

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

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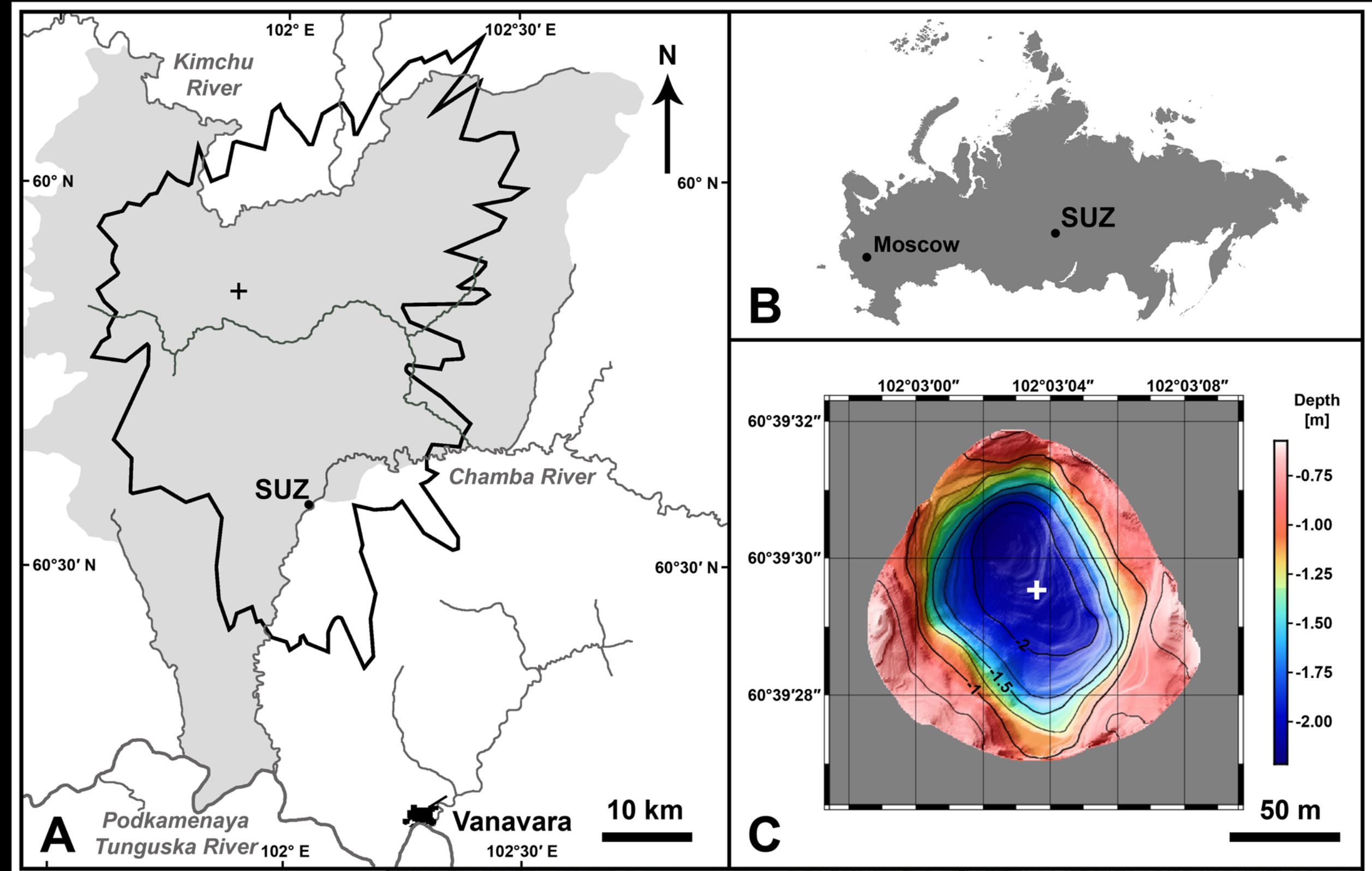
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The Tunguska event (TE) in 1908 damaged over 2,000 km² of Siberian taiga in the Evenkiysky District, Russia. Although the nature of the Tunguska impactor is still discussed, various imprints of the explosion are preserved in nature archives such as 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 (Fig. 1). According to oral testimony of local Evenki people, 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.

