Venus Origins Explorer (VOX), a Proposed New Frontier Mission. S. Smrekar[1], M. D. Dyar[2,3], S. Hensley[1], J. Helbert[4], C. Sotin[1], E. Mazarico[5] and the VOX team, [1]Jet Propulsion Laboratory, Caltech, 4800 Oak Grove Dr., Pasadena CA, 91109 (ssmrekar@jpl.nasa.gov), [2] Planetary Science Institute, 1700 East Fort Lowell, Tucson, AZ 85719, [3] Dept. of Astronomy, Mount Holyoke College, South Hadley, MA 01075, [4]Institute for Planetary Research, DLR, Rutherfordstrasse 2, 12489 Berlin, Germany, [5]NASA Goddard Space Flight Center, Greenbelt MD, 20771.

Introduction: Of all known bodies in the galaxy, Venus remains the most Earth-like in terms of size, composition, surface age, and distance from the host star. Although not currently habitable, Venus lies within the 'Goldilocks zone', and may have been habitable before Earth [1]. As we search for habitable planets around other stars, we do not yet understand why Venus is currently not a habitable planet. What caused Venus to follow a divergent path towards its present hostile environment, devoid of oceans, magnetic field, and plate tectonics that enable Earth's long-term habitability? How do we know if an exoplanet is an Earth 2.0 or rather a Venus 2.0?

Venus Origins Explorer (VOX) determines how these twin planets diverged, and enables breakthroughs in our understanding of terrestrial planet evolution and habitability in our own solar system — and others.

Overview: At the time of the 2011 Decadal Survey, the full capabilities of near-IR instruments to map global mineralogy from orbit and present-day radar techniques to detect active deformation could not be fully assessed because their development was still ongoing. VOX leverages these new methods to answer essential questions, many of which can only be addressed with high resolution, global data. VOX meets and exceeds the New Frontiers science objectives using orbital, global reconnaissance, and in-situ noble gas measurements:

1. Atmospheric physics/chemistry: noble gases, their isotopes, and light stable isotopes to constrain atmospheric sources, escape processes, and volcanic outgassing; additional, multi-year global search for volcanically outgassed water.

2. Past hydrological cycles: global tesserae composition to determine the role of volatiles in crustal formation, determines if global, 'catastrophic' resurfacing occurred, and assess initial volatile sources and outgassing history.

3. Crustal physics/chemistry: determine global variations in crustal mineralogy/chemistry, tectonic framework and heat flow, whether catastrophic resurfacing occurred, what types of geologic processes are currently active and possible crustal recycling.

4. Crustal weathering: global mineralogy distinguishes between surface-atmosphere weathering reactions by quantifying the redox state and the chemical equilibrium of the near-surface atmosphere.

5. Atmospheric properties/winds: map cloud particle modes and their temporal variations, and track cloud-level winds in the polar vortices.

6. Surface-atmosphere interactions: mineralogy maps distinguish between models for surface-atmosphere chemical interactions; search for new and/or recent volcanism and outgassed water.

VOX consists of: 1) an Atmosphere Sampling Vehicle (ASV), and 2) an Orbiter that performs global reconnaissance using two instruments and a gravity science investigation. The ASV dips into the well-mixed atmosphere to deliver an atmospheric sample to the Venus Original Constituents Experiment (VOCE [2]). Measurement of noble gases reveals the source and evolution of volatiles in the inner solar system.

From orbit, Venus Emissivity Mapper (VEM [3-5]) provides global surface mineralogy and thus a test of whether tesserae formed in the presence of water [5], unprecedented frequency of observations of clouds (and thus winds) in the polar vortices [6], and searches for active and/or recent volcanism. Venus Interferometric Synthetic Aperture Radar (VISAR [7]) generates long-awaited high-resolution imaging and digital elevation models, and surveys possible active deformation locations with repeat-pass interferometry to reveal geologic evolution. Ka-band tracking provides the gravity field resolution needed to estimate global elastic thickness [8]. Requirements are specified in references.

Conclusion: VOX is the logical next mission to Venus because it delivers: 1) top priority atmosphere, surface, and interior science objectives; 2) key global data for comparative planetology; 3) the first high-resolution global topography, composition, and imaging to optimize future landed missions; 4) opportunities for revolutionary discoveries including active geologic processes, with a 3-year long orbital mission and proven implementation; and 5) 44 Tb of data to fuel the next generation of planetary, Earth, and exo-planet scientists.

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