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# Additional Tools for Surface Analysis in ArcGIS

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## Abstract

Automated and semi-automated measurements and calculations are important tools within ArcGIS, which can improve geological and geomorphological interpretations in the field of planetary science. Based on observed surface features different tools can be selected by the user to enhance certain research question and foci.

## 1. Introduction

The analysis and interpretation of geological and geomorphological surface features in planetary science is user-based and therefore depends on the experience and knowledge of the user. As a result interpretations of geomorphological and geological analysis can vary to a great extent. The process of analyzing takes a lot of time, effort, knowledge and workforce.

How can we reduce the time needed for analysing and interpreting data, without losing quality and support the user in terms of additional information?

## 2. Background

Planetary missions collect large amount of data by using remote sensing techniques. Remote sensing is becoming increasingly important as it provides new insights for Earth and planetary observations in general. Almost complete coverage of high resolution images is available for the Martian surface. Various tools (slope, elevation, surface features) are used for the digital data analysis of observations in Geographical Information Systems (GIS). We use the software ArcGIS to capture, manage, analyze and present the image data. All available information can be used to identify and classify observed surface features and to obtain geomorphological maps.

## 3. Concept

We are developing conceptual tools for GIS, which are needed to analyse the Martian surface and improve the analysis concerning time and effort. The input data for those tools are Digital Terrain Models (DTMs) and a user based mapping. Tools contain calculations, measurements or classifications. Two analysis types are used: 1. Automated 2. Semi-automated (Fig.1).

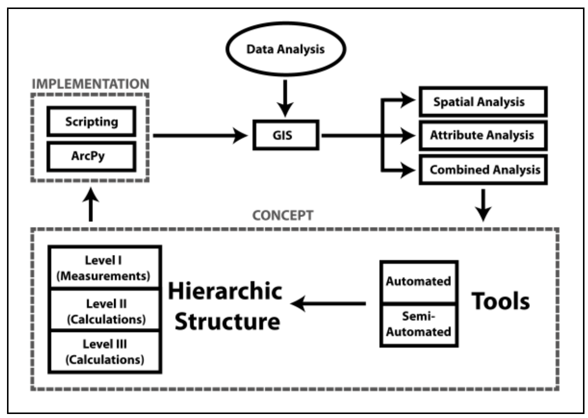


Figure 1: Principle of Data Analysis by using GIS. The work is divided into a conceptual part, including additional tools for the surface analysis, and an implementation part, at which the scripting and coding is in ArcPy.

1. Automated tools operate without user interaction. Simple surface measurements (e.g. diameter) and calculations (e.g. average crater rim height) are based on the DTM and simple mapping.

2. Semi-automated tools are a combination of automated tools and user decisions (e.g. classification of erosion type).

Additionally the tools are organized in a hierarchic order and follow depend principles (Fig. 2). The user can decide and pick the measurements (Level I) and calculations (level II+III), which need to be done for his research (e.g. focus on crater rim). For each surface feature different measurements, calculations and classifications are feasible and therefore certain tools are available. A limited selection of tools is visible as soon as a particular surface feature is chosen.

The tools are grouped into three dependency levels. Level I measurements needs the DTM and mapping. Level II needs additionally the results of Level I measurements. Level III requires the results of Level II calculations respectively.

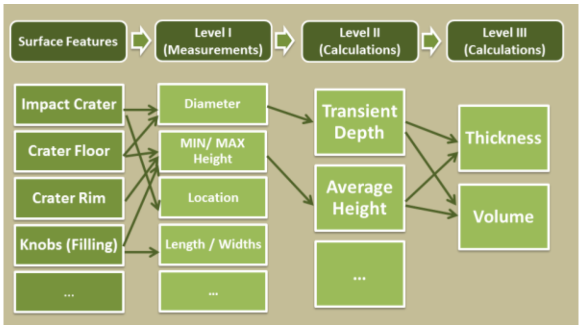


Figure 2: Example of the hierarchic order of measurement and calculation tools, grouped into three dependency levels.

## 4. Advantages

The qualitative analysis, including mapping and classifications, need to be performed by the user. The automated and semi- automated tools yield further detailed and objective surface observations and calculations, but they are based on a mapping and DTM. Quantitative information support and prove the geological interpretations of the user.

## 5. Case Study

Which information is important and necessary for the analysis and geological and geomorphological interpretation of surface features? Our research focusses on quantitative analysis regarding location, scale and shape of impact craters. Data about location and scale of impact craters can be obtained by crater catalogues [2] or user based mapping. Here we focus on the shape classification of impact craters.

We have also taken the applicability of those tools into account and therefore conducted a case study. Several tools have been tested on a specific type of impact crater on Mars- Floor Fractured Craters (FFCs). The floor and infilling of those craters is fractured and separated into knobs of different shape and size.

Crater analysis is performed to define and characterize the shape of the craters. Measurements and calculations help to classify observed surface details. Crater rim, floor, knobs (filling), fractures, ejecta, channels, linear features and central peak are analysed concerning length, depth, height, orientation, thickness, amount and number.

The classification and calculations are based on former research done on impact craters on Mars. The transient crater depths and central peak height are calculated [4]. Impact craters are classified concerning the level of erosion [5]. Furthermore a classification of craters into closed and open basin lakes can be achieved [6].

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## References

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