Evidence for a Possible Late Pliocene Impact in the Ross Sea, Antarctica. Peregrine Gerard-Little[1], Dallas Abbott[2], Dee Breger[3], and Lloyd Burckle[4] [1]Lamont-Doherty Earth Observatory, Columbia University, 61 Route 9W Palisades, NY 10964. pag2107@columbia.edu [2]Lamont-Doherty Earth Observatory. dallas@ldeo.columbia.edu [3]Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104 deebre@coe.drexel.edu [4]Lamont-Doherty Earth Observatory, Columbia University 61 Route 9W Palisades, NY 10964 burckle@ldeo.columbia.edu

Introduction: Several years ago, a number of what seemed to be large, clear tektites were found in a core from the Ross Sea, MC173-2, by Guillaume Gastine. These finds could be evidence of a cosmic impact in the Ross Sea, something that was not previously suspected. This project is attempting to discover whether such an impact did occur, and if so, when.

The Ross Sea is just to the north of Antarctica in an area which at different times during history has been heavily populated by icebergs and glaciers. When measuring oceanic cores in other areas, impact layers are often associated with high magnetic susceptibility. We found that high susceptibility layers are present in the cores from the Ross Sea, making this area a candidate region for an impact, but also presenting the possibility that the high susceptibility could be at least partially due to high amounts of ice-rafted debris common in such areas.

Procedure: The main aim was to search for distinctive grains in the high susceptibility layers which would provide further evidence for the theory that these layers contained impact ejecta and not merely ice-rafted debris. Things such as tektites, shocked quartz, impact glass, melted or deformed metallic grains, Ni-rich spinels, and cosmic spherules in a higher than average concentration are all considered to be impact markers [1]. The definitive presence of these items would point to an impact in the Ross Sea, Antarctica.

The Eltanin cores used for this study are stored at the Antarctic Core Repository at Florida State University. Because ejecta from a cosmic impact would most likely be highly magnetic, the areas in which we sampled were determined by the magnetic susceptibility of the area in relation to the rest of the core.

We individually measured each sample's magnetic susceptibility, rinsed the sample in double distilled water, and sieved it into >150, >63, and >38 micron size fractions. These were examined under a microscope and distinctive grains were picked out and placed on mounts. We examined and analyzed the mounts with a scanning electron microscope with an EDAX (Energy Dispersive X-Ray Microanalysis) X-ray analyzer, which reveals the elements present in an individual grain. While this was the main method undertaken during the time of this project, thin sections of certain types of grains were compiled and sent off (to look for shocked quartz), and samples were set aside for dating.

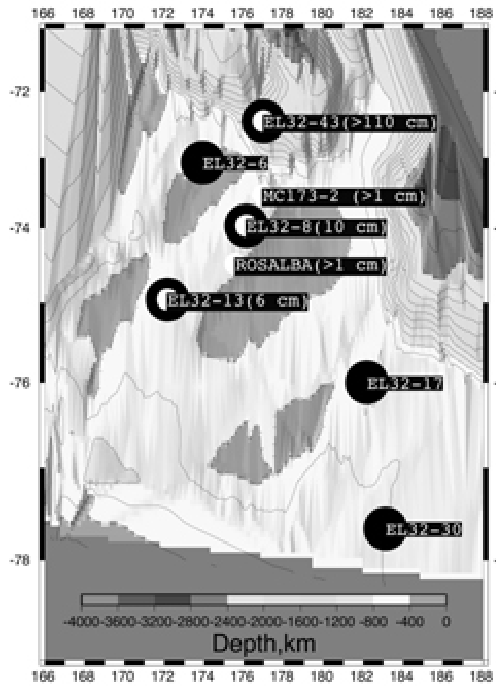
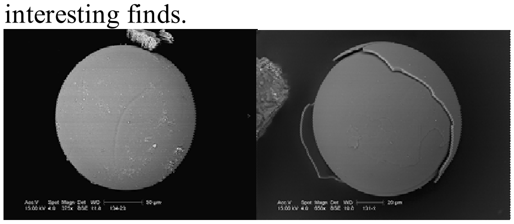


Fig 1. This map shows the locations of the Eltanin cores within the Ross Sea, Antarctica. The larger dots: cores in which impact glass was found. Smaller, lighter dots within the larger dots: cores in which microtektites were discovered. Based on biostratigraphic work on diatoms, the inferred age of the impact layer is late Pliocene. The cores themselves have basal ages in the Gauss [6].

