CURIOSITY ON MARS : WHAT IS NEW ABOUT ORGANIC MOLECULES ?

Michel Cabane, emeritus, LATMOS, Sorbonne Université, campus UPMC, Paris

In 2012, Curiosity, a NASA rover, landed on Mars. Here, some results of Gale Crater exploration will be presented, especially the methane concern (how to explain/reconciliate the various observations) and the quest for organic molecules (are there complex organic molecules on Mars ? what about habitability ?)

Key words: Mars, Curiosity, organic molecules, habitability.

Since September 2012, Gale crater, which results from a meteoritic impact, about 3.7 billion years ago, is explored by NASA's Curiosity that uses its robotics and science payload to obtain a better understanding of Mars story : geology, habitability.

For that purpose, two main features of the crater are of interest : (i) M^t Sharp (4500m height) at crater center, is the remains of a partial or total filling of Gale crater by sediments, dust, etc., followed by erosion : from its base to some kilometers height, geological strata are witnesses of Mars history (mineralogy, organic molecules) (ii) between M^t Sharp base and crater rim, the 'initial' crater floor shows alluvial fans and sediments due to water flows, æons ago. In both cases, concurrent presence of water, carbon bearing molecules, minerals will be an indicator for habitability.

Aboard Curiosity, SAM is mainly devoted to mineralogy and exobiology. The tunable laser spectrometer (TLS, JPL/NASA) measures CH_4 down to some tenths of a ppt, and may obtain isotopic ratios in H, C and O. The gas chromatograph (GC, Univ. of Paris/CNRS-CNES) and the mass spectrometer (MS, GSFC/NASA) analyze gases obtained from heating+pyrolysis of soil and rock samples, which provides clues about their composition (minerals and organic molecules). SAM detects down to 1 pmol of organic matter, i.e. about 0,5 ppb in the sample.

Atmospheric methane is of importance on Mars : if there is no current life on the planet, it only has a geologic origin that needs to be understood, but observations give contradictory results. Before Curiosity landing, observations gave a global CH_4 level from 10 to 60 ppb, with, in some cases, a high variability that has been contested *(Zanhle, 2010)*. From 2012, at Mars ground, Curiosity detected a very low CH_4 concentration (≈ 0.4 ppb), excepted for a few months, in 2014, where it climbed to values close to 10 ppb. More, in 2018, it was shown that the CH_4 background is a function of the epoch in the year, varying from 0.2 to 0.7 ppb (*Webster, 2018).* Up to now, no explanations exist and this will be discussed here, may be using new results from TLS/Curiosity or from spectrometers on ESA's Trace Gas Orbiter.

The presence of organic structures in sediments is now proven by the emission, after heating and pyrolysis, of complex organic molecules from mudstones : from 2014, C_6H_5Cl, $C_3H_6Cl_2$, etc. … have been found at pmol levels in 'Cumberland' *(Freissinet, 2015)* (presence of chlorine is due to the activity of soil perchlorates during heating), and C_2H_6S, C_5H_6S, etc. at nmol levels in 'Mohave' and 'Confidence Hills' *(Eigenbrode, 2018)* (sulfur indicates a possible role of sulfates in the preservation of organics). In July 2018, on M^t Sharp, Curiosity is exploring a hematite-rich layer ; a few weeks/months later, it will move to the next zone, where clay layers have been detected by orbiters. This will be of high interest, as far as clays play a very important role in prebiotic processes. All these results will be discussed, possibly in the light of new information coming from the rover.

References

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