SURVEY OF ZIRCON TEXTURES AT GARDNOS IMPACT STRUCTURE. L. Shteynman[1,2], S. J. Jaret[2], and D. S. Ebel[2], [1]Department of Geology and Environmental Geosciences, Lafayette College, 730 High St, Easton, PA 18042, [2]Department of Earth and Planetary Sciences, American Museum of Natural History New York, NY 10024. (leah.shteynman@gmail.com)

Gardnos Background: The Gardnos Impact Structure in Hallingdal, Norway [1,2] is a 5-6km diameter structure in Precambrian crystalline granitic and gneissic target rocks. Gardnos hosts easily accessible outcrops primarily of crater-filling breccias, crater floor, and sub-crater breccias, making it particularly useful for studying impact effects within silicate minerals. Shock features, (PDFs, PFs) have been reported [2-4] within polymict melt-bearing breccias (referred to as "suevite" as well as "melt-matrix breccias"), but are confined to small areas adjacent to the central uplift.

The age of Gardnos remains poorly constrained, but is likely either Precambrian [2,3] or as young as 385 Ma [5,6]. Like for many other impact structures, dating Gardnos has been difficult: melt-bearing breccias contain small volumes of melt and are dominated by clastic, unmelted material. Previous dating attempts [2] have measured zircons from the suevitic breccias, but data lack context between shocked, unshocked, and potentially melt-grown zircons occurring within the same rock. Here we present a survey of zircon textures and describe their likely shock effects.

Samples: GS-01 is a polymict, melt-bearing, clastic-matrix breccia collected from a dump pile outside a hydroelectric dam in the center of the impact structure. Similar rocks from this locality have been reported previously [1] (referred to as "suevite" defined by less than 2 % melt in the matrix. GN-10-27-3 is collected from a 12-inch dike through the unshocked brecciated basement, approximately 20 meters below the con-tact of the melt-matrix breccia of [3]. This sample is considered a melt-rock, dominated by melt matrix (which has been altered to clinochlore and epidote). The sample is blue in hand sample and contains multiple mm to cm-sized clasts of granitic gneiss.

Shocked Zircon Background: Zircon is highly resistant to chemical and physical alteration, mean-ing it is one of the last minerals to undergo shock deformation [7]. Zircon is able to record high pressure and high temperature conditions, making it useful for investigations of impact structures, where high temperatures and high pressures occur. Planar microstructures in zircon and the transition to polymorph reidite occur together between 20-52 GPa [7]. At ambient pressures, pure zircon decomposes at 1676˚C to cristobalite and tetragonal ZrO_2 grains [7]. Granular zircon which was formerly reidite [8] can be identified using Electron Backscatter Diffraction (EBSD), and such grains are useful in dating the age of impact.

Methods: Whole rock sample was crushed us-ing the SelFrag electromagnetic pulse disaggregation instrument at Lamont-Doherty Earth Observatory. Crushed sample was hand sieved. Fraction between 250-63 μm was separated by magnetism and density using sodium polytungstate (density = 3.0 g/cm^3). Non-magnetic high-density fraction was used to make grain mounts on glass slides. Grinding on 800, 1000, 1200 grit size pads, followed by hand polishing to 0.5 μm using alumina powder. Characterization using transmitted and reflected light, and by electron microscopy at the American Museum of Natural History. Electron backscatter imaging was done using Zeiss EVO 60 variable pressure SEM and a HITACHI S4700 Field Emission-SEM. Cathodoluminescence was conducted with a Gatan MonoCL cathodoluminescence detector (CL) attached to the field emission SEM.

Zircon at Gardnos: Multiple textures were observed in zircon crystals from the suevite. Some crystals had parallel offsets/micro-faults (Figure 1). This crystal was highly cracked, but oscillatory zoning throughout the crystal was visible in CL.

There were multiple observed zircons appearing to granular. In one case (Figure 2), granules are between 2-6um in their maximum dimension, entirely making up the grain. Granules are the same shade in both BSE and CL. Between some granules is a material much brighter in backscatter, which may be fluorite. In another granular zircon (Figure 3), granules only make up parts of the crystal, and are >2 μm in their maximum dimension. These granules are a brighter than their host grain in CL.

