CRATER IDENTIFICATION AND CLASSIFICATION BASED ON EJECTA USING RADIAL BAND FFT

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Introduction: Comets and asteroids strike the Moon at a wide range of impact speeds. Such a high-speed impact will produce a crater that is 10 to 20 times larger in diameter than the impacting object. Lunar craters exhibit varying shape, size, chronology etc. and they are excellent records of the history and evolution of the lunar surface.

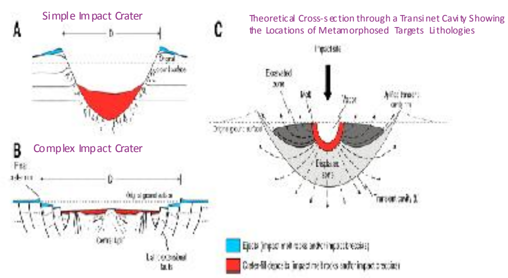
Classification of Lunar Craters : Different criteria has been used in classification of Lunar craters.
The lunar crater categorization as per the Lunar & Planetary Lab (LPC):

- *ALC* — small, cup-shaped craters with a diameter of about 10 km or less, and no central floor.
- *BIO* — similar to an ALC, but with small, flat floors. Typical diameter is about 15 km.
- *SOS* — the interior floor is wide and flat, with no central peak. The inner walls are not terraced. The diameter is normally in the range of 15–25 km.
- *TRI* — these complex craters are large enough so that their inner walls have slumped to the floor. They can range in size from 15–50 km in diameter.
- *TYC* — these are larger than 50 km, with terraced inner walls and relatively flat floors. They frequently have large central peak formations.

❖ Lunar craters classified morphologically based on a number of parameters:

- Rim degradation state.
- Presence of terraces and slumping on the internal slopes.
- The external rim character.
- Presence of central peaks, ridges and mountains on the floor.
- Presence of chains and fissures.
- Character of the floor.
- Presence of lava on the floor.
- Ray systems.

Crater Ejecta: When a large body hits the Moon, a huge amount of material is thrown out from the resulting impact crater. Material that is travelling slowly overturns as it is ejected from the crater and builds up the crater rim. Other material gets strewn across the surface, surrounding the craters. This is called the 'Ejecta'. The ejecta is typically brighter/lighter in shade than older materials due to exposure to solar radiation for a lesser time (relatively younger craters). The ejecta material may get strewn across the surface, extending tens, hundreds or may be even thousands of kilometres from the crater itself as bright crater ray systems. The craters exhibiting ray system are named as 'Ray Craters' and these are relatively younger impact craters.



SCHEMATIC CROSS-SECTIONS OF SIMPLE AND COMPLEX CRATERS AND OF A TRANSIENT CAVITY (GORDON R. OSINSKI, ET AL)

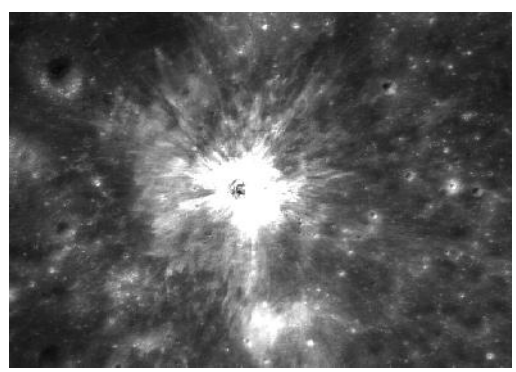


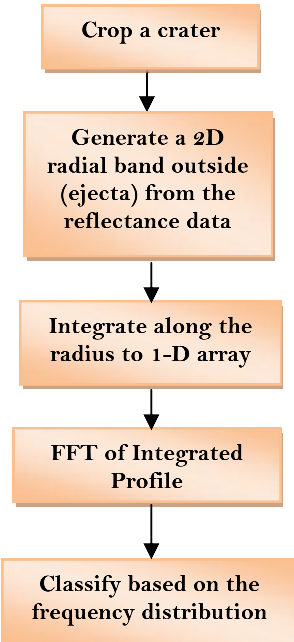
Fig.1. Ejecta

Importance of the ejecta : The ejecta material represents fresh sub-surface material and forms an ideal target for studying the mineralogical composition of the lunar sub-surface using hyperspectral RS data. The classification of craters with 'Ejecta' as a criteria has the following objectives:

- Identification and Classification of Craters for presence or absence of ejecta – Based on Reflectance.

