

# THE ORGANIC CARBON CYCLE IN THE ATMOSPHERE OF VENUS AND EVOLVING RED OIL

Jan Spacek<sup>1</sup>  
and Steven Benner<sup>2</sup>,

<sup>1</sup>Firebird Biomolecular Sciences, LLC (13709 Progress Boulevard, Box 17, Alachua FL 32614  
jspacek@firebirdbio.com),

<sup>2</sup>Foundation for Applied Molecular Evolution (13709 Progress Boulevard, Box 7, Alachua FL  
32614 sbenner@ffame.org).

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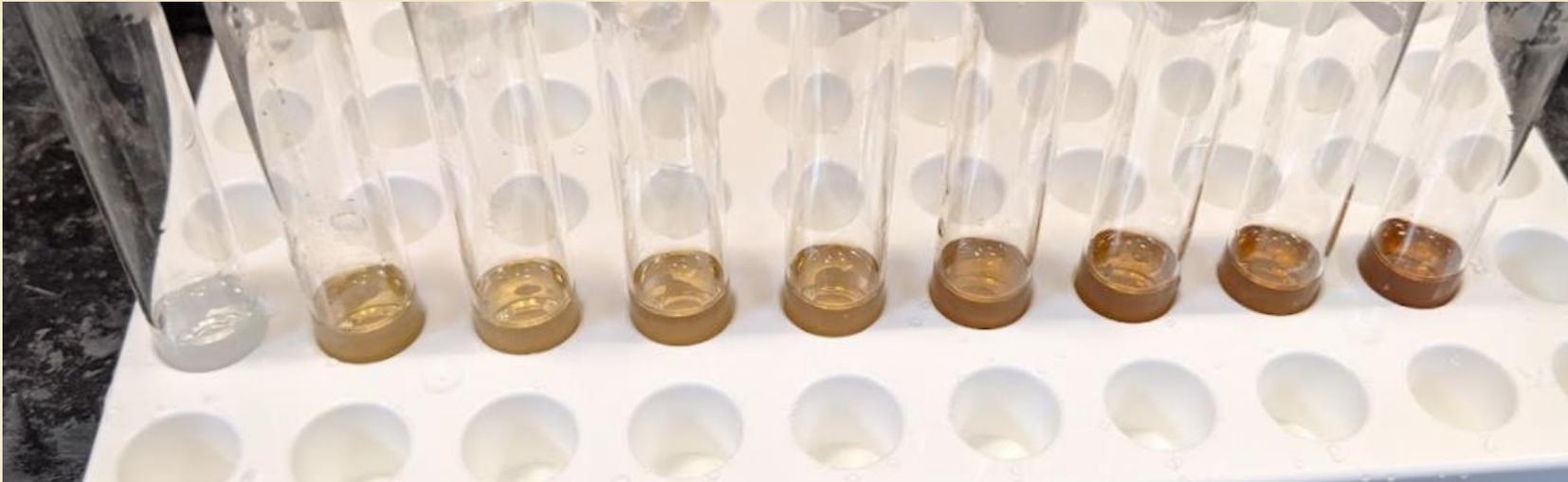
## **Students/Technicians:**

Gage Owens  
Spencer Cady

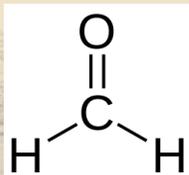
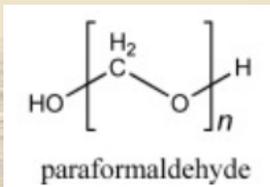
# Red oil

Organic molecules in concentrated sulfuric acid are generally **not oxidized** to CO<sub>2</sub> or CO gas. They **are converted** to the **red oil** and later to carbon particles.

*The name comes from side reaction of acid catalyzed alkylation during octane production.*



Paraformaldehyde in 70% sulfuric acid – different times at 90 °C.



Formaldehyde gas yields in the same product.



# Carbon particles



*The black sludge is dissolved in the sulfuric acid, but precipitates in water.*



*Assuming  $H_2CO$  is turned into mostly carbon, the yield is ~30 - 50%*

# Boudouard reaction



At elevated temperature and high concentrations of carbon dioxide (lower Venus atmosphere) carbon dioxide reacts with graphite (coal, soot...) to form carbon monoxide.

