A Proposed Geotechnical GIS for Lunar Exploration

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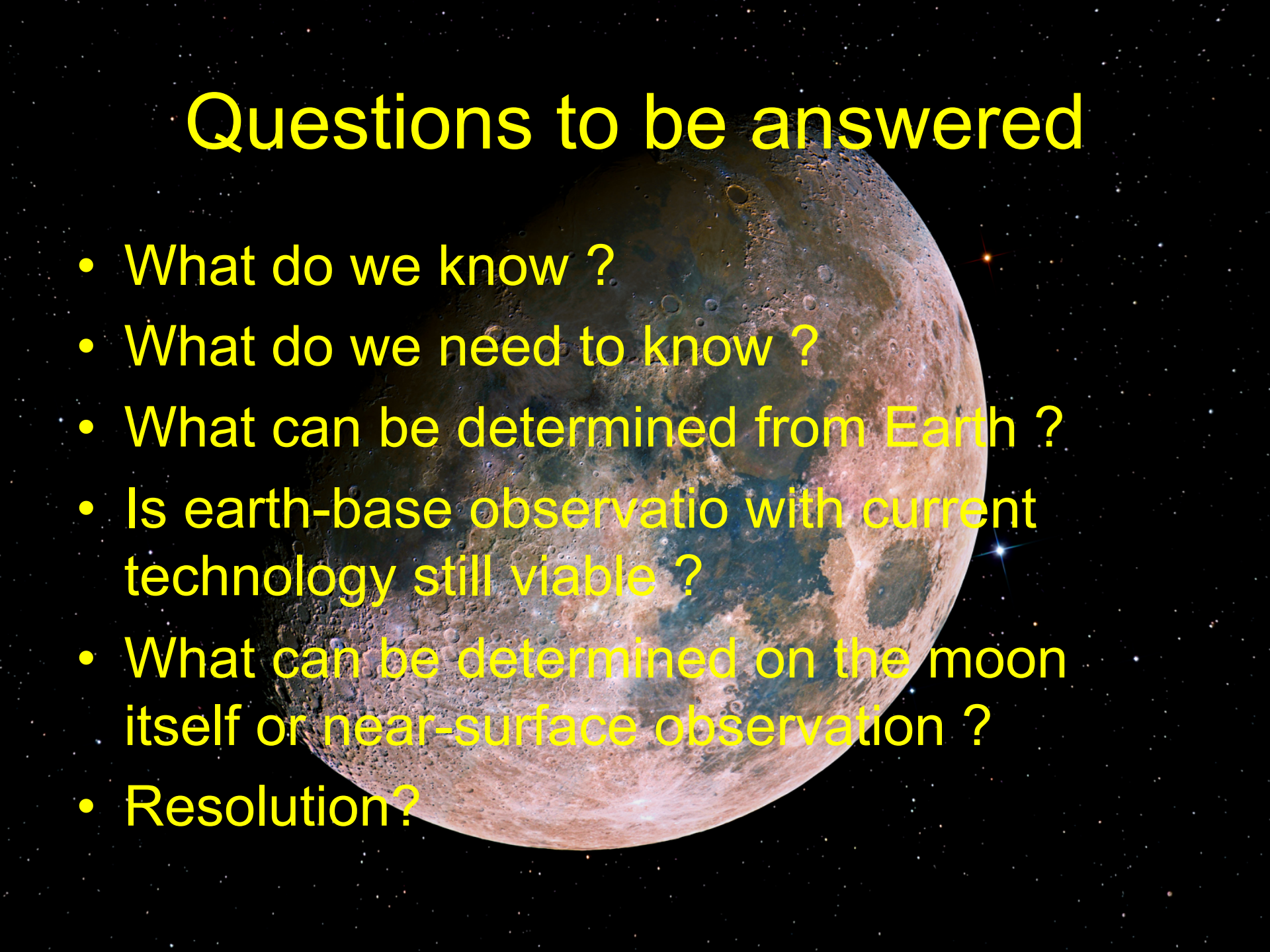
Questions to be answered



- What do we know ?
- What do we need to know ?
- What can be determined from Earth ?
- Is earth-base observatio with current technology still viable ?
- What can be determined on the moon itself or near-surface observation ?
- Resolution?

