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Реакция диатомей на условия окружающей среды морских изотопных стадий 11-9 Курильских островов, Северо-Западная Пацифика

Diatom responses to marine isotopic stage 11-9 environments on Kurile Islands, Northwestern Pacific

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Установлены палеоклиматические колебания и изменение уровня моря в среднем плейстоцене по отложениям верхней части головнинской свиты острова Кунашир (Курильская островодужная система). Во время первой трансгрессивной фазы уровень моря был выше современного на 20–25 м (11 МИС – морская изотопная стадия) и на 5 м выше во вторую трансгрессивную фазу (9 МИС). Различия в таких изменениях среды между 11 и 9 МИС позволяет предположит, что теплый климат и высокий уровень моря во время весьма длительного межледникового периода МИС 11 в истории Земли были индуцированы не только орбитальными изменениями Земли и солнечной инсоляцией.

Ключевые слова: диатомеи; средний плейстоцен; МИС 11-9; палеоклиматические изменения; уровень моря; Курильские острова; Северо-западная Пацифика.

Reconstructing paleoclimatic changes and sea-level fluctuations during warm marine isotopic stages (MIS) 11-9 is one of the important challenges in Quaternary geology. As shown in numerous recent studies (e.g. Berger at al., 1999; Berger, Loutre 2002; Loutre, 2003; Wang et al., 2003; Raynaud et al., 2005; Yin, Berger, 2010, 2012), MIS 11 is an extraordinarily long interglacial period that occurred some 400 000 years ago and lasted for about 30 000 years. During this period there were weak, astronomically induced changes in the distribution of solar energy reaching the Earth. The conditions of this orbital climate forcing are similar to Holocene interglacial period, and they rendered the climate susceptible to changes in the level of atmospheric carbon dioxide (Raynaud et al., 2005). Another paleoclimatic and sea-level situations have been established for the MIS 9 induced changes in the Earth's orbital parameters. The differences in the paleoclimatic and sea-level position between two stages indicate strengthening of carbon dioxide concentration, and it is quite obvious that global carbon cycles have own reaction to changes of orbital character and own history which is not caused by a glacial periodicity as an original cause (Wang et al., 2003; Raynaud et al., 2005; Yin, Berger, 2010, 2012). The sea-level position during 11-9 MIS connected with a volume of melting ice sheets, is a very difficult task too. A number of paleogeographic proxy data have provided insights into paleoclimatic changes and sea-level position during these interglacials. There are several point of view on amplitudes sea-level rise during MIS 11 transgression: more than +20 m a.m.s.l. (e.g. Pushkar et al., 1999; Hearty et al., 1999; Olson, Hearty, 2009), and near the recent sea-level position (e.g. Rohling et al., 2010). The analysis of such hypotheses based on the interpretation of shoreline and marine sediments in exposed outcrops, and oxygen-isotopic data and atmospheric CO_2 concentration changes respectively have been constructively carry out by Bowen (2010).

Phytoplankton providing the ability to live and high productivity by process of photosynthesis can reflect the changes in atmospheric carbon dioxide concentration. The Diatoms as photosynthetic microorganisms are marine primary producers and play an important role in carbon, silica and nutrient budgets of the World Ocean. Their important role is consisted in export of organic carbon to the deep sea and the efficiency of the biological pump for carbon dioxide exchange. It is quite admissible that diatom paleoproductivity efficiency change can correspond to such carbon cycles. From another hand, diatoms

having sensitive and fast response to environment ecological changes and good preservation in sediments can be potentially used to reconstruct past climate and sea-level events. It's well known that zone of transition from continent to ocean is extremely sensitive to geological events. Therefore, such events should be recorded in the sediments and formations of geological bodies, especially in shelf deposits of the marginal arc-island systems.

