Is there a Seasonality of the Martian Seismic Event Rate?

Martin Knapmeyer¹, Simon C. Stähler², Martin van Driel², John F. Clinton², W. Bruce Banerdt³, Maren Böse⁴, Savas Ceylan⁵, Constantinos Charalambous⁴, Raphael F. Garcia⁵, Anna Horleston⁶, Taichi Kawamura⁷, Amir Khan⁵, Philippe Lognonne⁷, Mark Panning³, Domenico Giardini², William T. Pike⁴, John-Robert Scholz⁸, and Renee C. Weber⁹

¹DLR, Institut für Planetenforschung, Berlin, Germany (martin.knapmeyer@dlr.de)
²Institute of Geophysics, ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland
³Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA
⁴Department of Electrical and Electronic Engineering, Imperial College London, South Kensington Campus, London, SW7 2AZ, United Kingdom
⁵Institut Supérieur de l’Aéronautique et de l’Espace SUPAERO, 10 Avenue Edouard Belin, 31400 Toulouse, France
⁶School of Earth Sciences, University of Bristol, Wills Memorial Building, Queens Road, Bristol BS8 1RJ, UK
⁷Université de Paris, Institut de physique du globe de Paris, CNRS, F-75005 Paris, France
⁸Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany
⁹NASA MSFC, NSSTC Mail Code ST13, 320 Sparkman Drive, Huntsville, AL 35805, USA

We analyze the sequence of seismic events of different types as recorded by the SEIS instrument of the InSight mission. After several weeks without any detection, event counts started to increase at the end of May 2019. The majority of recorded events belongs to the class of 2.4 Hz events, which prominently excite a continuously observed natural resonance frequency.

After a sudden onset of seismic detections by the end of May 2019 (about sol 180, $L_s=32^\circ$), especially the combined event rate of the High Frequency, Very High Frequency, and 2.4 Hz family of events increased from 3.6 events/sol in June 2019 to more than 9 events/sol until late August 2019, i.e. increased by a factor of about 3.

Estimating event rates as if events are the result of a constant-rate Poisson process leads to contradictions with the statistical properties of those, either in the cumulative event count or in the lag time distribution. These contradictions can be overcome by assuming a step-wise increase of the event rate.

Any deviation from a purely random occurrence of quakes, in both time and space, requires a mechanism to suppress or support the source process. The seismic activity of the Moon is mainly controlled by tidal deformation, at least in terms of source time. What controls the event rate of Martian high frequency events is currently elusive.