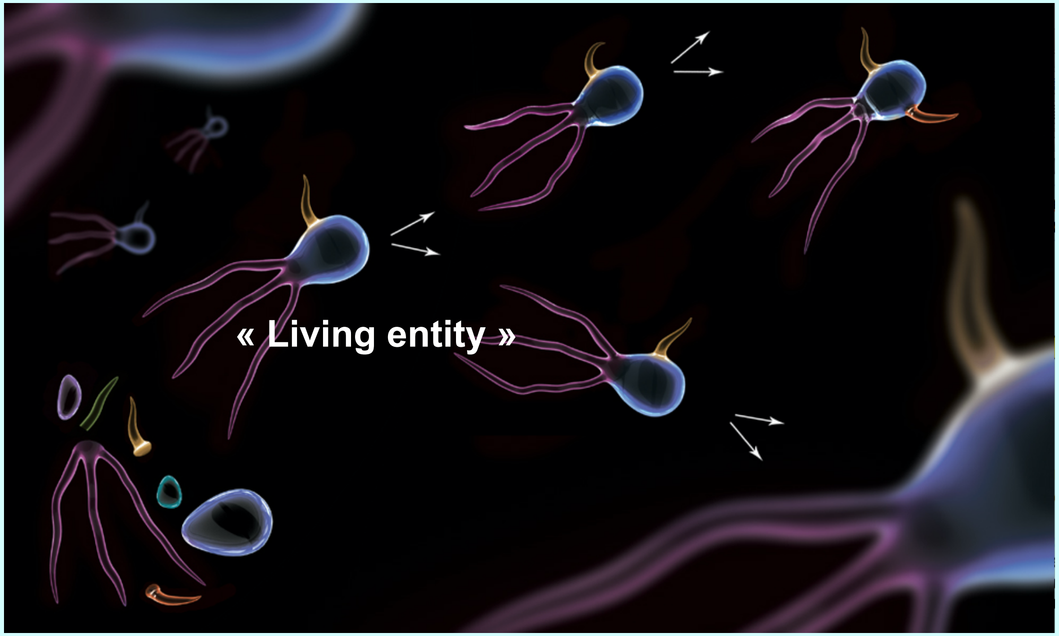
Astrobiology: from the origin of terrestrial life to the search for life in the Universe

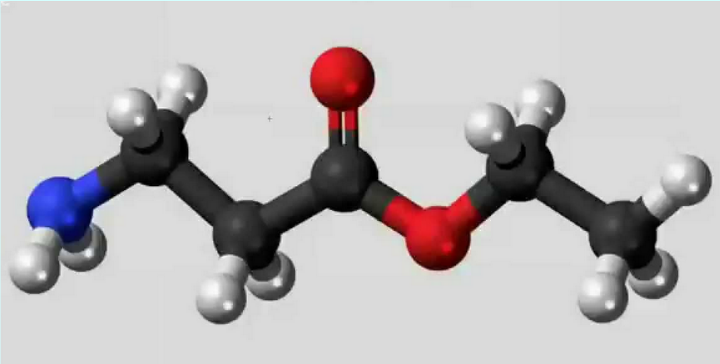
Supernova G299 in the Milky Way

On Earth, life emerged in **water**, about 4 Ga years ago with **chemical automata,** self reproducing and evolving.



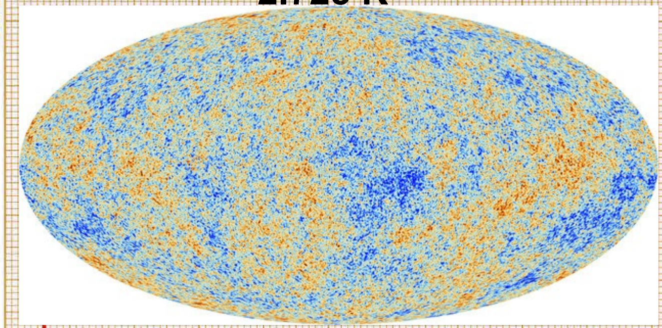
The pieces were **organic molecules**, i.e. carbon atom scaffoldings garnished with hydrogen, oxygen, nitrogen, atoms.

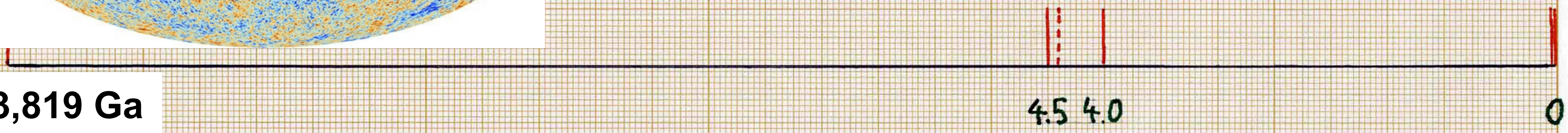
Chemist's concerns:
- Origin of water?
- Origin of organics?
- Recreate an automata?
- Fossils?



Water at the origins

Cosmic Microwave Background
2.725 K

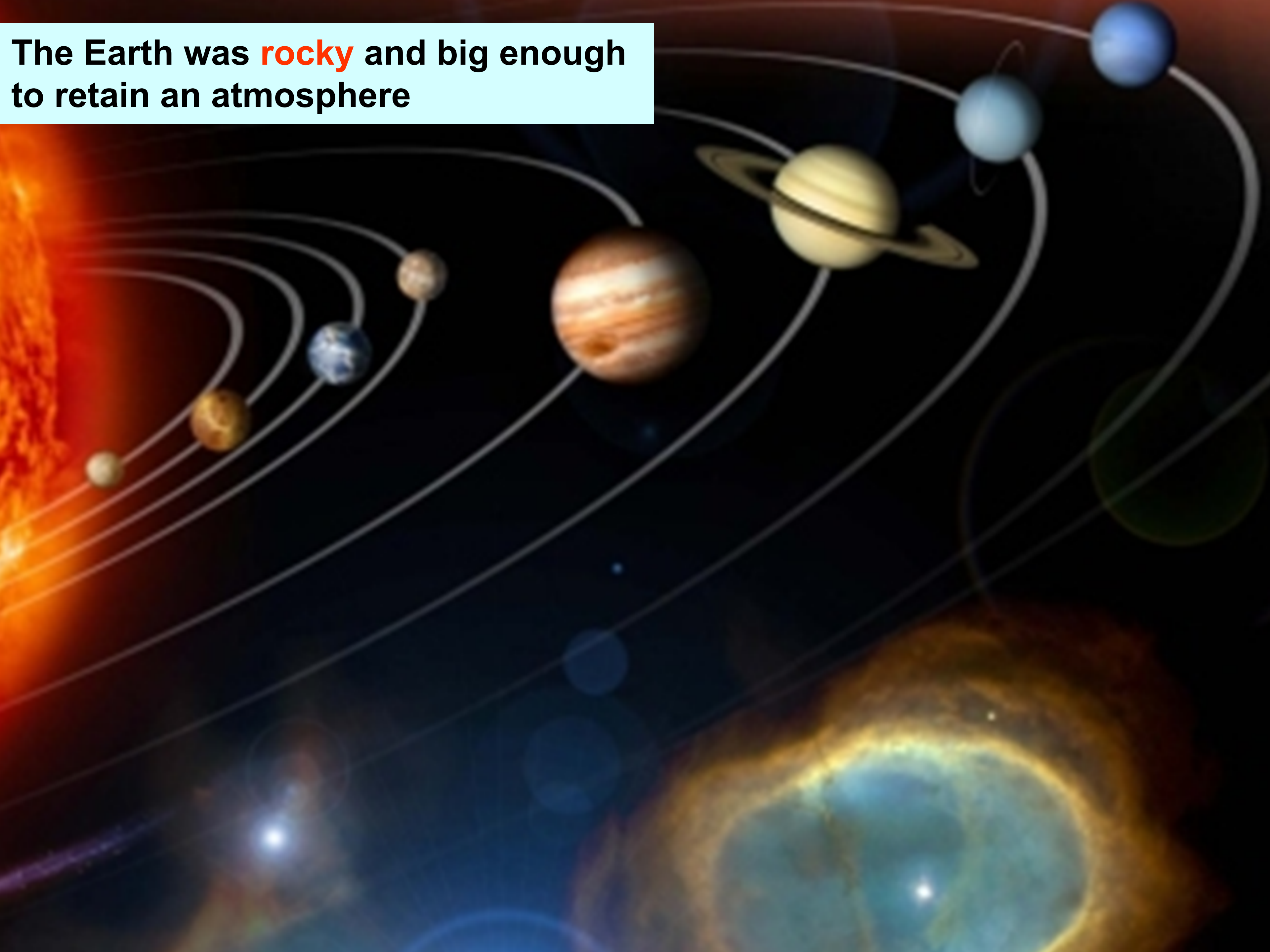




3,819 Ga

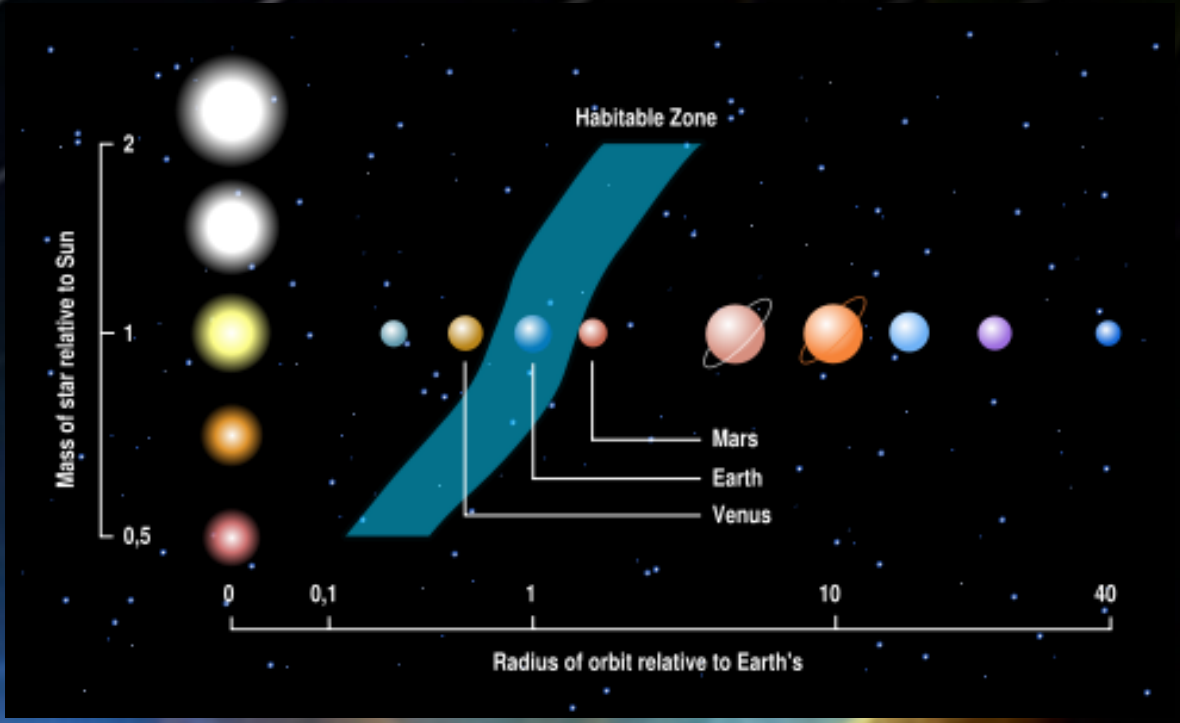
4.4 Ga years old zircon (zirconium silicates with datable traces of uranium and thorium) have been processed by liquid water, as testified by oxygen isotope ratios.

The Earth was rocky and big enough to retain an atmosphere

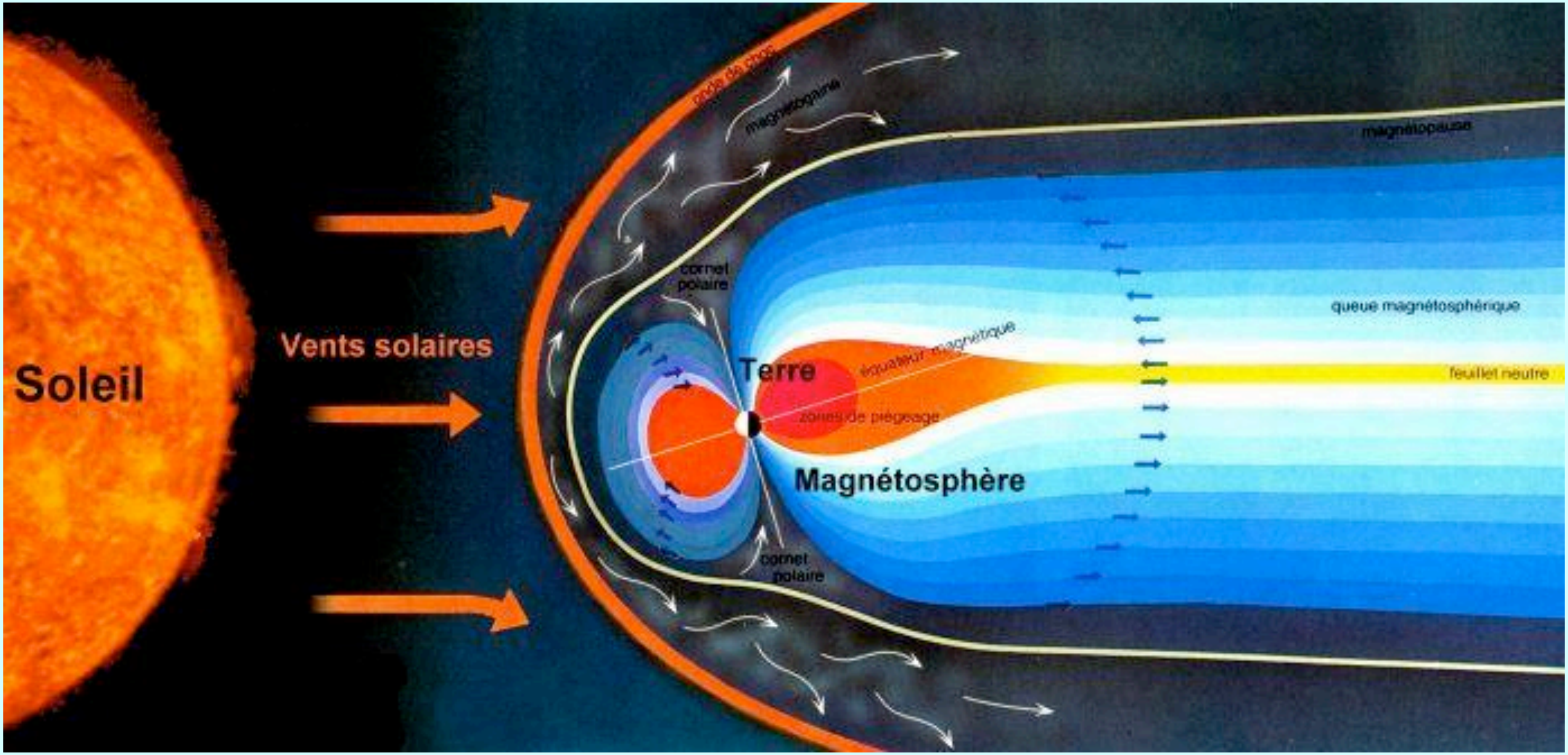


- **not too close to the Sun (divergent green house),**
- **not too far (glaciation)**

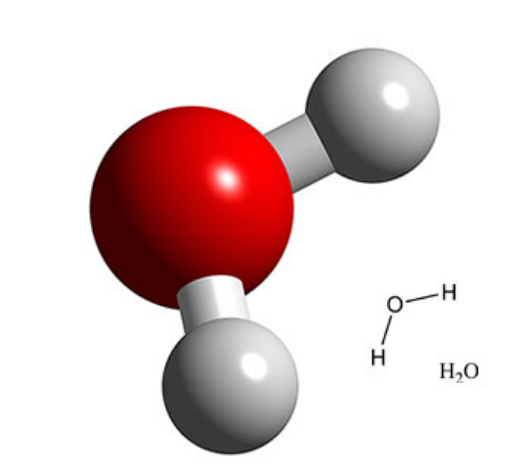
In the so-called « habitable zone »

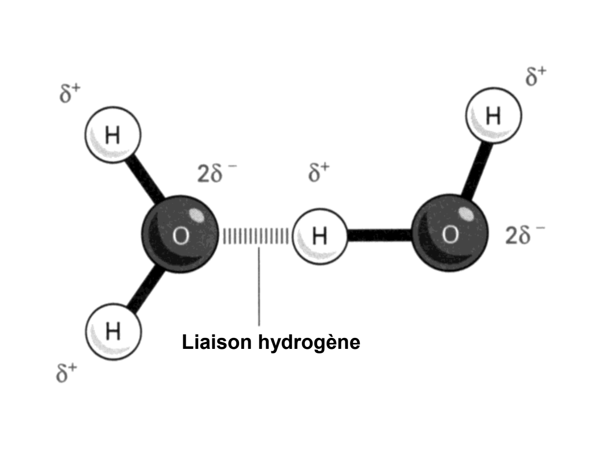


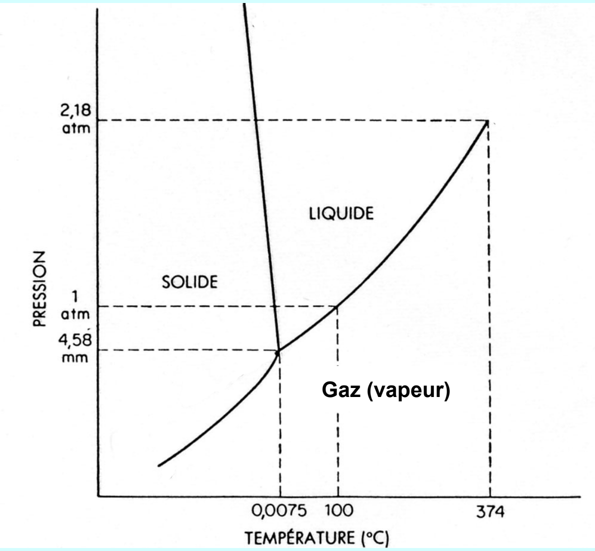
The Earth has a permanent magnetic field which generate a magnetosphere protecting from the air-corrosive solar wind.



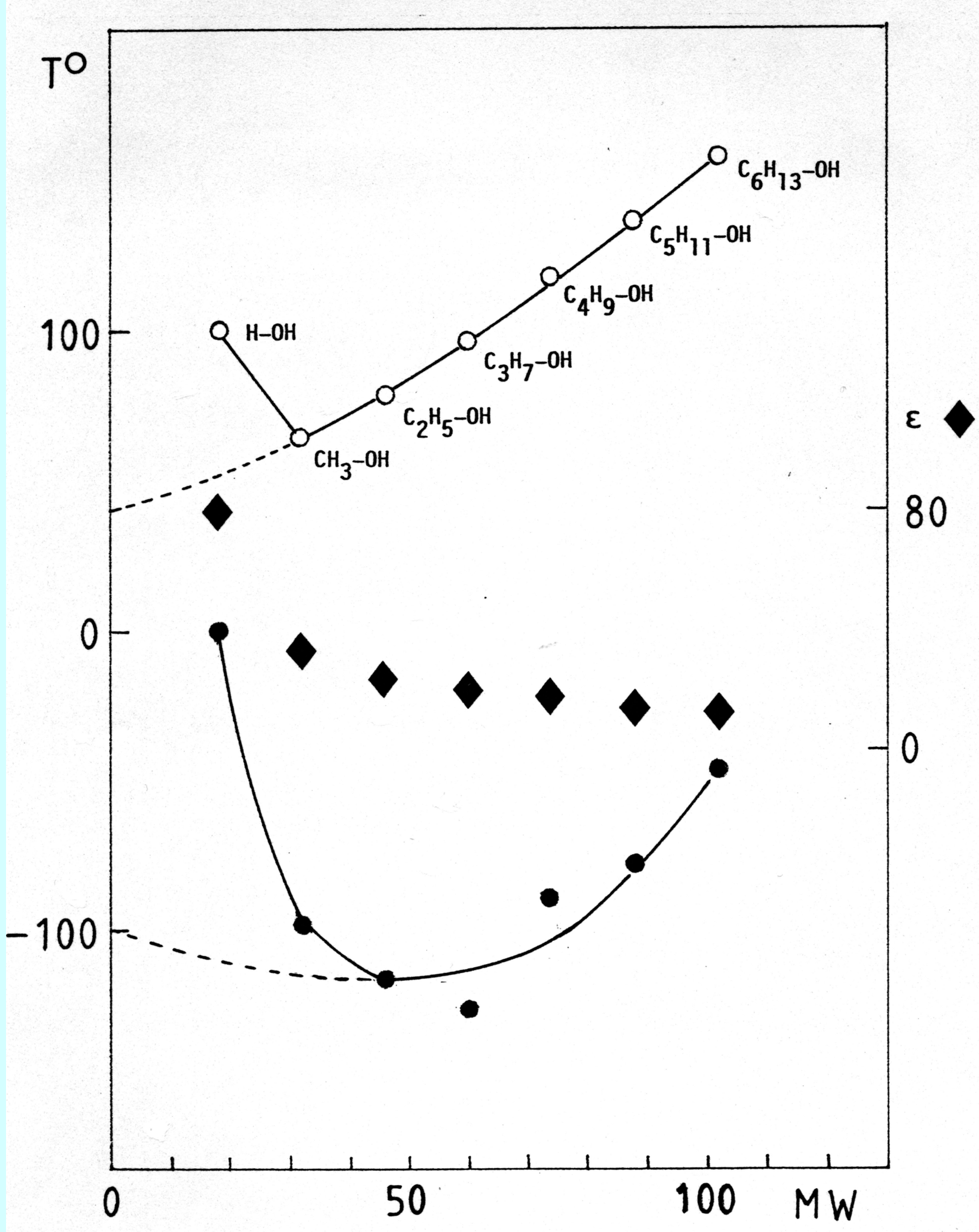
The virtues of water





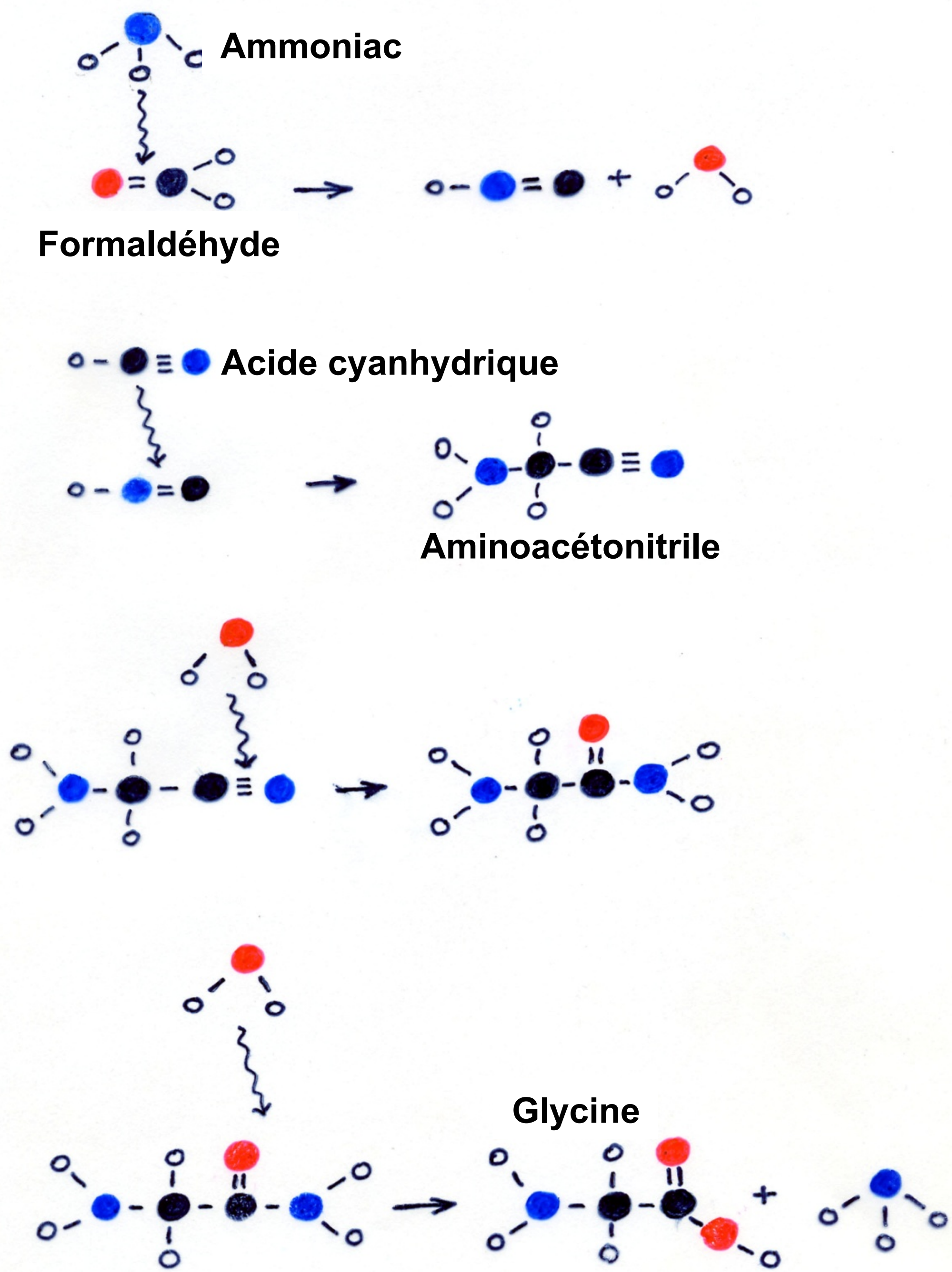


Compared to CO_2 (M_w 44), H_2O (M_W 18) should be a gas at the surface of the Earth. A very tight network of hydrogen bonds gives to water its remarkable properties (including wine!).

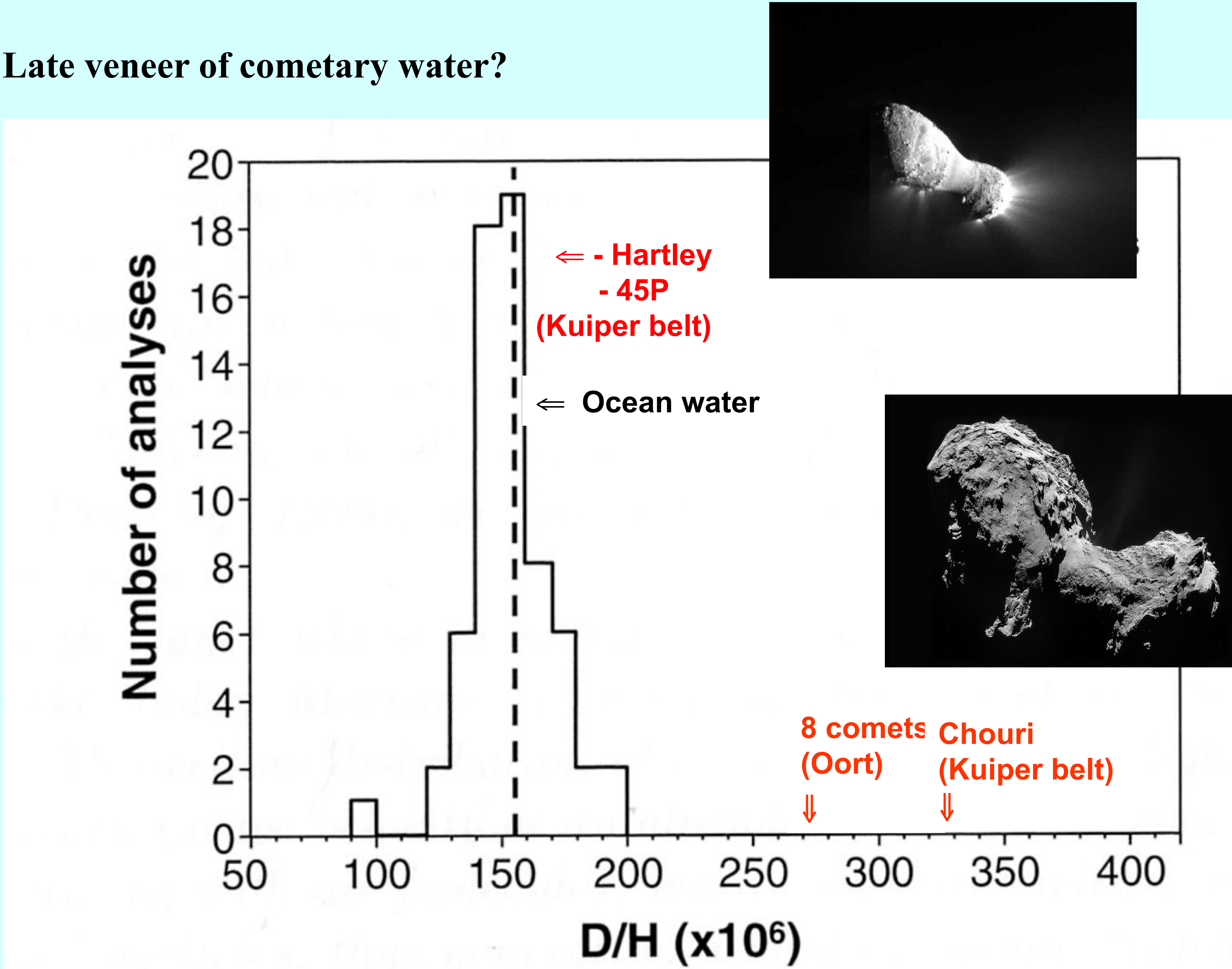


T°
100
0
-100
0
50
100
MW
ε
80
0
H–OH
CH3–OH
C2H5–OH
C3H7–OH
C4H9–OH
C5H11–OH
C6H13–OH

Water is a good solvant but also a chemical reactant. For example, it provides oxygen atoms in the synthesis of amino acids *via* the Strecker reaction.



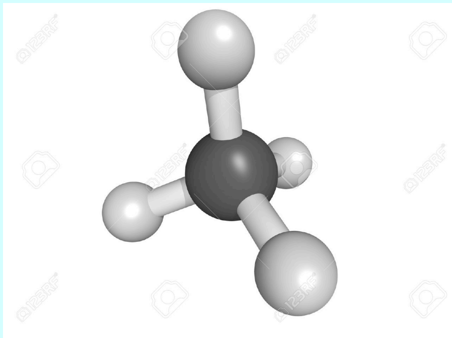
Late veneer of cometary water?

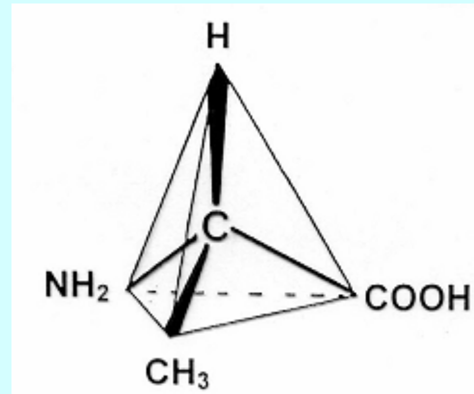


Why carbon?

… which represents only 0.094 %e of the terrestrial crust, while silicon amounts to 27.7 %.

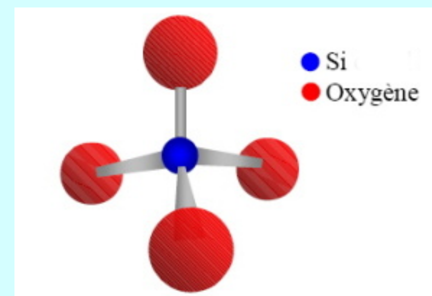
Carbon is tetravalent and is chemically very active (several millions of carbon molecules in the Beilstein)

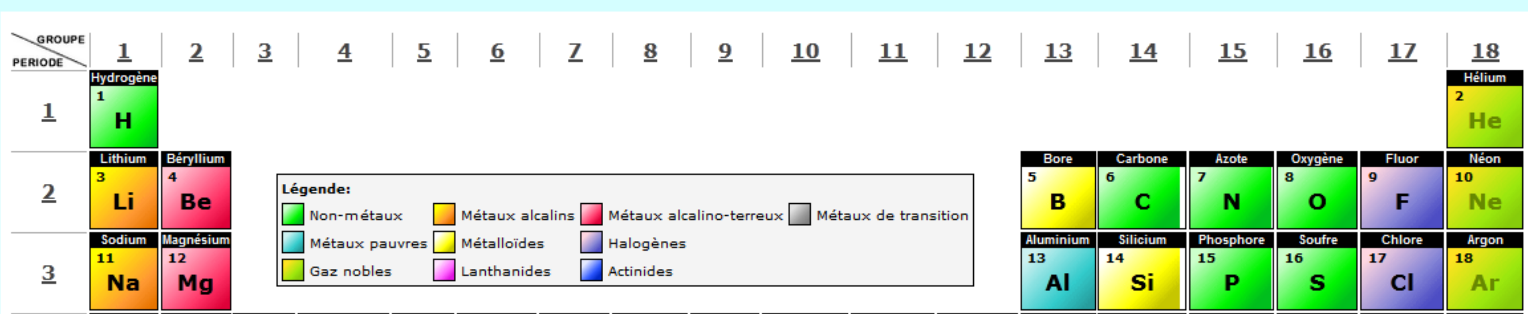




As for silicon:

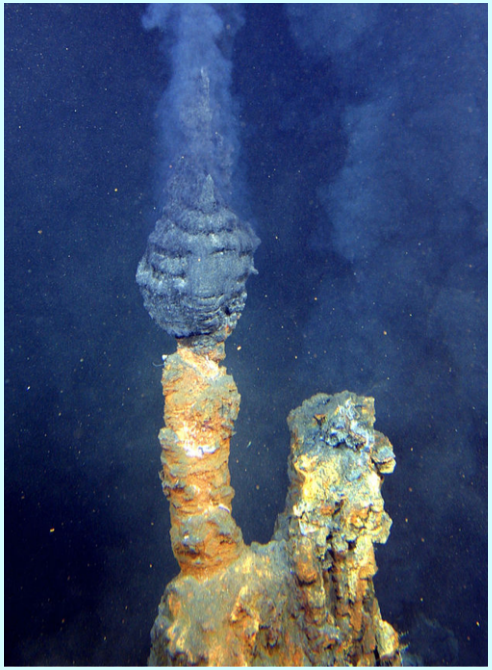
- Its chemistry is less inventive
- bigger atom → weaker bonds
- no gazeous silicon derivatives (SiO_2)
- few double bonds -Si=Si-, no triple bonds -Si≡Si-





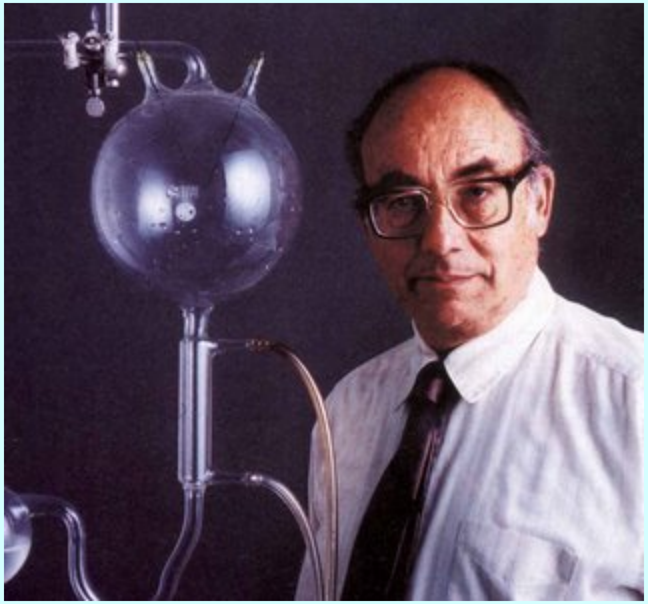
Three possible sources for prebiotic organic carbon:

