DELINEATING RIFT FAULTS ON RADAR IMAGES IN HECATE CHASMA, VENUS. J.R. Graff[1], R.E. Ernst[1,2], C. Samson[1], [1]Department of Earth Sciences, Carleton University, Ottawa, ON, Canada (JamieGraff@cmail.carleton.ca), [2]Ernst Geosciences, Ottawa, ON, Canada.

Introduction: Hecate Chasma is a major rift system within the confines of the Beta-Atla-Themis (BAT) region on Venus [1] [2] [3]. Our study area is located within the coordinates of 240-245^{o}E and 10-15^{o}N, and contains two separate segments of the Hecate Chasma rift system. The identification and mapping of rift systems on Synthetic Aperture Radar (SAR) images has often been mostly concerned with their large-scale appearance. However, close-up small-scale images were still used to focus on their spatial relationship to other tectono-magmatic structures [2] [3]. Individual rift faults are discussed in terms of qualitative characteristics such as their recognition as parallel and dense packing of extensional structures [2] [3] [4].

In this present analysis, methods for accurate identification of rift faults, in addition to distinguishing them from radar-bright lineaments that define associated graben-fissure systems are addressed in greater detail. We propose two quantitative *rift-distinguishing criteria* based on systematic difference between the thickness and sinuosity of radar-bright lineaments representing rift faults from those associated with graben fissures. Lineament thickness corresponds to the depth of the trough along one side of a rift fault or of a graben fissure wall, and corresponds to the magnitude of fault displacement. The calculation of sinuosity (the ratio of total lineament length relative to its end-to-end length) captures departure from a linear trend. To validate our approach, we also look into similar representative rifting along the East African Rift System (EARS), as a terrestrial analogue for rifts on Venus. All basemaps were obtained from the Magellan mission radar images [5] and Google Earth landsat imagery [6].

Mapping Methodology: Both rift faults and graben fissures can often appear very similar on SAR images by their radar-bright signatures as geological lineaments, however, qualitative and quantitative methods are available to distinguish between these two features. The presence of large rift zones along the Hecate Chasma was initially inferred by the occurence of more densely packed and thicker radar-bright lineaments [3,4], following an irregular E-W trend along the mid-western part of the study area. This was further supported through the use of radar altimetry data, indicating the presence of both topographic lows and steeper slopes in these areas.

Mapping Graben Fissures. In SAR images, graben-fissures appear as thin sets of radar-bright lineaments, with their geometry dependent on the radar looking direction of the imaging satellite relative to the structure.

Mapping Rift Faults. Using tools available through ArcMap's ArcToolbox function (such as 'hillshade relief', raster 'reclassify', and 'weighted sum' [7]), we were able to combine attributes from topography and slope data (zones of topographic lows and relatively steeper slopes) to automatically generate a map highlighting all areas of candidacy for rift system locations within the BAT region (Figure 1). We have also mapped a summary of rift fault sets (RFS) and graben-fissure systems (GF) along the Hecate Chasma on SAR images (Figure 2).

Terrestrial Analogues. To further support the proposal of *rift-distinguishing criteria*, rift faults and mafic dykes along the EARS have also been mapped using Google Earth (Figure 3).

Results: Performing this analysis involved measuring and calculating quantitative characteristics of over 80 geological lineaments from a combination of both Venusian and terrestrial rift faults and graben fissures/mafic dykes (MD). As shown in Table 1, the average values for thickness and sinuosity of rift faults and sinuosity for graben fissures/mafic dykes exhibit clear differences. On Venus, rift faults display both larger thicknesses and sinuosity than graben fissures. This result remains consistent with the observation on Earth – from the EARS – that rift faults display greater sinuosity than mafic dykes.

	Venus	**Earth**
Image Type	SAR	Landsat
Image Resolution	75-100 m/pixel	10-15 m/pixel
Thickness – RFS	896 +/- 263 m	356 +/- 288 m
Sinuosity – GF/MD	1.015 +/- 0.009	1.015 +/- 0.006
Sinuosity – RFS	1.057 +/- 0.032	1.117 +/- 0.133

Table 1: Characteristics of rift faults and graben-fissures.

