NEW SOFTWARE TOOL FOR MAP-PROJECTION-INDEPENDENT CRATER SIZE-FREQUENCY DETERMINATION IN ARCGIS. T. Kneissl, S. van Gasselt and G. Neukum, Institute of Geosciences, Planetary Sciences and Remote Sensing, Freie Universitaet Berlin, 12249 Berlin, Germany, thomas.kneissl@fu-berlin.de.

Introduction: Statistical analysis of crater size-frequency distributions (CSFD) of impact craters on planetary surfaces is a well-established method to derive absolute ages on the basis of remotely-sensed image data. Although modelling approaches and the derivation of absolute ages from a given CSFD have been described in considerable depth (e.g., [1], [2], [3], [4]), there is no standardised methodology and guideline for measuring impact-crater diameters and area sizes that are both needed in order to determine absolute ages in a correct way.

Common Measurement Methods: Since the method of age determinations on planetary surfaces with impact crater size frequency determination has become established, a number of different methods in order to determine the diameters of impact craters and the size of measurement areas have evolved. Using traditional photogrammetric instruments (e.g., Zeiss PS2-K) it is possible to measure image coordinates (e.g., crater diameters) on large-format film transparencies in monoscopic or in stereoscopic view. Another method is to measure impact-crater diameters directly on the projected raster datasets counting the number of pixels defining an impact crater. Using this approach small diameter impact craters are frequently measured with large errors, as the determined diameter-values always represent multiples of the pixel size. Nowadays, crater size-frequency measurements are often performed in GIS environments, which allow the measurement of impact crater diameters as vector data superimposing the original raster dataset. However, the crater diameter measurements are still done on map-projected image data either processed individually or obtained from catalogs with already map-projected data. Any GIS measurement relys on the map projection and uses this map definition for measurement rather than calculating areas and lengths on the geographic reference.

Revised Approach: Distortions of distances (i.e., diameters) and areas within different map projections are the largest error sources within the measurement phase. The new approach to overcome the problem of errors introduced by map projections is to use different map projections for different tasks at the backend without any interaction required from the user. For simplifying correct measurements we developed an extension for ESRI's ArcGIS suite to measure the diameters of impact craters independently of the map projection of the image basis. The output data comprise correct impact-crater diameters and area sizes and can be used for accurate age determinations, thus limiting the error in age determination to the cratering model rather than the measurements.

Whenever an impact crater has been digitized during a mapping process within a given map projection, the digitized measurement points are re-projected internally into a stereographic map projection with the crater center as the projection center. Here, the undistorted crater-perimeter circle is created which is then projected into a sinusoidal projection, using the central point's longitude as the central meridian. Since there is no scale distortion along the central meridian and parallels in a sinusoidal map projection, the north-south extent of the circle reflects the true crater diameter. Afterwards the circle is reprojected into the current map projection and is distorted in the same manner as the imagery. Independent of the currently employed map projection, the measurement area size is also calculated within the equal-area sinusoidal map projection. Additionally, the CraterTools extension provides several small functionalities in order to simplify and speed up the measurement process.

Conclusions: The measurement approach and the developed ArcGIS software extensions significantly improve the process for generating GIS-based crater size-frequency distributions and derive age determinations of planetary surfaces.

- Reprojection of measurement areas and each impact crater using individual stereographic and sinusoidal map projections provide the highest-possible accuracy for determining crater diameters and sizes of measurement areas.
- User-friendly design of the CraterTools ArcGIS extension eliminates the problem of errors caused by employing map projections that are not suitable for this particular task.
- The measurement process is reduced to outlining (mapping) a particular investigation area and digitizing crater diameters by two different methods.
- Determination of impact-crater diameters is significantly improved when compared to older methods and also accounts for heavily eroded craters.
- The measurement process and surface age extraction is significantly accelerated allowing for a much more efficient measurement process over larger/more heavily cratered areas on high-resolution data.
- The mapping process as aided by the CraterTools extension is seamlessly integrated into tools for extracting surface ages including resurfacing corrections [5].

This tool is free for academic/educational use. System requirements: ArcGIS 9.1 or higher. For more information, please contact thomas.kneissl@fu-berlin.

Acknowledgement: This research was partly supported by the German Science Foundation (DFG) through the Priority Program Mars and the Terrestrial Planets (DFG-SPP 1115, Project: Chronostratigraphy of Mars, grant: NE 212/8-3), the Helmholtz Association through the research alliance "Planetary Evolution and Life", and the German Space Agency (DLR), grant 50QM0301 (HRSC on Mars Express).

References: [1] Crater Analysis TechniquesWorking Group (1979) *Icarus*, *37 (2)*, 467-474. [2] Neukum, G. (1971) *PhD thesis*, Heidelberg. [3] Hartmann W. K. and Neukum G. (2001) *Space Science Reviews*, *96*, 165-194. [4] Ivanov B. A. (2001) *Space Science Reviews*, *96*, 87-104. [5] Michael G. and G. Neukum (2008) *LPSC XXXIX* p. 1780.

