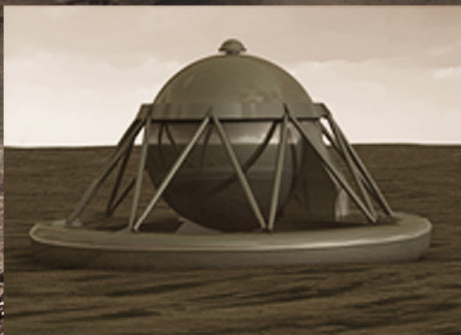


# VENUS STRATEGIC DOCUMENTS 2019



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# Foreword and Acknowledgements

## Venus Strategic Documents

Why Venus and why now? Venus plays a pivotal role in our understanding of the origin, evolution, and habitability of rocky planets in our solar system and throughout the galaxy. Venus has key characteristics of habitable planets: geologic activity, a substantial secondary atmosphere, past surface water, and possibly a past dynamo. Of all the numerous Earth-sized exoplanets thus far discovered, none is more similar to Earth and more accessible to us than Venus. Venus acts as a proxy for those exoplanets. NASA has visited all other major rocky bodies of the solar system in the last two decades, including several missions to both the Moon and Mars. The **VEXAG Goals, Objectives, and Investigations** document is a community consensus document that describes the scientific discoveries needed to fill the enormous gaps in comparative planetology that will advance our understanding of planet evolution and habitability.

A suite of missions is ready and actively being proposed to fill these gaps. The breadth of highly-rated mission proposals to NASA's Discovery and New Frontiers programs reflects the compelling nature of Venus and the science drive to understand its evolution from interior to surface to atmosphere. The high ratings, supported by funded Phase A studies of recent Venus mission proposals, demonstrate both technical feasibility and the value of Venus science in the coming decade. The U.S. is poised and primed with the advanced technologies, solid mission concepts, and talented, enthusiastic workforce necessary to resume international leadership of a Venus exploration program. Over the past 25 years, NASA has explored the expanse of the solar system, from the Sun itself to Kuiper Belt Objects, and from comets to giant planets. The **VEXAG Roadmap for Venus Exploration** delineates how we can return to our nearest neighbor.

The missions in the Roadmap are enabled by the technologies described in the **VEXAG Venus Technology Plan**, which performs a detailed assessment of the maturity of the technologies needed to conduct missions to Venus. It expands upon a series of earlier studies of small satellites<sup>1</sup>, aerial platforms<sup>2</sup>, and "Venus Bridge" small mission approaches<sup>3</sup> to Venus exploration. In addition to these overarching studies, NASA has made significant investments in developing enabling technologies, including the High Operating Temperature Technology (HOTTech), Long-Lived In-Situ Solar System Explorer (LLISSE), and Heatshield for Extreme Entry Environment Technology (HEEET). Many of scientifically important missions to the second planet can be implemented with existing technology, while some fundamental science questions can only be successfully answered with new mission paradigms.

Collectively, these three Venus Strategic Documents lay out the vision of the Venus Exploration Analysis Group (VEXAG) and the Venus community it represents. In addition to periods of weekly committee meetings, many opportunities for public input resulted in improvements in these documents:

- First draft versions were posted on the VEXAG site for public comment in December of 2018. A virtual town hall to discuss these drafts was held on February 7, 2019. Approximately 30-40 Venus community members participated.

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<sup>1</sup>NASA (2017) Planetary Science Deep Space SmallSat Studies (PSDS3) program, <https://www.nasa.gov/feature/nasa-selects-cubesat-smallsat-mission-concept-studies>.

<sup>2</sup>Cutts, J.A. and the Venus Aerial Platforms Study Team (2018) Aerial Platforms For the Scientific Exploration of Venus, Summary Report. JPL D-102569.

<sup>3</sup>Grimm, R., Gilmore, M.S., and the VEXAG Venus Bridge Study Team (2018) Venus VEXAG Bridge Study.

- Second drafts were posted by March 1, 2019, and an in-person Town Hall meeting was held on Sunday, March 17 in The Woodlands, Texas at the 50th Lunar and Planetary Science Conference to review those drafts with about 50 attendees.
- Third drafts were posted in the VEXAG site on May 24, 2019. A virtual town hall with about 25-30 participants to discuss these drafts was held on June 10, 2019.
- Final drafts were edited and posted on the VEXAG site in September of 2019, with a six-week period for final comments.

This iterative process ensured that the Venus community had ample time and opportunity to provide expert input to, and edit the documents. As a result, they represent a true consensus of Venus scientists and engineers.

This Plan owes much to the effort of the committee members who wrote them. We thank the GOI committee, led by Allan Treiman (LPI) and Joseph O'Rourke (ASU), which also included Giada Arney, Paul Byrne, Lynn Carter, Darby Dyar, James Head III, Candace Gray, Stephen Kane, Walter Kiefer, Kevin McGouldrick, Laurent Montesi, Chris Russell, and Suzanne Smrekar. The Roadmap committee was led by James Cutts (JPL) assisted by Michael Amato, Tibor Kremic, Candace Gray, Scott Hensley, Gary Hunter, Noam Izenberg, Walter Kiefer, Kevin McGouldrick, Joseph O'Rourke, and Suzanne Smrekar. The Technology Plan effort was led by Gary Hunter (GRC) supported by Jeffery Balcerski, Samuel Clegg, James Cutts, Candace Gray, Noam Izenberg, Natasha Johnson, Tibor Kremic, Larry Matthies, Joseph O'Rourke, and Ethiraj Venkatapathy. We are grateful to everyone who made this document possible.

It is our hope that these Strategic Documents will pave the way for exploration of the least-studied terrestrial planet in our solar system, and launch a decade or more of Venus exploration. We stand ready as a community to go back to Venus!



M. Darby Dyar, Chair, Venus Exploration Analysis Group Steering Committee



Noam Izenberg, Deputy Chair, Venus Exploration Analysis Group Steering Committee