MORPHOMETRIC ANALYSIS COMPARISON OF DIFFERENTLY DEGRADED SIMPLE CRATERS ON THE MOON

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INTRODUCTION

Morphometric techniques can supply a valuable support for the datation of planetary surfaces.The greatly improved data from recent remote sensing space missions have provided a new level of details in terms of crater morphometry. The recent high resolution DTMs (Digital Terrain Model) enable this research to find out a morphometric signature of some significant sectors of craters, different of degradation.

CLASSES OF DEGRADATION

In this work we aim to establish a numerical classification of the four degradation classes proposed by Arthur et al. in "Lunar and Planetary Laboratory" (1963).
First of all we subdivided a crater in five significant sectors (FIG 1-A), more susceptible to degradation. We firstly find the characteristic values of different morphometric variables of each crater sector.
In particular the slope classification, created for this analysys, shows how the rim crest tends to enlarge and smooth with the increase of the degradation rate. So we are able to quantify the relation between diameter and thickness of the rim crest, as a function of crater degradation .

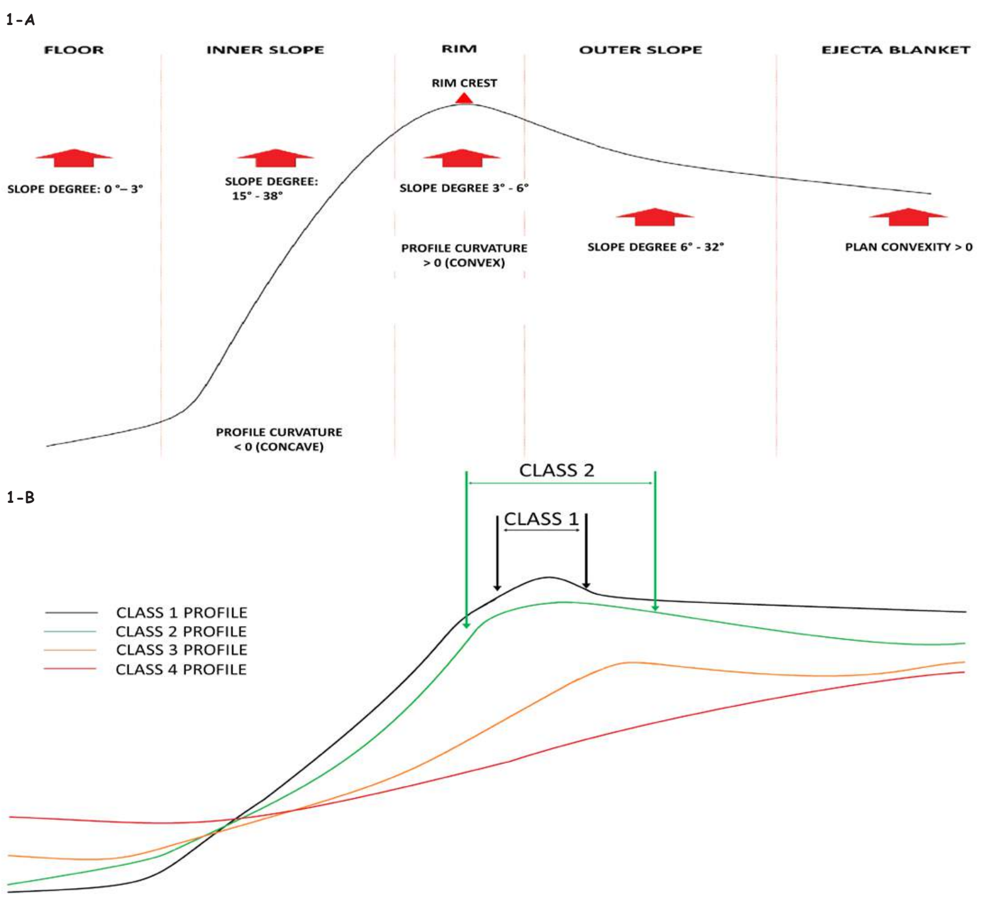


FIG. 1 A - Schematic topographic profile of a class 1 crater, with the five main sectors proposed in this research, correlated with the morphometric values.
B - Comparison of topographic profiles of the four classes of crater degradation. This scheme shows how the rim enlarge and smooth with the increase of the degradation, up to eroded in classes 3 and 4.