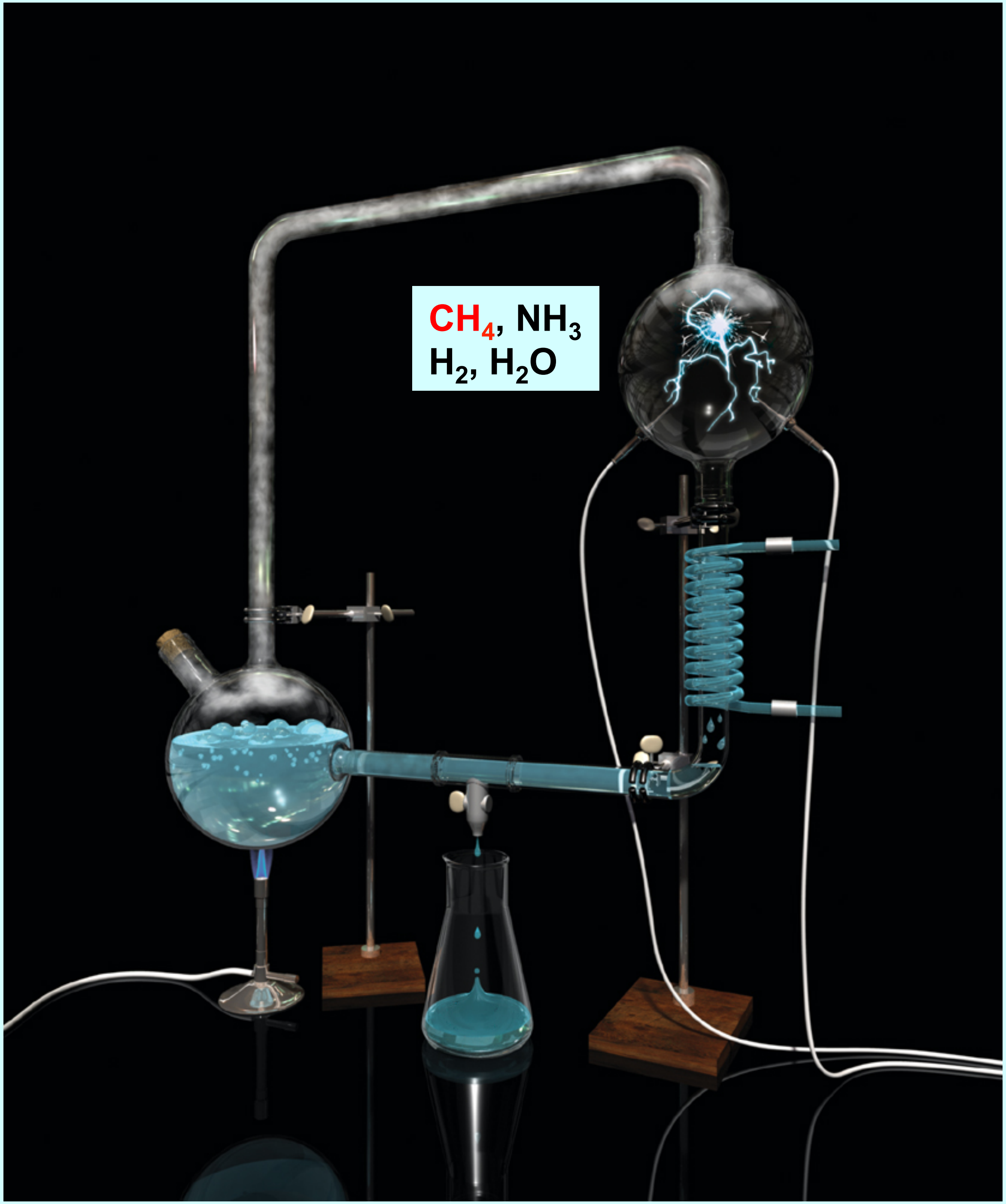
1) Atmosphere



2) Hydrothermal systems

3) Space





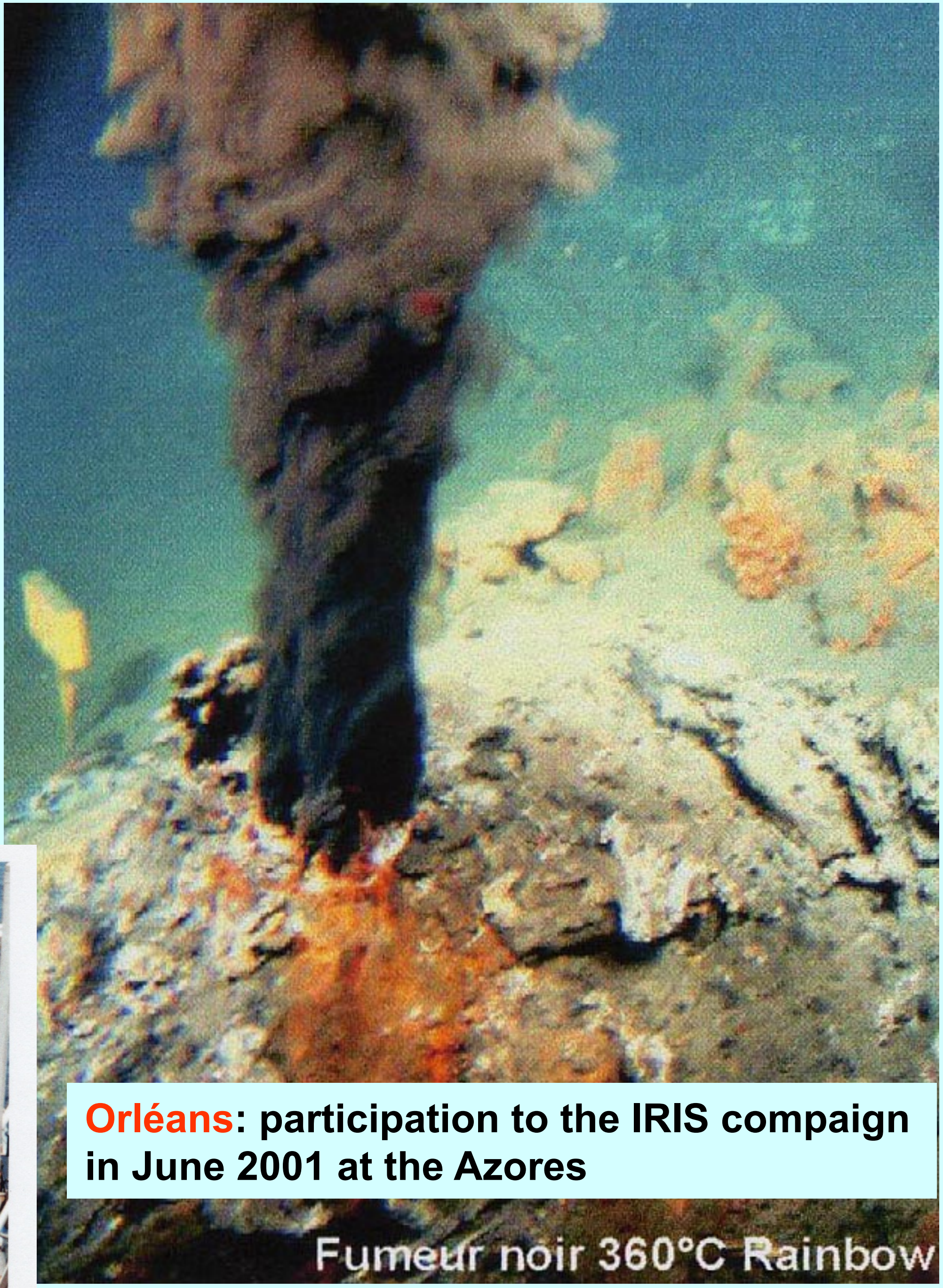
Miller experiment for the prebiotic synthesis of amino acids

- **But there was very few methane in the primitive atmosphere**

Rainbow submarine hydrothermal system

- **No prebiotic molecules detected so far**

Gas	%
Hydrogen	45
Methane	6
Carbon dioxide	43
Nitrogen	4
Hydrogen sulfide	2



Orléans: participation to the IRIS compaign in June 2001 at the Azores

The Ensisheim meteorite, November 7, 1492, at 11h30

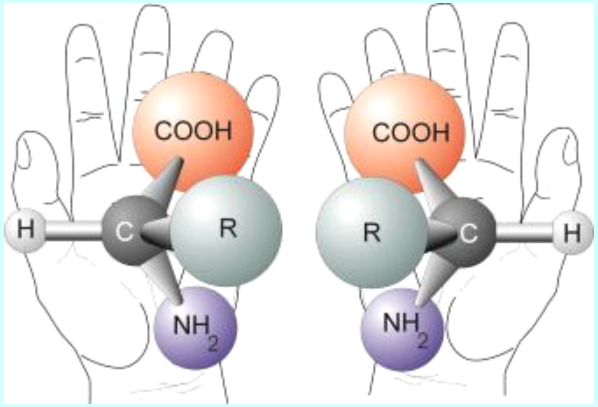
Albrecht Dürer

in « Schweitzer Bilderchronik der Luzerners (1512)

Murchison meteorite

Biological compounds in Murchison

Glycine	C_2-C_{12} carboxylic acid	Adenine
Alanine	Lactic acid	Guanine
Valine	β-hydroxy butyric acid	Xantine
Leucine	Malic acid	
Hypoxantine		
Isoleucine	Succinic acid	Uracil
Proline	Fumaric/maleic acid	
Aspartic acid	Acetone	
Glutamic acid	Urea	
	Ethanol	

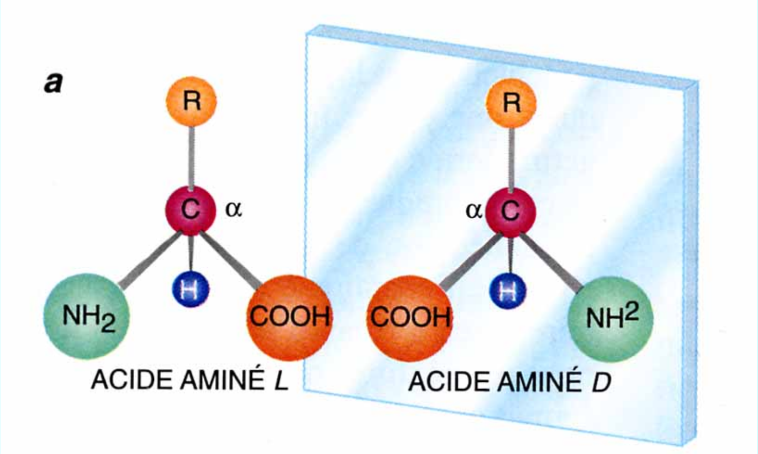


Rather modest delivery per year: today, « only » 10-40 tonnes

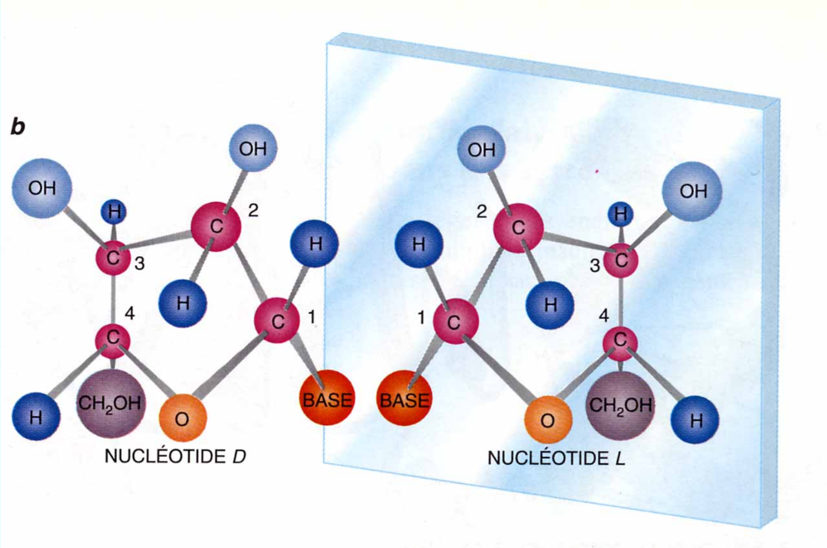
«The idea of the molecular dissymmetry of biological products establishes perhaps the only clear line of demarcation that can be placed today between the chemistry of the still life and the chemistry of living nature».

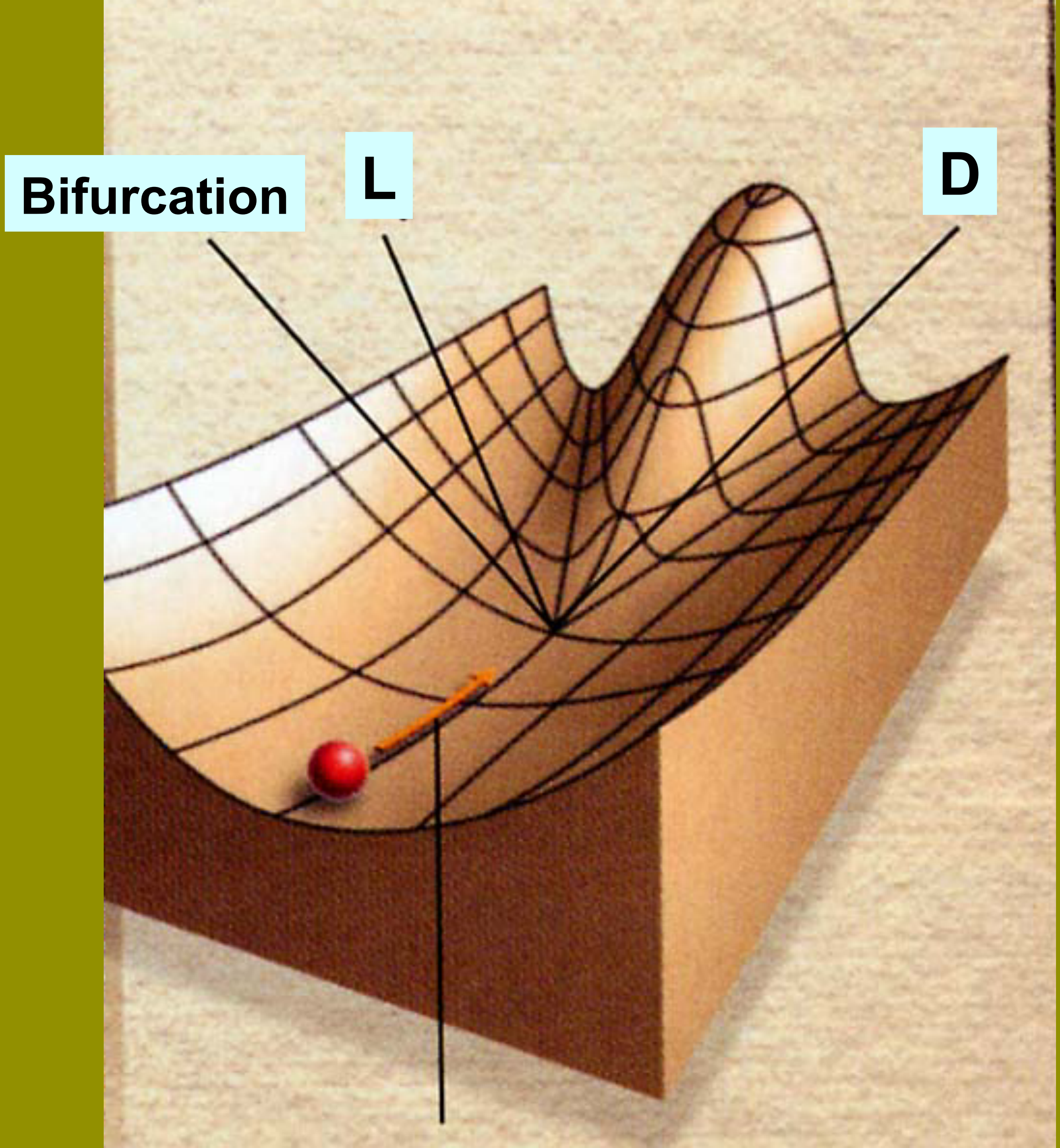
Pasteur, L. (1860) Recherches sur la dissymétrie moléculaire des produits organiques naturels. (pp. 342-343). In Oeuvres de Pasteur, tome 1, Dissymétrie moléculaire.

Amino acids exist under two forms, left- and right-handed, mirror images, like our two hands.
Proteins use only the left-handed form.

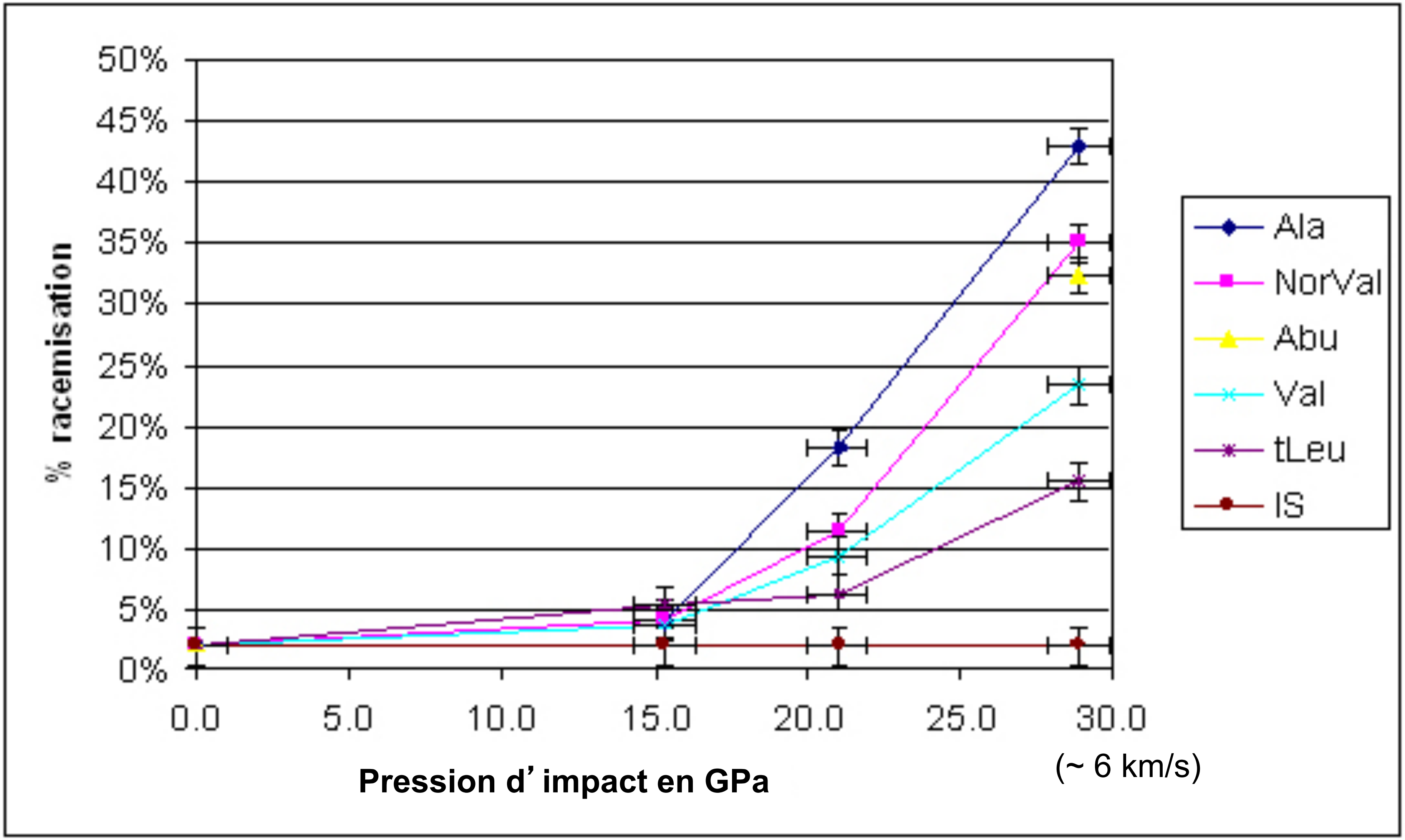


Sugars are right-handed




Bifurcation
L
D

Orléans: Epimerisation of meteoritic amino acids embedded in saponite under laboratory shock waves at Johnson Space Center in Houston

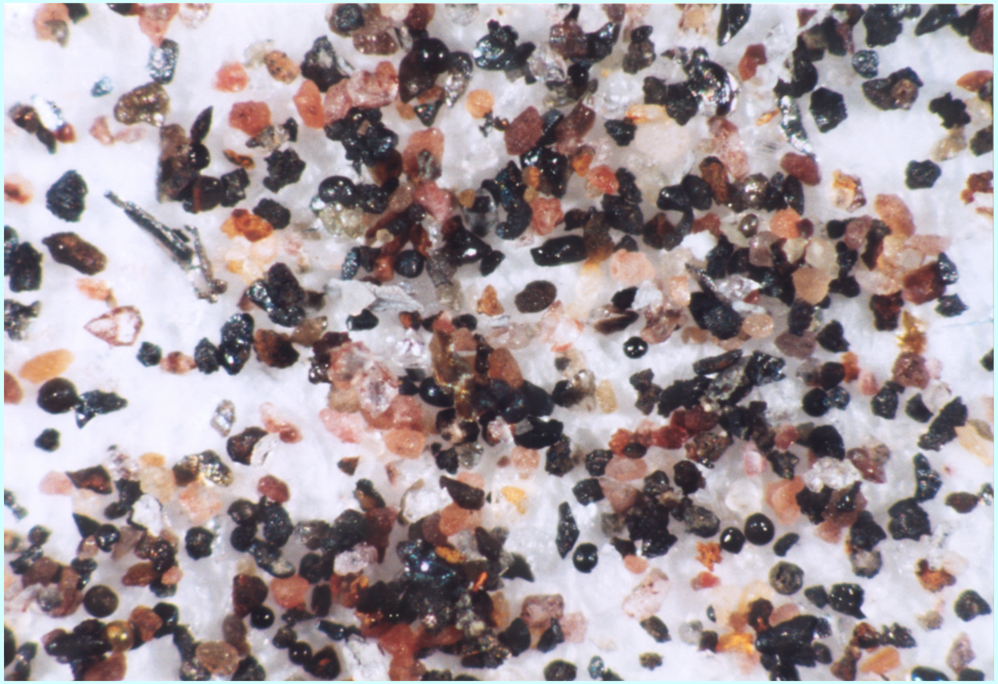


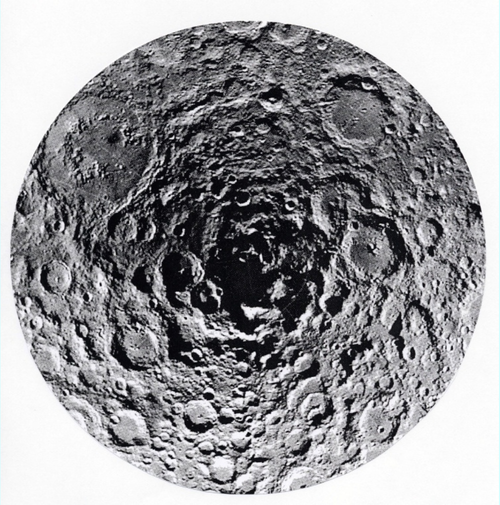
Micrometeorites: from collection and heavy bombardment

↓

Organic matter delivered during the heavy bombardment represented 25 000 times that of the present biomass, i.e. a 30 m thick layer of « oil slick » cumulated all over the globe.

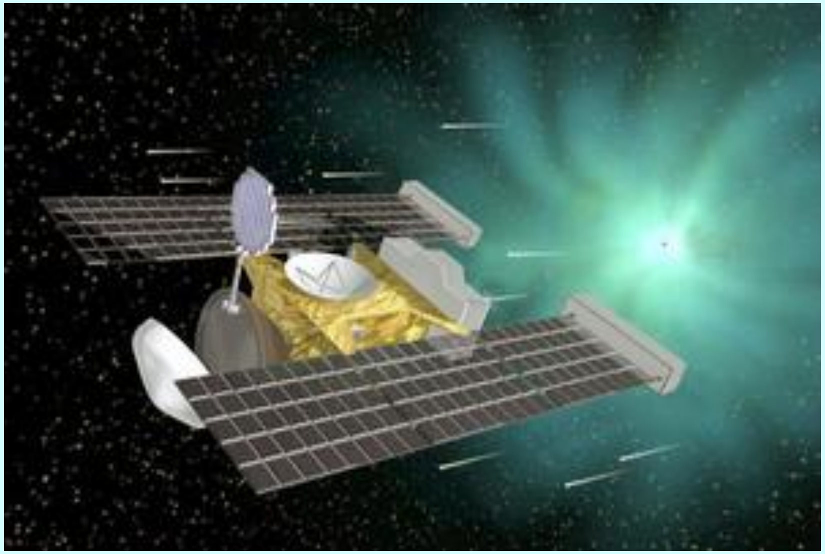
(Orléans: collaboration with Michel Maurette)

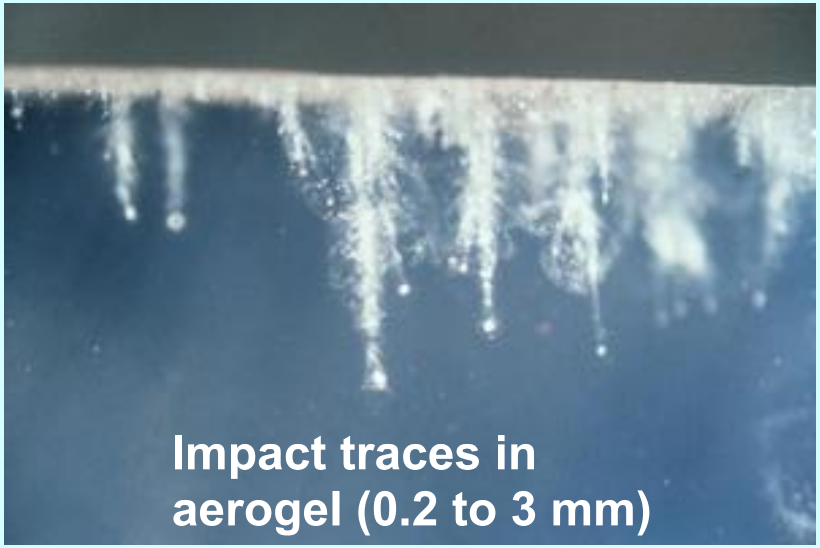




The Stardust mission

Launched in1999, the probe collected cometary dust of Wild 2 on January 2004. The capsule landed on January 2006 in Utah desert.



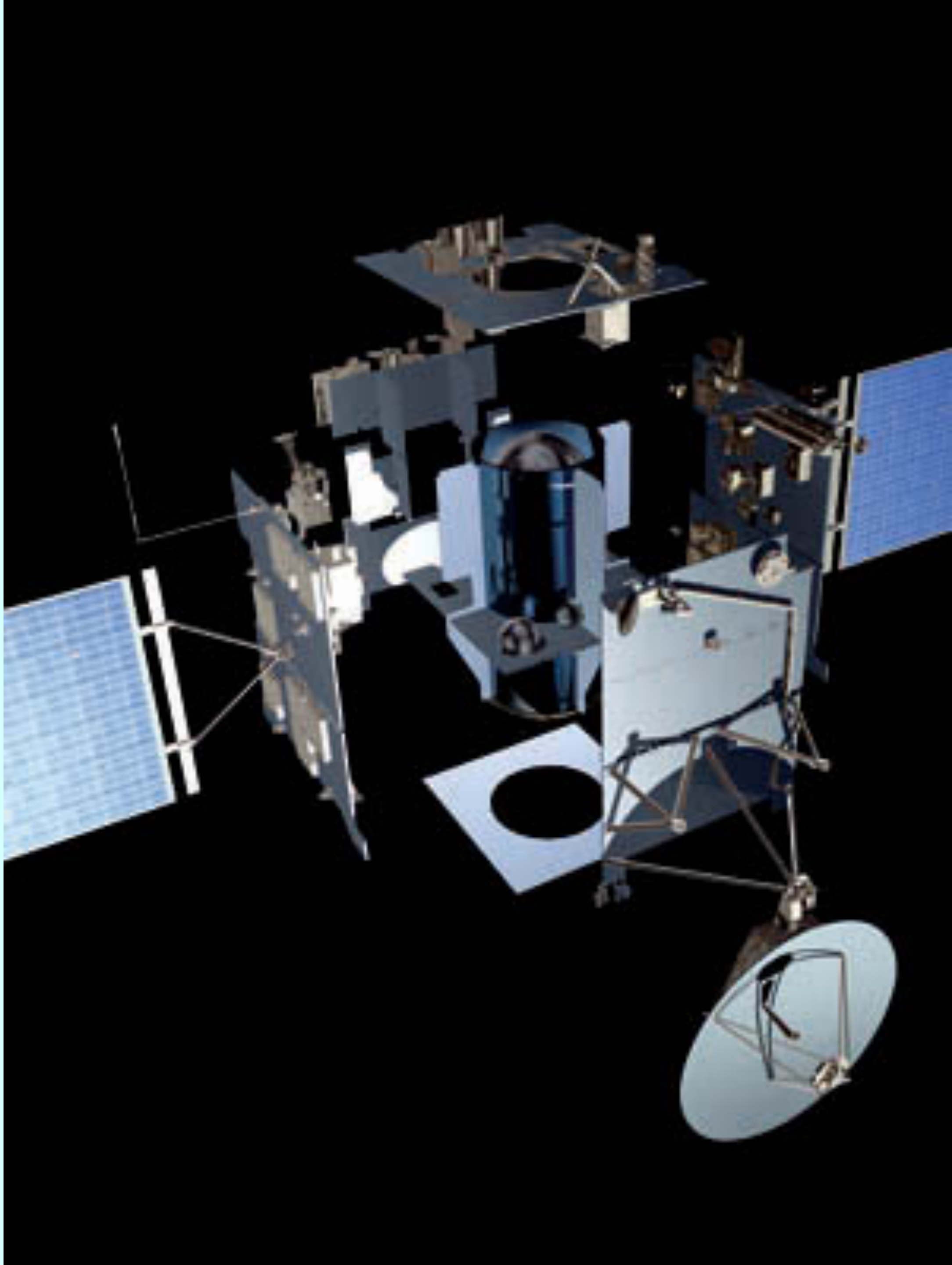


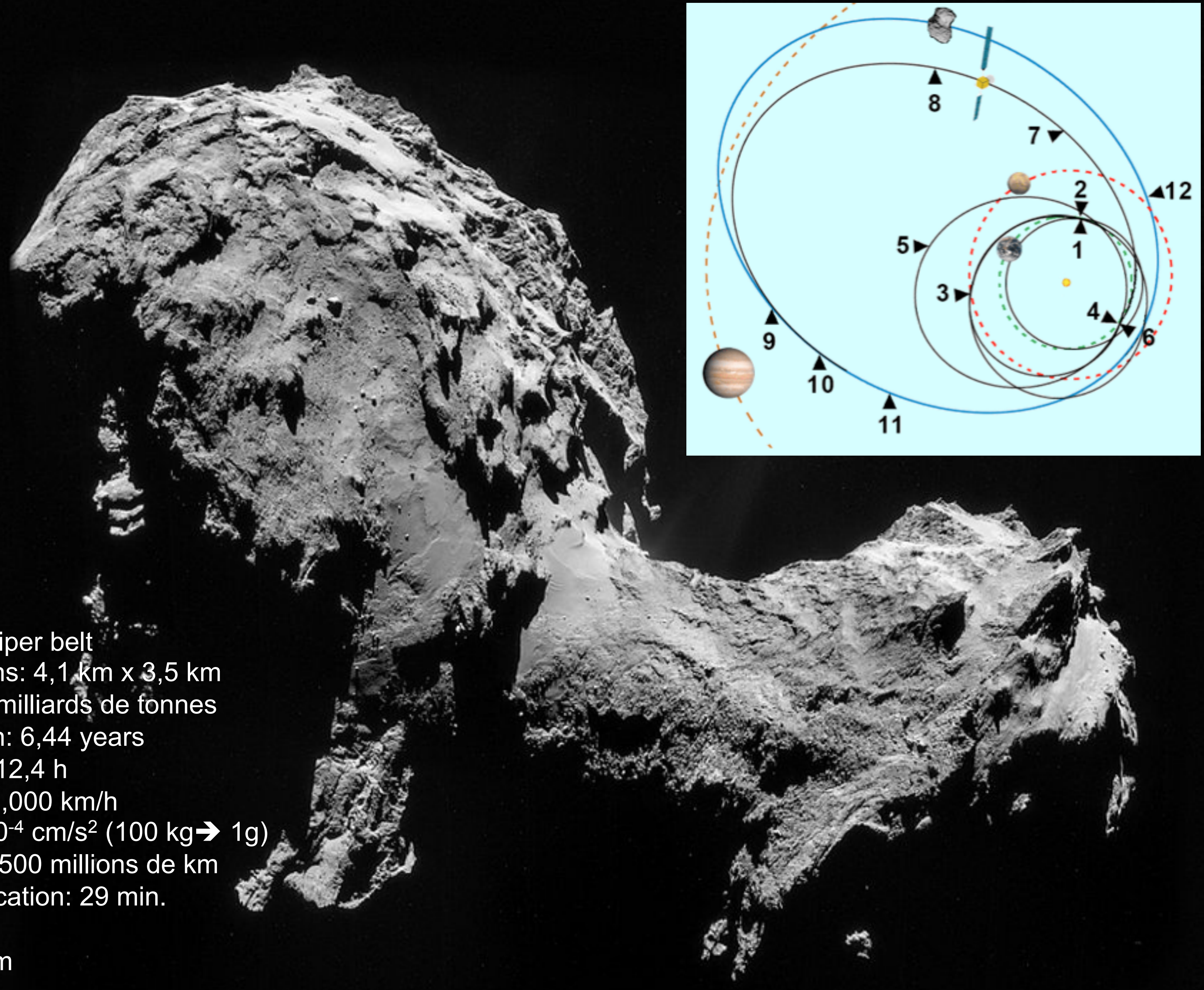
Impact traces in aerogel (0.2 to 3 mm)

The grains contain organic matter (identified functions: alcohol, cetone, aldehyde, carboxylic acid, amide, nitrile, glycine, etc.)

Micrometeorites are cometary.

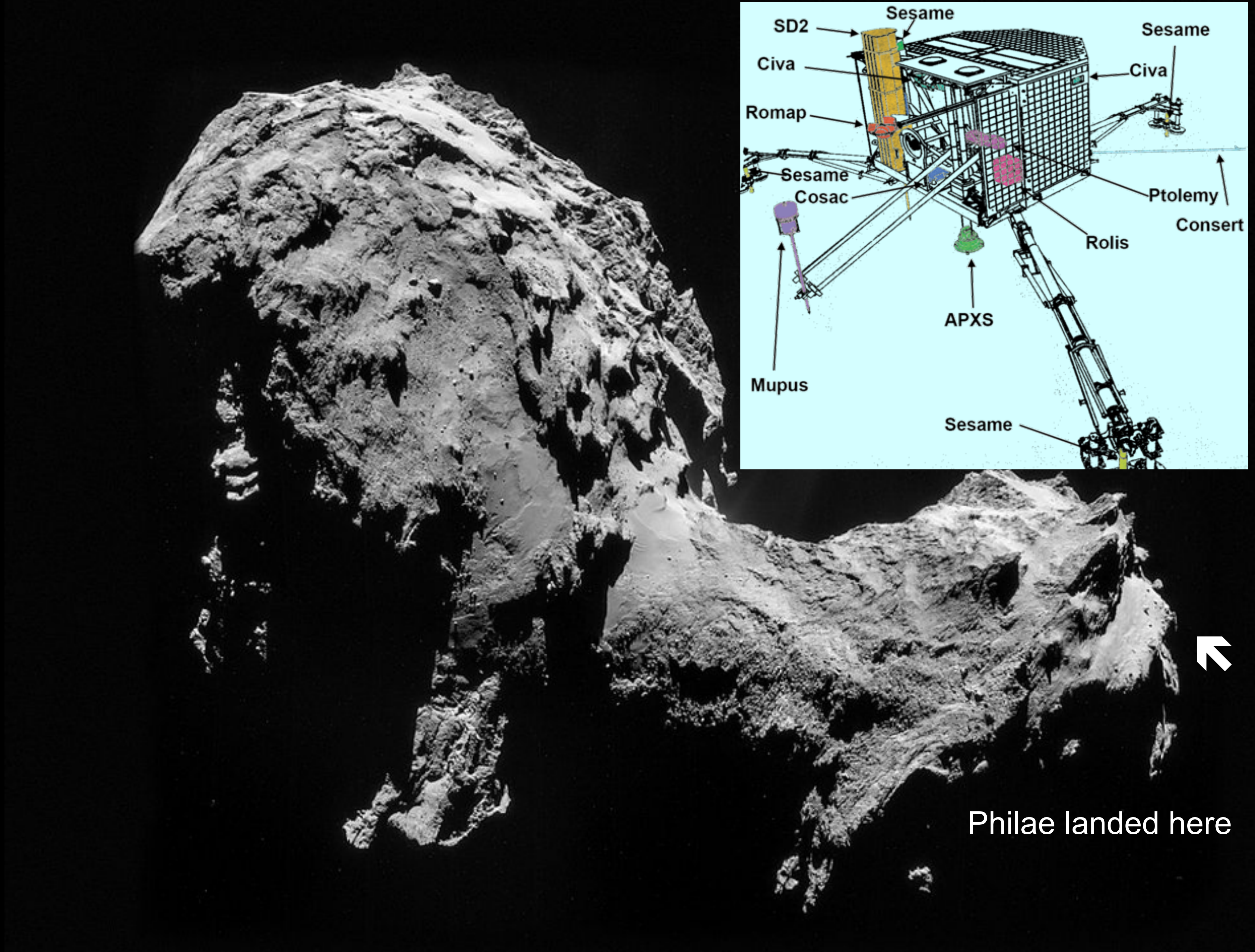
The Rosetta probe to comet Churyumov-Gerasimenko.
Launched : 2 march 2004
Arrived August 2014
(4 gravitational assistance, 3 Earth, 1 Mars)

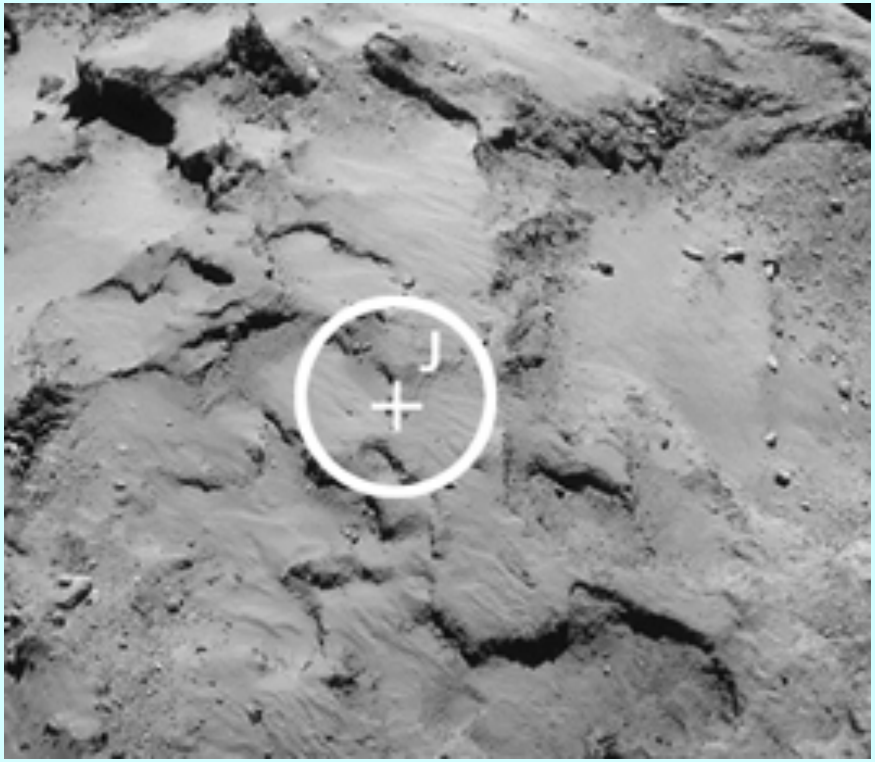


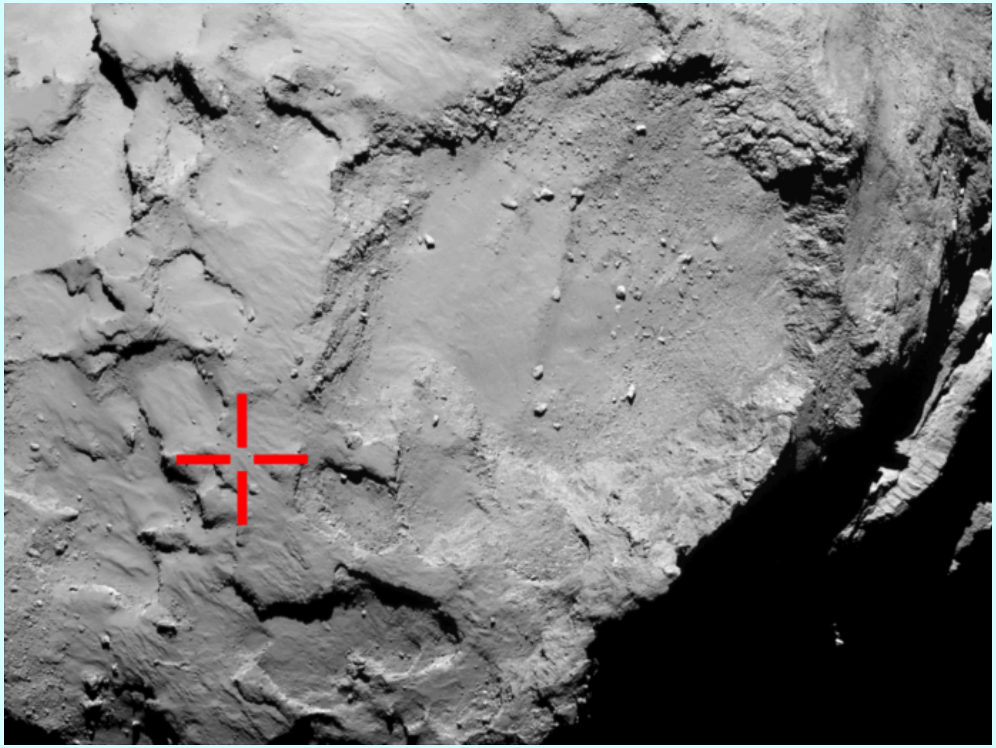


Origin: Kuiper belt
Dimensions: 4,1 km x 3,5 km
Mass: 10 milliards de tonnes
Revolution: 6,44 years
Rotation: 12,4 h
Speed: 50,000 km/h
Gravity: 10^{-4} cm/s^2 (100 kg→ 1g)
Distance: 500 millions de km
Communication: 29 min.

