

# VEXAG Steering Committee

Darby Dyar (PSI, Mount Holyoke College), Chair  
Noam Izenberg (Applied Physics Laboratory), Deputy  
Giada Arney (NASA GSFC)  
Lynn Carter (University of Arizona)  
**Natasha Johnson** (NASA GSFC)  
Candace Gray (NM State University)  
**Jeff Balcerski** (Ohio Aerospace Institute)  
Gary Hunter (NASA GRC)  
Kevin McGouldrick (University of Colorado)  
Pat McGovern (Lunar & Planetary Institute)  
Joseph O'Rourke (ASU)  
Emilie Royer (University of Colorado)  
**Jennifer Whitten** (Tulane)  
Colin Wilson (University of Oxford)  
Tommy Thompson (JPL), Scribe  
Adriana Ocampo (NASA HQ) ex officio

Bold indicates new  
Committee members



VEXAG Steering Committee Rotation Schedule

Name, starting	2020		2021		2022		2023		2024		2025		2026	
	1/1	7/1	1/1	7/1	1/1	7/1	1/1	7/1	1/1	7/1	1/1	7/1	1/1	7/1
Darby Dyar														
Noam Izenberg														
Emeritus Chair														
Gary Hunter	1													
Kevin McGouldrick	1													
Colin Wilson	1	1	1	1										
Pat McGovern	1	1	1	1	1									
Candace Gray	1	1	1	1										
Joe O'Rourke	1	1	1	1										
Emilie Royer	1	1	1	1										
Giada Arney	1	1	1	1										
Jeff Balcerski		1	1	1	1	1								
Paul Byrne		1	1	1	1	1								
Jenny Whitten		1	1	1	1	1								
Natasha Johnson		1	1	1	1	1	1							
Stephen Kane		1	1	1	1	1	1							
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TOTALS	10	11	13	15	11	13	12	12	12	10				

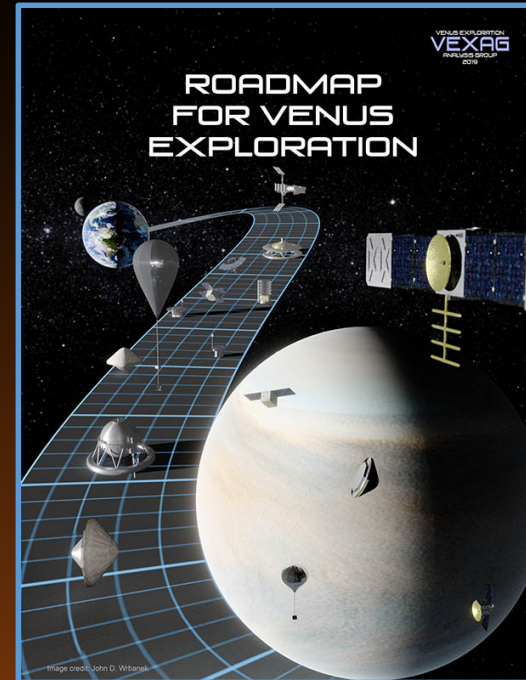
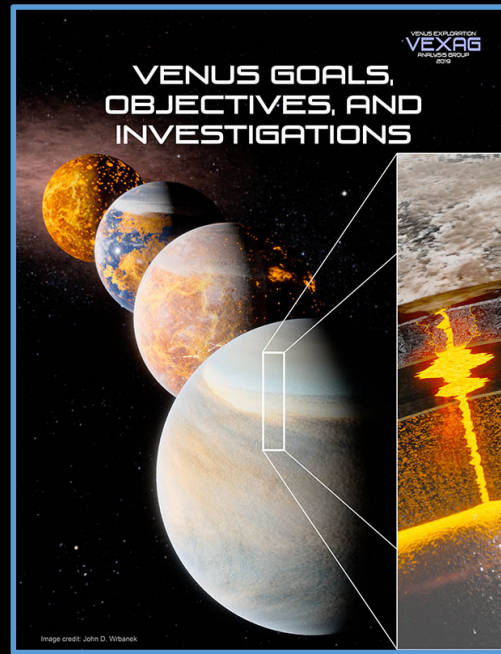
New 6-month rotation established, with 30% early career investigators required at all times.

