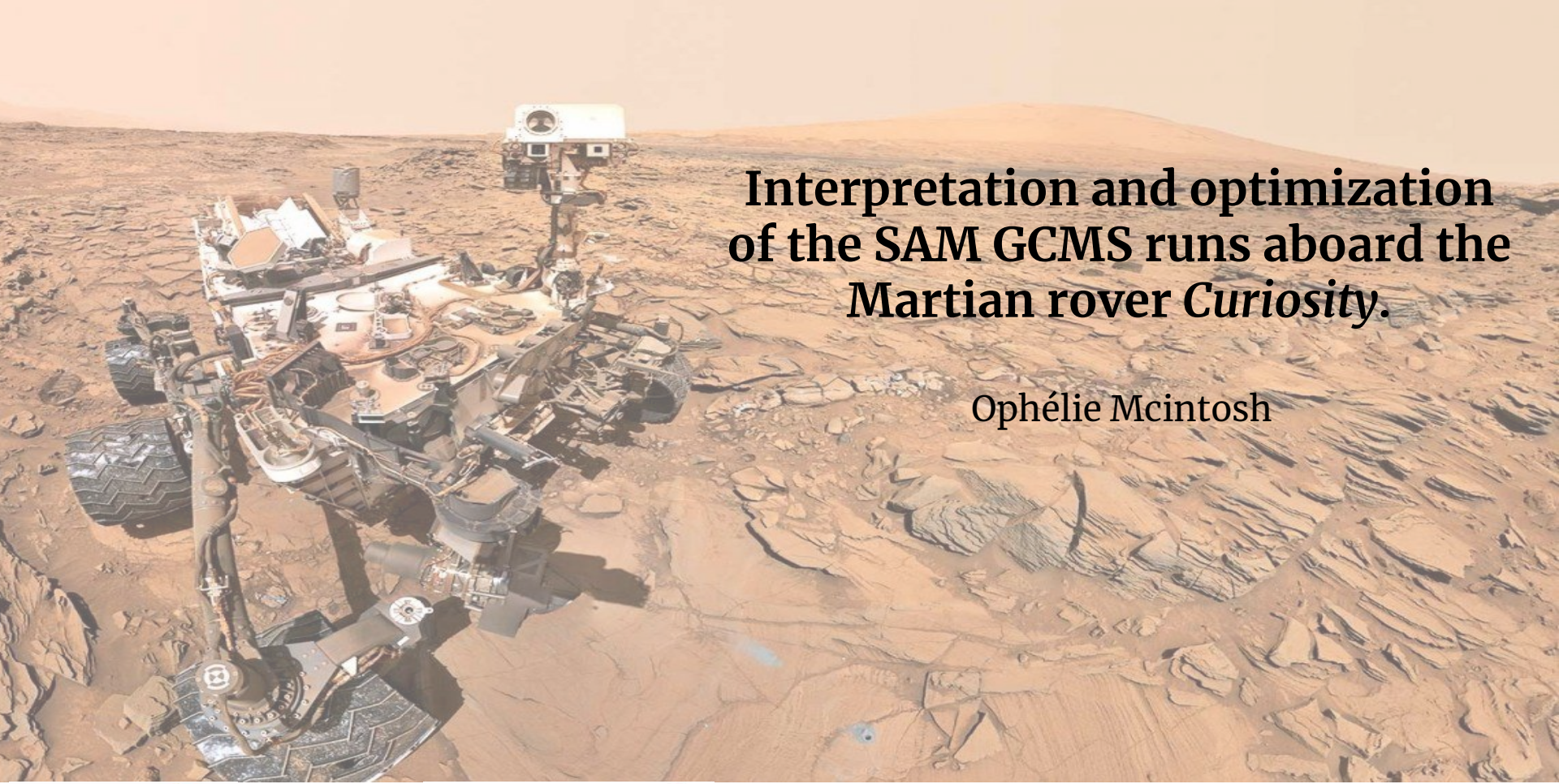

Interpretation and optimization of the SAM GCMS runs aboard the Martian rover *Curiosity*.

