7-19-2024

Lunar Crater Categorization and Why Accessibility Matters for Planetary Scientists

Gavin Soueidan
Ursinus College, gasoueidan@ursinus.edu

McKenzie Snyder
Ursinus College, mcsnyder@ursinus.edu

Lunar Crater Categorization and Why Accessibility Matters for Planetary Scientists

McKenzie Snyder and Gavin Soueidan

Advisor: Kassie Martin-Wells
Ursinus College, Pennsylvania, USA
July 19, 2024

Ursinus College

Open Science

Open Science – scientific research should be accessible to everyone
for the benefit of all scientists and society as a whole.

How do we practice open science?

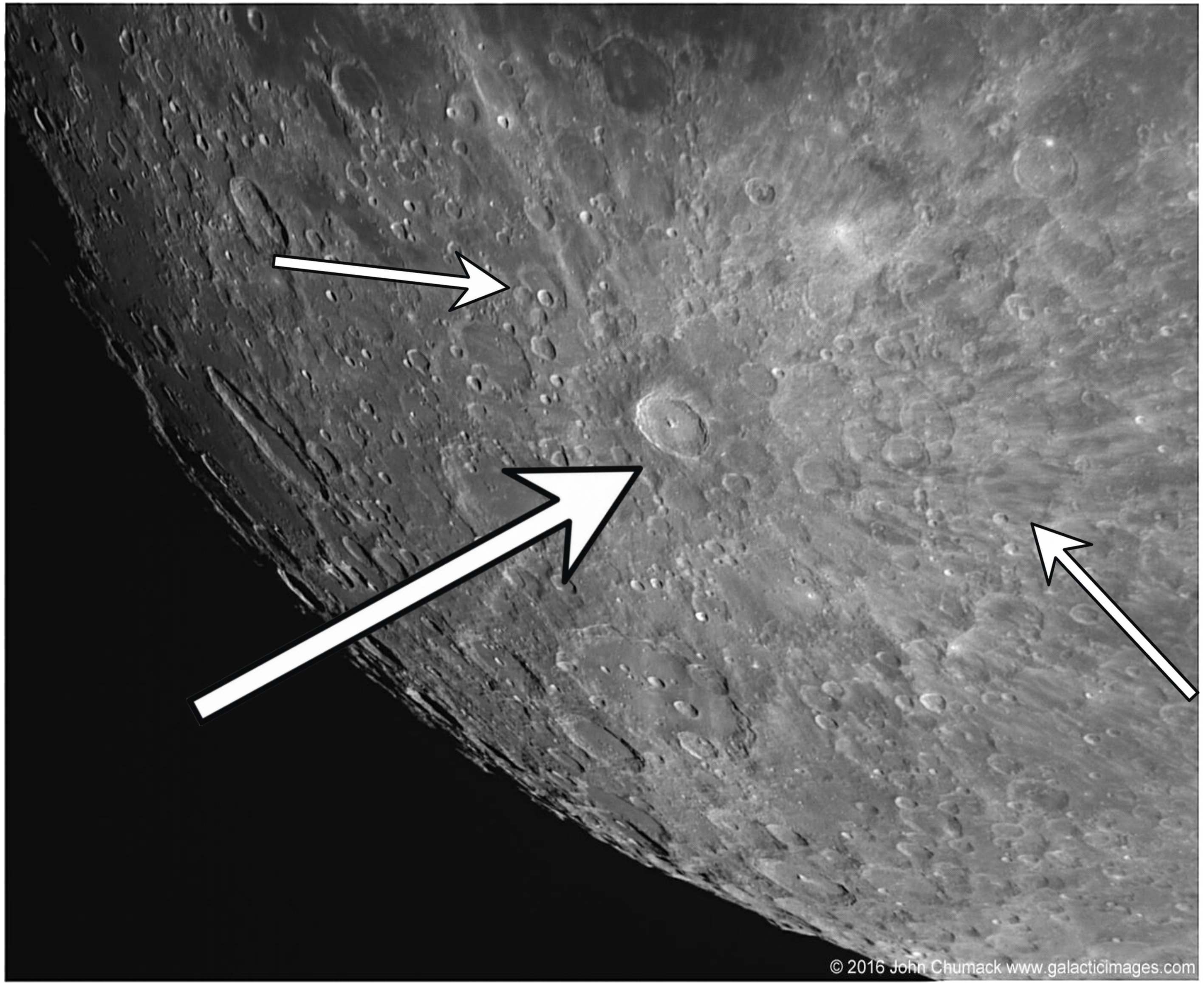
What are craters?

