Magnetism of microspheres from the proposed Younger Dryas impact event 12,900 years ago

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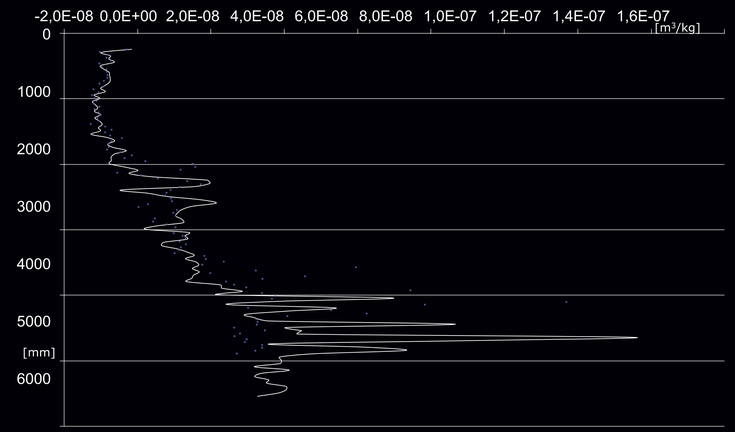
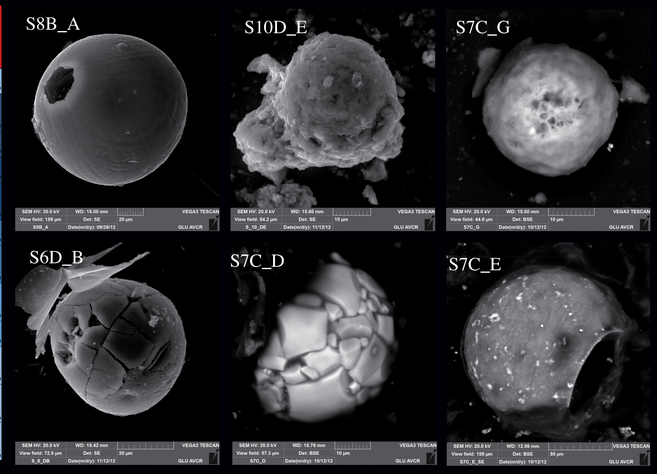
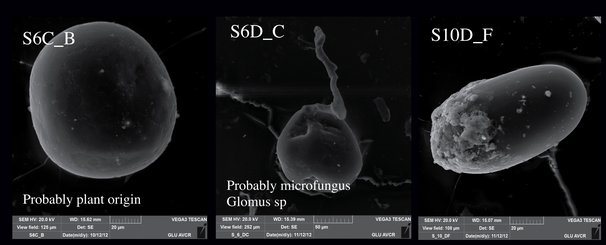
Megafauna extinction

This work refers to the Younger Dryas (YD), a period of global cooling 12,900 years ago that coincided with the extinction of many species of megafauna. There are several proposed causes for these events, one of which is the suspected collision of Earth with an extraterrestrial object, possibly a comet (Bunch et al., 2012). In the layers of sediment from this era, there have been worldwide discoveries of nanodiamonds, glass particles, scoria-like objects, and microscopic spheres with an average diameter of ca. 50 micrometers, largely composed of Si, Fe and O. These spheres have been uncovered in 12,900-year-old layers on several continents indicating multiple impact sites. Some of these melted particles contain lechatelierite, which can form only at temperatures near 2000 degrees Celsius, similar to melted particles found in areas of nuclear weapons testing. Thus, the subterranean layers contain particles that have been subjected at that point in time to temperatures greater than 2000 degrees Celsius, far higher than produced by normal terrestrial processes.



