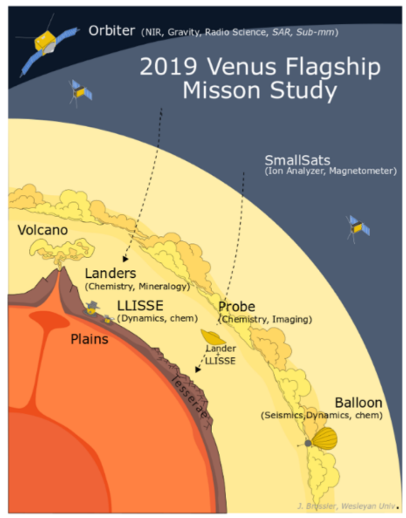
A PROPOSED VENUS FLAGSHIP MISSION. M. S. Gilmore[1] and P. M. Beauchamp[2], and the [3]2019 Venus Flagship Science Study Science Team [1]Department of Earth and Environmental Sciences, Wesleyan University, 265 Church St. Middletown CT 06459, mgilmore@wesleyan.edu. [2]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, patricia.m.beauchamp@jpl.nasa.gov. [3]S. Atreya, Univ. of Michigan, P. Boston, NASA Ames, M. Bullock, Science & Technology Corp, S. Curry, U.C. Berkeley, R. Herrick, Univ. of Alaska, J.Jackson, Caltech, S. Kane, U.C. Riverside, A. Santos, NASA Glenn, D. Stevenso, Caltech, C. Wilson, Oxford Univ., J. Luhmann, UC Berkeley, R. Lillis, UC Berkeley, J. Knicely, Univ. of Alaska.

Introduction: More than any other known planet, Venus is essential to our understanding of the evolution and habitability of Earth-sized planets in the solar system and throughout the galaxy. Volatile elements have strong influence on the evolutionary paths of rocky bodies and are critical to understanding planetary evolution. It is clear that Venus experienced a very different volatile element history than the Earth, resulting in a different evolutionary path. The science objectives of the Venus Flagship Mission (VFM) focus on understanding volatiles on Venus. The mission concept's science goals, similar to those for other solar system bodies that were shaped by volatiles such as Mars and Europa, are: to 1) assess the volatile reservoirs, inventory, and cycles over Venus history, and 2) use the understanding of the environments created by and availability of these volatiles to constrain the habitability of Venus. The VFM aims to address two critical questions for planetary science: How, if at all, did Venus evolve through a habitable phase? What circumstances affect how volatiles shape habitable worlds?

Objectives and Overview. The VFM concept study seeks to design a flagship class that mission enables us to understand the: 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 and 3) geologic history of Venus and whether Venus is active today.

The proposed VFM concept comprises an Orbiter with several instruments (near infrared spectrometer, radar, gravity measurements), two (or more) SmallSats that carry magnetometers and ion analyzers, and two Landers/Probes capable of measuring atmospheric chemical composition, isotopic ratios, pressure, temperature, as well as obtaining 1-μm descent images below ~5 km altitude. Once landed, a panoramic camera would sweep the horizon, and instruments, such as the Planetary Instrument for X-ray Lithochemistry or Raman/Laser Induced Breakdown Spectroscopy, would be used to measure the rock chemistry and mineralogy at nominally two sites. The landers would target the basaltic plains that comprise the bulk of the surface, and tessera terrain, which provide the only access to rocks from the first 80% of the history of the planet. One lander would carry a longer-lasting technology demonstration, the Long-Lived In- Situ Solar System Explorer, which measures surface temperature, pressure, wind and atmospheric chemistry as a function of time. The proposed study will also examine the possibility of detecting ground motions via a landed seismometer or by an infrasound technique from aerial platforms.



A Venus Flagship mission, similar to prior flagship missions such as Galileo and Cassini, would accomplish scientific discoveries greater than the sum of what is possible with the individual instruments, employing synergistic observations that work together to answer the 'big questions' relating to Venus' evolutionary path. Our proposed mission could be the first mission to trace volatile inventory, phase, movement, reservoirs and loss over Venus history. Specifically, it will provide the first measurements of the isotopes and inventory of all major atmospheric noble gases, the first measurement of the isotopes and volatile content of rocks, and the first measurement of the chemistry of the oldest rocks on Venus, the first measurement of global sur-face composition from orbit, the first measurement of interior structure and remanent magnetism, the first modern, multiple measurements of lower atmosphere in situ and over time via orbital spectroscopy, the first deployment of SmallSats at Venus and simultaneous measurements of the exosphere. Although we will be specifying a point-design, we will provide a range of mission implementation strategies at a number of cost points that can address significant science goals. This study will also evaluate and make recommendations for future technology investments and maturation schedules.