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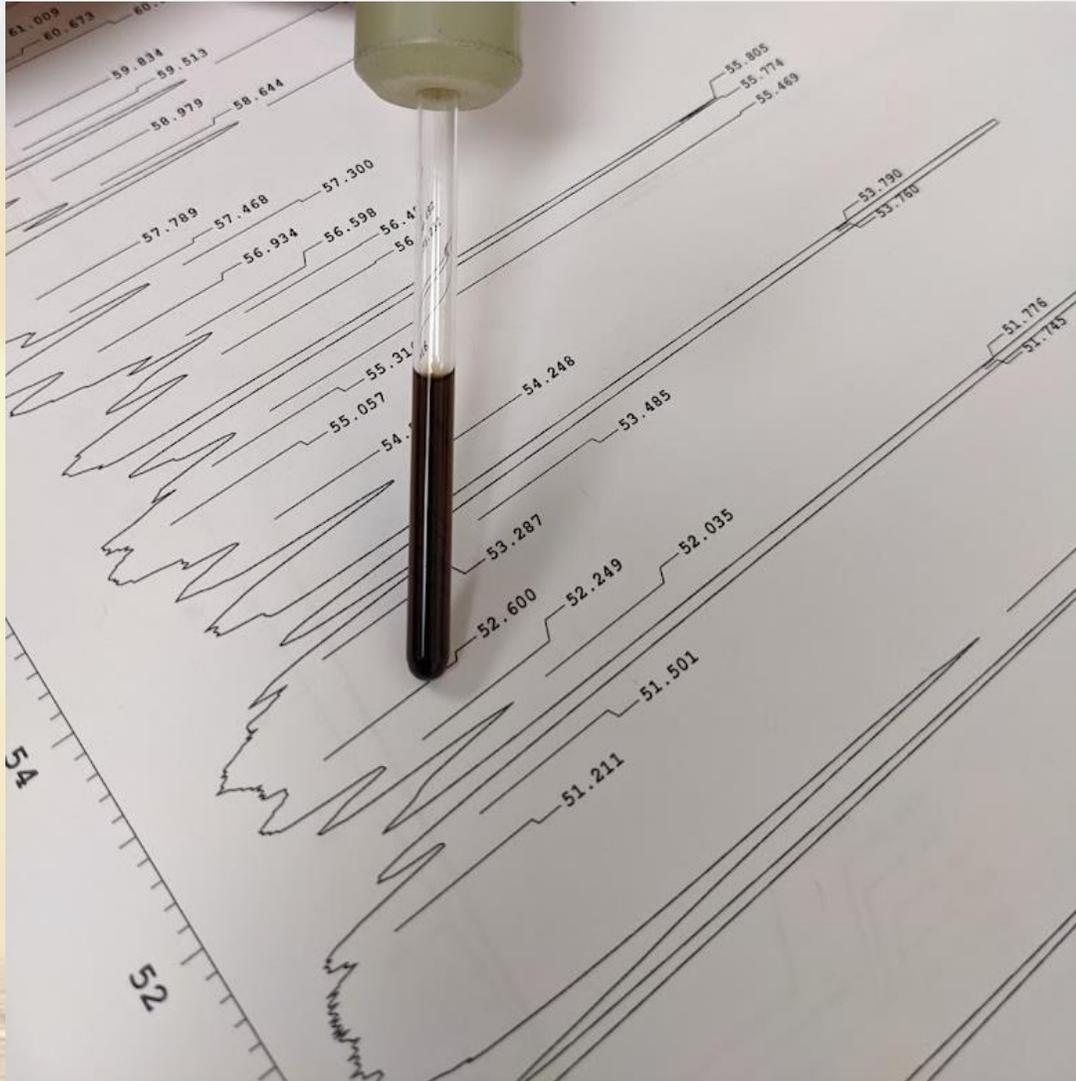
# Identification of the red oil

Steven Benner and I have two conflicting hypotheses what is the red oil made from.

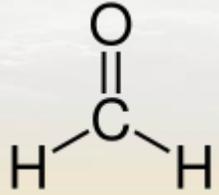
We are currently collecting NMR and MS spectra from different stages of the red oil conversion to see who was right.

But from the preliminary NMR and MS we are certain that **new C-C bonds are formed even when starting from single-carbon species**. The new products are large molecules (up to over 1600 m/z) even with not yet visibly colored red oil.