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Elbereth 2021

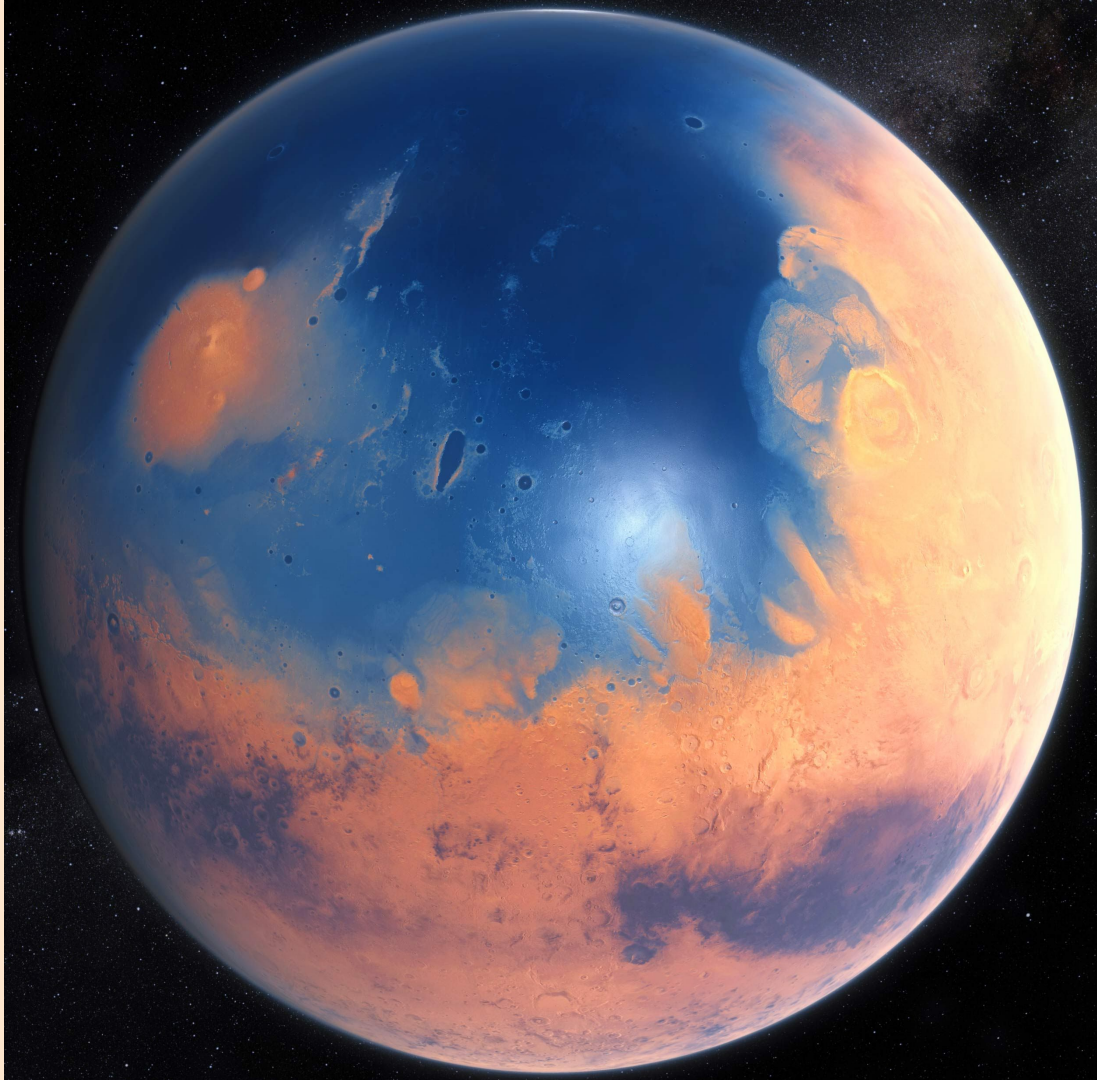
Mars is a planet with high astrobiological interests:

→ **Earth-like planet** in its early history:

- Denser atmosphere
- Warmer climate
- Liquid water on the surface

→ Criterias of **habitability**

→ The Martian surface could have **supported life** in the past and maybe in the present day

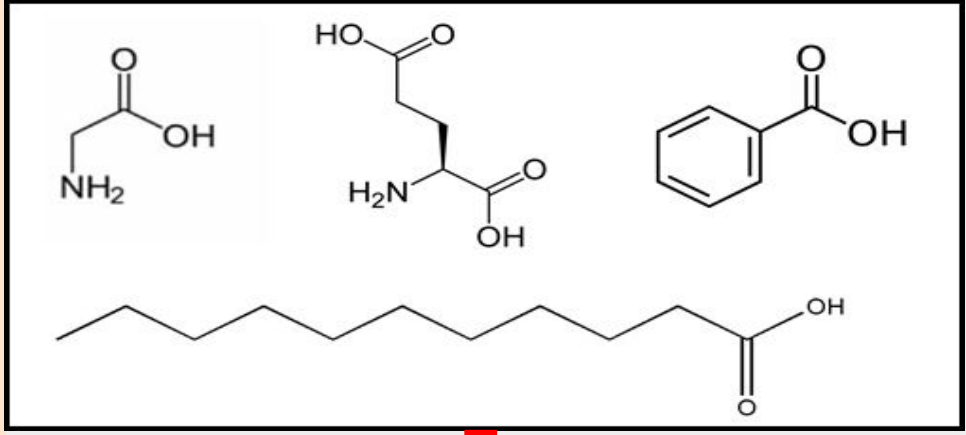


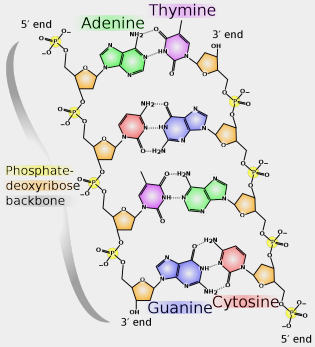
Organic molecules:

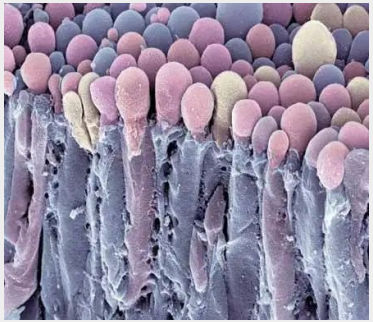
→ Endogenous or exogenous (meteorites)

→ Essential to life

→ Building blocks of life (Cells, DNA, lipids, etc.)







→ Found on the surface of Mars:

Emergence of prebiotic chemistry or extraterrestrial life-forms?

There can be organic molecules without life, but there can't be life without organic molecules

Some exploratory missions on Mars:

