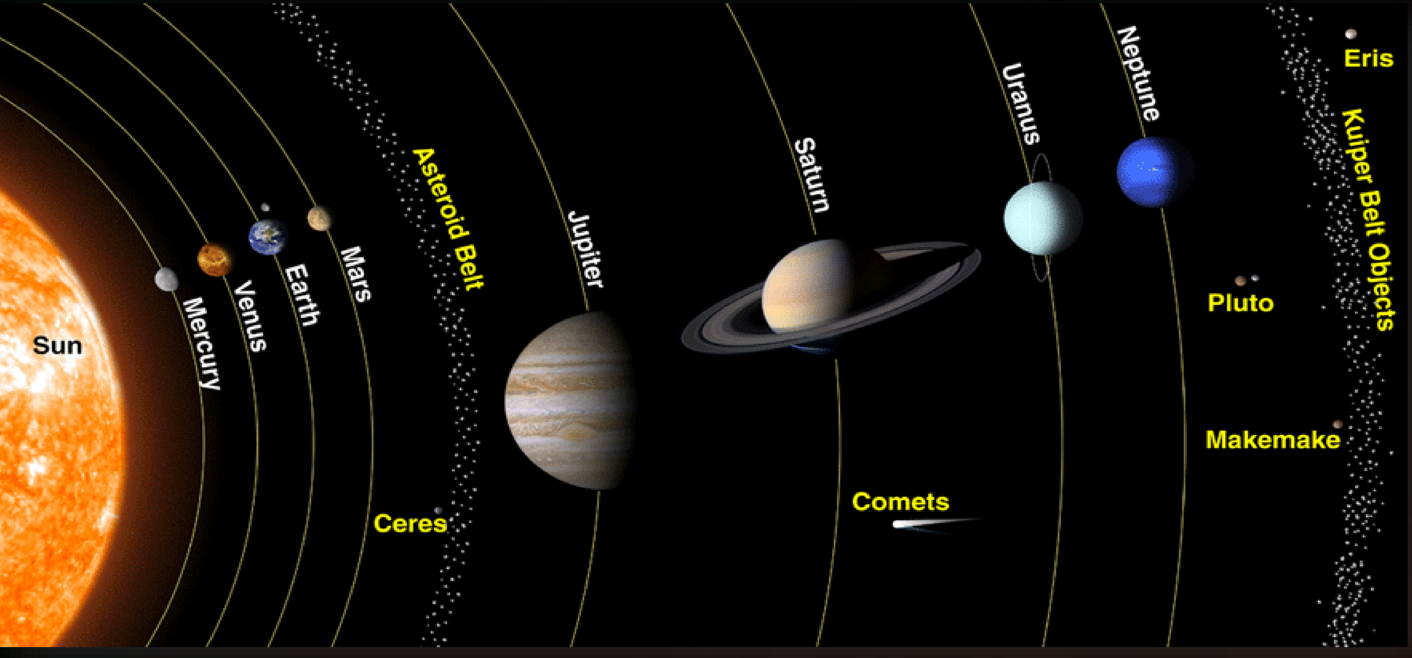

WAS THERE LIFE ON MARS?

To help answer the big question a controlled laboratory experiment has been planned.

