

# Establishing a Dated Stratigraphy for a Core from Black Rock Forest, Hudson Highlands, New York

## Possible applications of distal impact ejecta as geologically instantaneous markers

Peregrine Gerard-Little, DEES, Columbia University  
Dr. Dallas Abbott, Lamont-Doherty Earth Observatory, Columbia University  
Dr. Stephanie Pfirman, Barnard College Dept. of Environmental Science

### Abstract

Through careful examination of a hand core from Black Rock Forest, Hudson Highlands, New York, it is hoped that a dated stratigraphy can be established through a combination of  $^{14}\text{C}$  dating of buried organic material and the identification of a geologically instantaneous cosmic impact event. In order to determine whether such a layer is present, a variety of techniques will be used to find and analyze distinctive impact grains including: digital photography, optical microscope selection of distinctive grains, SEM analysis, EDAX analysis, and examination of thin sections in the search for shocked quartz. A dated stratigraphy for this core could increase understanding of the rate of deposition in this pond over time, as well as provide a basis for further research in the pond. If indeed an impact layer is identified, it could be connected to a known impact event and possibly contribute to the understanding of the distribution of distal impact ejecta.



**Figure 1.** Top: Tamarack Pond, Black Rock Forest, the coring location. Bottom: The overall study area, overlain on topography, looking west toward the Hudson River. Tamarack is circled. Images from Google Earth.

### Introduction

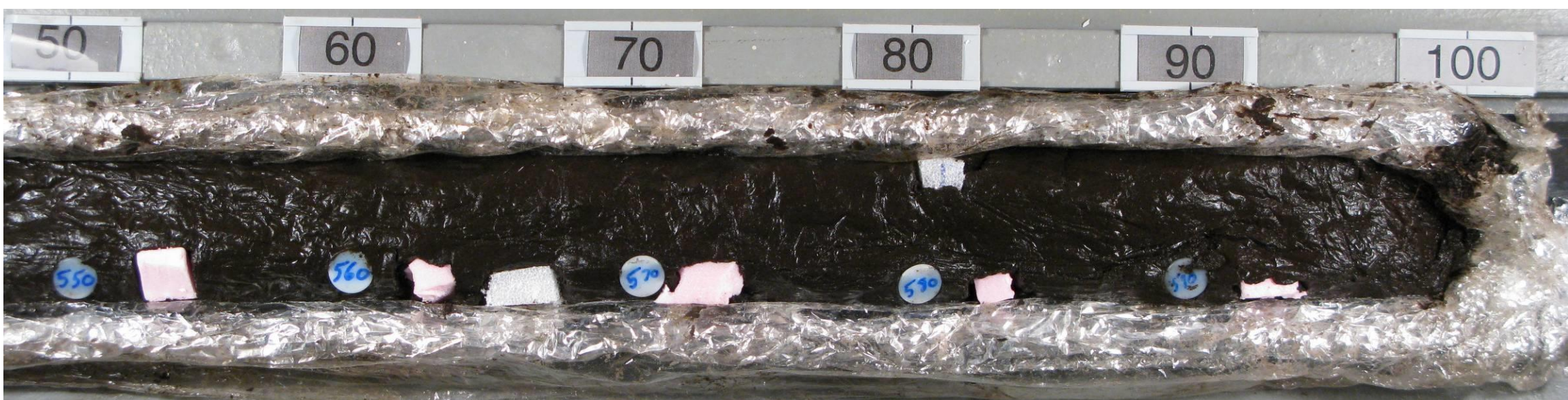
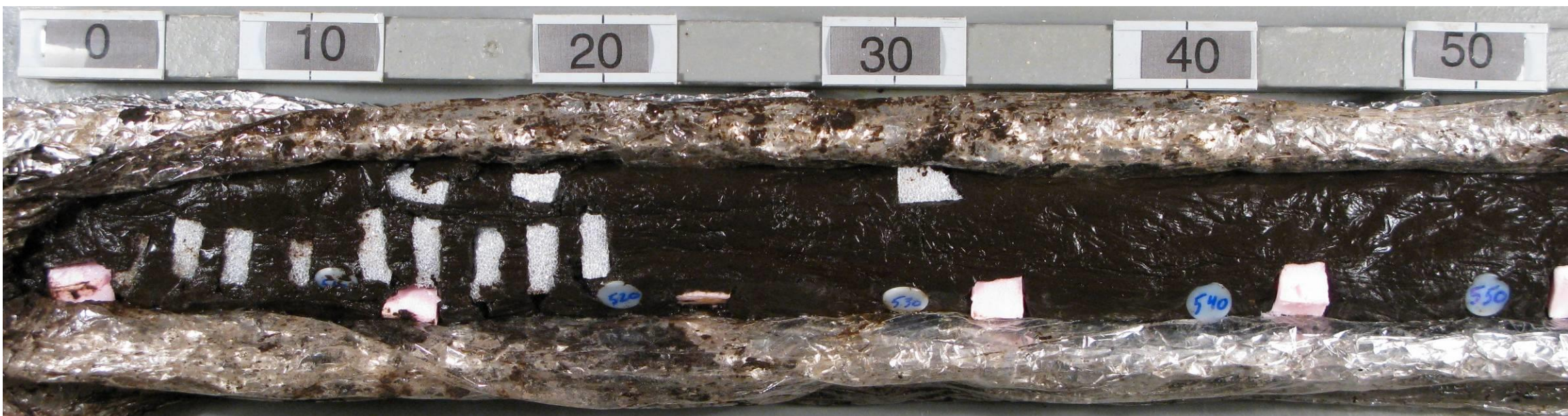
The possibility that distal impact ejecta layers can be used to calibrate the stratigraphy of recent sediments is a compelling one, especially in locations where organic material is not easily available for carbon dating. However, definitively identifying a distal impact ejecta layer can be a daunting task because of high standard of proof in order to make a compelling case, as well as the amount of close examination required of very small grains.