Primary Craters

- formed when a space object collides with a planetary surface
- your "average joe" crater

Secondary Craters

- formed by fragments of material on the planetary surface that are disrupted and thrown in the air by the initial, primary forming collision



Differentiating Primaries from Secondaries

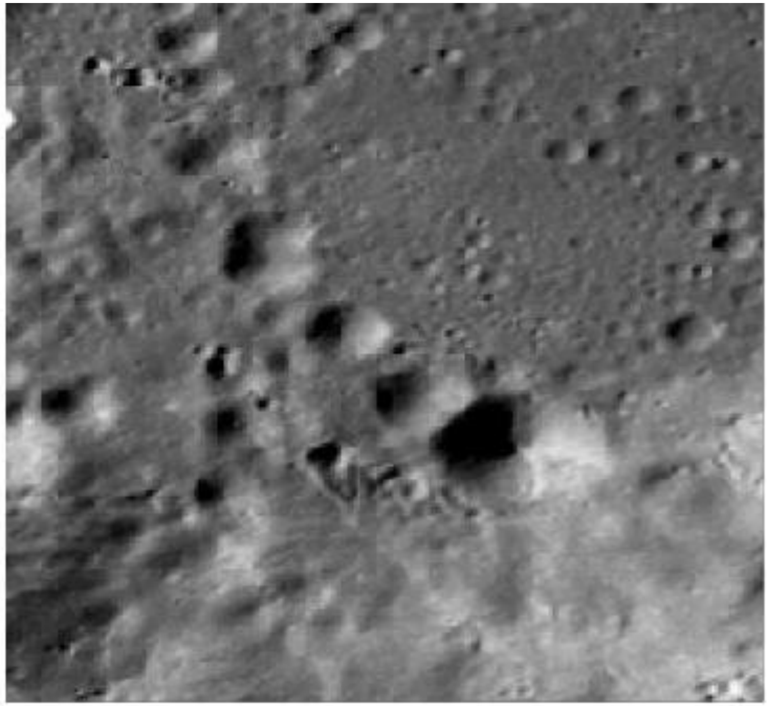
Primaries

- Formed at high velocities causing their creation to be like an explosion - round and deep

Secondaries

- formed at a lower velocities causing unique characteristics such as:
  - Ellipticity
  - Clustering
  - Size-frequency distribution
  - Shallow Profiles
  - CPR tails

