Title

Low sea surface salinity in the Japan Sea during the last glacial maximum

Members' names and affiliations

Name	Institution and Department	Employment on
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Aim

This project aims to clarify the sea surface salinity in the Japan Sea during the last glacial maximum (LGM) and to estimate the impacts of the volume transport through the Tsushima Strait as well as evaporation and precipitation on the reduction of sea surface salinity in the Japan Sea.

Procedure

The principal investigator (PI) carried out many sensitive experiment using a freshwater budget model for the Japan Sea and obtained following conclusions.

1 The minimum value during the LGM (around 20 ka) is 14-27 and is very sensitive to the change of the volume transport.

2 The change of the volume transport through the Tsushima Strait is linear with the reduction of sea level.

3 The variation trend of salinity is consistent with that of the oxygen isotope of planktonic foraminifera in the paleoclimatic results.

During the stay of PI in Matsuyama, I reported above results by giving an oral presentation "Low sea surface salinity in the Japan Sea during the last glacial maximum"

Results

1. The volume transport through Tsushima Strait

We use POM (Princeton Ocean Model) to simulate the Japan Sea and designed 11 cases, where we change the topography conditions that every 10 meters drop in sea level, from 0 m to -100 m. Then we select the cross-section of the Tsushima Strait to calculate the volume transport in each case and obtain the relationship between the sea level and the volume transport (Fig.1), they are the linear relationship. And we collect the details of sea level and time from other studies (Yokayama et al., 2019, Saito et al., 1998, Arz et al., 2007). Finally, we get the curve of volume transport and time (Fig.2). The changing trend of volume transport is very consistent with that of the sea level. These apply to the calculation of the salinity in the Salt budget model.

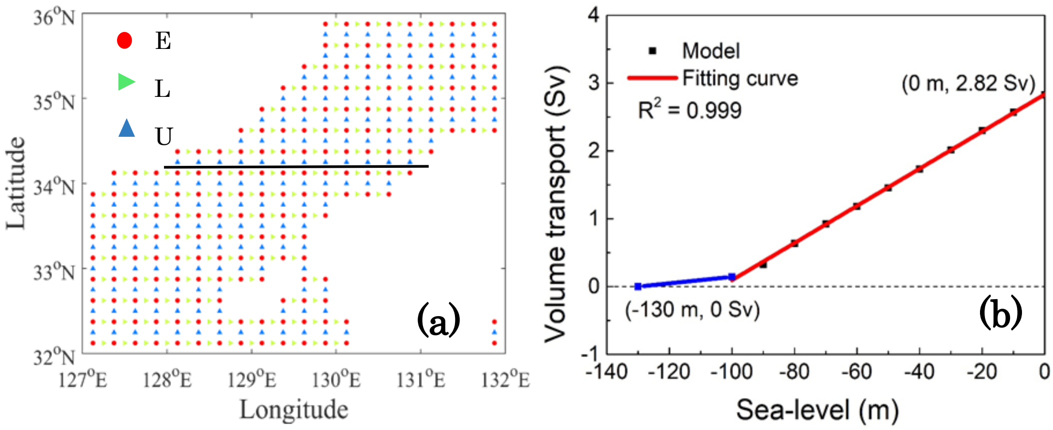

Fig. 1 (a) The section in Tsushima Strait that we chose (black line 34.25°N, 127.375 -130.625°E). The triangular and circular signs indicate the location of the water level, the velocity in the U direction, and the velocity in the V direction. And the volume transport through Tsushima Strait to the Japan Sea (b) is calculated from the cross-section and velocity of the Tsushima Strait, where the velocity and the cross-section variation are obtained from the details of the POM model. The black box is the calculation result of the POM model, the red line is the curve of the linear fitting, and the blue line is the assumed volume transport.

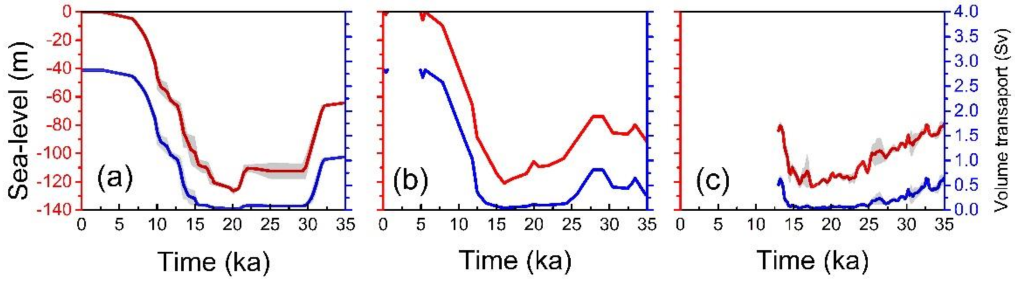

Fig. 2 The red lines represent the sea level data sources that we used are from (a) Yokayama et al. (2019), (b) Saito et al. (1998) and (c) Arz et al. (2007), respectively. The blue lines are the volume transport through the Tsushima Strait, whose relationship to time corresponds to the relationship between sea level and time.

2. The salinity simulation

Due to the different sources of sea level data, the variation of salinity varies to some extent. The salinity begins to gradually decline from 30 ka, until the minimum, and then slowly recovers in about 13ka and returns to the normal level. However, the minimum occurs at different times and the minimum values are different, which is related to the change of the minimum value of the volume transport. The minimum values occur at 20ka, 17ka or 16ka. The values are 14.0, 25.5 or 27.0. And the variation trend of salinity is consistent with that of oxygen isotope of planktonic foraminifera in the paleoclimatic results. The reduction of salinity is not enough to lead to the degree of isotope reduction, there are other factors to cause isotope reduction.

