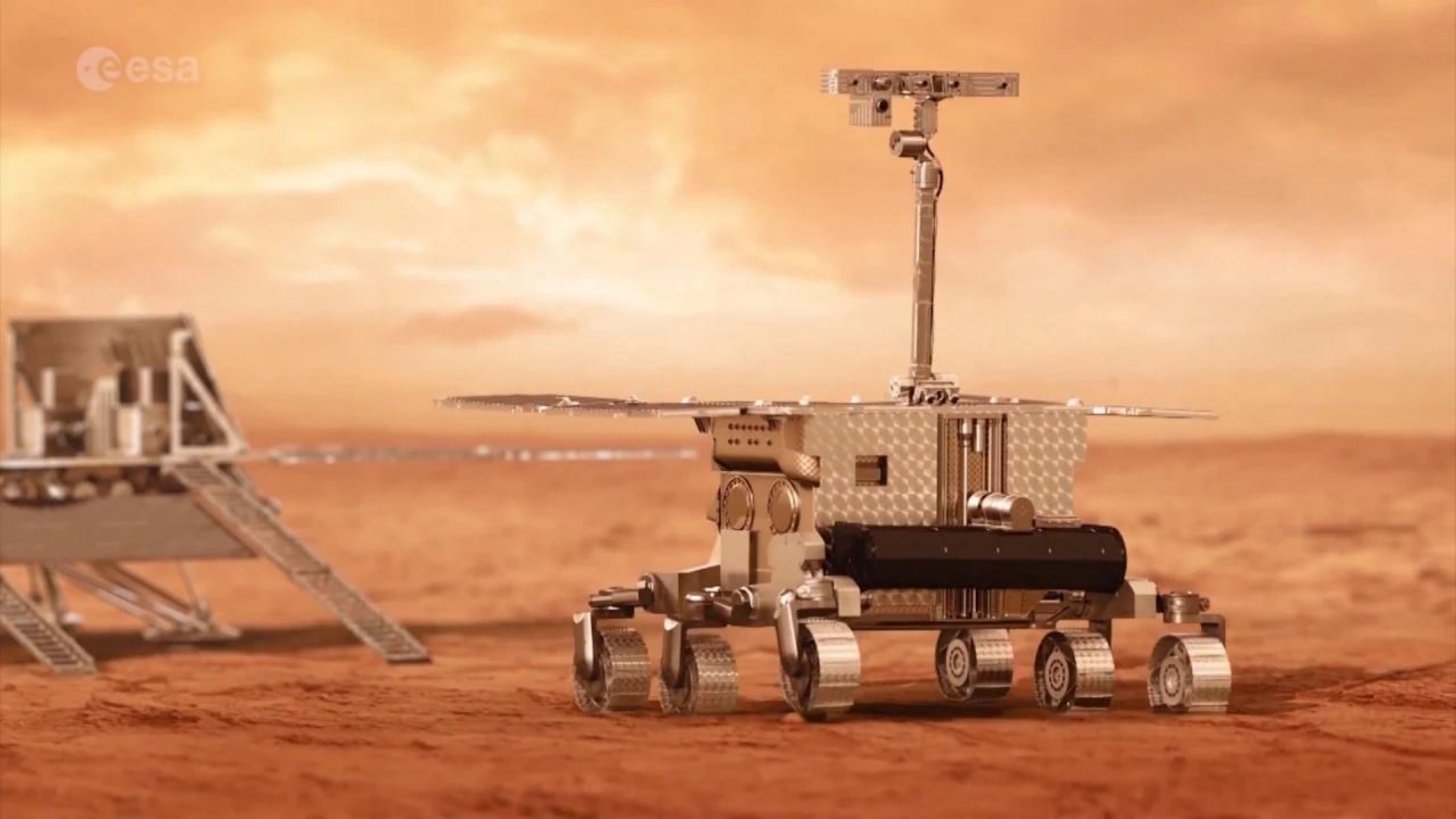
esa

1
00:00:00,601 --> 00:00:04,404
2020 will be a banner year
for the exploration of Mars.

2
00:00:04,404 --> 00:00:07,908
In addition to the launch of
NASA's Mars 2020 rover, the

3
00:00:07,908 --> 00:00:11,011
European Space Agency and
Roscosmos are sending the

4
00:00:11,011 --> 00:00:14,014
ExoMars rover to the red planet.

5
00:00:14,014 --> 00:00:17,618
As it descends from its landing
platform, ExoMars will embark on

6
00:00:17,618 --> 00:00:21,555
an enterprising mission: to
uncover buried signs of past or

7
00:00:21,555 --> 00:00:22,923
present life.

8
00:00:22,923 --> 00:00:26,159
The Martian surface is a harsh
environment, bombarded with

9
00:00:26,159 --> 00:00:28,695
cosmic radiation, but the
subsurface

10
00:00:28,695 --> 00:00:30,364
could offer better protection.

11
00:00:30,364 --> 00:00:33,834
For this reason, ExoMars is

equipped with an extending drill

12
00:00:33,834 --> 00:00:36,370
that can retrieve samples
from up to two meters

13
00:00:36,370 --> 00:00:38,138
below the surface.

14
00:00:38,138 --> 00:00:41,742
Studying these samples will be
the job of the Analytical Lab, a

15
00:00:41,742 --> 00:00:44,745
trio of instruments designed
to search for the molecular

16
00:00:44,745 --> 00:00:46,747
fingerprints of life.