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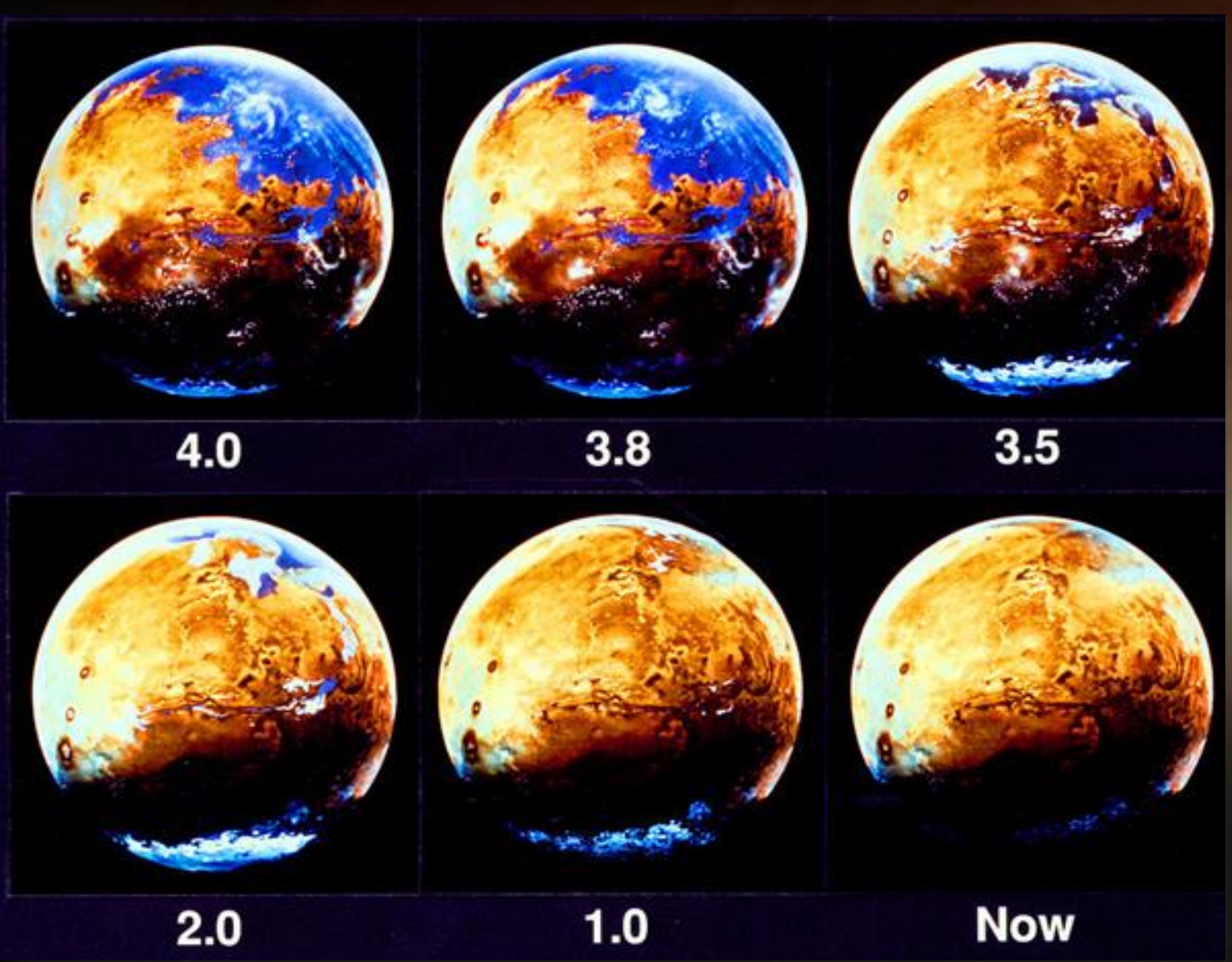
MARS? - is the fourth planet from the Sun!