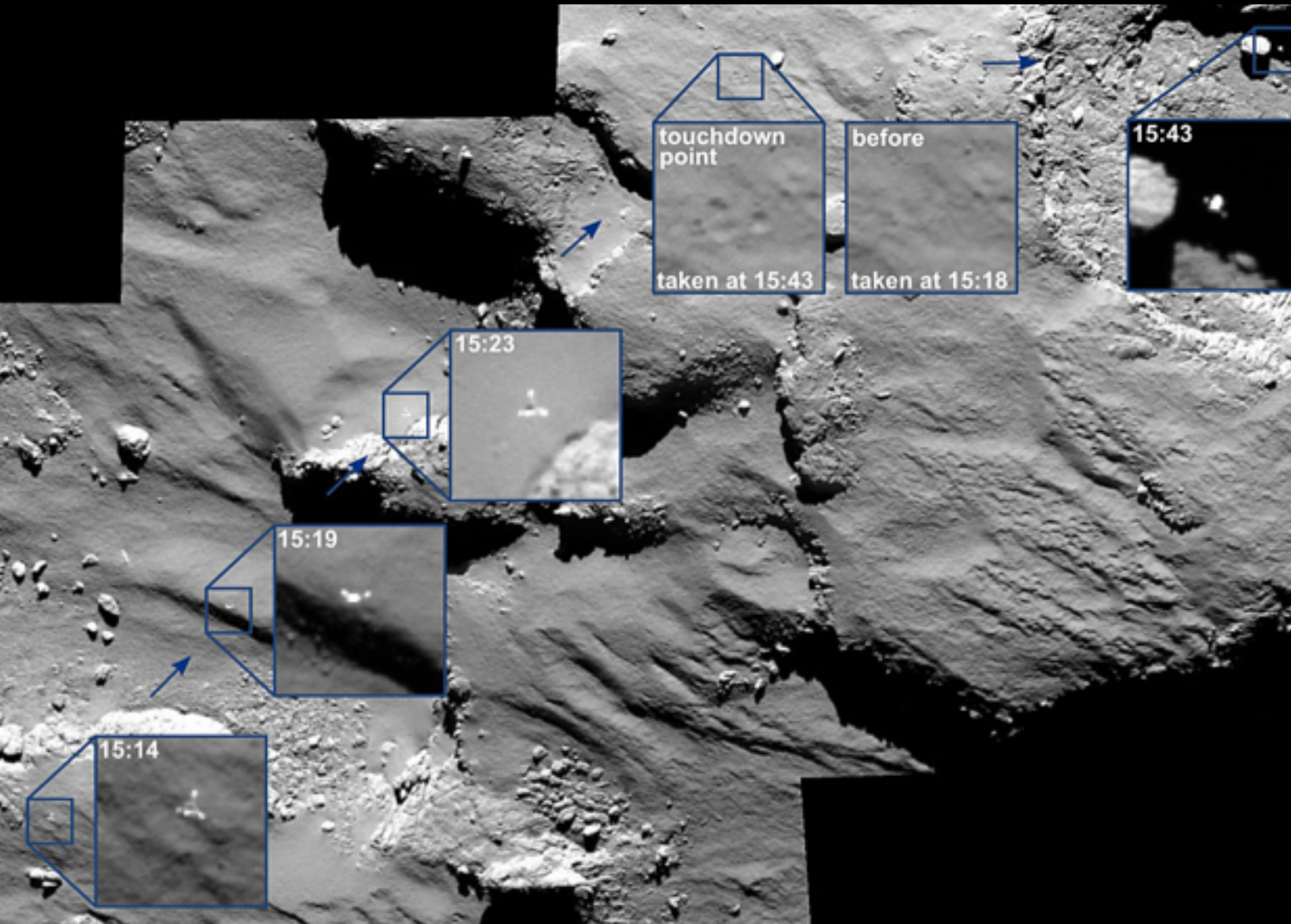
7 billion km


Sesame
SD2
Civa
Romap
Sesame
Cosac
Mupus
APXS
Sesame
Civa
Ptolemy
Consert
Rolis
Sesame
Philae landed here





Philae bumped twice ...



touchdown point
taken at 15:43
before
taken at 15:18
15:43
15:23
15:19
15:14

... before immobilization in a ridiculous position!

Outcome

- **16 molecules were detected by Philae in the splinters during the first bump**

- **glycine was detected in the coma by Rosetta**

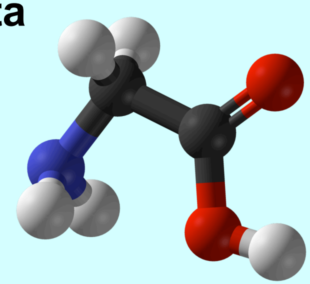
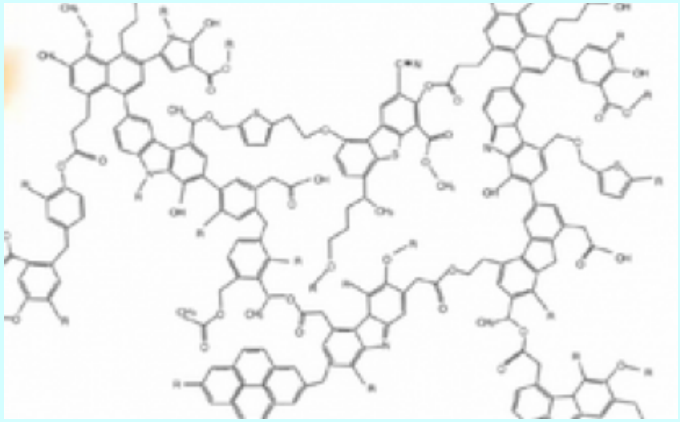


Table 1. The 16 molecules used to fit the COSAC mass spectrum.

Name	Formula	Molar mass (u)	MS fraction	Relative to water
Water	H_2O	18	80.92	100
Methane	CH_4	16	0.70	0.5
Methanenitrile (hydrogen cyanide)	HCN	27	1.06	0.9
Carbon monoxide	CO	28	1.09	1.2
Methylamine	CH_3NH_2	31	1.19	0.6
Ethanenitrile (acetonitrile)	CH_3CN	41	0.55	0.3
Isocyanic acid	$HNCO$	43	0.47	0.3
Ethanal (acetaldehyde)	CH_3CHO	44	1.01	0.5
Methanamide (formamide)	$HCONH_2$	45	3.73	1.8
Ethylamine	$C_2H_5NH_2$	45	0.72	0.3
Isocyanomethane (methyl isocyanate)	CH_3NCO	57	3.13	1.3
Propanone (acetone)	CH_3COCH_3	58	1.02	0.3
Propanal (propionaldehyde)	C_2H_5CHO	58	0.44	0.1
Ethanamide (acetamide)	CH_3CONH_2	59	2.20	0.7
2-Hydroxyethanal (glycolaldehyde)	CH_2OHCHO	60	0.98	0.4
1,2-Ethanediol (ethylene glycol)	$CH_2(OH)CH_2(OH)$	62	0.79	0.2



- **Very complex organic matter was detected in the dust ejected by the nucleus**

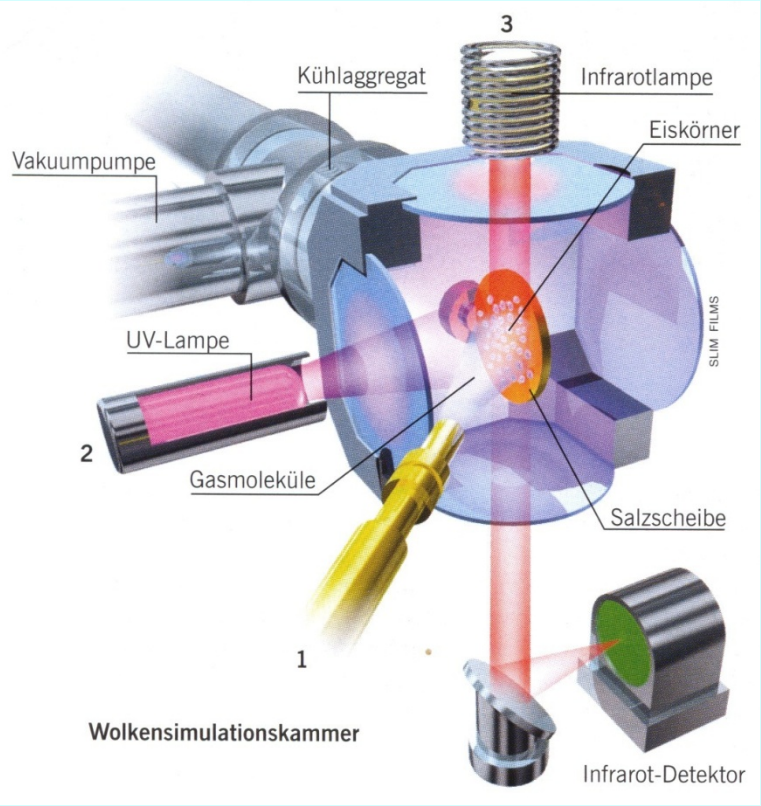
- **Cometary water does not fit with terrestrial water (D/H).**

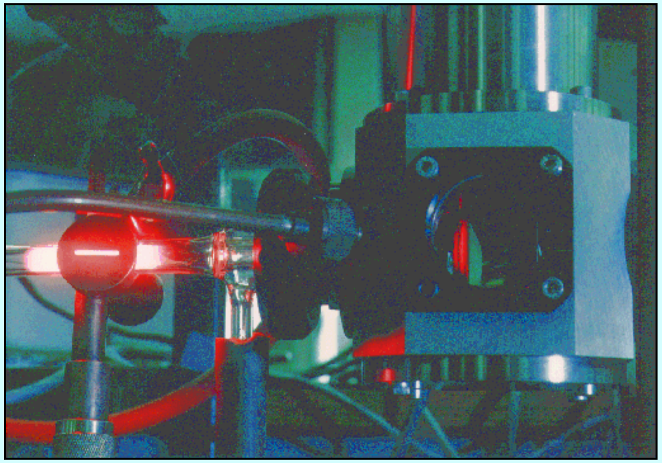
- **Comets could have delivered 22 % of our atmospheric xenon**

- **Detection of oxygen in the coma, probably embedded in the nucleus ice (pre-cometary oxygen?)**

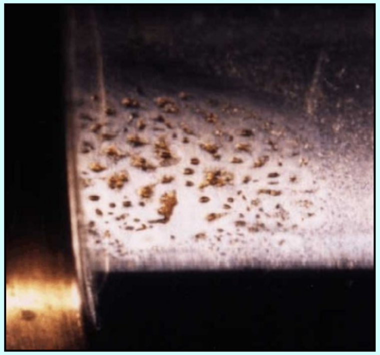
Mimicking interstellar chemistry produced amino acids in the lab

Ices of water, carbon monoxide and dioxide, methanol and ammonia (2,1,1,1,1) wer irradiated at 12 K in Leide.
16 amino acids were identified in Orléans.

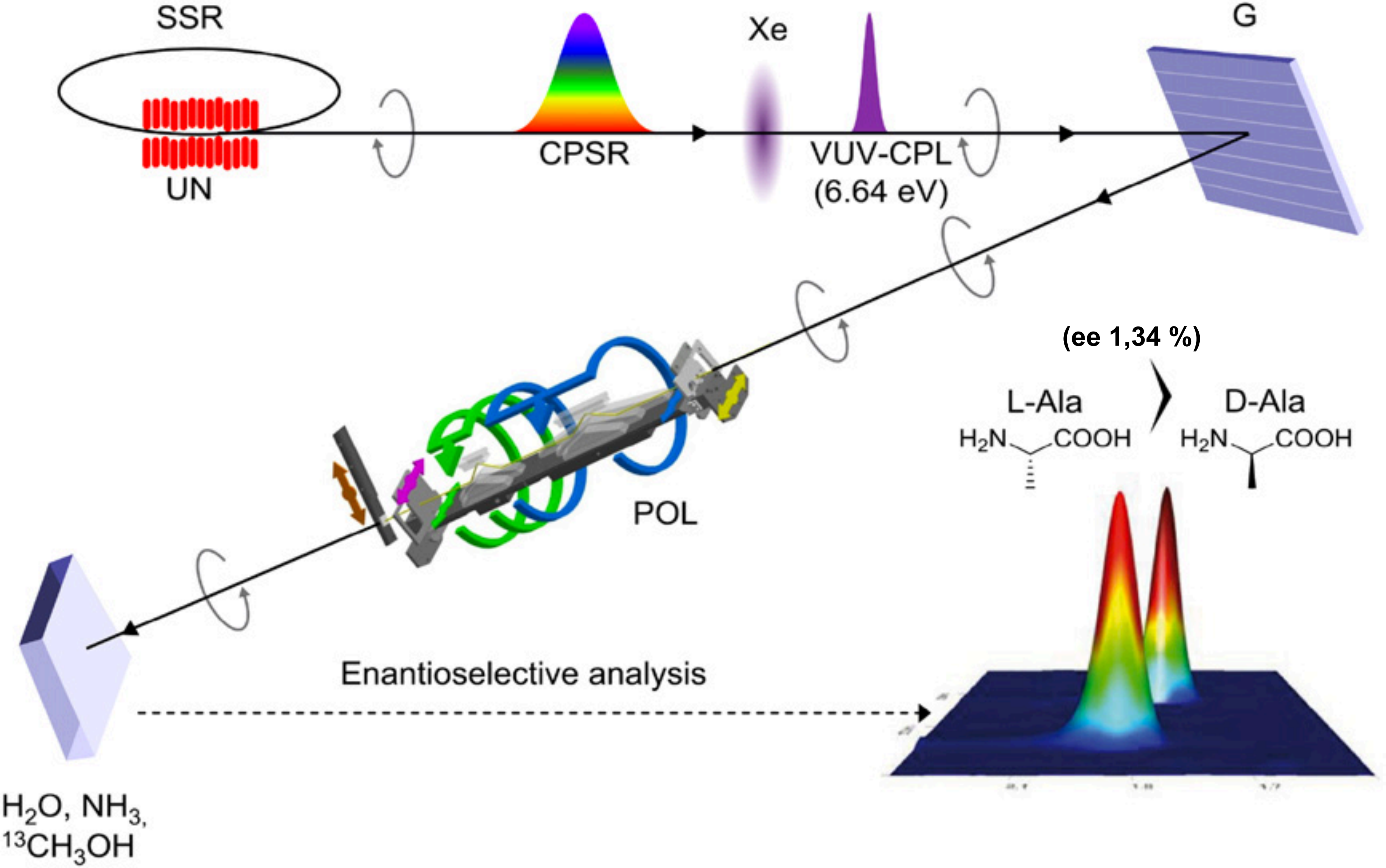




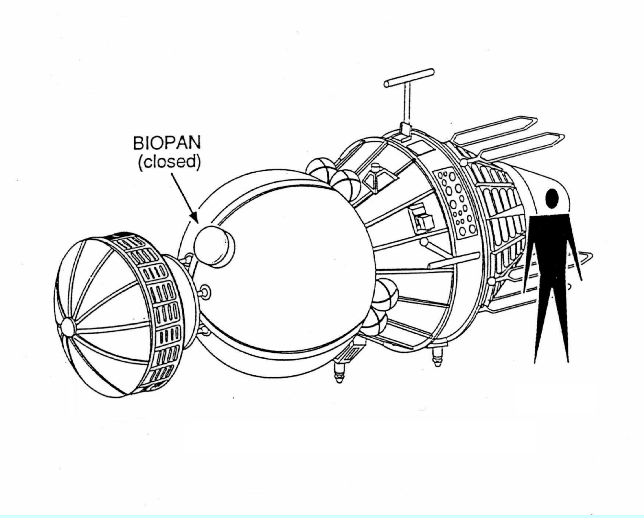
- Glycine
- Alanine
- Valine
- Proline
- Serine
- Aspartic acid

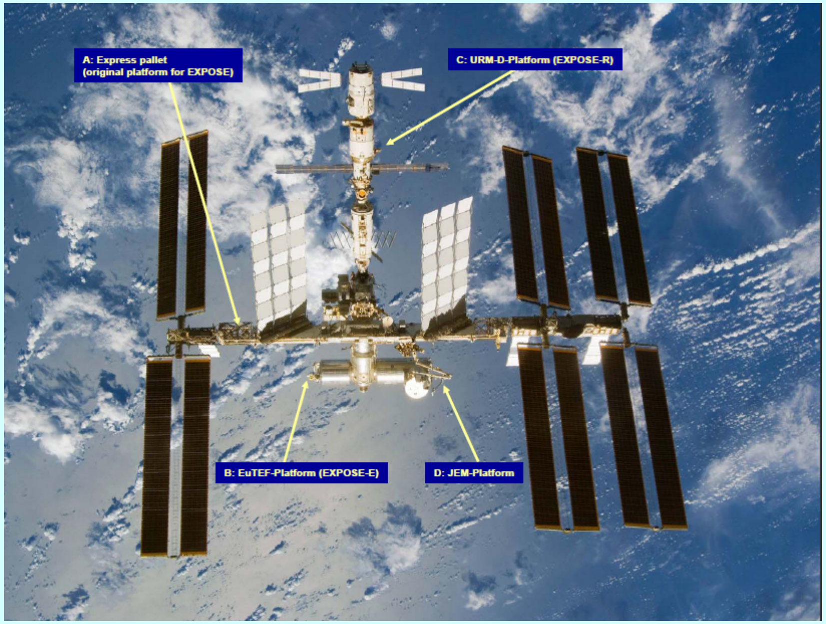


Assymetric synthesis of alanine in ices under circularly polarized VUV (line DESIRS of SOLEIL)

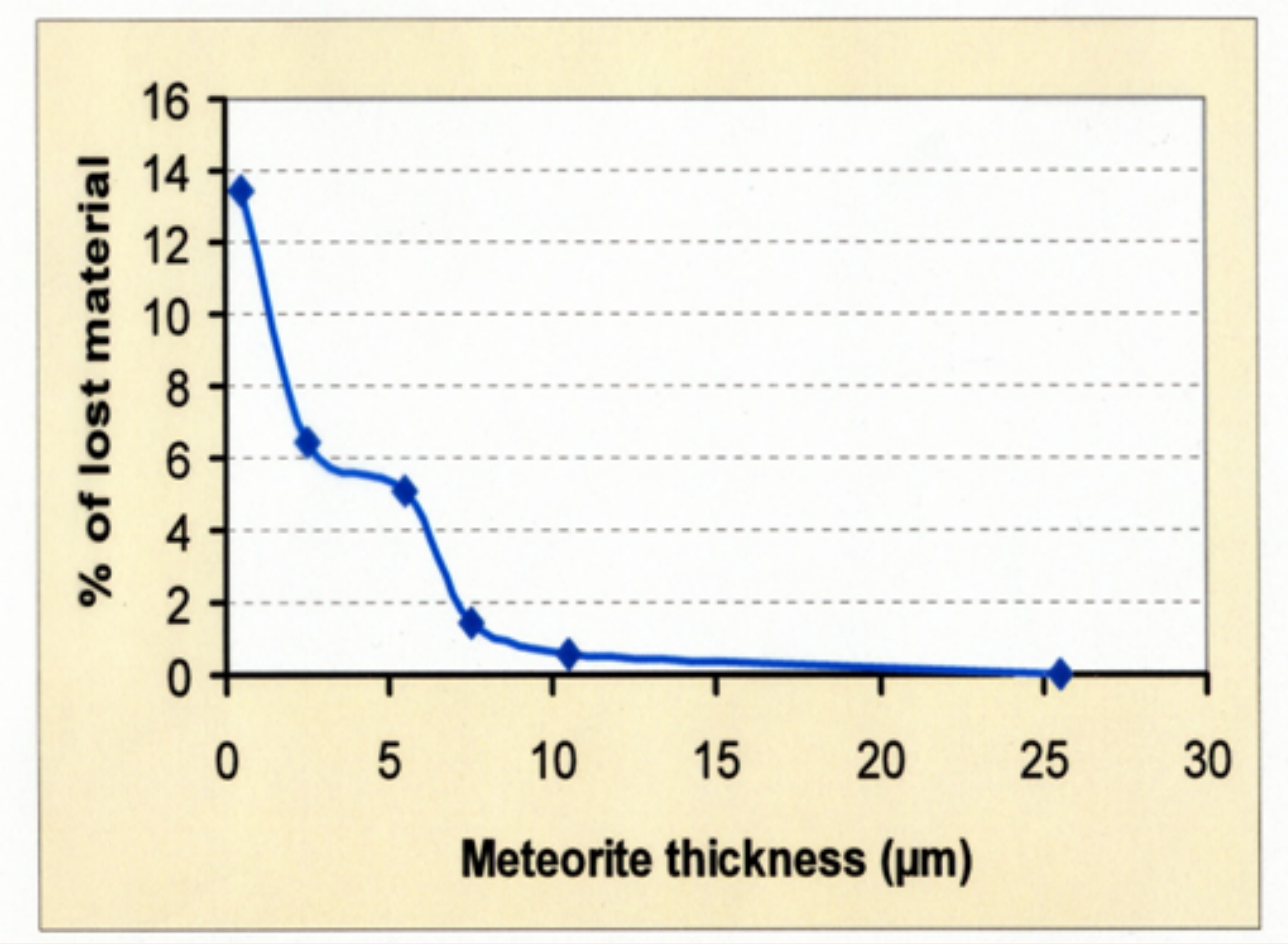


Amino acids were exposed in space: they travel safely in space if embedded in at least 5 microns of minerals.





Loss of amino acids as a function of the thickness of the mineral protection

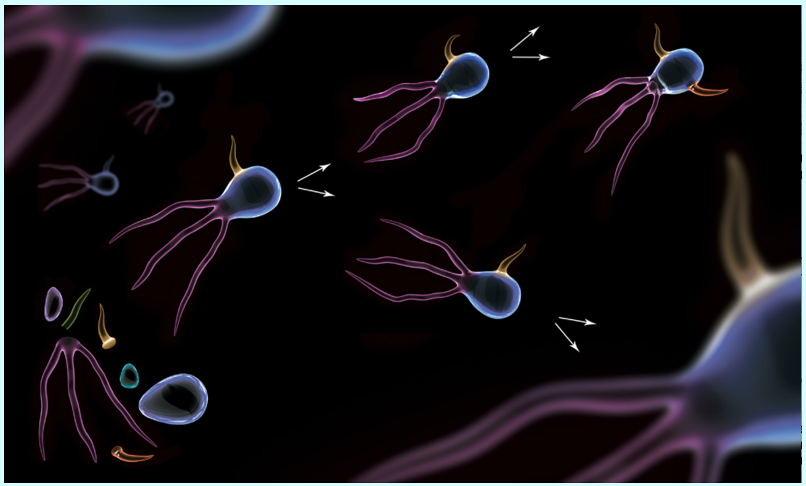


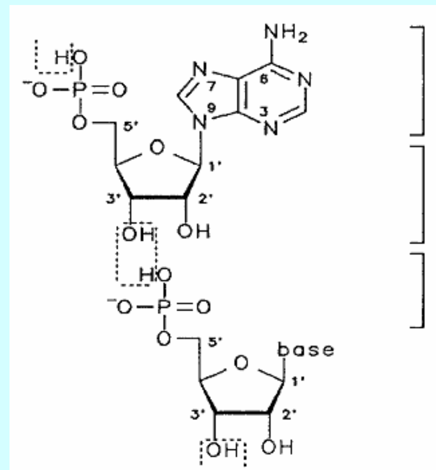
Making life in a test tube

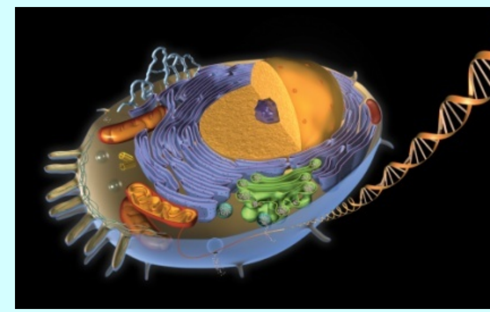
i.e. creating self-replicating and evolving chemical systems

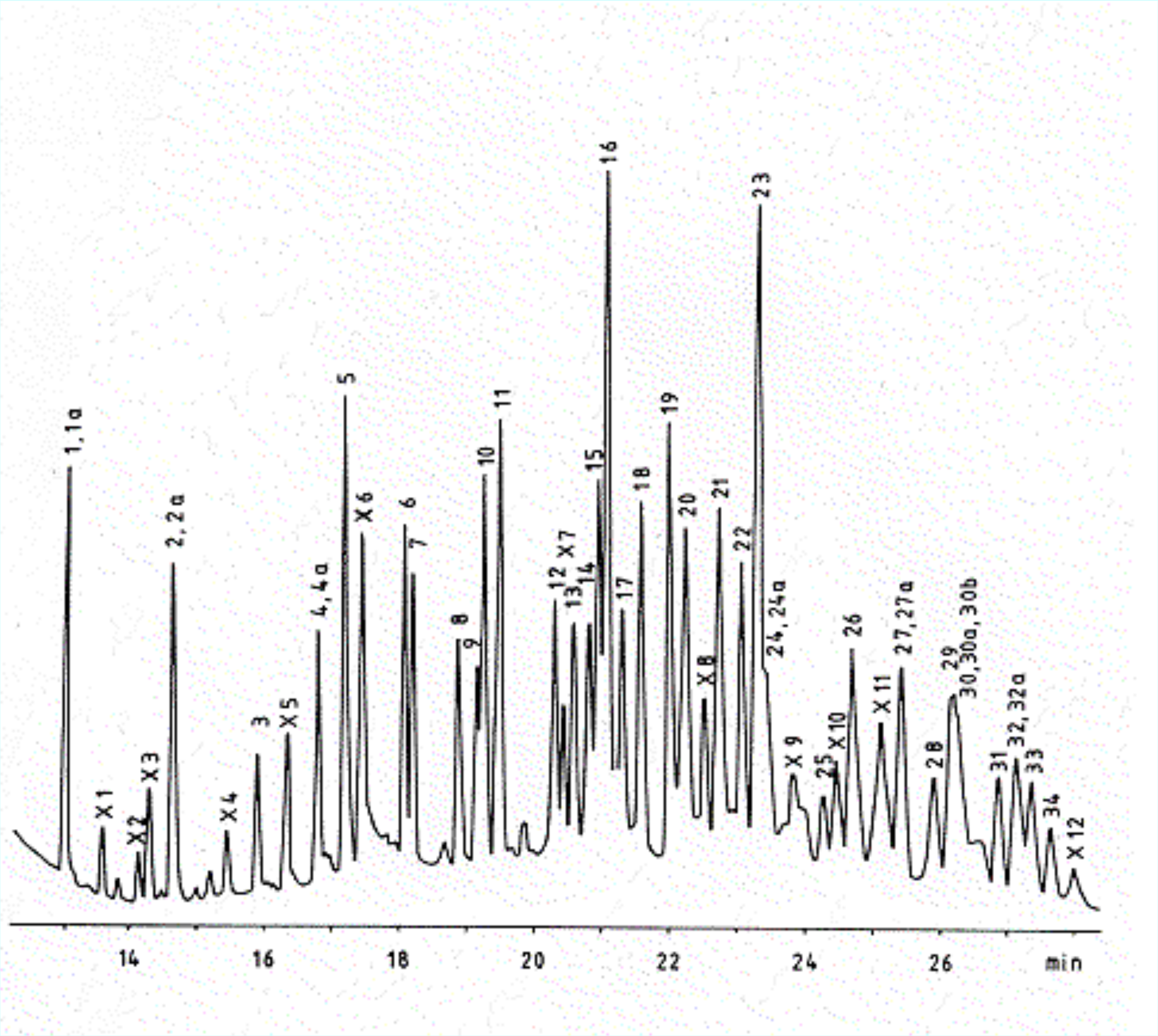
The « Primordial soup - RNA world » scenario

CHONS + H_2O ⇒ Chemical automata? ⇒ RNA Virus? ⇒ Cell with: RNA Proteins Membranes





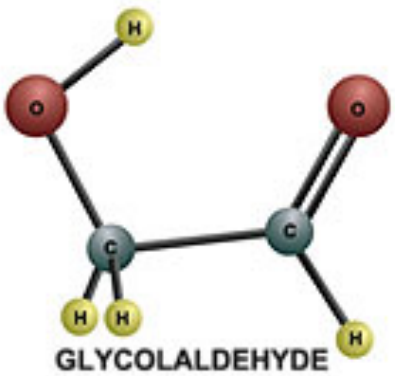




The formation of RNA sugar ribose (peak 8) from formaldehyde (Formose reaction) is really modest

Cold Sugar in Space Provides Clue to the Molecular Origin of Life

Source: National Radio Astronomy Observatory   Posted Monday, September 20, 2004

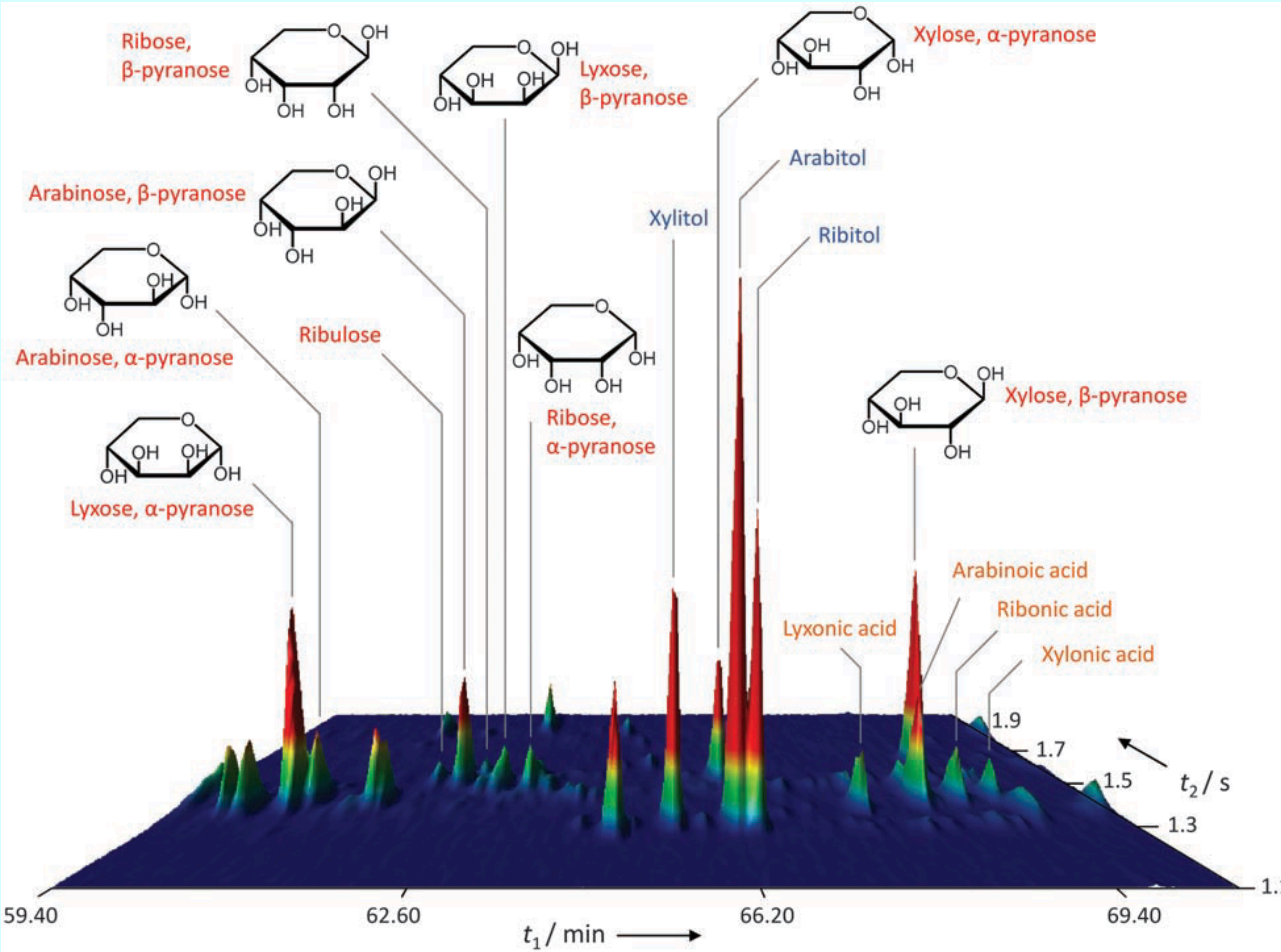


NRAO

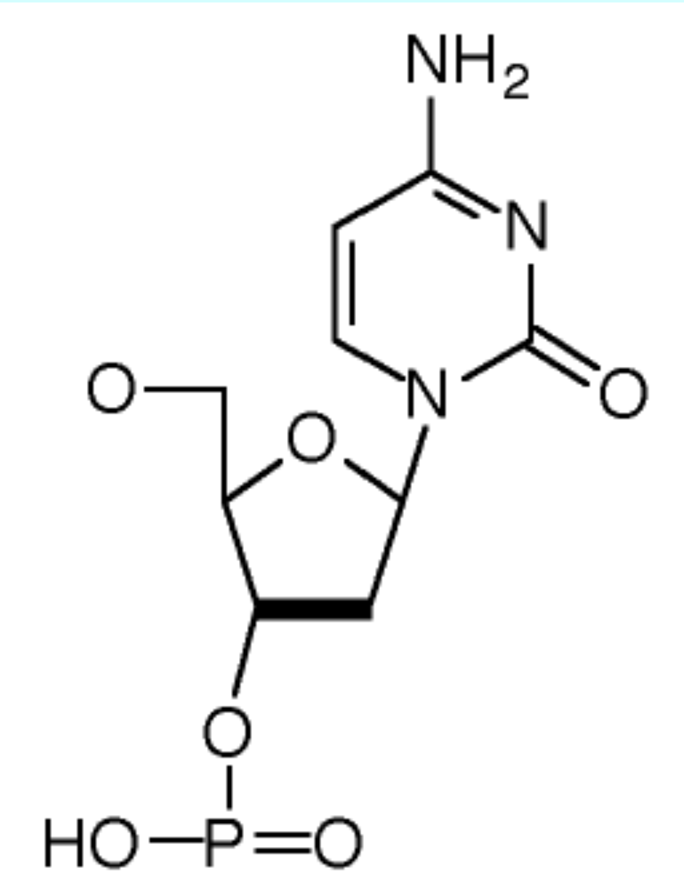
Astronomers using the National Science Foundation's giant Robert C. Byrd Green Bank Telescope (GBT) have discovered a frigid reservoir of simple sugar molecules in a cloud of gas and dust some 26,000 light-years away, near the center of our Milky Way Galaxy. The discovery suggests how the molecular building blocks necessary for the creation of life could first form in interstellar space.