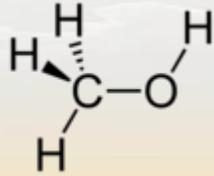
**Red oil conversion increases complexity of material.**



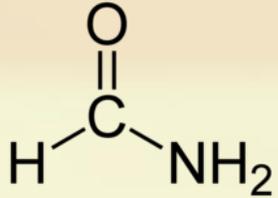
# Fluorescence of the red oil



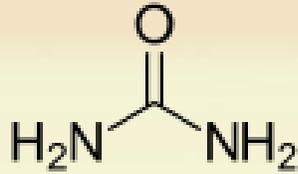
Formaldehyde



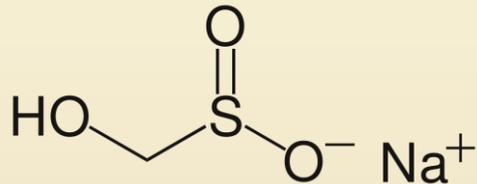
methanol



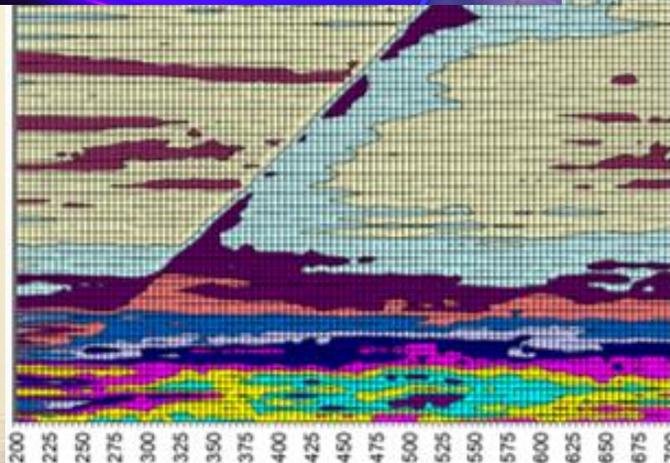
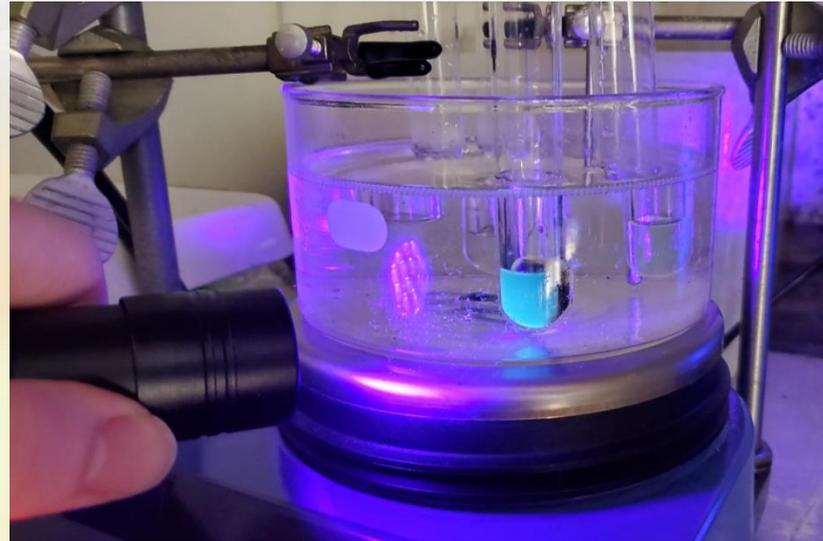
Formamide



