures









Concentration of Al normalized elements in surface sediments of the Chukchi Sea.

Red and blue arrows mark warm and cold currents accordingly; red dashed line contour main neotectonic depressions (as Shipilov et al., 1989)

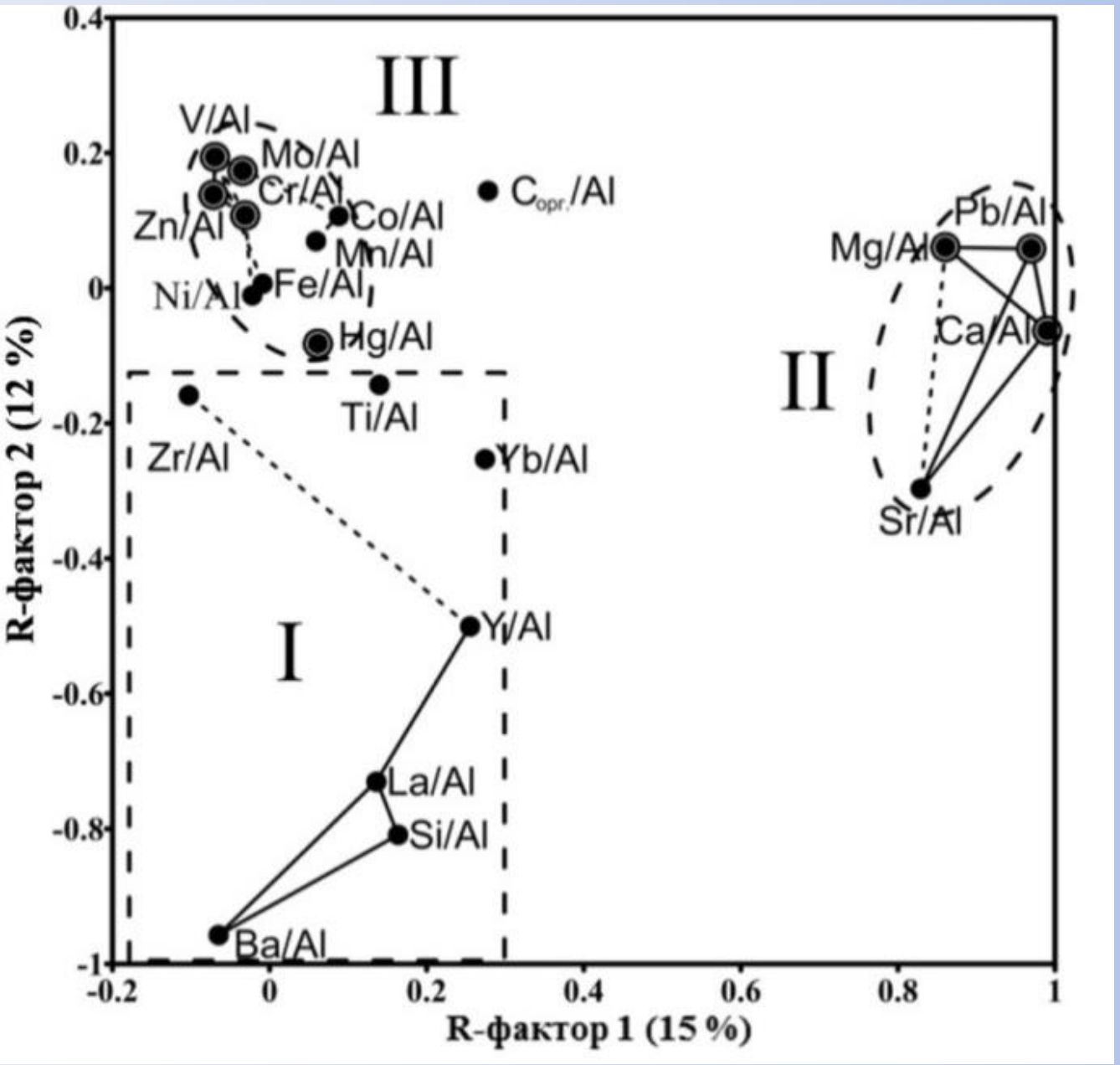


Diagram of Al normalized element contents in 1 and 2 factor space (R-factor analyze with varymax rotation).