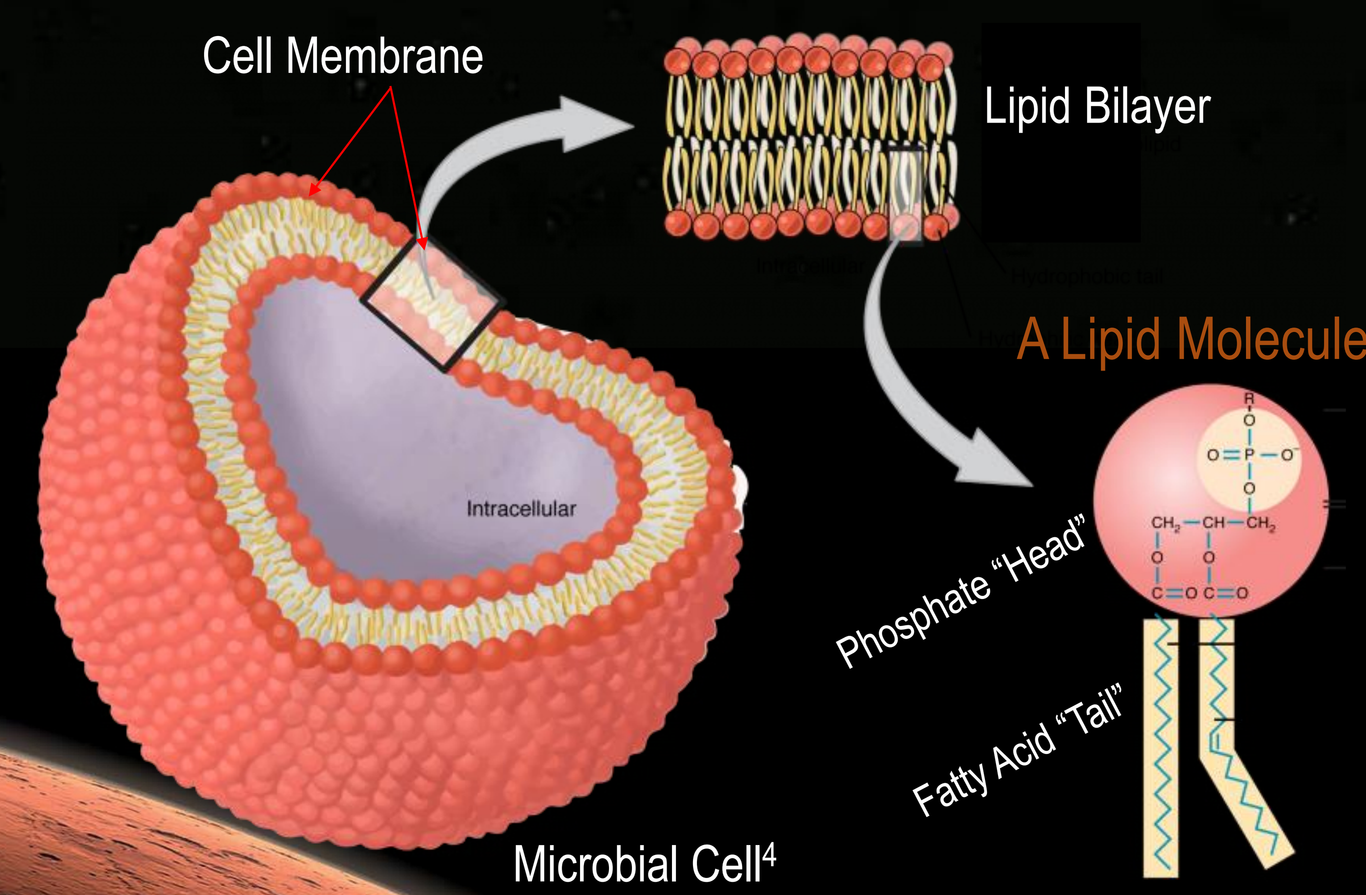
Extent of liquid water (blue) on Mars (billions of years). NASA/Ames Research Centre

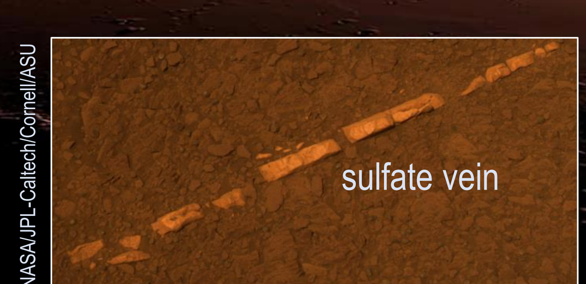
1. WHY MARS?

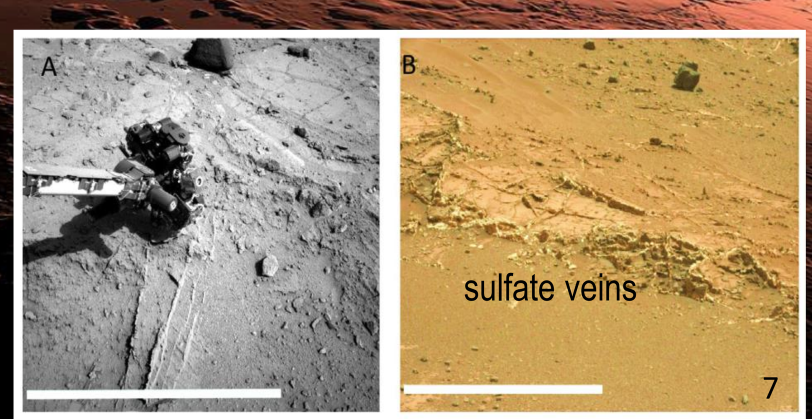
Early Mars was similar to early Earth. In fact, Mars was habitable when life arose on Earth. Cumulative evidence suggest that early Mars (~ 4 billion years ago – Noachian age) had a warmer climate and denser atmosphere that could support surficial liquid water, planetwide groundwater, and provide protection from UV and cosmic radiation. Therefore, conditions on early Mars would have been hospitable for microorganisms[1].