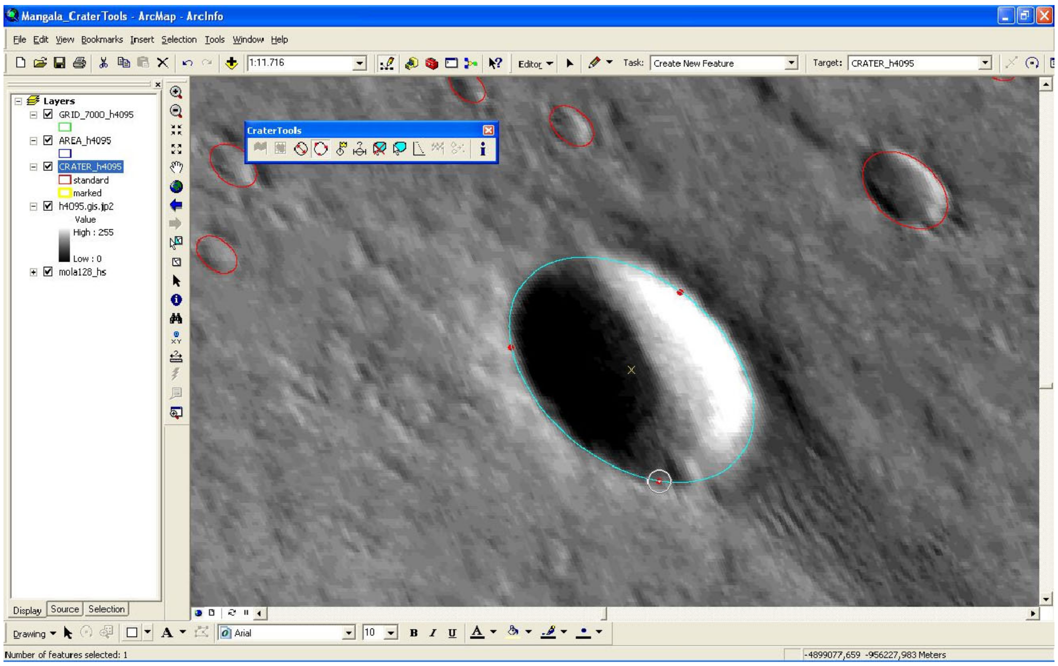

Figure 1: ***Three-point-crater digitizing*** **in** ***CraterTools*****. Even distorted craters can be measured.**

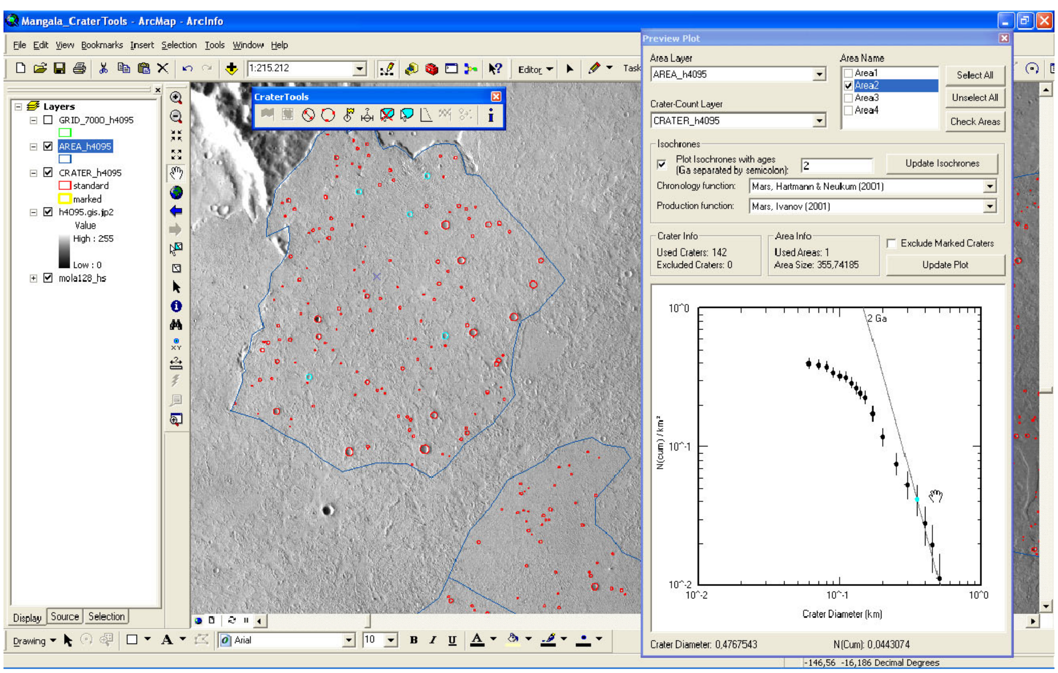

Figure 2: ***PreviewPlot*****-dialog in** ***CraterTools*** **with the possibility to plot isochrones.**