Quaternary International xxx (2017) 1–12

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

# Palaeoceanography changes in the Okhotsk Sea during Late Pleistocene and Holocene according to diatoms

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ARTICLE INFO

*Article history:*
Received 28 December 2016
Received in revised form
2 October 2017
Accepted 3 October 2017
Available online xxx

*Keywords:*
Diatom assemblages
Okhotsk Sea
Environment
Holocene
Late Pleistocene

ABSTRACT

Paleontological records of six sediment cores in the Okhotsk Sea (OS) marked the regional environmental changes over the last 140 kyr on orbital time scales. The diatom assemblages and content of diatom frustules in the sediments during Marine Isotope Stage (MIS) 6–1 indicate the dramatic climatic and environmental changes in the OS. A small abundance and low diatom species diversity as well as the high percentage of near-ice species indicate the cold surface environmental condition during glacial time (MIS 6, 4, 2) with low temperatures, cold climate conditions and extended sea ice cover. The presence of extinct redeposited species in the glacial assemblages indicates a low sea level during this time. The proportion of ice species enlarged and diatom abundance reduced due to increase of the influence of the sea ice, reflecting the sharp climatic cooling of adjacent land and regional environmental deterioration.

The subsequent increase in diatoms productivity at 129.8–117.0 kyr BP and 8.3–5.5 kyr BP indicates the strong climate warming accompanied by decrease of sea ice coverage and surface water stratification (mixing of surface and intermediate water) during the warmest MIS in the Okhotsk Sea. The diatom abundance and high content of the oceanic and warm-water species reflect the warm surface environmental condition during MIS 5e and 1 since 8.3 kyr due to decrease of the sea ice influence.



## 1. Introduction

The aim of this work is to reconstruct the climate and paleoenvironment conditions of the Okhotsk Sea during the Late Pleistocene and Holocene by diatom abundance and species changes in the fossil assemblages from the deep sea sediments. Diatoms are the most informative microfossils for palaeoceanographic research (Jousé, 1962).

The Okhotsk Sea, marginal sea of the North Pacific, plays important role in the Pacific hydrology of Northwestern Pacific Intermediate Water masses formation (Honjo, 1997). Relatively warm and saline Pacific waters flow northward as West Kamchatka Current, and then mixed on the northern shelf and flow to south. The Japan Sea warm saline water flows into the southwestern part of the Okhotsk Sea (Fig. 1). The high diatom productivity of the Okhotsk Sea is related to nutrients abundance. There are two main sources of nutrients: Amur River and Pacific water (Chen et al., 2004). Vertical mixing supplies these nutrients to a photic zone resulting in the increase of productivity.

Data on the taxonomic structure of diatom assemblages and the distribution of most typical species in the Okhotsk Sea sediments were studied from 1962 (Jousé, 1962; Sancetta, 1981, 1982; Shiga and Koizumi, 2000, Gorbarenko et al., 2010, 2012, 2014; Pushkar and Cherepanova, 2001, 2008, Tsoy et al., 2009; Ren et al., 2014). These researches showed that diatoms abundance and species composition in their assemblages for both the sediment cores and surface sediments. The researchers connect the diatom assemblages with water masses hydrology, sea-ice condition and sedimentation at the main bottom topography. However, diatom assemblages changes related to the Okhotsk Sea environment changes during the Late Pleistocene, deglaciation and Holocene

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https://doi.org/10.1016/j.quaint.2017.10.002

