A SEARCH FOR IMPACT DEBRIS IN THE PLIOCENE AGE SIRIUS GROUP, TRANSANTARCTIC MOUNTAINS. Ralph P. Harvey[1] and Hiram Boyd[2] [1]Department of Geological Sciences, Case Western Reserve University, Cleveland OH 44106-7216 ({ HYPERLINK "mailto:rph@cwru.edu" }), [2]Department of Biological, Geological, & Environmental Sciences, Cleveland State University, Cleveland, OH 44115-2406.

The Sirius Group: The Sirius Group is a mixed sequence of interbedded diamictite and mudstone of Pliocene age found at scattered locations along the length of the Transantarctic Mountains. Sirius Group rocks are usually considered tillites, but contain some very "un-tillite" elements. Within section and from site to site, Sirius Group rocks vary considerably in terms of texture and relative abundance of clast lithologies, recording a history that includes shifting influences of glacial, lacustrine, fluvial and wetland processes (Figure 1). The colorful heritage of the Sirius Group has generated a lot of interest due to its potential as a record of changes in the behavior of the East Antarctic icesheet during a climatologically interesting period.

One of the more notorious features of the Sirius Group is the presence of marine diatoms. These diatoms are an unambiguous sign that oceanic material has been incorporated into Sirius Group rocks; but vigorous debate continues as to how this marine material was incorporated into glacial debris commonly found at altitudes of 2000 m or higher and hundreds of miles from the open ocean [1]. The debate has become polarized around two possibilities that have decidedly different climatic implications. To some, the extraordinary abundance of marine diatoms in an alpine tillite suggests that the East Antarctic icesheet must have been wet-based and open to the Antarctic Ocean while the Sirius Group was being deposited, implying a period of significant glacial retreat and instability just 2-3 million years ago [2]. Others argue that independent evidence requires that the East Antarctic icesheet has been stable for 8-11 million years, and hypothesize that the diatoms must be an eolian "contaminant", part of the slow but consistent rain of marine debris transported inland from the oceans [3].

Impact debris? Of interest to planetary geologists is a variant on the eolian hypothesis; the possibility

Figure 1. A view of the Sirius Group in outcrop near the Shackleton Glacier, Transantarctic Mountains, Antarctica. In this exposure, dark grey layers at top and bottom are unsorted, poorly consolidated and contain a rich variety of clasts. The lighter colored, layered bands in the center represent material that has been re-worked by fluvial and lacustrine processes (picture provided by D. Harwood, U. Nebraska-Lincoln).

that the diatoms present in the Sirius Formation are not part of the general background of planktonic debris being distributed planet-wide, but instead represent material lofted into the Earth's atmosphere by an oceanic impact event. The potential influence of this impact event on Sirius Group rocks ranges from gently increasing the abundance of airfalling marine debris to large contributions of ballistically- and tsunami-transported material.

These impact scenarios might be dismissed as *ad hoc* were it not for the fact that independent data points toward several impact events whose ages are similar to the Sirius Group, one of which is both large and geographically nearby [4,5,6]. The most promising candidate is the Eltanin impact feature, located in the Southern ocean between South American and Antarctica and of 2.15 myr [6]. This impact event is recognized by a huge region of disrupted ocean bottom sediment including recognizable impact melts and meteoritic fragments [6]. The estimated energy released during this event is in the 10^5–10^7 megatons TNT range, suggesting devastating local effects and significant influences globally in the form of mega-tsunamis and airfalls [6, 7].

The Search: Our current study explores whether material of an unambiguous impact origin is present in Sirius Group rocks. During the 1999-2000 and 2001-2002 ANSMET field seasons, several large specimens of Sirius Group lithologies were collected from Queen Alexandra Range and Darwin Mountain sites, totalling 20 kg. At these sites, Sirius Group rocks exhibit no sorting and contain abundant clasts, indicating minimal reworking by fluvial or lacustrine processes. Specimens were identified as Sirius group from their characteristic Ferrar Dolerite clasts , and came from the western-facing slopes of mountains above 1500 m in altitude.

Interior subsamples of these specimens have been disaggregated in an ultrasonic bath filled with a soapy-water solution. This disaggregation allowed the suspension of nearly 100% of the abundant clay fraction, which was subsequently decanted. The resulting sediment was then wet-sieved to produce 1.0-0.5, 0.5-0.25, 0.25-0.125 and 0.125-0.0625 mm size fractions. Each size fraction was then examined with a stereo microscope. Within each size fraction, individual grains were sorted into roughly a dozen distinct lithological classes based on observed mineralogy, texture and color. Most of these classes correspond to the exposed bedrock of the mountains surrounding the sample collection sites, and include fragments of the Jurassic Ferrar Dolerite, volcaniclastic sandstone and shale from the Triassic Falla and Fremouw Formations, and cyclothemic rocks from the Permian Buckley Formation. Sorting of 100% of the grains into these categories, we have built up an identification catalog of the expected lithic components of the Sirius Group rocks, and (more importantly) identified those components that most closely resemble potential impact debris.

As of this writing, we have completely sorted most of the larger size fractions. We have identified a few dozen grains that are the most likely to have an origin as impact debris- dark, glassy fragments and laminar fragments containing glassy lithologies. These grains, along with grains from more recognizable lithologies, will be mounted in epoxy, sectioned, and examined using electron microprobe techniques. Major and trace element chemistry will then be used to compare these interesting grains to known Antarctic lithologies as well as the impact glasses identified in Eltanin and other suspect impacts. We will then use this data to evaluate what influence, if any, impact events have had on Sirius Group rocks in Antarctica.

References:

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