A Method for Studying Planetary Stratigraphy using ArcMap

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For Christ and His Kingdom

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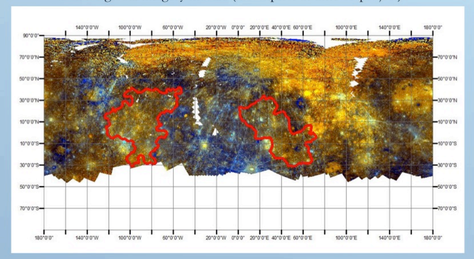
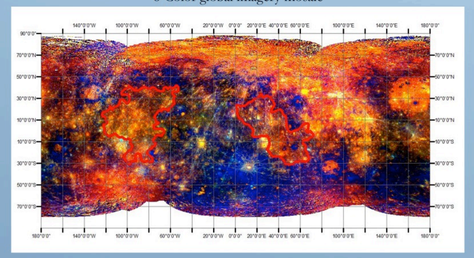
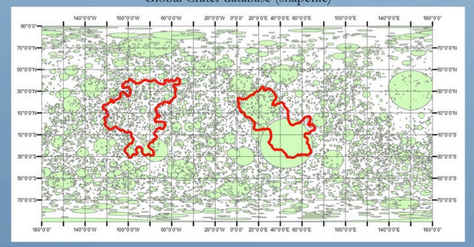
3-Color global imagery mosaic (incomplete at time of project)



8-Color global imagery mosaic



Global Crater database (shapefile)



Introduction:

- A GIS class project
- Use ArcMap to interpret the subsurface stratigraphy of Mercury
- Apply methods of Ernst et al. 2010 using craters as windows to the subsurface

Background:

- Impact craters expose subsurface layers (Ernst 2010
- Larger diameter craters (20-40km) can excavate or expose deeper units
- Three main stratigraphic units on Mercury: Crust, Low Reflectance Material (LRM), Red material (RM)
- Maximum excavation and melting depths can estimate the depth to material

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Dr. Carolyn Ernst
-JHAPL

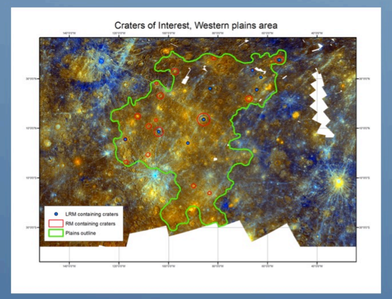
Data:

- Global MESSENGER imagery of Mercury and crater database provided by JHAPL
- 3-Color mosaic used
- Different reflectances can represent different lithologies
  - Blue (LRM)
  - Red (RM)
  - Brown (Crust)
  - Grey/Light blue (ejecta)
- Two intercrater plains chosen for this study

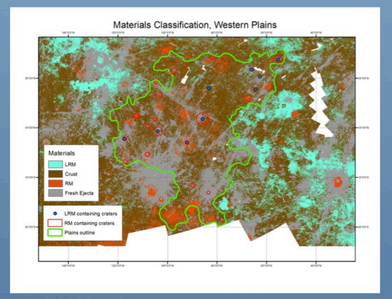
Classifying the imagery:

- Set stretch and statistic settings for proper false color
- Maximum likelihood supervised classification (5 training samples for each of 4 material categories)
- Choose craters of interest which expose materials of interest
- Confirms visual inspection

Craters of Interest, Western plains area



Materials Classification, Western Plains



Calculations:

- Given crater diameter (known from JHAPL Mercury crater database shapefile): we calculate the transient crater diameter (Dtc) for craters of interest
  - Assuming planet dependent constants (surface gravitation, speed of impact, density of impactor and crustal rocks)
- Dtc used to estimate the crater excavation depth
- To calculate max melting depth, we use a high order polynomial fit (provided by Dr. Ernst) to summarize the necessary impact calculations: including quantities like entropy, energy, and pressure

Measured Diameter (Shapefile) → Transient Crater Diameter (Dtc) → Approximate Excavation Depth → High order polyfit: approximate melting depth → If material in ejecta: use approx depth / If material in central uplift: use polyfit depth → Use appropriate depths to interpolate between craters

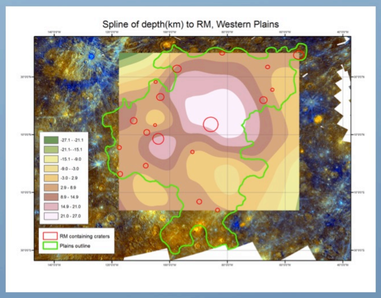
Interpolation of estimated depth surfaces:

- Select depth to material crater to crater
- Use depths to interpolate a surface for each material
- Two methods (built-in tools in spatial analyst)
  - Spline
  - Kriging
- Input: point values
- Outputs surface raster

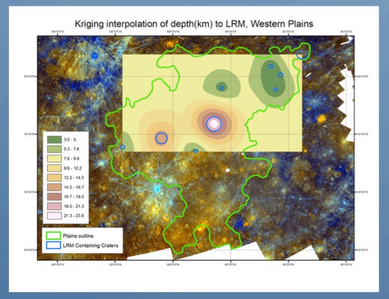
Conclusions:

- Maps that approximates the minimum upper boundary depth for each material with a surface
- These are preliminary results: more processing power and data-points could increase scale and accuracy of this technique

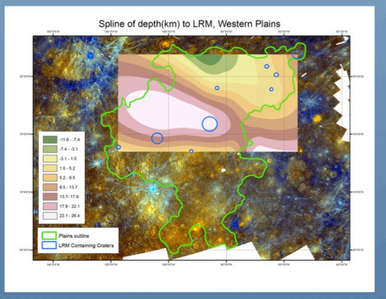
Spline of depth(km) to RM, Western Plains



Kriging interpolation of depth(km) to LRM, Western Plains



Spline of depth(km) to LRM, Western Plains



Kriging interpolation of depth(km) to RM, Western Plains