PERMAFROST DESTRUCTION DUE TO AIRBURST IN TERRESTRIAL ENVIRONMENT. Daniel Vondrák[1], Radana Kavkova[2], Viktor Golias[3], Marian Takac[2], Richard Storc[2], Eva Svecova[2], Nicholas Hasson[4], Carlo Stanghellini[5], Giuseppe Stanghellini[6], Luca Gasperini[7], Denis Yu. Rogozin[8] , Artur V. Meydus[9] and Gunther Kletetschka[1,4,10], [1] Institute for Environmental Studies, Faculty of Science, Charles University, Prague 2, Benátská 2, Czechia, CZ-12801, daniel.vondrak@natur.cuni.cz, [2]Institute of Hydrogeology, Engineering Geology and Applied Geophysics, Faculty of Science, Charles University, Prague 2, Albertov 6, CZ-12800, Czechia, gunther.kletetschka@natur.cuni.cz, [3]Institute of geochemistry, mineralogy and mineral resources, Faculty of Science, Charles University, Prague 2, Albertov 6, CZ-12800, Czechia, [4]Geophysical Institute, University of Alaska Fairbanks, Fairbanks, 903 N Koyukuk Drive, AK, USA, [5]INAF Istituto di Radioastronomia, Bologna, Via Gobetti 101, I-40129, Italy, [6]Istituto di Scienze Marine, CNR, Bologna, Via Gobetti 101, I-40129, Italy, [7]Istituto di Scienze Marine, CNR, Bologna, Via Gobetti 101, I-40129, Italy, [8]Institute of Biophysics, Siberian Branch of the Russian Academy of Sciences, Krasnoyarsk, Akademgorodok, 660036, Russia, [9]State Nature Reserve Tungusskiy, Krasnoyarsk 66002, Street 27 19, Russia, [10]Institute of Geology, Czech Academy of Sciences, Prague 6, Rozvojová 269, CZ-16500, Czechia.

Introduction: Suzdalevo is a thermokarst pond situated in a region affected by the Tunguska Event (TE) in 1908 AD. Evenki people inhabited this region prior to the Tunguska impact/airburst and reported no lake present. On the other hand, they claim that Suzdalevo Lake was created at the time of the TE. This small lake (150 m in diameter) of rounded shape is located close (20 m aside) to the Chamba River, a tributary of the Podkamennaya Tunguska, 20 km SW of the alleged epicenter of the TE, where a giant impact/airburst-related explosion flattened over 2000 km^2 of Siberian continental taiga [1, 2]. Because there were rumors (Evenki's reports) that Suzdalevo was not existing before 1908 AD, we decided to collect sediments and detailed morpho-bathymetric data from this lake to gather information about its possible origin.

Methods: *Bathymetry.* The bathymetric survey has been performed with a 200 kHz echosounder tied to a wooden stick aside of a boat; the transducer was located at about 30 cm below the water surface. Instead of acquiring only the depth value provided by the echosounder at serial port, we collected the entire echogram by mean of a 16bit A/D converter driven by SwanPRO acquisition software. The acquisition parameters of the echosounder signal were: sample rate 0.856 ms; trace length 25 ms; number trace samples 2140; number of traces per seconds 7. The collected data were stored in XTF format, then converted to SEGY format and checked its consistency using segy-change [4]. Data were then processed using SeisPrho [5], to display the echograms and semi-automatically digitize the sediment-water interface. The lake floor profiles were subsequently corrected for the vertical offset between water surface and transducer vertical position, and then exported in ASCII (lon, lat, z) format. The file was then processed with GMT to produce both a regular grid file and the final map. The original data were affected by spatial noise due to GPS precision limited to about 1 meter. In order to reduce this spatial noise, the map was compiled using a 2D median filter with a searching radius of 10 meters.

Sediment coring. In June 2019, two lake sediment short cores, SUCH01 and SUCH03, were collected using a Kajak gravity corer (chamber diameter 6 cm, chamber length 50 cm). Length of the collected cores: SUCH01 – 42 cm, SUCH3 – 46 cm; sediment was cut with 1 cm step, with exception of the first 1cm which is divided into 0–0.5 cm and 0.5–1 cm.