Primary Crater

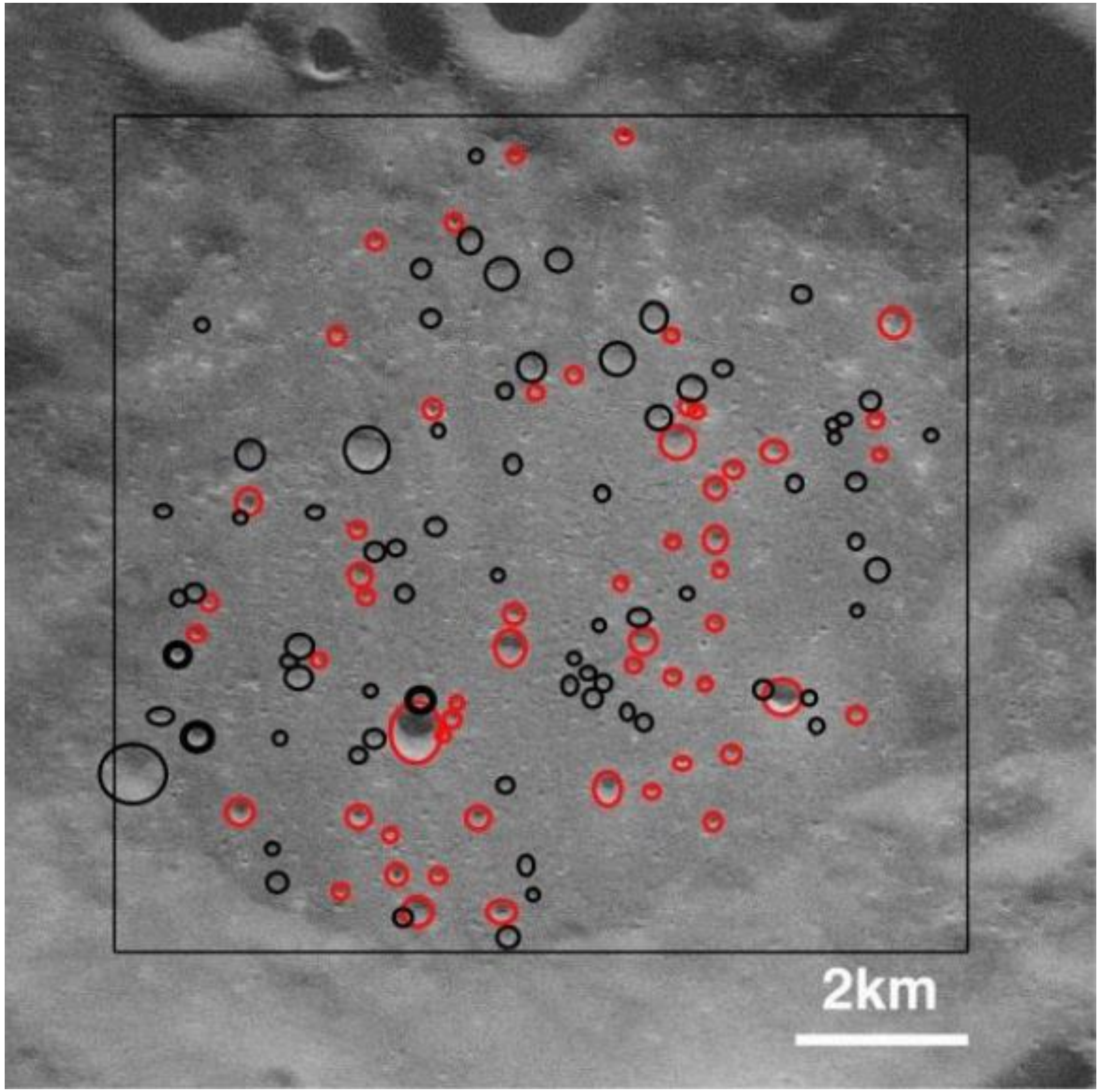


Secondary Craters

Differentiating Primaries from Secondaries

Telling the difference with the naked eye is difficult

- Primaries are in black
- Secondaries are in red
  - Proximal vs. Distal



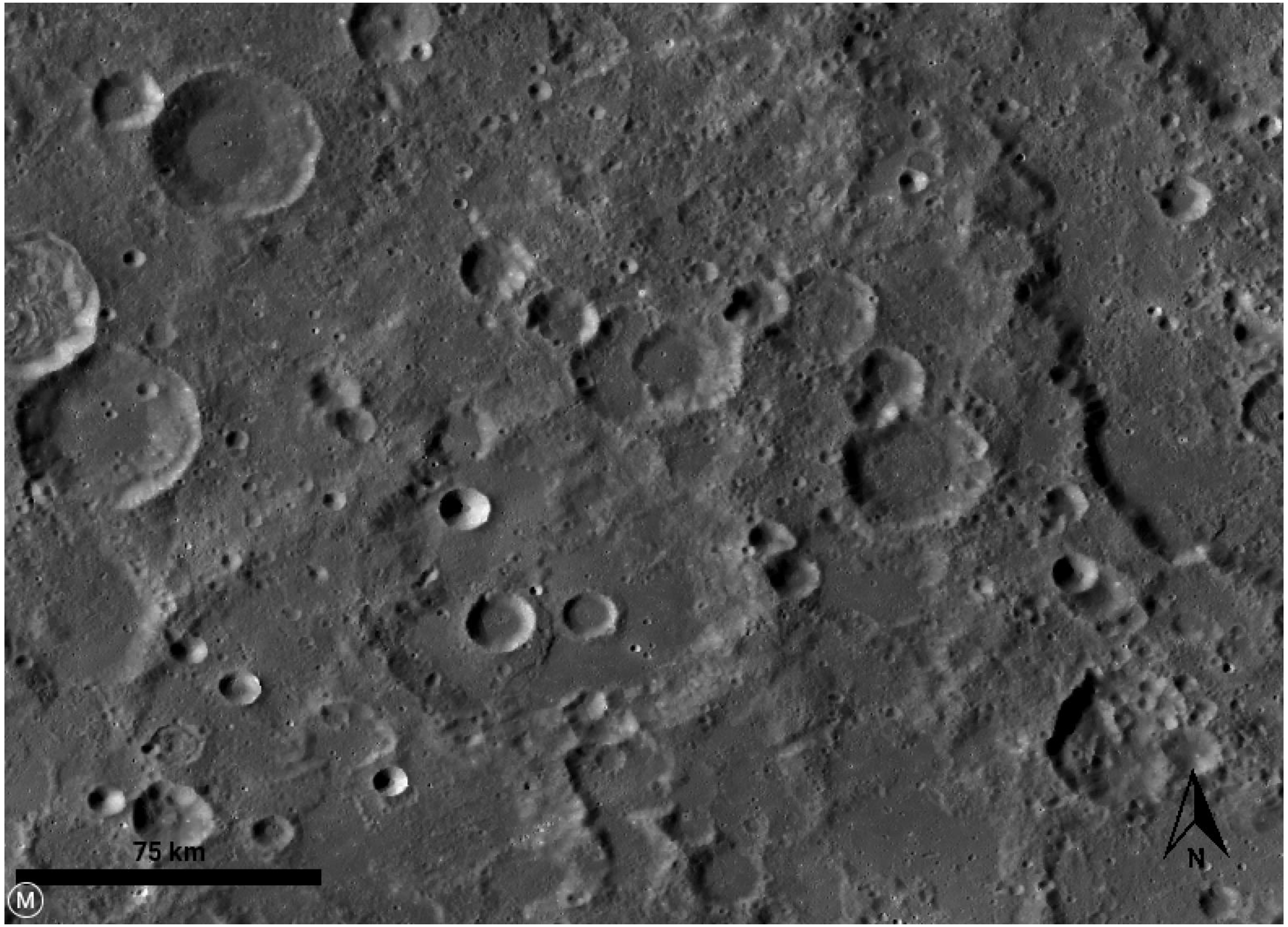
Why do we count craters?