# New VEXAG Subcommittees

1. Nugget Officers: Pat and Jenny
2. Committee Organization Document Committee: Darby, Noam, Colin
3. Working Group for Next Off-season VEXAG meeting (2021): Jeff, Giada, Stephen
4. Working Group for next VEXAG meeting (Nov 2020): Darby, Noam, Natasha
5. VeGASO committee: Joe, Paul, Emilie, Candace

# VEXAG Near-Term Goals

- Provide **support for the Decadal Survey**
  - 3 documents done, paper in *Space Science Reviews*
- Build a **Venus program!**
  - **Engage the community** to come together with a common vision
  - **Improve communication** within Venus community and among the general public: listserve has >500 members, **media outreach**
  - Open meetings and **public forums**
  - Expand **visibility of Venus science** at conferences and at NASA
- Selection of Venus missions for Discovery and New Frontiers programs



# DAVINCI+ will explore past and present Venus

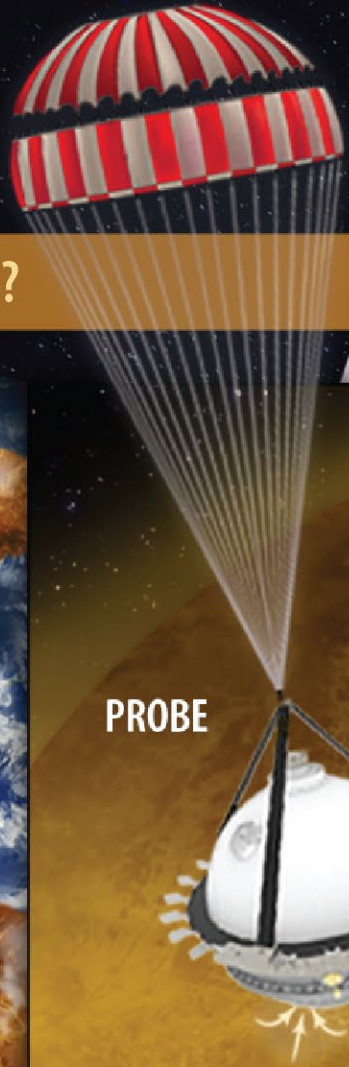
Deep Atmosphere Venus Investigation of Noble Gases, Chemistry, and Imaging *Plus*

Dr. James B. Garvin  
NASA GSFC, Principal Investigator

Drs. Stephanie Getty and Giada Arney  
NASA GSFC, Deputy Principal Investigators

*Establishing Venus' place  
in our Solar System*

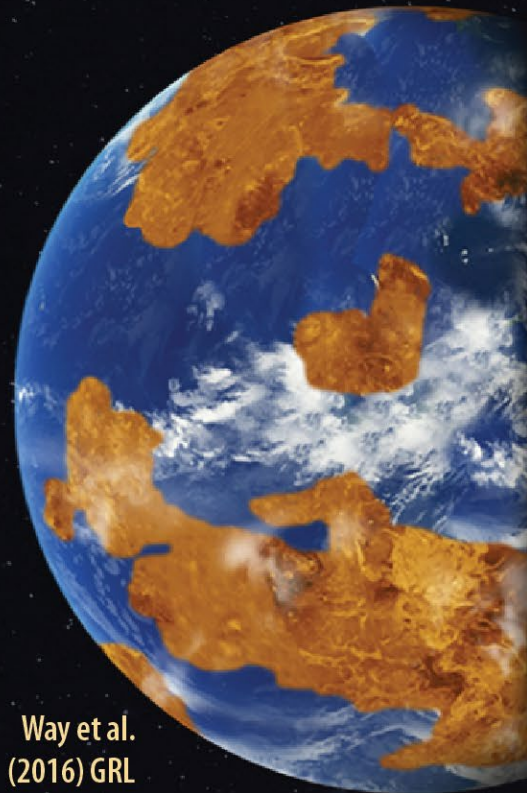
*Enabling exploration of Venus-like  
exoplanets and Earths*



