

## IDENTIFYING CRYPTIC MAGMATIC CENTRES IN THE GALINDO REGION OF VENUS BY MAPPING GRABEN-FISSURE SYSTEMS. A. Leung<sup>1</sup>, R. E. Ernst<sup>1,2</sup>, C. Samson<sup>1</sup> and E.B. Grosfils<sup>3</sup>.

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**Introduction:** Graben-fissure systems are suites of structural surface lineaments caused by magmatic and/or tectonic processes (e.g. [1, 2]), and here we focus on graben-fissure systems that exhibit a partial (fanning) or full radiating pattern. The geometry of these systems suggests they are underlain by dyke swarms fed laterally from a central magmatic source [1], and examples with a radius >300 km are inferred to be generated by a mantle plume [2]. This effort is part of the Global Dyke Swarm Project [3], which aims to produce a global map of graben-fissure systems on Venus with a focus on those related to magmatic activity.

We mapped in detail graben-fissure systems located within the northwestern part of the Galindo region of Venus (approximately 112.6°-120°W and 3.4°-9.8°S; area  $\approx$  570,000 km<sup>2</sup>) (Fig. 1) using SAR images from the Magellan mission at the highest available resolution (75 m/pixel). The most prominent feature in our study area is Dhorani Corona [4], associated with our mapped graben-fissure System 2.

**Mapping:** The Galindo Quadrangle (90°-120°W, 0°-25°S) has been mapped at the reconnaissance level (at 1:5M and 1:10M scale) by Chapman [4] and Ivanov and Head [5], respectively, and these maps identified the most prominent sets of graben. As a result of detailed lineament mapping in our study area (Fig. 1) 15 systems were identified, with 1 system having a full radiating pattern (System 2), 4 systems forming a fanning pattern (partial radiating pattern) (Systems 1, 7, 8, and 11), and 8 smaller systems that were linear or too small to discern a pattern (Figs. 1 & 2; Table 1); 4 of these systems had not been identified in previous mapping efforts [1,4,5]. The majority are partially flooded by younger basalts. Many of these systems are densely overlapping, especially within the northern portion of the Dhorani Corona.

**Cryptic centres:** It has been shown previously that the majority of fanning/radiating graben-fissure systems converge on known magmatic centres (volcanoes or corona)[1, 2], but some have no observed tectono-magmatic edifice at their convergence point [2] and as such can be termed a “cryptic” magmatic centre (potentially explained by an underlying magma chamber that did not generate a major surface construct). In the present map area, one centre (associated with System 2) corresponds to Dhorani Corona and the four other identified centres (systems 1, 7, 8 and 11) are “cryptic”.

**Cross-cutting relationships:** With many of the graben-fissure systems being so densely distributed within the study area, it is possible to explore their cross-cutting relationships. Through the evaluation of multiple points of intersection between two systems at a time, we can assess the relative age of their associated magmatic centres (Fig. 3). The presence of lobate lava flows, partial flooding, and topographic-high inliers also contribute to the understanding of the regional relative chronology.

System 8, located west from System 2 (associated with Dhorani Corona), is consistently cross-cut by System 2, suggesting that System 8 is older than System 2. Systems 13, 14 and 15 are flooded with a thin layer of lobate flows with trends [4,5] suggesting that the source of flooding (at least in part) came from System 2, and that System 2 is younger than these systems. However, System 14 cross-cuts System 2, and is therefore younger. The cross-cutting relationship between Systems 13 and 15 is not clear, as both are partially obscured by thin volcanic flooding. The interpreted age relationships are summarized in Fig. 3.

**Concluding remarks:** Detailed mapping and careful examination of the geometry of graben-fissure systems is an effective approach for identifying cryptic magmatic centres, and those with the largest radiating systems inferred to be mantle plume related [2]. Our study identified 4 new cryptic centres in part of the Galindo region alone (Systems 1, 7, 8 and 11). This further supports the idea from detailed graben-fissure mapping elsewhere (e.g., [2]) that the number of mantle plumes on Venus (based on visible edifices) has been greatly underestimated. Relative magmatic ages can be determined from cross-cutting relationships between different graben-fissure systems. In addition, four of the centres (associated with Systems 1, 2, 7 and 11), lie along a SE-NW line. A hotspot track is unlikely since the age order is not systematic (cf. Figs. 2 & 3), so we provisionally suggest this alignment is due to magma ascent along a trans-lithospheric break (buried by younger flows?), as observed on Earth [e.g. 6].

**References:** [1] Grosfils & Head, 1994, *Geophys. Res. Lett.* 21: 701–704. [2] Ernst et al., 2003, *Icarus*, 164: 282-316. [3] Ernst et al., 2009, *AGU, Jt. Assem. Suppl.*, 90(22), GA13A-06. [4] Chapman, 1999, *Galindo Quadrangle (V-40), Venus. USGS Geol. Invest. Ser. I-2613*. [5] Ivanov & Head, 2011, *Planetary and Space Sciences*, 59: 1559-1600. [6] Begg et al., 2010, *Econ. Geology*, 105:1057-1070.

