EFFECT OF THE TUNGUSKA EVENT ON LAKE ECOSYSTEMS: A CASE STUDY OF SUZDALEVO LAKE

D. Vondrák[1], R. Kavková[2], B. Chattová[3], V. Goliáš[4], M. Takáč[2], E. Švecová[2], R. Štorc[2], G. Kletetschka[2,5], [1]Institute for Environmental Studies, Charles University, Benátská 2, CZ-12801 Prague 2, Czechia, daniel.vondrak@natur.cuni.cz, [2]Institute of Hydrogeology, Engineering Geology and Applied Geophysics, Charles University, Albertov 6, CZ-12843 Prague 2, Czechia, [3]Department of Botany and Zoology, Masaryk University, Kotlářská 2, CZ-61137 Brno, Czechia, [4]Institute of Geochemistry, Mineralogy and Mineral Resources, Charles University, Albertov 6, CZ-12843 Prague 2, Czechia, [5]Geophysical Institute, University of Alaska, Fairbanks, 903 N Koyukuk Drive, USA.

Introduction: The Tunguska event (TE) in 1908 damaged over 2,000 km^2 of Siberian taiga in the Evenkiysky District, Russia. Although the nature of the Tunguska impactor is not known, various imprints of the explosion are preserved in nature archives such as tree rings, peat, or lake sediments [e.g., 1, 2, 3, 4]. We investigated sediments of Suzdalevo Lake (60°39'29.05"N, 102° 3'3.36"E) which is located inside the former tree damage area. According to oral testimony of local Evenki people [Evgeniya Karnouchova, pers. comm.], the origin of the water body is related to the TE, however, no other evidence of its age or process of its formation is available. In our study, we focused not only on the age of Suzdalevo Lake, but also on reconstructing environmental changes caused by the event. So far, this issue has been studied only in terms of the forest damage and the extent of forest fires [5, 6], but data on TE-related changes in water ecosystems are missing.

Methods and results: Two sediment short-cores (42 cm and 46 cm) were retrieved from Suzdalevo Lake using a Kajak gravity corer. Short-lived isotope dating was performed using low background gamma-ray spectrometry (modified SILAR® low-background anticompton-anticoincidence gamma spectrometer; for details see [7]) based on activities of ^{210}Pb, ^{137}Cs, and ^{226}Ra isotopes in 0.5–1-cm-thick layers. Age of sediment at the depth of 30 cm and deeper was older than 1897 CE ± 9.4 yr. The calculated depth of the TE impact layer (1908 CE) was confirmed by detection of an erosional input from the lake watershed. This erosion signal was marked by increased magnetic susceptibility values, an increase in strontium to rubidium ratio (XRF analysis), and abundant terrestrial plant remains. Potential presence in impact-related melted objects was tested by magnetic separation of magnetic grains and observation under a dissecting optical microscope at 25–70x magnification, however, no material of this kind with diameter over 5 µm was found near the TE horizon except of equidimensional grains of reduced titanomagnetite. For evaluation of lake ecosystem response to the TE, we used analyses of freshwater algae (diatoms) and freshwater insect (chironomid larvae) remains. The diatom record revealed four statistically significant accumulation zones (optimum sum of squares partitioning method on relative abundance data and broken-stick model) with a sudden increase in taxonomic diversity and abundance of the fossils at the depth of 28 cm (i.e., upper part of the first zone (Zone 1b); see Fig. 1). This shift is also characterized by maximum dominance of lake-bottom associated (benthic) species and corresponds well with the TE horizon. A similar signal was observed in benthic chironomid larvae assemblages (Fig. 1).

Discussion and conclusions: Despite the Evenki oral testimony, Suzdalevo Lake was formed before the TE, likely due to thermokarst processes. However, its sediments can be used as an unique nature archive showing effects of the TE on the lake-watershed (eco)system. Our results reveal major changes in water biota associated with disturbance of lake's watershed and pronounced water column mixing that is essential for the bottom species [7]. On the other hand, we did not observed presence of any allochthonous objects, such as melted spherical objects [8], with exception of titanomagnetite crystals with lack of oxygen which could originate from local volcanic rocks.

Acknowledgments: This work was supported by the Czech Science Foundation (project no. 20-08294S).

References: [1] Kletetschka G. et al. (2017) *Tree-Ring Research* 73(2):75–90. [2] Tositti L. et al. (2006) *Global and Planetary Change* 53:278–289. [3] Gasperini et al. (2009) *Terra Nova* 21(6):489–494. [4] Kletetschka G. et al. (2019) *Meteoritics & Planetary Science* 54(S2): Abstract #6506. [5] Nesvetaljo V. D. (1998) *Planetary and Space Science* 46(2/3):155–161. [6] Vasilyev N. V. (1998) *Planetary and Space Science* 46(2/3):129–150. [7] Hamrová E. et al. (2010) *Hydrobiologia* 643(1):97–106. [7] Moravcová et al. (2021) *The Holocene* 31(5):746–759. [8] Badyukov et al. (2011) *Geochemistry International* 49(7):641–653.

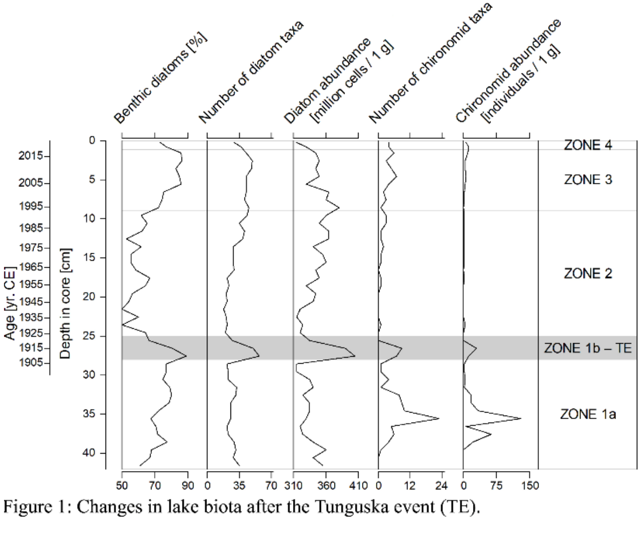

Figure 1: Changes in lake biota after the Tunguska event (TE).