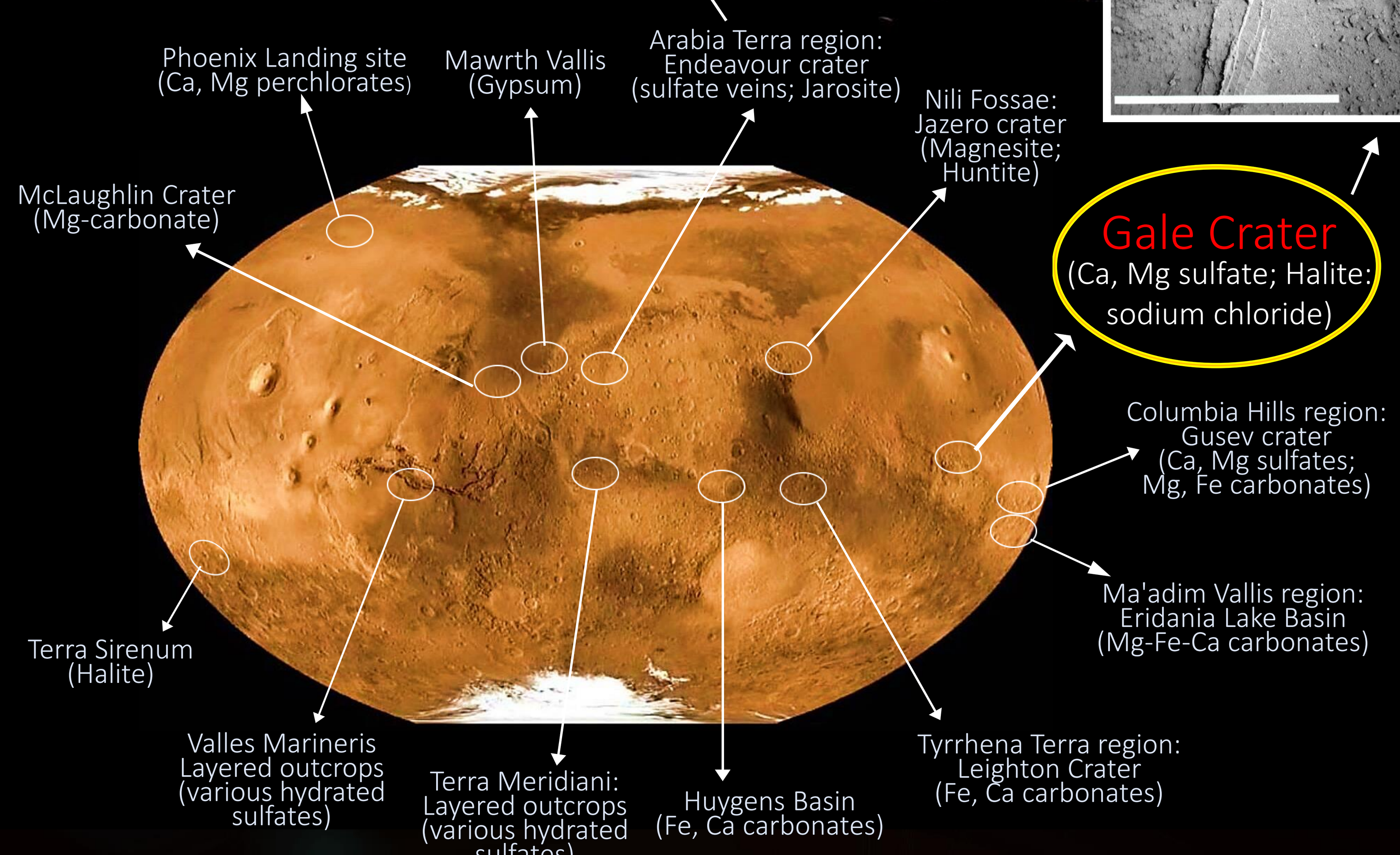
2. LIPIDS

Lipid molecules compose the cell-membranes, so these molecules are fundamental to all known Earth-life. Also, lipids can resist harsh environmental conditions and be preserved over geological time-scales. A distinct group of microorganism can leave behind a distinct lipid molecule (a lipid biomarker). A lipid molecule has two main components: phosphate & glycerol "head" and fatty acid "tail", and every microorganism has a unique fatty acid profile[2,3].