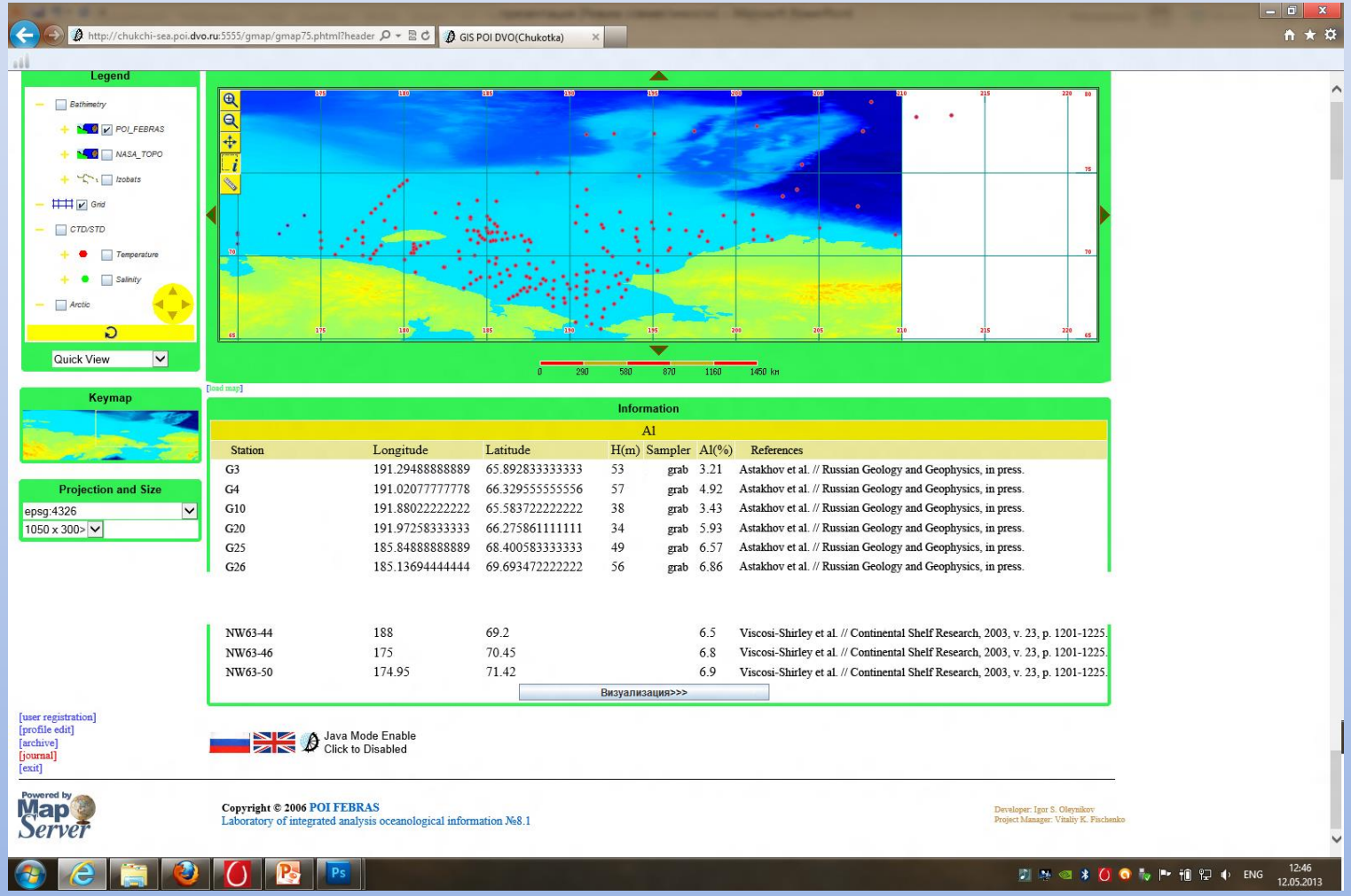
Circles - significant correlated elements with Corg content ($C_{opr.}$/Al), lines – the most significant correlations (solid - > 0.7, dashed– 0,6-0,7).