Principles of GIS

- Different layers of data
- Mostly “intelligent” data (each polygon contains several attributes with values)
- Raster images
- “Intelligent” Raster iamges (each square contains values for attributes)
- Stack, merge, union data sets
- Cell based statistics / surface analysis
- Pose “questions” to datasets (Boolean, etc)

Geotechnical properties

Earth analogy for geotechnical properties:

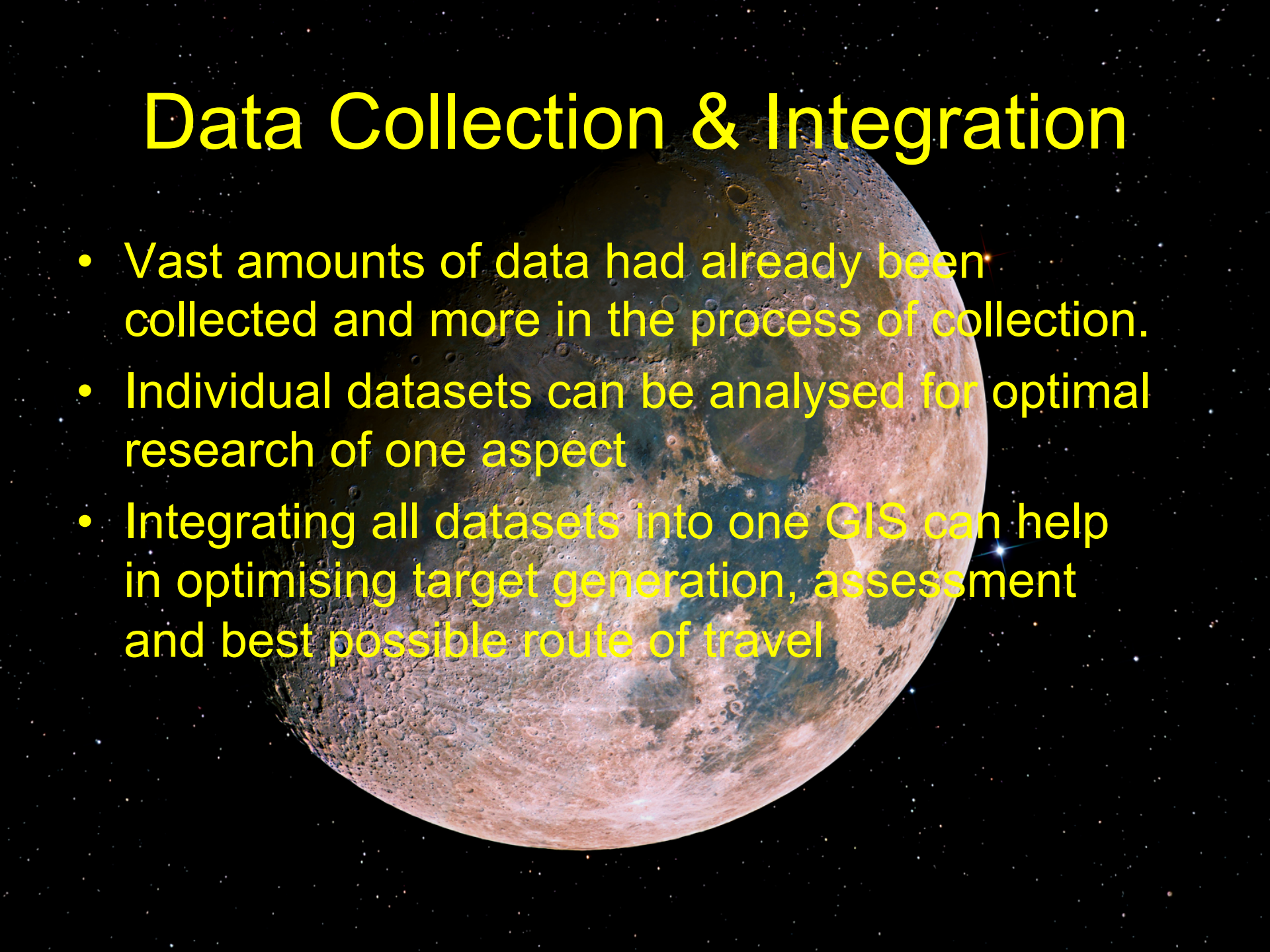
With the same geology, the same landform (eg. Gulley head, side slope) and the same climate /environment will typically lead to similar geotechnical properties

Is this true for the moon?