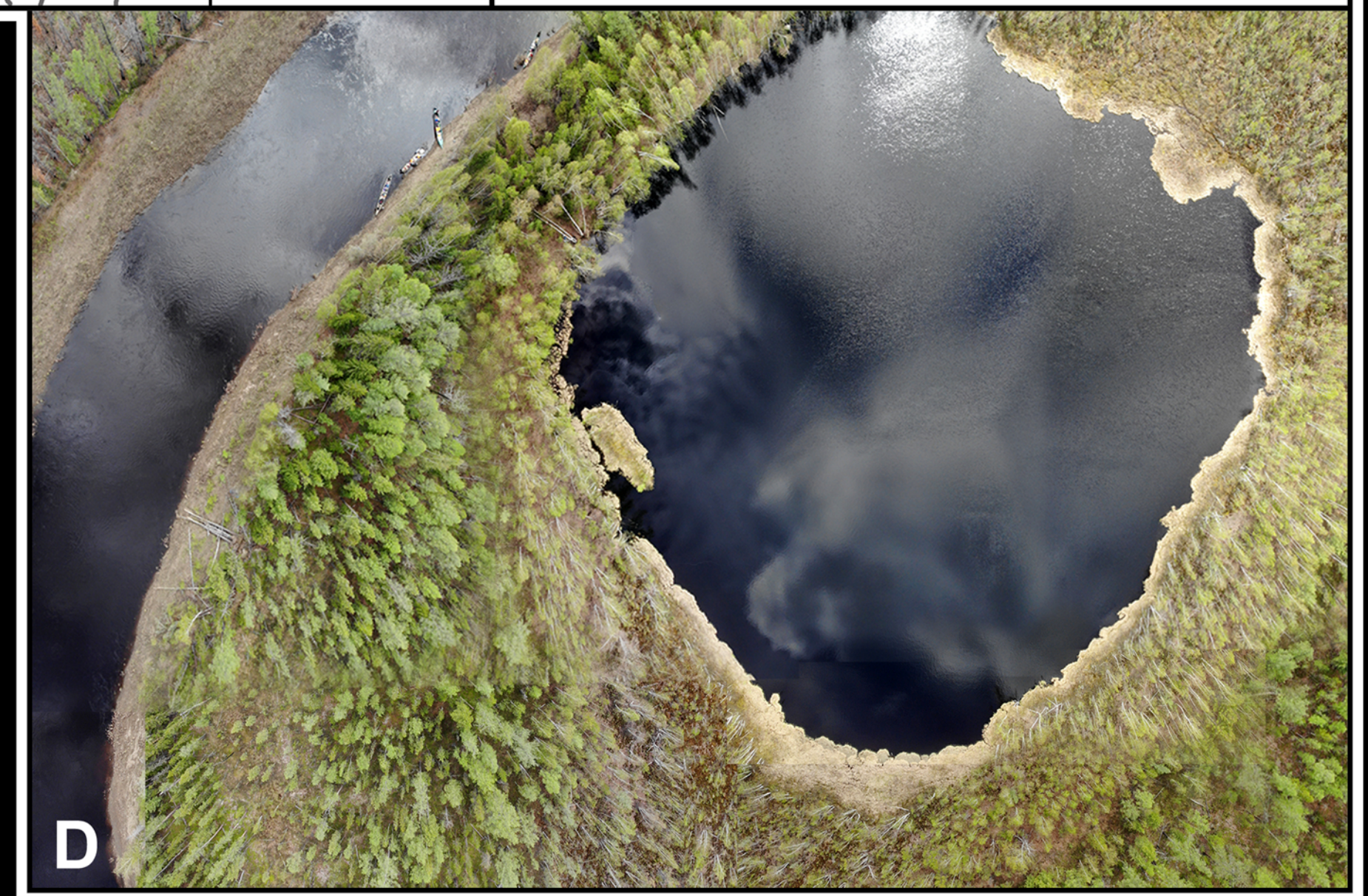
Figure 1. (A) The Tunguska region and the study site – Suzdalevo Lake (SUZ). Bold black line shows the border of tree damage area. (B) Geographical location of Suzdalevo Lake within Russia. (C) Bathymetric map of Suzdalevo Lake. White cross indicates the position where two sediment cores (SUZ1 and SUZ3) were taken. (D) Aerial photo of Suzdalevo Lake and the Chamba River.



Two sediment short-cores (42 cm and 46 cm) were retrieved from Suzdalevo Lake using a gravity corer. Short-lived isotope dating was performed using low background gamma-ray spectrometry (for details see [7]) based on activities of ²¹⁰Pb, ¹³⁷Cs, and ²²⁶Ra isotopes in 0.5–1-cm-thick layers. Age of sediment at the depth of 30 cm and deeper was older than 1897 ± 9.4 cal. yr. CE. 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 Sr to Rb ratio (XRF analysis), and abundant terrestrial plant remains (Fig. 2).