Some geochemical indicators of marine environment for Chukchi Sea region

Environment units	Geochemical indicators
Oxic waters	Mn, Mn/Al, (Fe+Mn)/Ti, Ca, Sr, Hg, Zn, Ni, V
Unoxic-euxinic (H_2S) waters	Mo/Mn, Mo, V/Mn, Ag
Seasonal ice sheet	Opal ($SiO_{2amorf.}$), Ba, Ba/Al
Cold and warm current system	$C_{org.}$, Opal ($SiO_{2amorf.}$), Zn
Active geodynamic (cold and hydrothermal vents)	Fe, (Fe+Mn)/Ti, Hg, $C_{org.}$

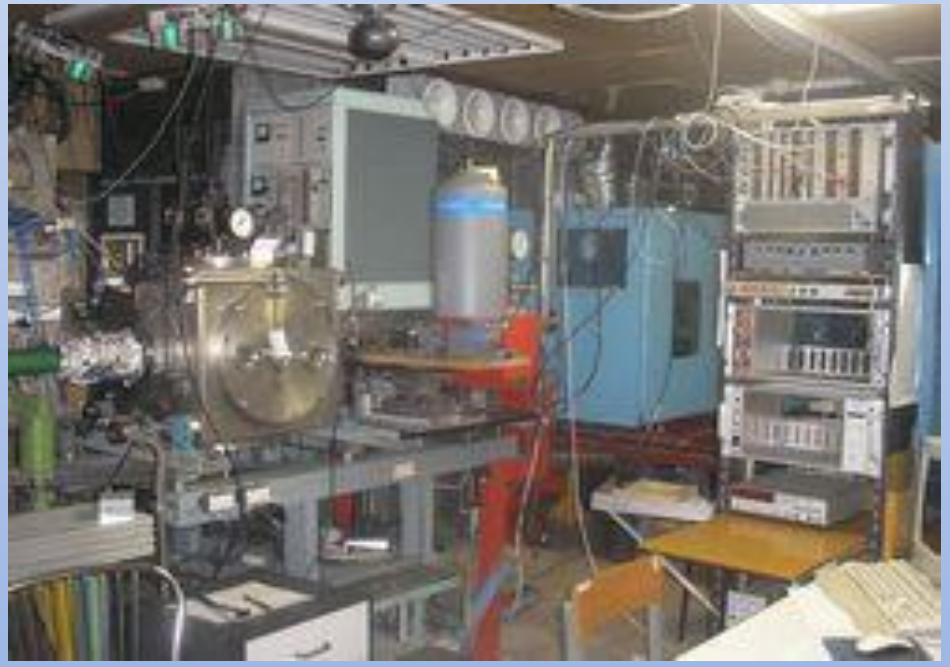
Electronic database on chemical composition of bottom sediments from the Chukchi Sea

http://chukchi-sea.poi.dvo.ru:5555/gmap/login.php



High resolution reconstruction of the paleoenvironments using sub-millimeter scanning element analysis of sediment core by XRF SR