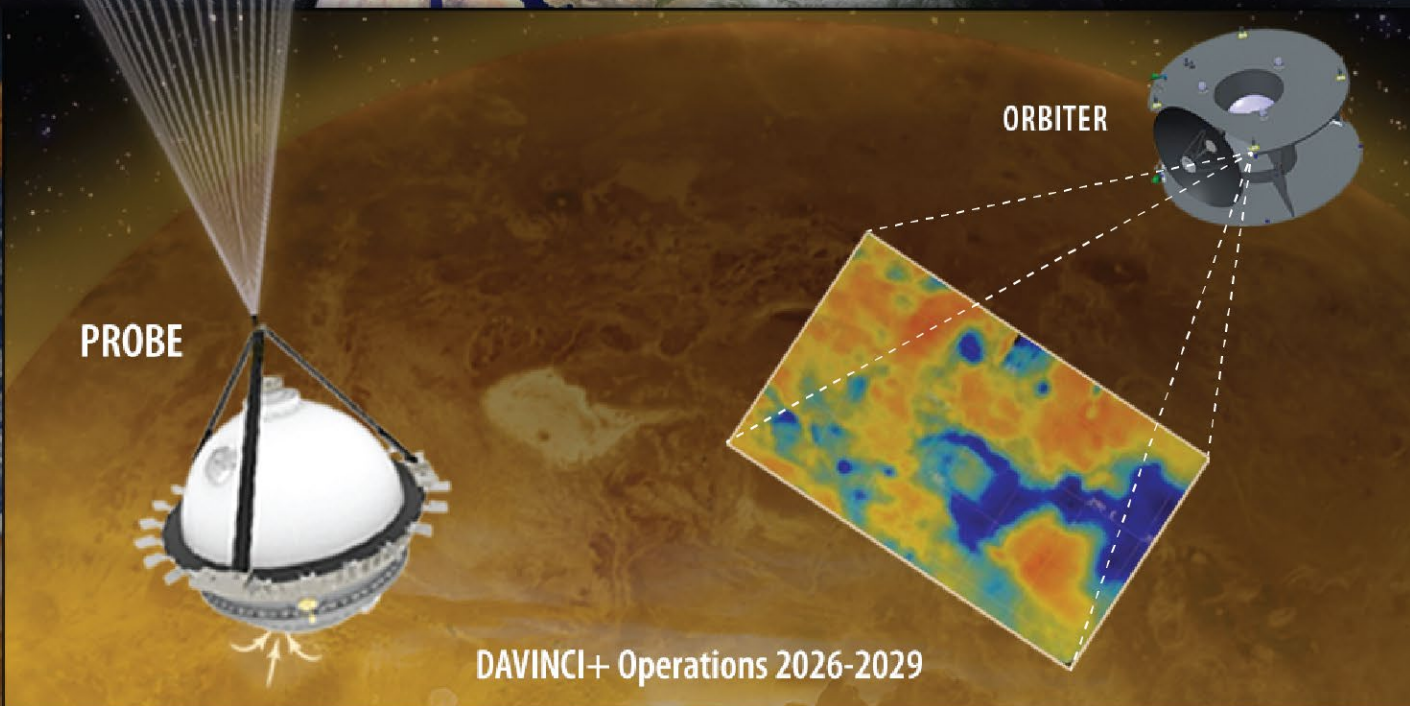
**Ancient Oceans on Venus?**

**Evolution of Habitability**

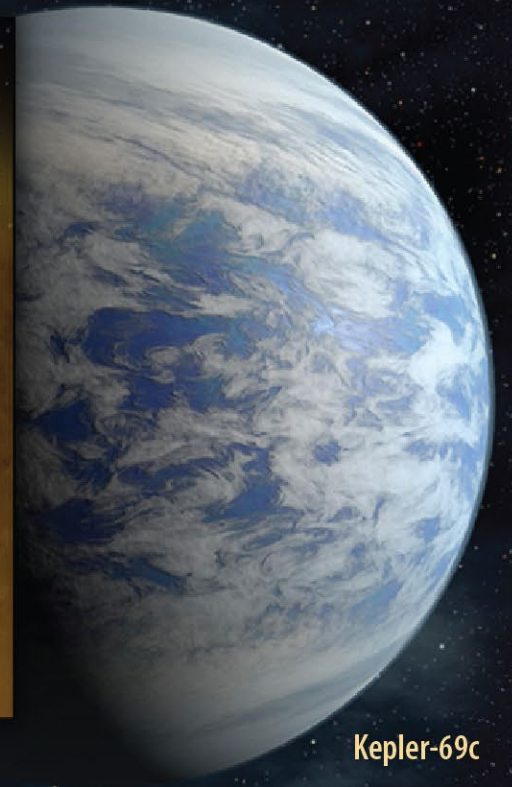
**Venus-like Exoplanets**



Way et al. (2016) GRL



**Major partners:** Lockheed-Martin • JPL • MSSS • LaRC • ARC • APL • KinetX • University of Michigan



Kepler-69c

# VERITAS

Venus Emissivity, Radio Science, InSAR,  
Topography, & Spectroscopy

## Science Goals

### 1 Rocky planet evolution

- 1a igneous rock type, surface-atmosphere interaction
- 1b ancient geologic processes
- 1c volcanic history
- 1d subduction, origins of plate tectonics

### 2 Active processes

Active and recent volcanism, tectonics?

