SYNCHROTRON COMPUTED TOMOGRAPHY STUDIES OF LUNAR ANALOGUE CRATERS.

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Introduction: Impact structures are found throughout the solar system. They record the history of the surface of a planetary body and can expose the layers beneath the surface, giving a glimpse into the geological history of the body. Impact structures are studied using a variety of techniques from geological mapping, to hydrocode simulations and geochemical analysis [1].

Such hypervelocity impacts can be experimentally simulated using light gas guns which accelerate projectiles to velocities similar to those found in planetary impacts (on the order of 1-7 km/sec) [2]. Compositions of the projectile and the impacted block, as well as environmental conditions can be varied to simulate different planetary bodies. These experiments produce craters and the impacted blocks of material are then typically subjected to a range of characterisation techniques including surface profiling and petrological investigations of the high pressure/temperature minerals formed in the impact. These analytical processes can be destructive and often information is lost when the blocks are sectioned for analysis.

To date, there have never been any large-volume X-Ray Computer Tomography (XRCT) investigations of these impact experimented blocks. Large-volume XRCT is the ideal non-destructive technique to image the entire impact crater and shock affected material *in situ* without risking destruction of the structures during sectioning. For the first time, it is possible to image the geological structures formed, qualitatively and quantitatively analysing features such as cracks and areas of different shock wave pressure effects (brecciation vs. vapourisation for example).

The structures revealed in these images will also inform the most relevant and interesting sections to take forward for further analysis such as Fourier Transform Infrared Spectroscopy (FTIR). FTIR can be used to analyse the crater surface but will require the samples to be cut in order to obtain spectral maps of the samples with distance from the impact site (vertically and horizontally). This technique can also be used to investigate any mineralogical alterations due to the impact (e.g. formation of diaplectic glass) [3][4].

This is an initial study that will focus on impacts into lunar highland analogue materials. These materials are anorthosite blocks from Sirevåg, Norway and are on loan from the European Space Agency's ESA^{2}C collection [5]. If these methods prove successful, basalt analogues will then be used to investigate the shock effects in lunar mare analogues. Here we present the preliminary results of the XRCT measurements.

Impact experiments: Stainless steel projectiles (~2 x 2 x 2 mm) were fired at lunar analogue blocks (10 x 10 x 4 cm).

Sample Name	Shot Number	Velocity of Projectile (kms-1)	Shock pressure (GPa)
Sample 1	n/a	n/a	n/a
Sample 2	S070918#1	0.83	6.9
Sample 3	G270918#1	1.98	20.5
Sample 4	G170818#1	3.92	53.5
Sample 5	G270918#3	4.94	75.8
Sample 6	G270918#2	6.04	103.6
Sample 7	G070918#2	6.22	108.6

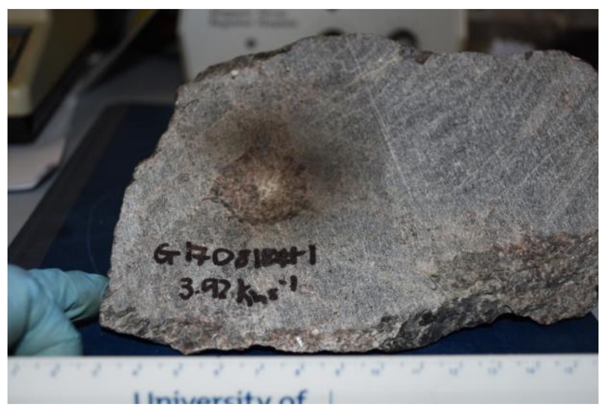

Figure 1. Exemplar impacted block

Synchrotron large volume XRCT measurements: 7 impacted blocks were scanned on the Imaging and Medical Beamline (IMBL) at the Australian synchrotron using the Ruby detector. The beamline was setup with a broad spectrum (pink) beam and experiments were carried out in hutch 3b at a distance of 150 m from the source.

Data slices were collected from 0 – 180° in steps of 0.1° every 0.1seconds. The intrinsic size of the beam using this setup (15 – 25 mm in height) limits the field of view. Thus, the blocks were scanned in vertical sections and the datasets subsequently stitched together during post-experiment processing. The detector was placed at a distance of 0.4 m from the sample position. Given this, the nominal voxel size was 200 µm.

Raw data were reconstructed using the X-TRACT (CSIRO) software available on the Australian Synchrotron Compute Infrastructure (ASCI). Datasets were aligned and stitched using the in-house software IMBL Stitch available at the beamline. Further analysis was carried out using the *Dristi* [6] image analysis software.

Preliminary images: Figures 2 and 3 show the initial data reconstructions from one of the impacted blocks (sample 4). The full submission will include quantitative measurements and comparisons of the impact craters and their structures through the impacted blocks.

Acknowledgments: This research was carried out on the Imaging an medical beamline at the Australian synchrotron.

References:

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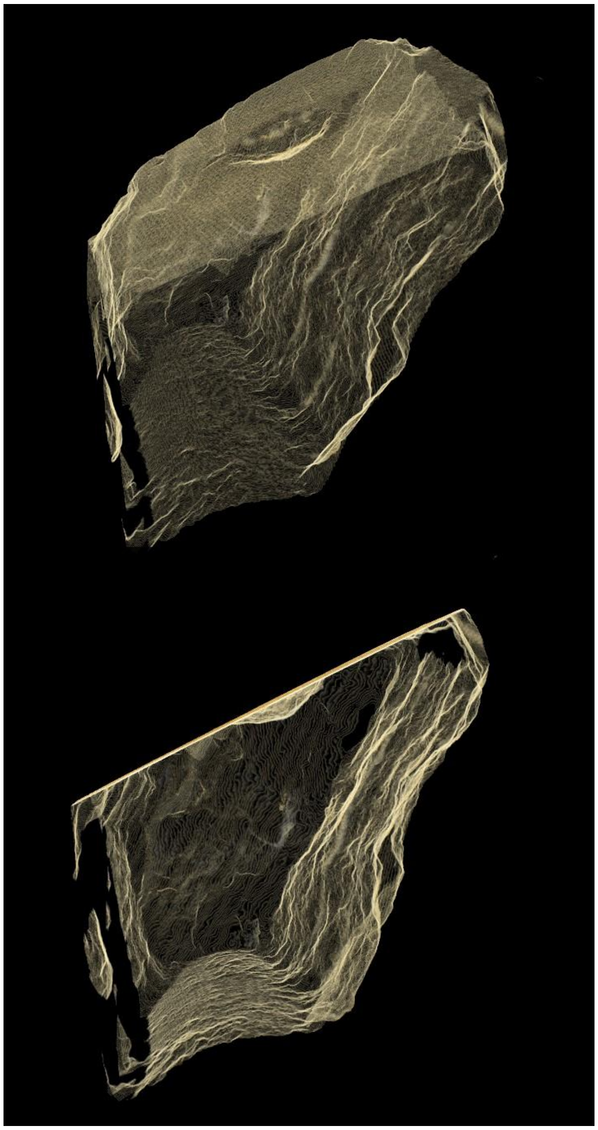

Figures 2 and 3: Reconstructed images of one of the impacted blocks showing the crater produced.