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

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Introduction: An earlier paleoecological study of a European lake found signals of two climatic perturbations in lake sediments at 12.9 ka B. P. While the older and less severe episode was explained by the Laacher See (LS) volcanic eruption, the later global cooling known as the Younger Dryas (YD) was triggered by an unknown event that has not been recognized [1]. Published evidence of an extraterrestrial impact event dated approximately to the same period [2] and information about its large geographical extent covering North America, Europe, and Middle East [3] inspired our study. We focused on finding evidence of a cosmic impact in the sediment of acid-sensitive mountain lakes in the Bohemian Forest, Central Europe. In addition, we evaluated the effect of this event on the functioning of the whole catchment-lake system.

Methods: We determined the content of a large range of elements by non-destructive robotized XRF analyses, which allowed us to identify the relevant part of a long sediment core for further more detailed analysis. We were able to detect low concentrations of elements with a resolution 2 mm without slicing the sediment core. Material from the most promising layers was then sub-sampled for advanced physical (glassy microspherules, framboids), chemical (ICP-MS), and biological (pollen, algae, cladoceran, and chironomid remains) analyses.

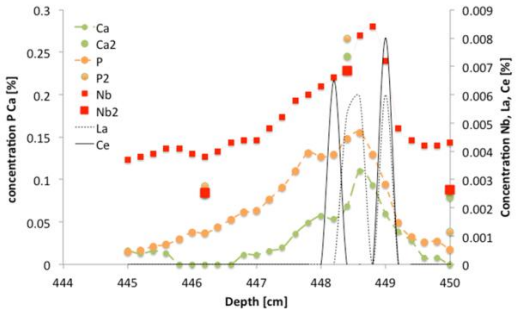

Fig. 1. Variations in elemental composition (P - phosphorus, Ca - calcium, Nb - niobium, La - lanhanum, and Ce - cerium) in the sediment core from Stara Jimka – XRF results. Single points for P2, Ca2, and Nb2 are ICP-MS results from the same material. Lanthanum and cerium (belong to REEs - rare earth 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. B. P., which corresponds with the recently established modeled YDB age range for a cosmic impact [4].

Results and discussion: We found substantial anomalies of elements in a narrow interval of YDB layers in the lake Stara Jimka (Fig. 1). 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. The center of this event was localized, consistently with published data, to Quebec and Ontario [2,5], an area known for sites with carbonatite – an igneous alkaline rock rich in P, Nb, and REEs (Oka complex, Prairie Lake). Biological analyses showed clear signs of severe 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. Anoxic conditions in the eutrophized lake and high levels of sulfate from atmospheric acidity resulted in the creation of pyrite framboids in YDB layers. These are absolutely unique in lakes with low mineralization such as Stara Jimka. The eruption of LS induced similar but less significant changes as the later cosmic impact, and with a lack of framboids. Our findings from the Stara Jimka site are consistent with XRF analyses we performed in two other Bohemian Forest lakes. Moreover, a 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 [6].

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