Sediment dating. The uppermost (0–16 cm) dried sediment samples of SUCH01 were measured by gamma spectroscopy for the specific activity of ^{210}Pb, ^{137}Cs and ^{226}Ra. Samples were measured by well-in-well geometry in a SILAR® low-background anticompton-anticoincidence gamma spectrometer with specially designed 40 x 40 mm Na(Tl) well-type LEADMETER® detector with a total efficiency of 46.2 % (for ^{210}Pb line of 47 keV) placed in a well-type guard NaI(Tl) detector 160 x 125 mm in 10 cm low-background lead shielding [3]. A Canberra DSA 2000 multichannel analyzer controlled by GENIE 2000 software was used to determine the specific isotope activities. The measuring time for individual samples was 2 days, and 6 days for background. Special in-home standards with a light matrix are used for radionuclide quantification in the same geometry of the 8 ml vials. The IAEA-447 standard (moss-soil) was used as ^{210}Pb reference material with a result of 340±6 Bq kg^{-1} for the recommended value of 338 Bq kg^{-1}, corrected for decay from the reference date (2009/11/15).

Magnetic susceptibility. Individual samples were weighted, placed inside 10 ml plastic holders and acquired magnetic susceptibility. We used magnetic susceptibility meter SM30 ZHulka Inc, operating with 8kHz frequency and amplitude 40 A/m.

Geochemistry. The total content of selected elements was determined by means of X-ray fluorescence (XRF) spectrometry using a handheld ED-XRF analyzer VANTA VCR with a Silicon Drift

Detector (Olympus, USA). National Institute of Standards and Technology (NIST) standard reference materials 2711a Montana II Soil and 2710a Montana I Soil were used for quality control.

Discussion and Results: Suzdalevo Lake is a very shallow water body with max. depth about 2.3 m, depth-to-diameter ratio of about 0.015 and an irregular inverted-cone morphology slightly elongated in the N-S direction. The depocenter in located close to the N shore, while the E and W shores show morphological irregularities.

Both sediment cores (SUCH01 and SUCH03) consist of a homogeneous dark brown gyttja with no distinct lamination. The specific activities of ^{210}Pb exponentially decreased from the topmost layers to background ("supported") activities in the lower part of the measured depth interval. Although low inaccuracies are due to the low weights of the measured samples (0.4–1.6 g of dry sediment, median 0.9 g), ^{210}Pb dating was successfully used for upper 16 horizons in the SUCH01 profile (back to 1848 AD ±53 years). The calculated sedimentation rates decrease downwards in the profile due to sediment compaction, varying between 0.03–0.26 cm·year^{-1} in profile.

The ^{137}Cs specific activities, namely "Novaya Zemlya cesium", were relatively low in the profile measured. This demonstrates that sediment was quite low contaminated by this anthropogenic radionuclide. The maximum of 93 Bq kg^{-1} was detected in SUCH01 core at a depth of 9–10 cm, which corresponds to the date of 1953 AD ±17 years, which is in very good agreement with the maximum of the surface nuclear tests on the Novaya Zemlya in 1958–1962 [6]. ^{137}Cs activities are detectable (dispersed) in most samples of this profile, because of the migration of cesium by its resuspension [7].

At depths below 16 cm, the development of radionuclide activities is very irregular. Therefore, it is likely that the sediment record is disturbed below this depth or represents multiple erosion event.

Also, magnetic susceptibility and concentration of selected elements and their rations (e.g., phosphorus, titanium, strontium/rubidium, silicon/titanium, silicon/zirconium, iron/manganese) showed a distinct transition at ca. 15.5 cm in both cores documenting sudden environmental changes or a change in the sedimentation regime.

Conclusions: Our data show that Suzdalevo Lake has disturbed sediment below 15.5 cm. Above this depth the studied record demonstrates a regular sedimentation pattern corresponding to limnic conditions. This is a clear indication that the water body is a thaw lake in its origin and supports the Evenki's reports that it appeared just after the TE. We assume that the Tunguska impact/airburst has likely melted the permafrost landscape near the TE epicenter.

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