COULD AN AIRBURST ABOVE CANADA AT THE YOUNGER DRYAS ONSET TRIGGER LAKE EUTROPHICATION AND ACIDIFICATION IN CENTRAL EUROPE?

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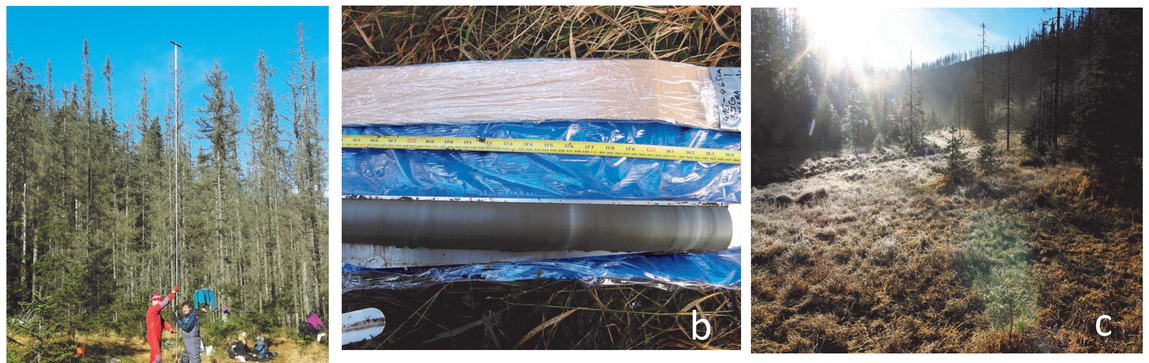

a—coring of Stara Jimka paleolake, b—core of the lake sediment containing YDB layer; c—sunrise above the paleolake.

Stara Jimka paleolake: (49.068° N, 13.403° E, 1 110 m asl) is a former mountain lake (now a peat bog) of surface area ~6.7 ha and Norway spruce-forested watershed (143 ha including the lake) situated in central part of the Bohemian Forest, Czech Republic. The watershed ranges in altitude from 1314 to 1110 m a. s. l. and it is covered by soils derived from the underlying gneiss. The lake was possibly created by a landslide around 14 kyr cal. BP. The maximum thickness of lake sediment documented during our field works is 10.7 m.

The Younger Dryas impact hypotheses (YDIH)

The Younger Dryas is well documented cold period. Reasons for this climate change are widely discussed. It began ~12,900 years ago and lasted 1,200 years and it is considered a brief ice age or the Younger Dryas Boundary (YDB). According to Firestone's discovery (Firestone et al., 2007), new evidence in terms of impact proxies supports a major impact event (most likely comet) that was responsible for disappearance of pre-historic paleoindian Clovis culture and large North American and Euroasian animals such as mastodon, mammoth and many others. Finding of micro-particles containing iridium, magnetic microspherules, and nano-diamonds in a carbon rich black YD layer provided a new evidence of a massive impact localized to the Laurentide Ice Sheet .