→ Viking Project (*Vinking 1 & 2*)/ 1976-1982

→ MSL Mission (*Curiosity*)/ 2011-2022 (ongoing)- SAM instrumental suite

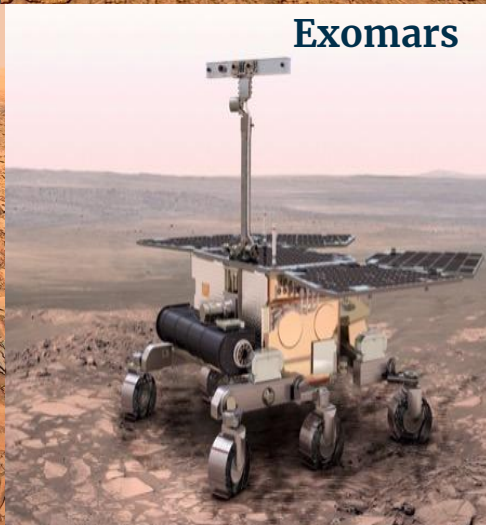
→ Mars 2020 (*Perseverance*)/2021

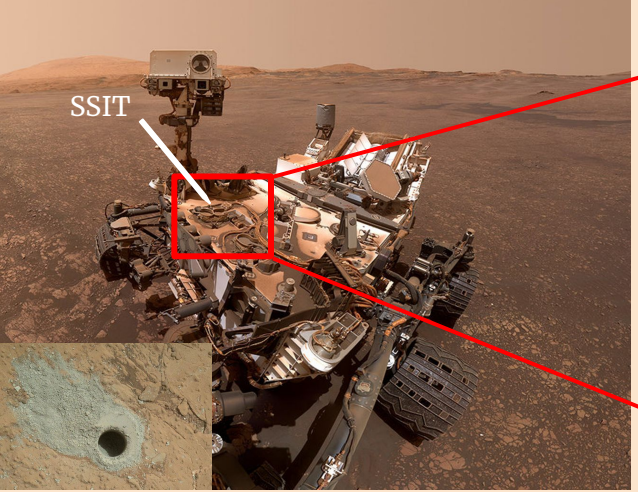
→ Exomars Mission (*Rosalind-Franklin*)/ 2022- MOMA Instrumental suite

Scientific goals (Astrobiology):

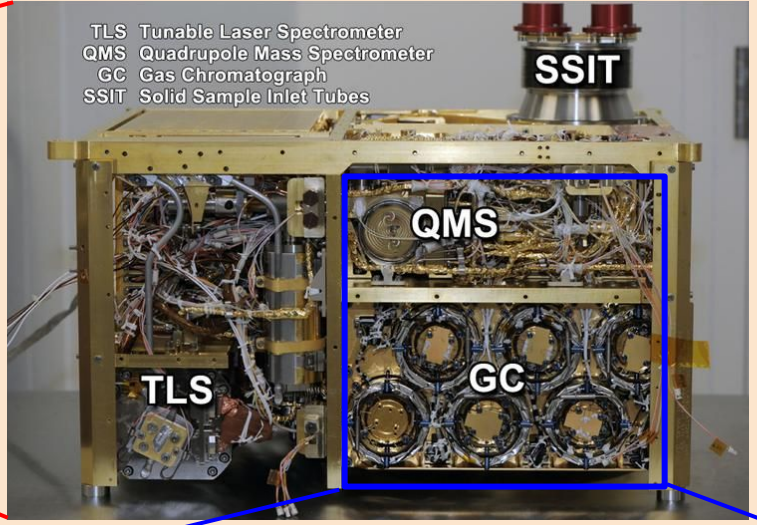
→ Looking for the building blocks of life:

- Water
- Organic compounds

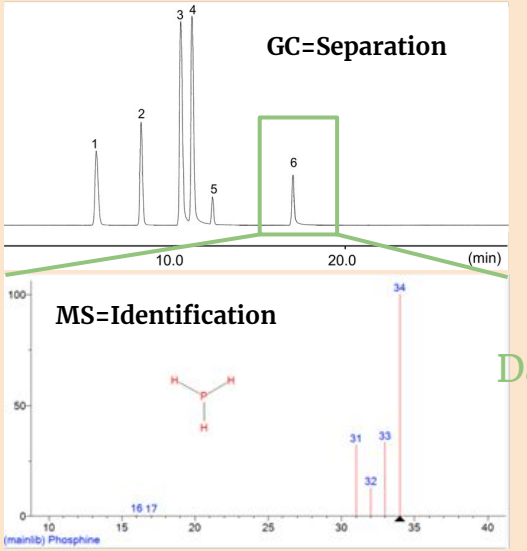




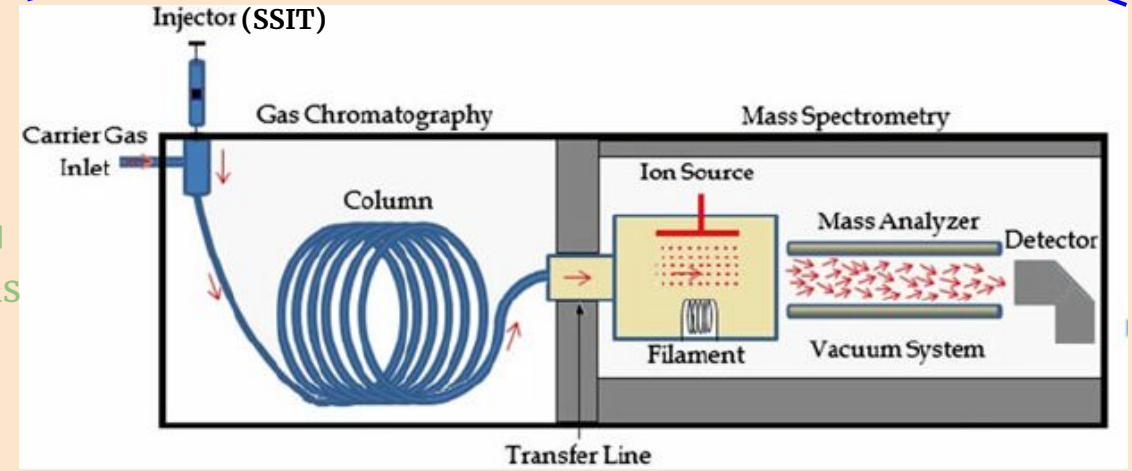
SAM

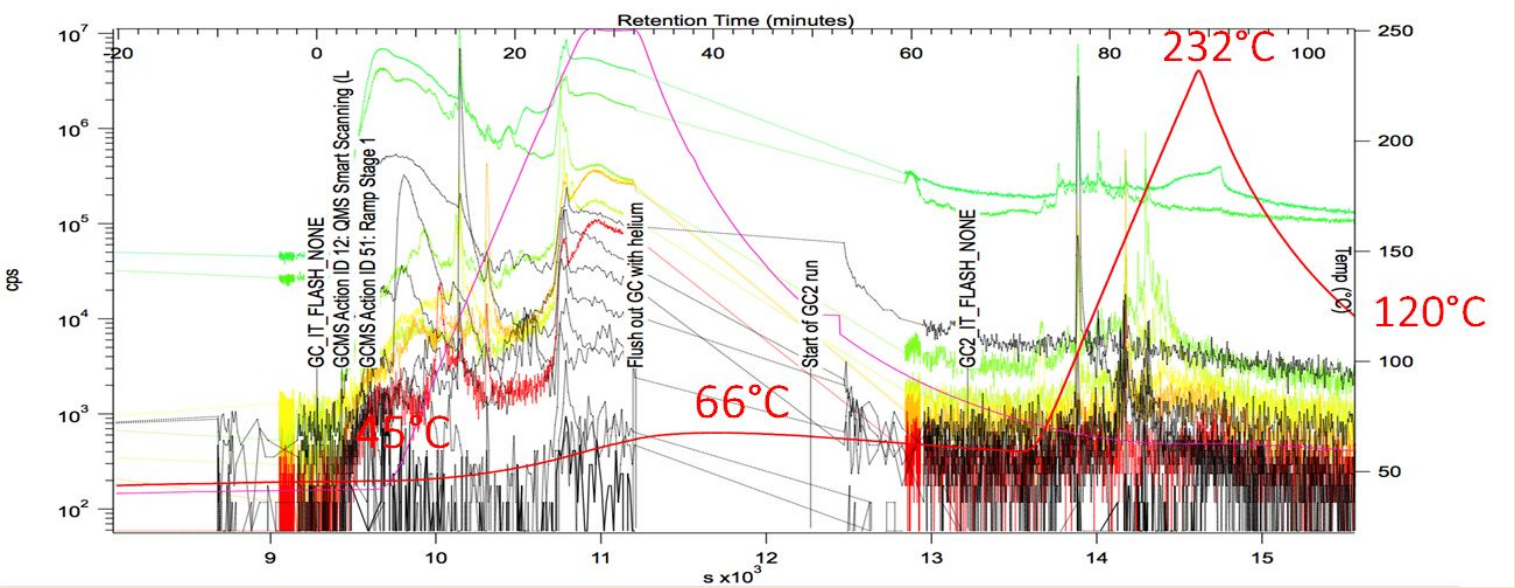


GCMS



Data analysis





SAM TMAH TID25608 Chromatogram

In situ results give complex signals that are difficult to analyse

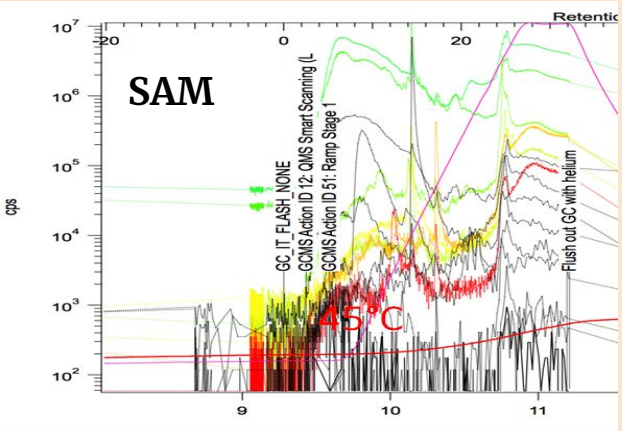