Spatial Analysis

- A key benefit of GIS is the ability to apply spatial operations to data to derive new information
- Identify spatial relationships
- Find suitable locations
- Calculate travel cost
- Work with all cell-based GIS data
- No Data – special situation as 0 is not nothing

Data Collection & Integration



- Vast amounts of data had already been collected and more in the process of collection.
- Individual datasets can be analysed for optimal research of one aspect
- Integrating all datasets into one GIS can help in optimising target generation, assessment and best possible route of travel

Lunar Geotech experiments

- Stem auger
- Problem with equipment (David Scott)
- Rock samples
- Bearing capacity (depth of LEM footpads)
- Mobility – photos, walking, Lunar Rover
- LRO
- Kayuga
- Selene television data
- Chandraan
- Chang,-e1, LRO, Chang-e2, Chandraan2

Envisaged data Layers

- Surface roughness (Boulder size, Ray areas, etc)
- Geology
- Geotechnical properties
- Perpetual shadow ice ?
- Slope angle
- Slope aspect
- Mineralogy
- He3 abundance … He3 Who should not be mentioned!!
- Manoeuverability
- Fuel/energy cost
- etc

Existing data

- slope angle: (LOLA, LROC),
- slope aspect: (LOLA),
- geology: (USGS, LRO),
- excavatibility: (Apollo, MiniRF, Diviner),
- sun/shadow areas: (LROC),
- topography: (LOLA, LROC),
- surface roughness: (LOLA, Diviner),
- soil density: (Diviner, MiniRF),
- bearing capacity: (Diviner, Apollo, MiniRF),
- etc.

Habitation

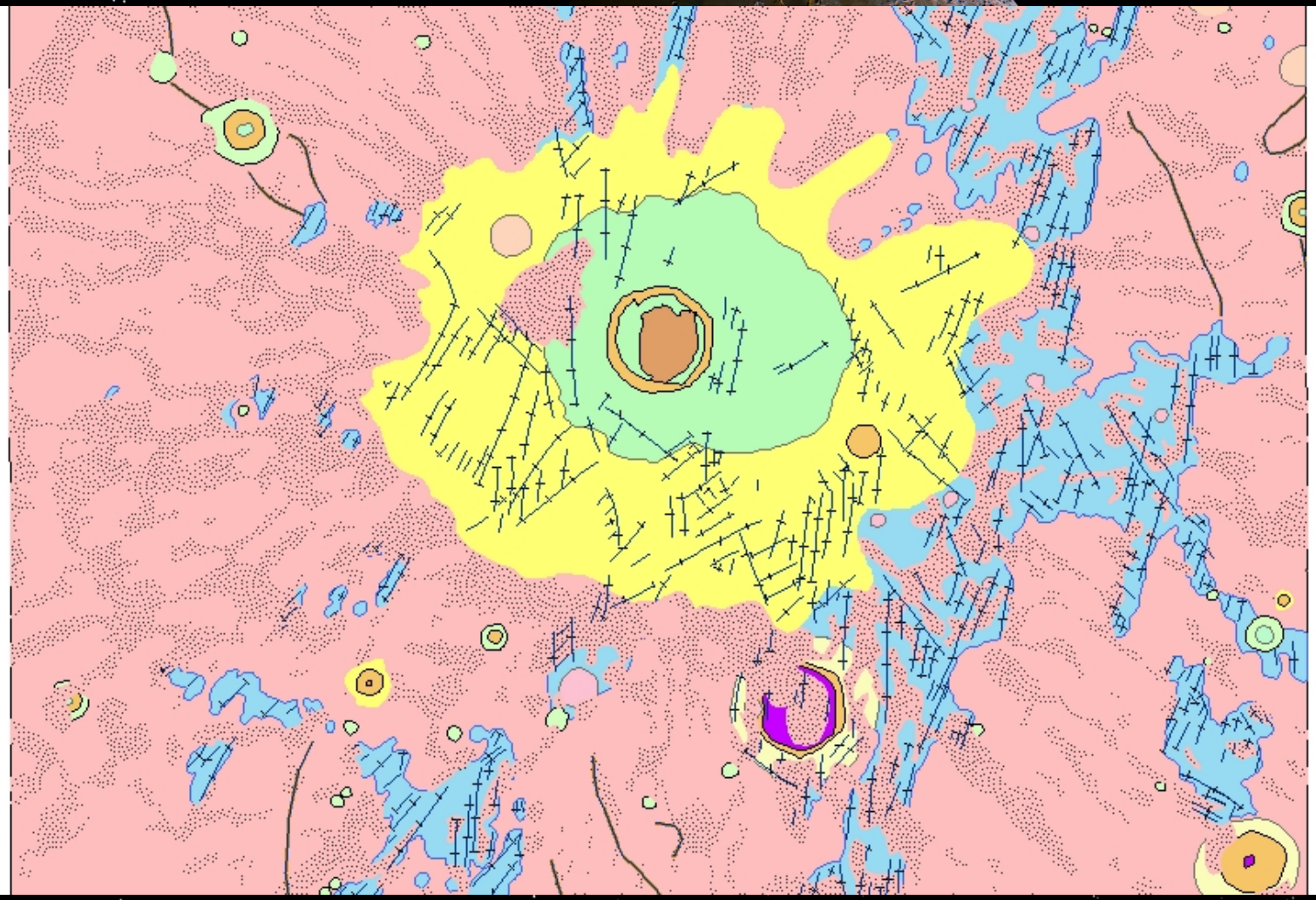
- Excavatibility
- Bearing capacity
- Air tightness
- Construction materials
- Materials needed from Earth
- Lunar fabricated materials – 3D print/ sintering/…
- Distance/Fuel/cost of delivery
- etc

