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Effect of hydroisostasy on postglacial transgression on the shelf and coast of Primorye as revealed by computer modelling

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Abstract Резюме RUS

Factors affecting the process of postglacial transgression on the shelf and coast of the Primorye (the territory of modern Primorsky Kray) in the Russian Far East are considered. The main regional feature consists in a significant lag of the sea level rise at the beginning of the Holocene following the completion of the Younger Dryas cold stadial. While some researchers explain this phenomenon in terms of descending tectonic movements that predominated in this region over the course of the Cenozoic era, traces of the Holocene climatic optimum sea level highstands along the coastline contradict the conclusion that tectonic submergence was uniform. In order to explain this contradiction, the hypothesis of hydroisostatic load compensation due to the viscoelastic properties of the mantle layers following the end of the last period of glaciation and involving the influx of huge volumes of water to the basin of the Sea of Japan is proposed. Dominating tectonic submergences of the western rim of the Sea of Japan and the Primorye coast were interrupted by hydroisostatic emergence during the Atlantic period between 5–6 ka BP. The use of a computer simulation of postglacial transgression in the SELEN 2.9 and SELEN 4.0 software environments demonstrates a transgression lag under hydroisostatic influence along with the increasing viscosity of mantle layers. The viscosity of mantle layers in the Primorye region is shown to be lower than for the Japanese Archipelago, which is located closer to the recent subduction zone.

Keywords

postglacial transgression, mantle viscosity, hydroisostasy, vertical movements, Primorye, Russian Far East

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References

1. Antipov M.P. **1987.** *Tektonika neogen-chetvertichnogo osadochnogo chekhla dna Iaponskogo moria* [*Tectonics of the Neogene-Quaternary sedimentary cover of the Sea of Japan floor*]. M.: Nauka, 86 p. (Trudy GIN [Transactions]; 412).