on-going project financed by RFBR, SB RAS, FEB RAS

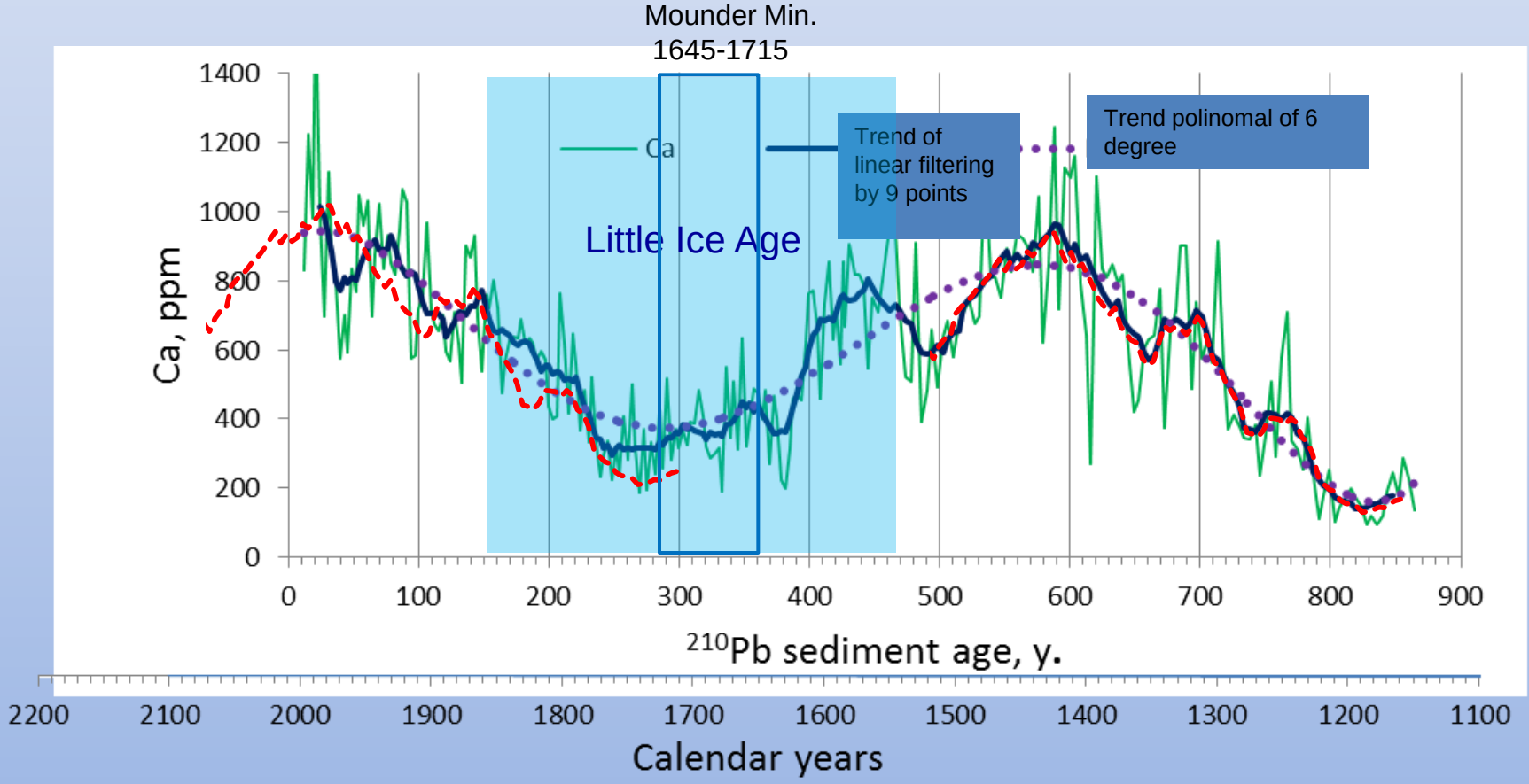


The equipment of the high-resolution scanning by X-ray fluorescence with synchrotron radiation (XRF SR) with step up to 0.5 mm

The Institute of Nuclear Physics
Siberian Branch of the Russian Academy of Sciences

Possibility forecast of future environmental changes based on SR XRF

- method of past analogue
- method of circles prolongation



Results

Intensive accumulation of biogenic components in the arctic shelf sediments, including produced by phytoplankton, cannot be straightly used as productivity indicator for paleoreconstructions. Distribution of biogenic opal, organic carbon and chlorophyll-a derivates is influenced by currents and waves transportation, biogens mostly accumulate in the seafloor depressions.

Besides, organic carbon and chlorin better preserve in anoxic conditions and vice versa, so sediments in the Chukchi Sea local hollows and depressions are enriched by organic matter. This bottom topography was formed by neotectonic processes in the zone of present geology activities, and anoxic conditions in this area could be caused by methane and hydrothermal vents.

Results

Paleooceanology indicators, such as sea ice conditions, are required with additional analysis of geological situation and hydrochemical conditions of near-bottom water. The most useful proxy for the Chukchi Sea paleooceanology reconstructions is biogenic carbon content indicated by Al normalized Ca and Sr content.

Diatom assemblages indicate different types of water masses and with additional information can be used for sea ice reconstructions.

Thanks for your attention