To understand the Solar System, we must understand Impact Cratering.

- impact cratering = the most common geologic process in the solar system (formation of craters)
- Primary crater counts are used to determine the age, origin, and history of celestial bodies.

Contaminating the Count

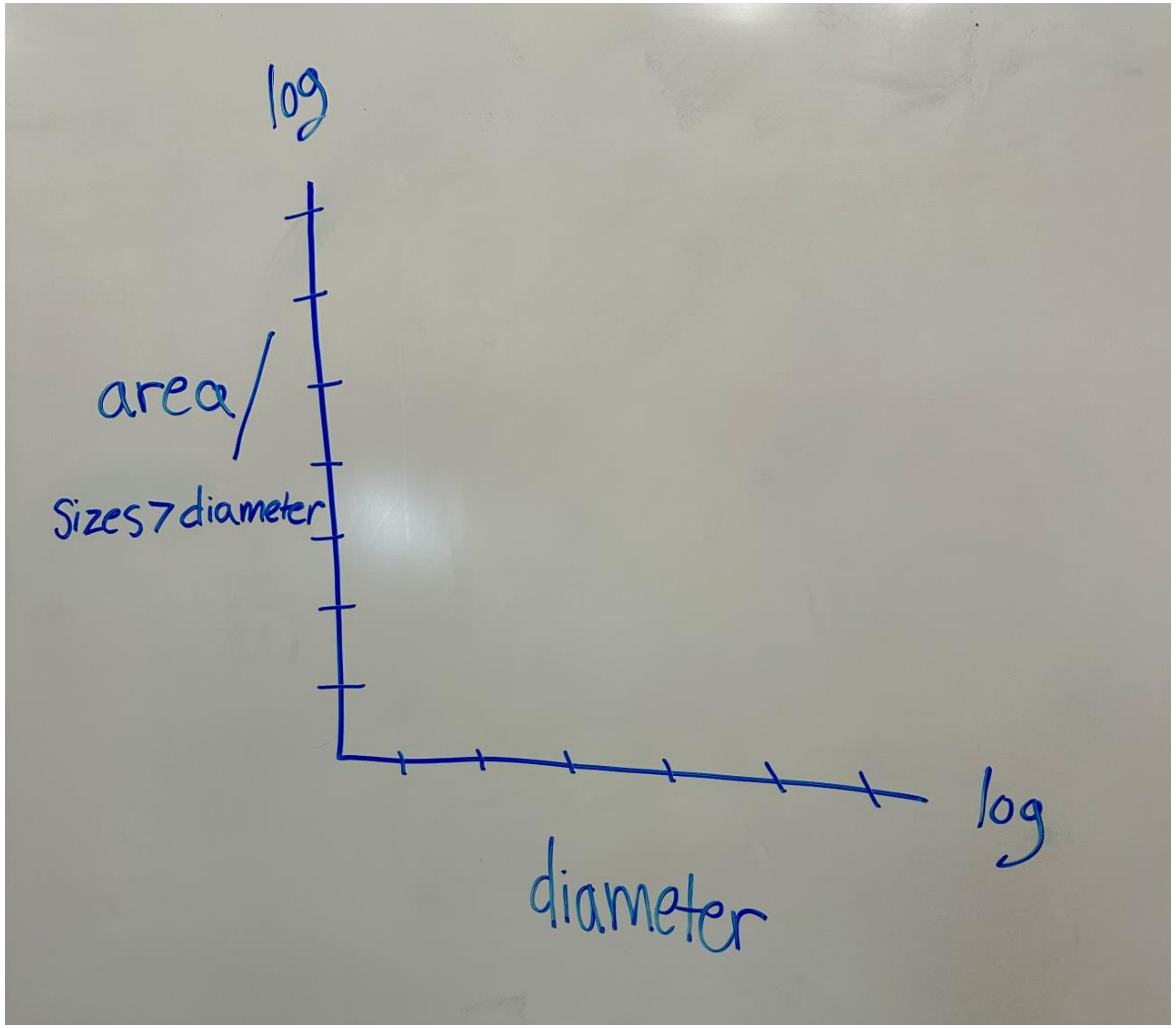
- ➢ Craters stack on top of each other as time passes and more and more collisions happen.
- ✓ many primary craters = older surface
- ➢ Secondary craters make a surface look a lot older than it is



