POSSIBLE RECENT OR CURRENT RIFT-ASSOCIATED VOLCANISM IN GANIS CHASMA, VENUS. J. Brossier[1]*, M.S. Gilmore[1], and J.W. Head[2]. (1) Wesleyan University, Planetary Science Group, Middletown CT, USA (brossier.jrmy@gmail.com). (2) Brown University, Providence RI, USA.

Introduction. Ganis Chasma (192°E, 18°N) is a region in Atla Regio where recent rift-associated volcanic activity has been reported [1]. This interpretation is primarily based on the Venus Monitoring Camera (VMC) data from Venus Express and the detection of transient bright spots. These bright spots would be consistent with the extrusion of lava flows that are locally causing significant increases of surface temperatures. Here we extract radar emissivity and elevation data collected from Magellan to produce scatterplots of the variation of emissivity with altitude for each of the sites of interest. We believe that a detailed description of the radiophysical behaviors of these regions may help to retrieve, or at least constrain, their relative age and composition. This was recently done for volcanoes and coronae [2] and for tesserae and mountain belts [3] on Venus.

Data & Methods. Morphological units are identified with the Magellan Synthetic Aperture Radar (SAR) images at 75 m.px^{-1} [4]. Magellan elevation and emissivity data are extracted to produce scatterplots of the emissivity variation with altitude [e.g., 2-3]. Both datasets are oversampled to 4.6 km per pixel. Elevation data are given in planetary radius with a mean value of 6051.8 km [5]. We retrieved temperatures by correlation to the Vega 2 lander entry profile [6].

Sites of interest. Our extraction is performed on the 4 sites studied with VMC [1] (A to D), and 3 other sites (E to G) for comparison purposes (Figure 1a). Sites A and D are located at the margins of the rift valley, and are interpreted as hotspots of recent activity in the region [1]. Both sites comprise outer flows and faulted walls from the rift valley. Sites B and C are also considered as areas of recent activity [1], and correspond to elevated and faulted walls of the rift valley. Among the new sites, E and F are similar to sites B and C, as they are characterized by similar morphologies ("walls") at high elevations. Site G is a bit unique, and corresponds to the extensive lava flows of Yolkai-Estsan Mons (Yolkai). This volcano has been heavily dissected by rifting, and is therefore considered as one of the oldest features in the region. Sitwell crater (D = 32.8 km) has a parabolic ejecta deposit (parabola) that is superimposed on Ganis Chasma, and may have undergone some rift-associated fracturing. This indicates possible continuation of rifting activity in this part of Ganis Chasma after the formation of the crater and its parabola [7]. Bashkirtseff crater (D = 36.3 km) is another crater in the region, however, it has no parabola and appears to be embayed by Yolkai lava flows.

Emissivity excursions. Figure 1b reports the magnitude of emissivity excursions detected in each site and the corresponding altitude and temperature. Magnitudes are defined by the percentage decrease between the minimum emissivity value observed and the planetary average of ~0.85. Here we define the terms "subtle" and "strong" to describe the magnitude of the emissivity decline with altitude: a strong excursion is where emissivity shows a decrease of ~30% or more of the planetary average value. Sites A to D and F have subtle declines in emissivity that reach low values of 0.672–0.753 at altitudes varying between 6054.2 km and 6055.8 km (701–716 K). Conversely, sites E and G have strong declines to values of 0.595–0.600 reached at 6056.2 km (697 K) and 6054.5 km (713 K), respectively.

Discussion. At each site, emissivity values gradually decline from the lowlands to a given altitude. This pattern of emissivity variations with altitude is consistent with ferroelectric behavior (e.g., Ovda Regio [8-9]). Ferroelectric minerals (e.g., chlorapatite, perovskite oxides) are known to be very conductive at a certain temperature, namely Curie temperature (Tc). In this model, the altitude of the excursion is a function of the composition, while its magnitude is a function of the volume of ferroelectric minerals [8]. Sites with strong emissivity excursions at high altitude are thought to have had enough time to produce the ferroelectric minerals responsible for the radar anomalies in the region via surface – atmosphere chemical weathering. Conversely, sites with subtle or no emissivity excursions at high altitude are considered as young or possibly active since they have limited ferroelectric minerals (e.g., Maat, Idunn [2]). If we use the radar emissivity as a proxy for relative age estimation (like a chronometer), this would imply that the oldest features are in sites E and G (magnitude ~30%), while the youngest features are in sites A, C and D (magnitude of 15% or less). This would be consistent with the observations made in Shalygin et al. [1] with VMC data.

Sites A and D show high emissivity values of 0.8–0.9 at their highest altitudes. These values match with the faulted walls of Ganis Chasma, while the low emissivity excursions are related to rift-associated flows at the edge of the rift. The high emissivity values at the rift walls could indicate recent activity, as the rocks did not have enough time to weather to low emissivity despite their high elevation. Overall the sites have similar emissivity patterns (variation with altitude) at comparable elevation ranges, although they display a different excursion magnitude (i.e., different volume, age) and slightly different critical altitude (i.e., temperature, composition). Site F is somewhat confusing since the data points are diffuse. Interestingly, site G has a distinct emissivity pattern, with a strong excursion at low elevation (below 6055 km) that resembles that of some volcanoes on Venus, such as Sekmet and Anala [2]. This slight variability in critical altitudes could be ascribed to slight differences in the ferroelectrics composition [8-9].

