DETECTION OF ACTIVE LAVA FLOWS ON VENUS USING REPEATED INSAR MEASUREMENTS: INSAR ANALYSIS OF THE 2018 HAWAII LAVA FLOWS.

M. C. Brandin[1], D. T. Sandwell[1], M. B. Russell[2], and C. L. Johnson[2,3], [1]Institute of Geophysics and Planetary Physics (9500 Gilman Dr., La Jolla CA, 92101), [2]Planetary Science Institute (1700 East Fort Lowell Suite 106, Tucson AZ, 85719-2395), [3]University of British Columbia Vancouver (6339 Stores Road, Vancouver B.C., V6T 1V4).

Introduction: The Magellan mission provided comprehensive global mapping of Venusian lava flows, however the ages of these flows remain largely unknown, and a major unanswered question is whether Venus is volcanically active today. Upcoming missions to Venus with Synthetic Aperture Radar (SAR) instruments (VERITAS [1] and EnVision [2]) may have the capabilities to detect active volcanism within their mission lifetime using repeat-pass SAR and possibly SAR Interferometry (InSAR)[3],[4]. Previous studies have shown InSAR decorrelation to be very effective for mapping new lava flows on Earth [5]. Bare rock lava surfaces remain highly correlated in SAR data over many years. A lava flow that occurs between the two SAR acquisitions will reduce the correlation to essentially zero. Atmospheric disturbances, which distort the InSAR phase, have little effect on the correlation [4].

We use Kilauea in Hawaii as a natural laboratory to test whether InSAR can be used to detect lava flows, assuming orbital and instrument parameters similar to those for a Venus mission. Kilauea was chosen since lava flows are well documented in USGS maps[6]. Moreover, the island of Hawaii is a SAR supersite[7], for which various international space agencies have provided open datasets for analyses. These open data have three different wavelengths (L, C, X), multiple radar bandwidths, multiple polarizations, multiple look angles, and a variety of orbital baselines, providing ample opportunity to test for optimal parameters for detecting lava flows.

We assemble data from ALOS-2 (L-band [8]), Sentinel-1 (C-band [9]), and TerraSAR-X (X-band [10]) spanning the 2018 lava flow event along the lower east rift zone. We perform InSAR correlation analysis over different temporal baselines; 12 days, representing the repeat pass period of these satellites over Earth, and ~240 days, representing the repeat pass period of a mission over Venus, a planet with a rotational period of 243 days [4]. We show that the 2018 lava flow event is visible in both the 12 day temporal baseline (400 repeat passes) and 240 day temporal baseline (5 repeat passes). As the expected lifespan of a Venus SAR mission could allow for 5 repeat passes[1],[2], we argue that the inclusion of repeat-pass InSAR capabilities in upcoming Venus missions, is key to detecting and quantifying current volcanic activity on Earth's sister planet.

References: [1] NASA.gov VERITAS. [2] ESA.int EnVision. [3] Hensley S. et al. (2022). [4] Meyer F. J. and Sandwell D. T. (2012). [5] Diettrich H. R. et al. (2012). [6] USGS.gov Kilauea East Rift Zone Maps. [8] JAXA.jp ALOS-2. [9] ESA.int Sentinel-1. [10] ESA.int TerraSAR-X.