Size Frequency Distributions

Our Focus:
Size Frequency Distributions

- **What is an SFD?**
  - how frequent craters of a certain size appear in a specific area
  - shown through a histogram of crater diameters



Our Goal

Crater counts vary from person to person.

We are creating a reproducible way
to categorize craters.

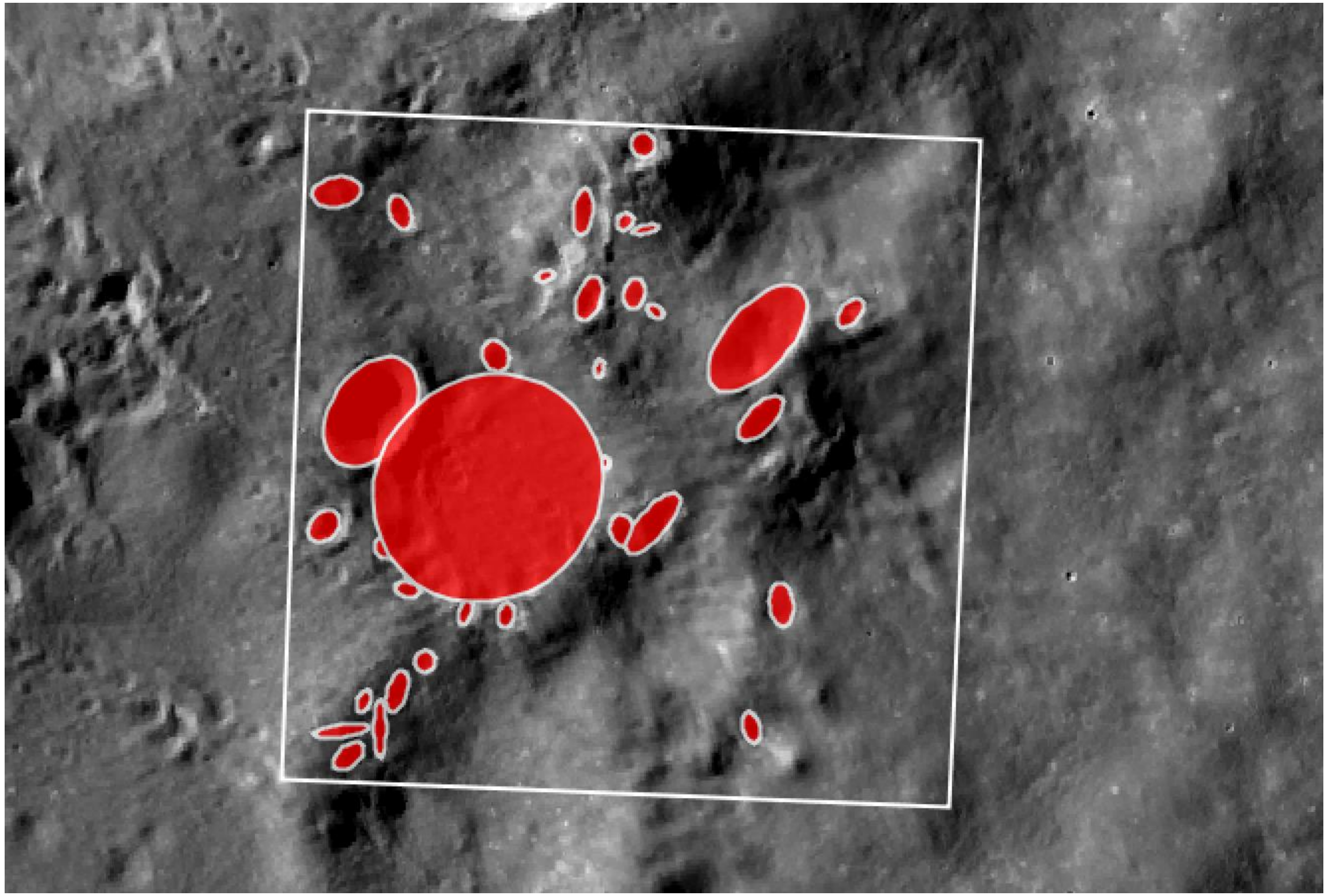
- automatically extract data to leave a transparent record of how a human investigator makes a classification
    - a program that semi-automatically analyzes input crater data