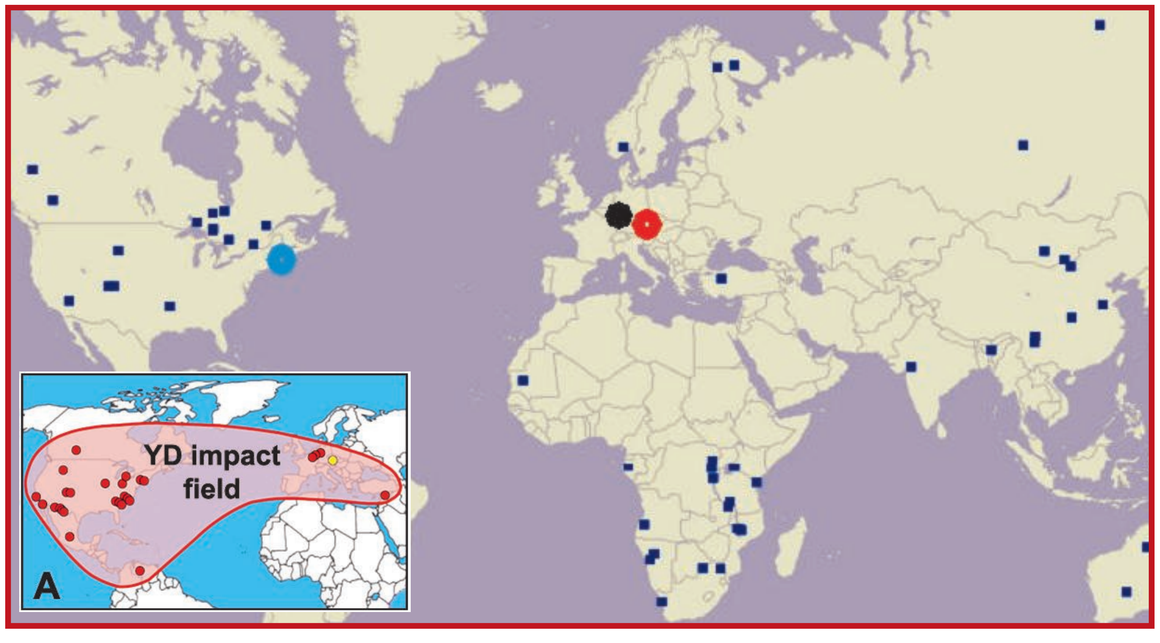

Fig. 2. Carbonatites of the world, explored deposits of Nb and REE (https://mrdata.usgs.gov/mineral-resources/carbonatite.html). Dark blue squares—carbonatites; red circle—Stara jimka lake; blue circle—Sargent Mountain Pond in Main, USA; black spot—Laachersee volcano (50 .417° N, 7.267° E, Germany), where carbonatites were also found after a Plinian eruption ~12,900 years ago. A—Younger Dryas impact field modified according to Wittke et al., 2013; yellow circle—Stara Jimka paleolake.

References: Firestone R. B. et al. (2007) PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES of the USA 104:16016–16021. **Kennett J. P. et al. (2015)** PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES of the USA 112:E4344–E4353. **Norton S. A. et al. (2016)** Journal of Paleolimnology 55:209-222. **Wittke J. H. et al. (2013)** PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES of the USA 110:E2088–E2097. **Wu Y. et al. (2013)** PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES of the USA 110:E3557–E3566.