17
00:00:50,284 --> 00:00:53,987
The Mars Organic Molecule
Analyzer, or MOMA, is the

18
00:00:53,987 --> 00:00:57,457
largest and most complex
instrument on the rover.

19
00:00:57,457 --> 00:01:00,661
Its mass spectrometer subsystem
and its main electronics were

20
00:01:00,661 --> 00:01:03,897
built and tested at NASA's
Goddard Space Flight Center,

21
00:01:03,897 --> 00:01:06,600
which also contributed
mass spectrometers to NASA's

22
00:01:06,600 --> 00:01:09,503
Curiosity rover
and MAVEN orbiter.

23
00:01:09,503 --> 00:01:12,906
MOMA is designed with a mix of
proven hardware and innovative

24
00:01:12,906 --> 00:01:15,008
new technologies.

25
00:01:15,008 --> 00:01:18,879
Here's how it works: in gas
chromatograph mode, crushed

26
00:01:18,879 --> 00:01:22,316
Martian rock is put into an
oven and heated to 900 degrees

27
00:01:22,316 --> 00:01:27,321
Celsius in just two
minutes, vaporizing the sample.

28
00:01:27,321 --> 00:01:31,258
Molecules of hot gas rise up,
and flow into a narrow, twenty

29
00:01:31,258 --> 00:01:33,226
meter-long tube.

30
00:01:33,226 --> 00:01:36,496
Special coatings inside the tube
cause molecules with certain

31
00:01:36,496 --> 00:01:39,533
chemistries to slow down more
than others, separating the

32
00:01:39,533 --> 00:01:41,802

mixture of molecules over time.

33
00:01:41,802 --> 00:01:45,339
Next, a beam of electrons
ionizes the molecules, giving

34
00:01:45,339 --> 00:01:48,642
them a positive electric charge
and deflecting them towards the

35
00:01:48,642 --> 00:01:50,377
linear ion trap.

36
00:01:50,377 --> 00:01:53,613
The ions are caught by a
fluctuating electric field, and

37
00:01:53,613 --> 00:01:57,784
sent to a detector to
determine their chemical makeup.

38
00:01:57,784 --> 00:02:00,787
While gas chromatography has
been used to study Mars since

39
00:02:00,787 --> 00:02:04,024
the Viking program, MOMA has
a second method for preparing

40
00:02:04,024 --> 00:02:07,627
samples that has never
been used on another planet.

41
00:02:07,627 --> 00:02:10,764
In laser desorption mode, a
sample is placed beneath a

42
00:02:10,764 --> 00:02:14,134
powerful ultraviolet laser.

43
00:02:14,134 --> 00:02:17,671
A beam of energetic light builds
within the laser and fires in a

44
00:02:17,671 --> 00:02:20,474
billionth of a second,
concentrating its energy onto a

45
00:02:20,474 --> 00:02:23,377
spot smaller than
a grain of sand.

46
00:02:23,377 --> 00:02:26,913
This rapidly vaporizes a portion
of the sample, releasing large

47
00:02:26,913 --> 00:02:30,684
organic molecules that could
be broken down by oven heating.

48
00:02:30,684 --> 00:02:34,254
The laser shot also ionizes some
of the molecules, allowing the

49
00:02:34,254 --> 00:02:37,758
vapor to head directly
to the linear ion trap.

50
00:02:37,758 --> 00:02:41,094
Neutral molecules are ejected
by a vacuum, while the remaining

51
00:02:41,094 --> 00:02:45,332
ions are sent to the detector to
determine their chemical makeup.

52
00:02:45,332 --> 00:02:48,835
Laser desorption will enable
MOMA to detect long molecules

53
00:02:48,835 --> 00:02:52,239
like lipids, the building
blocks of cell membranes, a leap

54
00:02:52,239 --> 00:02:54,708
forward in the
search for life on Mars.

55
00:02:58,912 --> 00:03:01,314
MOMA's linear ion trap is
another first

56
00:03:01,314 --> 00:03:02,816
for the red planet.

57
00:03:02,816 --> 00:03:05,085
It will scan for the
fingerprints of life using

58
00:03:05,085 --> 00:03:09,156
techniques normally confined
to laboratories on Earth.

59
00:03:09,156 --> 00:03:12,692
One technique, called SWIFT,
repeatedly ejects unwanted

60
00:03:12,692 --> 00:03:14,728
molecules from the trap.

61
00:03:14,728 --> 00:03:17,330
Over time this builds up
molecules of interest,

62
00:03:17,330 --> 00:03:20,367
improving detection.

63
00:03:20,367 --> 00:03:24,638
Another technique is tandem mass

spectrometry, or MS/MS, which

64
00:03:24,638 --> 00:03:27,774
identifies large molecules
by breaking them apart and

65
00:03:27,774 --> 00:03:30,010
analyzing their fragments.

66
00:03:30,010 --> 00:03:34,147
By combining SWIFT and MS/MS,
MOMA can determine an individual

67
00:03:34,147 --> 00:03:37,284
molecule's formula and its
structure, both important

68
00:03:37,284 --> 00:03:39,586
criteria in the search for life.

69
00:03:40,921 --> 00:03:43,990
The question of life on Mars
is among the most important in

70
00:03:43,990 --> 00:03:47,194
planetary science, and the
evidence may be buried just

71
00:03:47,194 --> 00:03:48,562
below the surface.

72
00:03:48,562 --> 00:03:52,199
With the help of MOMA, ExoMars
will take us one step closer to

73
00:03:52,199 --> 00:03:53,867
uncovering the answer.