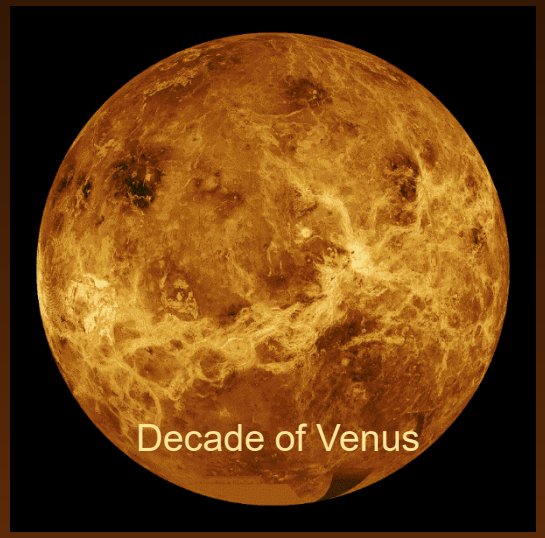
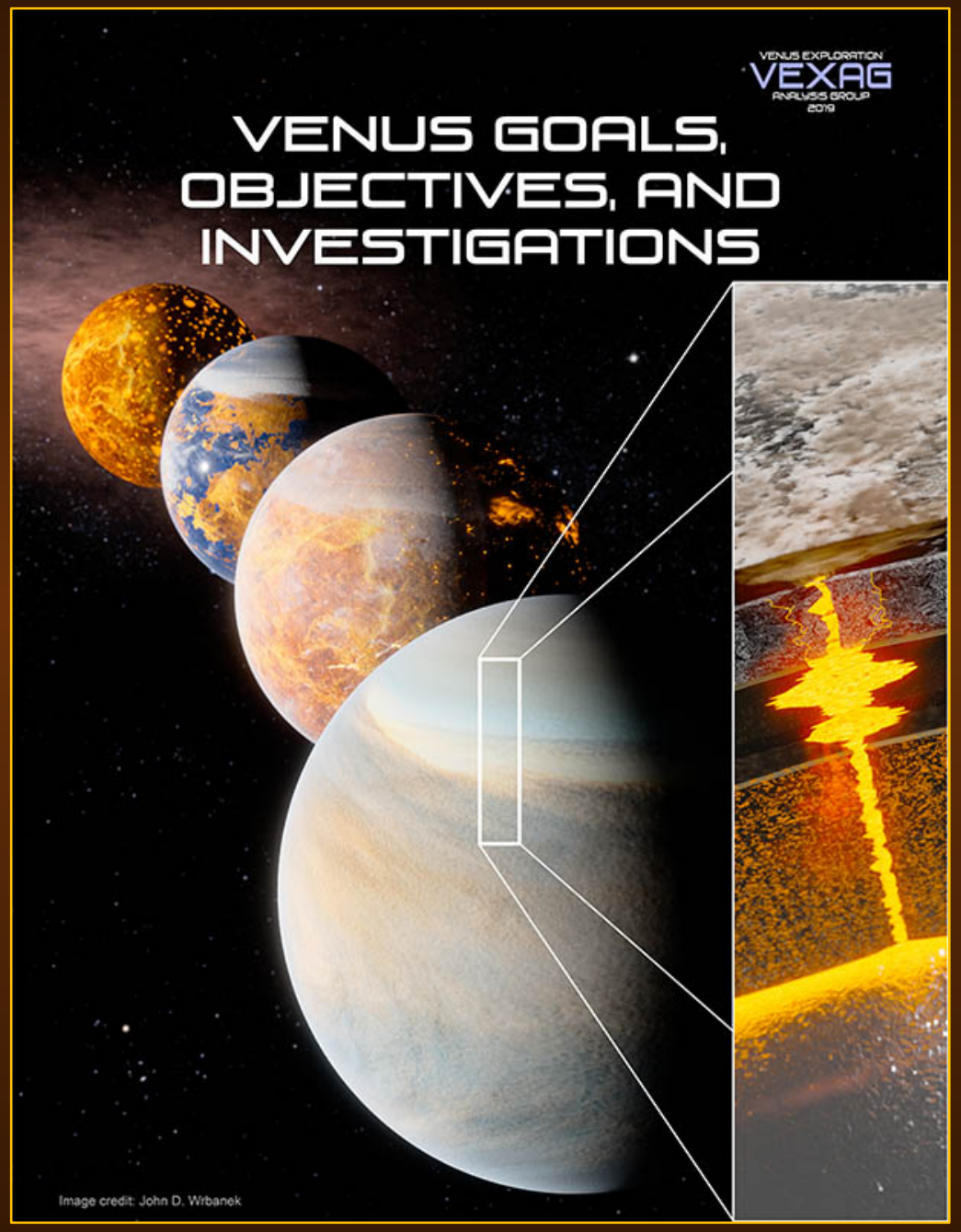
Update: Preparations for Decadal Survey