Not a sugar at all! Only a precursor of sugar.

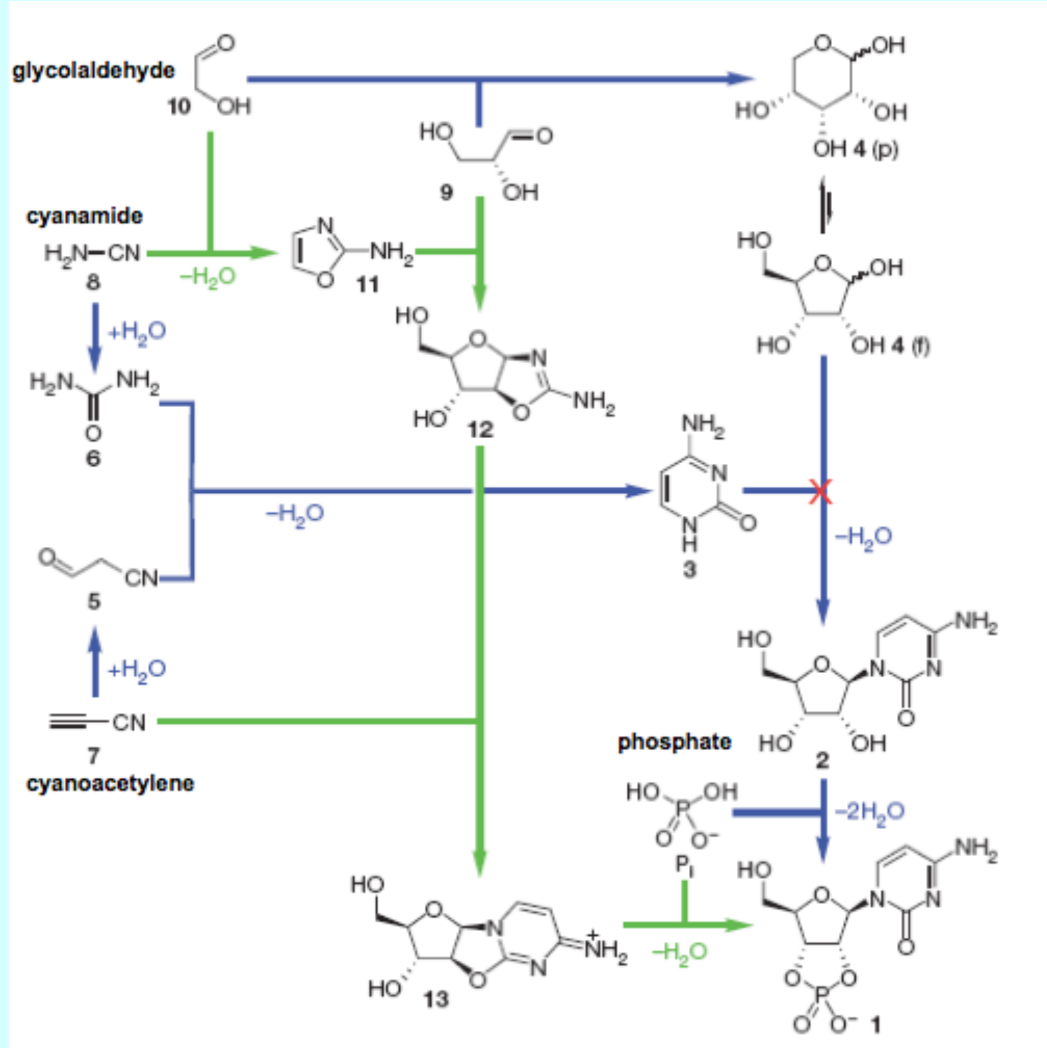
Sugars are formed by irradiation of ices of H_2O, $^{13}CH_3OH$ et NH_3 10:3.5:1 under ultraviolet photons



Bypassing free ribose and the nucleobases

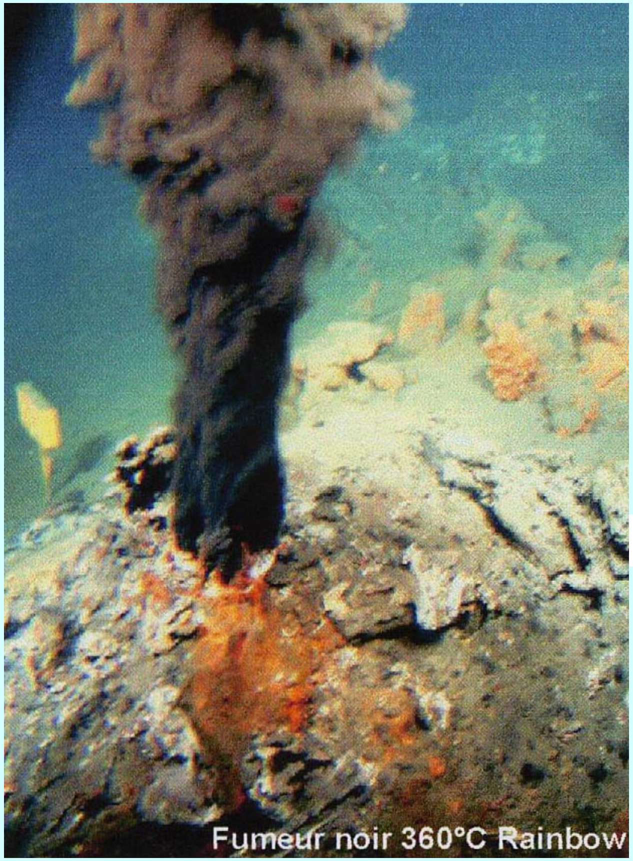


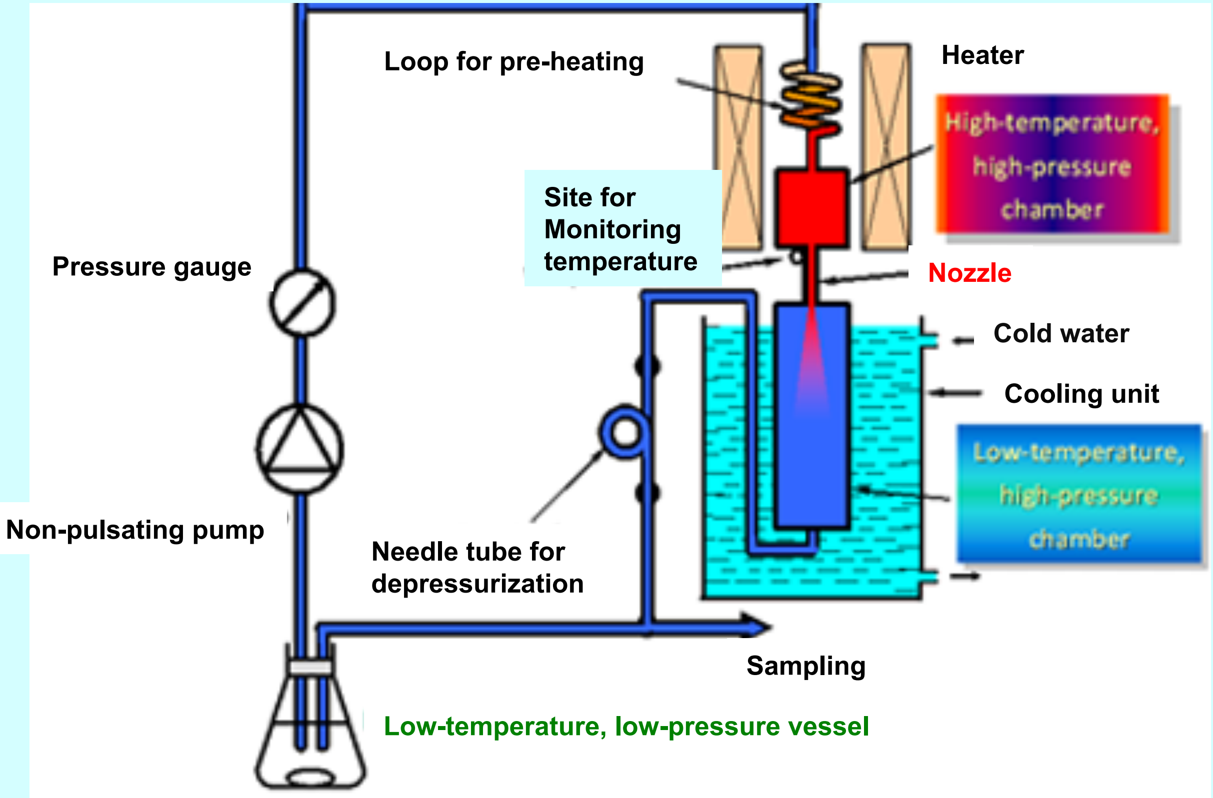
RNA nucleotide



John Sutherland

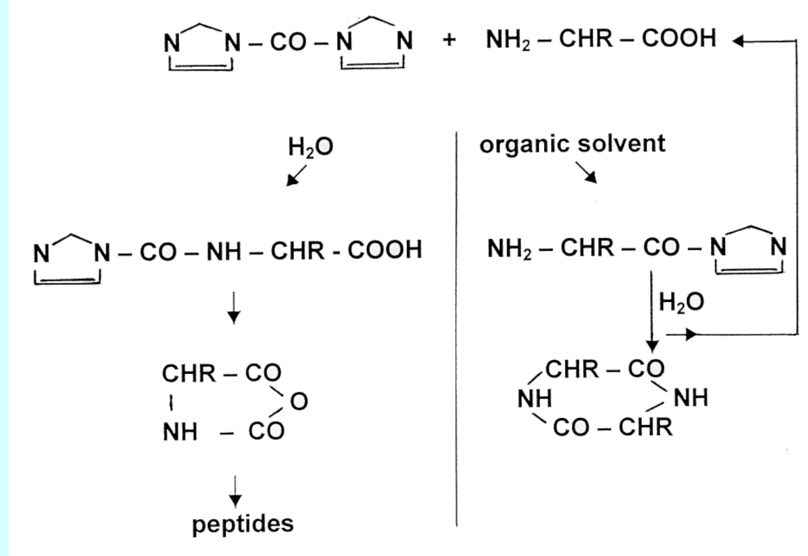
Polymerizing glycine by mimicking a hydrothermal system





A schematic diagram of the flow reactor system

Mini-proteins: selective synthesis and preservation



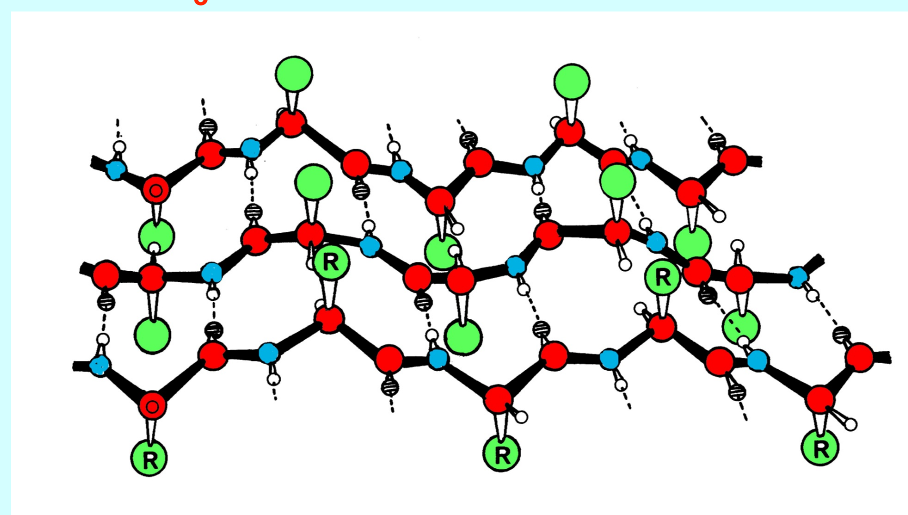
1) Water drives the synthesis

2) NH_2-CHR-COOH NH_2-$(CH_2)_3$-COOH

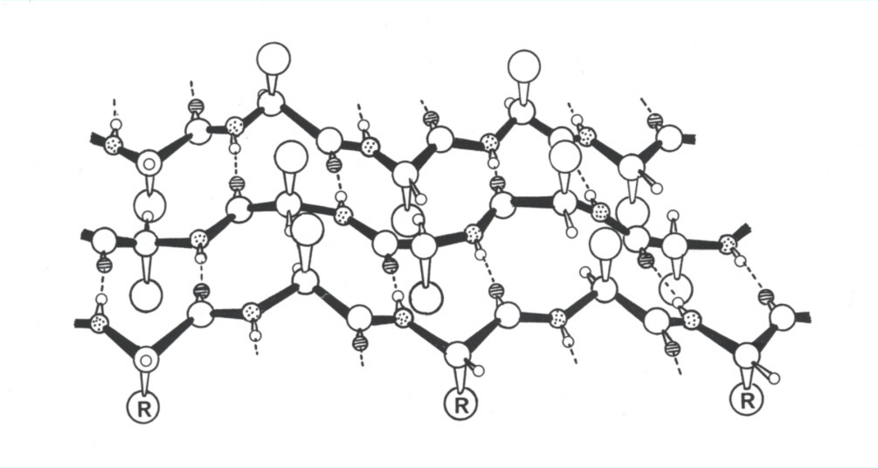
$$\begin{array}{c} CH_3 \\ | \\ NH_2\text{-}C\text{-}COOH \\ | \\ CH_3 \end{array}$$

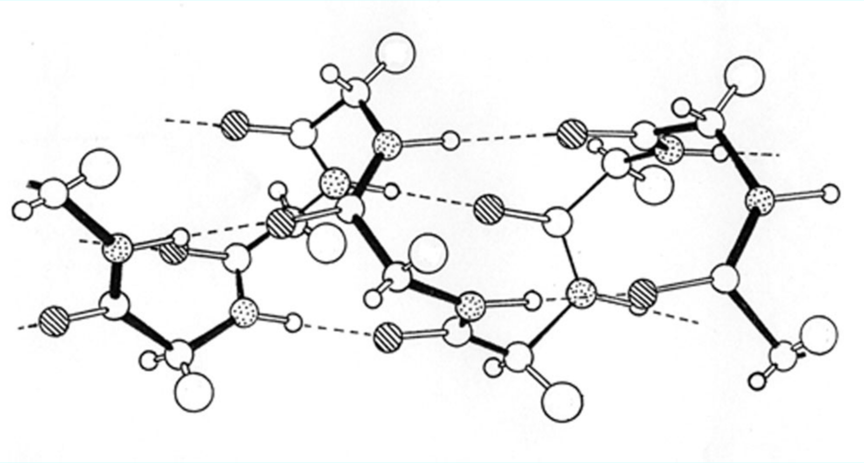
3) Mini-proteins with alternating hydrophilic and hydrophobic amino acids self-organize to form sheets:

- thermostable
- stereoselective
- protected against racemization



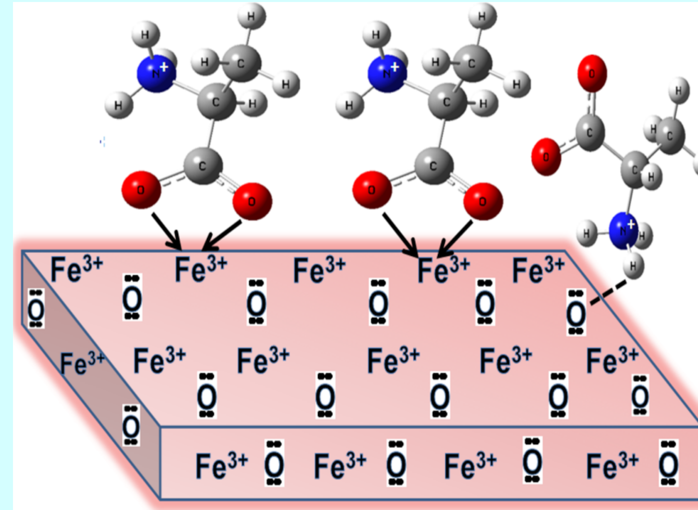
β- sheets of (Asp-Leu)$_{15}$ racemize 10 times slower than helices of (Leu-Asp-Asp-Leu)$_8$-Asp





Chemistry « on the rocks » ?

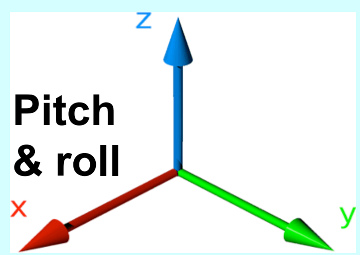
- -Sélective adsorption
- -Ionic interactions
- -Reduced mobility
- -Reduced hydrolysis



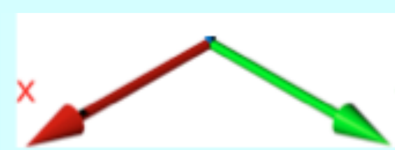
$$\Delta G = \Delta H - T\cdot\Delta S \quad \text{active if } \Delta G << 0$$

Gibbs free energy — Enthalpy (Internal energy) — Entropy (disorder)

	d° of freedom	ΔS	ΔH
Solution	6	+++	~ 0
Surface	2	~ 0	~ 0

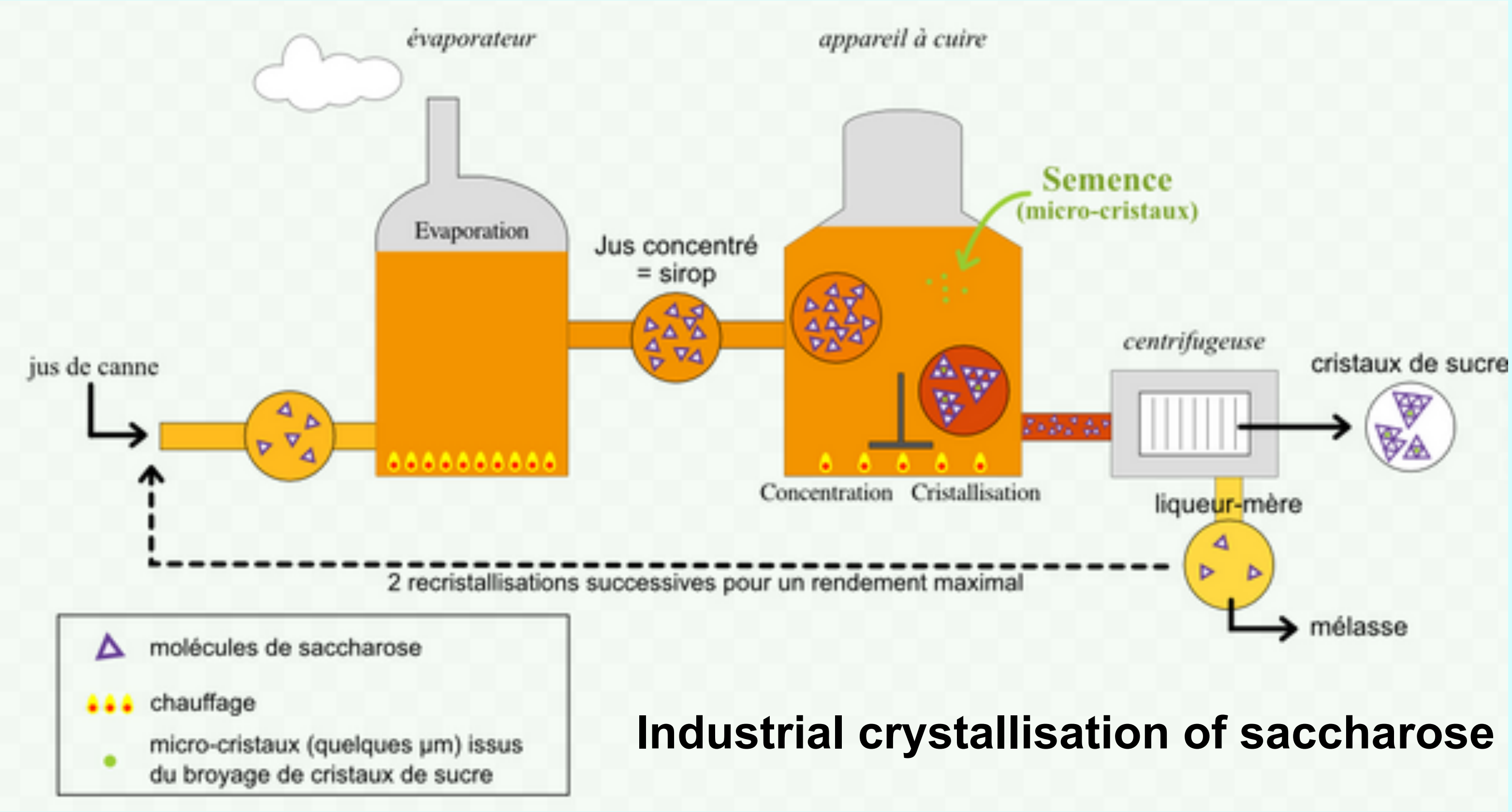


➔



Chemists are facing new dilemma:

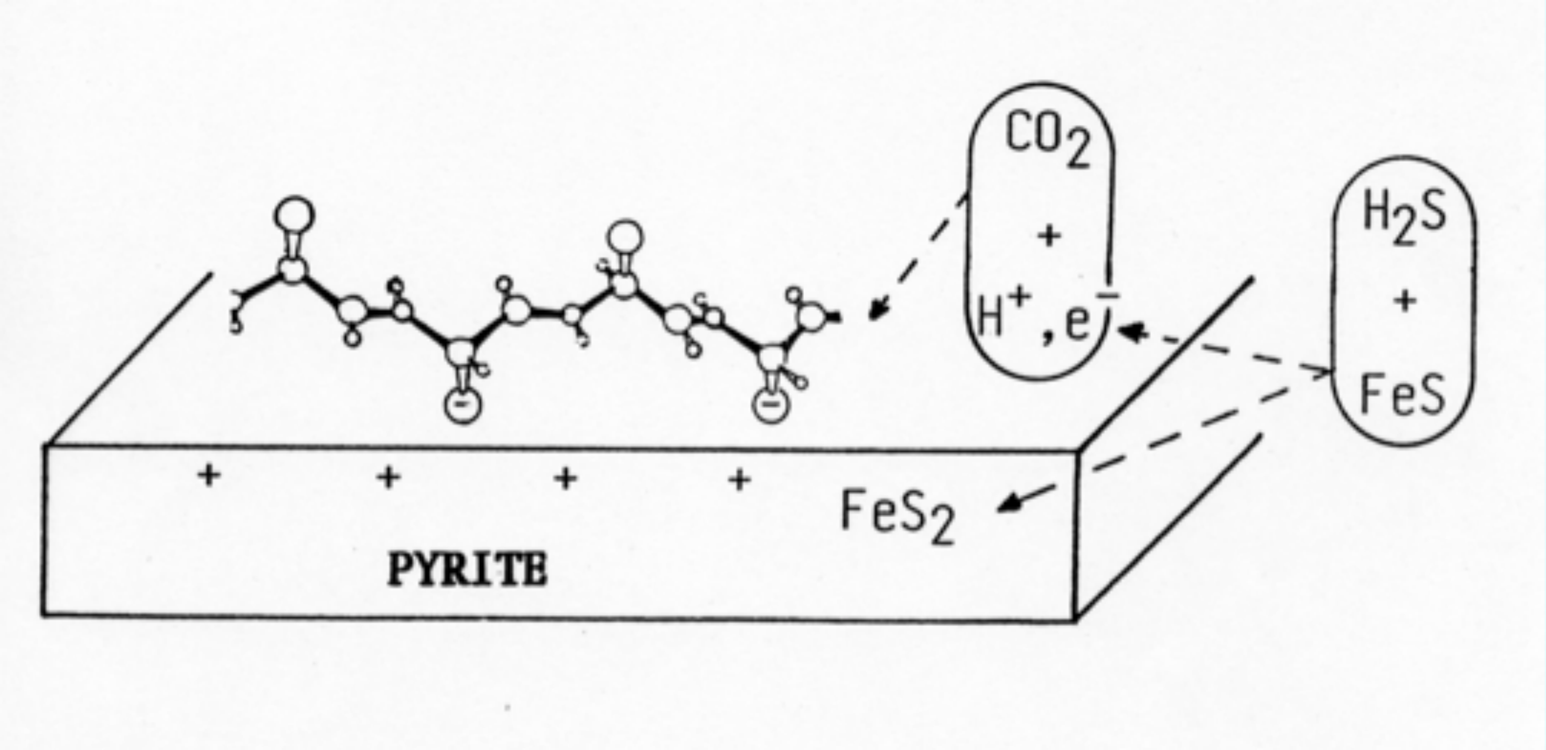
Singularity or ubiquity?
Should we consider :
- very specific local conditions ➔ few births seeding the whole primitive ocean?
- widespread conditions ➔ spontaneous births of life everywhere?



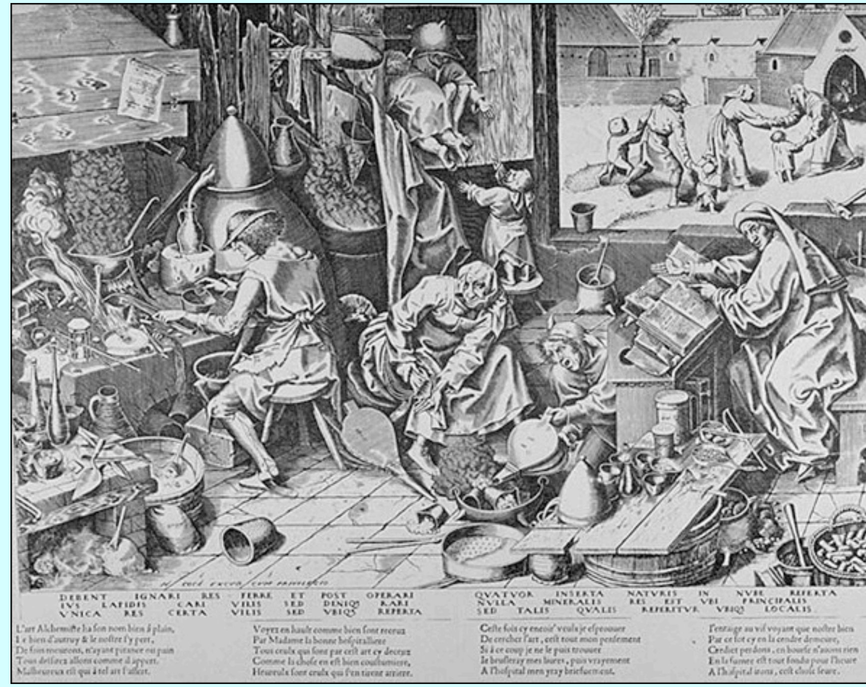
Industrial crystallisation of saccharose

Autotrophy instead of heterotrophy?

The «metabolism first» approach promoted by those who don’ t like the soup



Step-by-step predictive chemistry or stochastic chemistry?

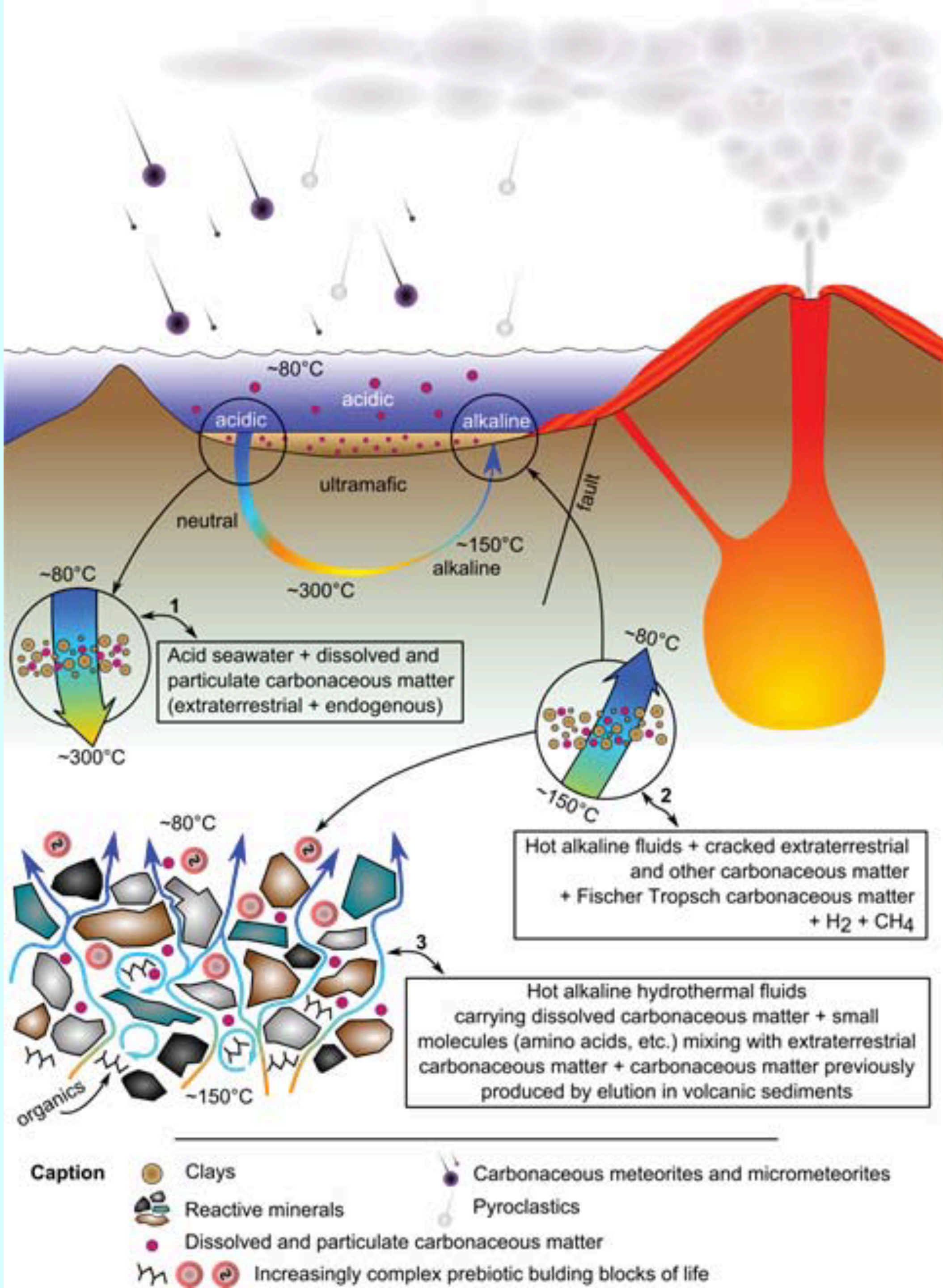


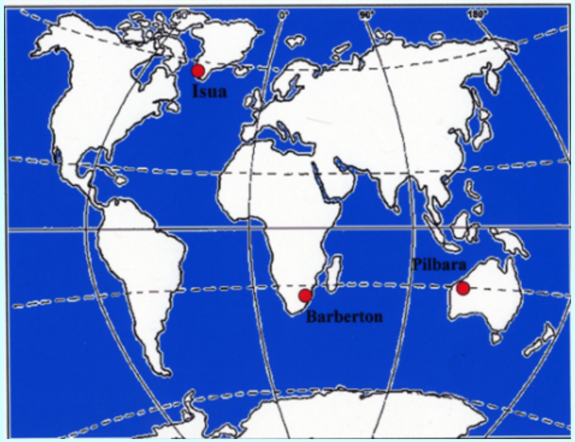
Step-by-step predictive chemistry ***versus*** **alchemist-type stochastic chemistry?**

i.e. to submit a maximum of prebiotic ingredients under prebiotic conditions and to let the system run for months…

Chemistry with rocks?

A new approach developped in Orléans:
Stochastic chemistry in a geochemical context as realistic as possble
→ open chemical system far from equilibrium permeating through sediments in a hydrothermal environment containing mineral catalysts.

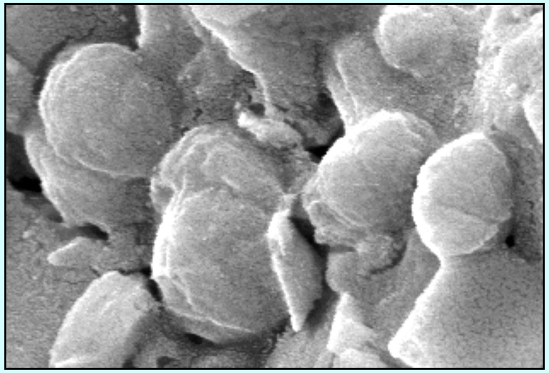




Early traces of life
Frances Westall, Orléans

3,8 Ga. Isua?

3,45 Ga. stromatolites



3,334 Ga. Microfossiles

Simple or awfully complex?

The discovery of a second genesis would support simplicity.

Where could we find liquid water and carbon chemistry?

Mars?

Europa?

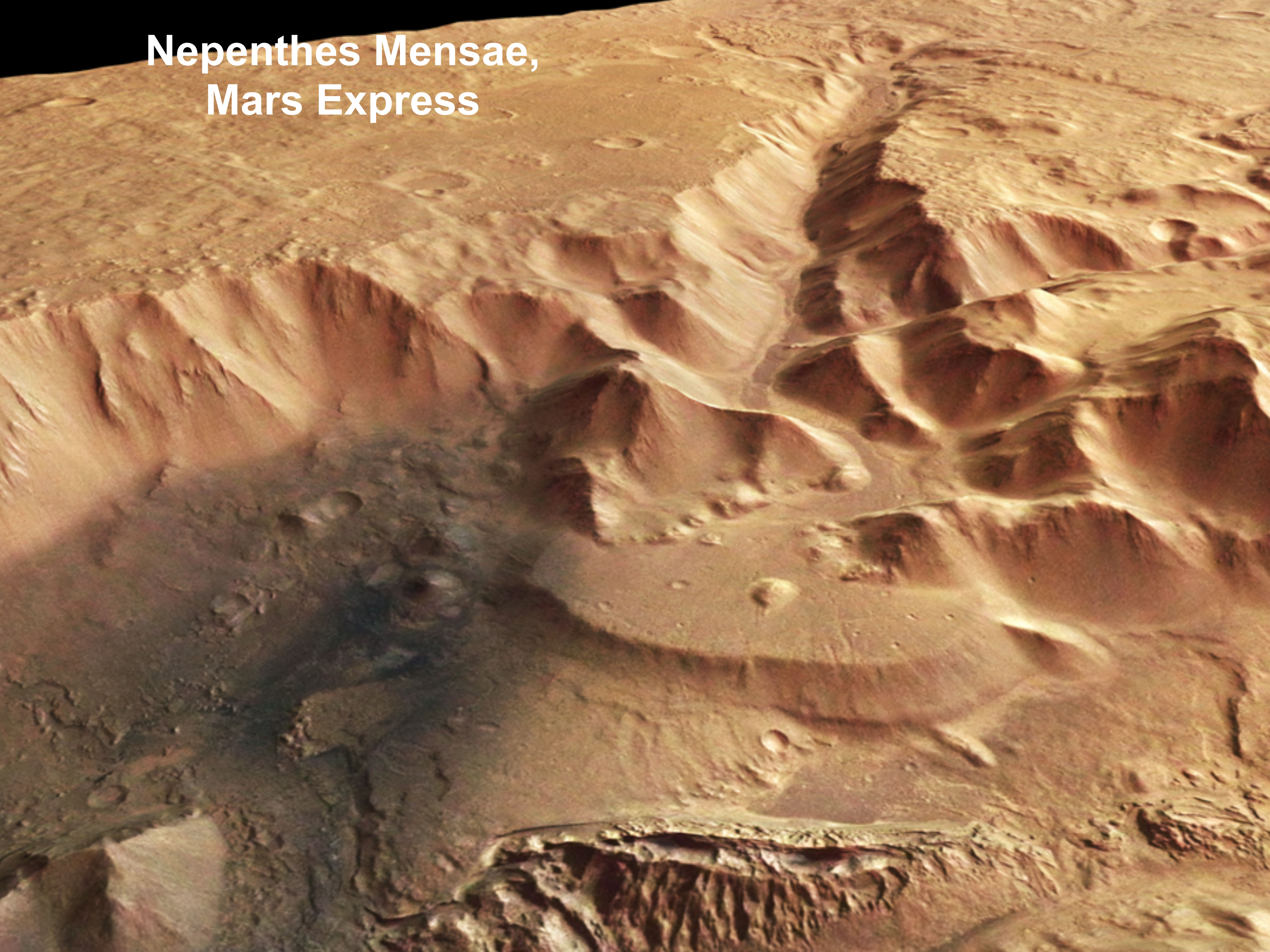
Titan?

