DETERMINING RELATIVE AGES OF STRUCTURAL FEATURES AROUND IRNINI MONS, VENUS – A COMPARISON OF FOUR TYPE LOCATIONS TO RESOLVE THE TIMING OF CROSS CUTTING FEATURES. M.A. Matiella Novak and D.L. Buczkowski, Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, Alexandra.Matiella.Novak@jhuapl.edu.

Introduction: Irnini Mons, a volcano in central Eistla Regio at 14ºN, 16ºE, is roughly centered on the V-20 quadrangle of Venus. While Eistla Regio as a whole is known to have the highest degree of poly-phase deformation on Venus, the area immediately around Irnini Mons is particularly complex, even at the 1:5,000,000 scale of the quadrangle map. The arrangement of cross-cutting tectonic structures indicates a detailed and multipart stress history, which suggests Irnini Mons is an ideal location to identify distinct patterns of changes in stress orientation over time, as well as to ascertain the deformation associated with the volcano relative to the deformation of the local regional plains. A thorough investigation of the distribution and orientation of the numerous structures around Irnini Mons at the highest possible resolution (75 m/pixel) is likely to reveal the relative timing of the structures and thus shed light on the deformation history of this region of Venus. However, the complicated nature of these structures and their relationship to each other makes it difficult to resolve relative ages holistically across the map. For this reason, we attempt to determine the relative ages of structures within four distinct type locations within the region, fitting the outcomes of these analysis into an analysis of relative timing of structures within the greater mapped area. For this study, we build upon previous mapping and the determination of structural ages for two locations within the northwest and southeast regions of the map, adding two more locations located in between the two previously mapped areas in an attempt to resolve the timing of features within an entire swath of the map stretching from the northwest corner to the southeast corner. Previous mapping in this area provided examples of how this high-resolution structural mapping may differ from the V-20 map and we will build upon this work by focusing on the high-resolution structural mapping of the four type locations described above.

Geology of Irnini Mons: McGill [1] mapped flows and other deposits from Irnini Mons that are superimposed on an older, regional plains material. These superposed materials include: 1) a shield plains unit (fs) younger than the regional plains (prb), 2) flows from Irnini Mons (fI and fhI) that are also younger than the plains (prb), and 3) a smooth plains unit (ps) that is younger than the flows (fI and fhI). The regional plains material (prb) has abundant wrinkle ridges in at least two sets: one trending generally east-west and another concentric to Irnini Mons. Graben associated with Badb Linea cut through the shield material, which overlies a lineated plains material (pl), interpreted as being a relatively old plain of deformed volcanic rocks [1]. The Irnini flows are described by McGill [1] as two units. The first is interpreted as basaltic lava flows (fI), while the second is basaltic lava overlain by a thin pyroclastic veneer (fhI). Both units are free of wrinkle ridges, but do show fabrics of lineations and graben. They seem to overlie every unit save the smooth plains (ps). Radial features on top of the Irnini flows (fI and fhI) were mapped by [1] as lineations or graben, as resolution allowed.

Structural Features around Irnini Mons: Previous work has determined the nature of large-scale structural features proximal to Irnini Mons. The volcanic edifice is about 475 km wide and 1.75 km high [1] and the volcano is capped by Sappho Patera, a 225 km diameter depression rimmed by both concentric graben and a large circumferential ridge. Sappho Patera has been characterized by [3] as a corona or corona-like feature; simply, a corona is a circular to elongate feature surrounded by multiple concentric ridges thought to be formed by hot spots. Irnini Mons is crossed by two rift systems, the north-south trending Badb Linea and an older rift that incorporates Guor Linea to the northwest and Virtus Linea to the southeast. Large surrounding structural complexities include four coronae and Anala Mons, a 550 km diameter, 2.25 km high volcano almost directly to the south of Irnini Mons.

High-resolution structural mapping was completed by [4] in a 1° x 1° region from 15º-16º N, 17º-18º E, north-east of Irnini Mons. The difference in radar backscatter in high resolution images (75 m/pixel) indicates that some of the radial features are topographic highs [4] although they are too narrow to be resolved in altimetry data sets. These features are similar to the "horst-like lineaments" identified by [5]. Unlike the textured plains material (pt) unit of arcuate ridges mapped by [1], which is directly south, these ridges are on top of the Irnini flows and cannot be an older feature. To the north the radial features appear to be graben, also located on top of the Irnini flows. Due north, the radial graben become indistinguishable from the graben associated with the Badb Linea rift.

The structural features in the study region include graben, coronal structures, ridges and lava flows. Previous mapping in this area provided examples of how high-resolution structural mapping may differ from the V-20 map [7]. We have built upon this work by focusing on the high-resolution structural mapping of cross-cutting features. We here present our analysis of four areas where relative timing can be established (Figure1).