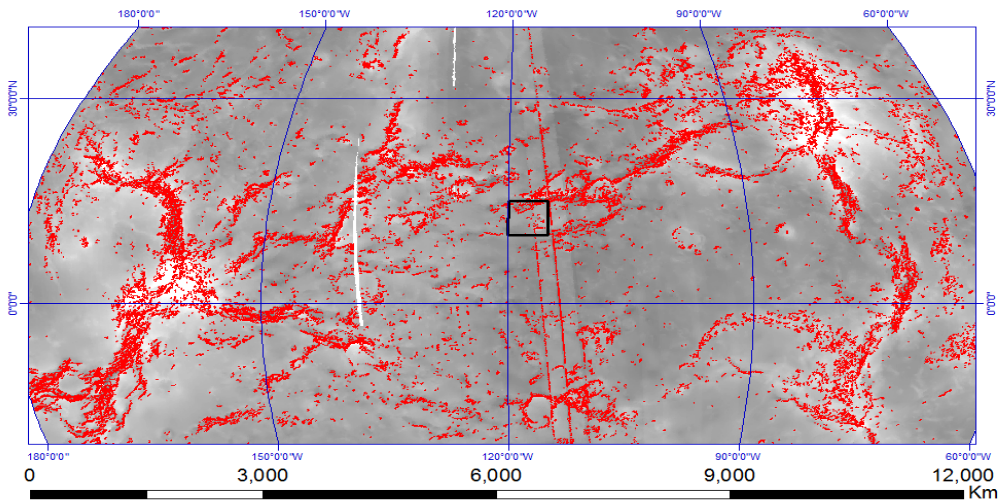

Figure 1: Topography map of the BAT region on Venus at 50% transparency (source: USGS). Areas in red show the locations of major rift systems as automatically calculated by the ArcMap geographical information system, using the approach discussed in the text. Black square indicates the area of Hecate Chasma under investigation.

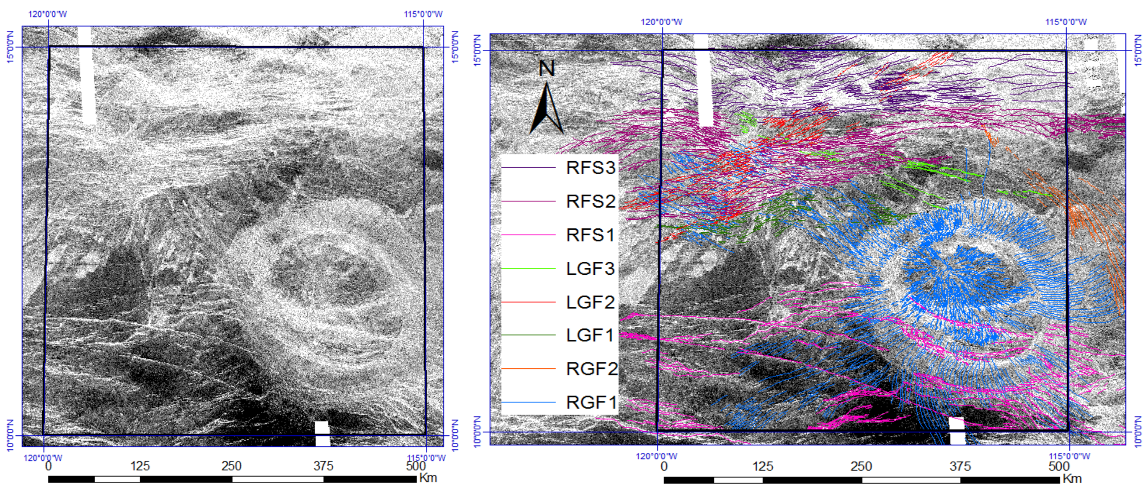

Figure 2: (Left) Close-up SAR image of the study area (source: USGS). (Right) Same area overlayed with polyline shapefiles representing rift fault sets (RFS) and graben-fissure systems – linear (LGF) and radiating (RGF).

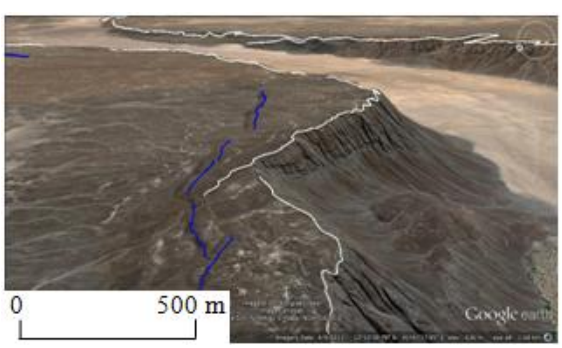

Figure 3: Small section of the East African Rift System displaying rift faults and subsequent mass wasting (white lines) and mafic dykes (blue lines) (source: Google Earth).

References: [1] Studd D. et al. (2011) *Icarus* 215, 279-291. [2] Hamilton V.E. and Stofan E.R. (1996) *Icarus* 121, 171-194. [3] Krassilnikov A.S. et al (2012) *Planet. Space Sci.* 68, 56-75. [4] Ivanov M.A. and Head J.W. (2013) *Planet. Space Sci.* 84, 66-92. [5] USGS Astrogeology Research Program (2013) <http://www.mapaplanet.org/explorer/venus.html>. [6] Google Earth Northeast Africa. DigitalGlobe (2014) <http://www.earth.google.com>. [7] ESRI ArcGIS Resources (2014). <http://resources.arcgis.com/en/home/>.