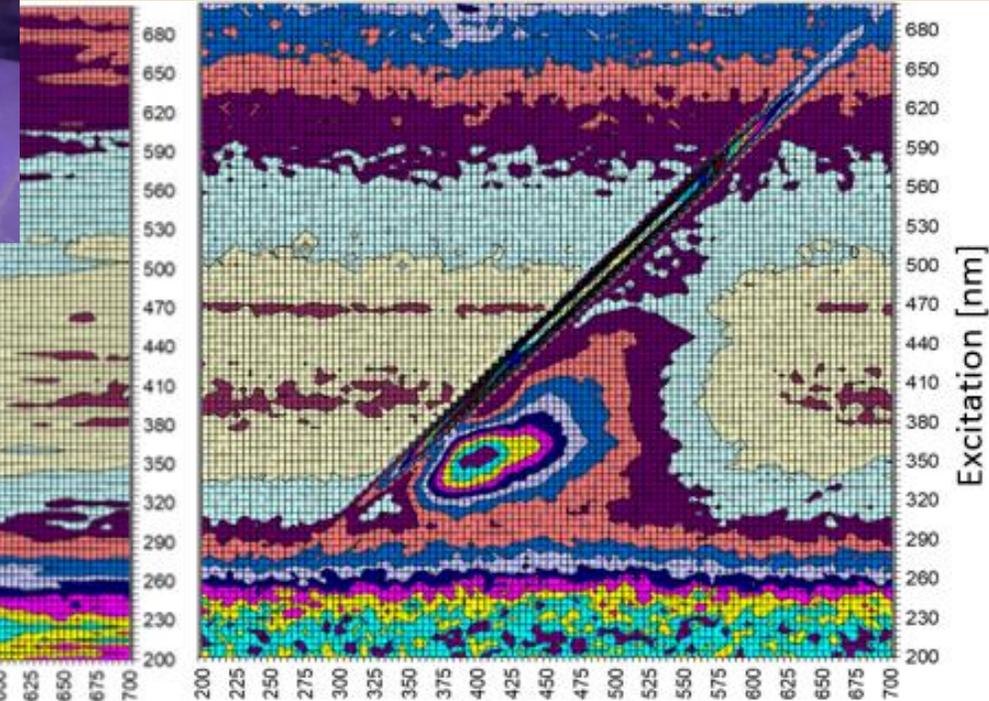
Urea



Sodium hydroxymethyl sulfonate

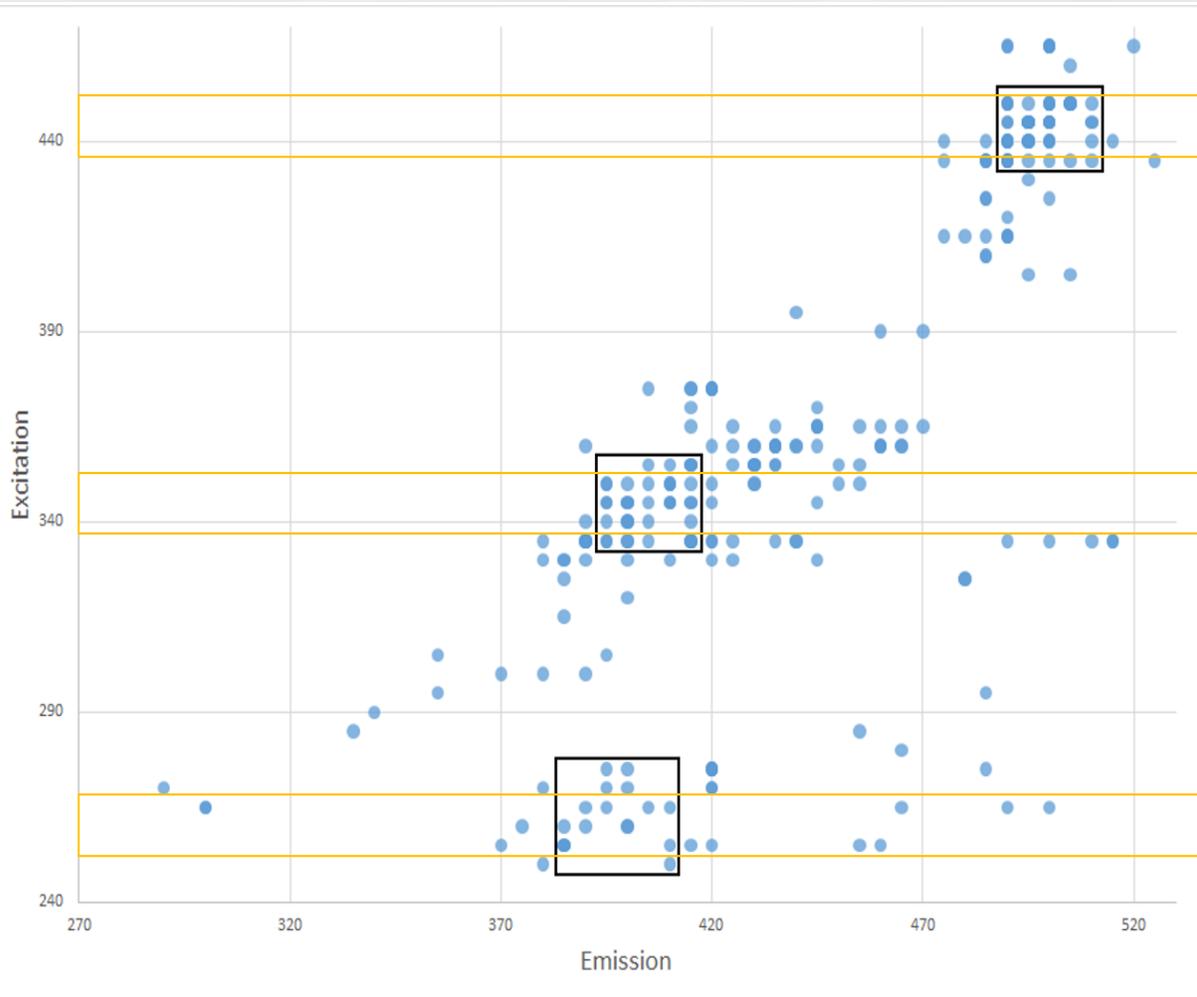


Formaldehyde 0 hours



Formaldehyde 48 hours