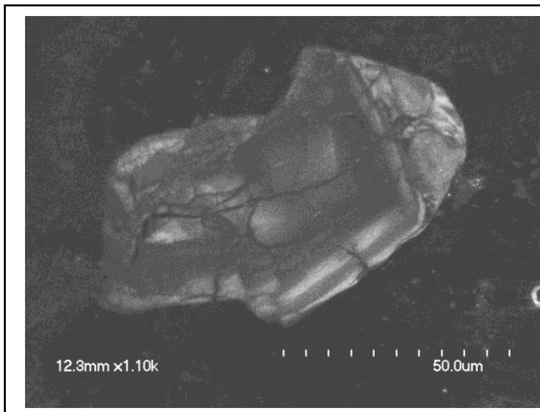

Figure 1: Zircon exhibiting microfaulting extending to the bottom edge. This crystal also shows oscillatory zoning throughout.

One zircon, 30μm in its maximum dimension, is euhedral and homogeneous in BSE (Figure 4). In CL, however, the grain exhibits complex zoning in its core, with a thin rim showing oscillatory zoning.

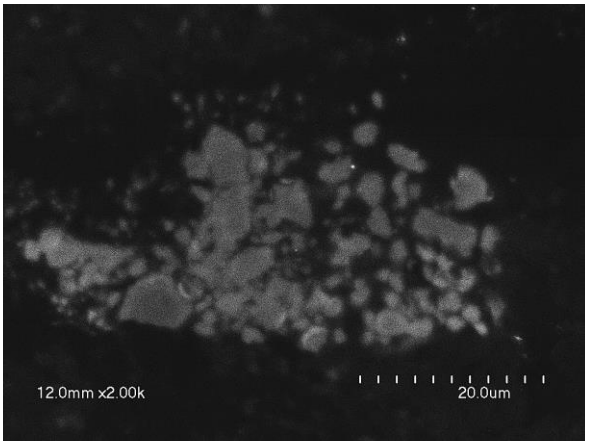

Figure 2: CL image of a granular zircon within sample GN-10-27-3

Discussion: The textures seen in these zircons are interpreted as being impact-related. The target rocks contain igneous zircons, some of which would have been affected by shock metamorphism. Figure 1 is an example which shows igneous zoning and cross-cutting microfaults interpreted to have occurred due to shock.

Impact-generated granular zircon can take on many textures, from the size of neoblasts to the presence of ZrO_2 grains. Figure 3 shows a different granular texture within the same rock. Both zircons may be candidates for radiometric dating, as granular zircons which were formerly reidite have been shown to give concordant U-Pb ages which appear to record the age of impact [9]. Granular zircons can, however, occur in non-impact environments, and those formed from impact may not record the age of impact, but future EBSD work will clarify this.

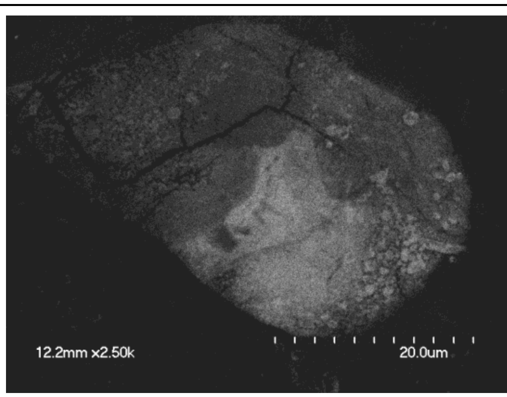

Figure 3: CL image of a zircon that appears to have domains of granular zircon texture. Individual granules are brighter in CL than the larger host zircon

The last zircon (Figure 4) appears to have impact-related texture on the interior, surrounded by a thin skin of oscillatory zoning. This zircon is located in a region of the rock identified as melt, leading to the interpretation that the grain was shocked, then grew in the impact melt. If this is the case, the exterior of the grain, the overgrowth, is melt-grown, and should record the age of impact.

Figure 4: Backscatter electron image (top) and CL (bottom) of a euhedral zircon within the impact melt. CL shows that this is actually a zoned and irregular zircon with a very thin euhedral rim. We suggest that this formed by a small amount of new zircon growth in the impact melt on top of an existing older inherited zircon.

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