- Automated Classification of Craters for the presence or absence of ejecta using FFT technique.

Algorithm / Methodology



Manual or automation for mass operation

Translating radial reflectance pattern to rectangular pattern for ease of computation

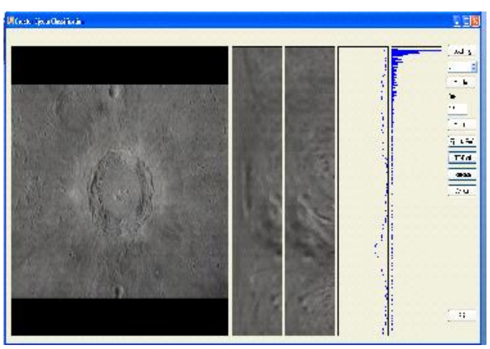
Improving the signal to noise ratio along the ray direction

Estimating the radial frequency which is characteristic of the ejecta

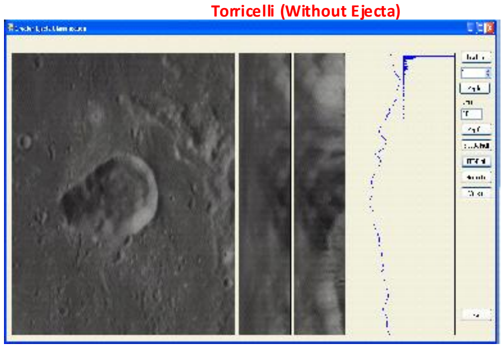
Classify the frequency distributions using Self Organizing Maps (like Neural Networks)

Results: Using the software tool (developed by DDU, Planex research team) and C++ Program, the FFT [5th column] is generated for 4 Craters, 2 with Ejecta and 2 without ejecta.

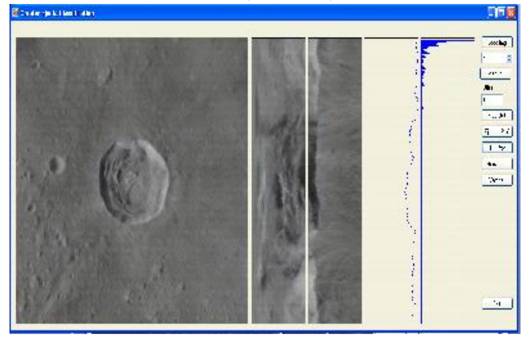
Copernicus (With Ejecta)



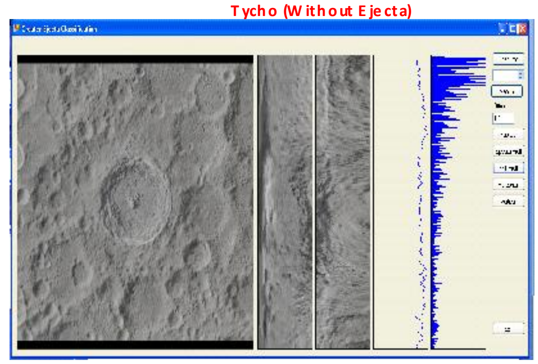
Torricelli (Without Ejecta)



Kepler (With Ejecta)



Tycho (Without Ejecta)



Conclusion : Ejecta is an important paramter for classifying the craters, and FFT technique may be effectively used in automatic classification of caters with ejecta. As the ejecta from the younger crater can form an important material for sample collection for elemental/mineralogical analysis, this can be an important criteria for the landing site selection.

Acknowledgement : The author acknowledges the guidance from Dr. H.S.Mazumdar, Professor, Dharmsinh Desai University, Planex research team and their software tool. Also the contributions from ISRO scientists Dr. T. John Tharakan , S. Nagarajan, Neeraj Mishra, and Dr. G Sreenivasan is acknowledged.

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