Topographic Comparisons of Uplift Features on Venus and Earth: Implications for Venus Tectonics. P. R. Stoddard[1] and D. M. Jurdy[2], [1]Department of Geology and Environmental Geosciences, Northern Illinois University, DeKalb, IL 60115-2854 (prs@geol.niu.edu), [2]Department of Earth and Planetary Sciences, Northwestern University, Evansont, IL 60208-2150 (donna@earth.northwestern.edu)

Introduction: Earth and Venus have many similar features, yet their tectonic histories are quite different. Like the Earth, Venus has a global rift system, which has been cited as evidence of tectonic activity, despite the apparent lack of Earth-style plate tectonics. Both systems are marked by large ridges, usually with central grabens. On Earth, the topography of the rifts can be modeled well by a cooling half-space and the spreading of two divergent plates. The origin of the topographic signature on Venus, however, remains enigmatic. Venus' rift zones (termed "chasmata") can be fit by four great circle arcs extending 1000s of kilometers. This chasmata system measures 54,464 km [1], which when corrected for the smaller size of Venus, nearly matches the 59,200-km total length of the spreading ridges determined for Earth [2]. Venus and Earth also both have large regions of apparent upwelling – hotspots on Earth, and regiones on Venus [3]. These are marked by broad topographic and geoid highs as well as evidence of volcanic activity. We use topographic profiles to look for well-understood terrestrial analogs to Venusian features. Specifically, we cross-correlate average profiles for terrestrial rifts (slow and fast) and hotspots (oceanic and continental) with those for Venusian chasmata and regiones, and draw inferences as to the processes responsible for shaping Venus' surface.

Procedure: Using Magellan topography data for Venus, and ETOP05 for Earth, and techniques described more fully in Jurdy and Stoddard [4], we analyze profiles for the Africa/South America portion of the slow-spreading Mid-Atlantic Ridge and the Pacific/Nazca portion of the fast-spreading East Pacific Rise for comparison with profiles for Ganis Chasma on Atla Regio and Devana Chasma, which extends from Beta Regio to Phoebe Regio [5]. These rifts are among the most recently active on Venus [6] with profuse volcanism as documented by the nature of cratering.

For upwelling regions, we consider the oceanic Hawaii and Iceland hotspots and Yellowstone, a hotspot beneath a continent on Earth. On Venus, broad topographic and geoid highs are called regiones [3]. Venus has approximately a dozen, and we examine Atla, Beta, and W. Eistla regiones.

For ridge features, we take profiles perpendicular to the ridge trend every half-degree or so. For uplift features, we take 36 radial profiles through the center of the feature at 10° intervals. All profiles in this study were 2400 km long. For each feature, we average all profiles, then cross-correlate the individual profiles with the average. Finally, we cross-correlate the average profiles of each feature with each other.

Results: Not surprisingly, the most closely-related features (the MAR and EPR spreading rifts on Earth; Atla, Beta, and W. Eietla regiones on Venus) have the highest cross-correlations. Next are the correlations between the Venusian and terrestrial rifts, and the correlation between the Yellowstone hotspot and Atla and Beta regiones. Yellowstone correlated only moderately well with the oceanic hotspots and W. Eistla. Correlations with Iceland are probably somewhat poorer than might be expected, due to the domination of the Mid-Atlantic Ridge and Iceland's proximity to Greenland.

Interestingly, Stoddard and Jurdy [7], using shorter profile lengths, found that Atla and Beta most closely correlated to Earth's spreading rifts, in agreement with Stofan and Smrekar's [3] ranking of these two regiones as the most rift-dominated on Venus. Comparison of [7] with this study suggests that the topography of the more local constructs of the regiones is dominated by rifting, but the longer-wavelength profiles reflect the larger-area upwelling processes.

We attempt a rigorous quantitative comparison of matches among uplifted features on Venus and Earth using the calculated correlation coefficients. Principal component analysis offers an independent and objective mode of comparison. We find the eigenvectors of the covariance matrix for the correlation of the profiles. In this analysis the principal eigenvector shows that for the uplift features on the two planets, Yellowstone more strongly resembles Atla, Beta and W. Eistla than it does the oceanic hotspots. A secondary eigenvector does differentiate the features by planet. In a separate analysis of the rifts, the primary eigenvector shows separation by planet.

References: [1] Parsons, B. (1981) GJRAS, 67, 437-448. [2] Jurdy, D. M. and Stefanick, M. (1999), Icarus, 139, 93-99. [3] Stofan, E. R., and Smrekar, S. E. (2005), GSA Spec. Pap. #388, 841-861. [4] Jurdy. D. M. and Stoddard, P. R. (2007), GSA Spec. Pap. #430, 859-878. [5] Price, M. and Suppe, J. (1995), Earth, Moon, and Planets, 71, 99-145. [6] Basilevsky, A.T. and Head, J. W. (2002), Geology, 30, 1015-1018. [7] Stoddard, P. R. and Jurdy, D. M. (2005), LPSC.

