VENUS: CONSIDERATION OF AEOLIAN (WINDBLOWN) PROCESSES.

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Any planet having a dynamic atmosphere of sufficient density to move particles on or near the surface will be subject to aeolian processes; aeolian processes are important in shaping the surfaces of Earth and Mars, and may be important on Venus (1,2,3) and Titan. In this report we review the atmospheric conditions conducive for aeolian processes on Venus, give threshold wind speeds for Venus extrapolated from wind tunnel experiments, discuss the implications for aeolian surface features, and report on plans to fabricate a Venus wind tunnel at NASA-Ames Research Center.

Venera results (4) show that atmospheric surface pressures on Venus range from 88 to 94 bar; windspeeds at the height of the Venera spacecraft sensor were 0.5 to 1 m s^{-1}. Similar speeds were estimated for near the surface through extrapolation of Pioneer-Venus probe data (5). Contrary to earlier predictions based on models that essentially held that surface winds would not exist because of the dense "sluggish" atmosphere, it is now evident that winds do exist near the surface. Recent wind tunnel experiments to determine minimum windspeeds required to inititate particle movement as a function of grain size and density have been completed for Mars in which atmospheric surface pressure (~5 mb) and composition (95 percent CO_2) were duplicated and various interparticle forces, lift functions and other factors taken into account (6,7,8). These results were then extrapolated to venusian conditions (3). Figure 1 shows threshold speeds for Earth, Mars, and Venus; note that on Venus the "optimum" particle size (grain size moved by minimum velocity wind) is about 50 μm and that the division between "dust" (material transported mainly in suspension) and "sand" (material transported mainly by saltation) is about 20 μm (3). Threshold *friction* speed (shown in Fig. 1) is approximately 1/10 that of freestream wind velocity for winds blowing across a "rocky" surface (e.g. Viking Lander sites, or the Venera 8 and 9 sites); thus, the windspeeds measured on Venus are within the range predicted for movement of particles by the wind. Images of the surface at the Venera 8 and 9 landing sites (4) show a bimodal particle size distribution, suggestive of fluid-transport sorting. Figure 1 also shows that the wind threshold curve for Venus falls near threshold for particles in water on Earth. The ~90 bar surface pressure on Venus is about the same as a water depth of about 1000 m on Earth. Although the fluid properties of water are different form those of carbon dioxide, saltation characteristics and other factors important to the aeolian erosion/transportation/deposition regime may be somewhat similar for the two fluids. Thus, at least to a first approximation, features formed by water moving at relatively low velocities on Earth may be analogous to some aeolian features on Venus. Recently obtained *sonographs* (9) of the sea floor show a wide variety of geological features, including sedimentary deposits formed by ocean currents (Fig. 2). Because sonographs are similar to radar images, they may be good analogs to future high resolution Venus radar images and they could be used as a basis for comparison of possible aeolian features on Venus. Recognition and mapping of aeolian features on Venus would permit near-surface atmospheric circulation patterns to be determined and would place constraints on various geological models.

To simulate more directly the aeolian environment of Venus and to provide better knowledge of the physics of windblown particles, a venusian wind tunnel is currently in design-study for fabrication at NASA-Ames Research Center.

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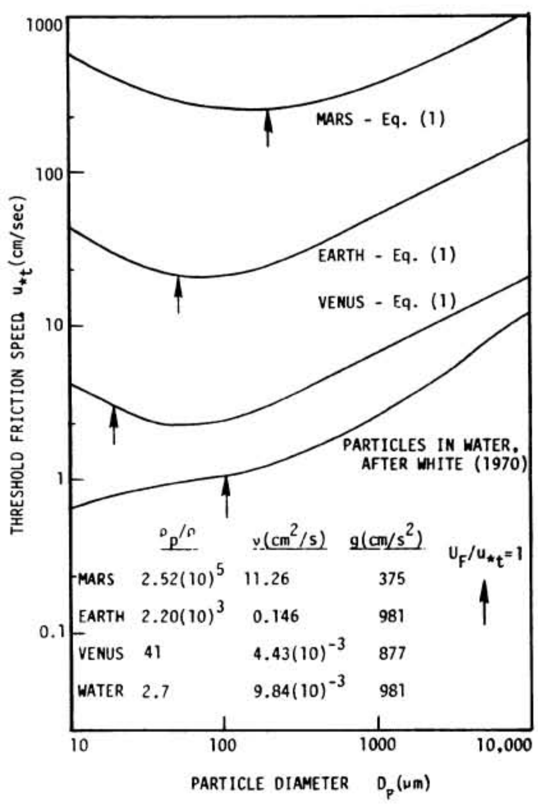

Fig. 1. Comparison of threshold friction speed versus particle diameter for Earth (air and water), Mars and Venus (ρp/ρ is ratio particle density to fluid density; ν is kinematic viscosity, g is gravity, and arrow indicates division between "dust" and "sand") (from Iversen, Greeley and Pollack, 1976).

Fig. 2. Sonograph (sonar image) of sea floor in North Sea showing image (300 m wave length) and small (~15 m wave length) sand waves; because fluid transport on the sea floor may be similar to aeolian processes in the dense venusian atmosphere features such as these might be expected on the surface of Venus, and to be visible in high resolution radar images (after Belderson and others, 1972).