# Fluorescence of the red oil



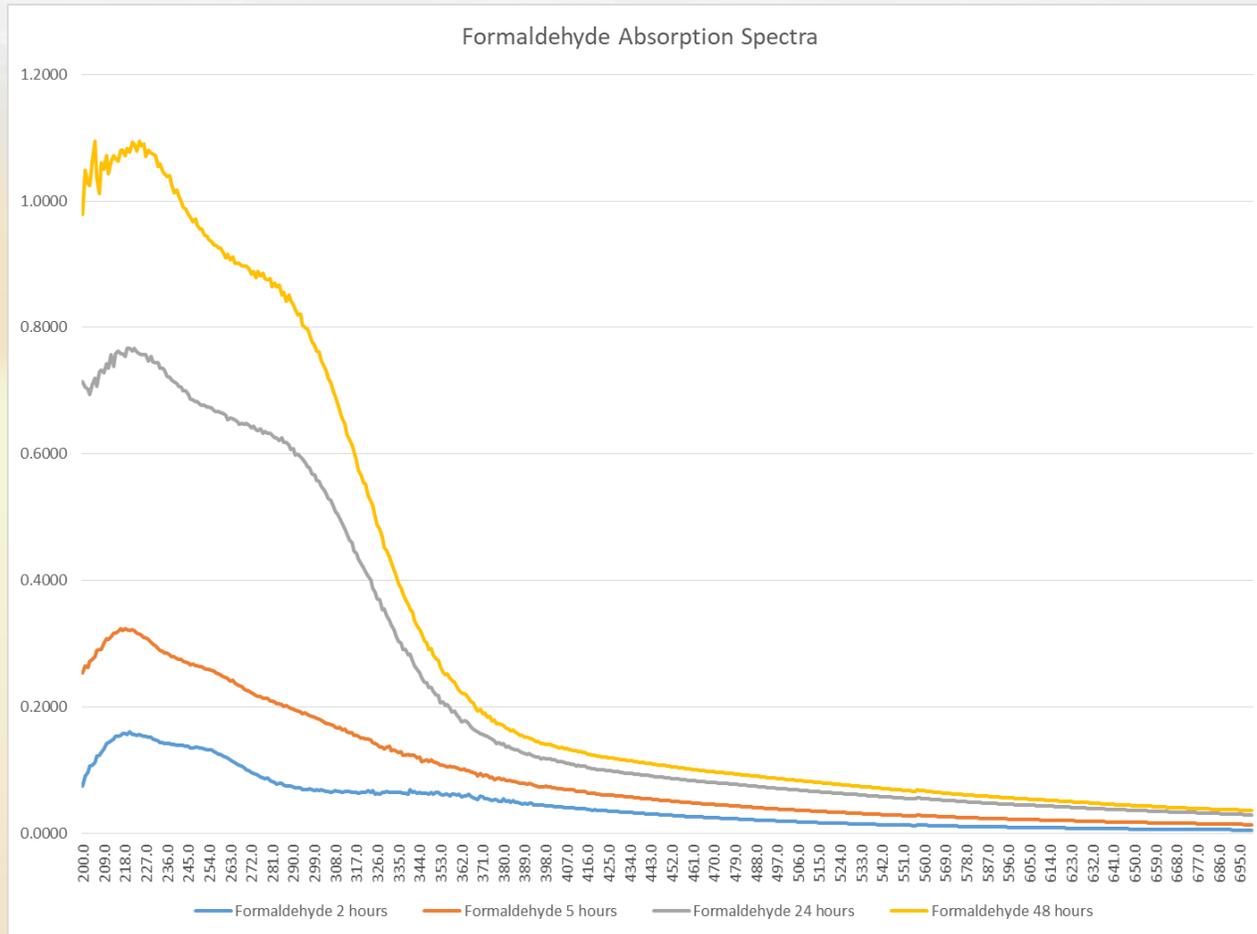
**Figure:** Locations of maximum excitation and maximum emission for all organic compounds tested. Darkness of circle indicates number of instances.

