UNLOCKING MERCURY'S GEOLOGICAL HISTORY WITH DETAILED MAPPING OF REMBRANDT BASIN: YEAR 3. B. M. Hynek[1-2], S. J. Robbins[3], K. Mueller[2], J. Gemperline[1], M. K. Osterloo[1], and R. Thomas[1], [1]Laboratory for Atmospheric and Space Physics & [2] Dept. of Geological Sciences, University of Colorado-Boulder, 3665 Discovery Drive, Boulder, CO 80303, [3]Southwest Research Institute, 1050 Walnut St., Suite 300, Boulder, CO 80302. hynek@lasp.colorado.edu

Introduction: The Rembrandt basin on Mercury was discovered during the second flyby of the MESSENGER spacecraft. At ~715-km-diameter, it is the second largest known well-preserved basin, after the Caloris basin (~1500 km). The large basins on Mercury record a focus of subsequent geological activity, including the interplay between tectonism and volcanism. Rembrandt, in particular, records prolonged compressional and extensional tectonism and multiple volcanic flooding events. The geologic evolution of Rembrandt and surroundings includes late-stage global planetary contraction, as indicated from cross-cutting thrust faults, including the largest identified to date on the planet [1]. Understanding the geological history of Rembrandt basin is thus key to interpreting the geologic evolution of Mercury at regional to global scales. A primary objective of this work is to produce a geologic map of the Rembrandt basin region (15°S, 65°E to 50°S, 110°E) at the 1:2M-scale that will be submitted for peer-review and publication by the USGS.

Scientific Objectives: Four goals for this project are: (1) Delineate the major geologic units in and around Rembrandt basin to infer the history of activity in a time-stratigraphic context. (2) Assess the tectonism in and around the basin, including spatial and temporal associations among the geologic units and tectonic structures. (3) Develop an understanding of how the rheology and stress fields of the lithosphere in this region affected the formation of the tectonic structures. (4) Chronicle the bombardment history of the Rembrandt region to place constraints on the basin-forming event and its subsequent modification, as well as the formation of tectonic structures both related and unrelated to the impact event.

Datasets: Basemaps provided by the USGS include a Messenger Team Global MDIS grayscale mosaic (250 m/pix) and MDIS color mosaic (665 m/pix) [2]. A 1 km/pix DTM exists over the western half of the map area [3] and custom DTMs have been generated based on stereo pairs of NAC images. Additionally, we have spent significant time making controlled mosaics from ~2600 NAC images available in the PDS, filtered by incidence angle (60°-70°; 70°-80°; 80°-90°) to highlight topographic features.

Current Status: Fig. 1 shows the complete draft of our geologic map and unit descriptions. We have delineated 11 distinct non-crater-related geologic units based on morphology, topography, texture, color (spectral information), and other primary characteristics. Units related to Rembrandt basin include several classes of interior plains, hummocky material, rim material, and basin-radial lineated terrain inferred to be ejecta. Exterior units include low and high albedo plains, intermediate terrain, and heavily cratered highlands. 820 individual tectonic structures were mapped, with 89% being contractional features. Large craters (>40km) were mapped as geologic units based on degradation similar to the five-age classification system yielding another three units corresponding to C4, C3, and C2 craters.

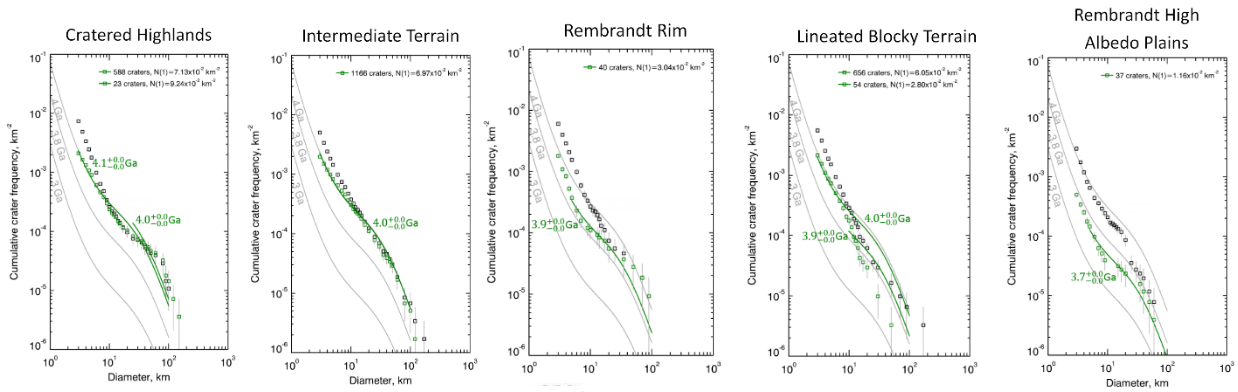
Crater Age-Dating: Additionally, 47,032 craters down to 3-km-diameter have been mapped for unit age determinations (Fig. 1). These have been classified as primary or secondary and superposed vs. pre-dating craters. Absolute ages are based on the primary superposed population. Isochron plots have been completed for all geologic units as a whole and also N(10) ages; all using both the Neukum Production Function [4] and that of Le Feuvre and Wieczorek's porous model [5]. Both systems give similar ages.