- The benefit of seeing the decision process of the classification
    - can be reproduced and done again
    - consistency

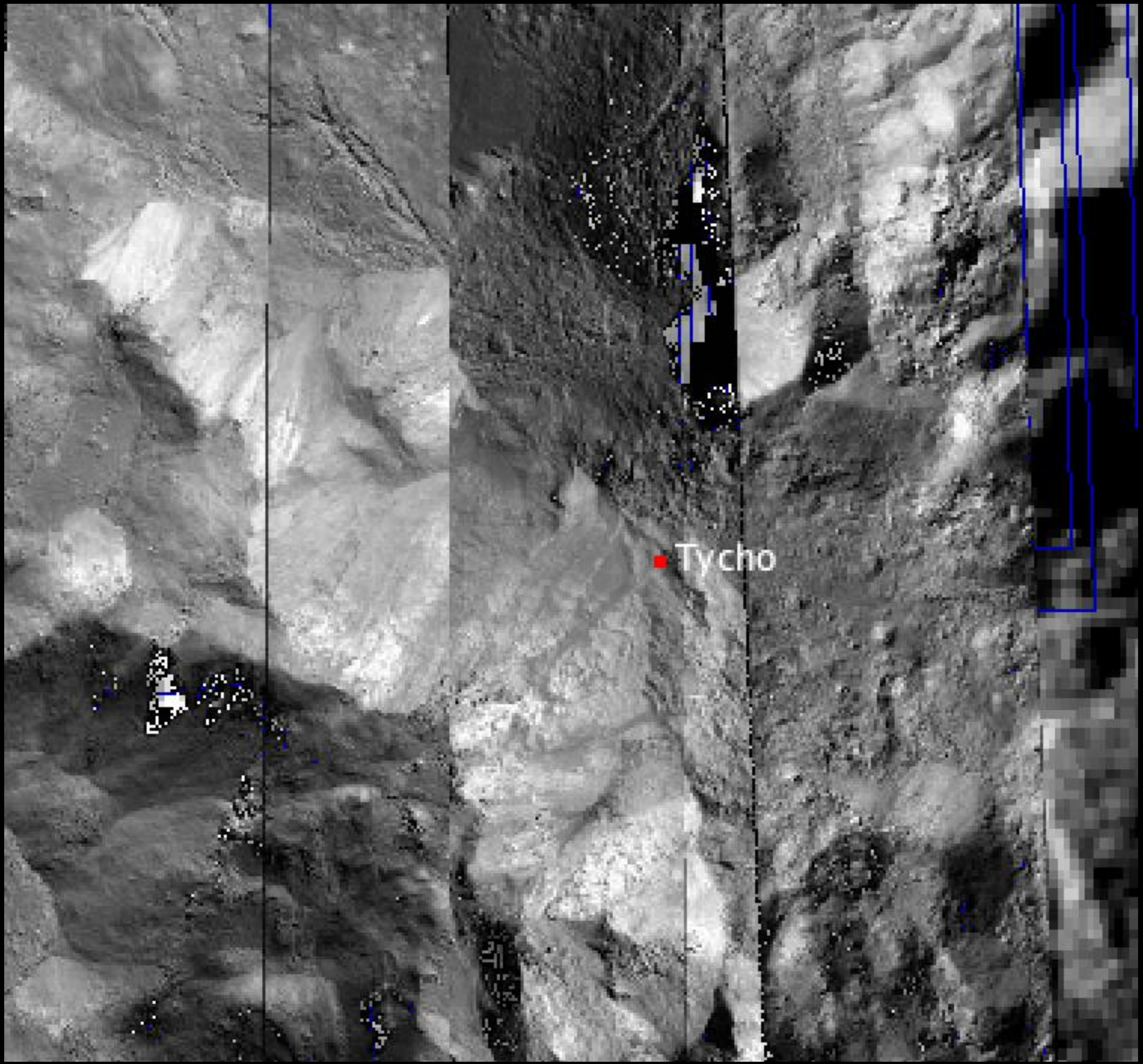
How We Count Craters: JMARS

What is JMARS?

- JMARS is a geospatial information system that utilizes the **Lunar Reconnaissance Orbiter Camera** (LROC)
- We needed a set of data to test our code on. How did we get it?
- This Is what we use to count craters and to retrieve our crater data




Tycho
100 meters/pixel



0.5 meters/pixel

Our SFD Code

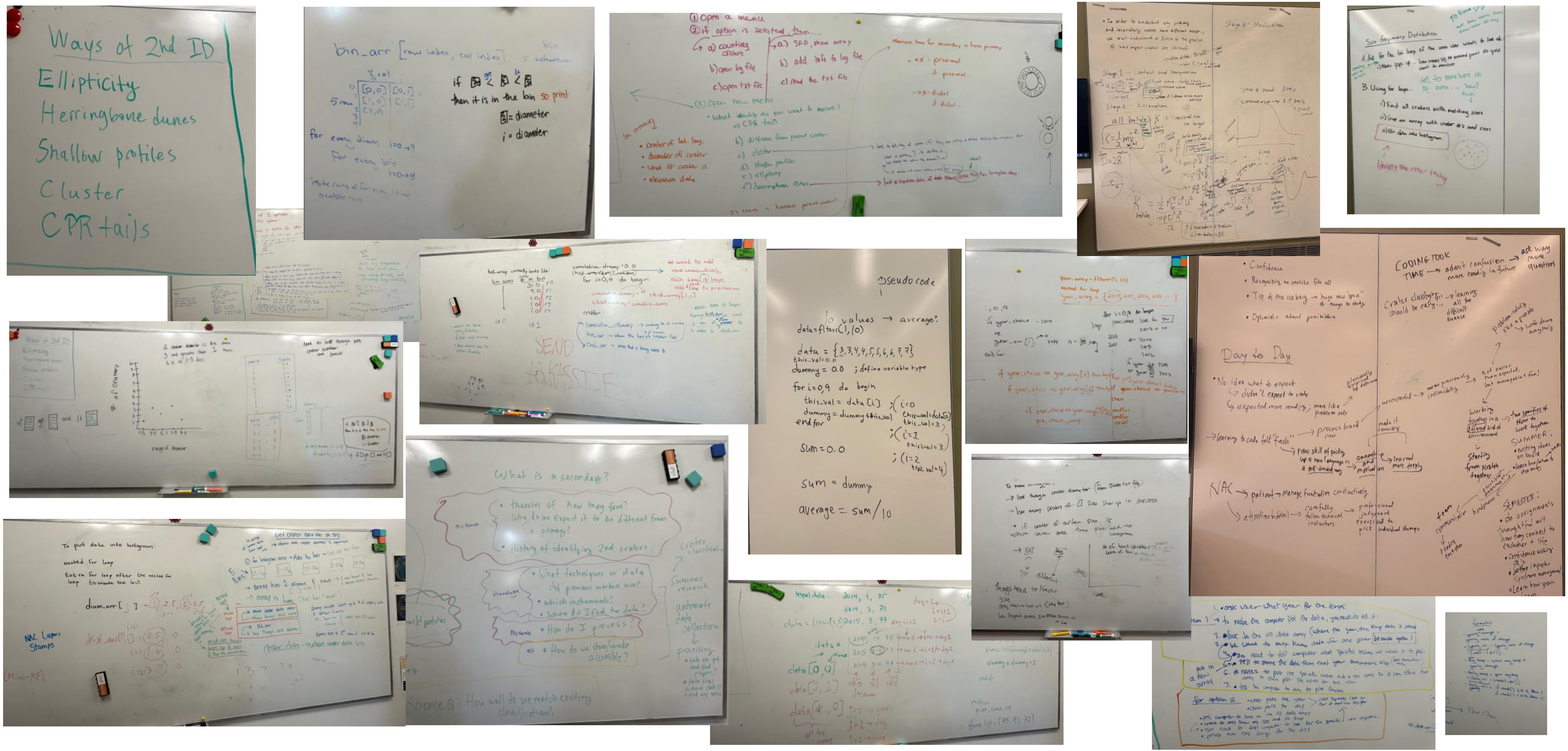
- We combed through a range of crater diameters and created a cumulative histogram based on them, a.k.a. our SFD
- We created the histogram from an array of crater data that we collected from JMARS

```
; ********* Make a histogram/SFD **********

  if menu eq 3 then begin

    print,''
    print,'Beginning histogram or SFD analysis.'
    print,''

; defining the maximum diameter and the minimum diameter within the data
max_d = 0.0
min_d = 0.0

max_d = diam_arr[1] ; seed dummy diameter to start the min search - where dummy diameter starts
min_d = diam_arr[1] ; seed dummy diameter to start the max search


; setting min and max bins
for i=0,n-1 do begin
  if diam_arr[i] le min_d then min_d = diam_arr[i]
  if diam_arr[i] ge max_d then max_d = diam_arr[i]
endfor


; sfd_arr = [[0.5, 0.0],[1.0,0.0],[1.5,0.0],[2.0,0.0],[2.5,0.0]]

; to know how many lines are in the craterdata file - minus one to exclude the titles
nlines = file_lines(craterdata) - 1
```

