DAVINCI: DEEP ATMOSPHERE VENUS INVESTIGATION OF NOBLE GASES, CHEMISTRY, AND IMAGING. L. S. Glaze[1], J. B. Garvin[1], N. M. Johnson[1], D. Atkinson[2,3], S. Atreya[4], J. Blacksberg[2], W. Brinckerhoff[1], B. Campbell[5], D. Crisp[2], F. Forget[6], M. Gilmore[7], D. Grinspoon[8], N. Izenberg[9], P. R. Mahaffy[1], W. Kiefer[10], R. Lorenz[9], A. A. Pavlov[1], M. Ravine[11], M. G. Trainer[1], C. Webster[2], K. Zahnle[12], and M. Zolotov[13], [1]NASA Goddard Space Flight Center (Code 690, Greenbelt, MD, 20771, Lori.S.Glaze@nasa.gov), [2]Jet Propulsion Laboratory, [3]University of Idaho, [4]University of Michigan, [5]Smithsonian Institution, [6]Laboratoire de Météorologie Dynamique, [7]Wesleyan University, [8]Planetary Science Institute, [9]Applied Physics Laboratory, [10]Lunar and Planetary Institute, [11]Malin Space Science Systems, [12]NASA Ames Research Center, [13]Arizona State University.

Introduction: Venus formed in the same part of our solar system, apparently from similar materials, as Earth. Although both planets are about the same size, their differences are profound. Venus and Earth experienced vastly different evolutionary pathways resulting in unexplained differences in atmospheric composition and dynamics, as well as in geophysical processes of the planetary surfaces and interiors. Understanding when and why the evolutionary pathways of Venus and Earth diverged is key to understanding how terrestrial planets form and how their atmospheres and surfaces evolve. The proposed Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI) mission will provide these missing puzzle pieces needed to understand terrestrial planet formation and evolution in the solar system and beyond.

Mission Concept: DAVINCI is one of five Discovery-class missions selected by NASA for Phase A studies. Launching in November 2021 and arriving at Venus in June of 2023, DAVINCI would be the first U.S. entry probe to target Venus' atmosphere in 45 years. DAVINCI is designed to study the chemical and isotopic composition of Venus' atmosphere at a level of detail that has not been possible on earlier missions and to image the surface at optical wavelengths and process-relevant scales. The three major DAVINCI science objectives are:

- Atmospheric origin and evolution: Understand the origin of the Venus atmosphere, how it has evolved, and how and why it is different from the atmospheres of Earth and Mars.
- Atmospheric composition and surface interaction: Understand the history of water on Venus and the chemical processes at work in the lower atmosphere.
- Surface properties: Provide insights into tectonic, volcanic, and weathering history of a typical tessera terrain.

The DAVINCI probe will make *in situ* measurements during a one-hour descent through the Venus atmosphere. The mission is tightly focused on answering fundamental questions that have been ranked as high priority by the last two National Research Council (NRC) Planetary Decadal Surveys [1-3] as well as by the Venus Exploration Analysis Group (VEXAG) since the time of its inception in 2005 [4]. For example, DAVINCI will make measurements of the heaviest noble gases, including dramatic improvements in quantifying krypton abundance and the first ever measurements of xenon, as well as precise isotopic measurements. These definitive measurements, which will be made well below the homopause to avoid any uncertainties, are sufficient to answer questions as framed by the NRC Planetary Decadal Survey and VEXAG, without the need to repeat them in New Frontiers or other future missions. The relative abundances of these inert gases, together with high precision measurements of the isotopes of argon, nitrogen, sulfur and carbon provide critical insight into the origin of Venus' atmosphere as well as clues regarding the role of large impacts in its atmospheric evolution.