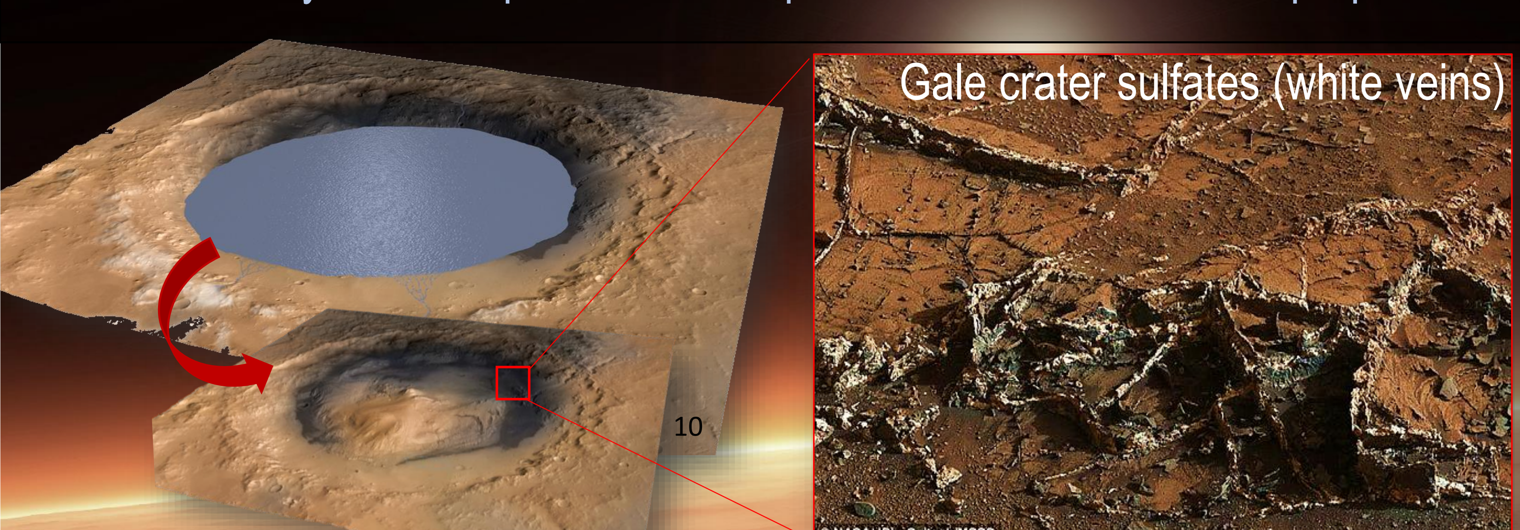


3. SALTS ON MARS

Mars is a salty planet. Various robotic and remote-sensing missions have confirmed the presence of salt deposits (e.g., chlorides, sulfates) on the ancient surfaces of Mars (4 to 3.7 billion years old)[5]. The extent of these salts indicates that there has previously been widespread liquid water on Mars. It is possible that remnants of microbial life present on early Mars would have been preserved within these salts. On Earth, crystalline salts have been found to harbour and protect microbial life for a prolonged period, possibly over millions of years[6].

4. DETECTION OF LIPID BIOMARKERS IN MARTIAN SALT

a. An experimental fluid[7] similar to the ancient Gale crater lake on Mars that may have evaporated and deposited sulfate salts will be prepared.

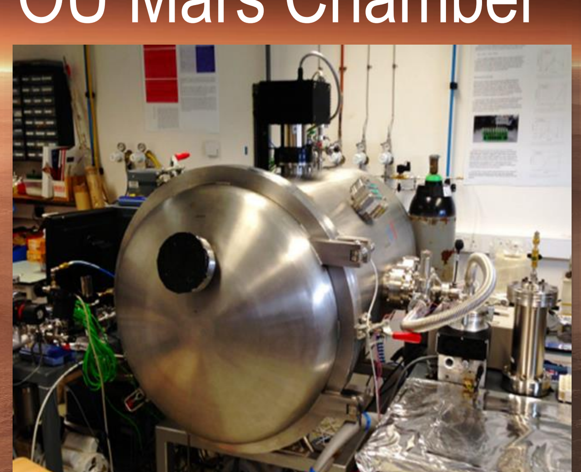


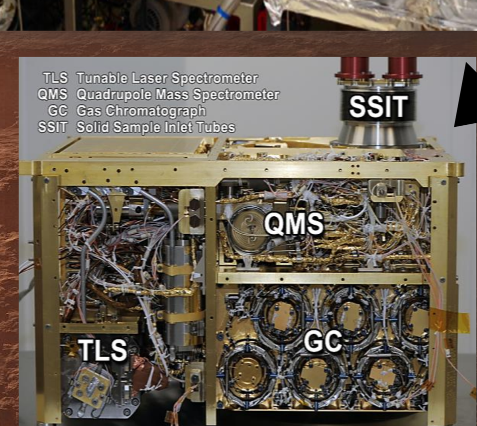
b. Microorganisms will then be introduced to the experimental Gale-crater-fluid and evaporated under high energy radiation and low atmospheric pressure in the Mars chamber, as well as, ambient conditions. The evaporated fluid now becomes (sulfate) salt crystals with microbial cells buried inside!

c. The fatty acid component of the lipids will then be extracted from the experimental sulfate crystals prepared under radiative-Mars and ambient conditions.