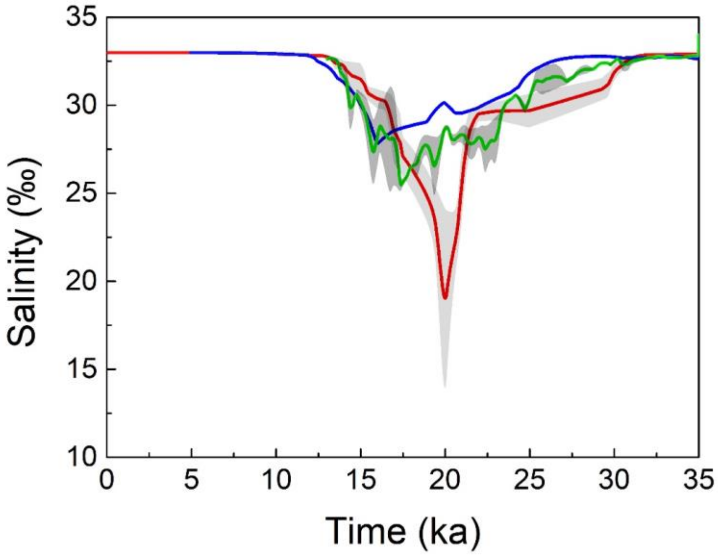

Fig. 3 The evolution of salinity for the basic case and the values means the salinity of the upper 200 m layer of the Japan Sea. The gray area represents the range of value fluctuations, while the red, blue, and green lines represent the sea level sources that we used from Yokoyama et al. (2019), Saito et al. (1998) and Arz et al.(2007), respectively.

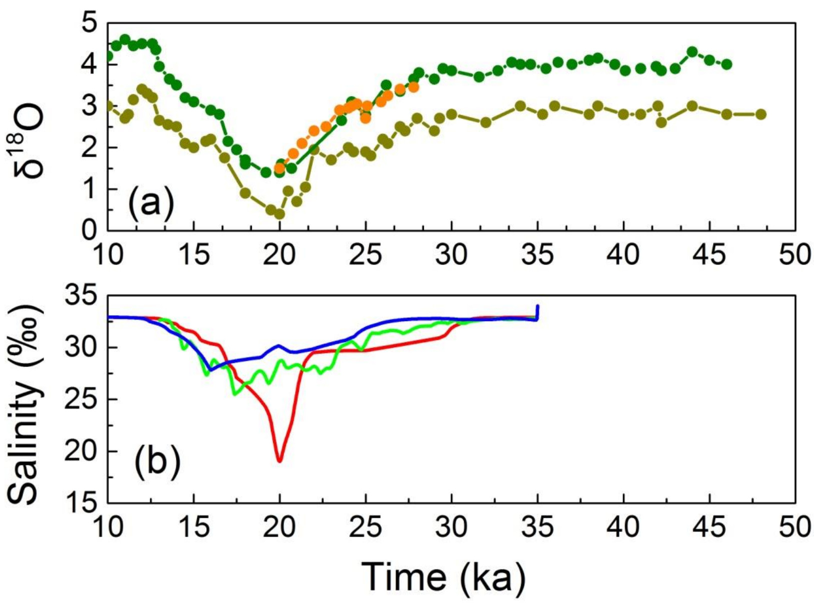

Fig. 4 Comparison of salinity and oxygen isotopes of planktonic foraminifera in the paleoclimatic results, which are obtained from Sagawa et al. (2018). The circle dot for orange, dark yellow and olive represent oxygen isotopes values of three different planktonic foraminifera in figures. And the salinity for red, blue, and green lines in figure (b) represents the sea level sources that we used from Yokoyama et al. (2019), Saito et al. (1998) and Arz et al.(2007), respectively.

References:

Arz, H. W., Lamy, F., Ganopolski, A., et al. Dominant Northern Hemisphere climate control over millennial-scale glacial sea-level variability. Quaternary Science Reviews, 26(3-4):0-321, 2007.

Sagawa, T., Nagahashi, Y., Satoguchi, Y., et al. Integrated tephra stratigraphy and stable isotope stratigraphy in the Japan Sea and East China Sea using IODP Sites U1426, U1427, and U1429, Expedition 346 Asian Monsoon. Progress in Earth & Planetary Science, 5(1):18, 2018.

Saito, Y., et al. Transgressive and highstand systems tracts and post-glacial transgression, the East China Sea. Sedimentary Geology, 122(1-4):217-232, 1998.

Yokoyama, Y., Purcell, A., and Ishiwa, T. Gauging quaternary sea level changes through scientific, ocean drilling. Oceanography, 32(1):64-71, 2019.

Publication/conference presentation

Oral presentation (LaMer):

Title: Low sea surface salinity in the Japan Sea during the last glacial maximum
Lecturer: Kailun Du.
Time: November 19, 2019.

Location: Ehime University.

Perspectives in future

We will clarify the impacts on the reduction of oxygen isotopes of planktonic foraminifera during the LGM, which can provide reference and basis for paleoceanography research. To further study the effects of the sea level drop on the Japan Sea.