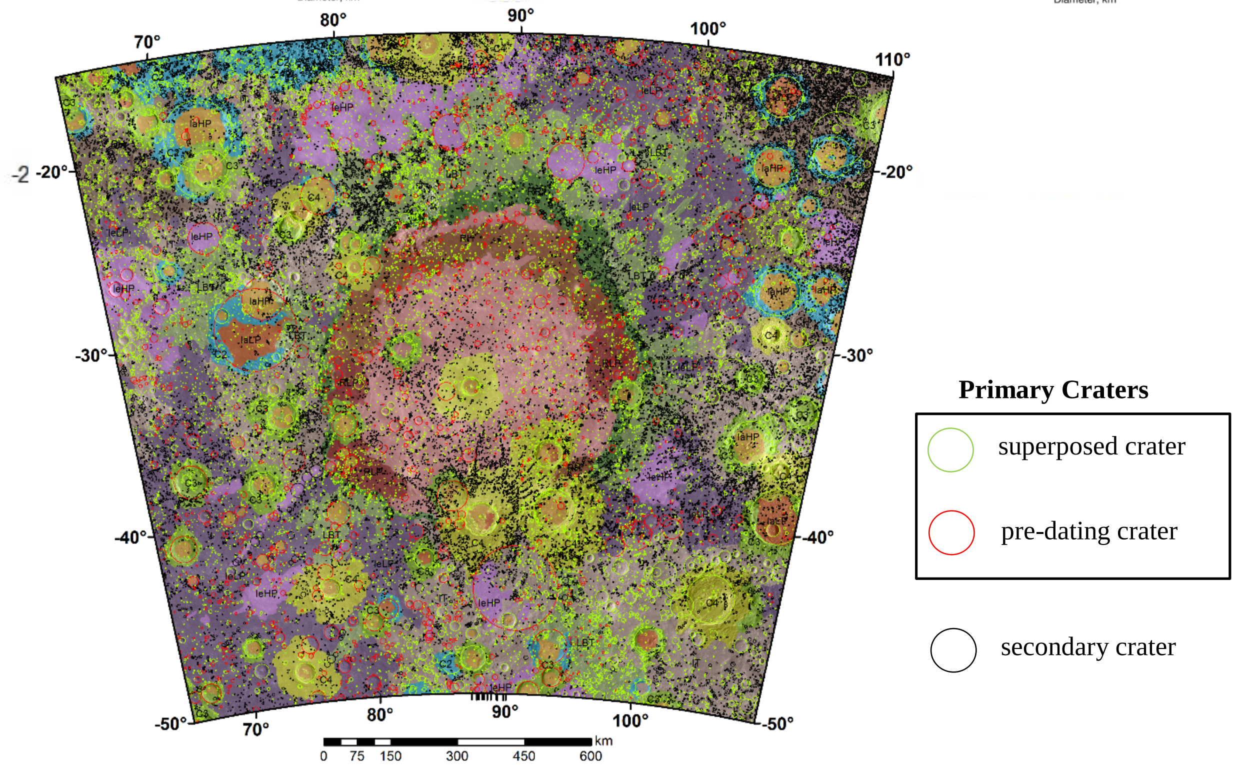
Geologic History: Cratered Highland and Intermediate Terrain are the most ancient features in the map region and record heavy bombardment and unit development until 4.0 Ga. The Rembrandt impact occurred around 3.9 Ga and was coeval with radial Lineated Blocky Terrain and low albedo exterior plains (IeLAP) that may be impact melt. Inferred volcanic plains units were emplaced within and outside of the Rembrandt basin until 3.6 Ga. Several classes of plains units were delineated based on setting (intra- vs. inter-crater) and spectral characteristics. A few depressions inferred to be volcanic vents are present; however, most plains units entirely fill low-lying depressions and source vents are not evident.