→ Natural samples are much more complex than pure molecules

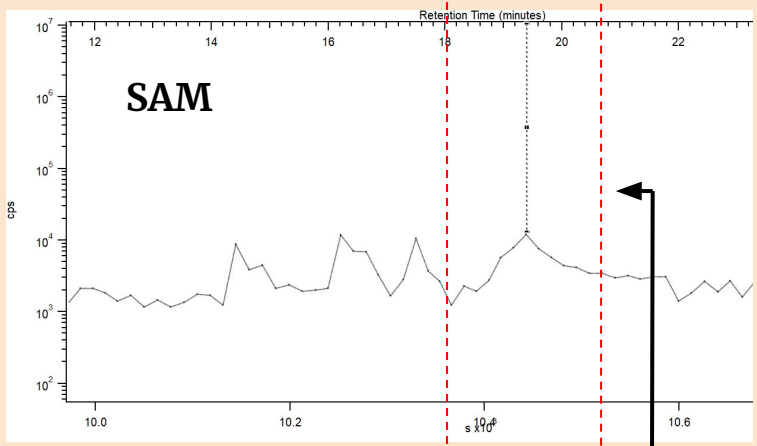
→ The experimental process (heating, wet chemistry etc.) can generate chemical reactions

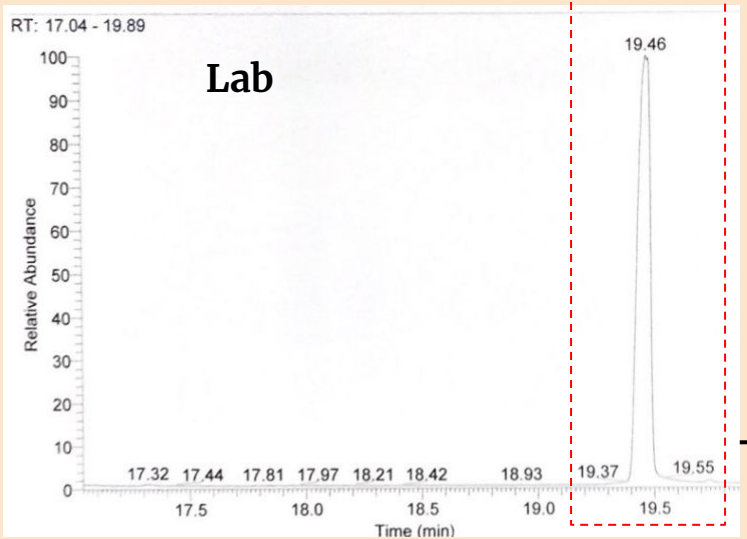
→ The instrumental resolution is constrained by space conditions (*e.g.* weight), generally lower than lab instruments