	Fe	O	Al	K	Ca	S	Si	Mg	Na	Cl	Mn	Zn	P	depth mm
S8B_A	71	20.6	0.27	-	-	-	-	-	-	-	-	-	-	4675
S6D_B	42.04	37.26	1.11	1.22	1.41	0.31	13.26	0.82	1.71	0.31	-	-	0.45	4675
S7C_D	57.81	30.24	-	-	0.68	-	-	1.27	-	-	-	-	-	4075
S7C_G	54.41	33.38	0.63	0.43	2.21	2.55	3.22	0.33	0.72	0.2	0.25	1.56	-	4075
S10D_E	42.55	35.71	1.78	0.74	2.58	1.58	7.84	2.45	1.29	0.99	-	1.83	0.66	4725
S7C_E	37.93	35.17	-	0.55	12.47	7.09	0.88	1.19	3.98	-	-	-	-	4075
S6D_A	16.04	32.23	2.14	0.4	35.38	2.54	0.71	4.23	2.71	-	-	3.61	-	4075
S6D_C	-	27.77	-	-	58.1	-	-	2.7	-	-	-	11.43	-	4075
S6C_B	-	27.91	-	-	54.08	-	-	5.28	-	1.11	-	11.63	-	4075
S10D_B	27.48	47.79	-	-	0.65	23.19	0.88	-	-	-	-	-	-	4725
S10D_C	38.9	47.05	-	-	0.67	21.63	1.74	-	-	-	-	-	-	4725
S10D_F	46.71	39.25	0.13	-	0.63	10.29	2.99	-	-	-	-	-	-	4725



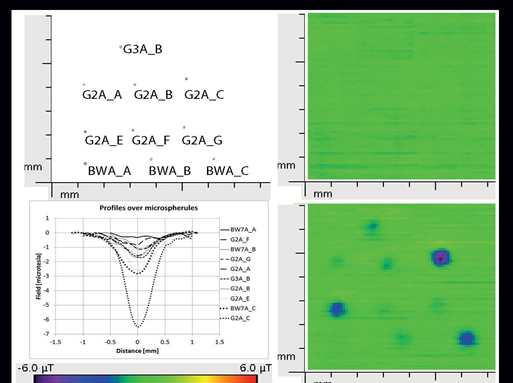


Material & Method

Material: Sediment, which corresponds to the time period of this event, has been analyzed from two US sites, Gainey in Michigan, and Blackwater Draw in New Mexico [1]. Also, a complete sediment profile was collected in Europe from Svarcenberk Lake in the southern Czech Republic, where samples of this age were dated using carbon dating and investigated by environmental magnetism testing [3,4]. After the freezing of Svarcenberk Lake, 6m long cores were extracted, from which 5-cm subsections were cut.

Magnetic susceptibility: The magnetic susceptibility data from these cores indicate an increase that we believe coincides with the Younger Dryas period at the depths between 4 and 5m. Extracted samples were subjected to the standard procedure for magnetic separation [5].

Lightning discharge: An alternate hypothesis to the comet collision theory is that microspherules could have formed through atmospheric lightning discharges that melted terrestrial sediment. If that is true, we realized that 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 [7,8]. Therefore, we focused on investigating the magnetic characteristics of the microspheres. 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 techniques. Next, the separates were analyzed under an optical microscope, and when objects resembling spheres were identified, they were manually placed on glass plates. Finally, the spherules were examined using a scanning electron microscope.



Magnetic analysis of Gainey and Blackwater Draw microspherules. A. Distribution of optical images of spherules' on the scanned substrate. B. Magnetic scan of the substrate in its natural state. C. Magnetic scan of the substrate after magnetizing it with the 1 T pulse field directed into the page. D. Magnetic profiles of each spherule in horizontal direction.

Results/Conclusions

We measured the amount of remanent magnetization in the microspheres by utilizing a magnetic scanner and a superconducting magnetometer. We found that there was no excess magnetization of the microspheres while residing in the Earth's geomagnetic field (50 microTesla); on the other hand, after being subjected to a powerful magnetic field (1 Tesla), they displayed substantial remanent magnetization . This finding is consistent with the hypothesis that the spherules formed during an extraterrestrial impact, and refutes the hypothesis that these microspheres could have formed during lightning discharges.

References

References: [1] Bunch, T. E. et al., (2012) *PNAS, 109*, 28, p. E1903-E1912. [2] Hosek, J. (2009), Master theses: Charles University, 78 p. [3] Pokorny, P., and Jankovska, V. (2000), *Folia Geobotanica, 35*, 4, 433-457, [5] Israde-Alcantara et al., (2012), *PNAS, 109*, 13, p. E738-E747, [6] Kletetschka, G (2001) Dordrecht, Proceedings, 157-159, [7] Kletetschka et al., (2003), *MPS, 38*, 3, 399-405, [8] Wasilewski and Kletetschka (1999), *GRL, 26*, 15, 2275-2278.

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