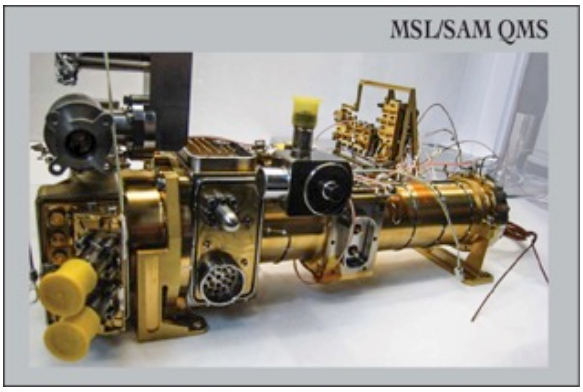
DAVINCI will make definitive measurements of hydrogen isotopes that can be used to constrain when and at what rates Venus lost its putative early water oceans. DAVINCI will also make the first-ever *in situ* trace gas composition measurements within 12 km of the surface (the altitude at which commercial airlines cruise on Earth) where 2/3 of the Venus atmospheric mass resides. These observations will be very useful to future orbiting missions that need to characterize the deep atmosphere in order to quantitatively interpret infrared emissivity observations. The measured composition of chemically active gases will provide information about chemical processes in the sub-cloud atmosphere, the oxidation state of the atmosphere, and the degree of equilibration among gases in the vicinity of the surface. This never before obtained information regarding the composition of the near-surface Venus atmosphere will lead to new evaluations of stability of minerals and improved understanding of pathways for chemical weathering of the surface.

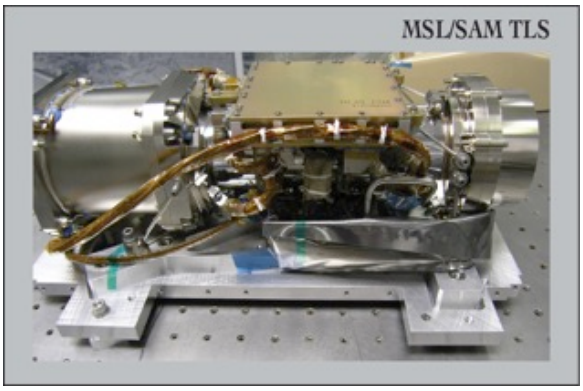
Finally, DAVINCI will return the first-ever high spatial resolution optical images of the enigmatic highland regions known as tessera terrain that may be analogous to remnant continents. Existing Magellan radar and topography, combined with Venus Express emissivity results are more than adequate for identifying an appropriate DAVINCI descent location. The carrier spacecraft easily receives all data during descent and relays those data back to Earth without requiring the presence of additional Venus-orbiting spacecraft.

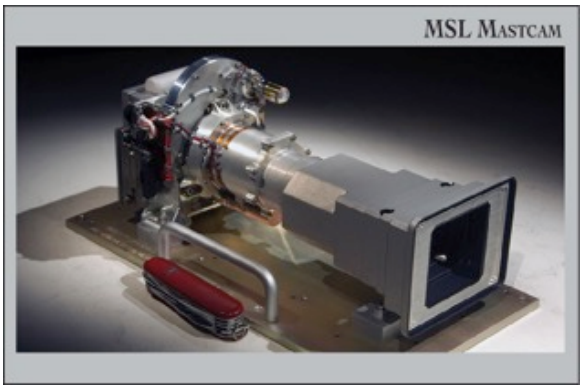
Payload: DAVINCI builds on the tremendous success of the Mars Science Laboratory Sample Analysis at Mars (MSL/SAM) suite carried on the Curiosity rover [5-12], by pairing the Venus Mass Spectrometer (VMS) led by NASA's Goddard Space Flight Center with the Venus Tunable Laser Spectrometer (VTLS) led by the Jet Propulsion Laboratory. Combined, these two instruments provide the first comprehensive measurements of noble and trace gas species, as well as key elemental isotopes.

These two state-of-the art instruments are complemented by the Venus Atmospheric Structure Investigation (VASI), which provides measurements of the structure and dynamics of the Venus atmosphere during entry and descent as context for the chemistry measurements, and enables reconstruction of the descent profile.

High-contrast descent imaging of the tessera terrain is enabled by the Venus Descent Imager (VenDI), provided by Malin Space Science Systems based on a design that leverages experience with the Curiosity Rover's Mastcam and MARDI descent video imaging systems.







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