### 3 Past and present water

- 3a continents from a wetter past?
- 3b current water outgassing?

## Mission Overview

Launch Date: May 2025

Venus Orbit Insertion: Dec 2025

3 years of science operations from orbit

>40 Tb of science data returned

PI: Sue Smrekar, JPL; Managed by JPL

## What makes a rocky planet habitable?

Like Earth, Venus started with all the  
building blocks of a habitable world.

How was habitability lost?

## High-Resolution Global Reconnaissance

### 1. VISAR (Venus Interferometric Synthetic Aperture Radar)

- Highest resolution global topography for terrestrial planets
- 1st planetary active deformation map

- Global data sets:

- Topography: 250 m horiz, 5 m vertical
- SAR imaging: 30 m

- Targeted data sets:

- SAR imaging: 15 m
- Surface deformation: 1.5 cm vertical

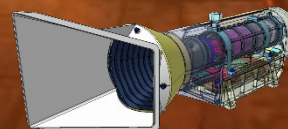
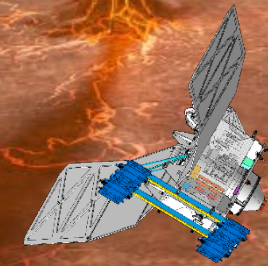
### 2. VEM (Venus Emissivity Mapper)

1st near-global map of igneous rock type, weathering

- 6 NIR surface bands with robust SNR
- 8 atmospheric bands for calibration / water vapor

