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The New Frontiers Venus In Situ Atmospheric and Geochemical Explorer (VISAGE) Mission Proposal

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Abstract

The exploration of the inner solar system is driven by the overarching concept of comparative planetology - that understanding the structure, history, processes, and evolution of each inner solar system planet directly addresses the understanding of the other planets. The 2013-2022 Planetary Science Decadal Survey [1] identified the Venus In Situ Explorer as the highest priority New Frontiers mission concept for future inner solar system studies. VISAGE, the Venus In Situ Atmospheric and Geochemical Explorer mission concept proposes to address three fundamental goals: 1) to understand why Venus is so different from Earth: VISAGE would measure noble gases to test models of the origin and evolution of Venus, and measures sulfur compounds and trace gas profiles to constrain atmospheric cycles, surface-atmosphere interactions, and climate models, 2) to understand whether Venus was ever like Earth: VISAGE would measure surface and subsurface composition, determine surface rock type, mineralogy, and texture to understand geochemical processes, weathering, and aeolian processes, and 3) to understand what Venus can teach about exoplanets.

The VISAGE Venus lander mission would perform atmospheric and surface science investigations with a flyby spacecraft that delivers a Lander and serves as telecom relay. The proposed VISAGE Lander science payload comprises five instruments: an Atmospheric Structure Investigation including Doppler Wind measurements, a Neutral Mass Spectrometer, an Imaging System, an X-ray Fluorescence experiment, and a Visible Near-Infrared Spectrometer. In the extreme surface environment of Venus, VISAGE is proposed to be a relatively short (several hours) autonomous landed mission that requires no ground control. Once on the surface, VISAGE measures the mineralogy and elemental composition at two depths, with samples brought inside the Lander for analysis. Science investigations include measuring the inventory of noble gases and light stable isotopes, the abundance of trace and reactive gases from surface to clouds, and to provide descent imaging of the surface below 15 km. During descent, the thermal, compositional, and dynamical structure of the atmosphere along the Lander trajectory is measured. Once on the surface, the elemental and mineralogical composition of surface rocks are measured, and panoramic images of the landing site are made.

Measurements of noble gases in the atmosphere help discriminate between models of Venus's origin, and the composition of the surface can elucidate the history of Venus. On the surface the mass spectrometer is used to get extremely precise measurements of atmospheric composition, including noble gases and isotopes, taking advantage of the multi-hour duration afforded there. Additionally, the trace gas analysis on the surface and in the lower atmosphere on descent helps determine the nature of surface-atmosphere interactions.

VISAGE would launch in December, 2024 with a targeted flyby of Venus in May, 2025 and Venus arrival in December, 2025. The VISAGE Lander descends under parachute and drag plate for one hour before landing at 8.8 m/s. Once on the surface, VISAGE conducts surface atmosphere measurements, surface and sub-surface

composition measurements, and take panoramic images of the surface region for up to 3.6 hours. The total surface science data return is expected to be ~1.4 GBits.

References

[1] “Vision & Voyages for Planetary Science in the Decade 2013-2022,” National Academies Press, Mar. 7, 2011.