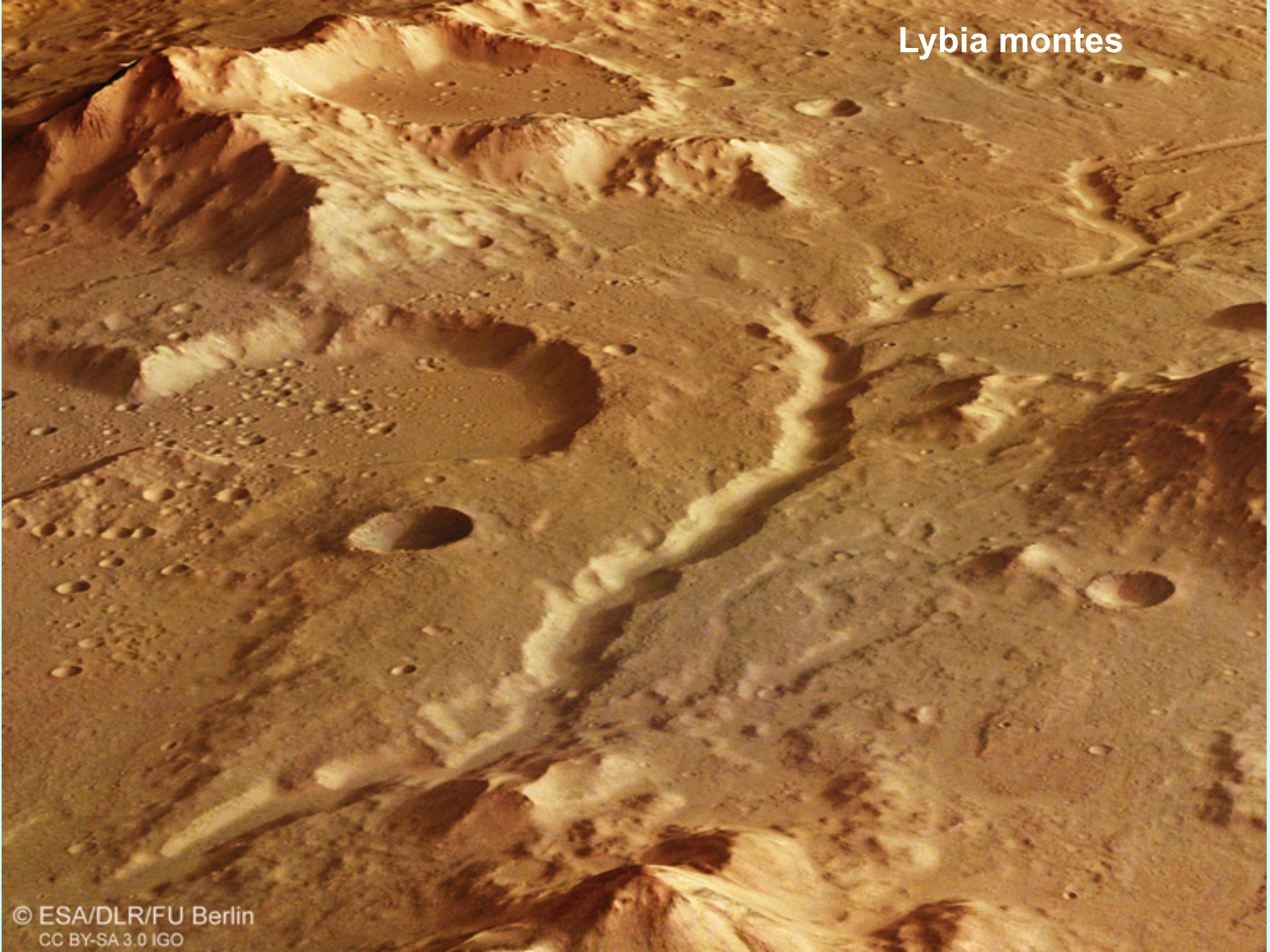
Enceladus?

Exoplanets?

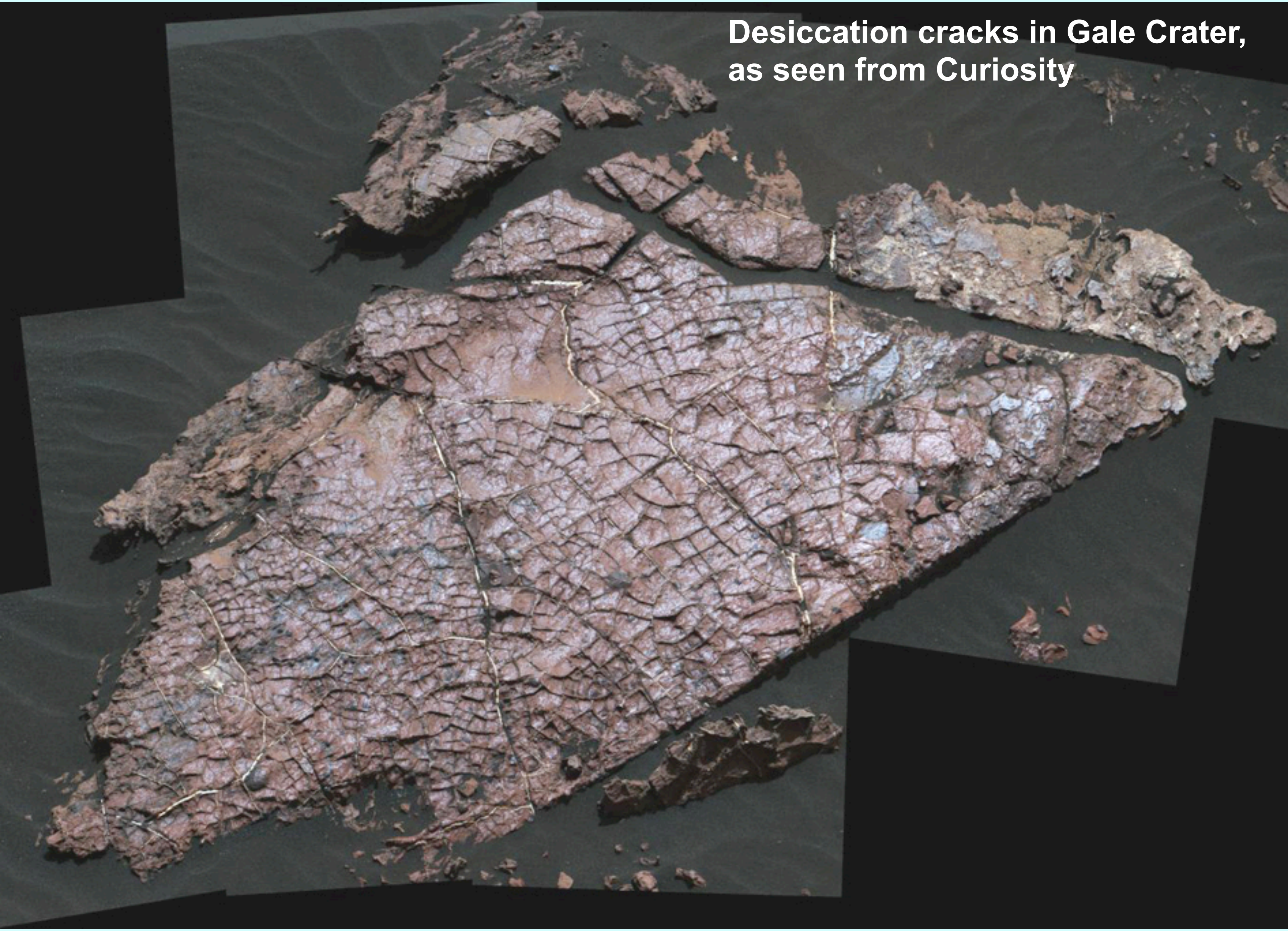
Mars is our first target

The red planet hosted liquid water ⇒ it had therefore an atmosphere capable to decelerate carbon-containing micrometeorites


Nepenthes Mensae,
Mars Express

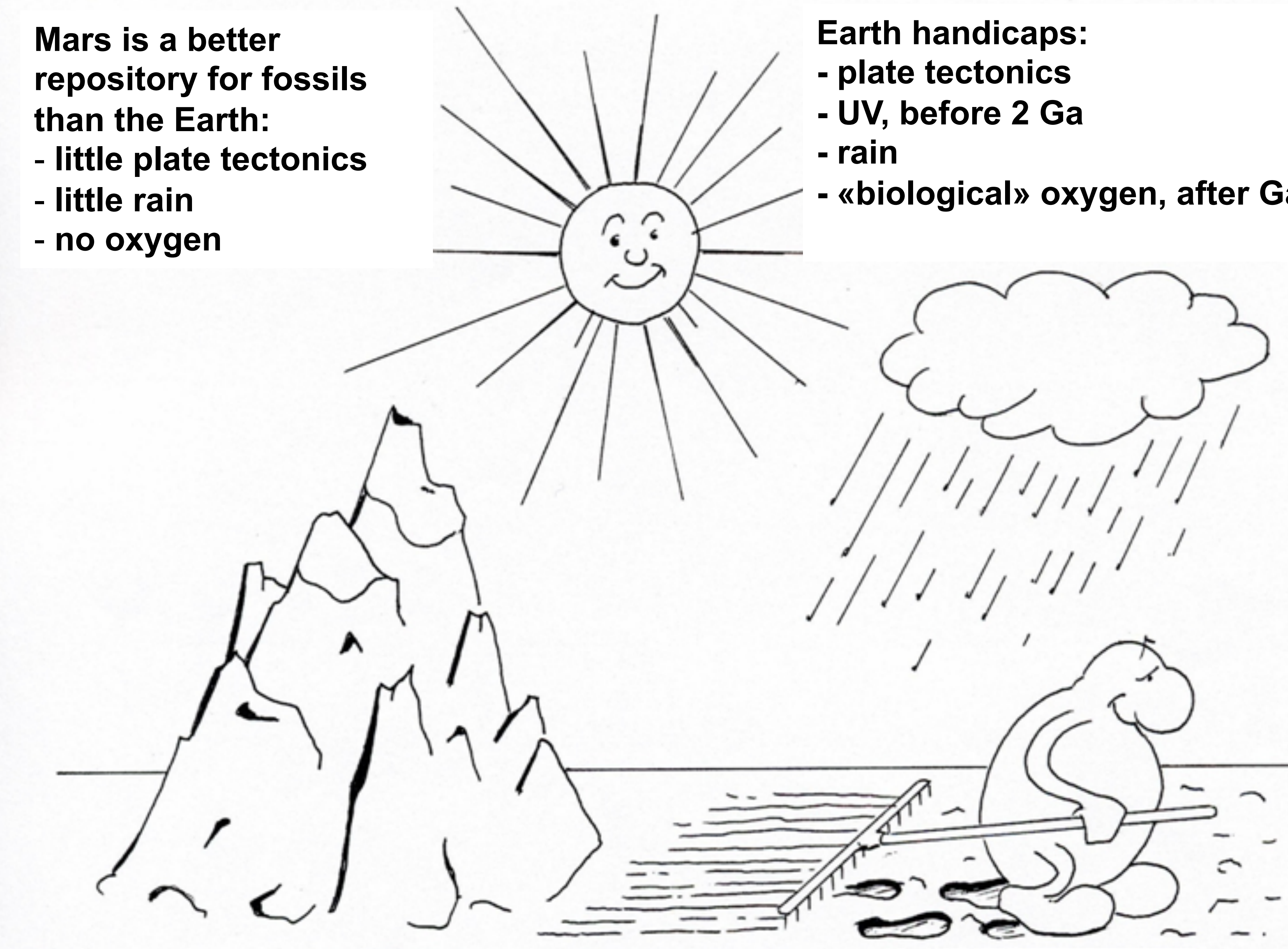

Lybia montes
© ESA/DLR/FU Berlin
CC BY-SA 3.0 IGO

Desiccation cracks in Gale Crater, as seen from Curiosity

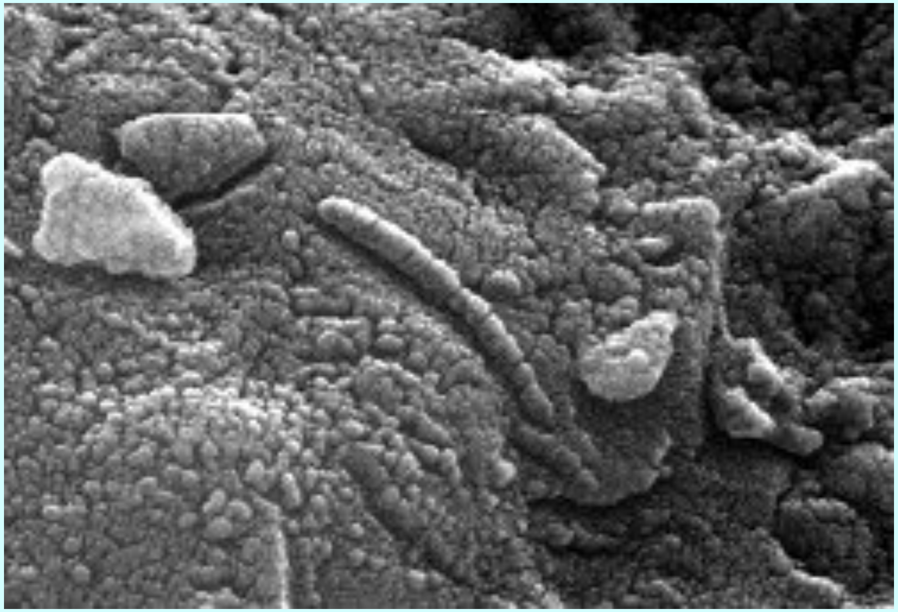


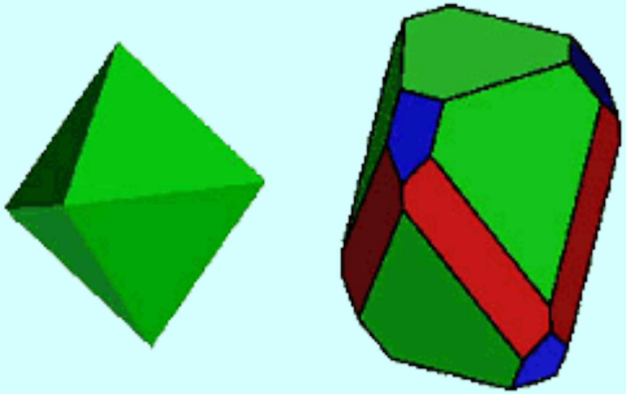
Mars is a better repository for fossils than the Earth:
- little plate tectonics
- little rain
- no oxygen

Earth handicaps:
- plate tectonics
- UV, before 2 Ga
- rain
- «biological» oxygen, after Ga



96 meteorites are accepted as Martian, including the famous ALH84001





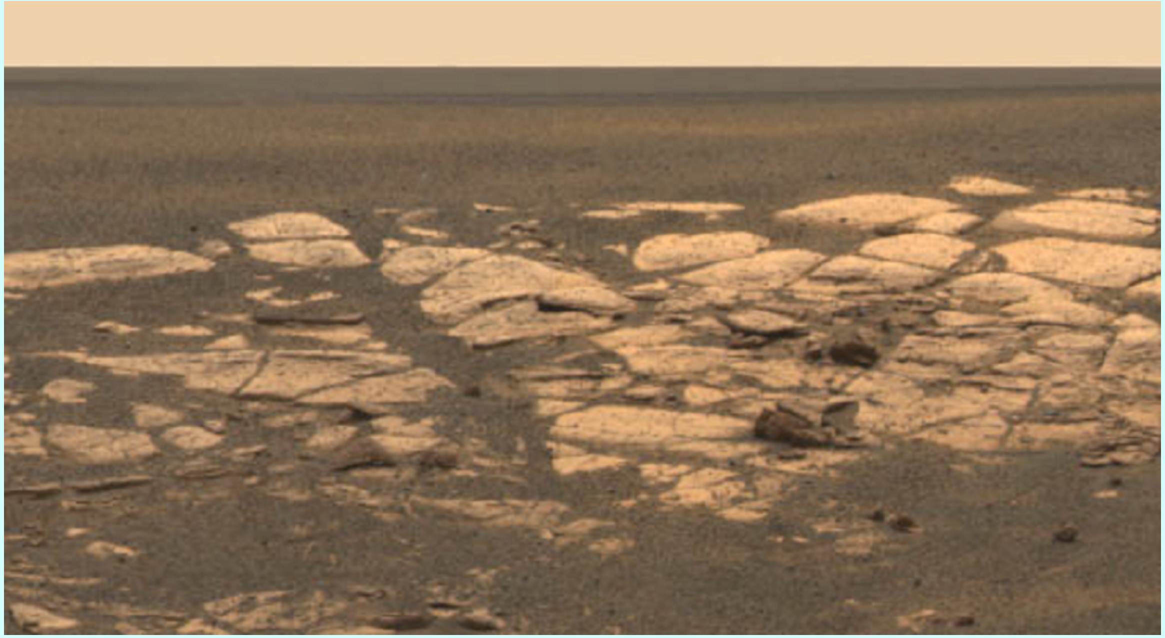
STONE experiment rational

Considering that:

- liquid water was once present on Martian surface
- there are sediments on Mars
- all Martian meteorites are igneous rocks,

I wondered whether Martian sedimentary rocks would resist atmospheric entry.

A proposal was written to expose sedimentary rocks inserted into the FOTON heat shield.



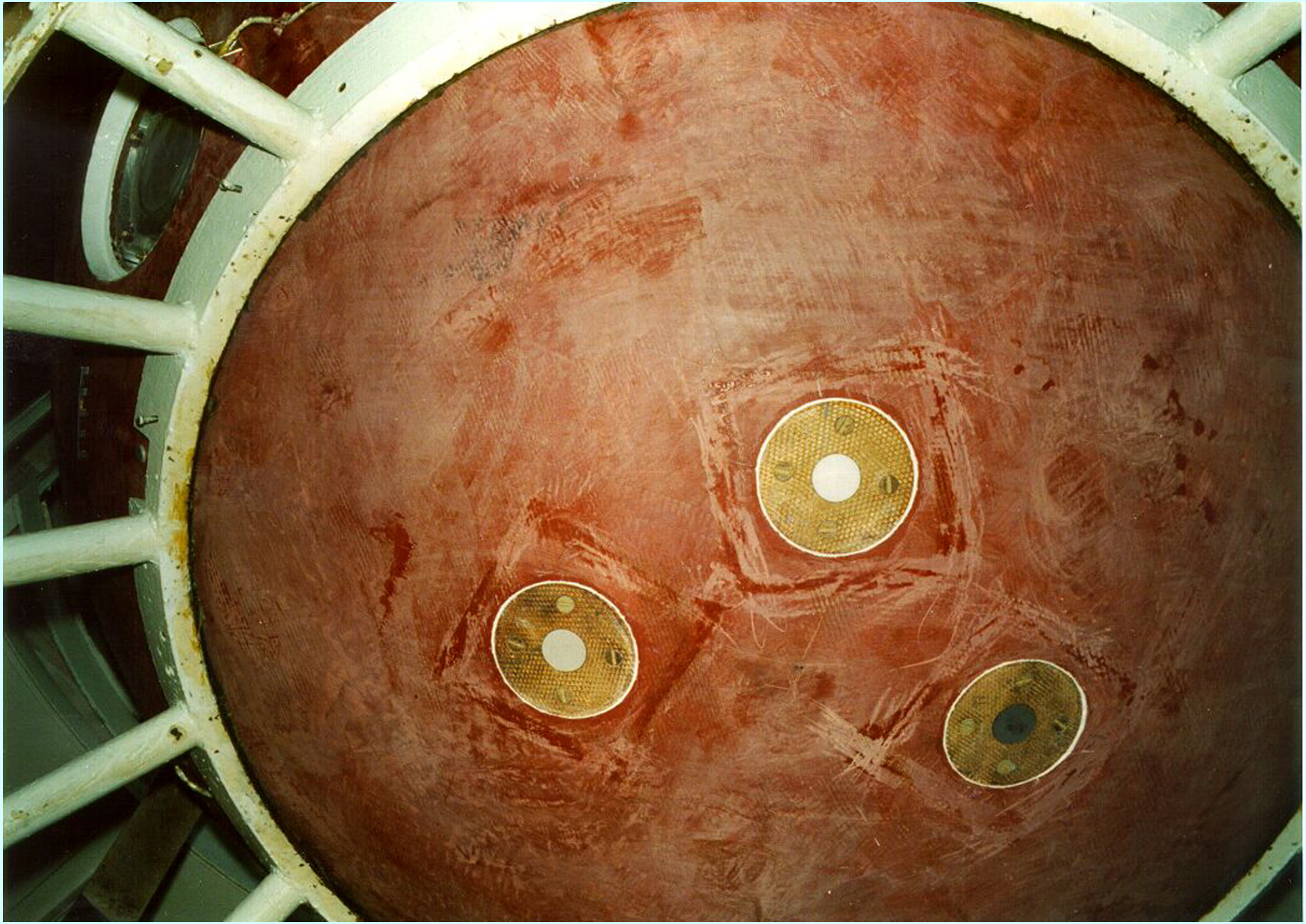
STONE-1 (9 – 24 September 1999)

Three samples were fixed to the heat shield of a recoverable FOTON capsule and flown in low Earth orbit in September 1999:

- **Dolomite, collected in the bed of Rio Lagazuoi, just below Passo di Falzarego, Cortina d'Ampezzo, Belluno, Italy**

- **Simulated Martian regolith (basalt fragments in a gypsum matrix)**
- **Basalt, from Pauliberg (Burgenland, Austria) of Miocene age**

➔ **Temperatures attained during re-entry were high enough to melt basalt fragments**



The STONE-1 space experiment: artificial meteorites fixed into the heat shield of the FOTON-12 capsule.

FOTON 12, after landing

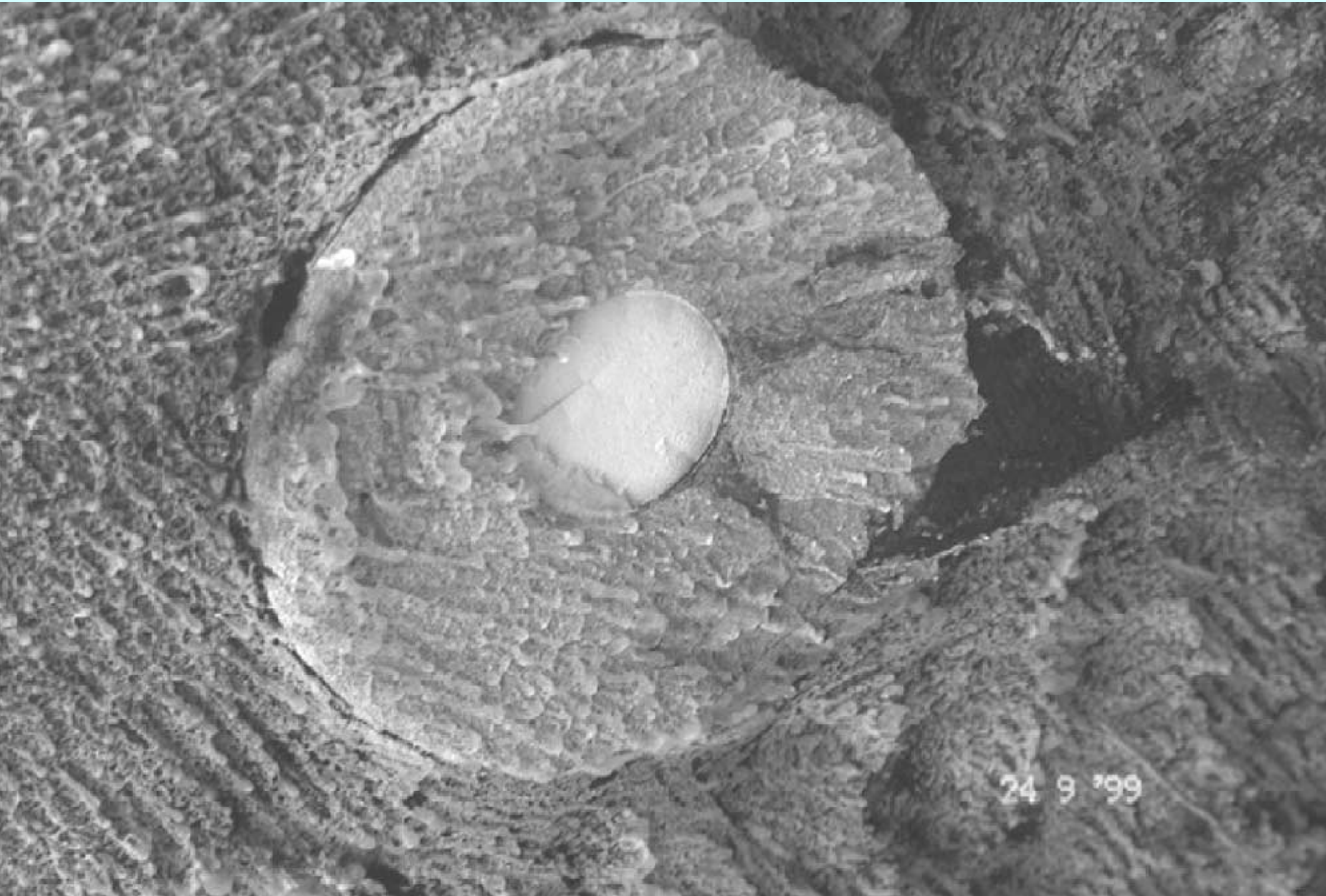
Gero Kurat watching the Russian engineer

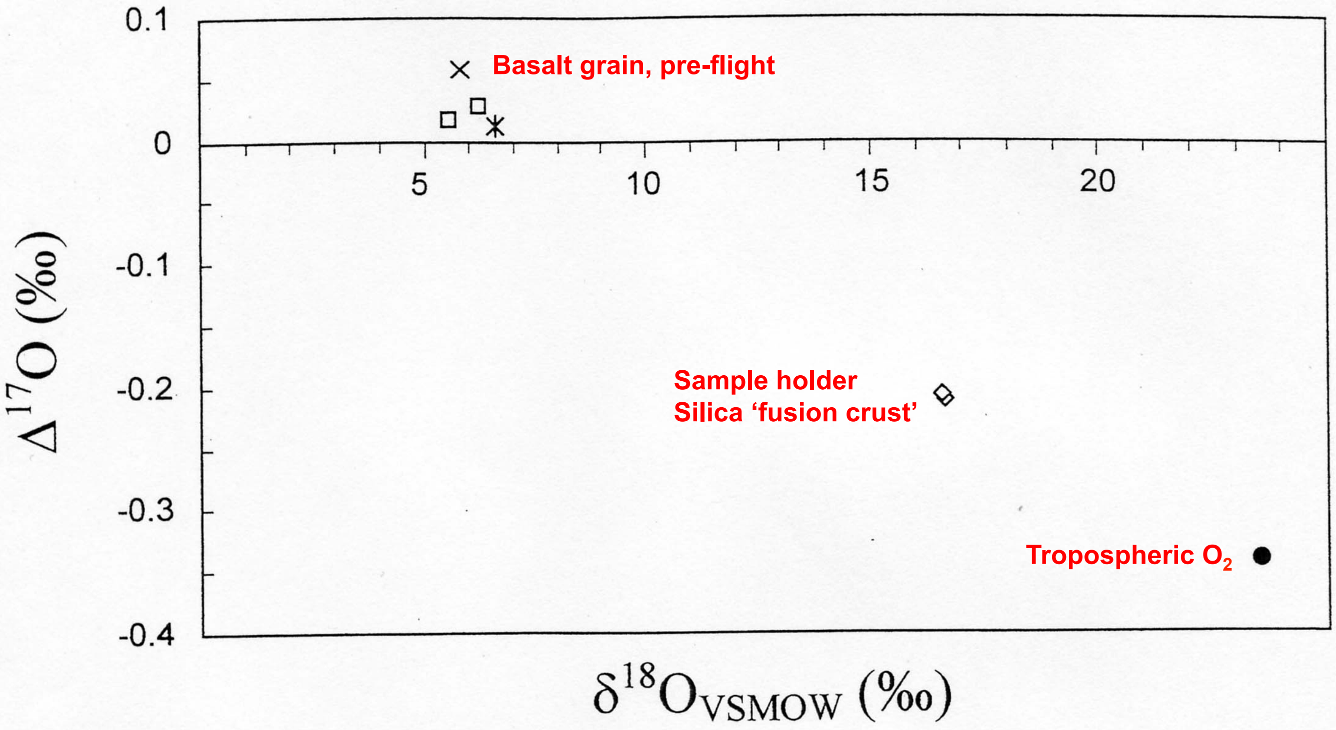
FOTON-12 heat shield after landing

Basalt….gone!

The simulated Martian sediment sample disintegrated before recovery. Small pieces of the flown sample rock were retrieved from underneath the sample holder.

One third of the dolomite sample survived atmospheric re-entry allowing examinations of chemical, mineralogical and isotopic modifications





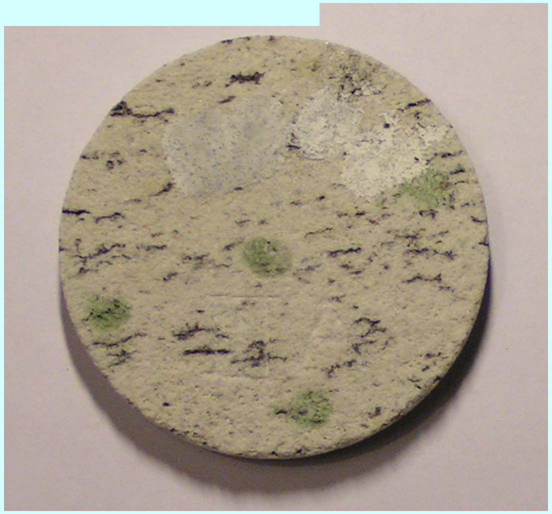
➔ **Oxygen three-isotope measurements of the silica 'fusion crust' formed on the sample holder during atmospheric re-entry fit on a mixing line between tropospheric O_2 and the interior of the sample holder.**

The STONE-5 experiment

On board FOTON-M2, launched on May 31, 2005, landed on June 16, 2005, South of Kostanay, Kazakhstan.

Dolerite, Pauliberg (igneous rock)

Sandstone, Melk (sedimentary rock)



Impactite gneiss from Haughton, Arctica carrying endolithic cyanobacteria

All samples have been drilled and loaded with:
- **bacterial spores (*Bacillus subtilis*)**
- **fungal spores (*Ulocladium atrum*)**
- **dried vegetative cryptoendolites (*Cyanobacterium Chroococcidiopsis*).**

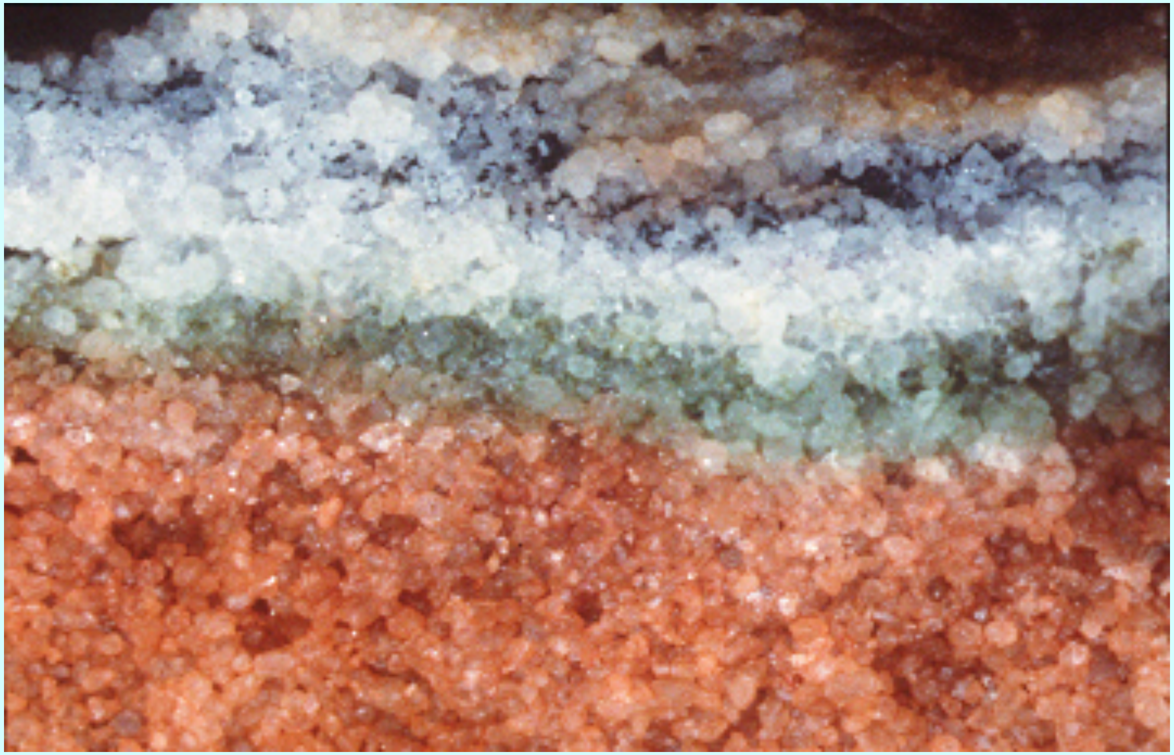
All rocks have been soaked with *Cyanobacterium Chroococcidiopsis* on the back side.

Conclusions

None of the Chroococcidiopsis cyanobacteria have survived the entry.

⇒ photosynthetic bacteria at the minimum depth (≅ 5 mm) in the rock where light is sufficient for photosynthesis will be destroyed.

⇒ atmospheric entry appears as a strong filter against the interplanetary transfer of photosynthetic organisms.



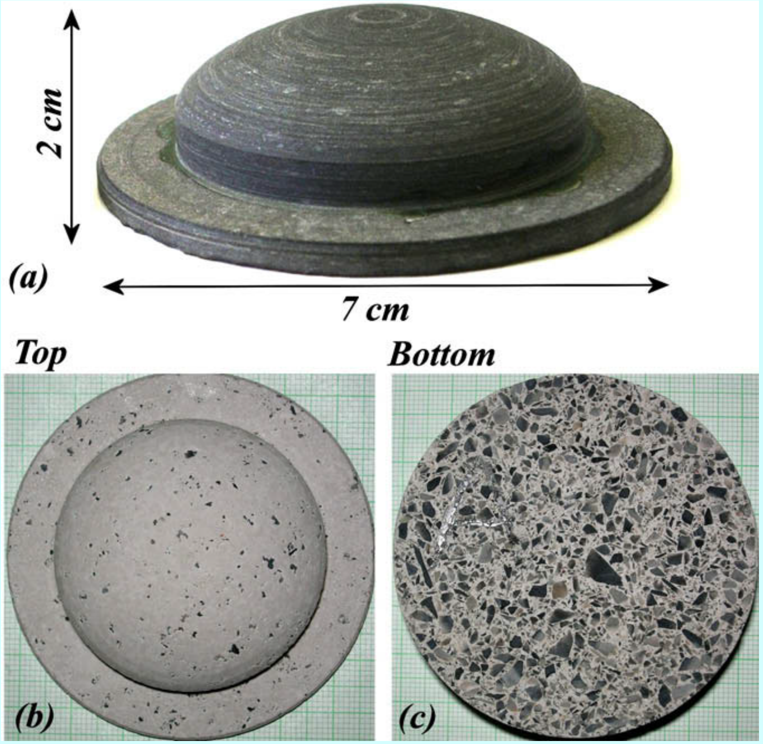
STONE 6 on FOTON-M3 (14-26 September 2007)

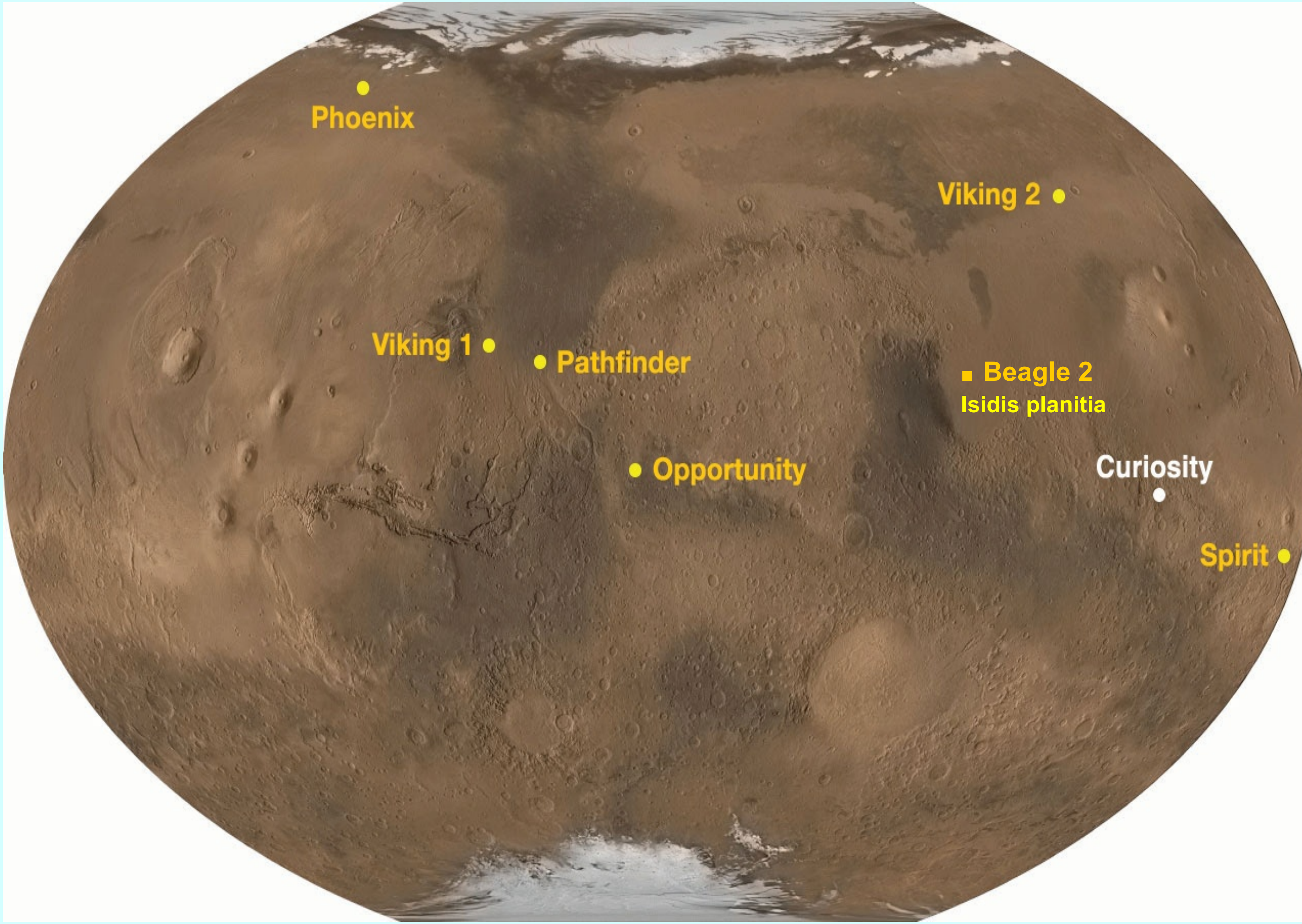
A volcanic sandstone from the Pilbara region of Australia, containing traces of primitive small, anaerobic fossil microorganisms.