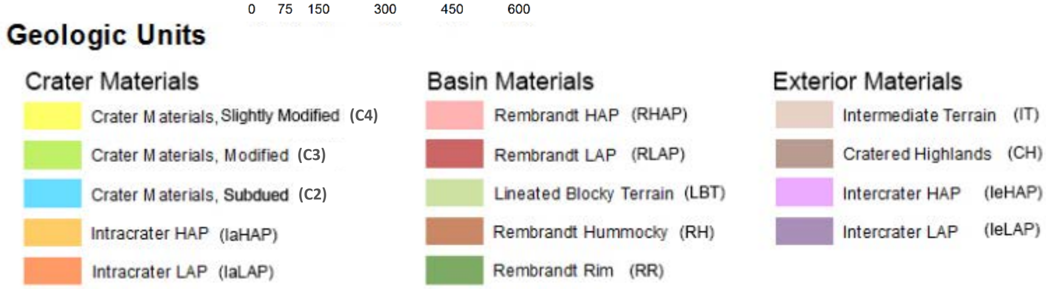
Acknowledgements: Funding for this work came from NASA PGG grant NNX14AP51G.

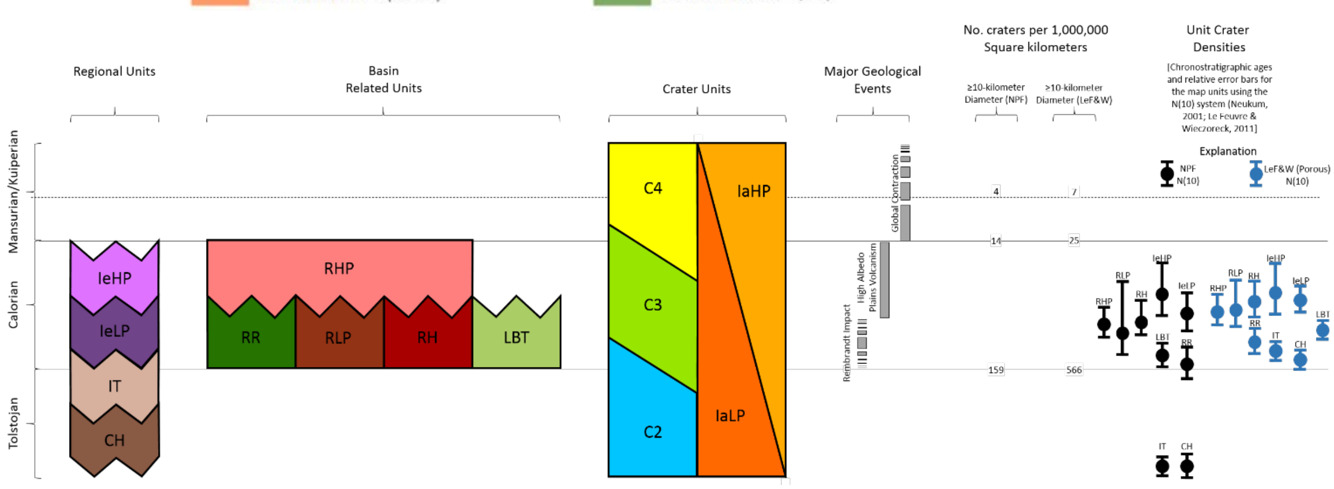
References: [1] Watters, T.R. et al, (2015), GRL, 42, 3755–3763. [2] http://messenger.jhuapl.edu/the_mission/mosaics.html. [3] Preusker, F.J. et al, (2011) PSS, 59, 1910–1917. [4] Neukum, G. et al., (2001) PSS, 49, 1507-1521. [5] Le Feuvre, M. & M.A. Wieczorek, (2011) Icarus, 214, 1-20.

Figure 1 (below): Geologic map, Correlation of Map Units, and representative isochron plots using only superposed primary craters (green) with the Neukum Production Function [4].


Cratered Highlands
Intermediate Terrain
Rembrandt Rim
Lineated Blocky Terrain
Rembrandt High Albedo Plains
Cumulative crater frequency, km^-2
Diameter, km


70°
80°
90°
100°
110°
-20°
-30°
-40°
-50°
0 75 150 300 450 600
km
Primary Craters
superposed crater
pre-dating crater
secondary crater


Geologic Units
Crater Materials
Crater Materials, Slightly Modified (C4)
Crater Materials, Modified (C3)
Crater Materials, Subdued (C2)
Intracrater HAP (IaHAP)
Intracrater LAP (IaLAP)
Basin Materials
Rembrandt HAP (RHAP)
Rembrandt LAP (RLAP)
Lineated Blocky Terrain (LBT)
Rembrandt Hummocky (RH)
Rembrandt Rim (RR)
Exterior Materials
Intermediate Terrain (IT)
Cratered Highlands (CH)
Intercrater HAP (IeHAP)
Intercrater LAP (IeLAP)


Regional Units
Basin Related Units
Crater Units
Major Geological Events
No. craters per 1,000,000 Square kilometers
Unit Crater Densities
Mansurian/Kuiperian
Calorian
Tolstojan
IeHP
IeLP
IT
CH
RHP
RR
RLP
RH
LBT
C4
C3
C2
IaHP
IaLP
Global Contraction
High Albedo Plains Volcanism
Rembrandt Impact
Explanation