



Large Scale Volcanism: an explanation for the heat-death of Venus like worlds

Michael Way^{1,2,3}, Richard Ernst^{4,5}, and Jeffrey Scargle⁶

¹NASA, Goddard Institute for Space Studies, New York, United States of America (michael.j.way@nasa.gov)

²GSFC Sellers Exoplanet Environments Collaboration

³Theoretical Astrophysics, Department of Physics and Astronomy, Uppsala University, Uppsala, SE-75120, Sweden

⁴Department of Earth Sciences, Carleton University, Ottawa, Canada K1S 5B6

⁵Faculty of Geology and Geography, Tomsk State University, Tomsk, 634050, Russia

⁶Astrobiology and Space Science Division, NASA Ames Research Center, MS 245, Moffett Field, USA

Large scale volcanism has played a critical role in the long-term habitability of Earth and possibly Venus. We examine the timing of Large Igneous Provinces (LIPs) through Earth's history [1] to estimate the likelihood of nearly simultaneous events that could drive a planet into an extreme moist or runaway greenhouse, quenching subductive plate tectonics. Such events would end volatile cycling and may have caused the heat-death of Venus. Using the Earth's LIP record a conservative estimate of the rate of LIPs in a random history statistically the same as Earth's, pairs and triplets of LIPs closer in time than 0.1-1 Myrs are likely. This simultaneity threshold is significant to the extent that it is less than the time over which environmental effects have been shown to persist, for example in the Siberian Traps record [2,3].

[1] Ernst, R.E. et al. (2021). Large Igneous Province Record Through Time and Implications for Secular Environmental Changes and Geological Time-Scale Boundaries. In: Ernst, R.E., Dickson, A.J., Bekker, A. (eds.) Large Igneous Provinces: A Driver of Global Environmental and Biotic Changes. AGU Geophysical Monograph 255 (pp. 3-26).

[2] Burgess, S.D. et al. (2014). High-precision timeline for Earth's most severe extinction. Proceedings of the National Academy of Sciences, 111:

3316–3321 [correction 2014, 111: 5050].

[3] Burgess, S.D. & Bowring, S.A. (2015). High-precision geochronology confirms voluminous magmatism before, during and after Earth's most severe extinction. Sci. Adv. 1 (7), e1500470. <http://dx.doi.org/10.1126/sciadv.1500470>.