HYPERVELOCITY IMPACT STUDIES CONDUCTED TO ANALYZE THE DYNAMICS OF FRAGMENTATION AND DISPERSION OF MICRON-SIZED FRAGMENTS OF AN INTERPLANETARY DUST PARTICLE ANALOG; [1]W. G. Tanner, [1]R. A. McDonald, [1]W. M. Alexander, [2]F. Hörz. [1]Space Science Laboratory, Dept. of Physics, Baylor University, Waco, TX 76798. [2]NASA/JSC, SN2, Houston, TX 77058.

INTRODUCTION: An effort has been underway at Johnson Space Center to determine the characteristics of the dispersion of a projectile caused by an hypervelocity impact with a thin film. The projectile was accelerated using the Hydrogen Gas Gun. It impacted a thin film at normal incidence. A witness plate was place behind the thin film to catch whatever fragments were created. The witness plate was then digitized at the VDAS lab at Johnson. The digitized image was then analyzed to determine the size and distribution of the craters caused by the projectile's fragments.

INTENSITY AND CLARITY: The creation of the best binary image has been one of the major concerns during initial stages of development. The acquisition of several public domain programs such as *Datascope, Image* and *ImageTool* enabled researchers to generate an on screen representation of the digitized image. The ability to see the results of the manipulation of the image greatly enhanced the capability to analyze the plate. The image is created by making a linear transformation from the values in the matrix to the set of integers between 0 and 240. The first technique used to clarify the image applied a threshold to the digital image in such a manner that all intensity values below the threshold were set to zero, while all pixels with intensity values above threshold were set to one. In addition to the threshold operator other operators that transform the image have been experimented with at Baylor. The two of these that have shown the most promise are the Zero Point Transform or the Zero Crossing Operator and the Sobel Operator. The latter of these, the Sobel Operator is an edge detection operator that can loosely be described as an average derivative over a nine member group. The noise reduction achieved by using a Zero Point Transform has no significant effect on the features consisting of impact craters.1], 2]

BINARY IMAGE REDUCTION: Each computer datafile represents a 3" X 3" digitization of a crater field on a witness plate. If all 2048 solid state photosites of the digitizer are contiguous then one "pixel" has a dimension of ~38.3 µm on a side. This implies that, for example, a central crater of T292 (Cf., Figure 1.) having a measured diameter of approximately 2.2 mm would correspond to a digital image feature 57 pixels wide. Even though positional resolution is coarse the present range of intensity values of the digitized image are not a limitation. Thus a Binary Image Reduction (BIR) scheme can be conducted without loss of significance, i.e., one can retain all relevant aspects of each crater following a slight change in threshold.

FEATURE IDENTIFICATION: The principal purpose of the Feature Identification scheme has been to delineate the dimensions of a crater, i.e., a digital image feature. Foremost, the method has been developed to establish the x-y extension of all interesting digital images in the digital map of the witness plates. A direct consequence of the BIR scheme is the creation of a sharp boundary surrounding each crater (or cluster of craters). Since each crater possesses a sharp boundary one may identify and exploit this fact to demarcate the extension in the x and the y direction of each feature. Final identification of the x-y extension of a feature is facilitated by use of an unique label assigned each binary image feature during the BIR scheme (Cf. Figure 3.). Trapping the maximum and minimum x and y location values for an unique label delineates the boundaries for that particular feature.3]

DIAMETER DETERMINATION: From the x-y extension of each crater one may derive a diameter based on the circumscribed circle enclosed by the feature boundaries. Beginning with an area counted via pixels as a best estimate of annulus area of outer crater extent and inner crater walls, and knowing an area derived from a circumscribed circle, i.e., the x and y extension of the feature, one can quickly find the area and diameter of the crater pit. With this information one may calculate the weighted mean of a feature's diameter. The location of the craters by size as a function of radial distance from the center of mass will be the natural outgrowth of these values and can be determined using these equations. The mass of the fragment while not known with accuracy may be estimated at this preliminary stage in the program development.4]

ITHD	DIAM	DXYA	DPIX	Δµm	Δ pix	Δ µm	Δ pix	Δ µm	Δ pix
50	2333	2333	1876	–	–	–	–	–	–
60	2257	2257	1777	76	~2	76	~2	99	~3
70	2218	2218	1719	115	~3	115	~3	157	~4
80	2218	2218	1649	115	~3	115	~3	227	~6

Table 1 Error in diameter due to threshold variations from 50 to 80 for central crater of T292.

