Abstract

Throughout North America’s eastern coastal plain are found a variety of features attributed to ice age climate. These include many elliptical, shallow depressions collectively called Carolina Bays, hypothesized to have been formed by the strong, sustained winds and air and cold climate characteristic of glacial periods (Reed, 1934; Johnson, 1942 and Kazakorvich, 1975). This view eclipsed the 1933 proposition by Milton and Schweitzer and expanded by Prost (1934, 1953), that extraterrestrial debris produced by an aerial meteorite or comet explosion in the vicinity of the Great Lakes during the late Pleistocene formed the bays. Recent discovery that a number of the bays were found to contain material associated with extraterrestrial impacts including carbon and magnetic spheres, glass-like carbon, and charcoal reinvestigated the debate over the bays’ origins (Firestone, et al. 2017).

To confirm the bays were receptacles for impact material, soil samples were previously taken from Rockhocks Bay in Edenton, NC. Samples of soil samples were excavated near the bay’s center and core samples extracted near the bay’s rim. The samples were examined to determine the presence of carbon-associated markers used to measure the density of magnetic grains and grain-size distribution. Magnetic spheres were found among the smaller size portions of the magnetic grains and spherule density estimated. The geochemistry of a magnetic sphere was determined using scanning electron microscope micro-analysis dispersive x-ray spectroscopy (SEM-EDS).

Introduction

Evidence for the hands climate prevalent during the Last Glacial Maximum (LGM) are seen in geoarchaeological studies of the spherule and coastal regions of the eastern United States. Among these are magnetic, spherule depictions collectively Carolina Bays, hypothesized to be formed by ‘star’ seen of loose sediment by the strong, sustained wind and cold climate characteristic of glacial epochs (Reed, 1934, 1953; Johnson, 1942). 12,000 years ago, post-LGM warming was interrupted by a return to a glacial climate that persisted for over 1,000 years. The intense prevailing the cooling, known as the Younger Dryas (YD), are the subject of debate. Recently Firestone proposed that an impact in the terrestrial core from a Columbian comet might have similarly instigated the YD and formed the Carolina Bays [10]. Carbon 14 dating and pollen analysis of core samples taken from Rocky Bays (RBH) in Currituck County, NC, by Whitlock (2001) indicates a young YD climate. However, a number of the bays have been found to contain material associated with extraterrestrial impacts including carbon and magnetic spheres, glass-like carbon, charcoal, and nanodiamonds (14). The discovery reinvigorated the debate over the bays’ origins.

Early bays, the “original” bays, would have experienced a peculiar geomorphological modification due to a cold, windy climate. With limited alternation with marine, wind and cold climate conditions Carolina Bays would likely quickly 18-O rich sediments or water borne sediment or water. Some evidence of biologic life should be evident in their stratigraphy. Whitlock’s correlation of depth to date is due to the Rocky Bays, shown in figure 3, makes it possible to establish a chrono-stratigraphic context for potential impact markers found in bay sediments and also provide opportunity to confirm Whitlock’s inferred bay structure and age.

Analysis Materials

There were four peaks in the bulk magnetic material (1) 61 cm, (2) 01 cm, (3) 17 cm, (4) 6 cm, at 121 cm as shown in figure 1. These peaks were noted due to their lower grain size in each sample. These peaks were noted due to their lower grain size in each sample. They were compared to other material and determined to have a magnetic signature. It was determined that the density of the first of the four site portions was calculated and than found to be a portion of the final figure 2. The magnetic peaks were calculated in sample 61 cm (depth). The smallest grain (4) 01 cm was most abundant in core samples from 121 cm in depth and the first peak was seen in core samples found from 61 cm in depth. As such, it is possible to determine the percentage of magnetic spheres and or abundance of these ‘small’ spherulites.

The peak magnetic composition of the 32 cm magnetic spherules found in the 121 cm depth (oxygen 29.28%, calcium 16.91%, germanium 14.94%, carbon 10.55%, magnesium 9.23%, silicon 9.02%, 10.52%) and potassium (0.51%) as seen in figure 12. These three magnetic Internal Remanent Magnetization (VRM) peaks were seen to confirm the spherules found in RBH. In doing so, the spherules’ chemical and elemental composition of the possible magnetic spherules can be determined. Afterwards, these magnetic peaks were compared to other magnetic peaks in other bays.

Figure 2. Some of the materials used for the analysis of the soil samples.

Procedure

To be performed: Micro-analysis dispersive x-ray spectroscopy (SEM-EDS) analysis. This analysis should be performed to extract the micro-analysis dispersive x-ray spectroscopy (SEM-EDS) of the minerals found in the bays.

Scanning Electron Microscope

SEM-EDS

Scanning Electron Microscope

Magnetic Spherules

Magnetic Spherules

Evidential Markers: Soil Conventional

Charcoal

Glassy Carbon

Carbon Spherules

Rockhocks Bay Soil Sample Source

Figure 1. Bulk magnetic peaks due to date correlation and SEM-EDS 2009 Glades core coring and analysis.

Figure 3. Weighing of a magnetic peaks.

Figure 4. Sherry being filtered through a 20 inch mesh filter.

Figure 5. Two filters containing magnetic spheres extracted.

Figure 6. Magnet being served over the mixture.

Figure 7. Rinsing the magnetic spheres.

Figure 8. Washing of a magnetic material.

Figure 9. Possible magnetic spheres.

Figure 10. SEM-EELS spectrums containing possible magnetic spheres.

Figure 11. SEM-EELS spectrums containing possible magnetic spheres.

Figure 12. Mass density of a magnetic products.

Figure 13. Mass density of a magnetic products.

Figure 14. Bulk magnetic peaks that were found in the 121 cm sample depth.

Figure 15. Composition of the magnetic spherules found from 121 cm.

Figure 16. SEM-EELS spectrums containing possible magnetic spheres.

Figure 17. Comparison of the magnetic spheres in RBH in other bays.

Figure 18. Rockhocks Bay soil sample location for Whirlwind depth to date correlation and SEM-EDS 2009 Glades core coring and analysis.

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