Assumptions

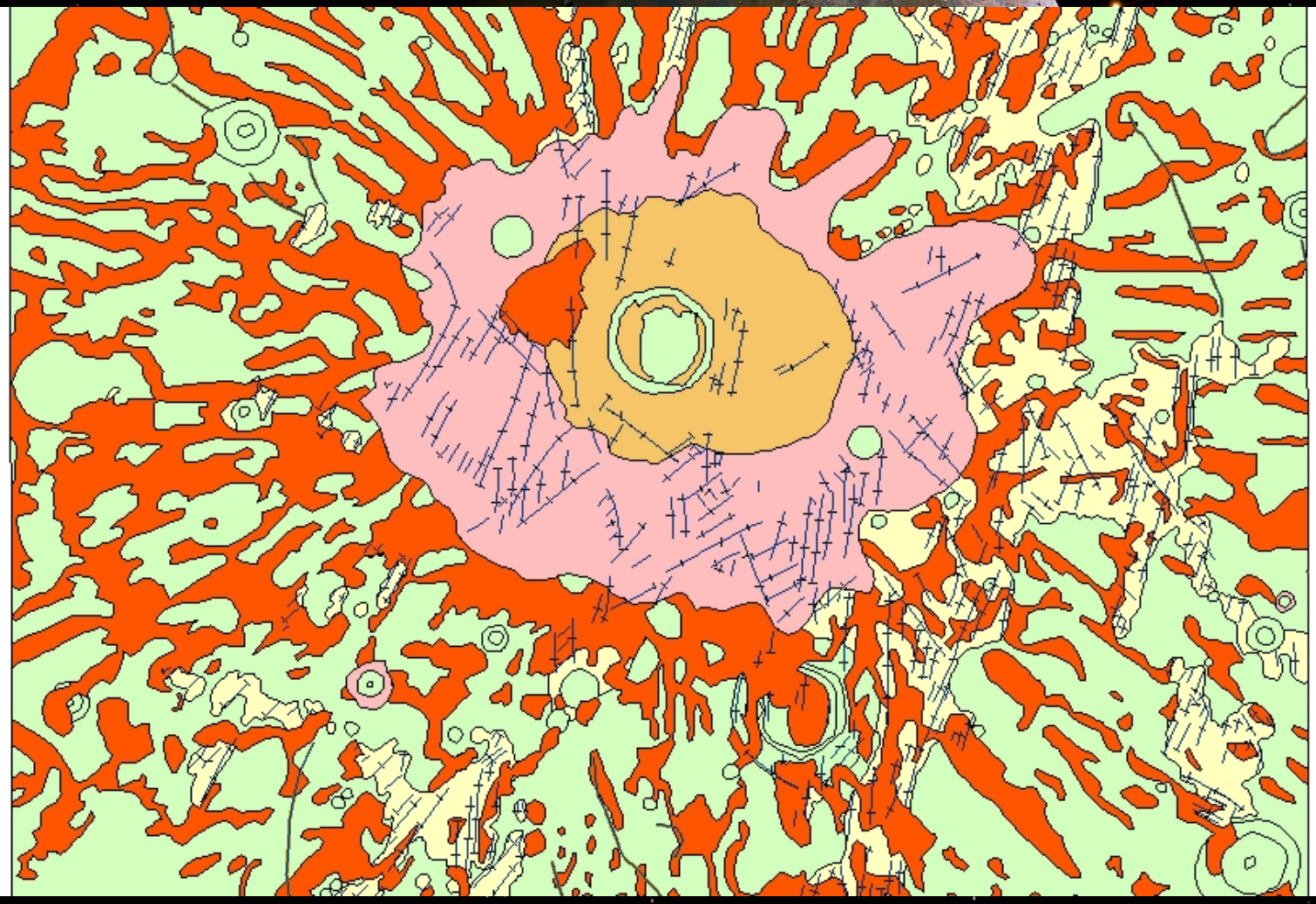
…never assume as it makes and ass out of U and me…