Laboratory experiments are necessary to interpret and optimize the SAM GCMS *in situ* runs

Molecular identification







Lab experiments run in the same conditions as on Mars

→ Compare lab results *vs in situ* data

Compound identification can be confirmed by running the molecule in SAM-like conditions in the lab

Confirmation of identification

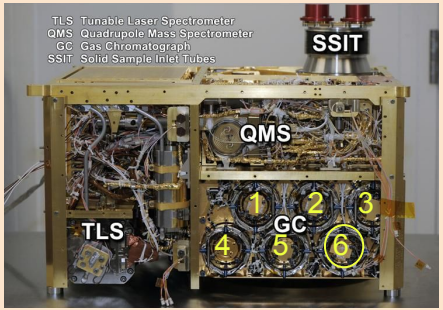
Instrumental conditions optimization

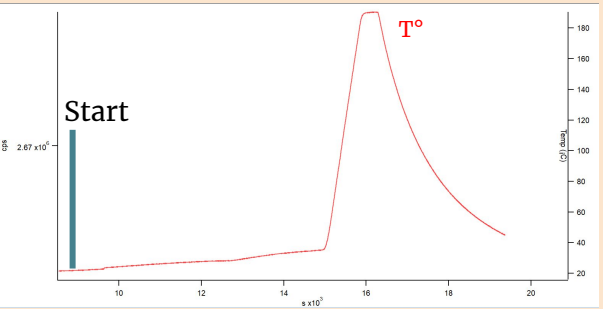
CG6				
	FM (min)	Temperature (°C)	FM Ramp 130 (min)	Temperature (°C)
	Pressure adjustement		Pressure adjustement	
Dead time (Air)	3.53	40	3.5	70
	Sodium hypophosphite monohydrate		Sodium hypophosphite monohydrate*	
Phosphine	8.09	62	6.29	98
	Aldhehyde		Aldhehyde	
Formaldehyde	13.71	122	9.01	125
	Alcohols		Alcohols	
Methanol	16.25	148	12.04	130
	Water		Water	
H20	12.55	110	8.15	116
	Magnesium sulfate heptahydrate*		Magnesium sulfate heptahydrate*	
H2S	9.44	79	7.02	105
SO2	13.76	123	10.36	130
	Hydrocarbons		Hydrocarbons	
Propane	14.21	132	10.35	128
Butane	19.2	182	16.31	130
Methane	3.8	40	x	x

→ Optimization of instrumental conditions

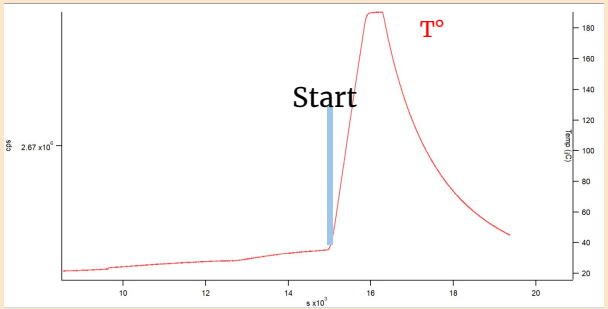
SAM: six GC columns

→ Each columns can identify a specific range of molecules





Good separation of the molecules
BUT time of detection too long



Good separation of the molecules and maximize number of molecules detected

Goal: What are the optimal temperature conditions for GC6 on a future run?

→ Good separation of the molecules

→ Maximise the duration of the run to detect as many molecules as possible

SUMMARY

- Mars is habitable
- Detection of ancient life by looking at the building block of life: water and organic compounds
- Organic compounds are identified through GCMS on SAM
- SAM results are complex
- Lab experiments are required to interpret and optimize the analyses