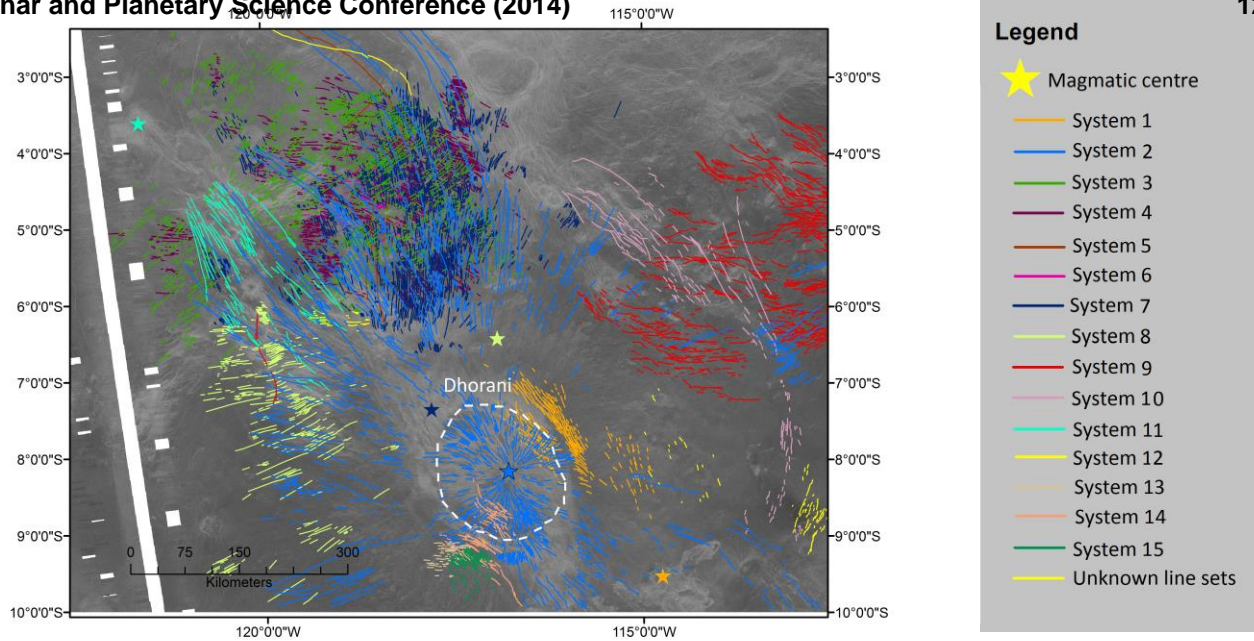


Fig. 1. Map of graben-fissure systems within the Galindo region of Venus

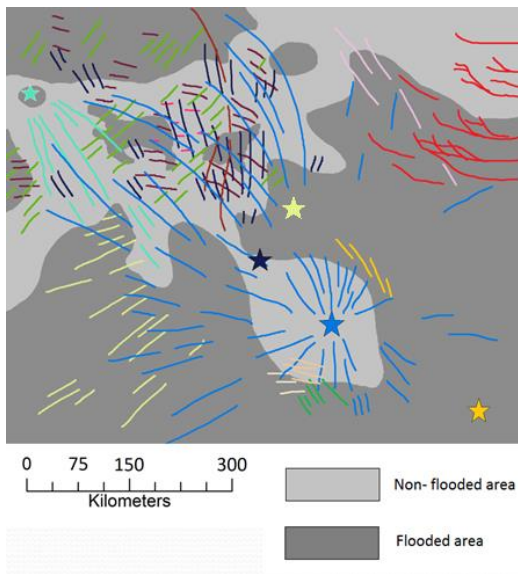


Fig. 2. Distribution of graben-fissure systems generalized from Fig. 1

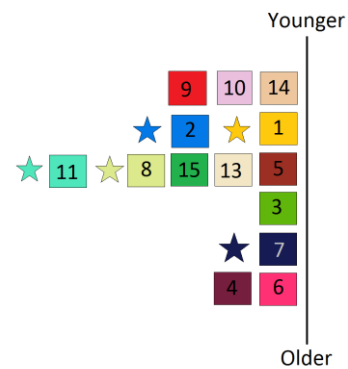


Fig. 3. Summary of relative ages based on crosscutting graben-fissure systems.

Table 1. Characteristics of mapped graben-fissure systems

System #	Pattern	Location (for linear systems), or location of centre (for fanning / radiating systems)	Size (L x W) or Max. Dist. from Centre
1	Fanning: NW-N (cryptic centre)	Centre: 114.8°W, 9.5°S	350 km max radius
2	Radiating: Dhorani Corona	Centre: 116.8°W, 8.2°S	>600 km max radius
3	Linear NE-ESE	119°W, 5°S	500 km x 400 km
4	Linear: E	118°W, 5°S	500 x 300 km
5	Individual linear: N	118°W, 5.5°S	150 km
6	Linear: E	118°W, 4.5°S	150 x 100 km
7	Fanning: NNW-NE (cryptic centre)	Centre: 117.8°W, 7.3°S	450 km max radius
8	Fanning: SW-W (cryptic centre)	Centre: 116.9°W, 6.4°S	500 km max radius
9	Rift-related	114°W, 5.5°S	>350 km
10	?Curving: N-NW	114°W, 5.5°S	>450 km
11	Fanning: SE-SSE (cryptic centre)	Centre: 121.6°W, 3.6°S	400 km max radius
12	?Linear: NNE-NE	113°W, 8.5°S	100 x 50 km
13	?Linear: W	117.5°W, 9.5°S	50 x 50 km
14	?Linear: SE	117°W, 9°S	80 x 100 km
15	?Linear: SSE	114°W, 9°S	80 x 80 km