~30 different species in ~500 different conditions:  
All organic carbon in CSA above ~60 % results in fluorescent, colored, UV absorbing red oil.

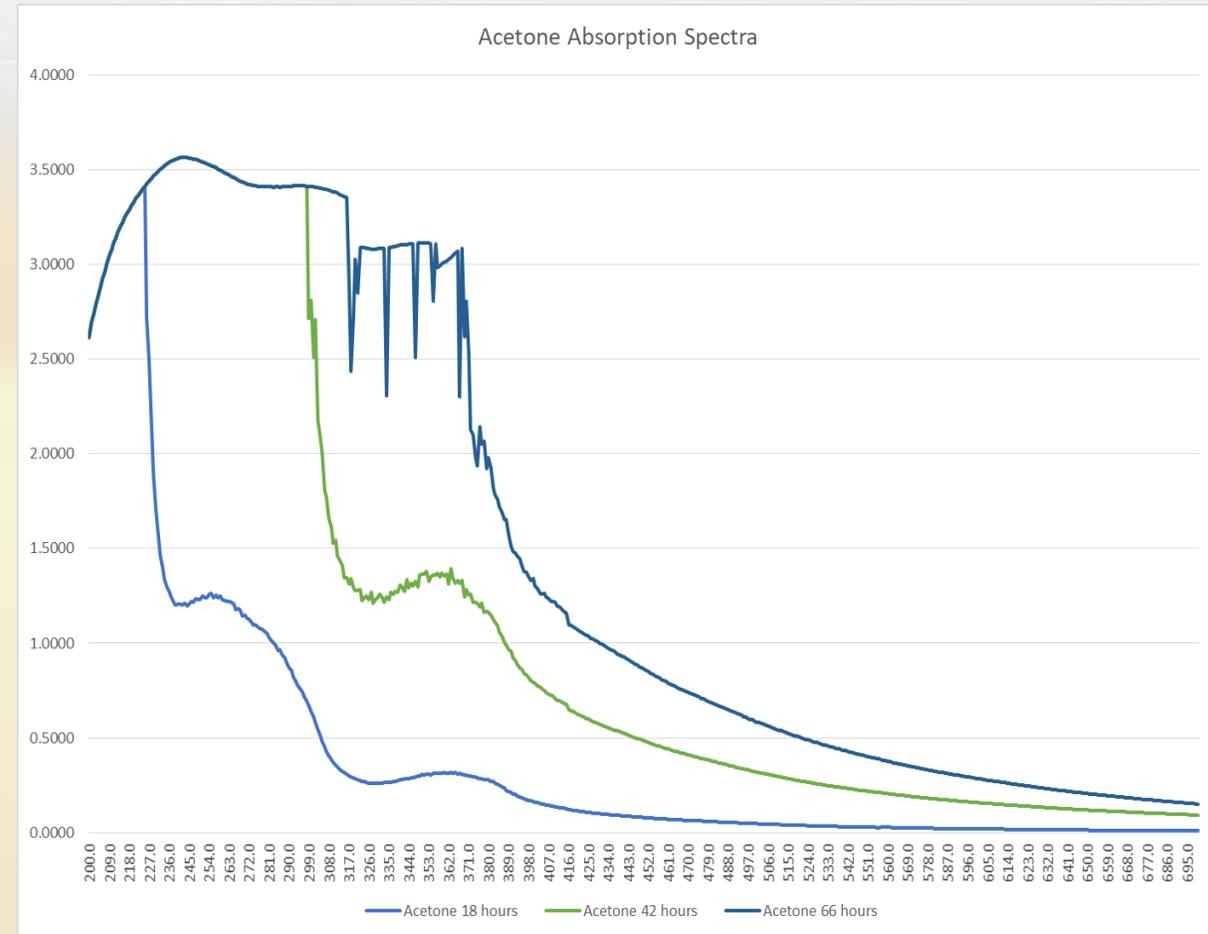
*In situ* test of the red oil hypothesis:

Based on the obtained results, the autofluorescence nephelometer flying to Venus in 2023 will be tuned to 350 nm. (Venus Cloud Life – MIT / Breakthrough foundation; <https://venuscloudlife.com/small-mission/>)