Structural Mapping around Irnini Mons and Timing of Events: As with solar illumination, radar illumination of a planetary structure highlights the surface that faces the source [6]. If a topographic low, such as a graben, were being imaged, the surface away from the radar look direction would be the surface facing the radar system and would be illuminated. The graben surface closer to the look direction would be facing away from the radar system and would appear relatively dark. Thus a linear feature in a radar image that is composed of a dark band then a bright band from left to right is some type of linear topographic low, such as a graben, trough or fracture. A topographic high, such as a ridge, would have the opposite appearance. The surface closer to the look direction would be facing the radar source and would be illuminated, while the farther surface would be facing away and thus dark. The image resolution used for quadrangle mapping commonly does not allow the discernment of both a bright and dark part of a linear feature. Without knowing whether these features are extensional or contractional in nature it is impossible to determine the stress history of the region. At the highest FMAP resolution of 75 m/pixel many of the features that [1] had to map as "radar bright lineations" are now resolvable as either topographic highs or lows and can be mapped as either graben, wrinkle ridges, fractures or ridge belts. The assignment of relative timing of the formation of these features is based on well-known intersection relationships on Earth that have been successfully applied to fractures and wrinkle ridges on Venus [8]. The relationship of these features to Sappho Patera is also utilized to understand the stress history of the region.

References: [1] McGill (2000) USGS map I-2637. [2] Billoti and Suppe (1999) Icarus **139**, 137-157. [3] Stofan et al. (1992) JGR **97**, 13,347-13,378. [4] Buczkowski (2006) JSG 2**8**, 2156-2168. [5] Ernst et al. (2003) Icarus **163**, 282-316. [6] Campbell (2002) Radar Remote Sensing of Planetary Surfaces, Cambridge University Press. [7] Matiella Novak and Buczkowski (2012) LPSC 43, Abstract #2070. [8] McGill (1993) GRL **20**, 21, 2407-2410.

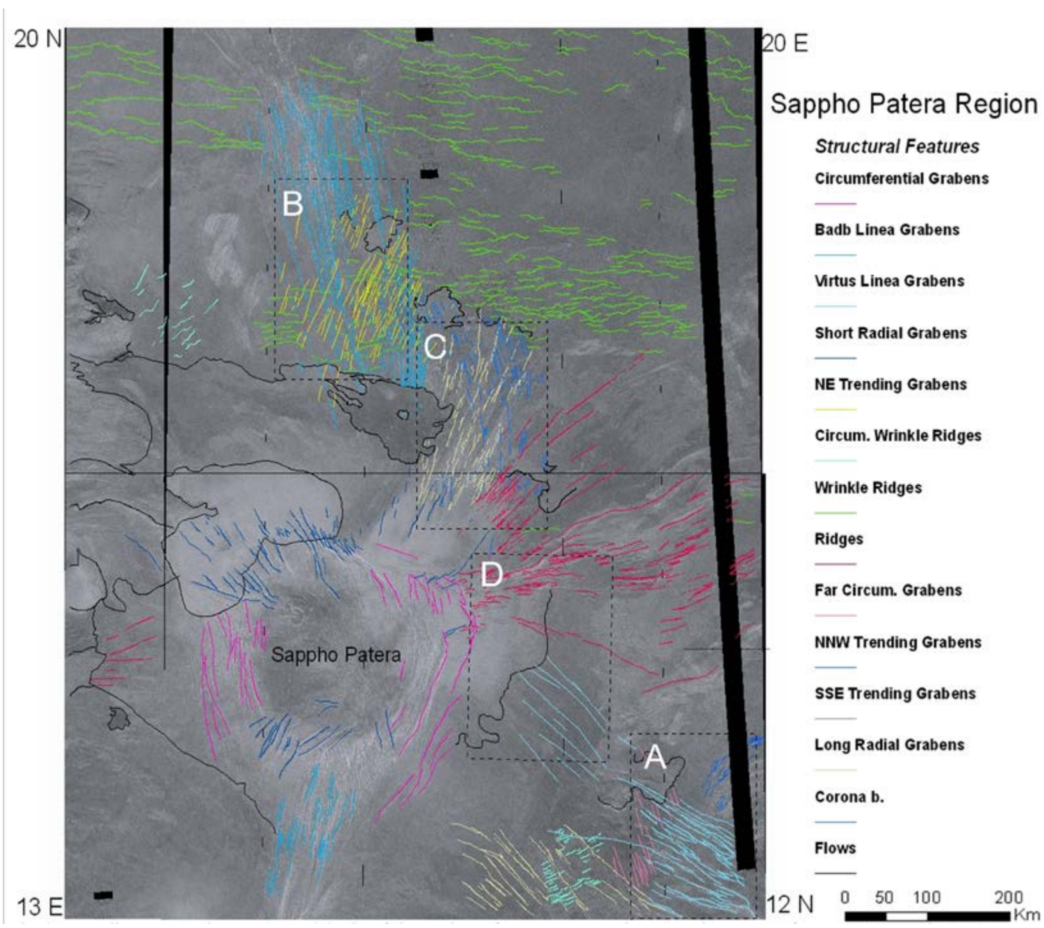

Figure 1. FMAP image of the region from 14°-15°N, 16°-18°E with four type locations (A, B, C, D) for establishing relative timing of structural features.