DATA ANALYSYS

We analyzed DTMs from:
- LROC NAC[(1)], with a resolution ranging from 0.5 to 1.5 m/pixel.
- LROC WAC[(2)], that is providing a global lunar surface coverage with a resolution of about 100 meters/pixel.
(1) = Lunar Reconnaissance Orbiter Camera, Narrow Angle Camera.
(2) = Lunar Reconnaissance Orbiter Camera, Wide Angle Camera.
Morphometric analysys of DTMs is performed by a multiscalar approch, helpful not only to reduce DTM noise, but also to smooth surface, enhancing different kinds of morphologies, by testing several values of kernel sizes (e.g. kernel = 15,25,35,50,75).

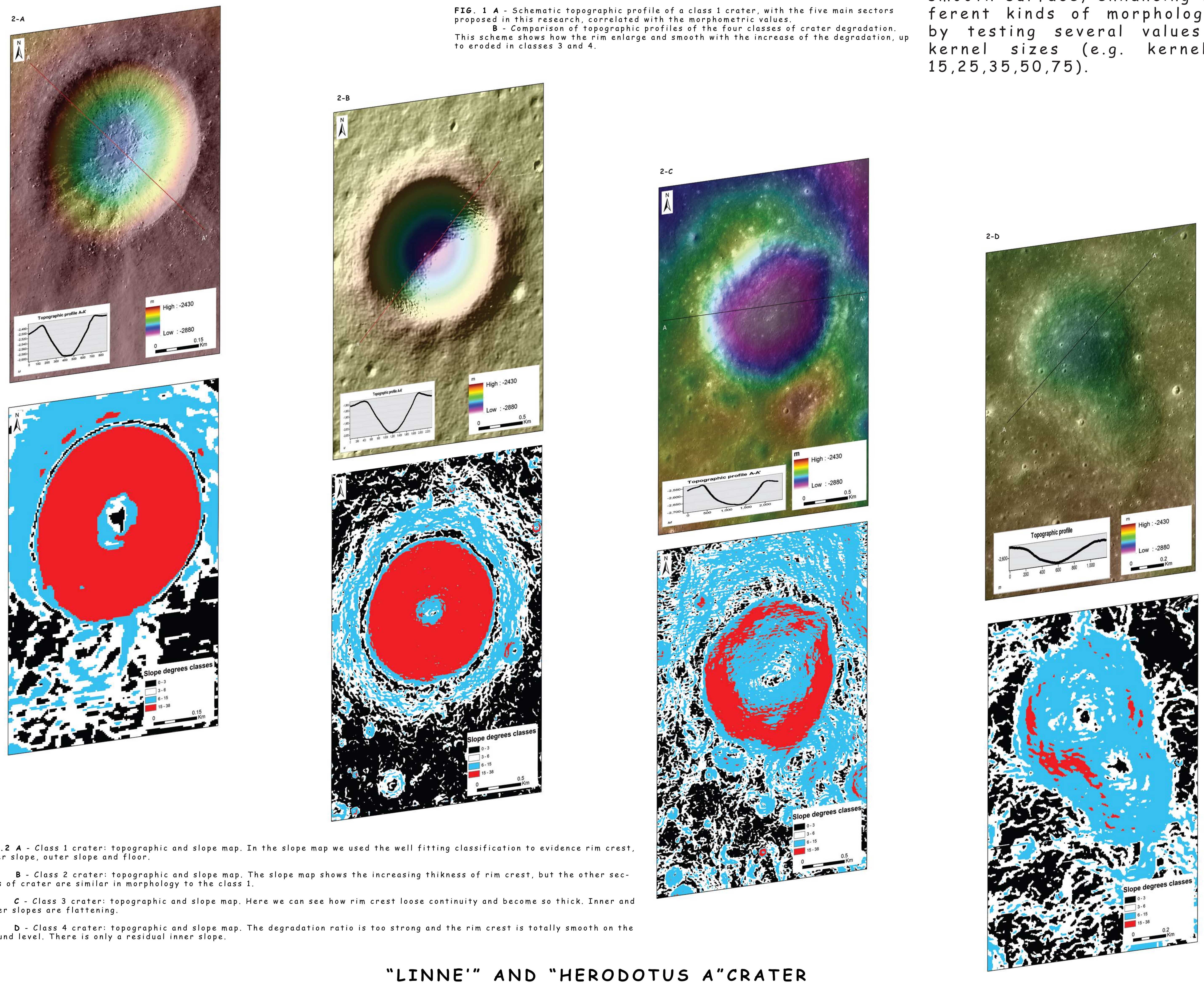


FIG.2 A - Class 1 crater: topographic and slope map. In the slope map we used the well fitting classification to evidence rim crest, inner slope, outer slope and floor.

