

**PREDICTING VENUS' SEISMICITY FOR INFRASOUND DETECTION.** L. Sabbeth<sup>1</sup>, S. E. Smrekar<sup>1</sup>, J. M. Stock<sup>2</sup>, J. M. Jackson<sup>2</sup>, <sup>1</sup>Jet Propulsion Laboratory/California Institute of Technology, Pasadena, CA 91024, <sup>2</sup>Seismological Laboratory, California Institute of Technology, Pasadena, 91125 (leah.sabbeth@jpl.nasa.gov).

**Introduction:** That Venus was once tectonically active, but is no longer, is a concept stemming from the model proposing a resurfacing event 300-600 Ma, followed by a decline in geologic activity [1,2]. On the contrary, thermal emissivity data and variations in lithospheric properties demonstrate that that parts of the planet are likely geologically active on times scales 100s of ka [3]. An assessment of seismicity, investigating the sources and possible magnitudes of events capable of generating infrasound, will highlight geologic features likely to be active, inform the planet's surface age, and will locate areas that are actively deforming.

We aim to discern which sources of seismicity may be detectable through infrasound by means of a balloon-based barometer floating ~55 km in the atmosphere of Venus. Due to the high density of the atmosphere, and a limited amount of loose, fine-grained material from erosion [3,5], seismoacoustic coupling should be sufficient such that the barometer will be able to detect seismic events at the surface of Venus. On Earth, ground-based infrasound detector-arrays reported infrasound (1-5 Hz) pressure traces from the 2011 January 3 magnitude 4.7 Circleville earthquake in Utah (depth 8km) [6]. Predicted seismicity requires distinguishing seismic sources, whether the sources are tectonically active, and the likely magnitudes of quakes from these sources.

#### **Methods:**

*Activity.* First, we assess which regions and features may be active. Several extant datasets inform the presence of activity. Anomalies in thermal emissivity and radar emissivity highlight compositional differences in lava flows and signify lack of weathering [3,5]. A comparison of impact crater density to the density of craters with extended volcanic ejecta identifies broad regions likely to have experienced relatively recent volcanism that covered the extended ejecta but not the craters [7].

Several regions have been suggested to be active, including the Beta-Atla-Themis region, Ganis Chasma [8,9], parts of Imdr Regio [10,11], and Dali Chasma [8]. Hot spots, where youngest lavas flows have high thermal emissivity anomalies, highlight active volcanoes [3], and presumably the surrounding regions host related tectonic activity. Radar emissivity anomalies reflect the compositional lack of weathering at high altitude in recent lava [5], and independently corroborate active regions detected with thermal emissivity. It is a priority to identify geologic features

in these regions and to determine if they are active. It follows that we estimate the magnitude of seismicity generated from these features.

*Infrasound sources.* Seismic sources on Venus include faults and volcanoes. Strike-slip, thrust, and normal faults are mapped on Venus and may generate large quakes. However, we initially focus on thrust and normal faults, which have the potential to dissipate the most energy into the atmosphere. For example, features associated with thrust faults include subduction zones, wrinkle ridges, and ridge belts. Of these features, we presume that subduction zones generate the largest quakes, and therefore the most infrasound. Normal faults include features such as grabens [12]. Volcanoes for example, produce infrasound signals via eruptions [13] or caldera collapse events. Flank eruptions are particularly conducive to causing caldera collapse [14], which could generate detectable infrasound in the atmosphere. Lava flows from these eruptions will be identified by seeking out horizontally offset thermal emissivity anomalies at volcanoes where VIRTIS data is available (roughly the southern hemisphere).

*Estimating magnitude.* After cataloguing likely active fault and volcano infrasound sources, we will estimate magnitudes of quakes possibly produced by these features. Similar to seismicity estimates on Mars [15], cumulative fault length will be used to determine possible quake magnitudes from faults. Where available, stereo topography allows one to calculate topographic highs and lows across ridge belts, giving insight to the depth of décollements of thrust belts, and will allow a more accurate estimation of quake magnitude. Volcanoes can be classified by their size and type. Larger elastic thickness is associated with larger magnitude quakes, except perhaps locally above mantle plumes [16], and we will compare our predicted activity to the elastic thickness. Ultimately, we aim to use strain rate and geothermal gradient to estimate the thickness of the seismogenic layer, helpful parameters for estimating seismicity and magnitude of quakes.

**Implications:** An understanding of seismically active features on Venus that will produce infrasound signal and the magnitudes of quakes that can be expected from these features will inform our understanding of activity on Venus, and may better constrain relative surface ages on the planet. Additionally, a better understanding of the seismogenic and elastic layers will help constrain the rheology of the lithosphere.

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