A live, hydrated culture of the photosynthetic endolithic microorganism, chroococcidiopsis.

Microfossils embedded in the chert fragments survived structurally.

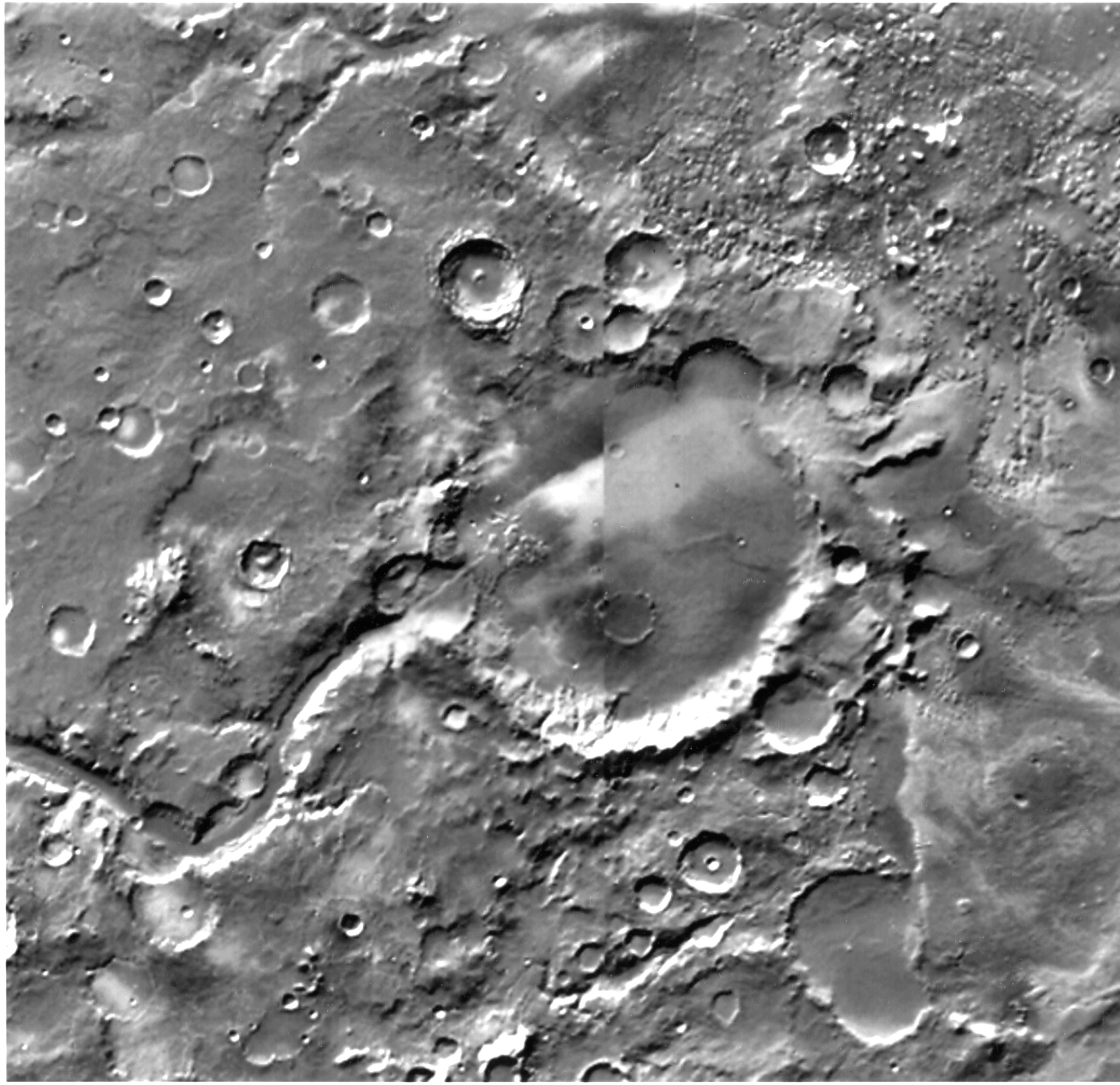
A 2 cm of rock thickness was not sufficient to protect live microorganisms




Phoenix
Viking 2
Viking 1
Pathfinder
Beagle 2
Isidis planitia
Opportunity
Curiosity
Spirit

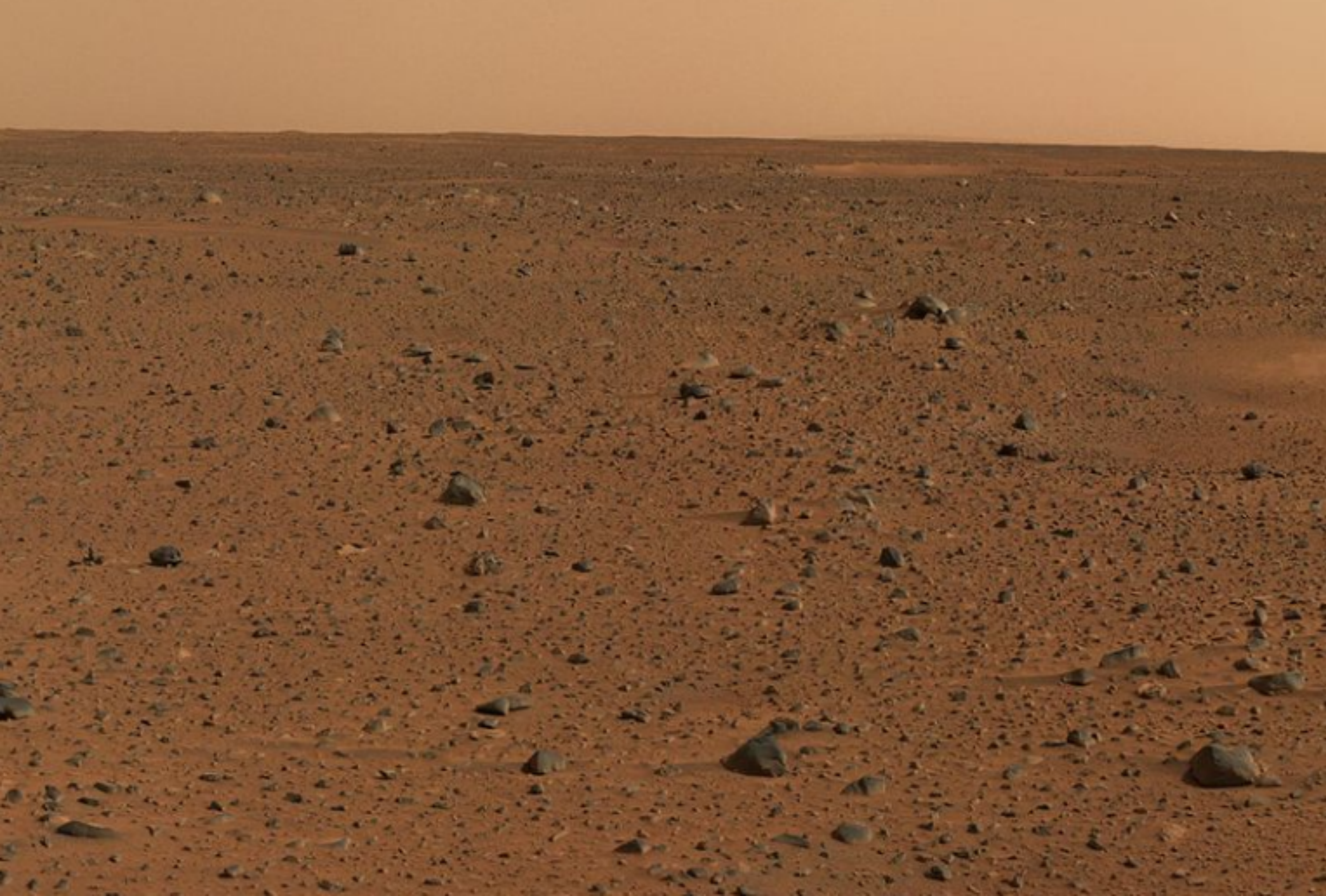
In 1976, Viking did not find organics at the Martian surface

Gusev crater and Ma' adim Vallis

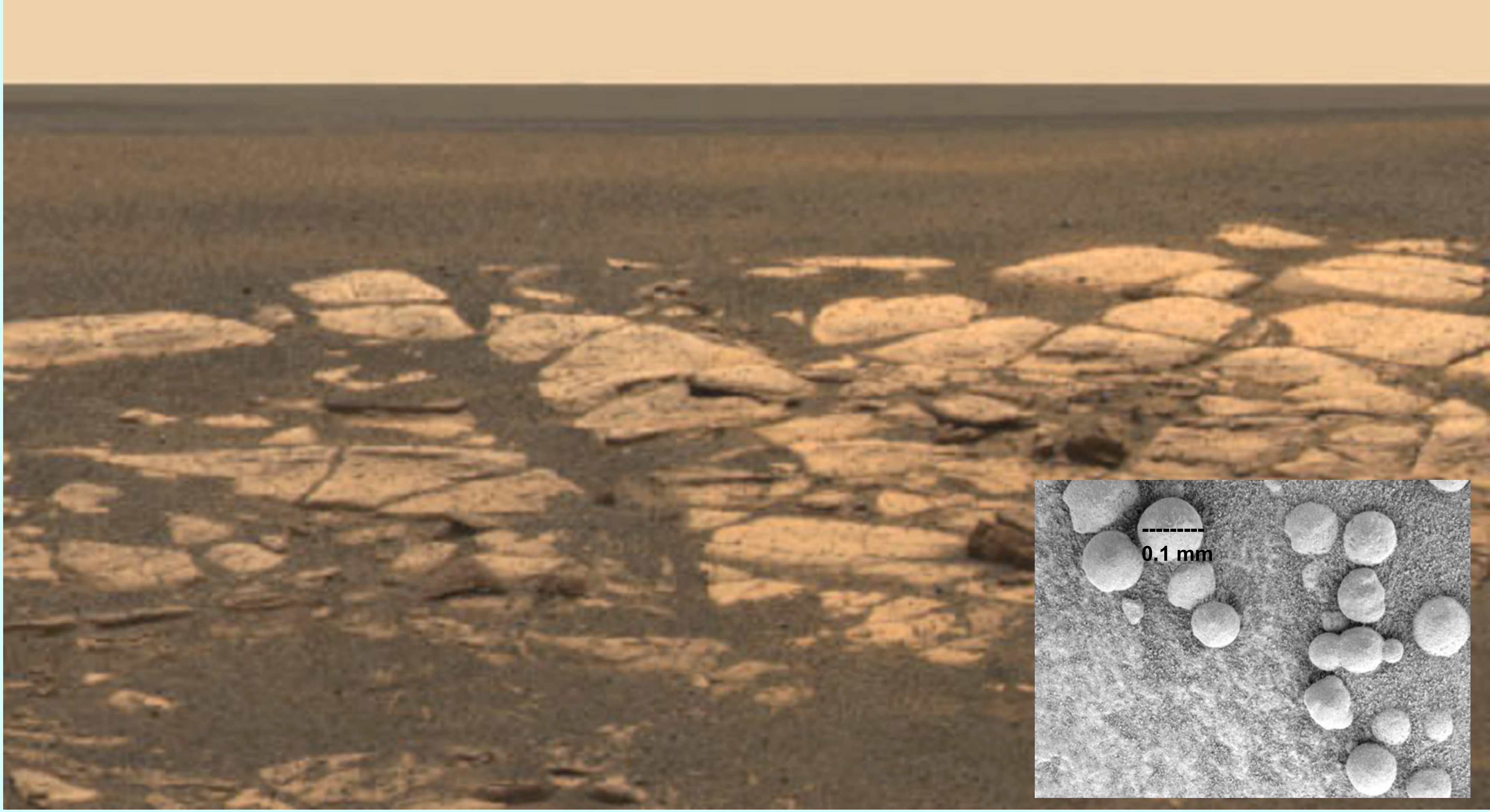


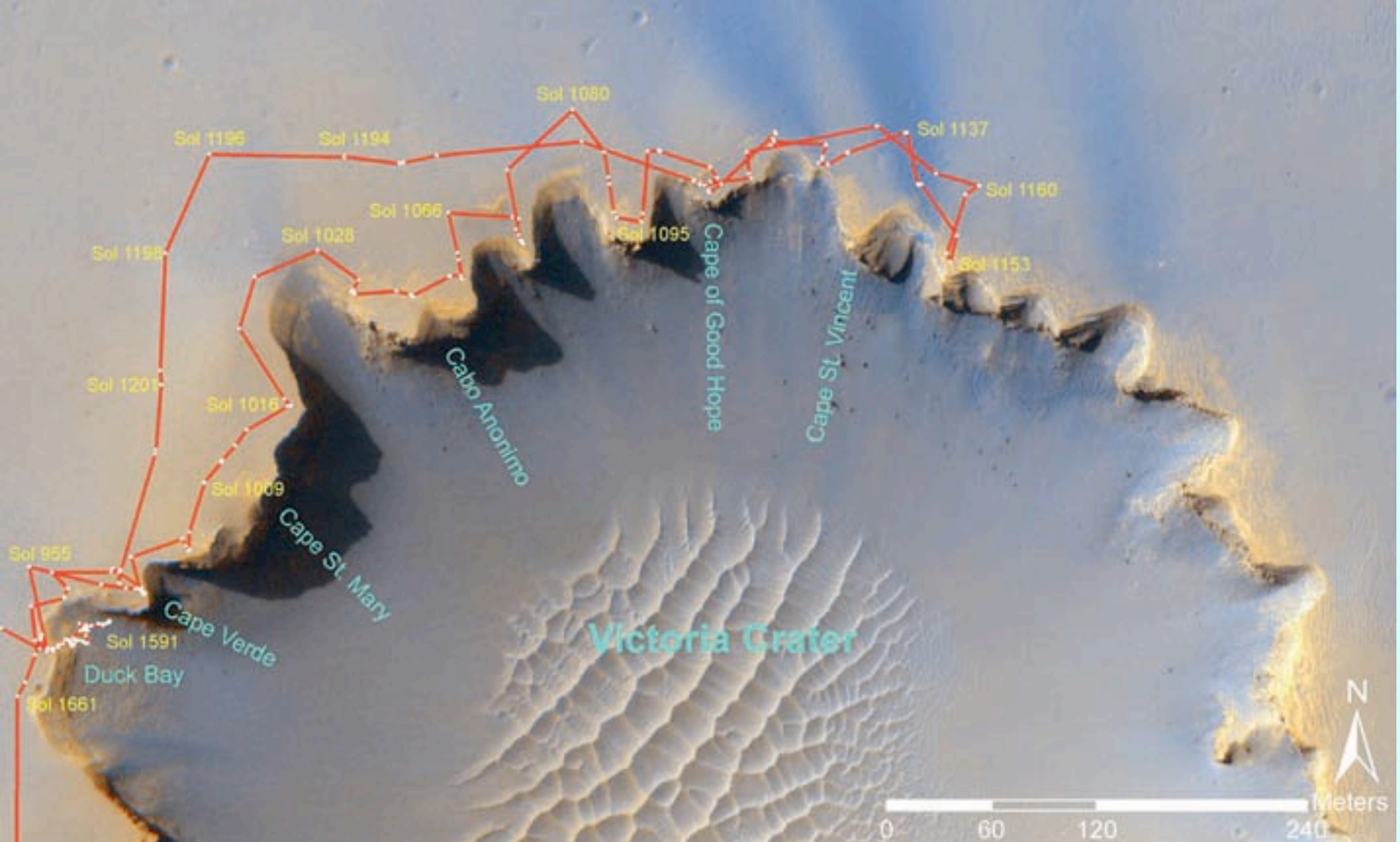
Dull and rather boring plain

« Waterloo ! Waterloo ! Waterloo ! morne plaine ! »



Opportunity landed at Meridiani Planum on the 25th of January 2004 for 3 months investigations. It Is still operating!

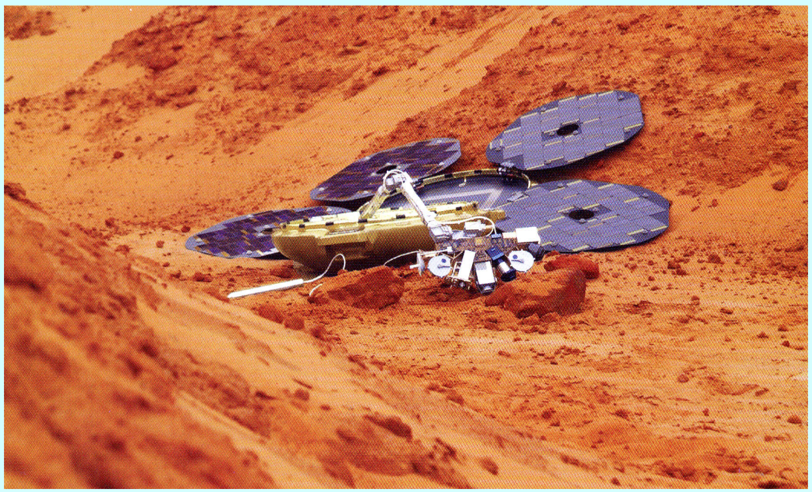


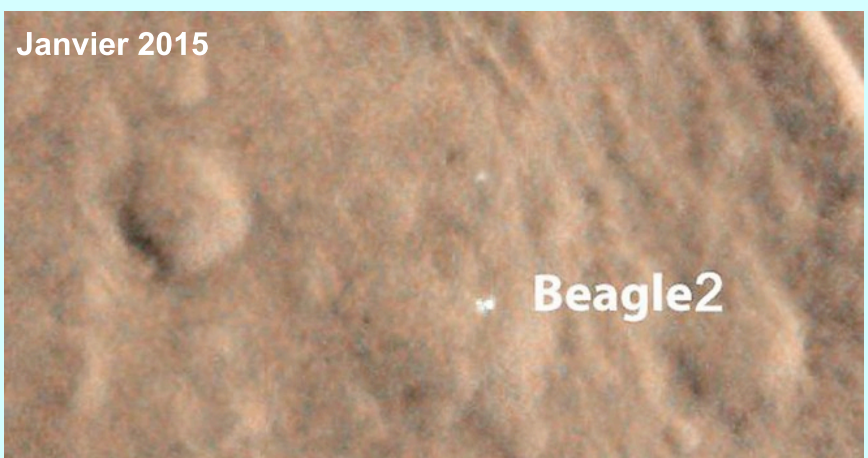


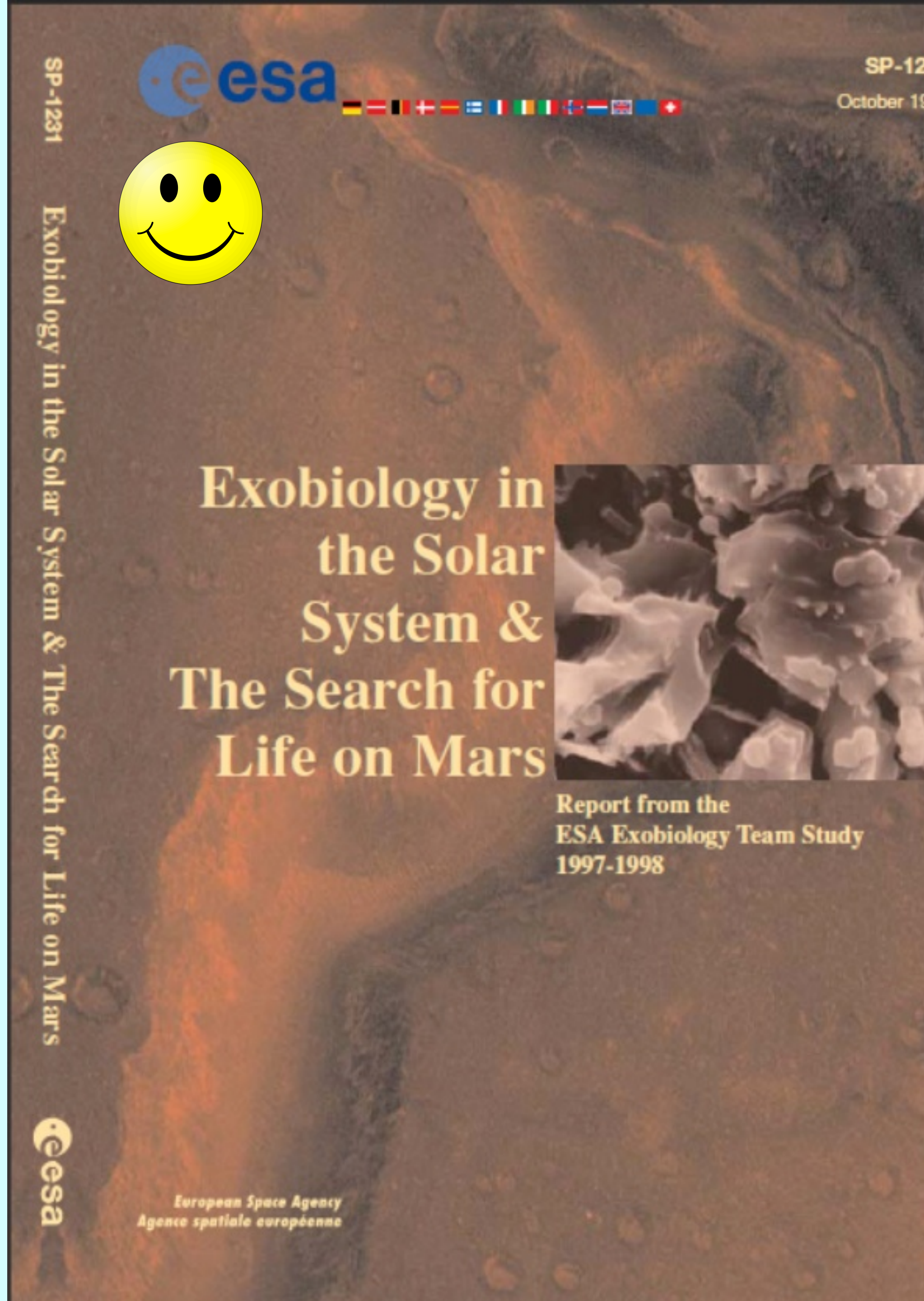
Hematite 'blueberries' are present in Victoria Crater cliff
⇒ ancient sea

Orléans contribution

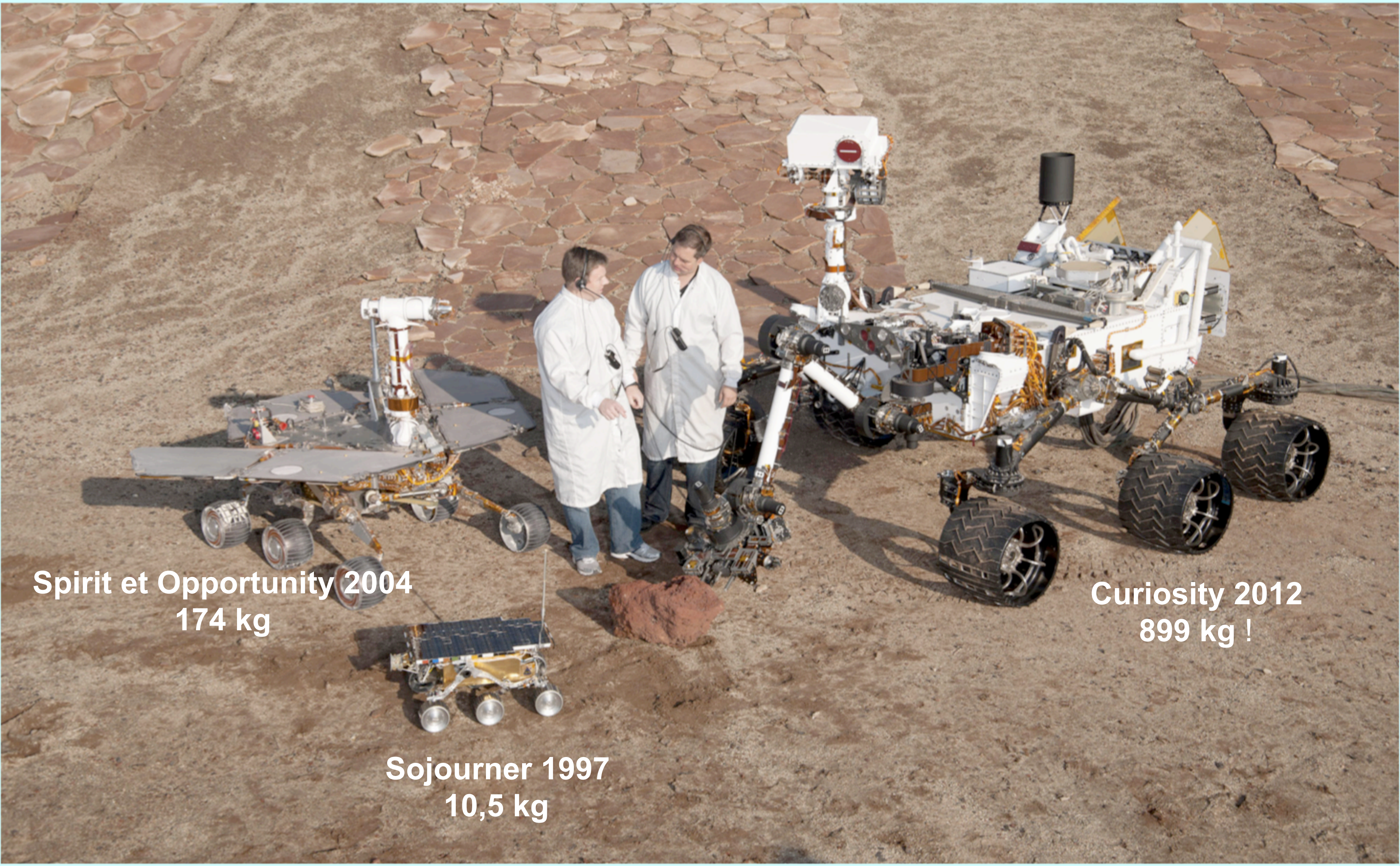
1997: head of the ESA Exobiology Science Team.
2001: Agreement for a lander on Mars Express. Head of the adjunct science team of Beagle 2.
2003: crash of Beagle 2





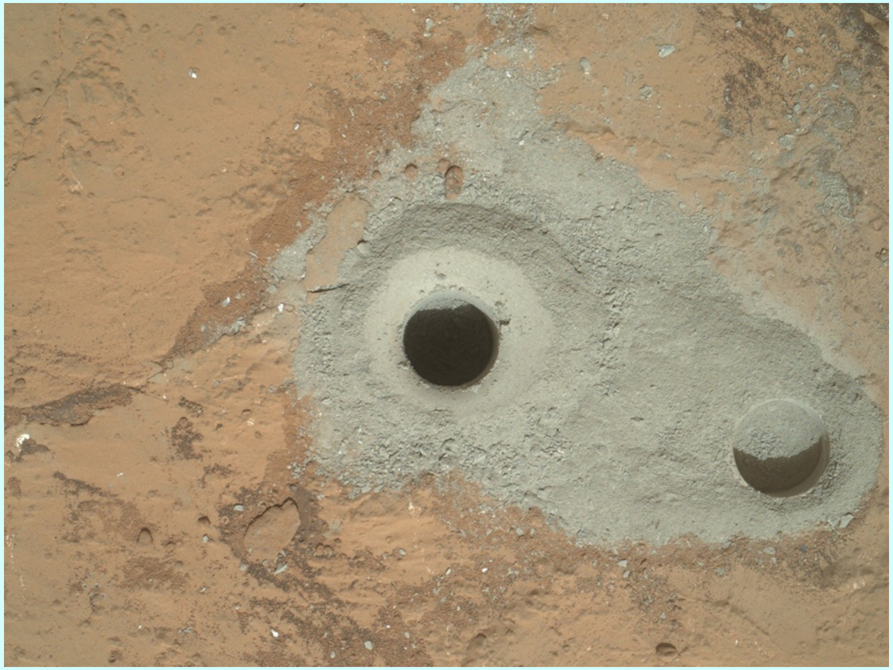


Curiosity, 2011
Search for traces of life, organics and oxidants

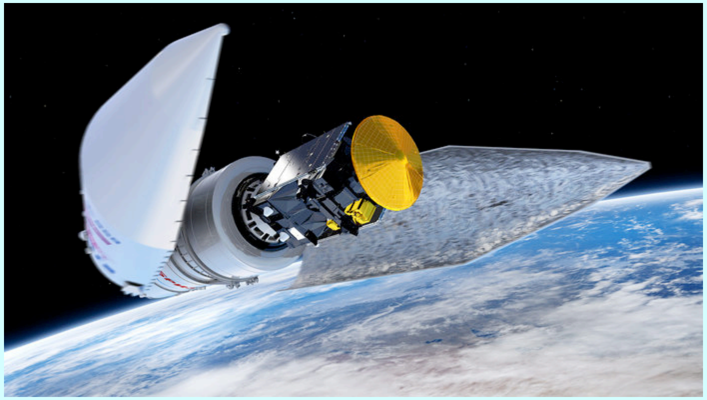

Spirit et Opportunity 2004
174 kg
Sojourner 1997
10,5 kg
Curiosity 2012
899 kg !

Curiosity, 2011

- Ancient fresh water lake (clays and gypsum)
- presence of chemical elements able to generate life (carbon, hydrogène, oxygen, phosphate, sulfur) but no prebiotic organic molecules detected so far.

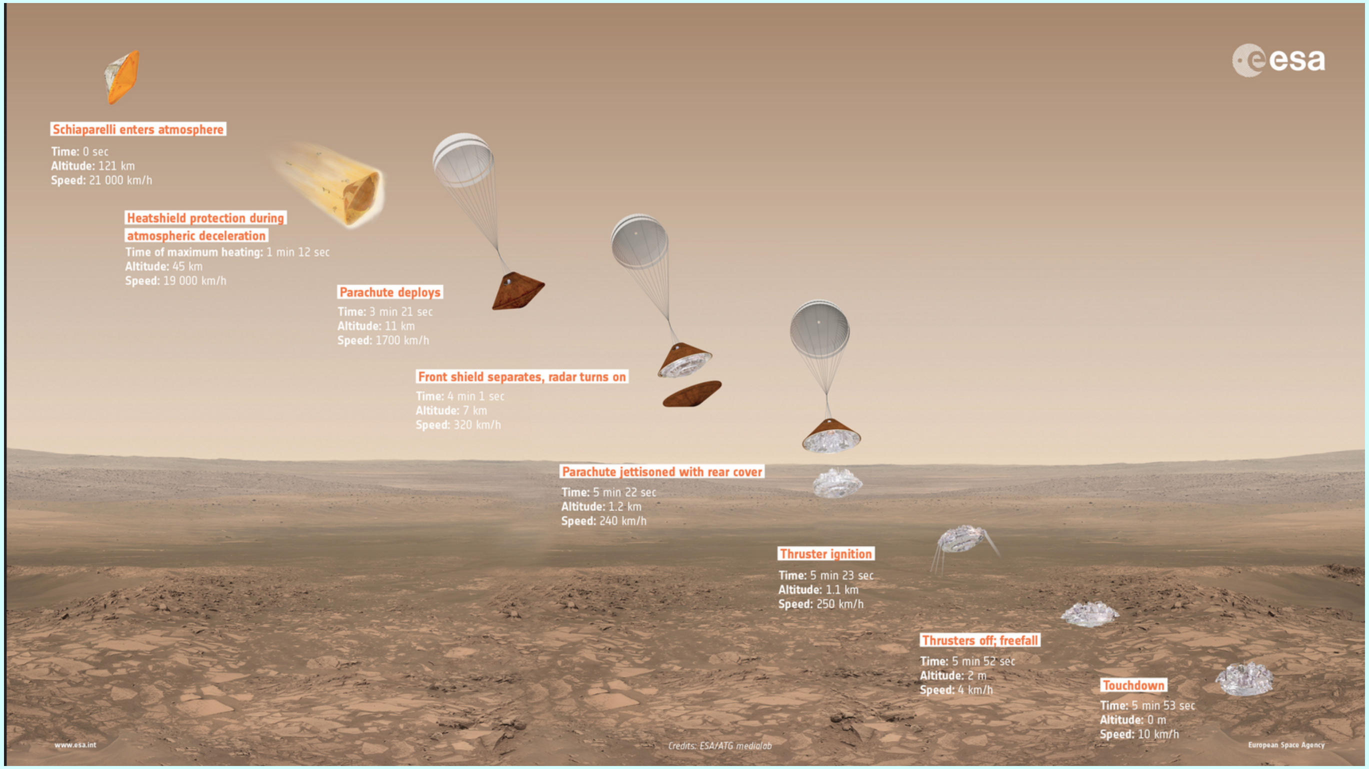


The two step ESA EXOMARS mission, a joint endeavour between ESA and Roscosmos



2016: launch on March 14 of the Orbiteur TGO (methane, telecommunication relay) with the demonstration lander Schiaparelli at *Meridiana Planum.*

October 19: crash of Schiaparelli



For less than 1 second, a dysfunction of the Inertial Measurement Unit indicated a negative altitude!

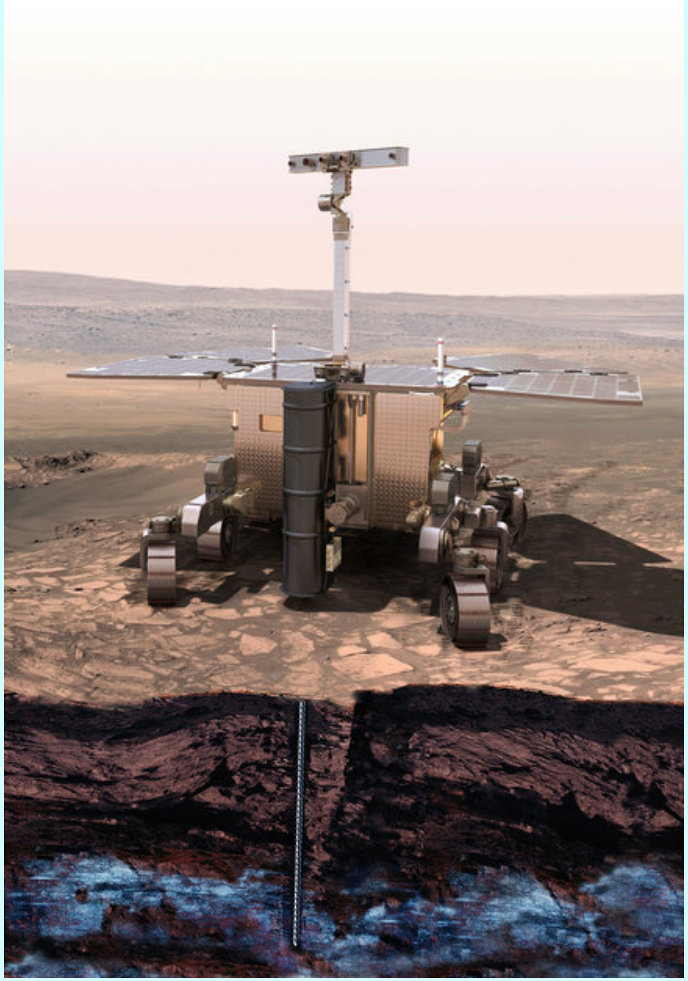
EXOMARS

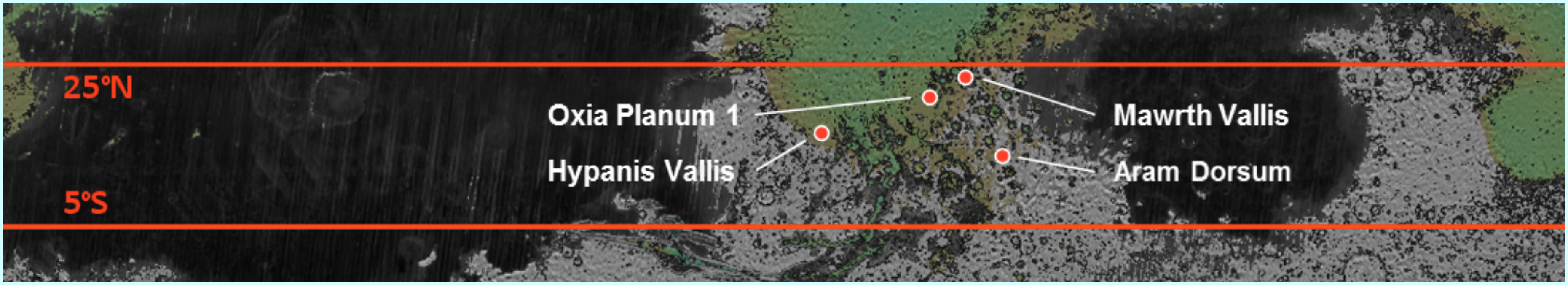
2022

Rover to search for traces of life with a drill (2 m) and a complete suite of instruments « Pasteur ». Russia will provide the launcher.

Contribution of Orléans

Close-UP Imager (CLUPI), a camera system designed to acquire high-resolution, colour, close-up images of outcrops, rocks, soils, drill fines and drill core samples. The visual information obtained by CLUPI will be similar to what a geologist would get using a hand lens ... if they were on Mars!