B - Class 2 crater: topographic and slope map. The slope map shows the increasing thikness of rim crest, but the other sectors of crater are similar in morphology to the class 1.

C - Class 3 crater: topographic and slope map. Here we can see how rim crest loose continuity and become so thick. Inner and outer slopes are flattening.

D - Class 4 crater: topographic and slope map. The degradation ratio is too strong and the rim crest is totally smooth on the ground level. There is only a residual inner slope.

"LINNE'" AND "HERODOTUS A"CRATER

To understand the great potential of the use of Morphometry in Planetary Sciences, here we show two examples of applications. The first one is the analysys of Linné, a small fresh crater (D=2.2 km, d= 0.6 km) located in Mare Serenitatis, that represents the class 1 of degradation. Morphometric analysys, using a multiscalar approach, confirmed a rheological boundary at a depth of 200 m within the crater, firstly hypothesized throughout numerical investigation (Martellato et al., 2013), and well identified as a bland morphological step on the inner crater scarp, by using slope and curvature maps, derived from a NAC DTM (FIG. 4B-4C).
The second one, regards the morphometric analysys of Herodotus A, a relatively fresh crater (D= 10 km, d= 1,8 km) that shows evidences of morphological changing in the inner slope, according with the theorical alternation of basalt stratification and regolythe or voulcanic dust, proposed for the lunar maria (Wilhelms, 1987 - Ono et al., 2009) (FIG. 3-4).