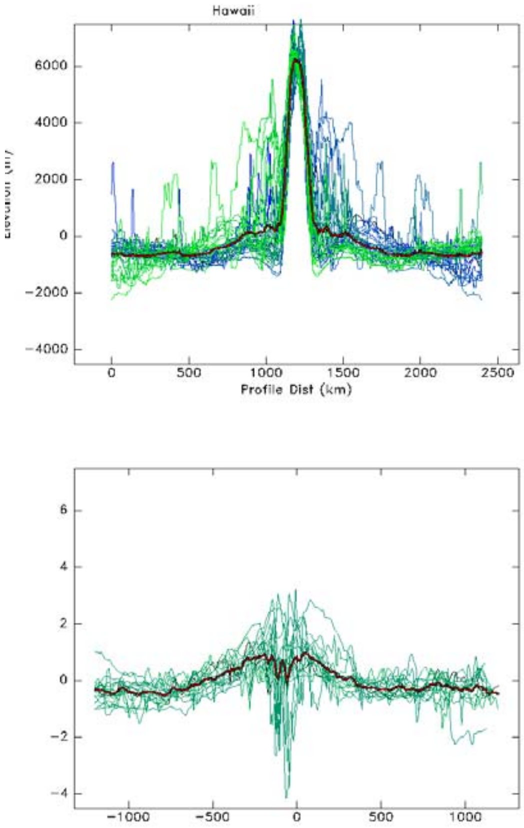


Figure 1: Sample profile analyses for Hawaii (top) and Ganis Chasma (bottom), showing individual profiles (blue/green) and average of all profiles (red).

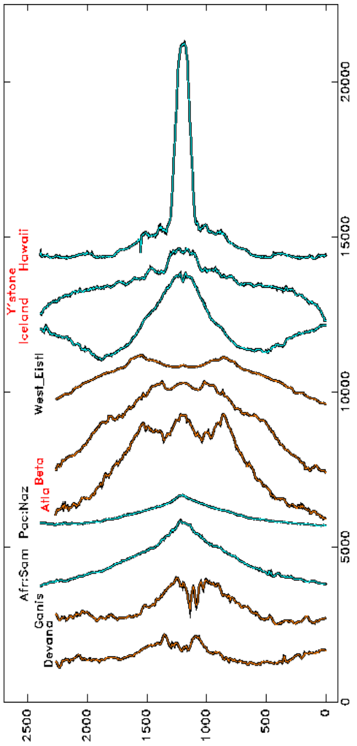
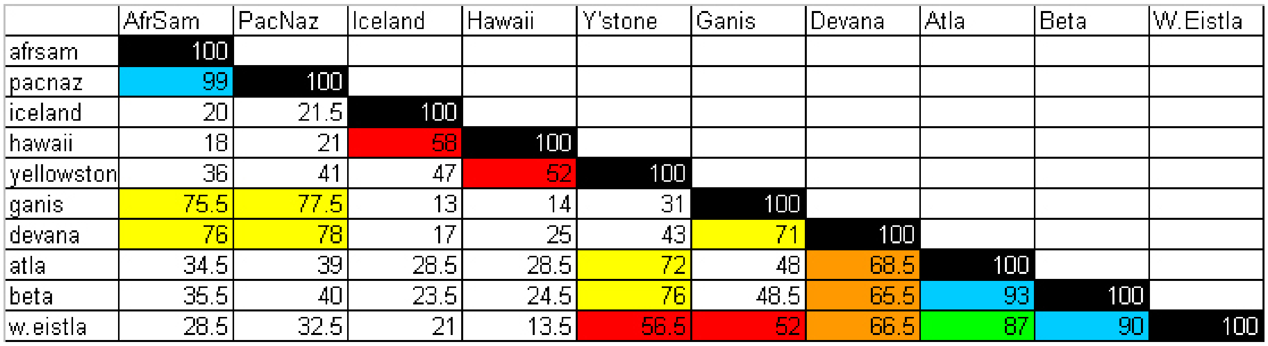


Figure 2: Comparison of average profiles for all features analyzed in this study. Aqua – terrestrial features. Orange – Venusian featues. Feature names in red indicate upwelling (quasi-ciricular) features, those in black are rifts and ridges.



	AfrSam	PacNaz	Iceland	Hawaii	Y'stone	Ganis	Devana	Atla	Beta	W.Eistla
afrsam	100									
pacnaz	99	100								
iceland	20	21.5	100							
hawaii	18	21	58	100						
yellowston	36	41	47	52	100					
ganis	75.5	77.5	13	14	31	100				
devana	76	78	17	25	43	71	100			
atla	34.5	39	28.5	28.5	72	48	68.5	100		
beta	35.5	40	23.5	24.5	76	48.5	65.5	93	100	
w.eistla	28.5	32.5	21	13.5	56.5	52	66.5	87	90	100

Figure 3: Correlation for features on Venus and Earth**.**

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