MICROSPHERULES IN THE SEDIMENT FROM THE ONSET OF YOUNGER DRYAS: AIRBURST AND/OR VOLCANIC EXPLOSION

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Introduction: Onset of Younger Dryas period is often recognized in sediment as a record of sudden climate cooling. Recent hypothesis consideres airburst as a possible cause. In the layer of sediment from this era are microspherules that are often mostly of iron oxide composition [1,2].

Material: We analyzed sediment from two US sites (Gainey in Michigan, and Blackwater in New Mexico [1], [3]) and one from Europe in the Czech Republic. Microspherules could have formed through atmospheric lightning discharges that melted terrestrial airborn material. During such discharges, there is a corresponding generation of intense magnetic fields and after the rapid cooling of these spherical particles, high-magnetic characteristics should remain within these particles [4-6]. We investigated the magnetic characteristics of the microspherules. In order to examine their natural magnetic state, non-magnetic separation techniques were utilized (heavy liquids), and after that, nonmagnetic, mechanical separation was performed using sieves of various sizes (100, 200, 325, 400 mesh; ~37, 44, 74, 149 micrometers, respectively). The separated material was then cleaned of excess clay using ultrasound. Next, the separates were analyzed under an optical microscope, and when objects resembling spheres were identified, they were manually placed on glass plates. The spherules were examined using a scanning electron microscope and than magnetic properties were obtained using superconducting rock magnetometer, and magnetic scanner.

Results: Magnetic analysis showed that microspherules have variety of magnetic remanence record. There is one group of microspherules that retain substantial amount of magnetization due to their high magnetic coercitivy. Second and third group contains medium and low resistance against demagnetization indicating medium and low magnetic coercivity.

Magnetic scanning allows to examine magnetic record of individual micropsherules. Magnetic remanence values of magnetic spherules, from Michigan and New Mexico, in their natural magnetic state were much lower compared to measurements after their magnetic saturation. This suggested that according to magnetic normalization technique [7] the microspherules do not contain magnetic remanence induced by lightning discharge and were formed within geomagnetic field. However, when examining several of the spherules from Stara Jimka paleolake in Europe, we found occasional record suggesting origin of the microspherules by electric dischcarge. These microspherules were coexisting with Laacher See microtephra fragments. Both volcanic tephra cloud and cloud due to extraterrestrial airburst are likely to be accompanied with electric discharges.

Conclusions: Magnetic record from micospherules revealed variable magnetic coercivities and potential to record magnetic field during their origin. Our magnetic analysis indicates that while some of the microspherules were formed in the terrestrial magnetic field, there are several whose magnetic record indicates that they could be formed in airborn dust cloud due to electric discharge. Such cloud would be either tephra cloud from volcanic eruption and/or dust cloud from the potential extraterrestrial airburst.

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