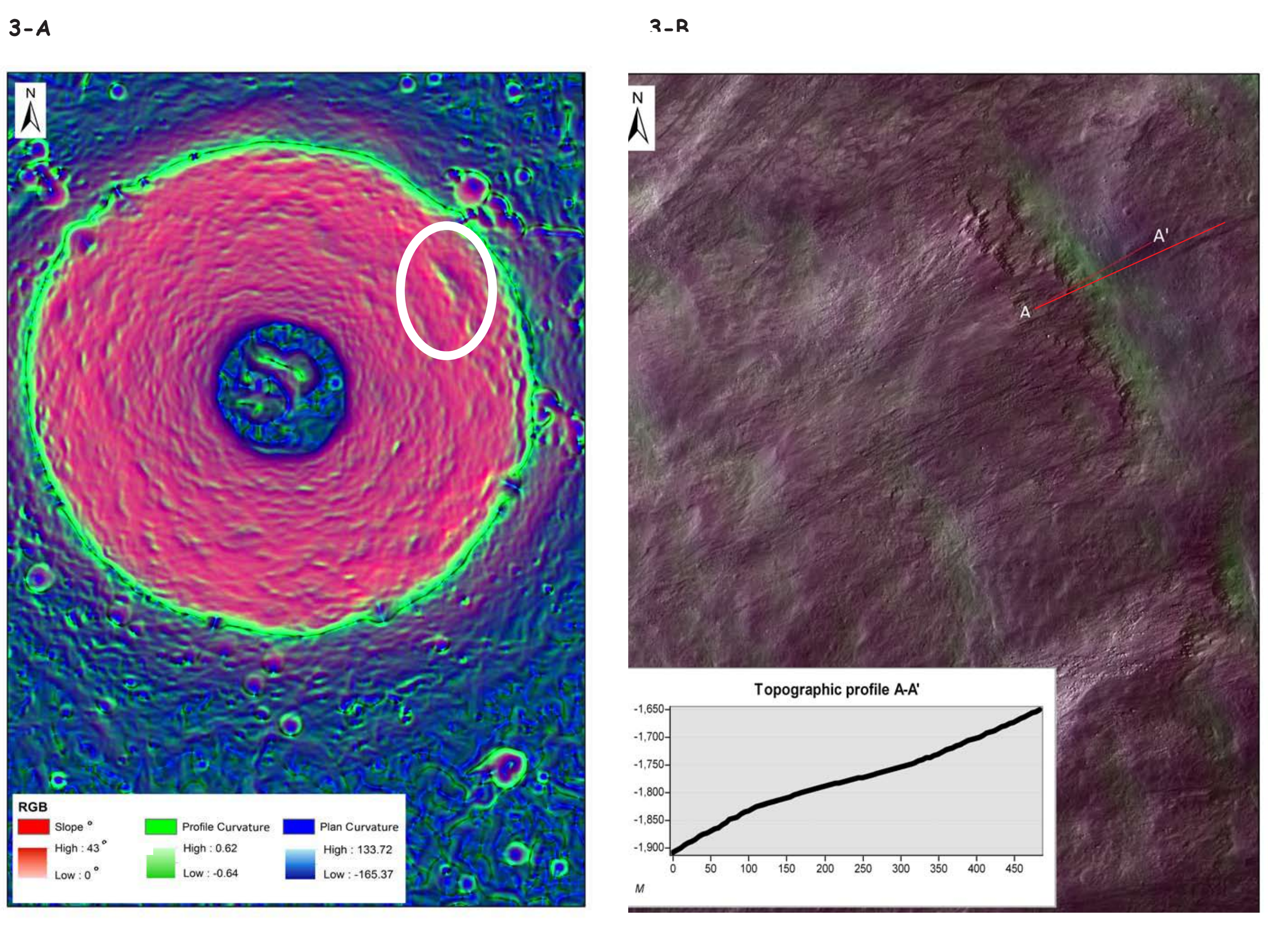


FIG.3 - A - False color composition of Slope, Profile Curvature and Plane Curvature. This elaboration show morphological steps on the inner slope of Herodotus A crater, enhanced by with green color.
B - Particular of the inner slope of Herodotus A framed bythe white circle in 3-A, with a morphological step and it's relative topographic profile where can be seen some landslides.
C - 3D view of Herodotus A.

