DETECTING CRUSTAL REMANENT MAGNETISM ON THE SURFACE OF VENUS: REQUIRED INSTRUMENT PERFORMANCE AND MISSION DESIGN. J. G. O'Rourke, SESE Exploration Postdoctoral Fellow, School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA (jgorourk@asu.edu).

Introduction: Venus is the only major planet with no known evidence for an internally generated magnetic field either today or in the past. Pioneer Venus Orbiter constrained the intrinsic dipole moment of Venus to less than 10^{-5} times that of Earth [1]. Crustal remanent magnetism—as already observed on Mercury, Mars, Earth, and Moon [2]—may still await detection because the surface temperature is currently below the Curie points of common magnetic carriers such as magnetite and hematite [3]. However, no magnetometer measurements have been made below the ionosphere—let alone a global search for magnetic signatures. Detecting crustal remanent magnetism would provide strong evidence that Venus and Earth both suffered energetic impacts during accretion, which formed metallic cores that were initially liquid and chemically homogenous. A non-detection would indicate formation under cold conditions, and thus that Venus and Earth always evolved along different paths.

Motivational Modeling: Previous presentations described numerical simulations that assessed the prospects for a dynamo in Venus over time [3]. Atmosphere/interior coupling was implemented to account for feedbacks between atmospheric evolution and mantle convection, including atmospheric escape and changes in mantle convective regime with surface temperature [4,5]. Core/mantle heat flow governs the thermal and chemical evolution of the core.

The key result with implications for Venus exploration is that dynamo activity within the surface age (~1 Gyr) is predicted even in simulations with no dynamo at present day, assuming that Venus has an "Earth-like" (chemically homogenous and at least partially liquid) core. An alternative scenario—chemical stratification in the core (Si & O abundances increasing with radius) that persists after accretion [6]—predicts no dynamo activity at any time. Completely solidifying the core of Venus [7] requires initial temperatures so low that stratification would also exist.

Searching for Crustal Remanence: Designing a magnetic survey requires estimating the magnitude of potentially observable fields and defining the associated requirements on instrument performance and mission design. Previous simulations yield estimates for the cumulative volume of magnetized crust—obtained by counting the volume of extrusive volcanism during periods of dynamo activity. Terrestrial basalt is an analogous carrier for thermoremanent magnetism. Crust that is buried below the depth where temperature equals the Curie point will have demagnetized. The lateral extent of individual lava flows and temporal pace of resurfacing remain critical unknowns [8].

Aerial platforms are ideal for a magnetic survey because of the possibility of covering long distances. Low altitudes are ideal because magnetic fields decay sharply with distance. Magnetometer performance requirements are defined assuming that the mission is focused on a search for remanent magnetism (unlikely) and also assuming that the platform primarily resides at altitudes convenient for achieving other science goals like EM sounding [9] and atmospheric studies.

References: [1] Phillips J. L. & Russell C. T. (1987) *JGR, 92,* 2253. [2] Stevenson D. J. (2003) *EPSL, 208,* 1-11. [3] O'Rourke J. G. (2018) *EPSL, 502,* 46-56. [4] Armann M. & Tackley P. J. (2012) *JGR, 117,* E12003. [5] Gillmann C. & Tackley P. J. (2014) *JGR, 119,* 1189-1217. [6] Jacobson S. A. et al. (2017) *EPSL, 474,* 375-386. [7] Dumoulin C. et al. (2017) *JGR, 122,* 1338-1352. [8] O'Rourke et al. (2014) *GRL, 41,* 8252-8260. [9] Grimm et al. (2012) *Icarus, 217, 462-473.*

Science Goal	Science Objective	Physical Parameter	Observable	Instrument Performance Requirements	Mission Requirements
Understand potentially habitable environments on Venus over time for comparison to Earth and exoplanets	What processes and conditions defined the divergent evolutions of Venus and Earth?	Remanent magnetic field	Magnetic flux density	Magnetometer: - Sensitivity - Accuracy - Precision - Range	Measurements below the ionosphere of Venus: - Altitude - Distance covered Observing geometry: - Multiple sensors separated by ~1 m Estimated data volume