2. Bulgakov R.F., Senachin V.N., Senachin M.V. **2020.** Density and rheological inhomogeneities in the mantle of the active oceanic margins of western part of Pacific Ocean and the Kuril deep-sea trench area. *Geosistemy perekhodnykh zon = Geosystems of Transition Zones*, 4(1): 116–130. https://doi.org/10.30730/2541-8912.2020.4.1.116-130
3. Evelpidou N., Kawasaki S., Kararkani A., Saitis G., Spada G., Economou G. **2019.** Evolution of relative sea level in Okinawa (Japan) during Holocene. *Geografia Fisica e Dinamica Quaternaria*, 42: 3–16.
4. Farrel W.E., Clark J.A. **1976.** On postglacial sea level. *Geophysical J. International*, 46: 647–667. https://doi.org/10.1111/j.1365-246X.1976.tb01252.x
5. Ignatov E.I. **2004.** *Beregovye morfosistemy* [*Coastal morphosystems*]. Moscow; Smolensk: Madzhenta, 352 p.
6. Kaplin P.A. **1978.** [Shelf zone development in the Pleistocene]. In: *Geomorfologiia i paleogeografiia shel'fa* [*Geomorphology and paleogeography of shelf*]. Moscow: Nauka, 157–164.
7. Korotkiy A.M., Karaulova L.P., Troitskaya T.S. **1980.** [*Quaternary sediments of the Primorye. Stratigraphy and paleogeography*]. Novosibirsk: Nauka, 232 p.
8. Kulakov A.P. **1973.** *Chetvertichnye beregovye linii Okhotskogo i Iaponskogo morei* [*Quaternary coastlines of the Okhotsk and Japan Seas*]. Novosibirsk: Nauka, 187 p.
9. Kuz'mina N.N., Poliakova E.I., Shumova G.M. **1982.** [On the Holocene transgression history of the Sea of Japan]. In.: *Geologiia morei i okeanov: Tez. dokl. V Vsesoiuz. shkoly morskoi geologii* [Geology of the seas and oceans: Reports theses of the V All-Union marine geology school]. Moscow: In-t okeanologii im. P.P. Shirshova AN SSSR [P.P. Shirshov Institute of Oceanology of the AS USSR], vol. 1: 50–52.
10. Kuz'mina N.N., Shumova G.M., Poliakova E.I. et al. **1987.** [Paleogeographic reconstructions of the Holocene of the northwestern coast and shelf of the Sea of Japan]. *Izv. AN SSSR, Seriia geograficheskaia = Bulletin of the Academy of Sciences of the USSR: Geography series*, 4: 78–89.
11. Lambeck K., Rouby H., Purcell A., Sun Y., Sambridge M. **2014.** Sea level and global ice volumes from the Last Glacial Maximum to the Holocene. *Proceedings of the National Academy of Sciences*, 111(43): 15296–15303. https://doi.org/10.1073/pnas.1411762111
12. Nakada M., Yonekura N., Lambeck K. **1991.** Late Pleistocene and Holocene sea-level changes in Japan: implications for tectonic histories and mantle rheology. *Paleogeography, Paleoclimatology, Paleoecology*, 85(1–2): 107–122. https://doi.org/10.1016/0031-0182(91)90028-p
13. Park S.-C., Yoo D.-G., Lee E.-I. **2000.** Last glacial sea-level changes and paleogeography of the Korea (Tsushima) Strait. *Geo-Marine Letters*, 20(2): 64–71. https://doi.org/10.1007/s003670000039
14. Peltier W.R. **2004.** Global glacial isostasy and the surface of the ice-age Earth: The ICE-5G (VM2) model and GRACE. *Annual Review of Earth and Planetary Sciences*, 20(32): 111–149. doi:10.1146/annurev.earth.32.082503.144359
15. Peltier W.R., Fairbanks R.G. **2006.** Global glacial ice volume and Last Glacial Maximum duration from as extended Barbados sea level record. *Quaternary Science Reviews*, 25: 3322–3337.
16. Peltier W.R., Argus D.F., Drummond R. **2015.** Space geodesy constrains ice-age terminal deglaciation: The global ICE-6G_C (VM5a) model. *J. of Geophysical Research: Solid Earth*, 120: 450–487. https://doi.org/10.1002/2014jb011176
17. Pirazzoli P.A. **2005.** A review of possible eustatic, isostatic and tectonic contributions eight late-Holocene relative sea-level histories from the Mediterranean area. *Quaternary Science Reviews*, 24: 1989–2001. https://doi.org/10.1016/j.quascirev.2004.06.026
18. Pletnev S.P. **2012.** *Paleogeografiia osadochnykh basseinov zapadnoi chasti Tikhogo okeana (pozdnii mel – kainozoi)* [*Paleogeography of the sedimentary basins of the western Pacific Ocean (Late Cretaceous – Cenozoic*]: [dissertation abstract for the Candidate of geographical sciences]. Vladivostok.
19. Rodnikov A.G., Zabarinskaia L.P., Piip V.B., Rashidov V.A., Sergeeva N.A., Filatova N.I. [Geotraverse of the Sea of Okhotsk region]. **2005.** *Vestnik KRAUNTs. Nauki o Zemle = Bull. of Kamchatka Regional Association "Educational-Scientific Center". Earth Sciences*, 5: 45–58.
20. Selivanov A.O., Stepanov V.P. **1982.** [Experience in geoarchaeological investigations on a marine coast (by the example of the Soviet Primorye)]. In.: *Izmeneniia urovnia moria* [*Sea-level changes*]. Moscow: Isd-vo MGU [MSU Press], 115–133.
21. Spada G., Melini D. **2019.** SELEN 4 (SELEN version 4.0): a Fortran program for solving the gravitationally and topographically self-consistent Sea Level Equation in Glacial Isostatic Adjustment modeling. *Geoscientific Model Development*, 12: 5055–5075. https://doi.org/10.5194/gmd-12-5055-2019
22. Spada G., Stocchi P. **2006.** *The sea level equation: Theory and numerical examples*. Roma: Aracne, 96 p.
23. Spada G., Stocchi P. **2007.** SELEN: A Fortran 90 program for solving the sea-level equation. *Computers and Geosciences*, 33(4): 538–562. http://dx.doi.org/10.1016/j.cageo.2006.08.006
24. Spada G., Melini D., Galassi G., Colleoni F. **2012.** *Modeling sea level changes and geodetic variations by glacial isostasy: the improved SELEN code*. http://arxiv.org/abs/1212.5061.

25. Tanabe S., Nakanishi T., Yasui S. **2010.** Relative sea-level change in and around the Younger Dryas inferred from late Quaternary incised-valley fills along the Japan Sea. *Quaternary Science Reviews*, 29: 3956–3971. https://doi.org/10.1016/j.quascirev.2010.09.018
26. Tushingham A.M., Peltier W.R. **1991.** ICE-3G – A new global model of late Pleistocene deglaciation based upon geophysical predictions of Post-Glacial relative sea level change. *J. of Geophysical Research: Solid Earth*, 96: 4497–4523. https://doi.org/10.1029/90jb01583
27. Wu P., Peltier W.R. **1983.** Glacial isostatic adjustment and the free air gravity anomaly as a constraint on deep mantle viscosity. *Geophysical J. International*, 74: 377–449.