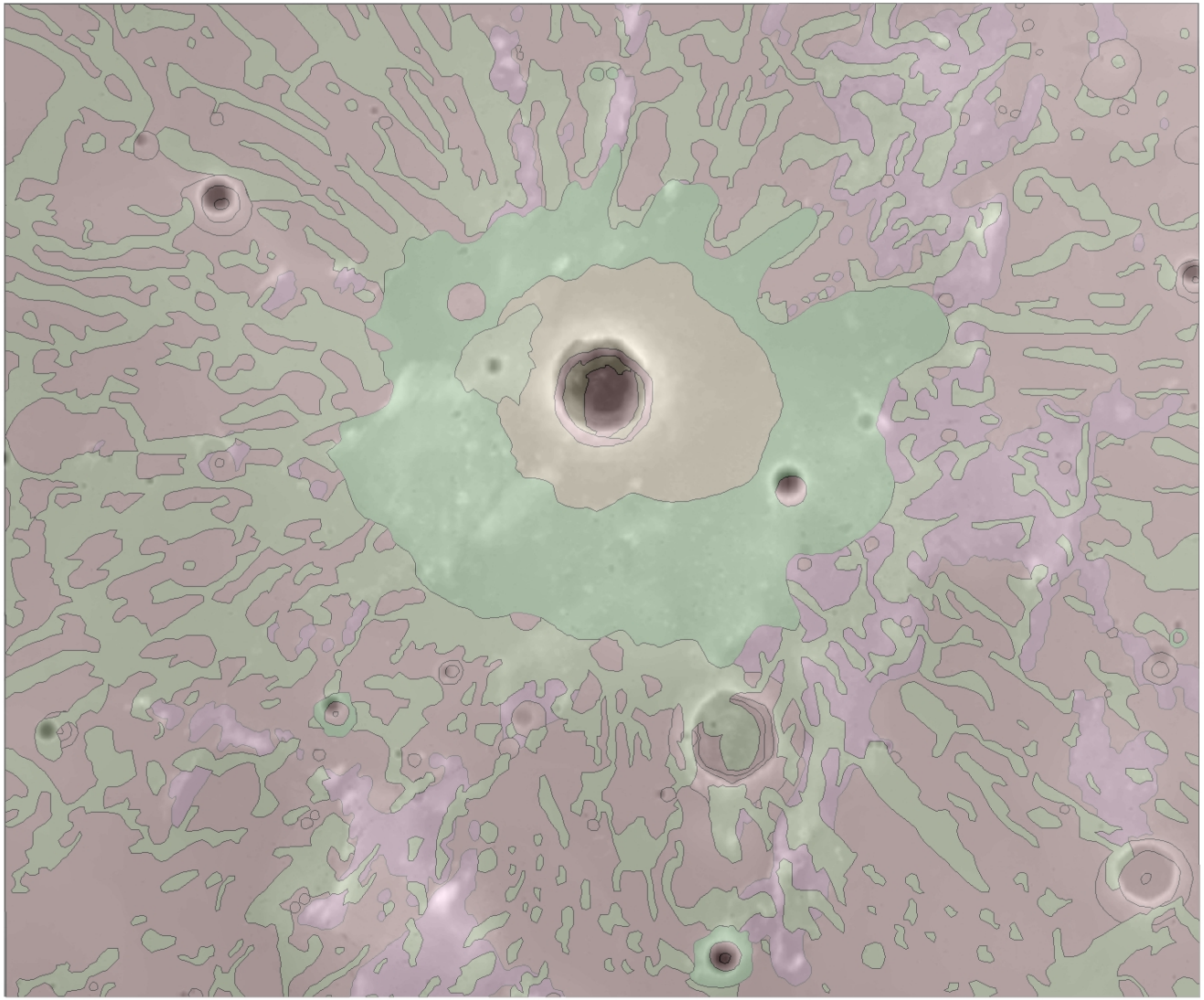
..OK, let me be an ass… ;-)