# UV/vis absorption of the red oil



Formaldehyde 2-48 hours @90 °C



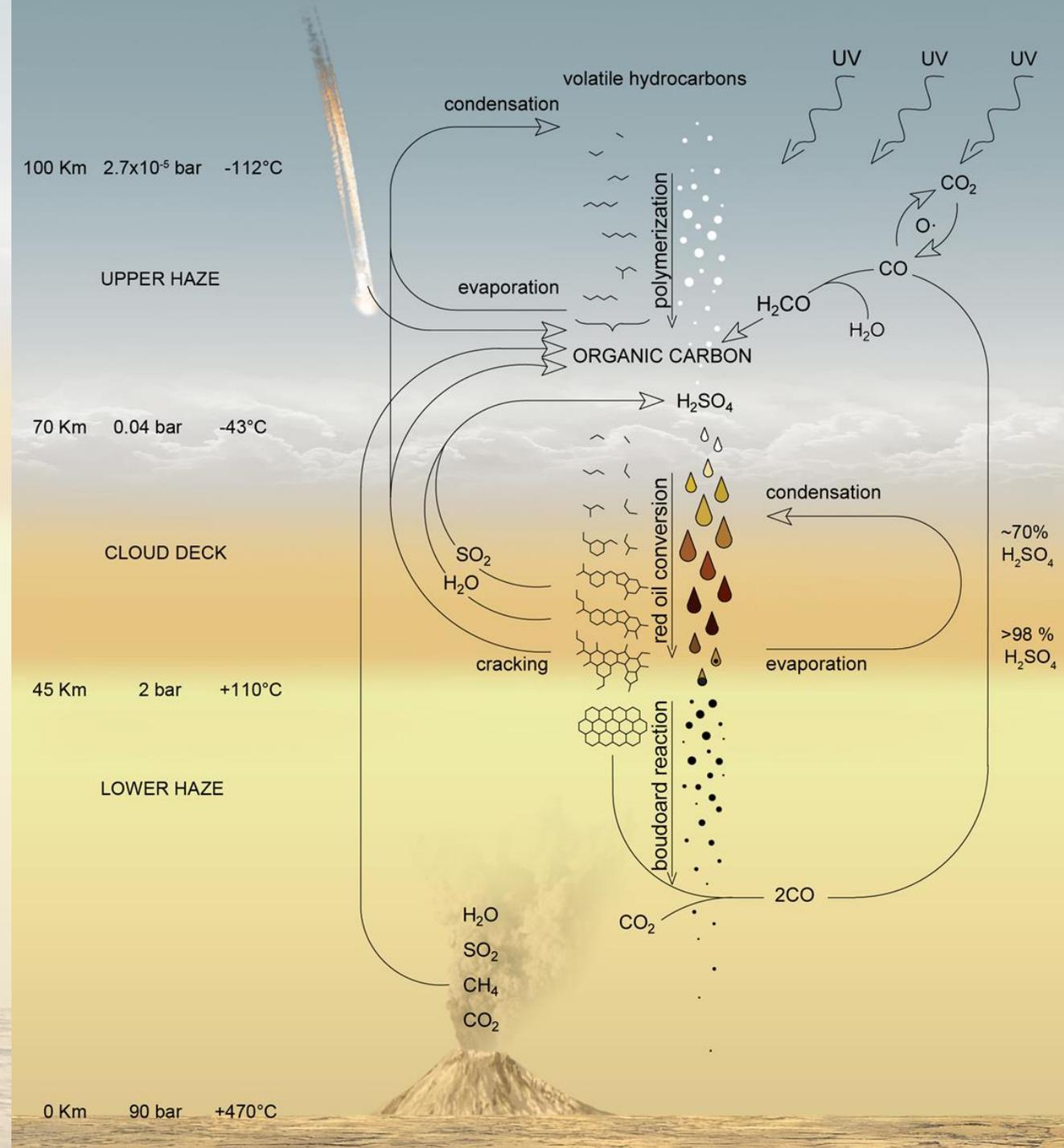
Acetone 18-66 hours @90 °C

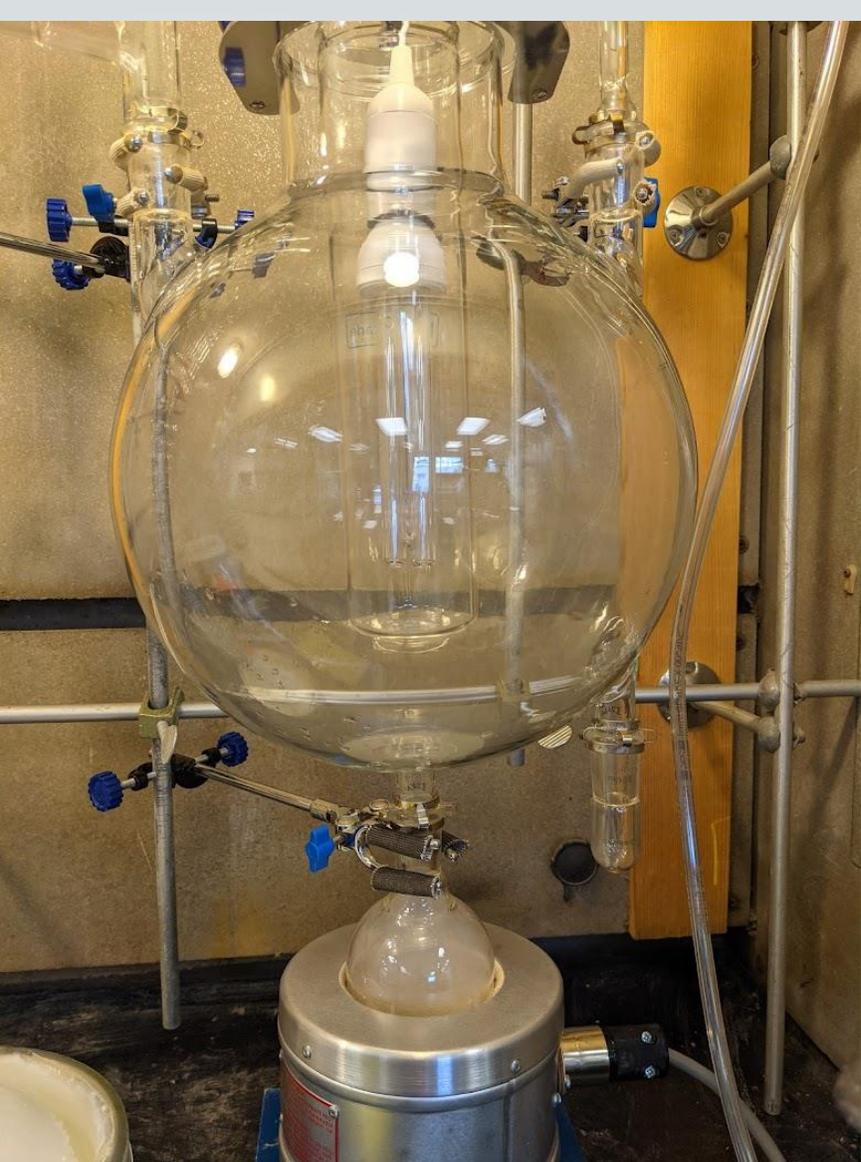
UV/vis absorbance of the red oil is “tunable” – depending on the initial reactants, their concentrations, and reaction conditions.

Organic carbon gases (formaldehyde) accumulate in the sulfuric acid droplets.

**Any** organic carbon in sulfuric acid above ~60 % concentration is converted to **red oil**.

**Red oil** is acid soluble, colored, UV-vis absorbent, and fluorescent.





Photochemical reactor waits for experiments with CO<sub>2</sub>/CO atmosphere.

# Potential for life in concentrated sulfuric acid

No organic carbon is stable in sulfuric acid above ~60 % w/w.

No membrane, no wax, no compartments of the known life can survive in the concentrated sulfuric acid.

The UV absorber is responsible for ~50 % of the solar energy capture in the cloud. It is strongly influencing the upwellings: Darker droplets heat a cloud region. This is elevated and not rained out of the cloud.

**Red oil life hypothesis:** By random chance some red oil gains self-replicating ability. Regions of droplets converting organic carbon to the red oil faster are selected for by the solar heating/uplifting.

Are these evolving self-replicators life?

*-Who cares? Life is a bad concept anyway.*



**“One of the saddest lessons of history is this: If we’ve been bamboozled long enough, we tend to reject any evidence of the bamboozle. We’re no longer interested in finding out the truth. The bamboozle has captured us. It’s simply too painful to acknowledge, even to ourselves, that we’ve been taken. Once you give a charlatan power over you, you almost never get it back.”**

~ CARL SAGAN

The red oil and reduced carbon cycle in the Venus atmosphere can explain the lower haze, the UV/vis-absorber, the asymmetric mode 3 particles, the yellow coloration of the clouds, and the upper haze.

Did Carl Sagan bamboozled the Venus community into believing there is no organic carbon in the Venus atmosphere?

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