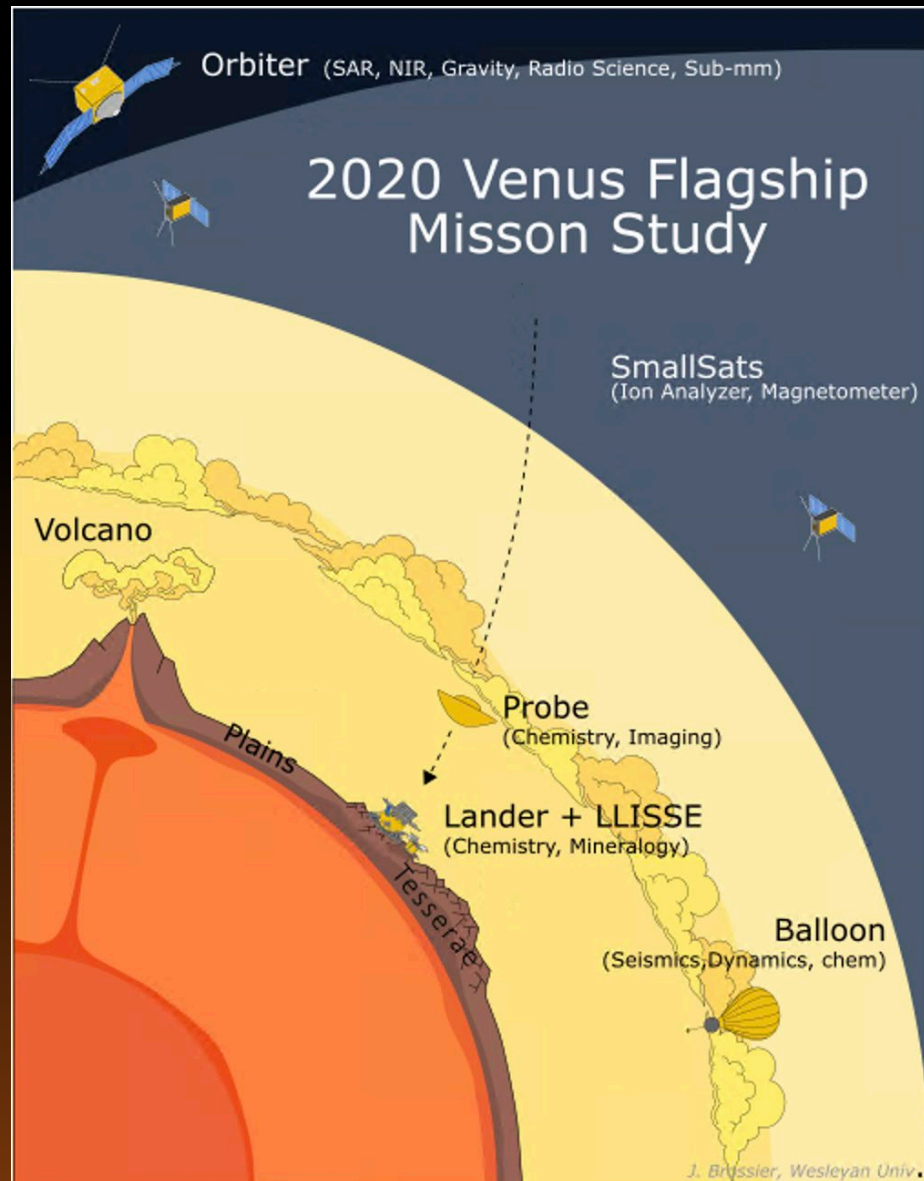
### 3. Gravity Science Investigation

1st global maps of derived elastic thickness & core size



# Venus Flagship – A Mission to Assess the Habitability of Venus

Martha Gilmore, Wesleyan Univ., Pat Beauchamp, JPL, VFM Science Team, GSFC



## Science Goals

1. History of volatiles and liquid water on Venus and determine if Venus was habitable.
2. Composition and climatological history of the surface of Venus and the present-day couplings between the surface and atmosphere.
3. The geologic history of Venus and whether Venus is active today.

## Key Elements of Current Design

Launch ~2031, Cost \$2B

Synergistic measurements between multiple assets

**Orbiter and Small Sats** support in situ assets prior to science campaign

**Probe/Lander** – 4-8 hour lifetime on tessera terrain

**Balloon** – 30 days

**Long-lived lander (LLISSE)** – 60 days

## Status

2/27 Design Run 1 at Goddard

3/15 LPSC report

3/30 Design run 2 at Goddard

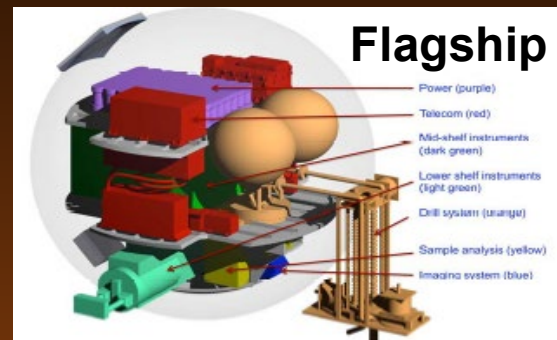
6/30 Report Complete for Input to Planetary Decadal

Feb 28, 2020



# Venus Surface Platform Study Status

- Implemented to understand state of capability for Venus surface exploration, explore what additional science can be achieved with increasing lander capability
- Two face-to-face meetings, telecons with experts from various Centers and Institutions
- 4 subgroups have produced a draft report and draft white paper. Both are in review / editing
- Identified 3 leading capabilities that drive science: lifetime, mobility, and “smarts”. Different degrees enable unique and compelling new science. Examples:
  - Increased lifetime enables temporal measurements, helps understand surface weather / climate. Lifetime also critical to seismology needed to gain insight into interior structure
  - Situational awareness and ability to make autonomous data based decisions (attributes of increasing “smarts”) can enable more productive targeting and/or sample acquisition and thus enable better knowledge of Venus geology, weathering, and history.
- Capabilities created, enhanced with specific technology investments (e.g., high temperature systems (sensors and electronics, memory, power); Mechanisms (actuators, drills, tools); introduction of autonomy: etc...)