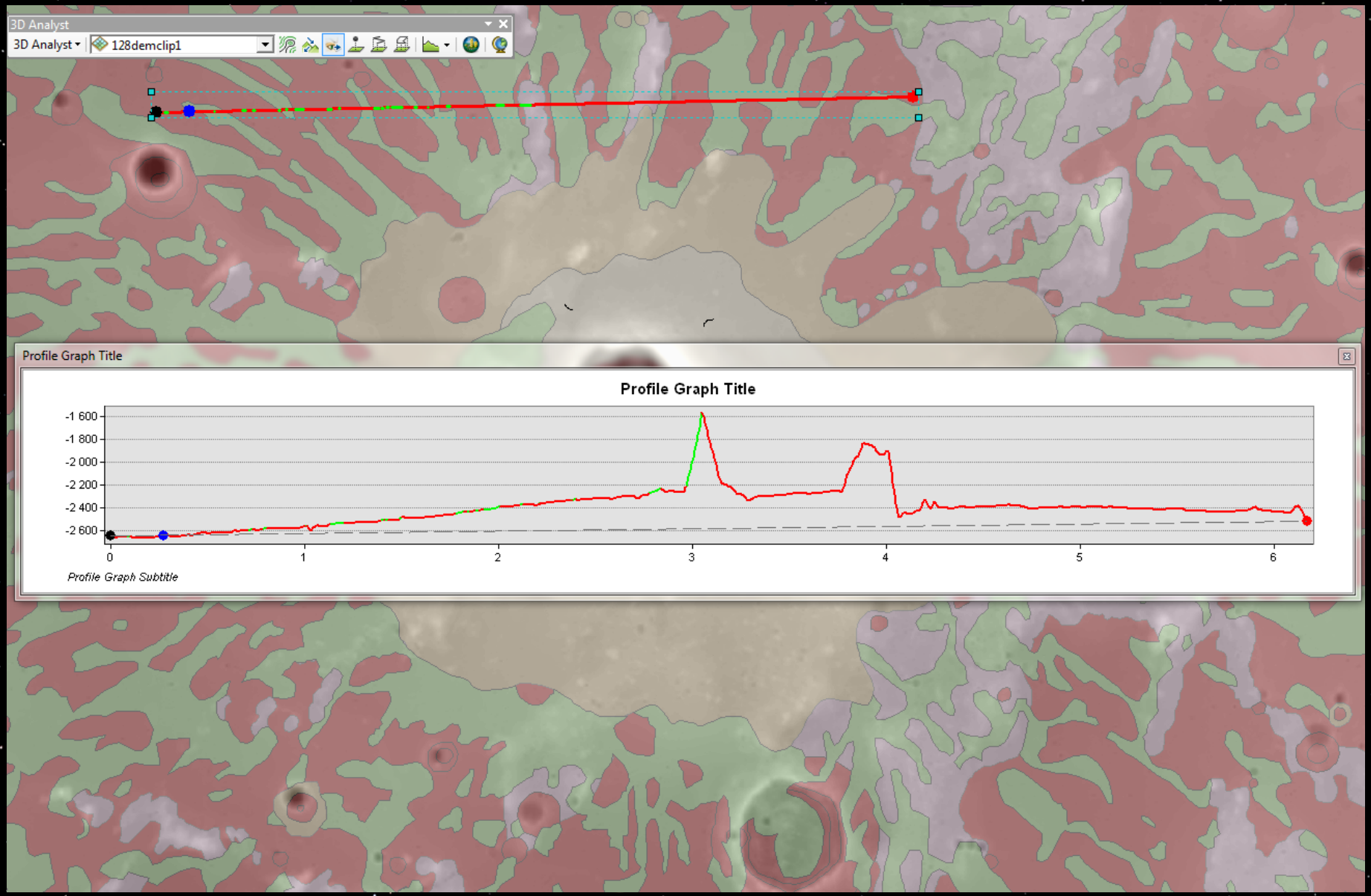
Geology



Surface Roughness (based on geological formation)



