GEOPHYSICAL TESTS FOR HABITABILITY IN EUROPA AND OTHER OCEAN WORLDS. S. D. Vance[1], S. Kedar[1], W. B. Banerdt[1], M. P. Panning[2], W. T. Pike[3], S. C. Stähler[4], [1]svance@jpl.nasa.gov, Jet Propulsion Laboratory, California Institute of Technology, [2]University of Florida, [3]Imperial College of London, [4]Ludwig-Maximilians-Universität München

Introduction: Seismic investigations can provide unique views into the habitability of ocean worlds. Measuring the radial depths of compositional interfaces using seismology in a broad frequency range can sharpen inferences of interior structures and compositions deduced from gravity and magnetometry studies, such as those planned for NASA's proposed Europa Mission and ESA's JUICE mission. This information informs the extent of water-rock interaction through rock composition and temperature, and the oxidation state of the ocean through ocean salinity. Seismology may also offer information about redox fluxes into the ocean by fluid motions within or beneath ice—which complements magnetic studies—and can record the dynamics of ice layers, which would reveal mechanisms and spatiotemporal occurrence of crack formation and propagation. This presentation will build on prior work [1,2] to summarize possible seismic sources and what they might reveal about Europa and other ocean worlds.

Fluid-Flow Induced Seismicity: Fluid flow generates unique and distinguishable seismic sources (Fig. 1). Ocean worlds may share common attributes with terrestrial analogs (geysers, sub-glacial flow, volcanos, cryovolcanos, and ocean resonance) whose frequencies and amplitudes represent underlying physical processes and fluid properties. Unlike brittle failures in rock or ice, which are associated with distinct compressional, shear, and surface waves, flow-driven seismicity results from a continuous interaction between the moving fluid and the surrounding rock or ice. These types of seismicity can be caused by many fluid states and flow regimes, yet they commonly appear as a continuous, quasi-monochromatic, low amplitude background vibration.

Simulations of Seismic Wave Propagation: Investigating structures and processes in the ocean worlds calls for detailed modeling of seismic sources and signatures. We will present results of detailed simulations of plausible seismic sources and wave-field propagation in Europa, with extension to other icy ocean worlds. These models enable the evaluation of seismic detectability as a complement to prior knowledge obtained by planned investigations [3] that include density and ice thickness via gravity; and salinity and ocean depth via induced magnetic fields.

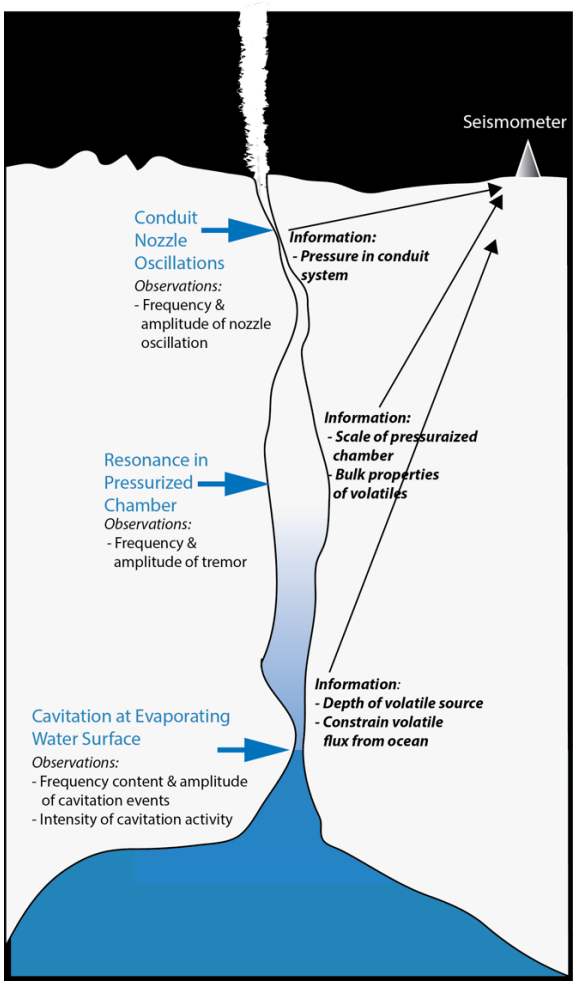

Figure 1: Inspired by Spencer and Nimmo [4], potential seismic sources (blue text) and how they might be used to constrain the physical properties and parameters of a cryovalcano system. The hypothesized seismic sources of cavitation, chamber resonance, and nozzle oscillations are based on terrestrial analogues of geysers, volcanoes and volcanic nozzles respectively.

References: [1] Vance, S. D., Kedar, S., Panning, M. P., Stähler, Bills, B. G., Lorenz, R. D., Huang, H.-H., Pike, W. T., Castillo, J. C., Lognonné, P. Tsai, V. C., and Rhoden A. R. arXiv:1610.10067. [2] Kedar, S. Vance, S., Banerdt, B., Panning, M. P., Pike, T. W., and Stähler, S. C. (2017). LPSC Proceedings. [3] Pappalardo, R. T., Senske, D. A., Korth, H. et al. (2017). LPSC Proceedings. [4] Spencer, J. R. and Nimmo, F. (2013). *Ann. Rev. Earth Plan. Sci.*, **41**(1):693.