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Reconstruction of Holocene environmental changes in Southern Kurils (North-Western Pacific) based on palaeolake sediment proxies from Shikotan Island

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ABSTRACT

We investigated a well-dated sediment section of a palaeolake situated in the coastal zone of Shikotan Island (Lesser Kurils) for organic sediment-geochemistry and biotic components (diatoms, chironomids, pollen) in order to provide a reconstruction of the palaeoenvironmental changes and palaeo-events (tsunamis, sea-level fluctuations and landslides) in Holocene. During the *ca* 8000 years of sedimentation the changes in organic sediment-geochemistry and in composition of the diatoms and chironomids as well as the shifts in composition of terrestrial vegetation suggest that the period until *ca* 5800 cal yr BP was characterized by a warm and humid climate (corresponds to middle Holocene optimum) with climate cooling thereafter. A warm period reconstructed from *ca* 900 to at least *ca* 580 cal yr BP corresponds to a transition to a Nara-Heian-Kamakura warm stage and can be correlated to a Medieval Warm Period. After 580 cal yr PB, the lake gradually dried out and climatic signals could not be obtained from the declining lacustrine biological communities, but the increasing role of spruce and disappearance of the oak from the vegetation give evidences of the climate cooling that can be correlated with the LIA. The marine regression stages at the investigated site are identified for *ca* 6200–5900 (at the end of the middle Holocene transgression), *ca* 5500–5100 (Middle Jomon regression or Kemigawa regression), and *ca* 1070–360 cal yr BP (at the end of Heian transgression). The lithological structure of sediments and the diatom compositions give evidences for the multiple tsunami events of different strengths in the Island. Most remarkable of them can be dated at around *ca* 7000, 6460, 5750, 4800, 950 cal yr BP. The new results help to understand the Holocene environmental history of the Southern Kurils as a part of the Kuril-Kamchatka and Aleutian Marginal Sea-Island Arc Systems in the North-Western Pacific region.

1. Introduction

Studies of Holocene environments of the coasts of the North-Western (NW) Pacific marginal seas are of interest for understanding the evolution of geosystems within the background of global climate warming (Korotky et al., 2000; Razjigaeva et al., 2002, 2004, 2013; Lozhkin et al., 2017). The one of the most important drivers of Holocene environmental change along the coastal Far East mainland and NW Pacific Islands, has been implied to be a series of transgressions and regressions that are linked to variations in global ice volume as climate

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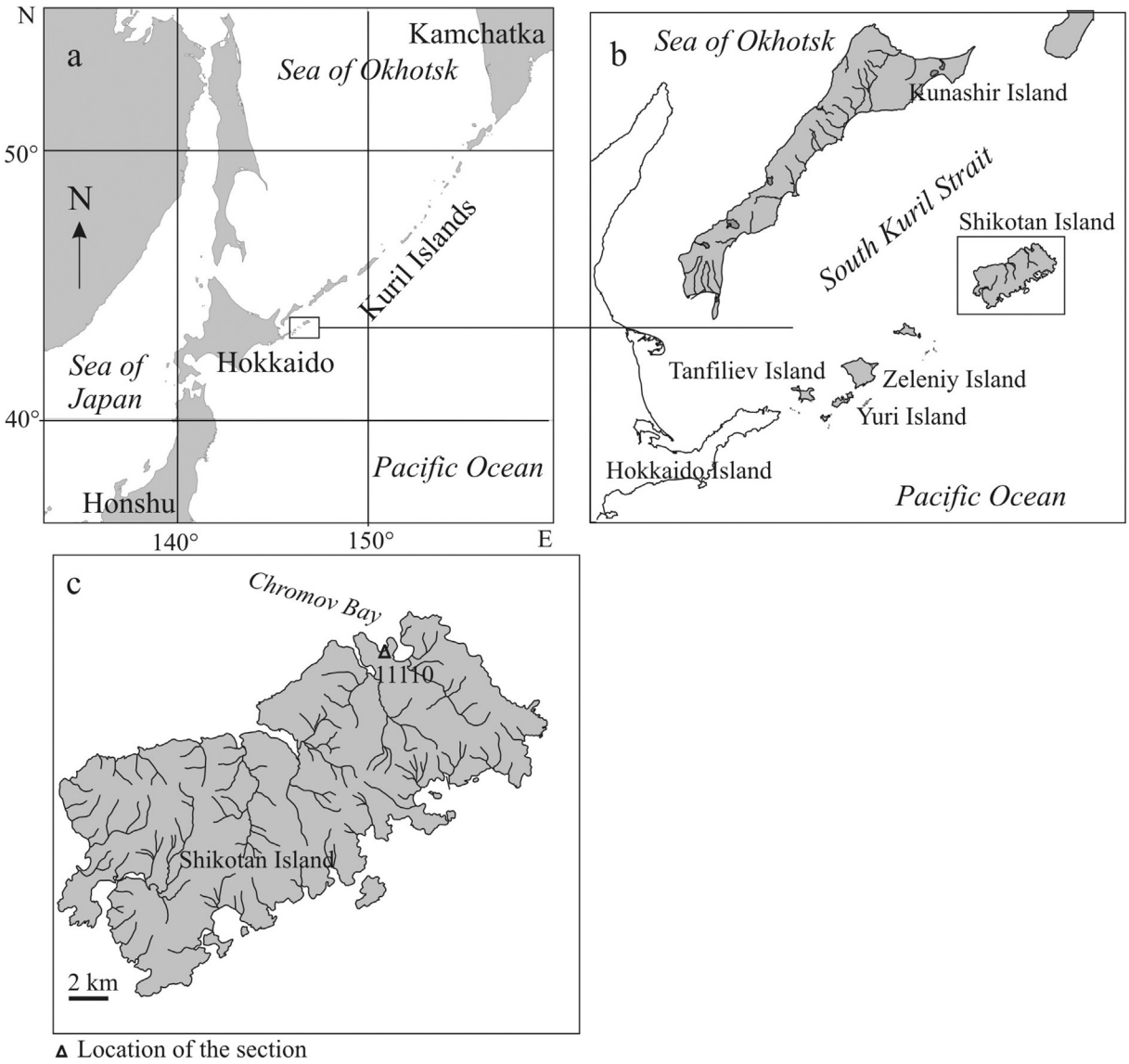