SUMMARY: There has been significant progress made in the problem of isolating and measuring the size of craters on impact plates. For targets whose crater distribution is dominanted by distinct craters, existing computer routines can establish the distribution of impact sites and determine diameters for each crater. The immanient of return of the Long Duration Exporsure Facility could provide much material possessing a multitude of distinct impact craters which are in need of analysis . The software already developed and tested could be utilized to analyze digitized LDEF data. The techniques developed can also determine of the dispersion angle of a fragmented IDP analog. The maximum angle of dispersion for the smallest fragments found on plate T292 was approximately 1.6° which corresponds to a velocity component perpendicular to the line of impact of 100 m/s. From the data gathered from the initially studied witness plates it appears that the path length of the fragments created by the impact with the thin film can be increased thereby making the resultant craters more distinct. Further investigation of similar plates will generate a better understanding of the physics of IDP analog fragmentation caused by hypervelocity impacts with thin films.

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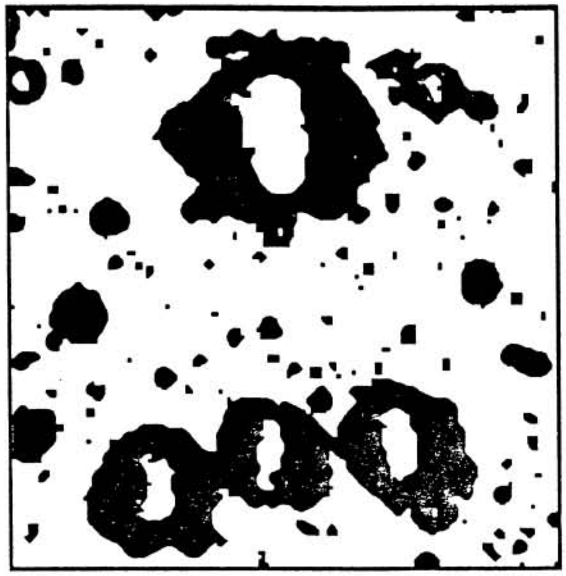

Figure 1. Plate T292 with Threshold of 50.

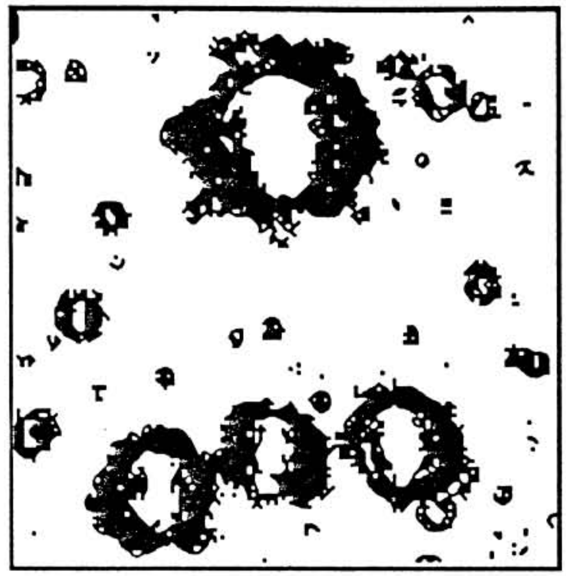

Figure 2. Zero Crossing Transform of T292 with Threshold = 50.

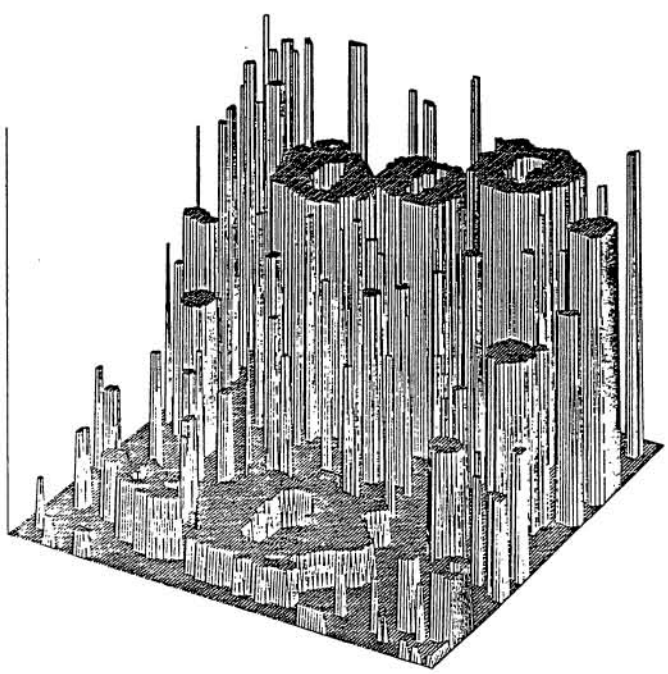

Figure 3. Results of application of Pattern Recognition Program to Binary Image of plate T292 with a Threshold of 50.