Potential presence in impact-related melted objects was tested by magnetic separation of magnetic grains and observation under a dissecting optical microscope (25–70x magnif.), 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. 2). This shift was also characterized by maximum dominance of lake-bottom associated (benthic) species and corresponded well with the TE horizon. A similar signal was observed in benthic chironomid larvae assemblages (Fig. 2).



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Conclusions

Despite the Evenki reindeer nomad oral testimony, Suzdalevo Lake was formed before the Tunguska Event, likely due to thermokarst processes.

However, its sediments can be used as an unique nature archive showing effects of the impact / airburst 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 survival [8].

On the other hand we did not observed presence of any allochthonous objects, such as melted spherical objects [9], with exception of titanomagnetite crystals with lack of oxygen which could originate from local volcanic rocks.

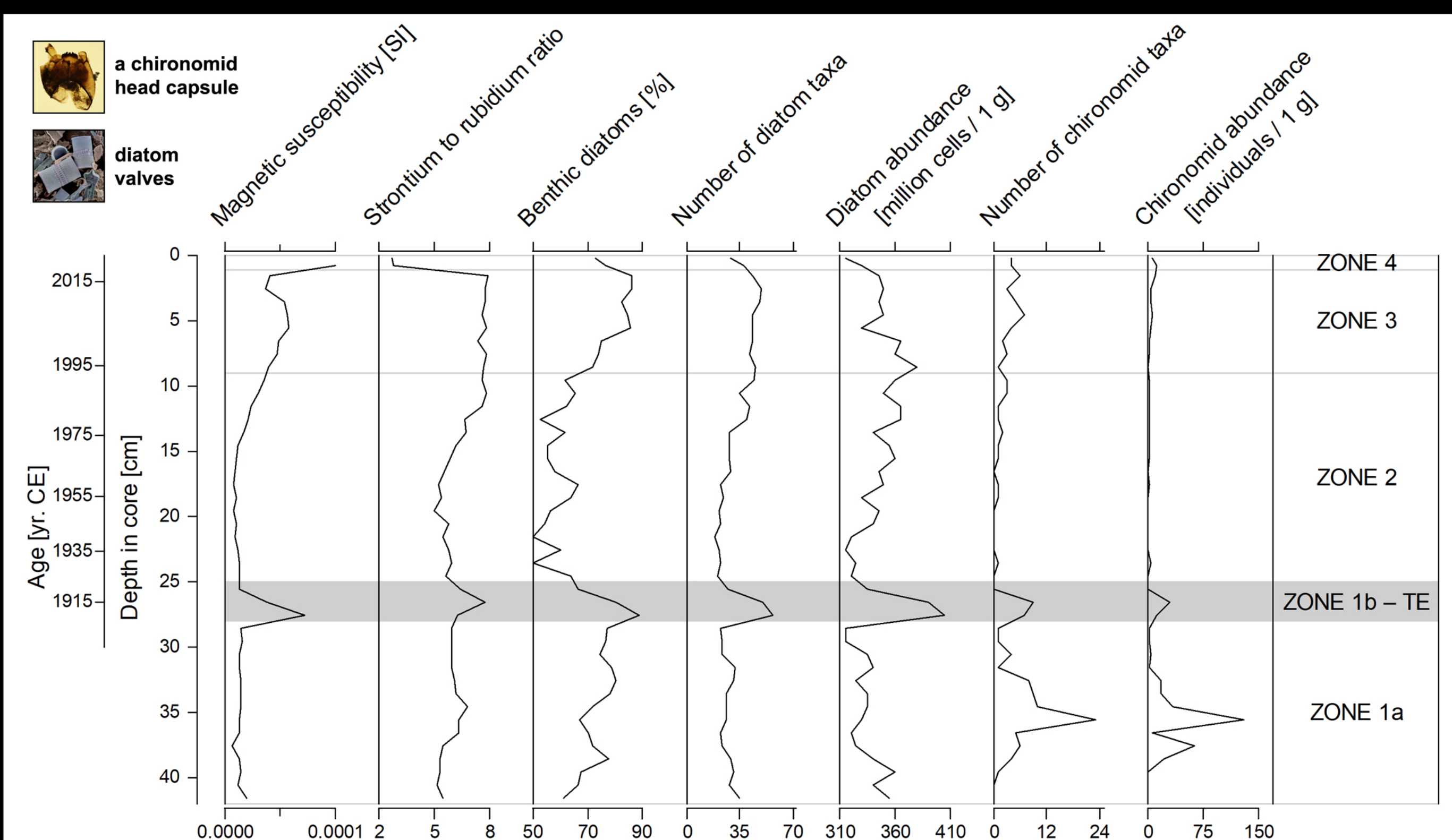


Figure 2. The record of the TE (see Zone 1b) in the Suzdalevo Lake sediment.

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