SEDIMENT GRAVITY FLOWS ON VENUS
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Sediment gravity flows are the downslope movement of material behaving as a fluid. Sediment gravity flows are significant agents of erosion and transportation on Earth and may be important on Venus. Although venusian environmental conditions should not significantly affect the sediment gravity flows that require little fluid for their motion (e.g. grain flow and debris flow), fluidized sediment flow, where particles are supported by upward intergranular fluid flow, could be enhanced by the high venusian atmospheric density.

Turbidity currents constitute a type of sediment gravity flow in which particles are supported by the upward component of fluid turbulence in the medium in which the particles are suspended (1). The velocity of turbidity currents can be expressed by the equations (2,3):

\[(\Delta \rho / \rho)(\text{Ch}/u^2)[\log(2.10^{-3}h/k)]^2 (\sin \beta + \nu/u) = 0.05; \text{and} \]

\[u = [(8g/(f_0 + f_1))(\Delta \rho / \rho)h\beta]^{1/2}\]

where \(u\) = speed of turbidity current head, \(\Delta \rho\) = density difference between particle and the fluid, \(\rho\) = fluid density, \(C\) = concentration of particulate matter by volume, \(h\) = turbidity current thickness, \(k\) = boundary layer thickness, \(\beta\) = slope, \(\nu\) = terminal fall velocity of particle, \(g\) = acceleration due to gravity, and \(f_0\), \(f_1\) = friction coefficients for the base and top of the turbidity current, respectively. These expressions allow comparisons of possible flows on Venus and Earth. If dynamically similar conditions are considered (\(C\) and \(\Delta \rho\) held constant) and \(C\), \(\Delta \rho\), \(g\), \(h\), and \(k\) are held constant, then the value of \(u\) on Venus will be higher as a result of the lower values for \(\rho\), \(f_0\), and \(f_1\) (Fig. 1). The terrestrial ocean and venusian atmosphere calculations suggest that a venusian sediment gravity flow may have a horizontal flow velocity that is an order of magnitude greater than a terrestrial oceanic flow bearing the same concentration of particles. This implies that sediment gravity flows in the venusian atmosphere may carry a smaller concentration of particles and that deposition from such flows may occur closer to the flow source for a given particle size and density than in the Earth’s oceans, assuming that horizontal flow velocity distributions are similar on both planets.

Although sediment gravity flows are not completely understood for terrestrial conditions, comparisons of Earth and Venus suggest that less fluid-dependent types of sediment gravity flows may not be much different on Venus than on Earth, but turbidity currents could be strongly affected. Turbidity currents and other sediment gravity flows would be expected where there is an unstable accumulation of sediments, an initiation mechanism, and a slope sufficiently steep to allow the flow to develop. Although these conditions could occur anywhere on Venus, it is likely that sediment gravity flows would occur in areas of high regional slope, such as on the slopes and near the bases of Anka, Freyja, and Maxwell Montes; the southern scarp of Lakshmi Planum; and the rift valleys of Aphrodite Terra. If venusian sediment gravity flows have the capabilities attributed to their terrestrial counterparts, then radar with km-scale resolution should be able to detect erosional and depositional features caused by flow. On a smaller scale, perhaps the layering and cross-bedding observed in some of the Venera images (4) could be part of a turbidite sequence.
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REFERENCES


Figure 1. A plot of mean horizontal flow velocity versus bed slope. Size of suspended particles is taken as 1 mm. Values for comparable events in the venusian atmosphere and terrestrial oceans are presented.