Fig. 1. Location of the study area.

shifted between comparatively warmer (transgression) and cooler (regression) conditions (Korotky and Khudyakov, 1990; Korotky et al., 1997, 2000; Razjigaeva et al., 2002, 2004, 2008; Lozhkin et al., 2017). However, the history of the climate evets and of the sea-level fluctuations in the region is still unclear as the paleorecords on which it is based are mostly from discontinuous records that suffer from poor dating control (Lozhkin et al., 2017).

Kuril Islands are a part of the Kuril-Kamchatka and Aleutian Marginal Sea-Island Arc Systems and form a volcanic archipelago that stretches from the Kamchatka Peninsula (Russia) in the north to the Hokkaido Island (Japan) in the south, separating the Sea of Okhotsk from the North Pacific Ocean. It consists of Greater Kuril and Lesser Kuril Ridges. The Lesser Kurils are a relic of a land bridge that existed at the Last Glacial Maximum and connected the Lesser Kurils with Kunashir and Hokkaido Islands and disappeared during the post-Glacial–Holocene transgression (Tsukada, 1988; Korotky et al., 1997; Razjigaeva et al., 2008) (Fig. 1).

Shikotan Island was the first to be separated from the land bridge in the early Holocene as the depth of Shpanberg Strait between Shikotan and a neighbouring Polonsky Island is approximately 30 m, whereas sea level at the beginning of Holocene was approximately 40 m lower than at present, as estimated for North Hokkaido (Maeda et al., 1994). The Kuril Islands are situated along a zone of convergence of two adjoining plates, where the Pacific plate subducts under the Eurasian plate. This leads to the intensive seismic and volcanic activity in the region. The islands are exposed to tsunamis, storms and strong tidal currents, which result in dramatic changes of the ecological situations on the coasts (Ganzey et al., 2010, 2011; MacInnes et al., 2009; Razzhigaeva et al., 2012; Kaistrenko et al., 2013). Neotectonic movements are among of the major forces, driving the position of the sea level during different intervals of the Holocene. Although the position of the marine Holocene deposits of the closed bays on the southern coast of Shikotan Island indicate that the cumulative effect of the neotectonic movements during the middle to late Holocene was insignificant, but the findings of the middle to late Pleistocene sea sediments on the island indicate descending movements, most likely in the Late Pleistocene – Holocene transition (Razjigaeva et al., 2008). In modern time during an earthquake in 1994, Shikotan Island fell by 0.5–0.7 m (Ivashchenko et al., 1996). Considering the mountainous or hilly relief of the islands of the region any change of the sea level position leads to the changes of the land area and can cause shifts in the microclimatic conditions and hence a disruption of vegetation boundaries. Therefore, neotectonic movements leading to the sea level changes alongside with the climate-born factors play a decisive role in the evolution of the ecosystems in