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国台学术报告 NAOC COLLOQUIUM

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Time: Monday 2:30 PM, Dec. 17th **Location: A601, NAOC**

Methane on Mars and Habitability: Challenges and Responses

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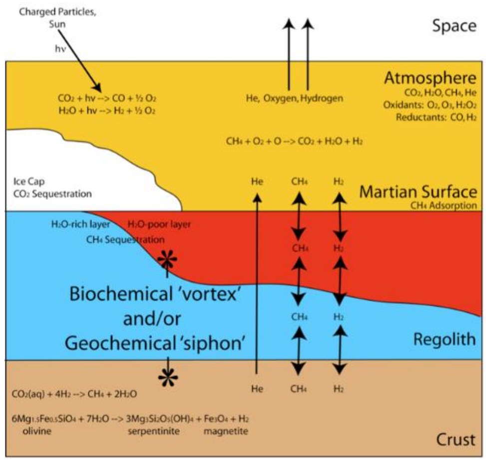
Prof. Yung got his Ph.D. in Physics in 1974 at Harvard University. In 1977 he was appointed an Assistant Professor of Planetary Science at Caltech, becoming a Professor in 1986. He is a Fellow of the American Academy of Arts and Sciences and the recipient of the 2015 Kuiper Prize of the Division for Planetary Sciences, American Astronomical Society. Professor Yung's research interest consists of six overlapping areas: planetary atmospheres, planetary evolution, atmospheric chemistry, atmospheric radiation, astrobiology and global climate change, as presented in more than 350 papers in peer-reviewed journals.



Abstract

Recent measurements of methane (CH_4) by the Mars Science Laboratory (MSL) now confront us with robust data that demand interpretation (see, e.g., Yung et al. 2018, Astrobiology 18 1221). Thus far, the MSL data have revealed a baseline level of CH_4 (~0.4 parts per billion by volume [ppbv]), with seasonal variations, as well as greatly enhanced spikes of CH_4 with peak abundances of 7 ppbv. What do these CH_4 revelations with drastically different abundances and temporal signatures represent in terms of interior geochemical processes, or is martian CH_4 a biosignature? Discerning how CH_4 generation occurs on Mars may shed light on the potential habitability of Mars. There is no evidence of life on the surface of Mars today, but microbes might reside beneath the surface. In this case, the carbon flux represented by CH_4 would serve as a link between a putative subterranean biosphere on Mars and what we can measure above the surface. Alternatively, CH_4 records modern geochemical activity. Here we ask the fundamental question: how active is Mars, geochemically and/or biologically? Here, we examine geological, geochemical, and biogeochemical processes related to our overarching question. The martian atmosphere and surface are an overwhelmingly oxidizing environment, and life requires pairing of electron donors and electron acceptors, that is, redox gradients, as an essential source of energy. Therefore, a fundamental and critical question regarding the possibility of life on Mars is, ''Where can we find redox gradients as energy sources for life on Mars?'' Hence, regardless of the pathway that generates CH_4 on Mars, the presence of CH_4, a reduced species in an oxidant-rich environment, suggests the possibility of redox gradients supporting life and habitability on Mars. Recent missions such as ExoMars Trace Gas Orbiter may provide mapping of the global distribution of CH_4. To discriminate between abiotic and biotic sources of CH_4 on Mars, future studies should use a series of diagnostic geochemical analyses, preferably performed below the ground or at the ground/atmosphere interface, including measurements of CH_4 isotopes, methane/ethane ratios, H_2 gas concentration, and species such as acetic acid. Advances in the fields of Mars exploration and instrumentation will be driven, augmented, and supported by an improved understanding of atmospheric chemistry and dynamics, deep subsurface biogeochemistry, astrobiology, planetary geology, and geophysics. Future Mars exploration programs will have to expand the integration of complementary areas of expertise to generate synergistic and innovative ideas to realize breakthroughs in advancing our understanding of the potential of life and habitable conditions having existed on Mars.

All are welcome ! Tea and coffee will be served at 2:15 PM.