Location of Source Crater: The source crater for the tektites and impact glass most probably lies in the northern part of The Ross Sea, where the tektite bearing layer is the thickest. There is no obvious topographic depression, but the source crater cannot lie on the oceanic crust, as the tektite bearing layer contains abundant quartz. The impact glass is K rich, and this composition of impact glass is inconsistent with an impact onto normal oceanic crust. As the source crater must lie on the continental shelf, it may be either extremely small or may have been obscured by glacial outwash. The size of the possible tektites is consistent with a source crater that is approximately 60 km in diameter. Tektite size, however, can also be dependent on other factors, in addition to the size of the impactor [1].

Scanning Electron Microscope Findings: Grains that were picked out of the sieved samples and examined under the scanning electron microscope produced some interesting finds.



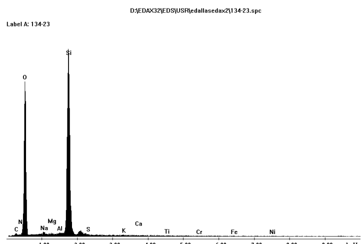


Fig. 2, 3, and 4 The top two images are SEM images of silicate microtektites. The tektite on the right shows exfoliation. The bottom image is an EDAX analysis of the tektite on the left, showing its composition of silicon and oxygen.

Tektites: Microtektites are generally defined as small (<1 mm), glassy grains that occur in shapes such as teardrops, spheres, oblate spheroids, and dumbbells [2]. The composition of tektites is due to melting of the top layer of their source material [3]. The microtektites were found in three cores: ELT32-13, ELT32-42, and ELT32-08, the majority of them in the >150 micron size fraction.

These microtektites (see Fig 2+3) are generally spherical and glassy and some display a type of exfoliation of a surface layer. They are made up of silicon and oxygen, something that could be explained by the impactor landing in the ocean and striking siliceous materials. The weathering of tektites has been previously documented [4] but not weathering of this specific type. Some tektites have been found with ablation on their surfaces which does not resemble normal silcate weathering.

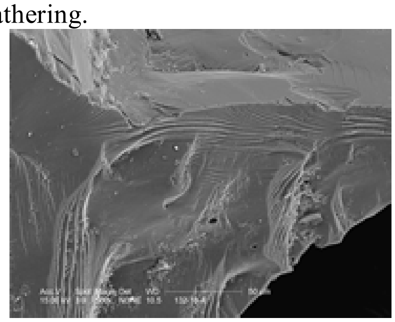


Fig5. This is a pure quartz grain from ELT32-08. It is currently being made into a thin section for further examination because of the almost straight ridges that appear in this image.

Glasses: The cores which were examined, even the ones that did not contain microtektites, contained black glasses which could have been formed by an impact in the region. The composition of the glasses is dominated by feldspar, and they do not have the vesicles of volcanic glasses. These cores come mainly from the eastern Ross Sea where the sand lithology is dominated by rounded quartz [5].

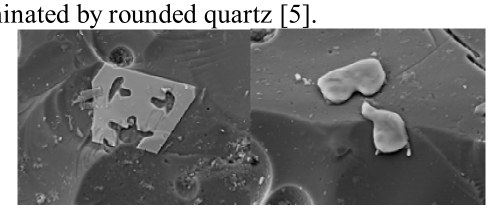


Fig 6 and 7. Two images from the same grain in ELT32-06, one of the cores without microtektites. Left: ilmenite in what appears to be a partially melted state. Ilmenite melts at 1800ºC. Right: sylvite (KCl) which also appears to be melted. It has a melting temperature of 770 ºC and normally dissolves in water, making its appearance on a marine sample interesting. It is possible that the silicate glass to which these samples are attached formed during an impact at a temperature of between 1180 and 1800 ºC.

Conclusion: While it cannot be said without any doubt that there was an impact in the Ross Sea, there is a considerable possibility that there was an impact in the Late Pliocene which is responsible for the layers with high magnetic susceptibility readings, as well as the tektite candidates and possible impact glass. More time and investigation are needed for this topic. For example: whether or not shocked quartz is present has yet to be determined, and a closer analysis must be performed on the supposed impact glasses in order to see whether they distinguish themselves from volcanic glasses in significant ways. Hopefully with more time and a closer look at some of the evidence, whether or not there was in impact in the Ross Sea will be determined more definitively.

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