PANCAKE DOMES ON VENUS AND THE SEAFLOOR; N.T. Bridges, Dept. of Geology and Geography, University of Massachusetts, Amherst, MA 01003

The steep-sided, flat-topped "pancake" domes on Venus are volcanic features of enigmatic origin. There are at least 145 pancakes on the planet, ranging from 10 to 100 km across and up to 1500 m high or more (1). Aspect ratios (height/diameter) and volumes range from 8×10^{-4} - 0.18 and 2×10^{9} - 4×10^{12} m^3, respectively (2). Genetic models include formation from continuously fed silicic eruptions (1), extrusion of basaltic foams (1), and episodic eruptions of silicic lavas (2). For lack of a better analog, Venusian pancake domes have been compared to terrestrial subaerial domes (1,2). However, these domes are not comparable in size, with the Venusian pancakes generally one to several orders of magnitude larger. However, *Gloria* sonar surveys of the U.S. Exclusive Economic Zone (EEZ) (3,4) off Hawaii reveal a suite of volcanoes more similar in size and morphology to the Venusian pancakes than any other volcano class in the Solar System. Here, Venusian and seafloor pancakes are compared. It is proposed that their similarities may be due to similar ambient eruption environments.

The seafloor near the Hawaiian islands contains hundreds of volcanoes, many of which have steep sides and flat tops (Figures 1 and 2). These "seafloor pancakes" were mapped and measured using *Gloria* side-scan sonar image mosaics and bathymetric maps. The map area, extending from ~15-27° N latitude and 151-163° W longitude, contains 286 pancake-like volcanoes. They generally have flat to curved tops and steep sides, bearing a striking resemblance to the Venusian pancakes. Sixteen (5.6%) of the seafloor pancakes have one or more central craters, 8 (3%) are within a grouping of coalesced domes, 2 (<1%) are truncated, probably because of extensive erosion, 4 (1%) have landslides on their flanks, and 3 (1%) have a secondary volcano on top of them. Similar features exist on the Venusian pancakes (1). The seafloor pancakes range in diameter from ~1 to > 30 km. Their heights vary from less than 30 m (corresponding to the minimum height recorded on bathymetric maps) to over 900 m. Their volumes range from 6×10^{7}-5×10^{11} m^3. Thus, though the seafloor pancakes are on average slightly smaller than the Venusian pancakes, they are much larger than most subaerial domes. Some of the Venusian pancakes have lower aspect ratios than the seafloor ones, perhaps simply because the lowest seafloor volcanoes are below the resolution of the bathymetry.

There are also some important differences between the volcanoes on the two planets. Sediment cover on the seafloor volcanoes masks some summit features and subdues the topography. Though there are no samples of the seafloor pancakes, they are probably basaltic like the rest of the ocean floor. On the basis of morphology and dimensions, the Venusian pancake domes are generally thought to be silicic (1,2,5). Finally, these oceanic volcanoes either form in the plate interior from hotspots or are born and later carried away from a spreading ridge. Due to the probable lack of plate tectonics on Venus, the Venusian pancakes are more tectonically analogous to seafloor pancakes that form in the plate interior.

The high pressures beneath the ocean and on Venus result in environments that are more similar to each other than other places in the Solar System. The pressure on Venus is ~90 bars compared to over 400 bars at the ~4500 m depth of the oceanic volcanoes. The high pressures in the two environments result in high ambient densities, so that there is a significant convective heat loss in addition to that due to radiation (6-8). The high pressures also inhibit the exsolution of volatiles that drive explosive volcanism (6). It is therefore likely that the similarities of the Venusian and seafloor pancakes are due in large part to their similar eruptive environments. Composition may also be a factor, and the remarkable similarity between the pancake volcanoes on Venus and the ocean floor reopens the question of the inferred silicic nature of the Venusian pancakes.

Future work will focus on further detailed comparisons between the Venusian and seafloor pancakes. Currently, volcanoes in other part of the EEZ and at the mid-Atlantic Ridge are being studied. Together with theoretical modeling of eruptive and tectonic conditions, this

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comparative study should result in a deeper understanding of the mysterious Venusian pancake domes.

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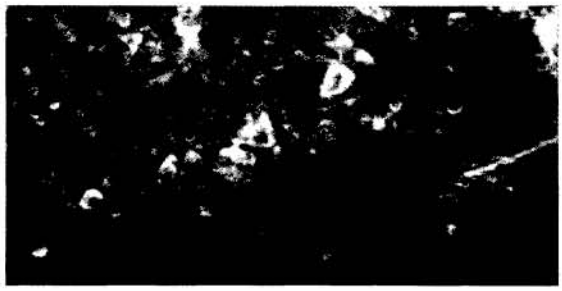

Figure 1: *Gloria* sonar image of pancake lava dome field north of Kauai, Hawaii. Image is about 180 km across.

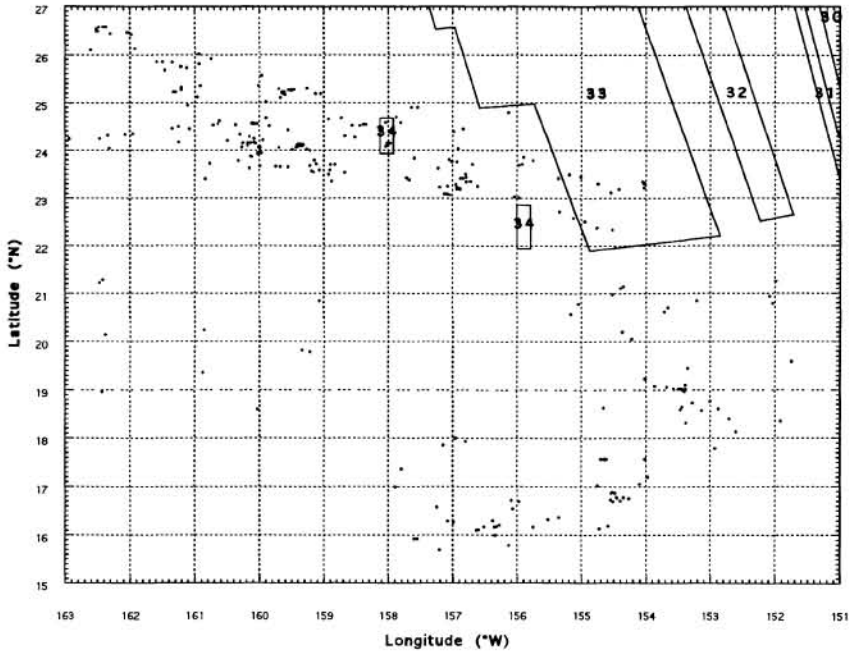

Figure 2: Map of the distribution of seafloor pancakes in the *Gloria* mosaic of the Hawaiian seafloor. Dark line is the boundary of the map area. Numbered boxes are normal magnetic anomalies (9): anomaly 30 ~ 67-68 Ma, anomaly 31 ~ 68.5-69.5 Ma, anomaly 32 ~ 72-73.5 Ma, anomaly 33 ~ 75-80.5 Ma, anomaly 34 ~ < 84.5 Ma.

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