A 7.5-meter hand core that was taken from Tamarack Pond in Black Rock Forest during the summer of 2005 is the basis for this research. The core is comprised of pond and bog material that is assumed to have a relatively high accumulation rate. This means that the core has a record that does not extend very far back in geological time. Tamarack pond has not had a dated stratigraphy established for it as of yet, although adjacent ponds have been previously studied. A combination of geologically instantaneous markers and carbon-dated stratigraphy would be very helpful in this location.

### Methods

Samples were taken from the core along its length at 35 cm intervals, with extra samples taken in areas that were thought to be of special interest. For carbon-dating material was removed from samples when it was found and placed in clean glass vials. These samples were then dried to prevent contamination by carbon from modern mold.

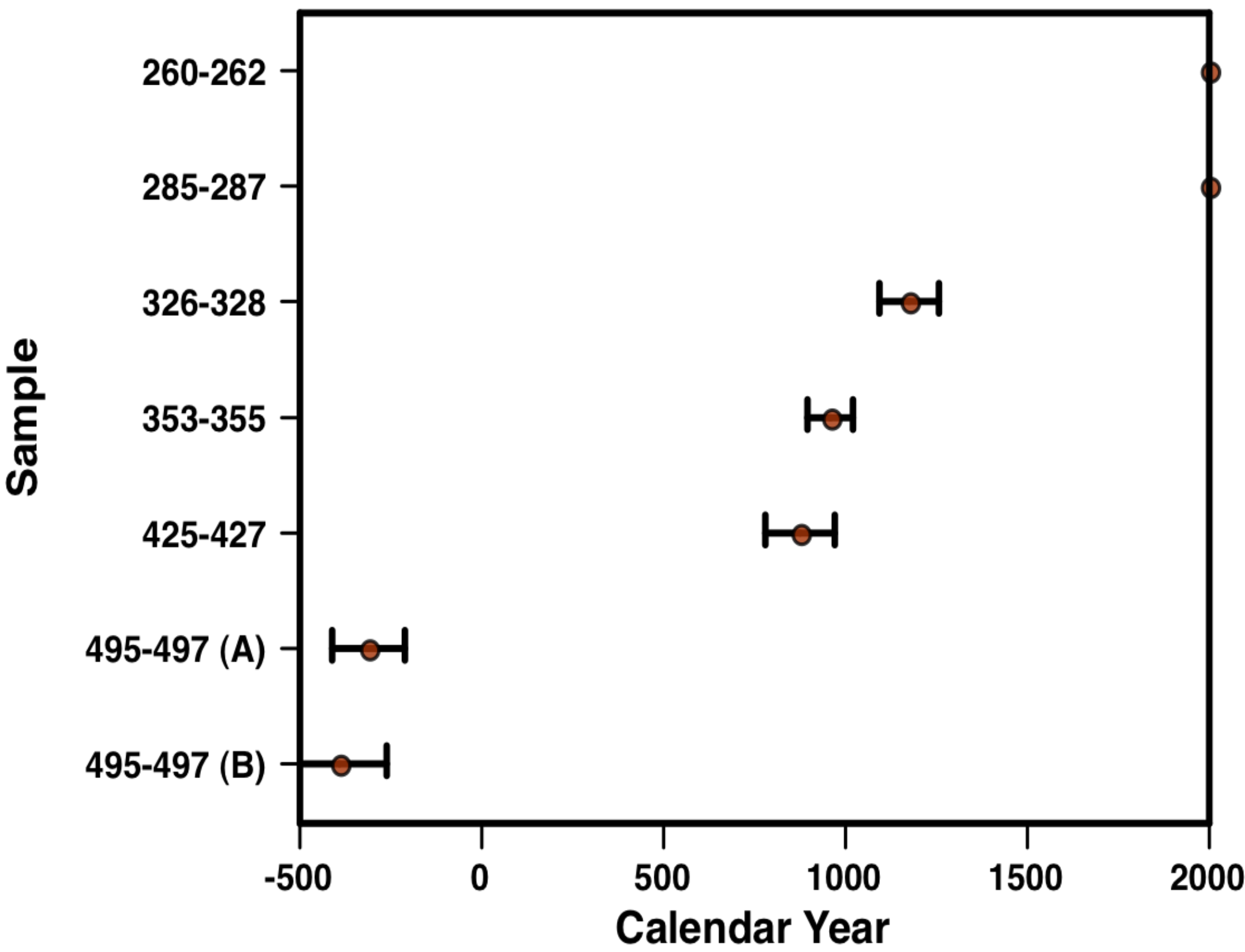
Each sample was sieved into  $>150\mu$ ,  $>63\mu$ ,  $>38\mu$ , and residue size fractions, which were dried in a  $65^\circ\text{C}$  oven and weighed. These samples were individually examined and grains were selected and placed on mounts for later use with the scanning electron microscope (SEM). These grains were photographed with the SEM and also subjected to Energy Dispersive X-ray Microanalysis (EDAX) to determine the elements present.



**Figure 2.** Photograph of the 500-600cm section of the Black Rock Forest Core. The squares mark locations where samples have been taken. 500-550 cm in the previous column, 550-600 cm above.

### Radiocarbon Results

The calibrated radiocarbon ages, returned from the CALIB program using the IntCal04 dataset, indicate that the top 500 cm of the core go back to approximately 500 BCE, with significant bioturbation [Stuiver and Polach, 1977]. There is an estimated sedimentation rate of 0.1 cm/year which is lower than the sedimentation rate calculated for nearby Sutherland Pond [Maenza-Gmelch, 1996].

