VENUS ATMOSPHERIC MICROPHONE FOR HIGH ALTITUDE APPLICATIONS

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Background: On March 1st, 1982 Russia captured the first sounds of Venus with an "electromagnet-type" microphone [1] on board the Venera 13 & 14 probes, proving such an instrument could function all the way to the planet's surface. A limited description of mechanics and sensory response suggests a likely bulky stainless-steel overall construction, however little to no further information appears to describe this initial instrument, and no other acoustic recordings of the planet are known to exist.

Abstract: This poster will share initial results of a compact, next-generation acoustic sensor payload (microphone) being tested for atmospheric deployment in the upper atmospheric region above 0.1 bar pressure (~65 km altitude) and ~ -30°C. This sensor will ideally be optimized for inclusion as an engineering type sensor for Entry-Descent-Landing (EDL) systems in missions like NASA's upcoming DAVINCI and / or Rocket Lab's privately funded Venus Atmospheric Probe. However, we will explore tolerances and operational capability deeper in the atmosphere down to 30-50 km altitude and 80-220°C.

Such a microphone could also function to a much greater degree of longevity as an incorporated sensor payload with future Venus-bound balloon missions, ideally long-term usage operating through extended periods in the ~50km range (around 1 bar pressure).

Mission Architecture: As neither DAVINCI nor the Rocket Lab mission are required to reach the surface to complete mission requirements, (unlike the initial Russian architecture) a far less ruggedized and mass-heavy construction should be sufficient to survive the initial atmospheric conditions of descent, capturing and returning data prior to plunging into the increasingly punishing heat and density of the Venusian atmosphere.

COTS (Commercial Off-The-Shelf) components are therefore a reasonable avenue for exploring inexpensive design and testing capabilities. Intrinsically sensitive and necessarily externally mounted, the microphone will still however have to contend with the same rigors of launch and long-term exposure to the vacuum of space on its long journey to Venus, along with high entry speeds and corrosive sulfuric acid cloud structures associated with the planet's upper atmosphere.

Performance Expectations: Initial integration onboard a high-speed atmospheric probe will mainly serve as a tech demonstration to provide basic validation for the instrument for future missions, as the high wind speeds will likely obscure any unknown (and potentially scientifically promising) subtle acoustic characteristics of the Venusian atmospheric soundscape.

It will therefore be most beneficial in these initial applications to engage the microphone during known periods of onboard mechanical activity such as protective lens cap ejection, fairing or thermal shielding release, etc. where quantifiably loud and well understood acoustic signatures are being produced, enabling positive instrumentation verification.

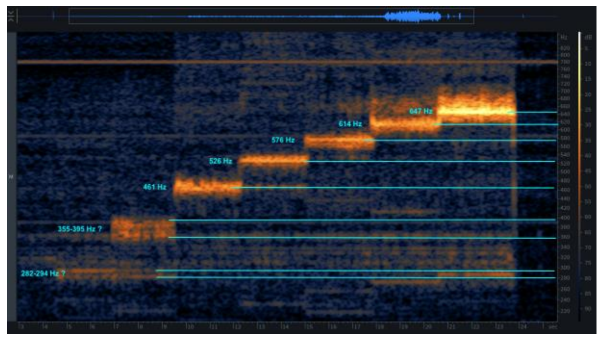

Figure 1 – Spectrogram analysis of mechanical systems on Martian surface as captured by the Mars 2020 EDLCAM microphone on Sol 46. Data is represented (L-R) as a function of amplitude & acoustic bandwidth over time (approx.. 30s) – *Zandef Deksit Inc.*

Analysis: In the long term, the expectation of an acoustic survey of the Venusian soundscape on a more atmospherically stable craft (stabilized balloon, dirigible etc.) is an exciting unknown. Venus is widely theorized to be a geologically active body with physical processes that could generate an acoustic signature at great distances, including a possible confirmation of either convectively generated or volcanic lightning (and resultant thunder) [2].

An acoustic analysis of the environment may also provide valuable insight to both atmospheric and mechanical properties, similar to analysis of sounds recently carried out on the Martian surface provided by two microphones onboard the Mars 2020 Perseverance rover [3] and [Figure 1].

References:

[1] Ksanfomaliti, L.V, et al; "Acoustic measurements of the wind velocity of the *Venera 13* and *Venera 14* landing sites"; https://adsabs.harvard.edu/full/1982SvAL....8..227K (1982)
[2] Lorenz, R.D. Lightning detection on Venus: a critical review. *Prog Earth Planet Sci* **5**, 34 (2018). https://doi.org/10.1186/s40645-018-0181-x
[3] Maurice, S., Chide, B., Murdoch, N. *et al.* In situ recording of Mars soundscape. *Nature* **605**, 653–658 (2022). https://doi.org/10.1038/s41586-022-04679-0