VENUS EXPLORATION VEXAG ANALYSIS GROUP

- 2018 March April — 3 teams formed; weekly meetings, writing
- December — 1st draft versions posted
- January — Virtual Town Hall to discuss
- February — 2nd draft versions posted
- March — Pre-LPSC public meeting
- April — 3rd draft versions posted
- May — Virtual Town Hall to discuss
- June — Final drafts completed
- July — Sent out for review
- August — Formatting for consistency
- September — Revisions
- October — Final edits, proofreading
- November 2019 — DONE



Goal #1. Understand Venus' early evolution and potential habitability to constrain the evolution of Venus-sized (exo)planets

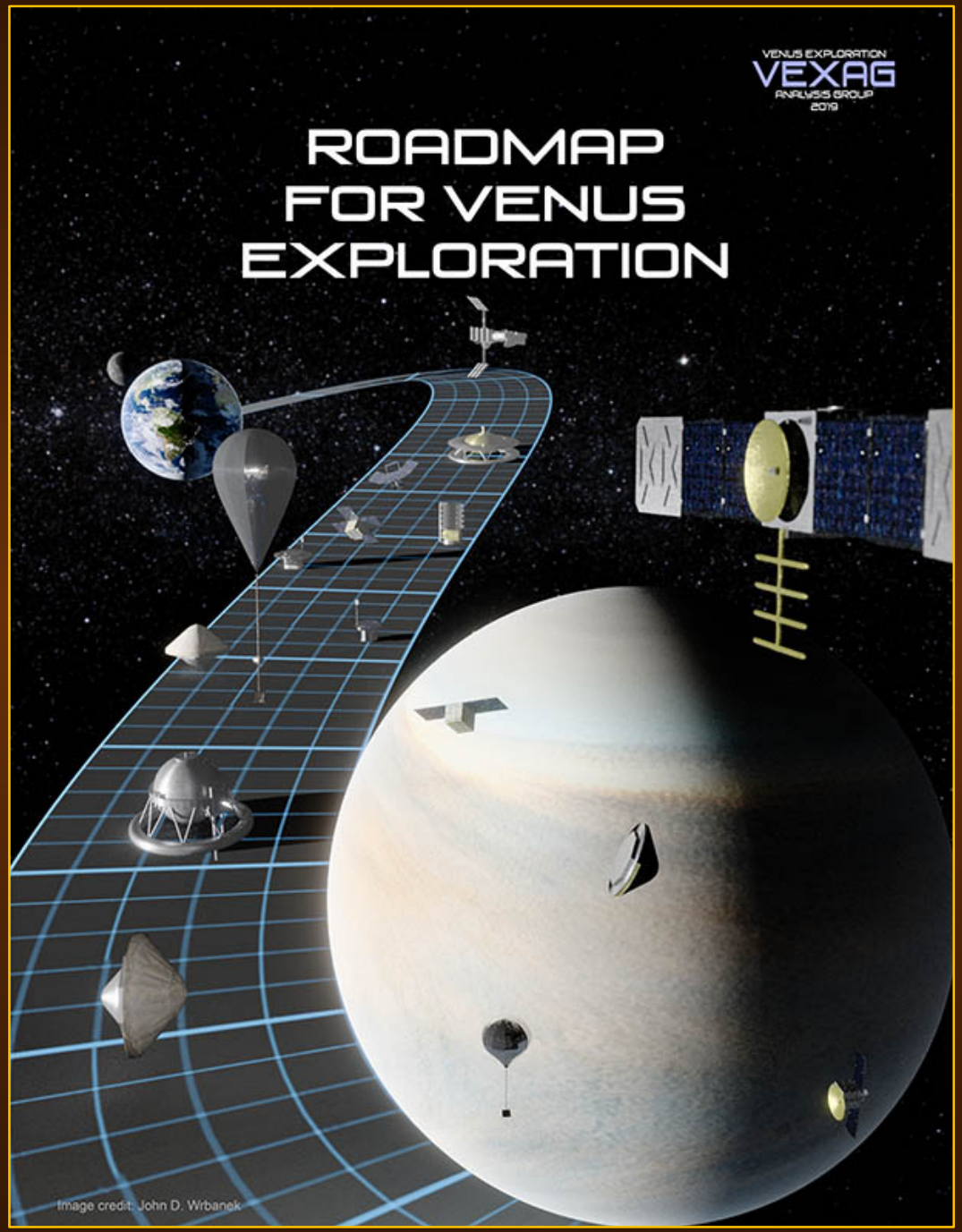
A. Did Venus have temperate surface conditions and liquid water at early times?
B. How does Venus elucidate possible pathways for planetary evolution in general?