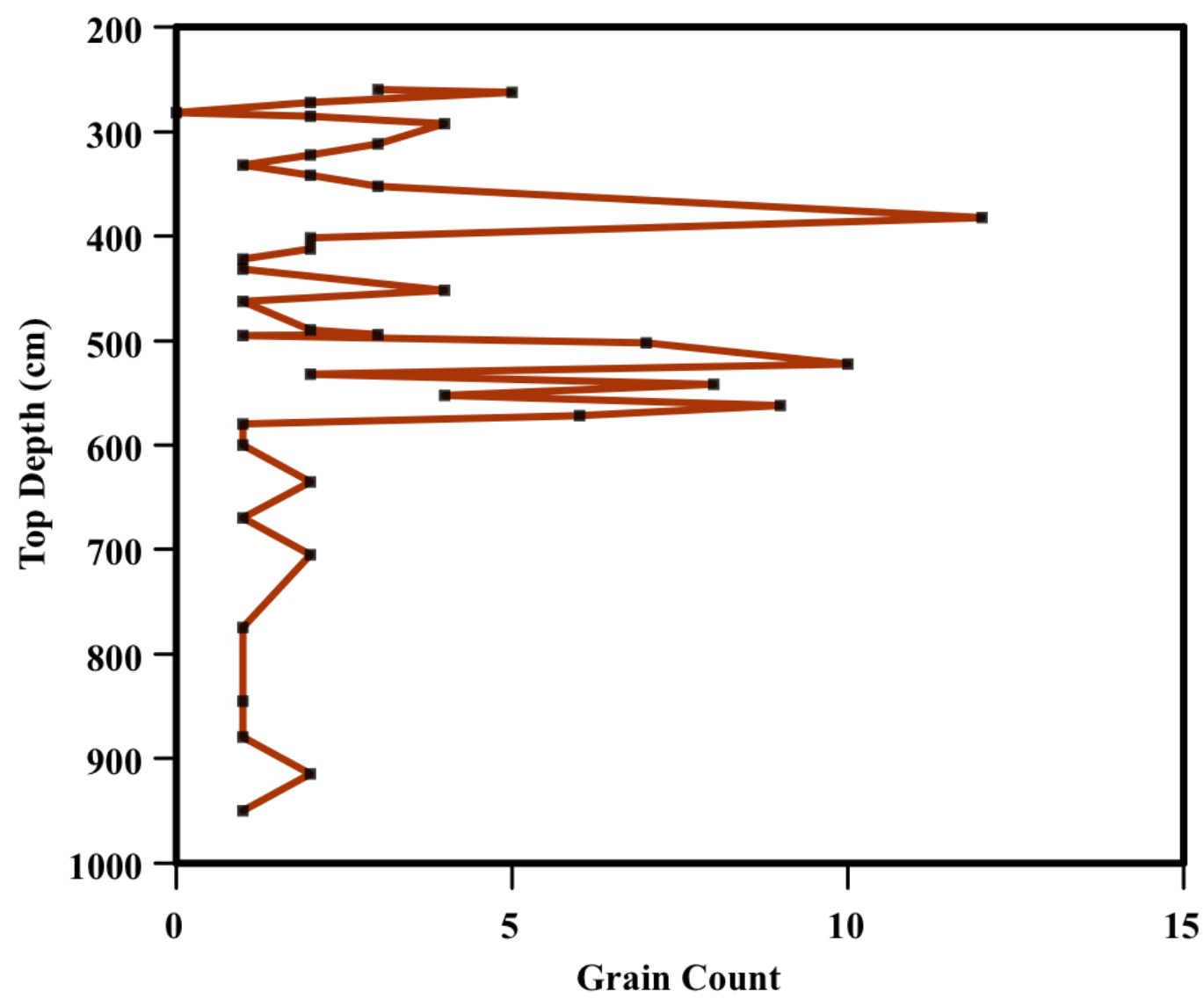


**Figure 3.** Plot of the calibrated  $^{14}\text{C}$  age ranges calculated by the CALIB program. The samples are identified by depth, bars indicate the  $2\sigma$  ranges, based on the error in the original radiocarbon measurements. Negative time is BCE.