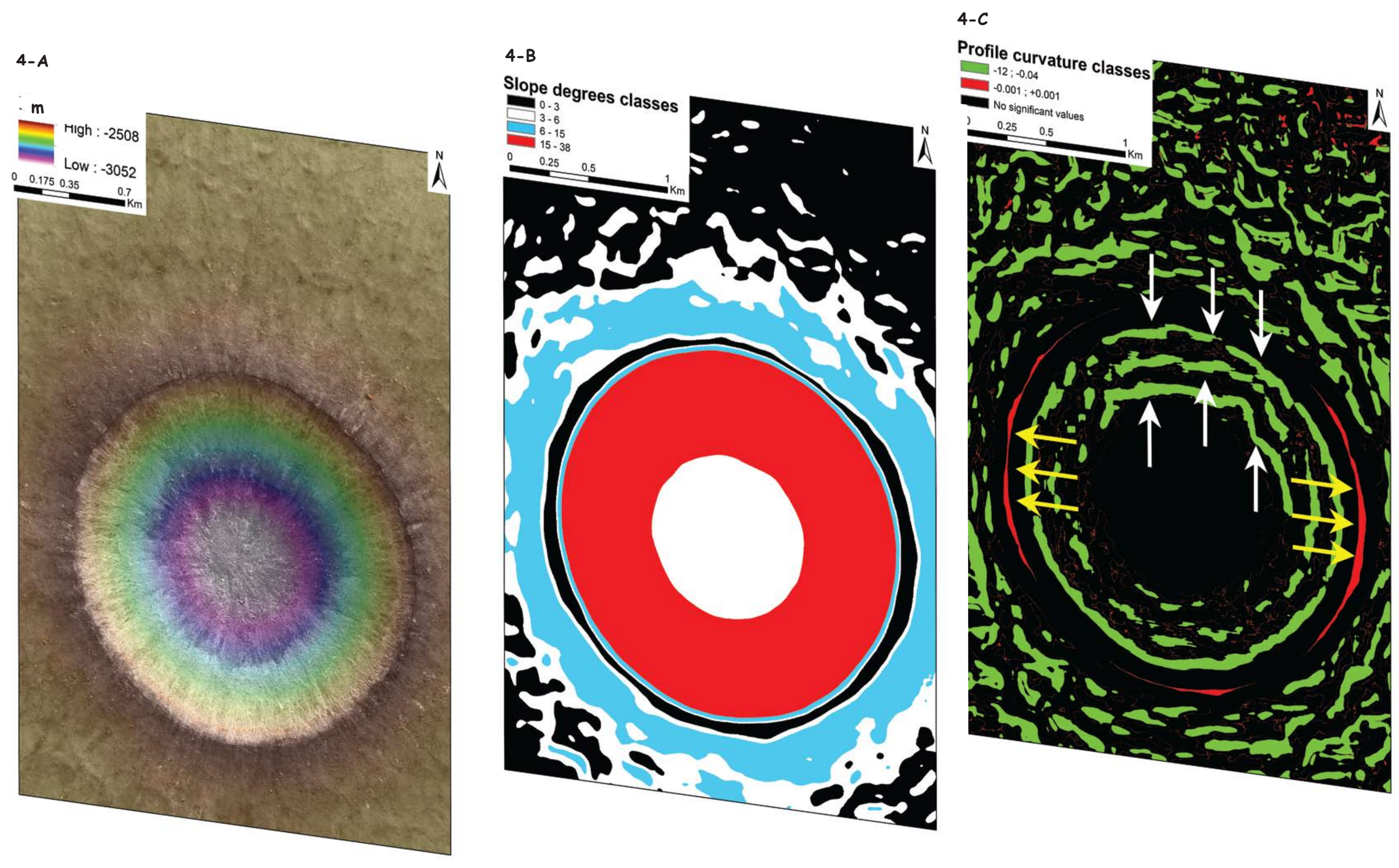
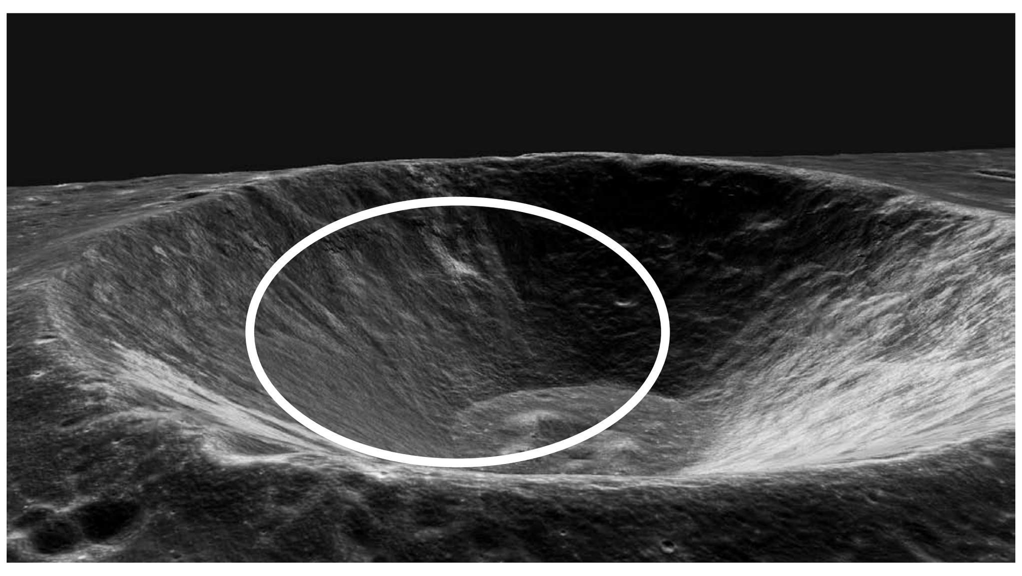


FIG.4 A - Topographic map of Linnè crater.
B - Slope classification enhance automatically rim crest, inner and outer slopes and floor (kernel size: 50m - window size: x).
C - Profile Curvature classified, to enhance Rim Crest (red color) and morphological steps of the inner slope, (kernel size:50m - window size: x).

3-C



PRELIMINARY RESULTS

This preliminary work highlighted promises of morphometric analyses to reveal with extreme accuracy structures and features on planetary surfaces. This is made happen through enhancement of crater appearance. Our methodology can have important benefit on interdisciplinary works (e.g., impact modelling).

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