Venus Pathfinder – A Compact Long-Lived Lander Mission

The interior of Earth's sister planet, and its surface meteorology, is largely unknown. To win an understanding of Venus' seismicity and surface diurnal cycles even comparable to that we gained at Mars from Viking 35 years ago, requires a new technological capability, namely that of long-duration survival on the torrid Venus surface. Consideration of the diurnal cycle, and communications windows with the Earth, suggest a 50-day minimum requirement for surface duration, with a 200 day goal.

This requires that the vehicle operate in a thermal steady state, which requires active cooling. We propose a compact equipment vault, protected by a robust dewar, with minimal heat dissipation inside. The nominal scenario is that electrical power, most of which would be devoted to cooling, would be provided by a Radioisotope Stirling Generator (we acknowledge that the present ASRG design does not tolerate either the ambient temperatures at Venus, or the likely >200g entry loads during delivery). Alternative power sources, such as batteries and fuel cells are also considered, but these fail to meet the minimum duration above.

Communications would be direct-to-Earth (DTE), enabling this mission to be self-contained i.e. without an orbiter for communications support (although of course such support could substantially augment the science return). DTE capability of 350 bps would permit a total return of ~270 Mbit over 50 days. The lander design implications for a mission that includes communication through an orbiter are also discussed.

The lander concept is a hybrid design including a thermally protected enclosure with exposed sensors. The internal power dissipation is limited to about 4 W. Heat leaks into the thermal vault add another 20 W, making the total cooling required by the protected area about 30 kW-hr.

This Venus Pathfinder mission has a substantial technology development associated with it, and should be seen largely as a technology validation mission with some unique science capabilities, rather than as a Flagship-class science mission. The payload is therefore somewhat austere, and focuses on the science that is uniquely enabled by a long-lived lander.

Primary instrumentation would include a descent camera (which would not be cooled, and whose function would end shortly after landing), a meteorology and atmospheric optics package, and a seismometer. Possible augmentations might include a Gamma ray spectrometer and a magnetometer.

Key payload issues are the deployment of the seismometer onto the ground (including decoupling it from the lander and protecting it from wind induced noise), and tolerance of the ambient conditions (temperature, pressure and composition) by the seismometer and anemometer.