Conclusions. We interpret sites A, C and D to be made of young materials as they lack minerals with high dielectric constant (not produced yet). This is consistent with the bright spots observed in Shalygin et al. [1]. Sites E and G are made of old materials (greater volume of minerals). This is further supported for site G that has been dissected by the rift formation. All sites are consistent with the presence of ferroelectrics with subtle differences in the mineral composition. This is in agreement with the other volcanoes in Atla Regio, i.e., Maat and Ozza montes [2,10].

References: [1] Shalygin et al. (2015) *GRL* 42, 4762. [2] Brossier et al. (2020) *Icarus* 343, 113693. [3] Brossier and Gilmore (2021) *Icarus* 355, 114161. [4] Ivanov and Head (2011) *PSS* 59, 1559. [5] Ford and Pettengill (1992) *JGR* 97, 13103. [6] Seiff et al. (1987) *ASR* 7, 323; Lorenz et al. (2018) *Icarus* 305, 277. [7] Basilevsky (1993) *GRL* 20, 883. [8] Shepard et al. (1994) *GRL* 21, 469. [9] Treiman et al. (2016) *Icarus* 280, 172. [10] Brossier et al., *under review*.

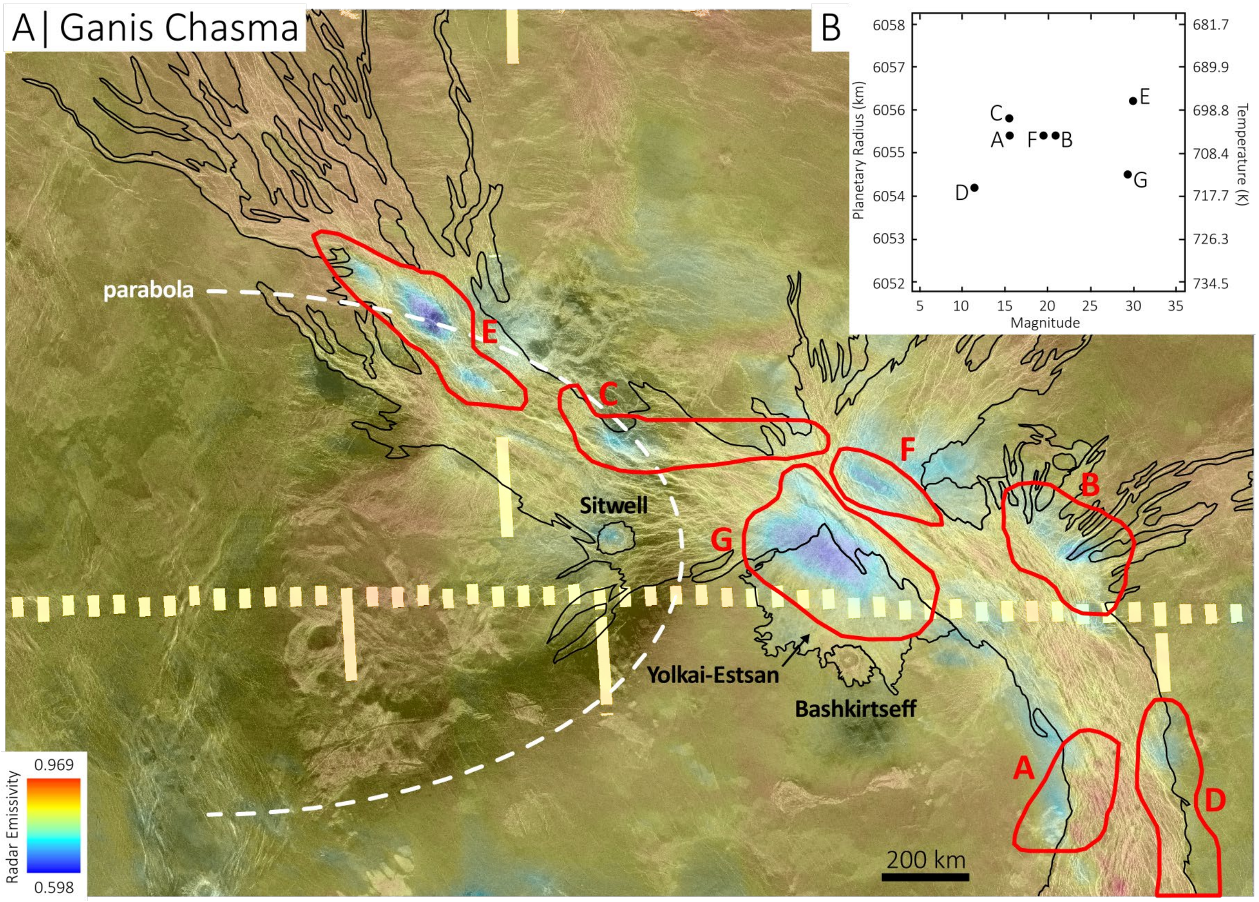

Figure 1 – (a) Ganis Chasma (192°E, 18°N) through emissivity map overlapping SAR images. The seven sites of interest defined by VMC observations [1] are outlined in red. Names of predominant features are indicated: Sitwell crater (with its parabola), Bashkirtseff crater, and Yolkai-Estsan Mons. (b) Magnitude of emissivity excursions (% change from global average value of 0.85) detected in each site vs. corresponding altitude and temperature. Temperatures are given by the Vega 2 lander data [6].