# 18th Meeting of the Venus Exploration and Analysis Group (VEXAG)

## November 16–18, 2020, at Caltech

- HQ presentation
- Mission summaries: solar orbiter summary, Parker Solar Probe, Akatsuki, Bepi Colombo, ISRO, various ride-along opportunities
- Updates from Discovery proposals
- New format: technique tutorials, science as posters, field trip
- Tutorials for 2020:
  - tbd: *Venus-like Exoplanets*
  - Reid Cooper: *High Temperature Experiments under Venus Conditions*
  - tbd: *tbd*
  - tdb: *tbd*
  - David Blake: *Venus Surface Mineralogy*
  - Darby Dyar: *Venus Surface Geochemistry*

1. Noam Izenberg: EMPIRE Strikes Back: Venus Exploration in the New Human Spaceflight Age
2. Darby Dyar: Revision of New Frontiers Goals for a Venus Mission
3. Stephen Kane: Venus as a Nearby Exoplanetary Laboratory
4. Marty Gilmore: Venus Flagship report (only if not funded)
5. Tibor Kremic/Gary Hunter: LISSEe, VBOS, etc. small platforms for long-lived surface missions
6. Gary Hunter: High temperature electronics, recent advancements
7. Raj Venkatapathy: HEEET
8. Jim Cutts: Aerial platform update to prior report, with ore emphasis on exploring the habitable zone
9. Joe O'Rourke: Searching for crustal remanent magnetism...
10. Kevin McGouldrick: Venus atmosphere/weather
11. Emilie Royer: Airglow as a tracer of Venus' upper atmosphere dynamics
12. Sue Smrekar: Venus tectonics and geodynamics
13. Joern Helbert: Orbital spectroscopy of Venus
14. Amanda Brecht: Coupling of 3D Venus models and innovative observations
15. Jenny Whitten: Venus tessera as a unique record of extinct conditions
16. Sanjay Limaye: Venus as an astrobiological target
17. Attila Komjathy: Investigating dynamical processes on Venus with infrasound observations from balloon and orbit
18. Pat McGovern: Venus as a natural volcanological laboratory
19. Helen Hwang: Thermal Protection System Technologies for Enabling Future Venus Exploration
20. Alison: Venus facilities and applications for them for technology development and science investigations
21. Allan Treiman/Molly McCanta: Experimental work for understanding Venus
22. Frank Mills: Carbon, oxygen, and sulfur cycles in Venus' atmospheric chemistry
23. Eliot Young: Ground-based observations of Venus in support of future missions
24. Glyn Collinson: Space plasma science questions and technologies
25. Colin/Sanjay: Coordination and strategy for international partners and collaborations for Venus: future fly-bys and international missions?

# VEXAG White Papers

To be presented at  
LPSC during Town Hall  
36 Titles tracked – about  
25 drafts circulating via  
Google Drive.

# LPSC Events Relating to Venus

- Monday 8:30 am session: Investigating Why Earth's Sister is Not its Twin
- Tuesday night posters: Venus: Geology, Geophysics, and Geochemistry
- Tuesday night posters: Venus Mission Concepts, Instruments, and Laboratory Facilities
- Wednesday 7 am: VEXAG breakfast
- Wednesday 12-1:15: Venus Town Hall
  - HQ presentation
  - Quick overview of the year
  - Discovery missions, Flagship, Surface Platforms, tech funding
  - Flash presentations of white papers
- Thursday 5-6:30: Venus Early Career Mixer

# Venus Petition

We write to address shortcomings with the current “Venus In-Situ Explorer” New Frontiers priority investigation, and to request a change in the upcoming New Frontiers Announcement of Opportunity.

As formulated in the 2003 decadal document, the primary science objectives of this mission were to examine the physics and chemistry of Venus’s atmosphere and crust. Several subsequent advances in instrument technologies and mission capabilities now present compelling means to achieve overarching Venus science objectives without physically being “in situ” on the surface. An emphasis on what science is achieved rather than on where it is done is suggested. In short, the requirement for in situ concepts as described in the current Decadal survey is nearly two decades out of date.

We now recognize that several different types of missions (e.g., orbiters at various altitudes, aerial platforms, deep probes, short- and long-lived landers), are all capable of producing crucial and transformational measurements. Particular needs with equal priority and urgency for measurements include but are not limited to the isotopic and chemical composition and dynamics of the atmosphere; surface–atmosphere physical and chemical interactions; high-resolution topography, global geomorphology, stratigraphic relationships, change detection, and gravity of the interior and surface; and the elemental and mineralogical composition of surface materials.

We propose two new goals to replace the six in the current “VISE” priority investigation. These new goals fully encompass the measurements we list above, and are of equivalent scientific importance. They are:

1. Examine the physics and chemistry of Venus to understand its current state and evolution, including past habitability.
2. Characterize the Venus surface–atmosphere interface and how it is shaped by physical and chemical processes.