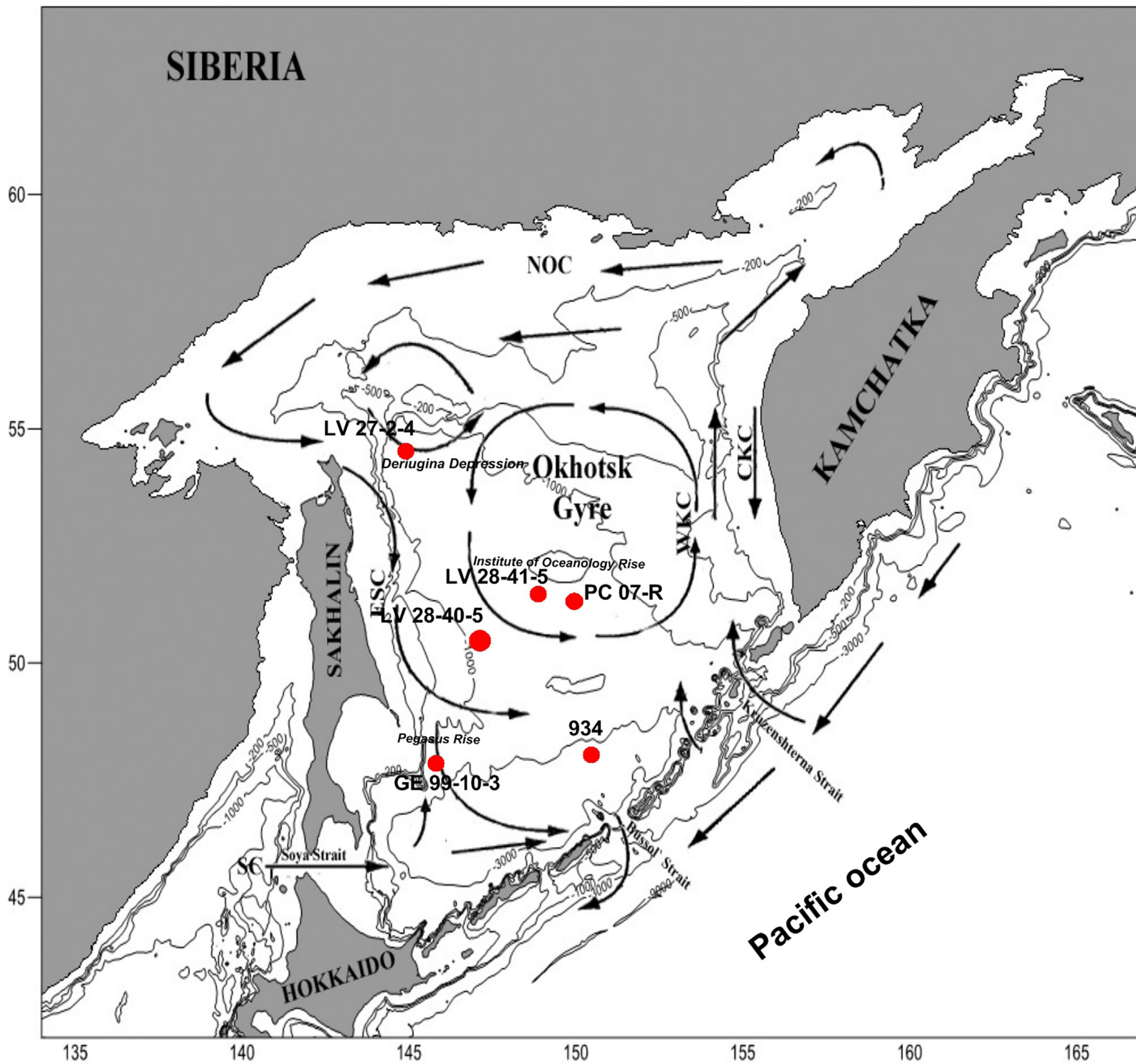


**Fig. 1.** Location of the investigated cores PC 07-R, LV 27-2-4, LV 28-41-5, LV 28-40-5, GE 99-10-3, 934.

remain still poorly studied in spite of the important diatom role as sensitive proxy of a surface hydrology and sea ice coverage variability in the OS. Here we presented the generalized data of different diatoms assemblages for six earlier dated sediment cores from different parts of the Okhotsk Sea over the last 140 kyr. The obtained results of studying the cores allow us to identify six diatom assemblages reflecting the OS climate and environmental changes over the last 140 kyr and correlate them with MIS 6 - MIS 1 according to earlier obtained stratigraphy (Gorbarenko et al. 2010, 2014).

## 2. Materials and methods

The basis for this work was formed by the results of the diatom analysis for the several sediment cores obtained in the OS (Fig. 1, Table 1). Six gravity cores were obtained during the expeditions carried out by the V.I. Il'ichev Pacific Oceanological Institute from the central, north-western and south parts of the Okhotsk Sea (Fig. 1, Table 1). Age model of the studied cores was earlier constructed for the MIS with age boundaries according to Martinson et al. (1987) by using the oxygen isotope records of planktonic and benthic foraminifera, magnetic sediment susceptibility records, AMS $^{14}$C data and tephrochronology (Gorbarenko et al., 2010, 2014). The sea ice conditions for studied core locations were earlier reconstructed by means of the calculation of the content of terrigenous particles in sediment fraction of more than 150 μ and less than 2000 μ per g of dry sediment called the ice rafting debris (IRD) (Vasilenko et al., 2011). The sedimentological changes indicated by variability of the magnetic sediment susceptibility (MS) were applied to reconstruct the Okhotsk Sea orbital scale climate changes according to our data (Gorbarenko et al., 2012; 2010, 2014)

The taxonomic analyses, as well as the quantitative content of