New implications for Tunguska explosion based on magnetic, dendrological, and lacustrine records

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Introduction: Evenkia is a district in Krasnoyarsk Krai, Russia, characteristic of preserved areas of East Siberian continental taiga. In 1908, this region experienced catastrophe (Tunguska event = TE). Over 2,000 km^2 of boreal forest were felled and burned [1,2]. The exact cause of this event is not known but this event has often been associated with either an asteroid or comet encounter [3,4,5].

Material and Methods: We collected tree samples that survived the explosion within the tree collapse area. Most of the tree is Siberian larix. Samples were analyzed for elemental composition (XRF and similar). We collected sediment from three lakes, Zapoviednoe, Cheko, and Gin. Lake Zapoviednoe and Cheko varved sediment came from similar depth of about 35-40 m with conical bottom bachymetry. Lake Gin was shallow (50-60 cm) and had no varves. Chronology of the sediment was already established in Cheko lake using ^{210}Pb, ^{137}Cs, and ^{226}Ra radioactive isotopes analysis [6]. An increase in ^{137}Cs corresponded to 1961 [6]. We ran similar analysis for the two new lakes, Gin and Zapoviednoe and established the sediment chronology. Zapoviednoe lake sediment was exposed to 0-50 keV X-Ray Fluorescence and major element data, including magnetic susceptibility, were obtained across the TE containing sediment. We plotted aeromagnetic data from the world magnetic map flown at ~4 km [7,8] over the tree fall area. Magnetic paleointensity was obtained from the samples collected from Mount Stoikovich and Farrington near epicentre.

Results: Tree samples provided an evidence that the ovepressure wave compressed the floem fluid rich in Ca, Sr, Mn into the xylem at the time of TE. This compression had strong anisotropy with maximum compression directed towards the epicenter. We detected that after TE, during the past 40 years the Larix trees in Tunguska have anomalous increase in Hg concentration. Lake sediment revealed 2-4 mm thick clay layer deposited at the time of TE. The layer has anomalous decrease in Fe, while magnetic susceptibility increased. In addition the TE layer has significant increase in Pa, Mo, Th, Cd, Nb, Y, Cu, Cr, Sr, Ti, and V. Aeromagnetic data showed negative magnetic anomaly covering the toppled forest area around the epicenter. Samples from Mount Farrington indicated magnetic paleofields exceeding 1 mT. Four samples from Mount Stoikovitch detected paleofields consistent with geomagnetic field intensity while two samples indicated magnetic paleofield exceeding 0.1 mT.

Discussion and Conclusion: TE was shown to leave a biochemical signature in the wood of Larix Sibirica sensitive to explosion direction. TE area was subjected to large energy pulse that may have compromised the permafrost in the area. This was indicated here by an excess of Hg detected in the last 40 years of tree ring material. Tunguska layer in the Zapoviednoe lake is of very fine nature, resembling the clay. While the content of Fe dropped from 160 ppm to 19 ppm the magnetic susceptibility increased two fold. This is an evidence of quick and intense burst of energy, melting vapourizing the dust, causing agglutination of the dust material. This resulted in a ubiquitous presence of nanophase iron with large magnetic susceptibility that became part of molten dust particulates and deposited in the lake sediment. Anomalous elemental increase in lake suggested possible allochtonous material. Paleomagnetic data revealed presence of plasma during the TE near rock surfaces.

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