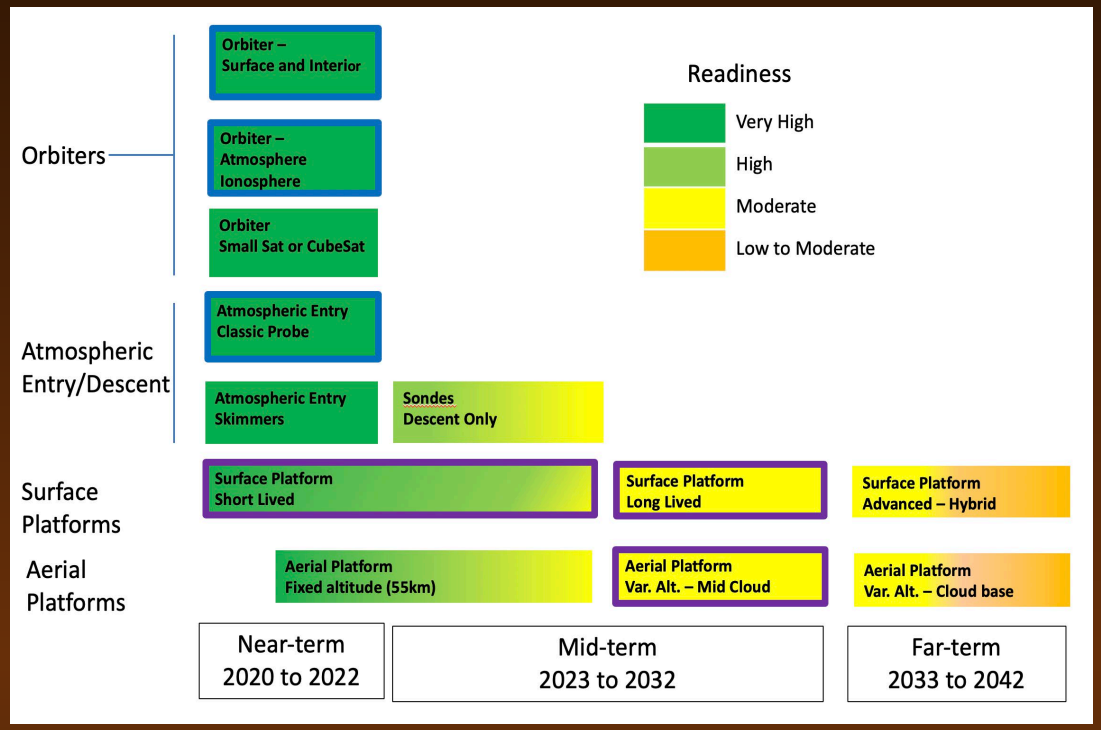
Goal #2. Understand atmospheric composition and dynamics on Venus

A. What processes drive the global atmospheric dynamics of Venus?
B. What processes determine the baseline and variations in Venus atmospheric composition and global and local radiative balance?

Goal #3. Understand the geologic history preserved on the surface of Venus and the present-day couplings between the surface and atmosphere.