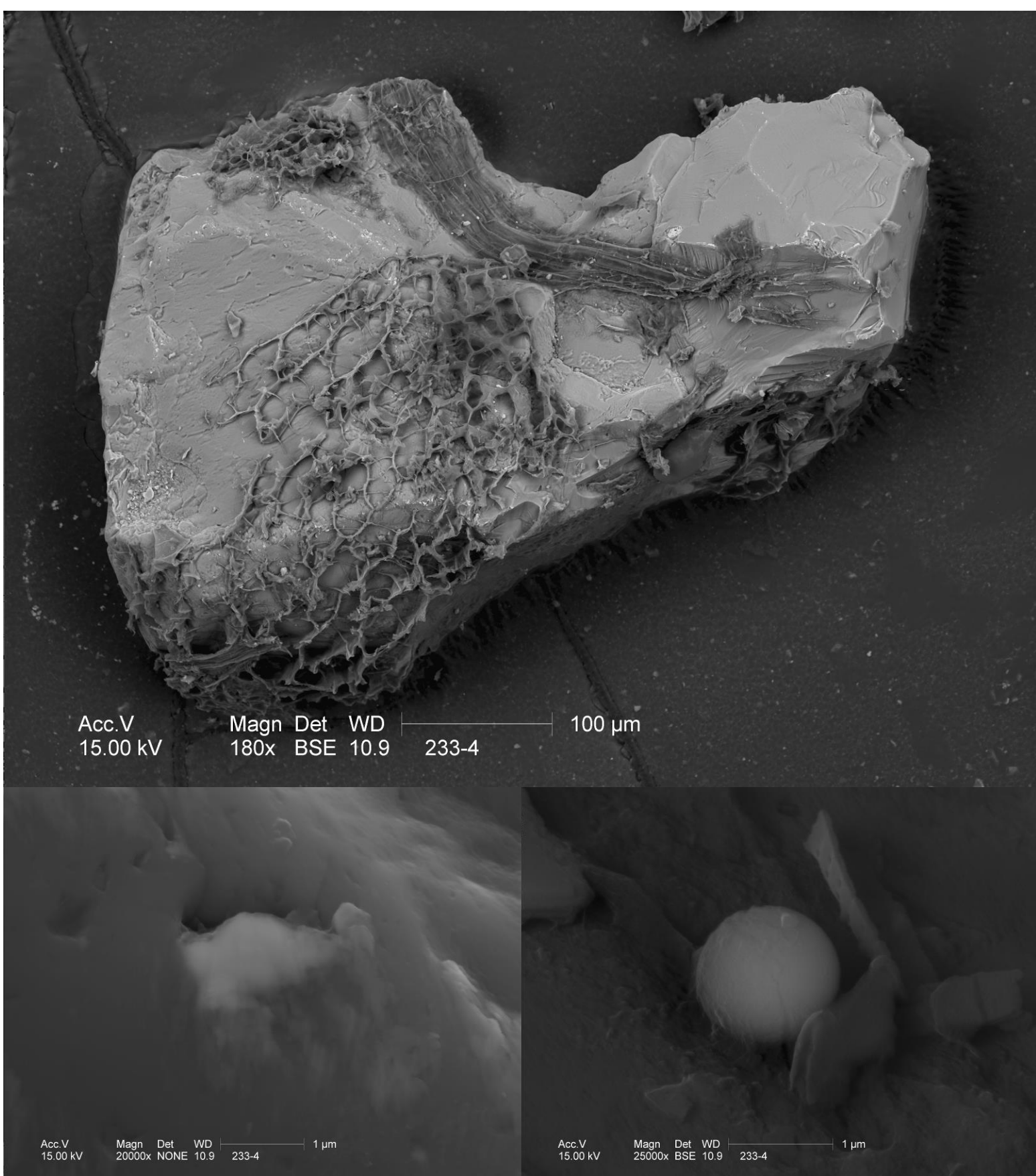
### SEM Results

When the records of all of the grains analyzed by scanning electron microscopy were examined, there were five general groupings of “intriguing” grains, grains that were most likely to be connected to an extraterrestrial impact event. The highest concentration of “intriguing” grains is between 382 cm and 572 cm, a roughly 200cm span. The intriguing grains fall into several general categories: grains with micron scale iron, nickel, chrome or other rare metal splash, foraminifera of indeterminate origin, quartz or feldspar grains with possible planar deformation features (PDFs) and conchoidal fractures, and spherules of different kinds.

The metal splash found on a number of grains in the core is significant because these metals (Ni, Fe, Cr) have high melting temperatures, all above  $1400^\circ\text{C}$ , and only melt in conditions that do not typically occur at Earth’s surface. In further support of the theory that the metal was emplaced during an impact event, Chao and El Goresy have found that Fe, Cr, and Ni are present in rocks in the crater bottom of the Ries impact crater in Germany from the vaporized impactor [El Goresy and Chao, 1976].



**Figure 4.** Plot of number of interesting grains found vs. depth in cm within the core. There is a clear concentration of finds above 600 cm and below 350cm in the core.



**Figure 5.** Top: Quartz grain with Fe-Ni-Cr Splash from the 326-328cm interval in the core. Bottom Left: Splash on the grain. Bottom Right: Spherule found on the surface of the grain.

### Conclusions

The findings from this study give a better control on the deposition rate and bioturbation that is occurring in Tamarack Pond. The hopes that this core would produce a definitive impact ejecta layer, which could be used as a geologically instantaneous marker, have been somewhat dimmed. While there are some anomalous grains, most significantly the grains with the Fe-Ni-Cr splash, we do not have the body of evidence to suggest that this core records the deposition of distal impact ejecta from a discrete event.

In hindsight, the Tamarack Pond core was not the ideal location to implement these procedures in search of a distal impact ejecta layer given the bioturbation in most pond environments. With such small concentrations of indicative grains, any disturbance is likely to spread these grains and make them more difficult to find and identify.

### References

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