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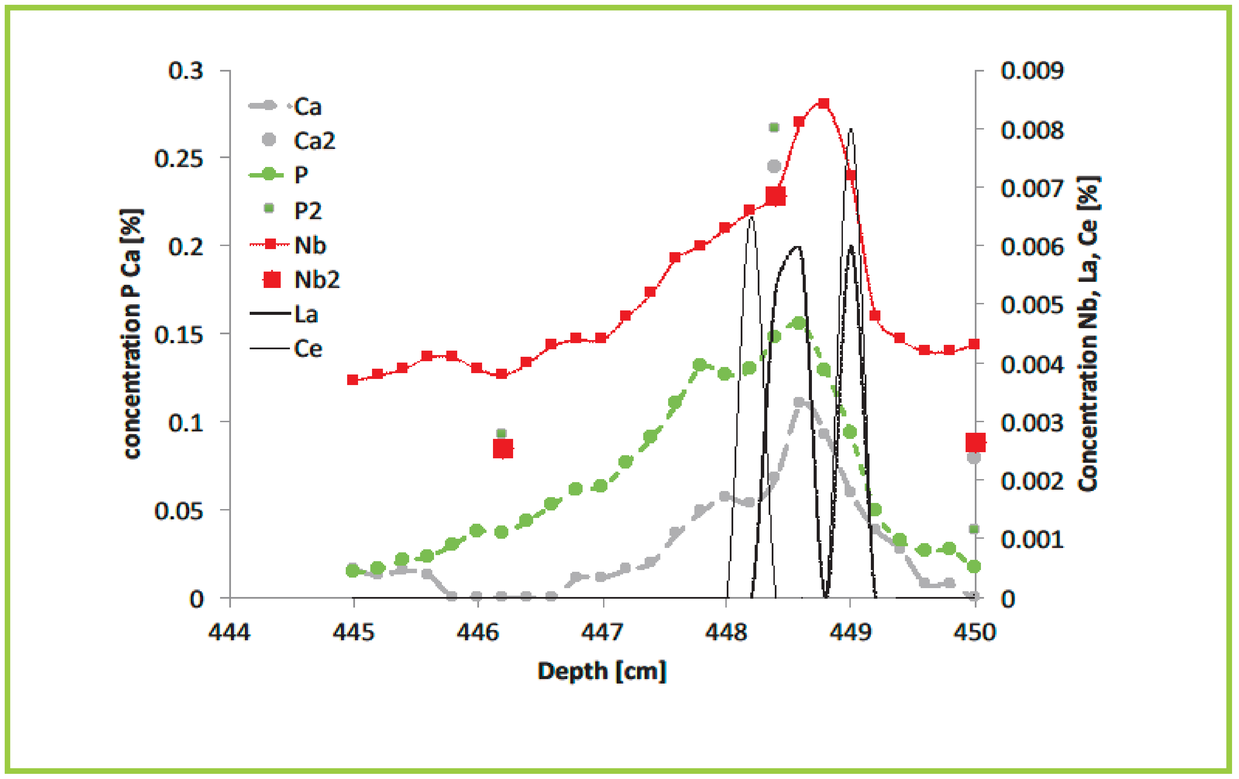

Fig. 1. Variations in elemental composition (P - phosphorus, Ca - calcium, Nb - niobium, La - lanhanum, and Ce - cerium) in the sediment core from Stara Jimka – XRF results. Single points for P2, Ca2, and Nb2 are ICP-MS results from the same material. Lanthanum and cerium (belong to REEs - rare earth elements) concentrations were higher in the depth associated with the Younger Dryas Boundary (YDB). The analyzed 5-cm-interval of the sediment was dated within the time window of 12,835 – 12,735 cal. yr. BP, which corresponds with the recently established modeled YDB age range for a cosmic impact (Kennett et al., 2015).

1. We found substantial anomalies of elements in a narrow interval of YDB sediment layer (Kennet et al., 2015) in Stara Jimka paleolake (Fig. 1).
2. Phosphorus, niobium, REEs, iridium, and arsenic, together with proxies such as melt glass and glassy Fe-rich spherules, composed an extraordinary "blend" of information that supports the idea of a catastrophic airburst (Firestone et al., 2007).
3. The center of this event was localized, consistently with published data, to Quebec and Ontario (Firestone et al., 2007, Wu et al., 2013), an area known for sites with carbonatite – an igneous alkaline rock rich in P, Nb, and REEs (e.g. Oka complex, Prairie Lake Fig. 2).
4. Paleolimnological reconstruction of lake biota (algae, macrophytes, Cladocera remains and, chironomid head capsules) showed clear signs of eutrophication and acidification. From this we suggest that the input of phosphorus from the airburst to the global atmosphere was accompanied with a high level of atmospheric acidity.
5. Anoxic conditions in the eutrophicated lake and high levels of sulfate from atmospheric acidity resulted in the creation of pyrite framboids in YDB layer. These are absolutely unique in lakes with low mineralization such as Stara Jimka.
6. The Laacher See eruption induced similar but less significant changes in Stara Jimka paleolake as the later cosmic impact, and framboids were not produced.
7. Similar time pattern of REEs enrichment was reported from the Sargent Mountain Pond in Maine, although those authors did not explain this phenomenon as the effect of an airburst event (Norton et al., 2016) (Fig. 2).