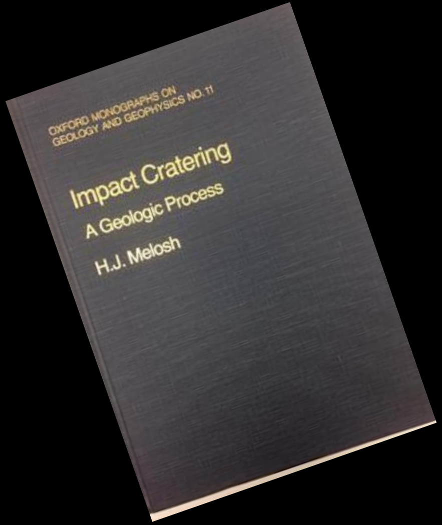
The Future of Our Code

- Make more user friendly
  - more options for user inputs
- Our SFD + Annalyse's contributions
- Recording data
- Publish

Reflection


Ways of 2nd ID
Ellipticity
Herringbone dunes
Shallow profiles
Cluster
CPR tails
Open a menu
Pseudo code
sum = dummy
average = sum/10
What is a secondary?
Day to Day
CODING TOOK TIME

Thanks :)



JMARS

IDL

NASA

LUNAR RECONNAISSANCE ORBITER CAMERA
LROC
MSSS
ASU
Scientia facultas explorationis
Exploratio facultas scientiae

NV5 GEOSPATIAL

Acknowledgments

We gratefully acknowledge the JMARS software and associated PDS data products, without which this work would not have been possible. This work was supported by a NASA RIA Grant (80NSSC24K0779).

References

[1] Robbins, S. J., et al., (2014), The variability of crater identification among expert and community crater analysts, *Icarus, 234*, 109-131.
[2] Martin-Wells, K. S., (2013), Radar Polarization Properties And Lunar Secondary Cratering, 1-58. Retrieved from https://ecommons.cornell.edu/items/36e28893-912f-4e11-a4f1-98987d0ba6e4.
[3] Christensen, P. R., et al., (2009), JMARS – A Planetary GIS. In: *American Geophysical Union Conference,* Abstract IN22A-06.
[4] Robbins, S. J., (2019), A New Global Database of Lunar Impact Craters >1–2 km: 1. Crater Locations and Sizes, Comparisons With Published Databases, and Global Analysis, *J. Geophys. Res., 124,* 871-892.