The middle Pleistocene paleoclimatic fluctuations and sea-level changes were recorded in the deposits of upper units of the Golovnin Formation, Kunashiri Island (Kurile Arc System). The middle Pleistocene age of the deposits was established by paleomagnetic, diatom and pollen analysis. Numerous tephra beds were used as age and correlation markers. The deposits were formed during interglacial-glacial climatic and transgressive-regressive cycles, corresponding to MIS 11-9. Evolution of interbedded marine and terrestrial sedimentary environments was reconstructed. The sea-level was raised to 20–25 m above modern sea level (a.m.s.l.) in the first transgressive phase time (11 MIS), and to 5 m a.m.s.l. in the second transgressive phase time (9 MIS). The tuff units and hiatus are corresponded to regressive phases. The Kunashiri tectonic uplift rate was estimated at 0,3–0,4 mm/year. The differences in paleoenvironment between 11 and 9 MIS allows us to suppose that warm climate and high sea-level position during extraordinarily long interglacial period MIS 11 in the Earth's history were not forced only by Earth's orbital changes and solar insolation. During this period there were weak, astronomically induced changes in the distribution of solar energy reaching the Earth. The 11 MIS condition rendered the climate susceptible to other forcing may be to changes in the level of atmospheric carbon dioxide recorded by a very high photosynthetic diatom paleoproductivity. The correlation of the middle Pleistocene paleogeographic events between Kunashiri Island, Japan, Chukotka and Alaska was carried out.

Список литературы

1. *Berger A., Li X.S., Loutre M.F.* Modelling northern hemisphere ice volume over the last 3 Ma // Quaternary Science Reviews. 1999. Vol. 18. P. 1-11.

2. *Berger A., Loutre M.F.* An exceptionally long interglacial ahead? // Science. 2002. № 297. P. 1287-1288.

3. *Bowen D.Q.* Sea level 400 000 years ago (MIS 11): analogue for present and future sea-level? // Climate of the Past. 2010. № 6. P. 19-29.

4. *Heartly P.J., Kindler P., Cheng H., Edwards R.L.* A +20m middle Pleistocene sea level highstand (Bermuda and the Bahamas) due to partial collapse of Antarctic ice // Geology. 1999. № 27. P. 375-378.

5. *Loutre M.F.* Clues from MIS 11 to predict the future climate – a modelling point of view // Earth and Planetary Science Letters. 2003. № 212. P. 213-224.

6. *Olson S.L., Hearty P.J.* A sustained +21 m sea level highstand during MIS 11 (400 ka): direct fossil and sedimentary evidence from Bermuda // Quaternary Science Reviews. 2009. Vol. 28. P. 271-285.

7. *Pushkar V.S., Razzhigaeva N.G.* Golovnin Formation of the Kunashiri Island (Kurile): stratigraphy and paleoenvironment of the formation // Stratigraphy. Geological correlation. 2003. Vol. 11. P. 492-504.

8. *Pushkar V.S., Roof S.R., Cherepanova M.V., Hopkins D.M., Brigham-Grette J.* Paleogeographic and paleoclimatic significance of diatoms from middle Pleistocene marine and glaciomarine deposits on Baldwin Peninsula, northwestern Alaska // Palaeogeography, Palaeoclimatology, Palaeoecology. 1999. Vol. 152(1-2). P. 67-85.

9. *Raynaud D., Barnola J.-M., Souchez R., Lorrain R., Petit J.-P., Duval P., Lipenkov V.Y.* Palaeoclimatology: The record for marine isotopic stage 11 // Nature. 2005. № 436. P. 39-40.

10. *Rohling E.J., Braun K., Grant K., Kucera M., Roberts A.P., Siddall M., Trommer G.* Comparison between Holocene and Marine Isotope Stage-11 sea-level histories // Earth and Planetary Science Letters. 2010. № 291. P. 97-105.

11. *Wang P., Tian J., Cheng X., Liu Q., Xu J.* Exploring cyclic changes of the ocean carbon reservoir // Chinese Science Bulletin. 2003. Vol. 48(23). P. 2536-2548.

12. *Yin Q.Z., Berger A.* Insolation and CO_2 contribution to the interglacial climate before and after the Mid-Brunhes Event // Nature Geoscience. 2010. Vol. 3(4). P. 243-246.

13. *Yin Q.Z., Berger A.* Individual contribution of insolation and CO_2 to the interglacial climates of the past 800,000 years // Climate Dynamics. 2012. Vol. 38. P. 709-724.

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Key words: diatoms; Middle Pleistocene; MIS 11-9; paleoclimatic changes; sea-level; Kurile Islands; Northwestern Pacific.

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