ESTIMATES ON THE FREQUENCY OF VOLCANIC ERUPTIONS ON VENUS. Paul K. Byrne[1] and Siddharth Krishnamoorthy[2], [1]Planetary Research Group, North Carolina State University, NC 27695, USA (paul.byrne@ncsu.edu), [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA.

Volcanic Venus: The NASA Magellan mission [1] showed Venus to be a world with discernable lava flows, thousands of shield volcanoes, shield fields and domes [2], and a range of volcanotectonic landforms [3]. The planet also boasts a dearth of impact craters below 25 km in diameter and none <3 km across [4]. Crater statistics derived from global Magellan data give an average model age for the surface of 700–800 Myr [5], with global-scale volcanic resurfacing likely the dominant reason for such apparent youth [6].

Ongoing Volcanism: But is Venus volcanically active today? Circumstantial evidence comes in the form of anomalously high thermal emissivity values of stratigraphically young flows recorded by the ESA Venus Express (VEx) Visible and Infrared Thermal Imaging Spectrometer. These values were interpreted as a lack of weathering arising from those flows having been emplaced perhaps within the last 250,000 years [7]. The VEx Venus Monitoring Camera also observed, over successive orbits, localized increases and decreases in surface temperature on a timescale of days to months, consistent with short-lived effusive activity [8].

The planet's atmosphere may record the effects of ongoing volcanism, with the global H_2SO cloud layer [9] itself likely maintained by the release of sulfur and water from the interior within the last several tens of millions of years [10]. And a dramatic reduction in the cloud top abundance of SO_2 observed during the Pioneer Venus mission is consistent with the injection into the atmosphere of that volatile by volcanism of a scale comparable to the 1833 eruption of Krakatau [11].

Extrapolating Eruption Data From Earth: We collated volcanic eruption data from the Smithsonian Institution's Global Volcanism Program (GVP) database [12], extrapolating those findings to Venus to estimate the frequency of eruptive events there. The GVP database catalogs the number and duration of terrestrial and submarine volcanic eruptions extending beyond the last 2,000 years. To minimize inconsistent reporting of historical eruptions, we only considered eruptions between 1 January 1900 through 24 July 2020 (assigning any ongoing eruptions that end date).

We identified 3,780 individual eruptions from 441 unique volcanoes in the GVP database between 1 January 1900 and 24 July 2020. We removed 316 eruptions associated with 65 submarine volcanoes, leaving 3,464 subaerial eruptions, of which approximately 100 were active as of 24 July 2020. Of those, 2,897 were recorded with both a specific start and end date, to which we limited our analysis.

Eruptive Frequencies: Most eruptions on Earth are relatively short-lived, with 12.7% ending within a day and 53% within 100 days; only 20% of eruptions persist beyond 1,000 days. With the GVP dataset, we generated bootstrapped estimates of the expected number of new or ongoing eruptions within a random 30-day period on Earth. We find that an average of 2.34 new eruptions ($\sigma = 1.79$) of any duration are expected on Earth in any 30-day period. When considering both new *and* ongoing eruptions that endure ≤100 days, 1.93 ($\sigma = 1.56$) events are expected within 30 days. That frequency increases to 7.74 ($\sigma = 5.22$) eruptions lasting ≤1,000 days.

We extrapolate our findings to Venus by assuming that eruptive frequency can be directly scaled first by surface area (344%, from land surface on Earth to planetary surface on Venus), and then by some planetary parameter, e.g., planetary mass, volume, silicate portion, or surface area. Of these parameters, planetary mass offers the lowest ratio: 0.816. Thus, by this reasoning, we calculate ~six new eruptions on Venus of any duration on Venus within any 30-day window. Similarly, we might expect ~five new and ongoing Venusian eruptions ≤100 days in length, but as many as ~22 by considering new and continuing eruptions lasting ≤1,000 days, in a given 30-day span.

Outlook: This scaling approach is simplistic—but serves to illustrate that, should Venus' volcanic activity resemble that of Earth, a nominal 30-day [13] aerial platform mission in the Venus atmosphere might reasonably expect to detect volcanic eruptions (via infrasound through direct atmospheric coupling or pre- and co-eruptive seismicity [14], say). Moreover, an orbiter equipped to detect changes in surface thermal emissivity [15] could, over a nominal four-year mission, be present for more than 1,000 discrete eruptive events.

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