A. What geologic processes have shaped the surface of Venus?
B. How do the atmosphere and surface of Venus interact?





VEXAG GOI			Roadmap Mission Modalities											
			Orbiter	Orbiter	Orbiter	Atmospheric Entry			Surface Platform			Aerial Platform		
Goal	Objective	Investigation	Surface/Interior	Atmosphere	SmallSat	Skimmer	Probe	Sonde	Short-lived	Long-lived (Pathfinder)	Long-lived (Advanced)	Fixed Altitude	Variable Altitude	Variable+ Altitude
			Near-term	Near-term	Near-term	Near-term	Near-term	Mid-term	Near-term	Mid-term	Far-term	Near-term	Mid-term	Far-term
I. Early evolution and potential habitability	Did Venus have liquid water?	I.A.HO. (1)												
		I.A.RE. (1)												
		I.A.AL. (2)												
		I.A.MA. (3)												
	How does Venus inform pathways for planets?	I.B.IS. (1)												
		I.B.LI. (1)												
		I.B.HF. (2)												
		I.B.CO. (2)												
II. Atmospheric dynamics and composition	What drives global dynamics?	II.A.DD. (1)												
		II.A.UD. (1)												
		II.A.MP. (2)												
	What governs composition and radiative balance?	II.B.RB. (1)												
		II.B.IN. (1)												
		II.B.AE. (2)												
		II.B.UA. (2)												
		II.B.OG. (3)												
III. Geologic history and processes	What geologic processes shape the surface?	III.A.GH. (1)												
		III.A.GC. (1)												
		III.A.GA. (2)												
		III.A.CR. (2)												
	Atmosphere and surface interactions?	III.B.LW. (1)												
		III.B.GW. (2)												
		III.B.CI. (3)												

Color Code	Meaning
	Vital: Mission modality enables measurements that are vital (either alone or in combination) to completing the investigation.
	Supporting: Mission modality enables measurements that substantially contribute to completing the investigation.

Table 1. Major Needs Arising from This Study	
Area	**Needs**
Entry Technology	Funding to ensure the entry technology capability does not atrophy
Subsystems	Development of high temperature electronics, sensors, and high-density power sources for the Venus environment with increasing capability
Aerial Platforms	A competitive program to determine which Variable Altitude balloons approach is most viable
In situ Instruments	Adaptation of flight-demonstrated technology and development of new instrument systems uniquely designed for the Venus environment
Communications and Infrastructure	Study of the feasibility of and methods for establishing a Venus communications and navigation infrastructure
Advanced Cooling	Investments in highly efficient mechanical thermal conversion and cooling devices
Descent and Landing	New concepts for adapting precision descent and landing hazard avoidance technologies to operate in Venus' dense atmosphere
Autonomy	Transitioning of automation and autonomous technologies to Venus-specific applications
Small Platforms	Development of small platform concepts in addition to larger missions, as well as a new mission typedesigned around small platforms
Facilities and Infrastructure	Support of laboratory facilitiies and capabilities for instrument and flight systems, including critical technologies to avoid atrophy of capabilities
Modeling and Simulations	Establishment of a system science approach to Venus modeling
Unique Venus Technology	Continued and expanded support for programs such as HOTTech, and other technology development

VEXAG White Papers

Drafts due Nov. 6, 2019

Round robin discussions at VEXAG

1. Noam Izenberg: EMPIRE Strikes Back: Venus Exploration in the New Human Spaceflight Age
2. Stephen Kane: Venus as a Nearby Exoplanetary Laboratory
3. Marty Gilmore: Venus Flagship report (only if not funded)
4. Tibor Kremic/Gary Hunter: LISSEe, VBOS, etc. small platforms for long-lived surface missions
5. Gary Hunter: High temperature electronics, recent advancements
6. Raj Venkatapathy: HEEET
7. Tibor Kremic: surface platform study? Status report or not at all if it's already done
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/Darby Dyar: 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. Devon Burr: Planetary Wind Tunnel Facility
19. Pat McGovern: Venus as a natural volcanological laboratory
20. Helen Hwang: Thermal Protection System Technologies for Enabling Future Venus Exploration
21. Alison: Venus facilities and applications for them for technology development and science investigations
22. Allan Treiman/Molly McCanta: Experimental work for understanding Venus
23. Frank Mills: Carbon, oxygen, and sulfur cycles in Venus' atmospheric chemistry
24. Eliot Young: Ground-based observations of Venus in support of future missions
25. Glyn Collinson, Janet Luhmann, Chris Russell, Steve Ledvina: Space plasma science questions and technologies
26. Colin/Sanjay: Coordination and strategy for international partners and collaborations for Venus: future fly-bys and international missions?