Achieving either of these goals would produce transformative science and justify an entire New Frontiers mission. Therefore, we propose that this New Frontiers priority be renamed simply “Venus Explorer” in recognition of the wide variety of modern mission types that can address important Venus science questions.

# VEXAG Findings

1. Careful evaluation of U.S. funding commitments to international missions, and prioritization of U.S.-led missions.
2. VEXAG and the entire Venus community ask to be kept informed as commitments to international partners are considered and selected.
3. Support of ride-along opportunities for Venus missions.
4. Support programmatic balance among mission selections.
5. Continue to support HOTTech, high energy entry capabilities, and long duration surface power systems.
6. New support for suborbital observations of Venus.

# VEXAG Findings, continued

7. VEXAG asks for an open reporting of all AG budgets and establishment of equity across them.

Attendance and participation at AG meetings are critically important in fostering a cohesive and collegial Venus research community and building collaborative research across institutions. However, the **lack of a current Venus mission and relatively small numbers of Venus R&A PIs** mean that only a subset of the community is financially able to attend.

**VEXAG functions are significantly limited** by an opaque budget and lack of support for critical functions, such as support for on-site meeting, editorial and printing of important documents, and travel funding for mid-career and older scientists to attend AG meetings.

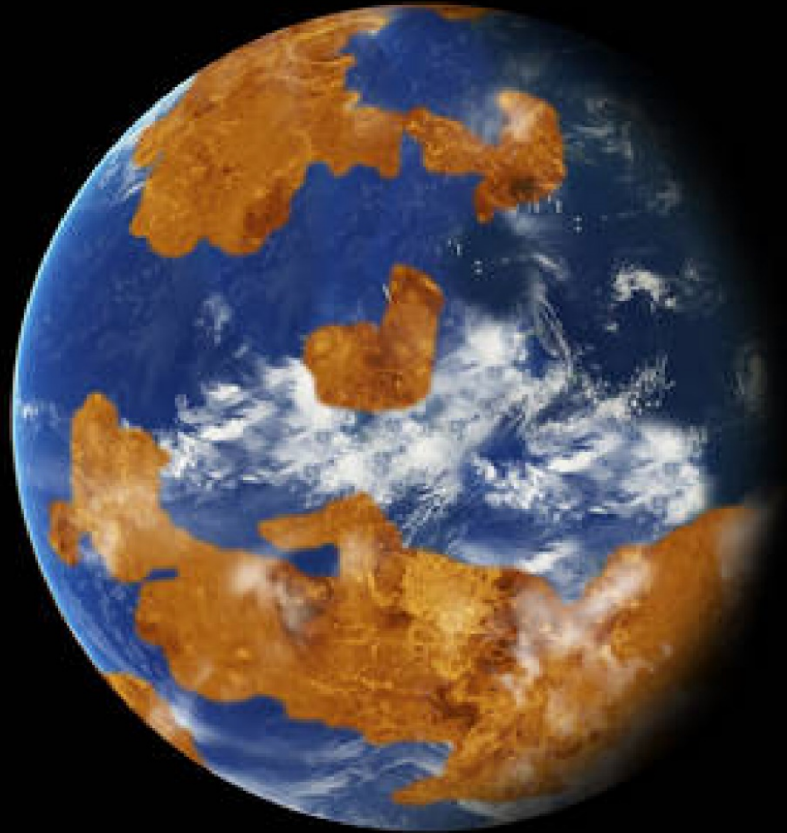
VEXAG requests **transparency and fairness in funding of AGs and their activities.**

# 2020 Venus-Related Workshops

- “Venus In Situ Sample Capture,” Keck Institute for Space Studies (KISS) Workshop (2x 1 week), CIT, Fall 2020 (Leads: Valerie Scott, Brent Fultz, Noam Izenberg)
- “Science Enabled by Human Presence on Venus,” KISS Symposium (2 day), CIT (likely), Summer 2020 (Leads: Alex McDonald, Bobak Ferdowsi, Noam Izenberg)
- “Venus Evolution Through Time,” International Space Science Institute (ISSI) Workshop, Berne, Switzerland, Summer 2020 (Leads : Doris Breuer, Cedric Gillmann, P. Senthil Kumar, Suzanne Smrekar, Thomas Widemann, Colin Wilson, Tilman Spohn)



# VENUS



THE ORIGINAL  
OCEAN WORLD