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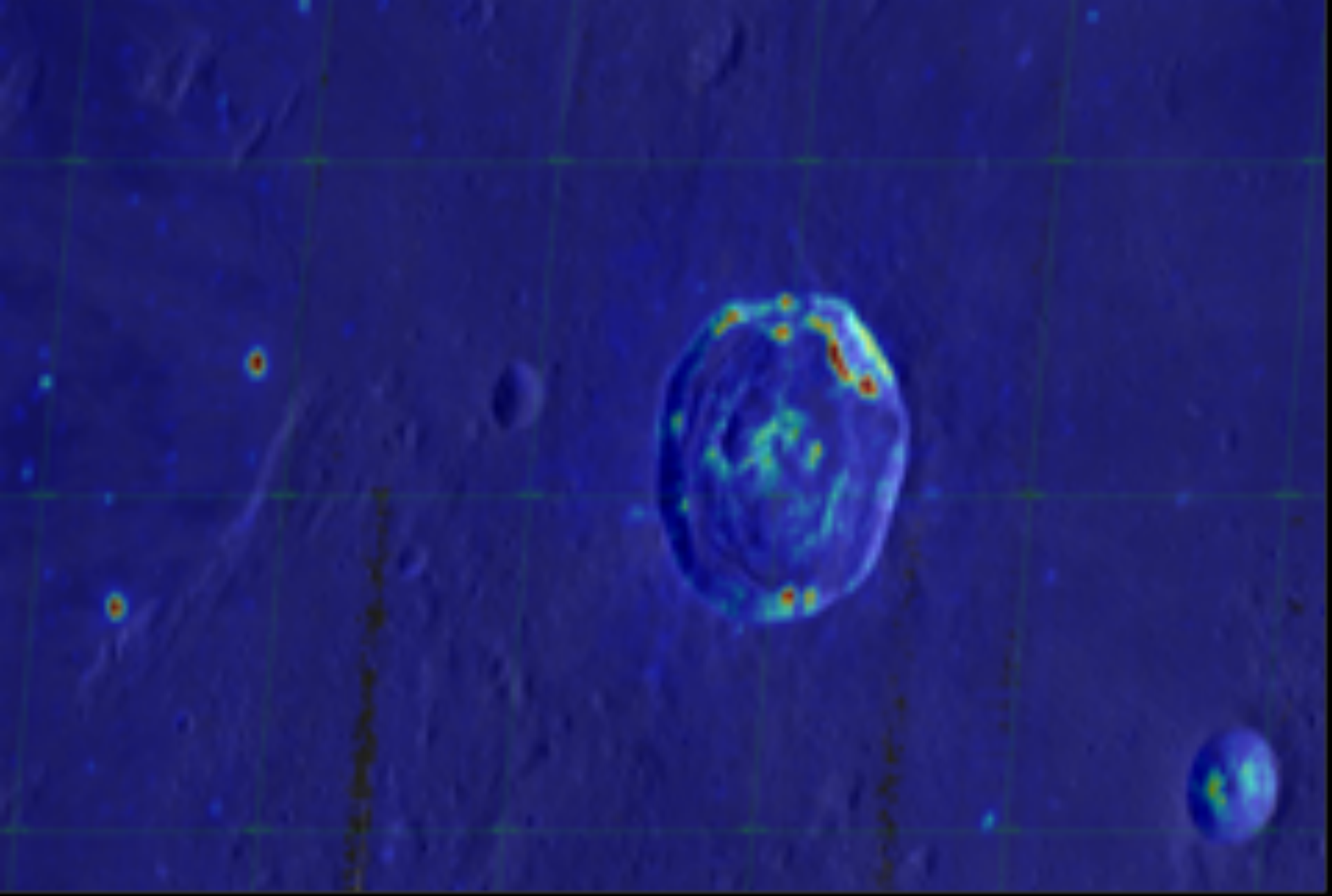

GIS as Decision Making Tool

- Use of these data layers in combination or separately and posing different questions could help in the finding of new resources such as water-ice.
- Generate exploration zones (EZ) automatically with limited human input.
- Rank EZ in order of importance, distance, etc

GIS as Decision Making Tool (contd.)

- In essence a manoeuvrability map will be the end result but also it would constitute a decision making tool determining the least-cost path once a mission objective is decided upon.
- This should be augmented from onboard visual instrumentation for on-the-spot-decision making in travel path

THANK YOU