Do Venusian Antidunes Exist? K. E. Williams, P. E. Geissler. USGS Astrogeology Science Center, 2255 N. Gemini Dr., Flagstaff, AZ 86001 kewilliams@usgs.gov.

Introduction: The surface pressure conditions beneath the 92 bar CO_2 atmosphere of Venus are similar to subaqueous terrestrial ocean pressure environments at a depth of ~1 km. Experimental evidence exists to suggest that sediment transport in the high-pressure CO_2 atmosphere on Venus may be similar to terrestrial fluvial sediment transport [1]. This has led other researchers [2] to propose that the dunes on Venus may be comparable to subaqueous dunes on Earth that formed at low flow speeds. Another alternative is that dunes on Venus formed under much higher flow speeds as antidunes in turbidity currents. In this work we proceed under the working hypothesis that aeolian antidunes may exist on Venus, and we use characteristics of transverse dunes from the Al-Uzza Undae region of Venus to constrain the formative flow properties of putative antidunes. Additional high-resolution data are required to further constrain dune properties and provenance, hence future investigation would benefit greatly from reprocessing of existing Magellan data.

Background and Model: Antidunes are fluvial bedforms found in supercritical flows. Antidunes are notable in that they can move against the flow. Terrestrial antidunes generally form in shallow, fast-flowing aqueous environments. Antidunes have also been found to form in terrestrial turbidity currents (Fig. 1). It seems plausible that antidunes could form under the thick Venusian atmosphere in a manner analogous to terrestrial turbidity currents. Venus has at least two officially named dune fields: Al-Uzza Undae and Menat Undae.

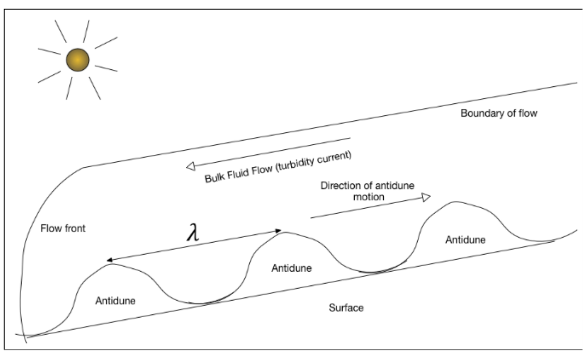

Figure 1. Diagram of antidunes and turbidity current.

Recent work by Geissler [3] has suggested that, given estimates of transverse dune spacing λ and an estimate of the operative reduced gravity term g', we may infer flow velocity v using the relation suggested by Kennedy [4] for subaqueous antidunes: $\lambda = \frac{2\pi v^2}{g'}$ where g' is defined via the gradient of the flow density and the ambient density [5] $g' = g\frac{\Delta\rho}{\rho_a}$. Here ρ_a is the ambient fluid density and g is gravity. There is a fair amount of uncertainty with this term, given that it depends on the sediment concentration of the flow.

The Froude number $Fr = \frac{v}{\sqrt{g'd}}$ is used to determine the potential for antidune formation in a given flow. $Fr \geq 1$ is required for antidune formation, though terrestrial flume work by Kennedy [4] as reported in Geissler [3] suggests that antidunes begin to form once flow velocities reach 80% of wave celerity or flow depths are less than ~14.2% of dune wavelength.

Solving for flow velocity and flow depth as functions of wavelength and reduced gravity, we find there is only a weak dependence on reduced gravity.

Radarclinometric analysis by Lorenz [6] suggests that dune wavelengths in Al-Uzza Undae are approximately 500 m, with a few slightly longer wavelengths of up to 1000 m. Given these constraints we can infer the flow depths may have been close to 80 m thick with a few thicker flows of close to 140 m. Similarly, flow velocities may be inferred to be approx. 22 m/s, with a few up to 32 m/s. We find that the suggested Venusian dune mechanisms relating wavelength and reduced gravity to wave speed and depth are more likely to exhibit weak (or zero) dependence on the reduced gravity of the flow.

Conclusion: The suggested Venusian antidune velocity and flow depth show only a weak (or zero) dependence on reduced gravity, whereas they show a significant dependence on estimated wavelength. We find, assuming the dunes in Al-Uzza Undae are analogous to those produced via terrestrial subaqueous turbidity currents, that we may infer flow depths of 80-140 m with flow velocities of 22-32 m/s. While measured surface wind speeds on Venus are generally < 1.5 m/s [7], it is worth noting that turbidity currents, being gravitationally induced flows, are potentially of much higher velocity than ordinary wind speeds. It is hoped that additional constraints on dune wavelength will be gleaned from the reprocessing of existing Magellan data in the manner suggested by Lorenz [6].

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