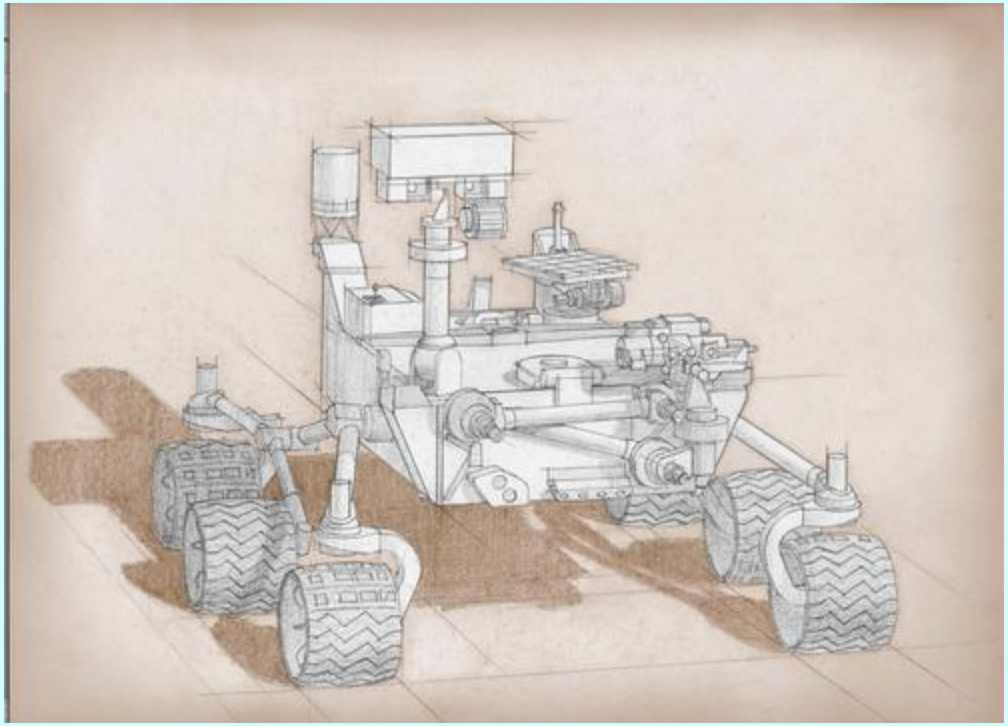


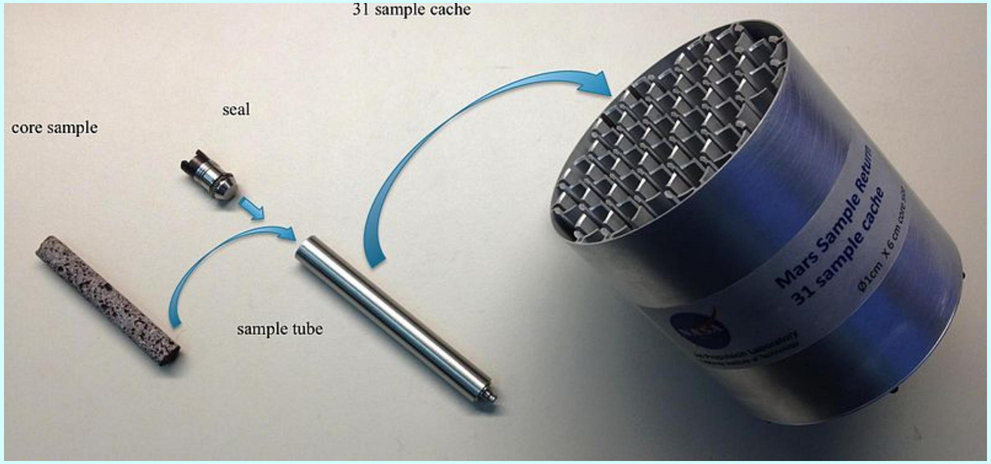


The US Mars 2020 mission

To:

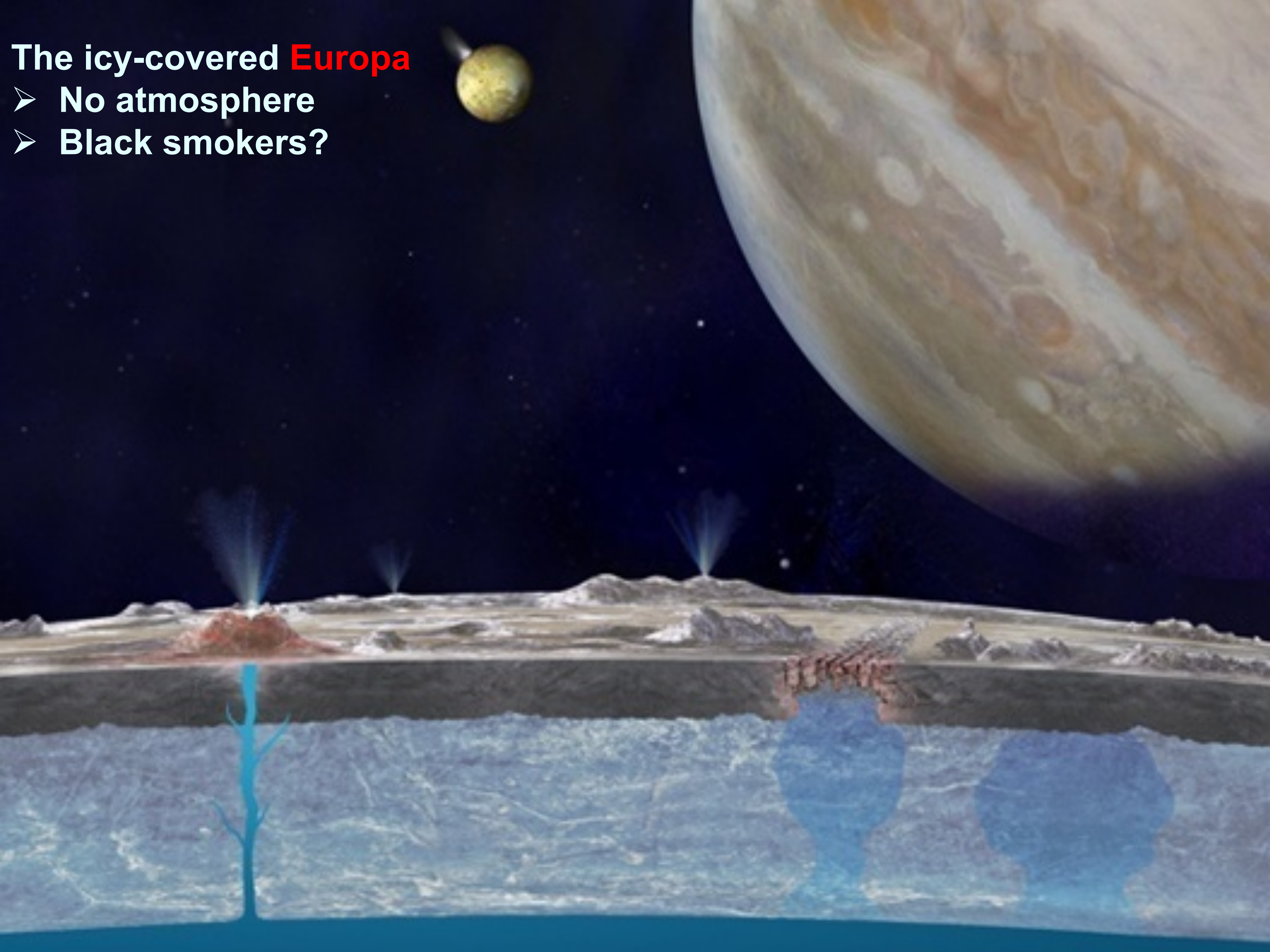
- **search for traces of life**
- **collect samples for a subsequent Mars sample return**
- **test a protection technology for a manned mission (Martian dust)**
- **test how to collect carbon dioxide as a source of oxygen and fuel for the return rocket)**





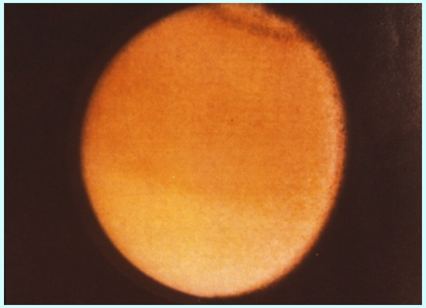
The icy-covered Europa

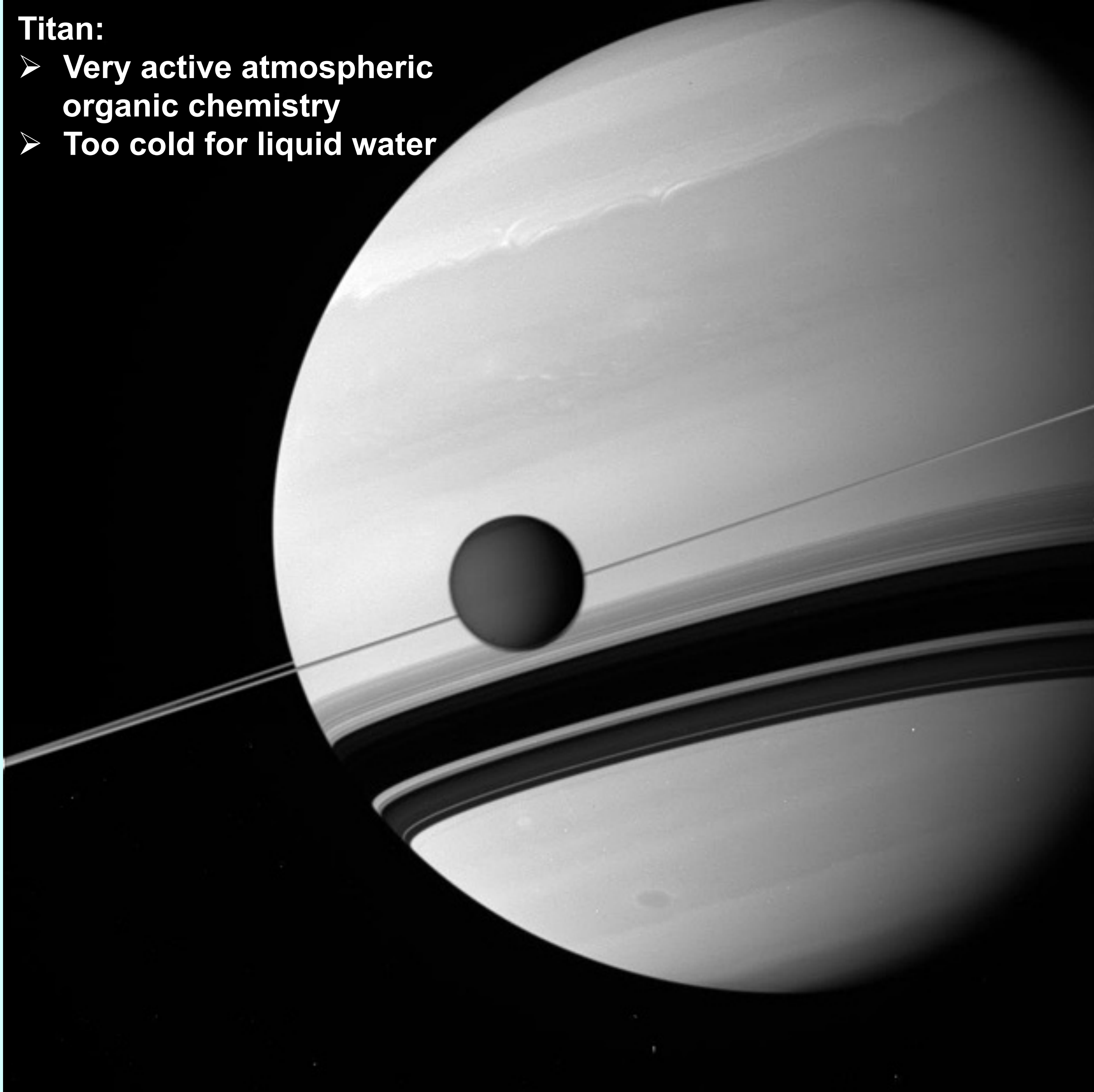
- No atmosphere
- Black smokers?

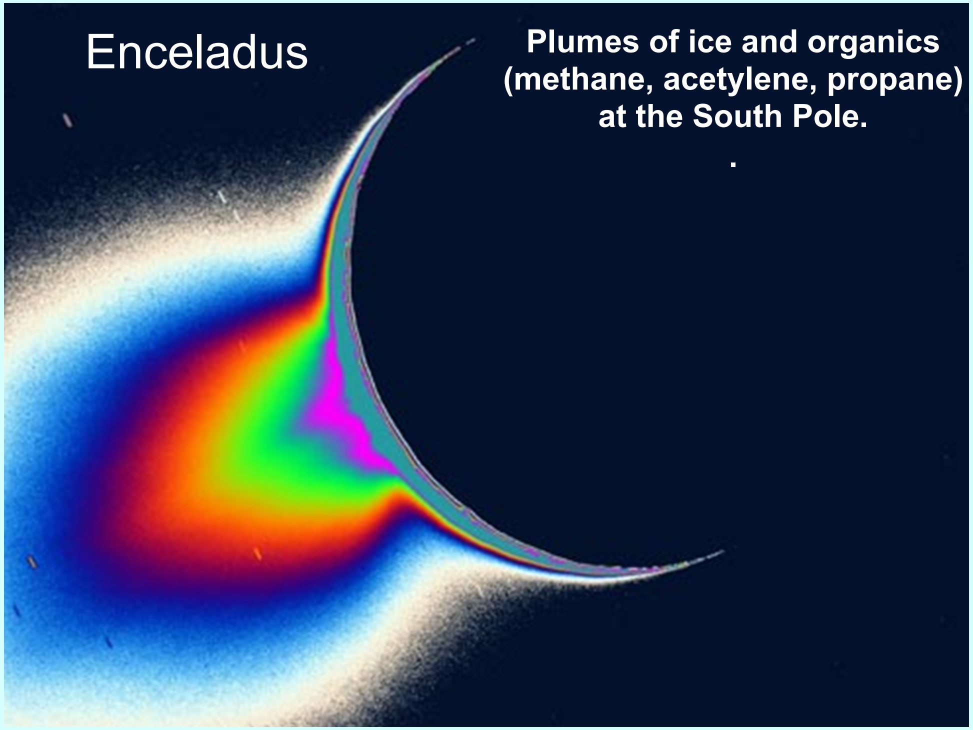


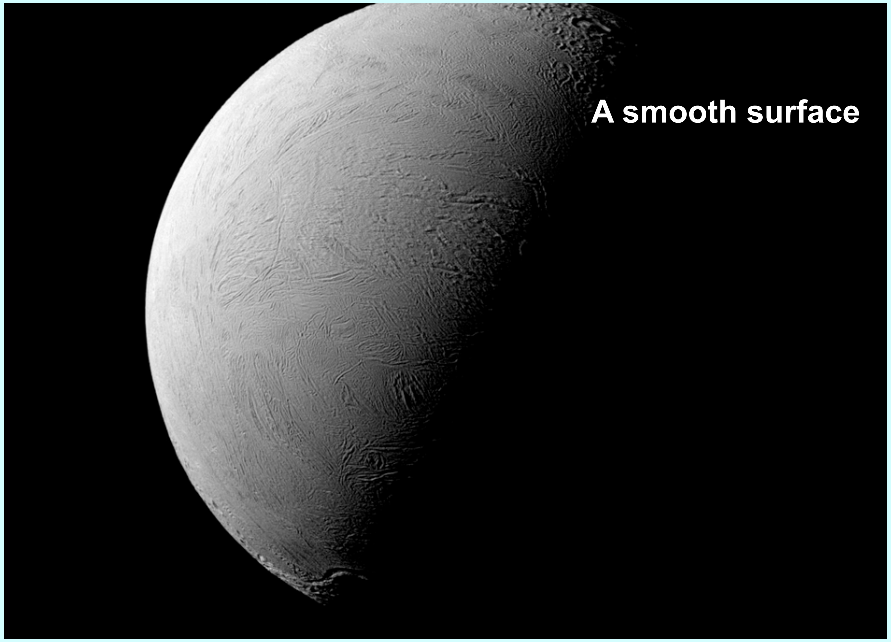
Titan:

- Very active atmospheric organic chemistry
- Too cold for liquid water



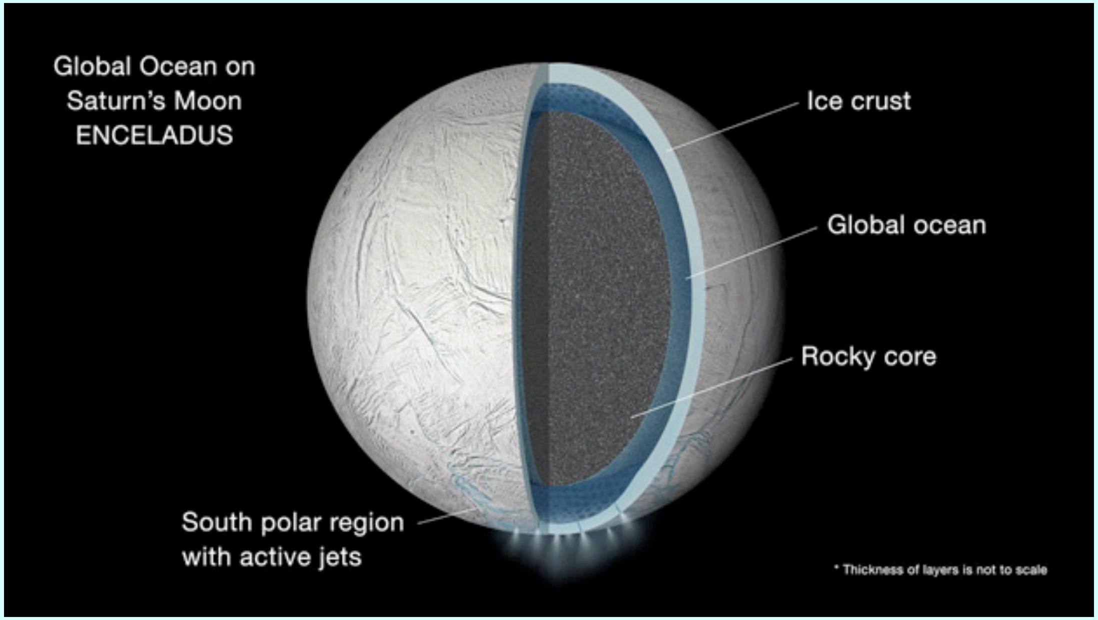






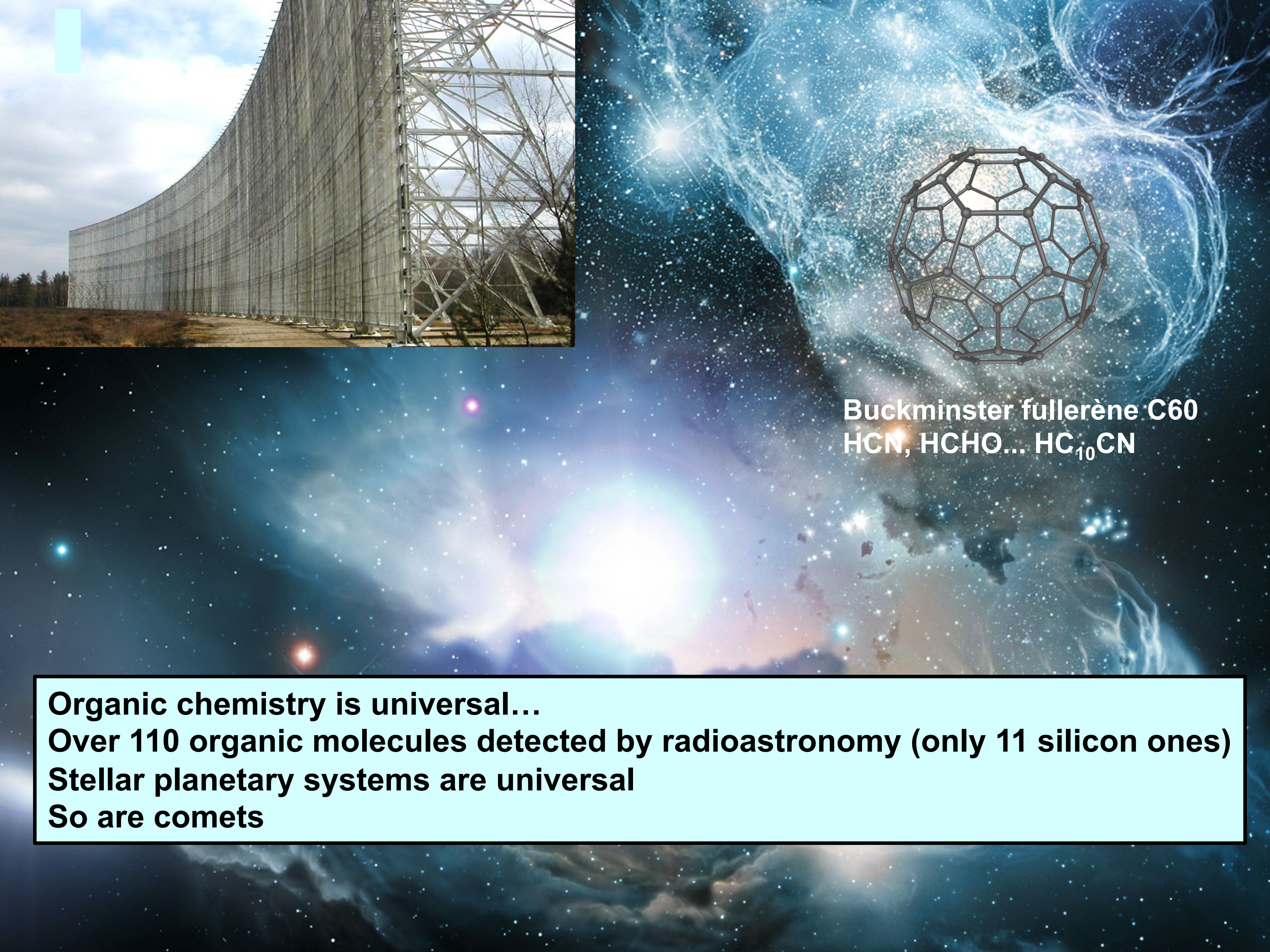
September 2015

Analyses from the Cassini probe suggest the presence of an ocean beneath the icy carapace.



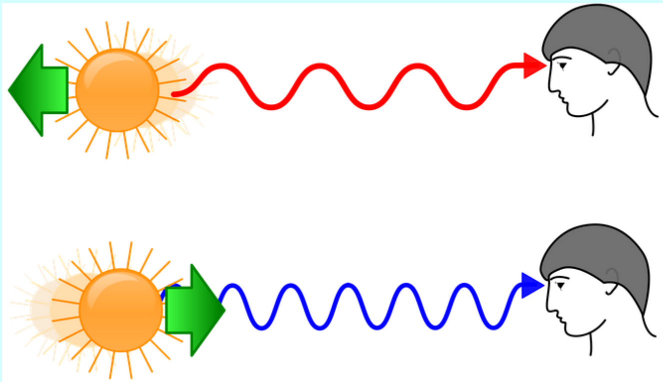
Images of the US probe New Horizons
suggest that Pluton
may have an ocean of
liquid water under
the icy carapace
(great impact
crater).

Europa
Ganymede
Callisto
Key
ice
water
rock
metal
Titan
Eris
Pluto
Sedna
Enceladus
Triton
Titania
Oberon
Rhea
Earth

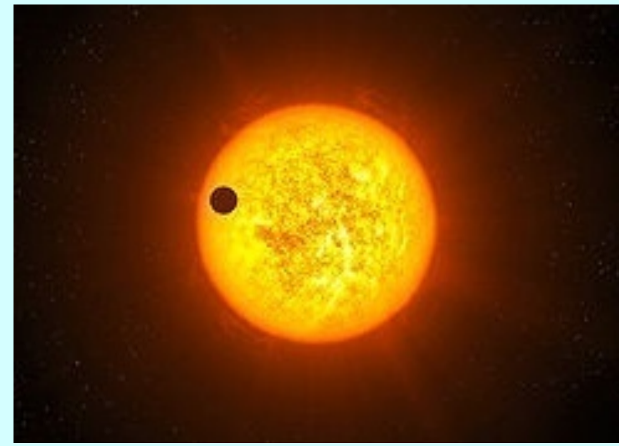

Buckminster fullerène C60
HCN, HCHO... $HC_{10}CN$
Organic chemistry is universal…
Over 110 organic molecules detected by radioastronomy (only 11 silicon ones)
Stellar planetary systems are universal
So are comets

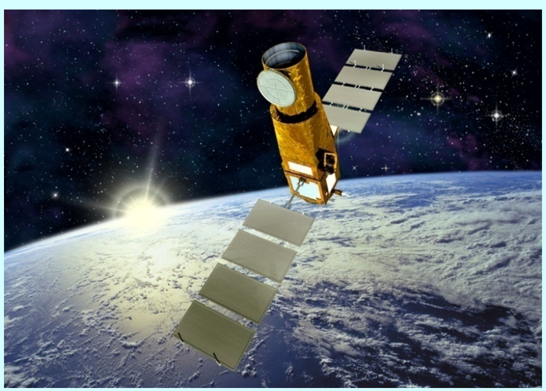
3767 explanets have been detected so far, using mainly 2 methods:

- Radial velocity

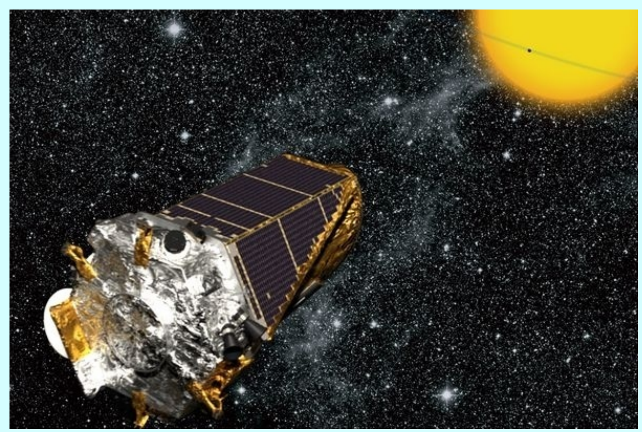


. Transit



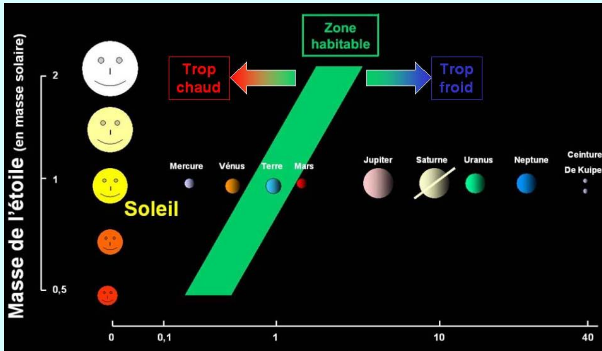


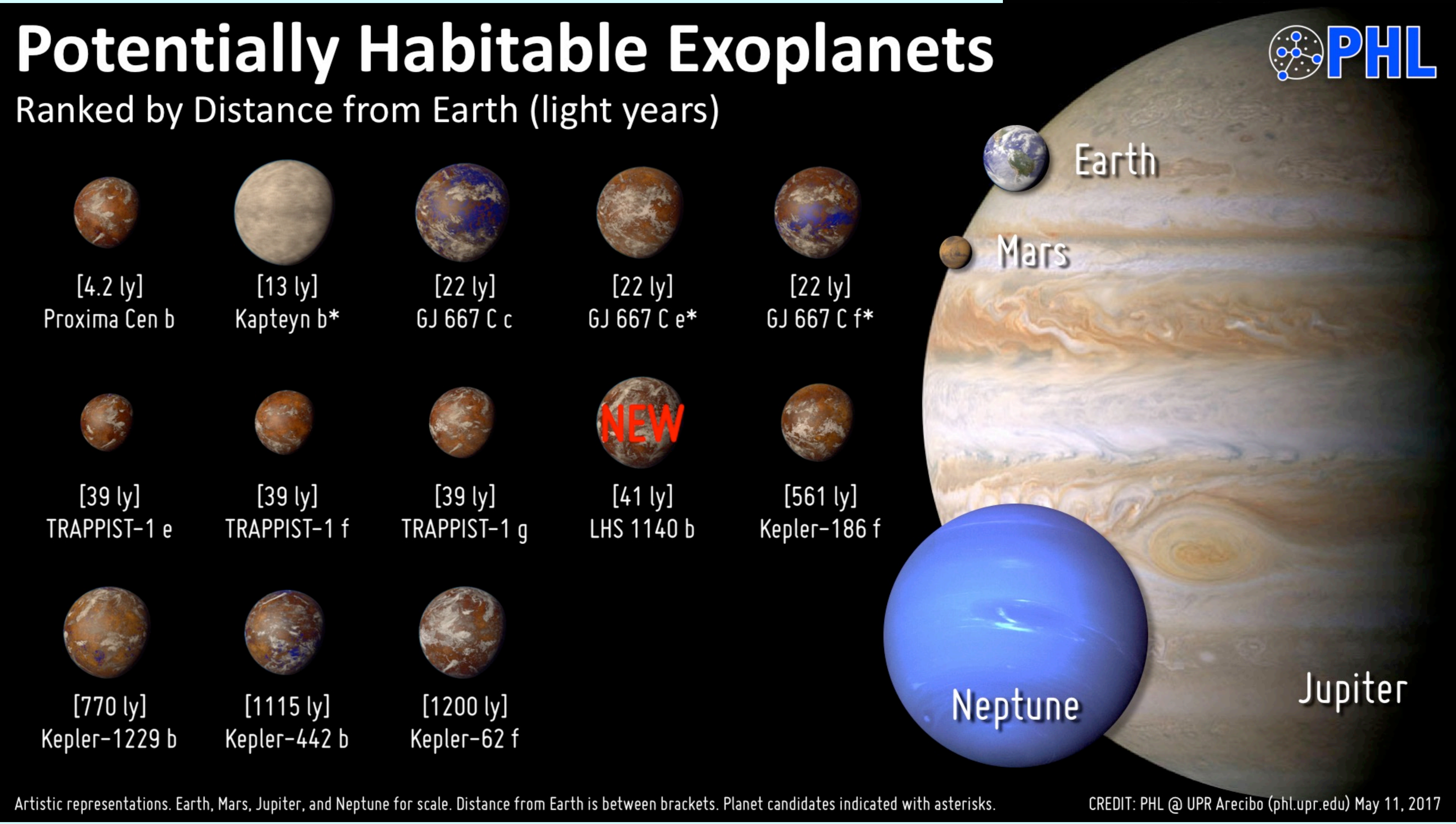
French telescope **COROT,** launched in December 2006



US telescope **Kepler**, launched in March 2009

Among the 3767 exoplanets detected, 44 are considered as habitable. The 13 nearest of home, ranked by distance from Earth. Do they host life?

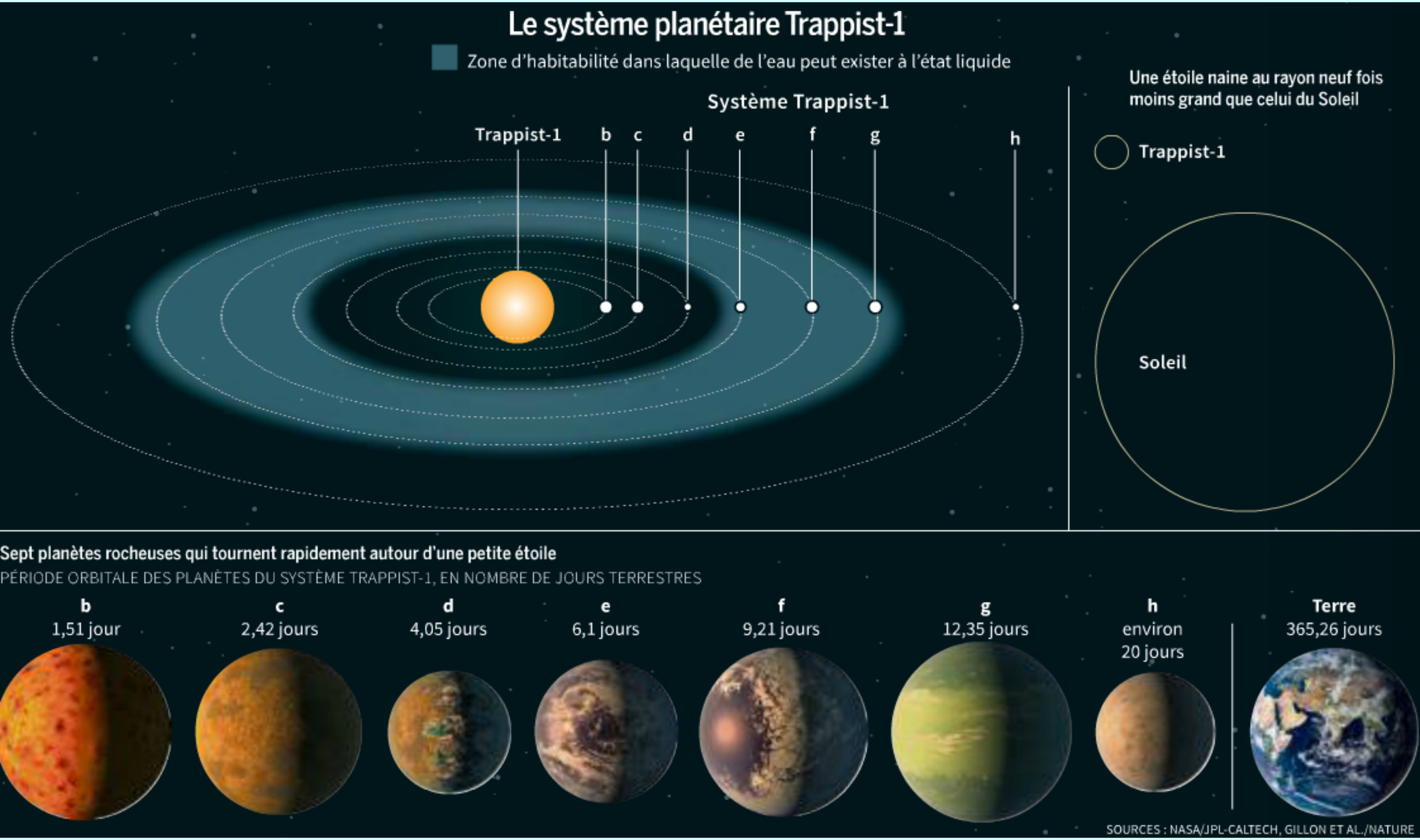




A living exoplanet in our backyard?

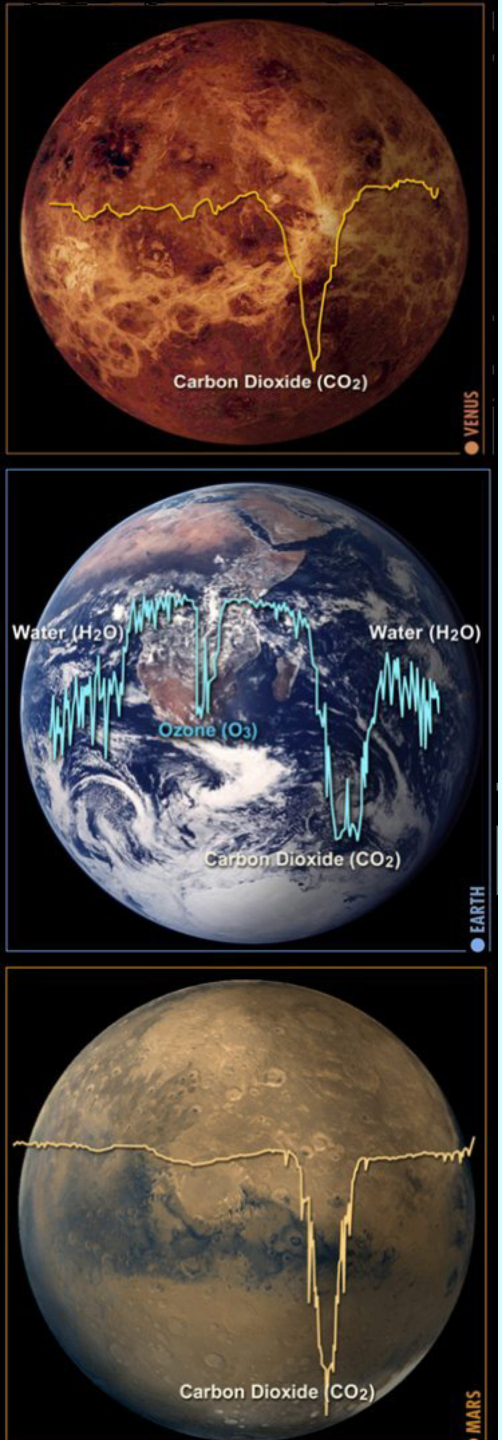
In August 2016, discovery of an exoplanet orbiting Proxima Centauri, the nearest star, a red dwarf at « only » 4.2 light-years (40 000 billion kilometers).
→1.3 time terrestrial mass
A « classical » space mission would take...20,000 years.
Late Stephen Hawking and Mark Zuckerberg (Facebook) have been developing the Starshot Project: a nanocraft pushed by a laser and the solar wind should reach its target and send pictures in 2061…

February 22, 2017
Detection of 7 Earth-size planets orbiting red dwarf TRAPPIST at 39 light-years.
Three of them are in the habitable zone allowing the presence of liquid water.