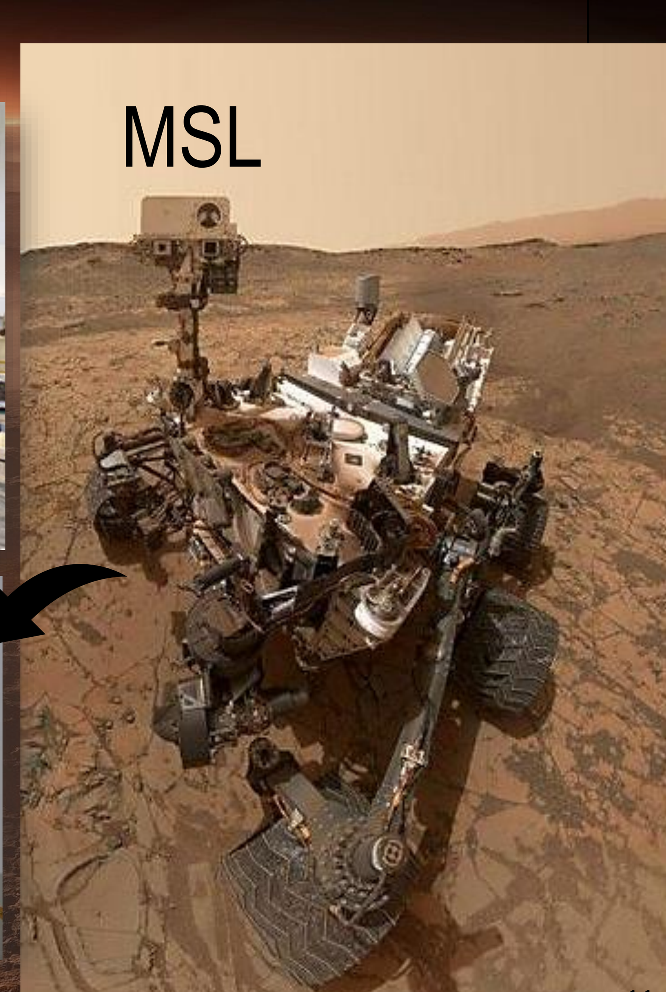
d. The extracted fatty acids will be injected into the Gas Chromatograph-Mass Spectrometer (GC-MS) to test the recovery (detection) of fatty acids from both set of samples and compare the level of degradation.

OU Mars Chamber





MSL GC-MS[8]



e. GC-MS is an important tool of NASA's Mars Science Laboratory (MSL)[8] and ESA's ExoMars[9] rover to seek the ancient signs of life on Mars.

The MSL and ExoMars GC-MS simulation facilities will be used to better understand the recovery of fatty acids from our Mars-like sulfate salts and predict the best possibilities of detection of ancient life-signatures on Mars.

The present study is timely as MSL's next stop will be the sulfate-bearing unite of the Gale crater!

1: Michalski et al., 2013 https://doi.org/10.1038/ngeo1706 2: Alberts et al., 2002 https://www.ncbi.nlm.nih.gov/books/NBK21054/
3: Luo et l., 2019 https://doi.org/10.1016/j.earscirev.2018.03.005 4: https://open.oregonstate.education/aandp/chapter/3-1-the-cell-membrane/ 5: Rapin et al., 2019 https://doi.org/10.1038/s41561-019-0458-8 6:Vreeland et al., 2000 https://doi.org/10.1038/35038060 7: Schwenzer et al., 2016 https://doi.org/10.1111/maps.12668
8: Mahaffy et al., 2012 https://doi.org/10.1007/s11214-012-9879-z 9: Vago JL et al., 2017 http://doi.org/10.1089/ast.2016.1533
10: NASA/JPL-Caltech/ESA/DLR/FU Berlin/MSSS 11: NASA/JPL-Caltech