Geophysical Research Abstracts
Vol. 20, EGU2018-9471, 2018
EGU General Assembly 2018

Reassessing the Case for Life on Venus

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Venus is considered hostile for life because its surface (and probably subsurface) temperature reaches 460 ˚C which is incompatible with life as we know it. However, recent simulations of early-Venus suggest a totally different panorama, including the presence of a surface water ocean and moderate temperatures where the emergence and maintenance of life is much more plausible[1]. This period is postulated to have lasted nearly 2 billion years, sufficient time for life to emerge considering that life evolved on Earth in less than a billion years.

If life evolved on early Venus, could it have persisted until the present in habitable refuges such as in the clouds? Venus is covered by dense clouds composed mainly of CO_2, N_2 and sulfuric acid. Temperatures compatible with life are found at high altitude. However, the extreme acidity (pH<2) and the possible lack of suitable reductants and oxidants to power metabolisms are considered major challenges for life to persist even in this temperate zone.

We postulate that, on the contrary, a very low pH environment offers some remarkable opportunities for life and should not be considered a major impediment for survival. In addition, recent detection or postulation of suitable electron donors and receptors that could drive thermodynamically favorable metabolic pathways strengthens the case for survival (or seeding) of life in the clouds. Other life issues such as low water concentration and intense solar radiation are also discussed.

The possibility of life in the clouds should help focus research efforts for proposed future missions to Venus. Even if life is not present in the Venusian clouds, the evaluation of their potential to harbor life will be important for understanding the habitability of other Venus-like planets and for assessing scenarios for the end stage of habitability on Earth, especially if it undergoes a runaway greenhouse trajectory.

[1]Way, M. J., et al., Was Venus the first habitable world of our solar system? Geophys. Res. Lett., **43**, 8376–8383 (2016).

Acknowledgements: Fondecyt 1181717, Basal CCTE PFB16.