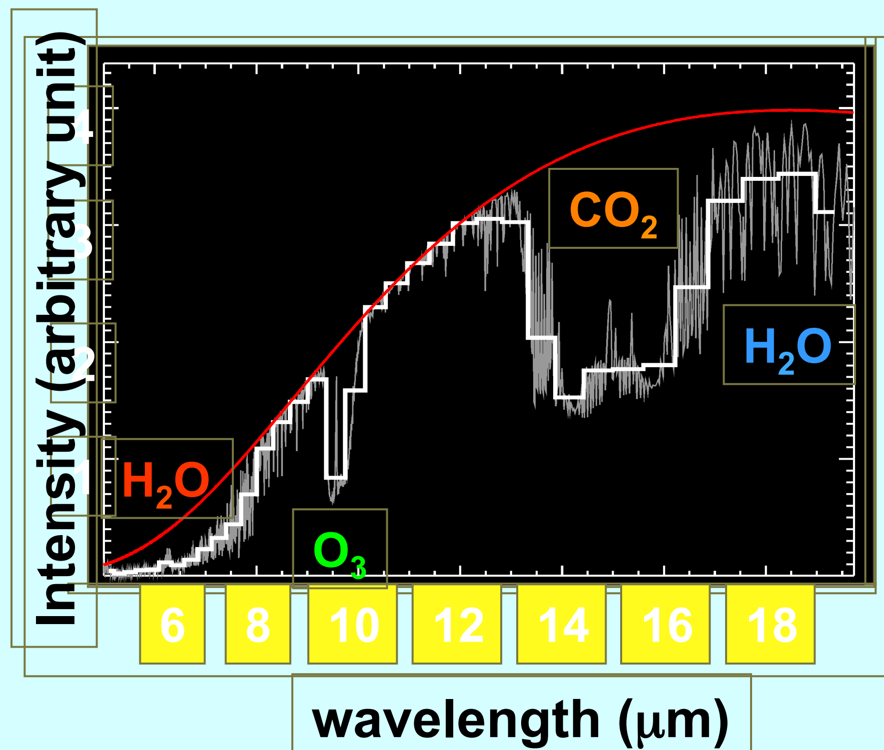


Densité 5,52 (3,93)

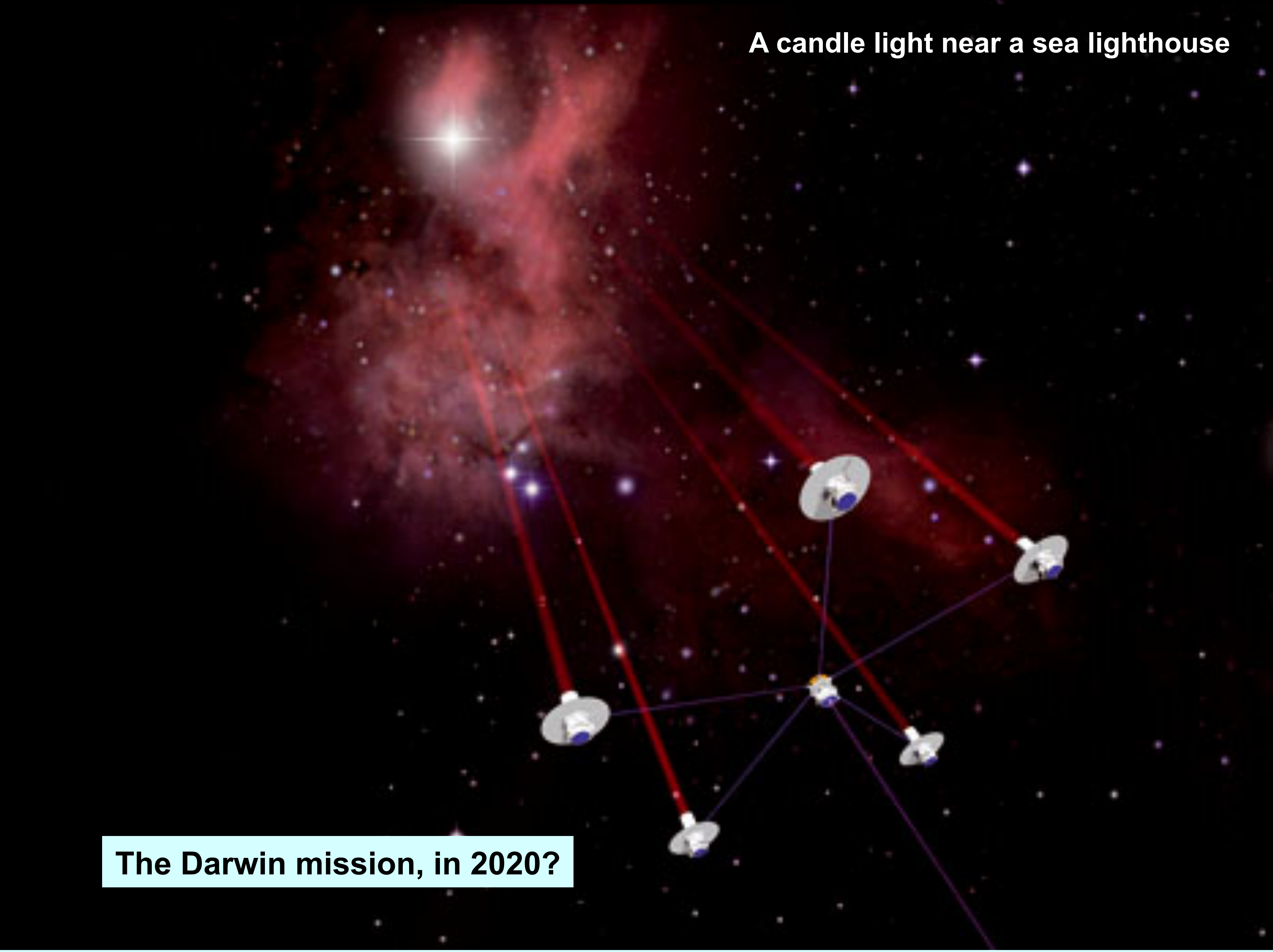
Biomarkers in the atmosphere of exoplanets



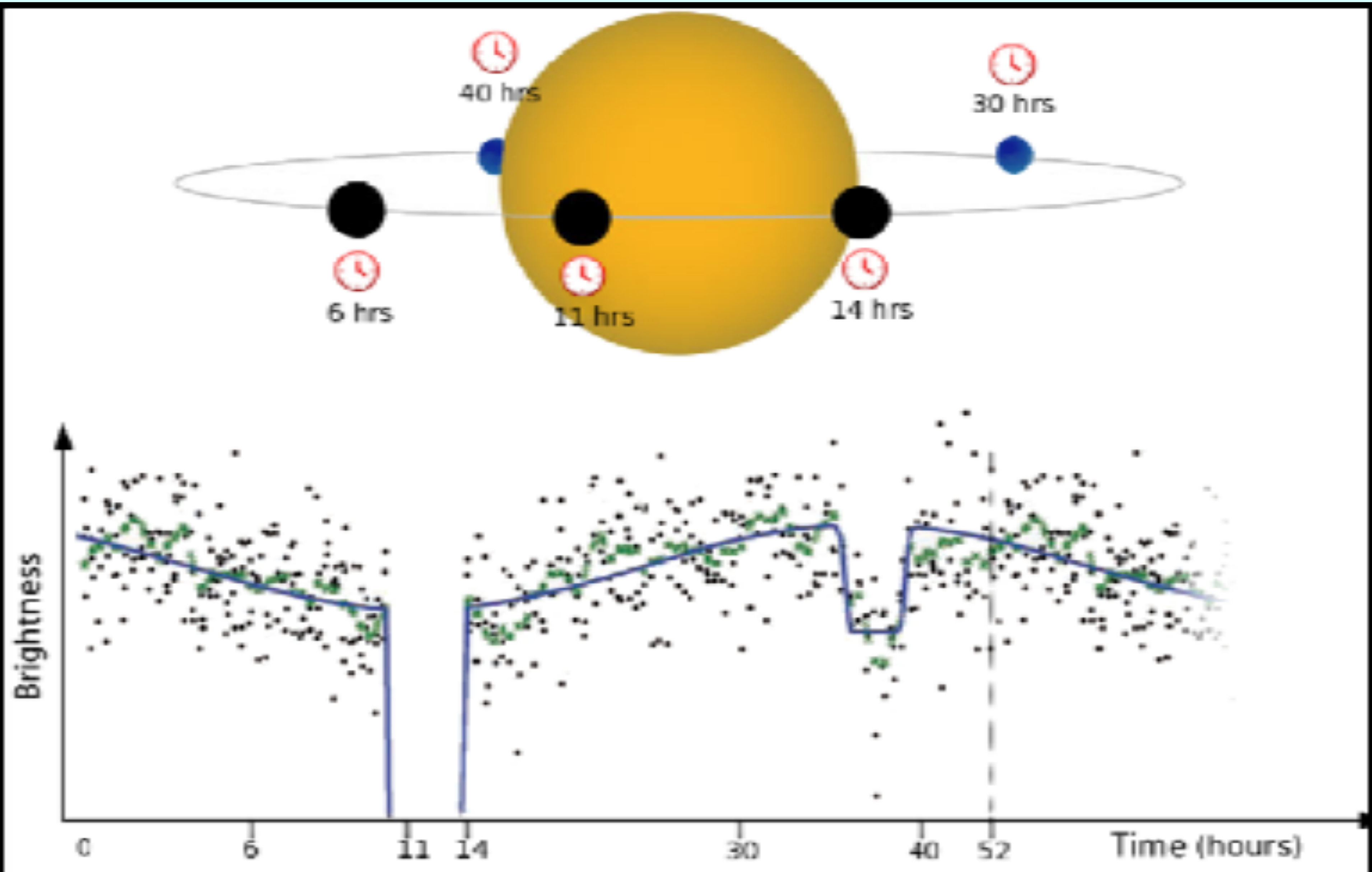
$$\{CO_2 + H_2O + O_3\}$$



A. Léger


A candle light near a sea lighthouse
The Darwin mission, in 2020?

Spectroscopy of a planetary atmosphere during its primary transit

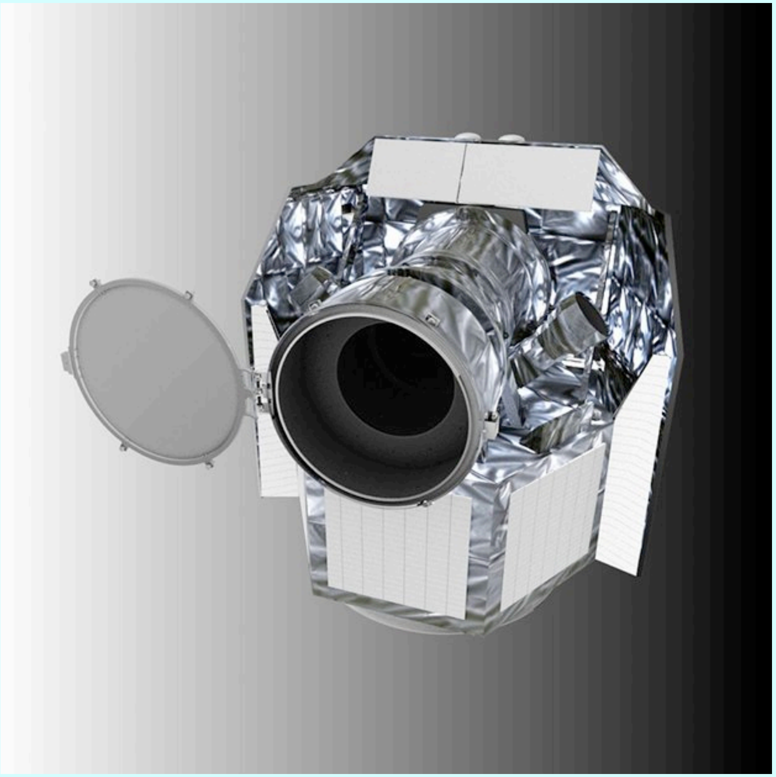


NASA's Transiting Exoplanet Survey Satellite (TESS) lifted off on Wednesday April 18, 2018. It is expected to find thousands of new exoplanets orbiting nearby stars.

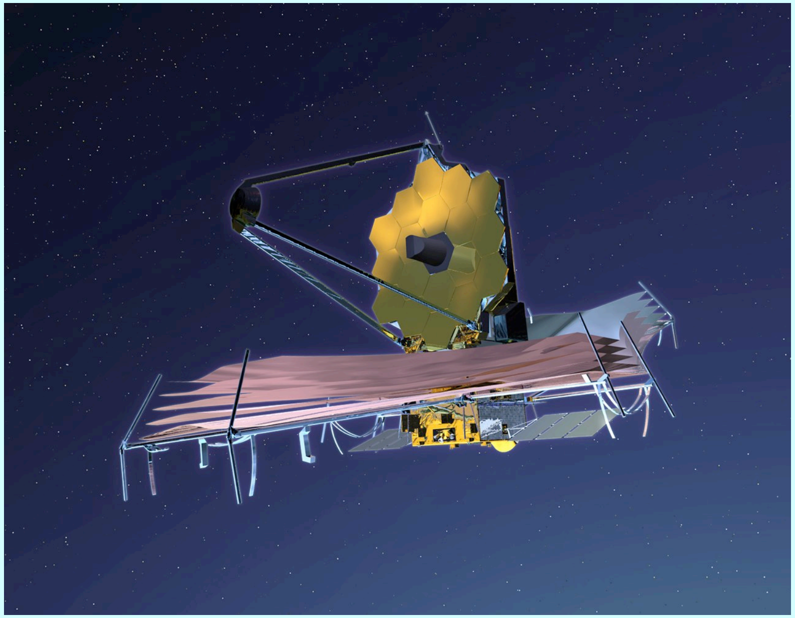
ESA CHEOPS satellite
(Small class mission of Cosmic Vision)

CHEOPS - *CH*aracterising *E*x*OP*lanet *S*atellite - will determine radii within ~10% accuracy for a subset of exoplanets, in the super-Earth to Neptune mass range, for which the mass has already been estimated using ground-based spectroscopic surveys, to get their bulk density. CHEOPS will operate in a geocentric Sun-synchronous orbit, at an altitude of 700 km. This choice permits the rear of the spacecraft to be permanently Sun-pointed.

Flight readiness of CHEOPS is planned for the end of 2018.



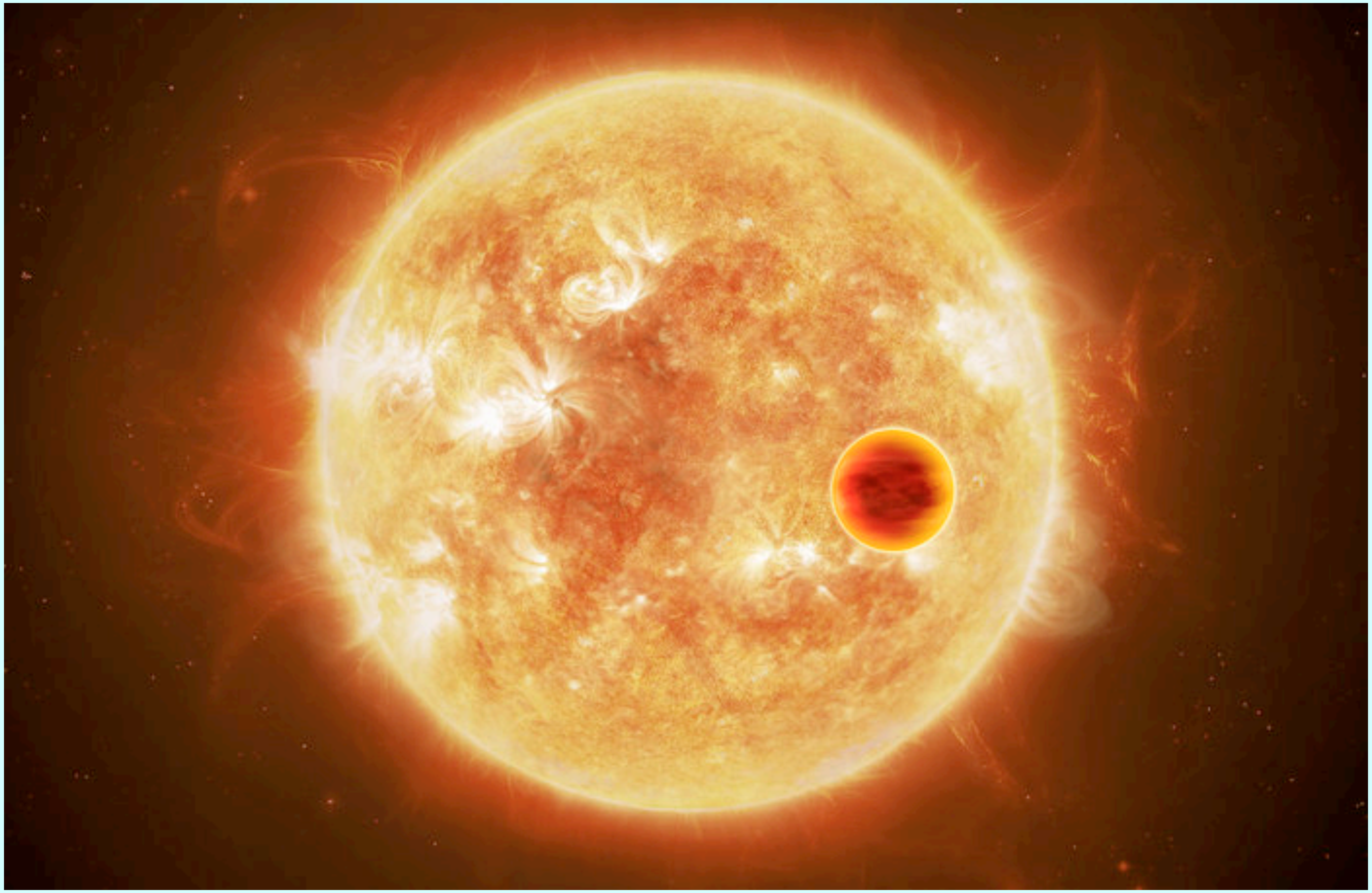
The new James Webb Space Telescope, operational in 2019 (?), will replace Hubble and will be able to « see » exoplanets.



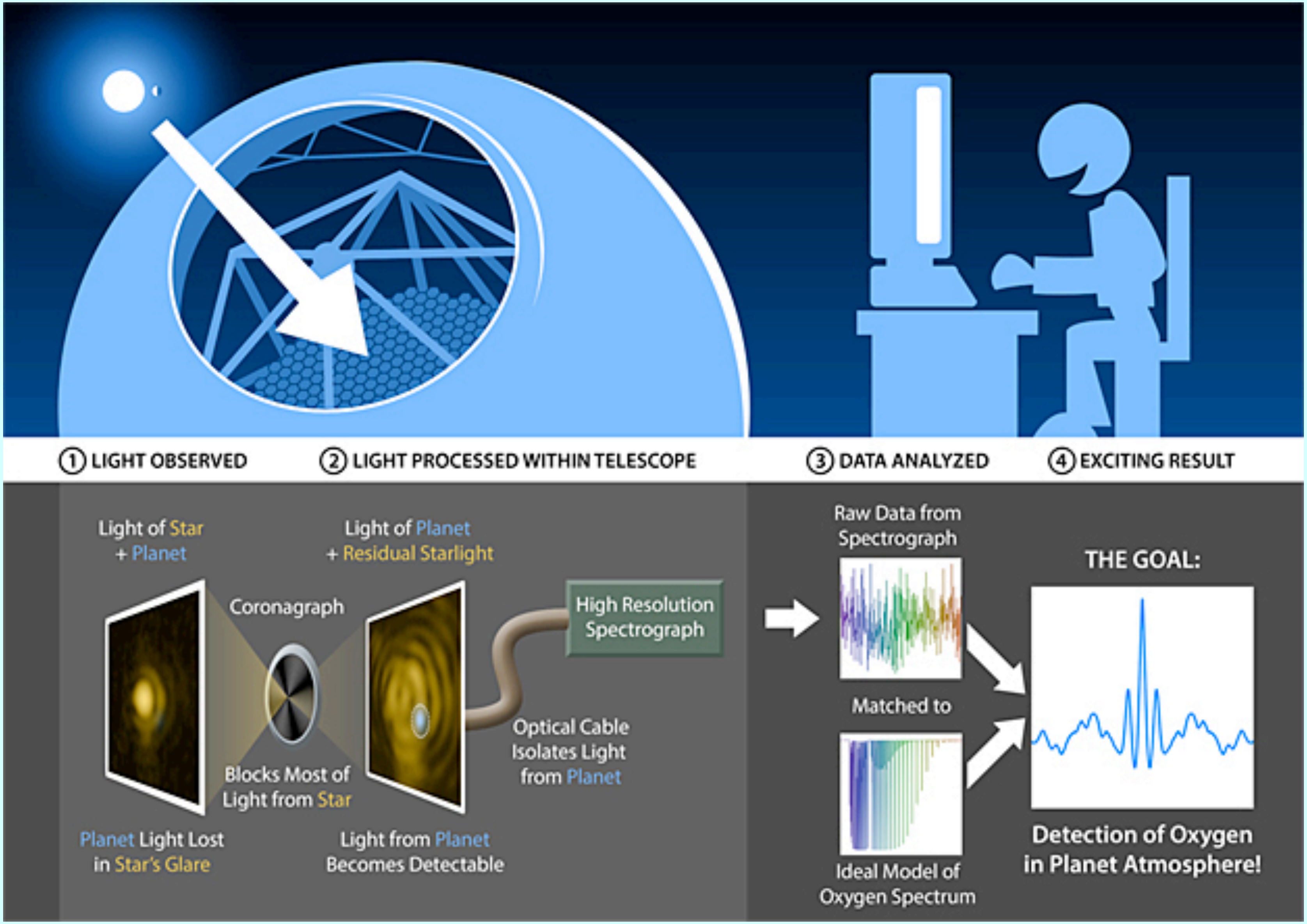
Glowing interstellar gas of the Lagoon Nebula on the occasion of the Hubble Space Telescope's 28th anniversary

ESA Ariel mission has been selected on March 20, 2018, to be launched mid 2028

Ariel (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) mission, a metre-class telescope, will operate at visible and infrared wavelengths. It will operate from an orbit around the second Lagrange point, L2, on an initial four-year mission. Ariel will measure the chemical fingerprints of the atmospheres as the planet crosses in front of its host star.

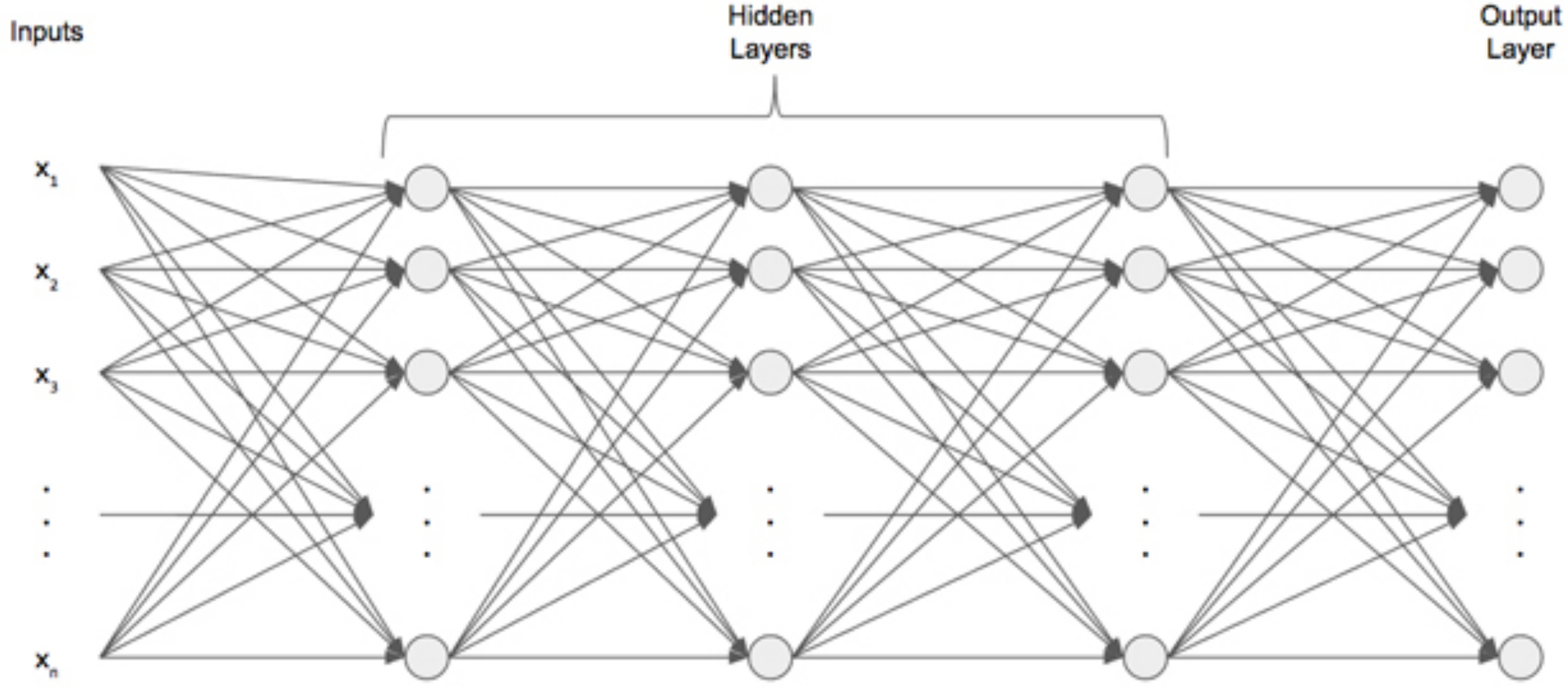


High dispersion coronography should allow to detect oxygen as a bioisignature with the 30 m telescope operational in 2020



Artificial Intelligence Helps Predict The Likelihood Of Extraterrestrial Life

Using artificial neural networks - the way the human brain learns − to classify planets into five types, to estimate a probability of life (the present-day Earth, the early Earth, Mars, Venus or Saturn's moon Titan).



The inputs represent values from a spectrum of a test planet's atmosphere. The output layer contains a 'probability of life', which is based on a measurement of the input's similarity to the five Solar System targets. The inputs pass through a series of hidden layers in the network, which are interconnected and enable the network to 'learn' which patterns of spectral lines correspond to a specific planet type. Credit: C. Bishop / Plymouth University

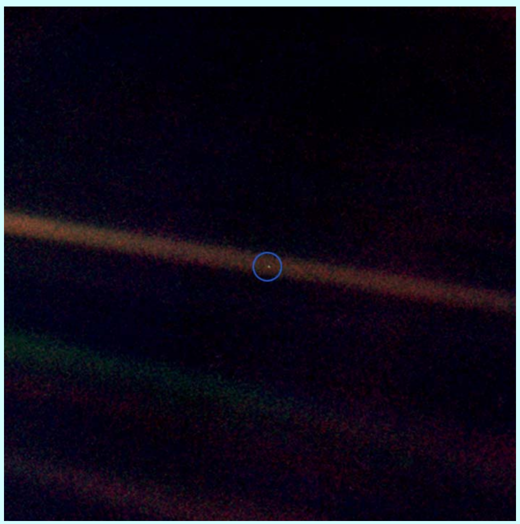
A Cosmic gorilla effect could blind the detection of aliens.

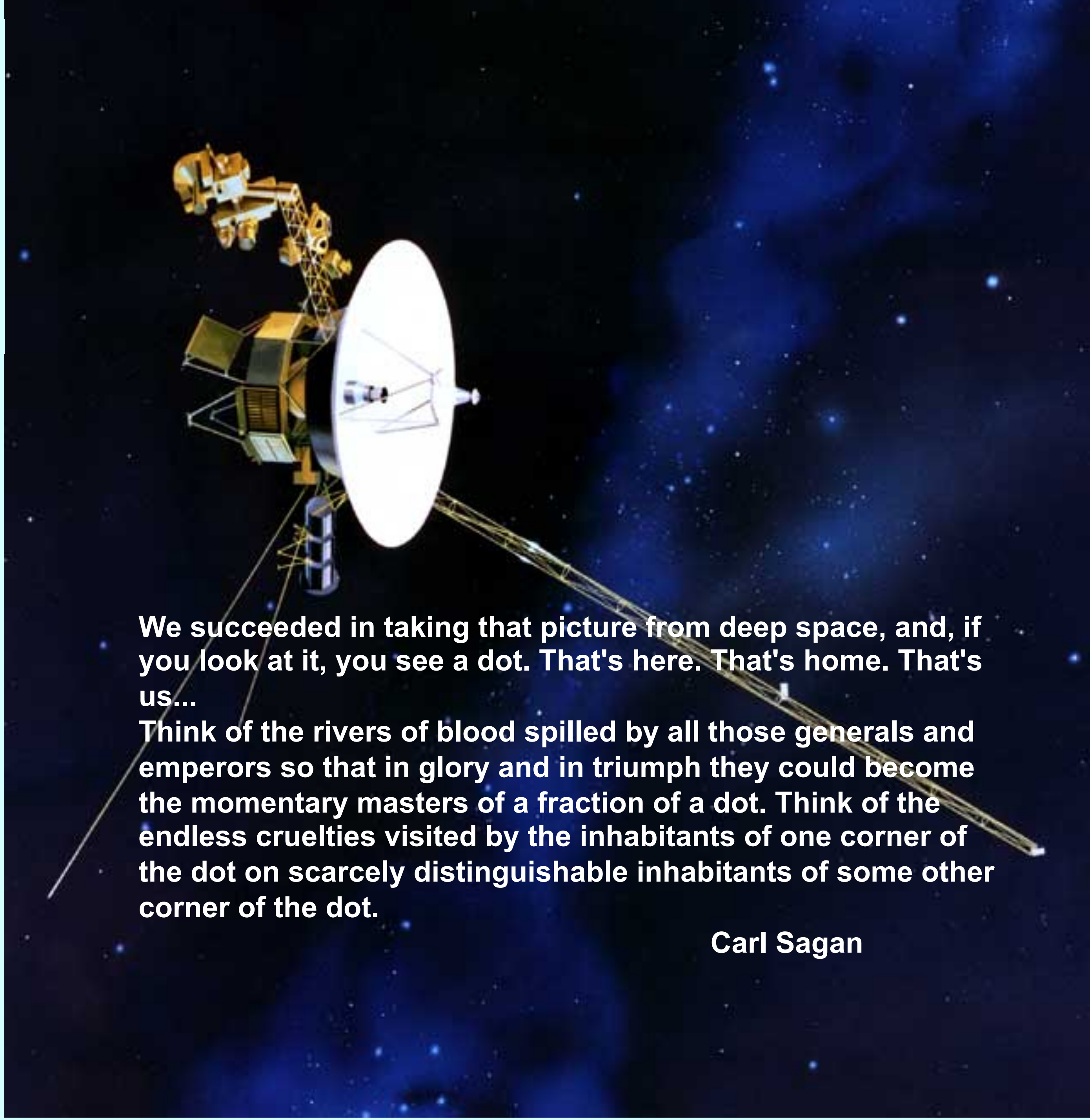
When an observer focuses on counting the passes of young people bouncing a ball, he does not detect if someone crosses the stage disguised as a gorilla. Something similar could be happening to us when we try to discover intelligent non-earthly signals, which perhaps manifest themselves in dimensions that escape our perception, such as the unknown dark matter and energy.

Glass of water half empty
Jan Van Kessel, *Still life with fruits and shellfish*, 1653

Pale blue dot

Voyager-1, launched in 1977, took a picture of the Earth in 1990, at 6.4 billion km.

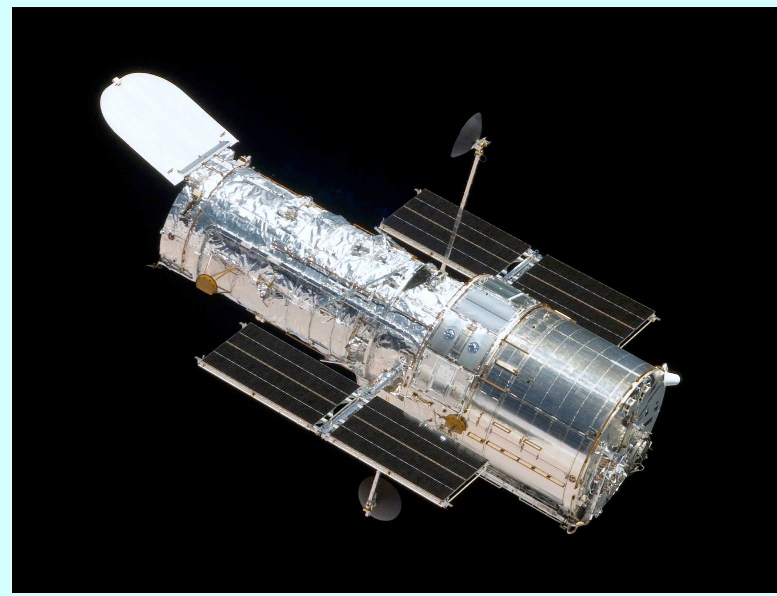




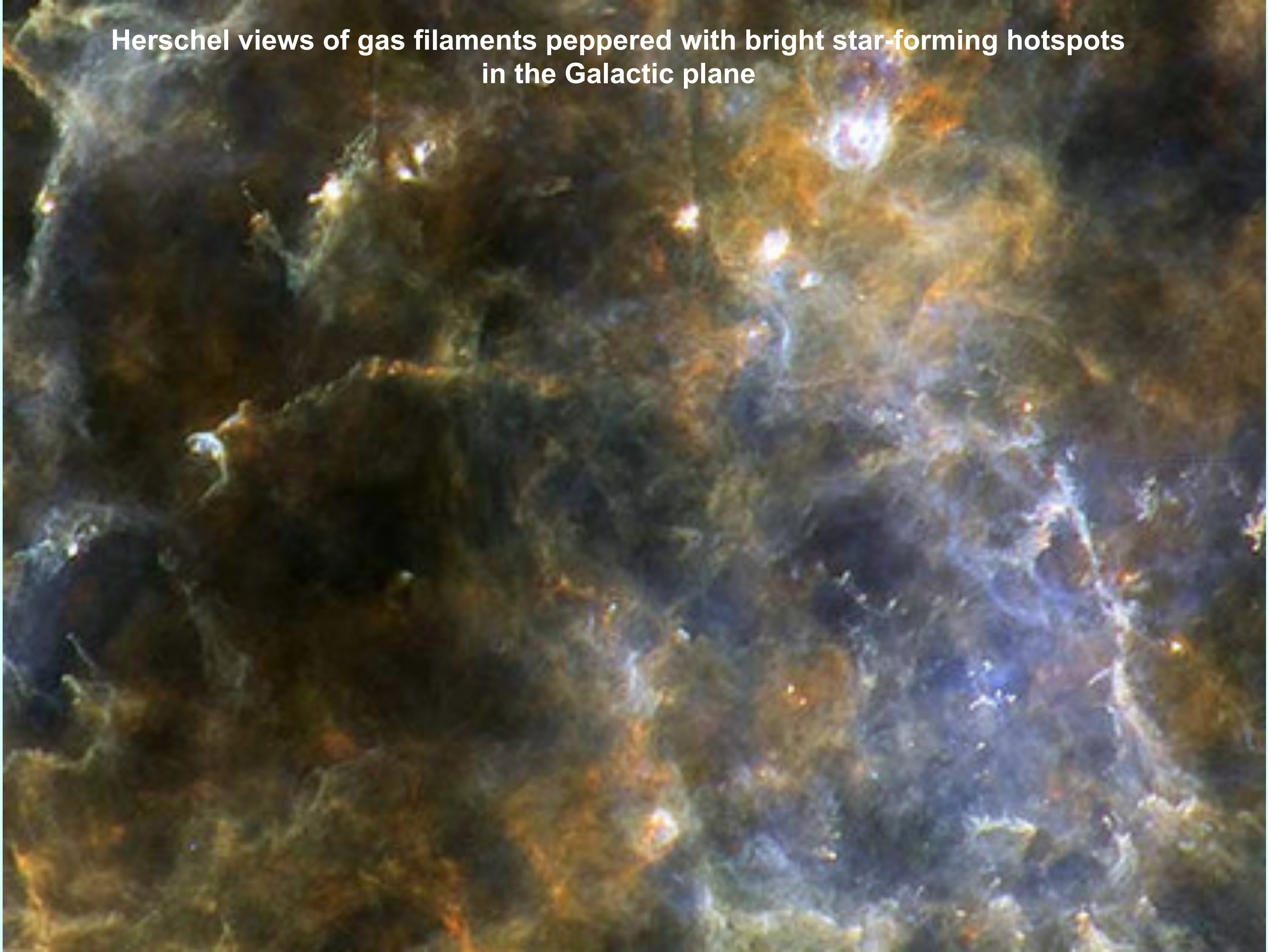

Glass of water half full
Jan Van Kessel, Still life with fruits and shellfish, 1653

In « Terre des Hommes », Antoine de Saint-Exupéry wrote in February, 1939:

«of a lava in fusion, a paste of stars, a living cell germinated by chance we came out, and, little by little, we rose to the point of writing cantatas and weighting milky ways»



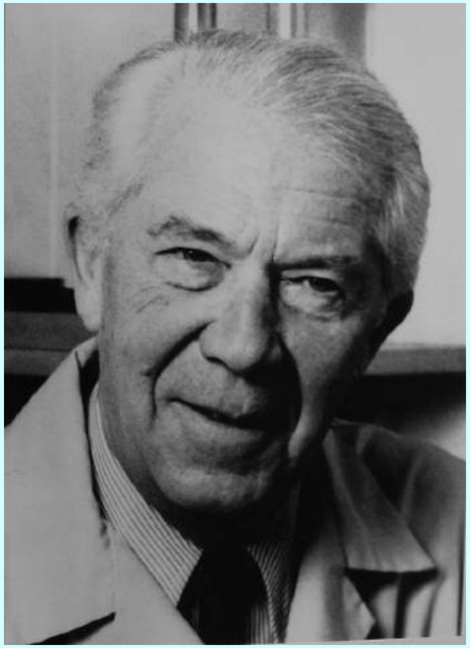
Herschel views of gas filaments peppered with bright star-forming hotspots in the Galactic plane



Christian de Duve (1917- 2013) Nobel Laureate in 1974

« "I knew the joy of learning, the almost voluptuous pleasure to understand,…", … »

A l' écoute du vivant, p. 362 (2002)



Seneca (4 av. JC → 65) wrote :

«The most beautiful discoveries would cease to please me if I were to keep them for me »