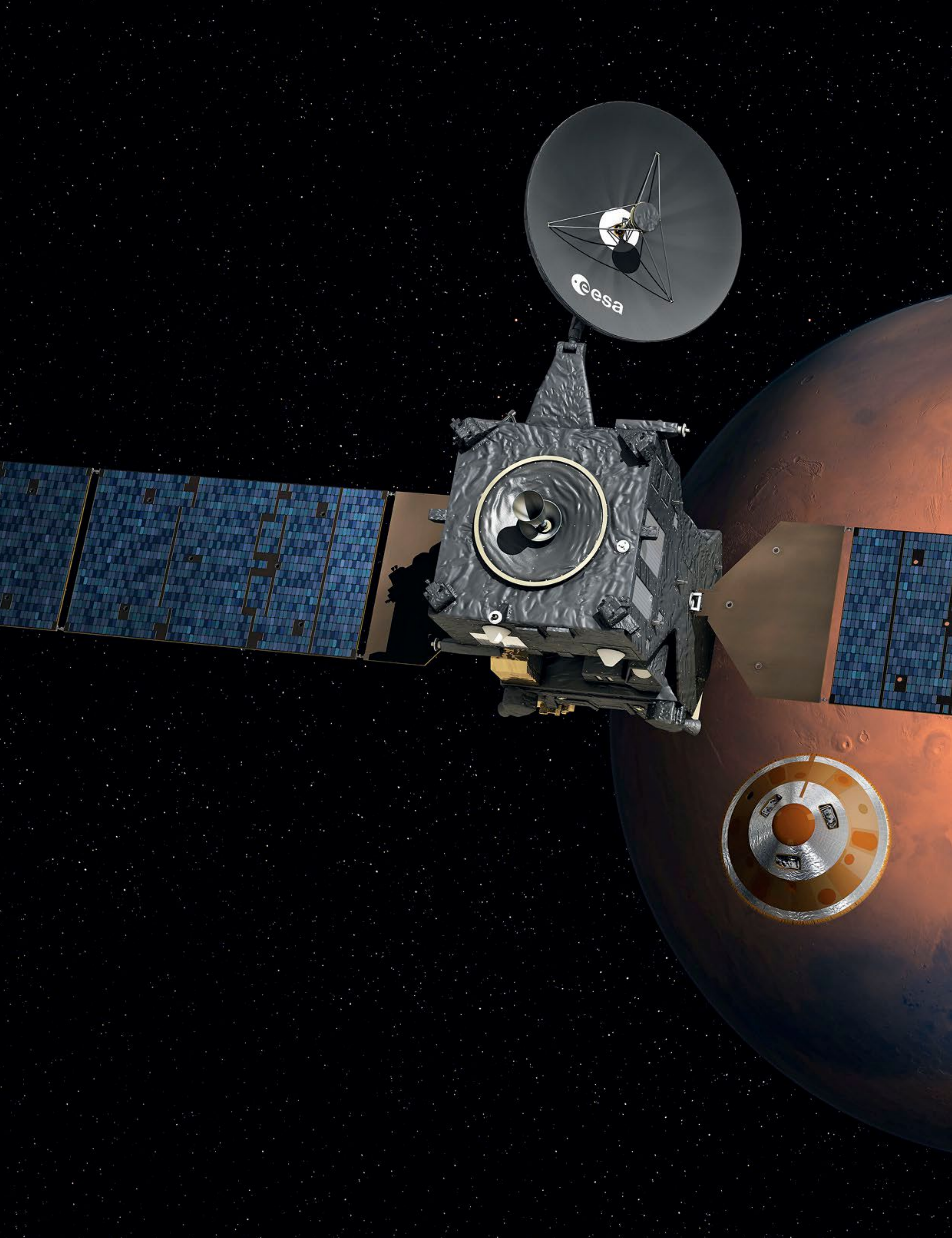
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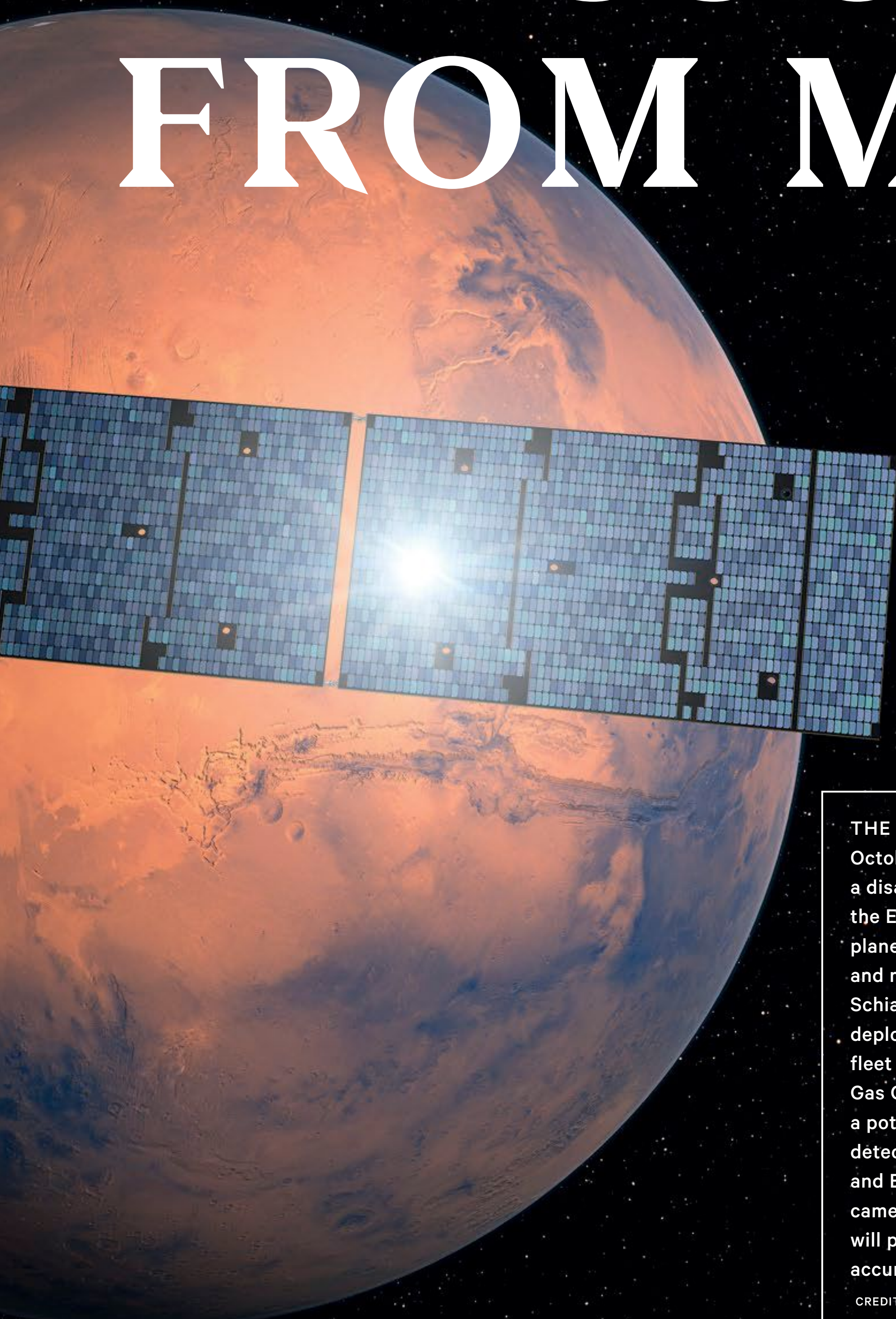
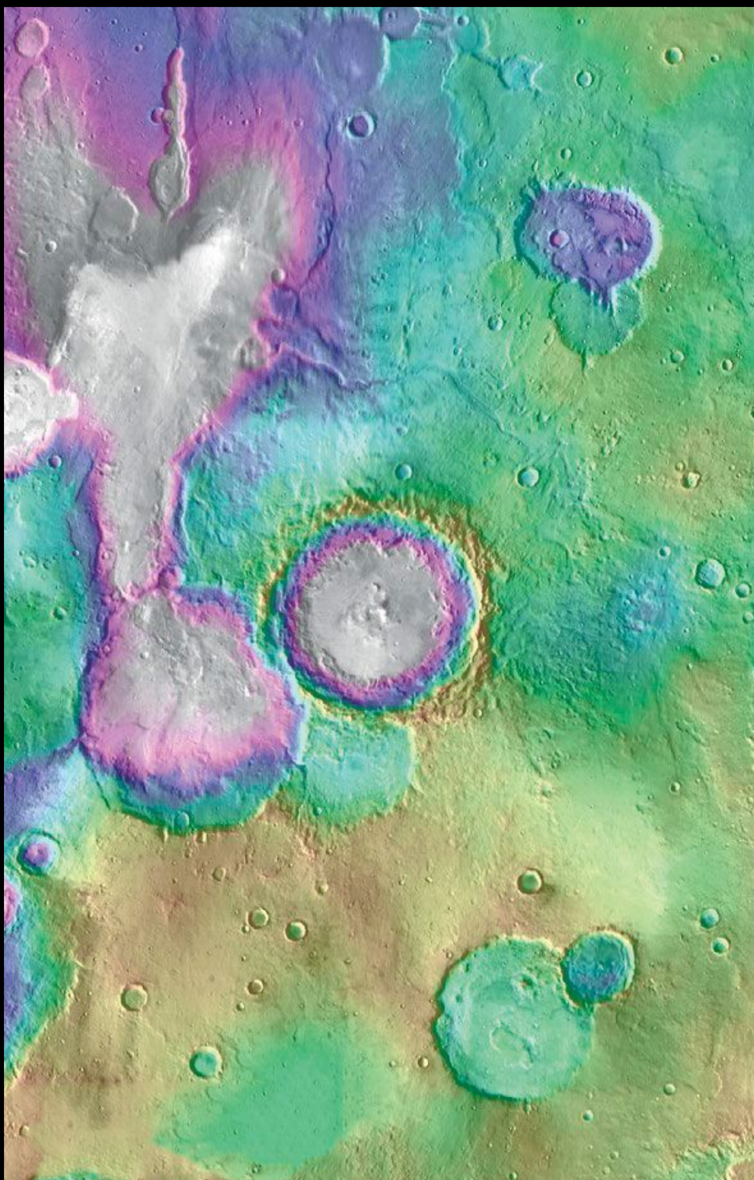
HOLODECK:
COMPILED BY JAMES MITCHELL CROW

LESSONS FROM MARS



THE SCHIAPARELLI PROBE made headlines in October 2016 when it crash-landed on Mars. It wasn't a disaster, though, it was mainly a practice run for the European Space Agency's next mission to the red planet: delivery of a craft bearing the science station and rover, scheduled for 2020. The main game of the Schiaparelli probe – the "ExoMars" mission – was to deploy the mothership, the 13th of an international fleet of ships spying on Mars. Known as the Trace Gas Orbiter (TGO), its goal is to sniff out methane, a potential signature of life. The gas has been detected by previous orbiters, the Curiosity Rover and Earth-based telescopes. But where the plumes came from was impossible to say. TGO's instruments will pinpoint the source with a thousand-fold greater accuracy than ever before.

CREDIT: ARTIST'S IMPRESSION / ESA / D. DUCROS



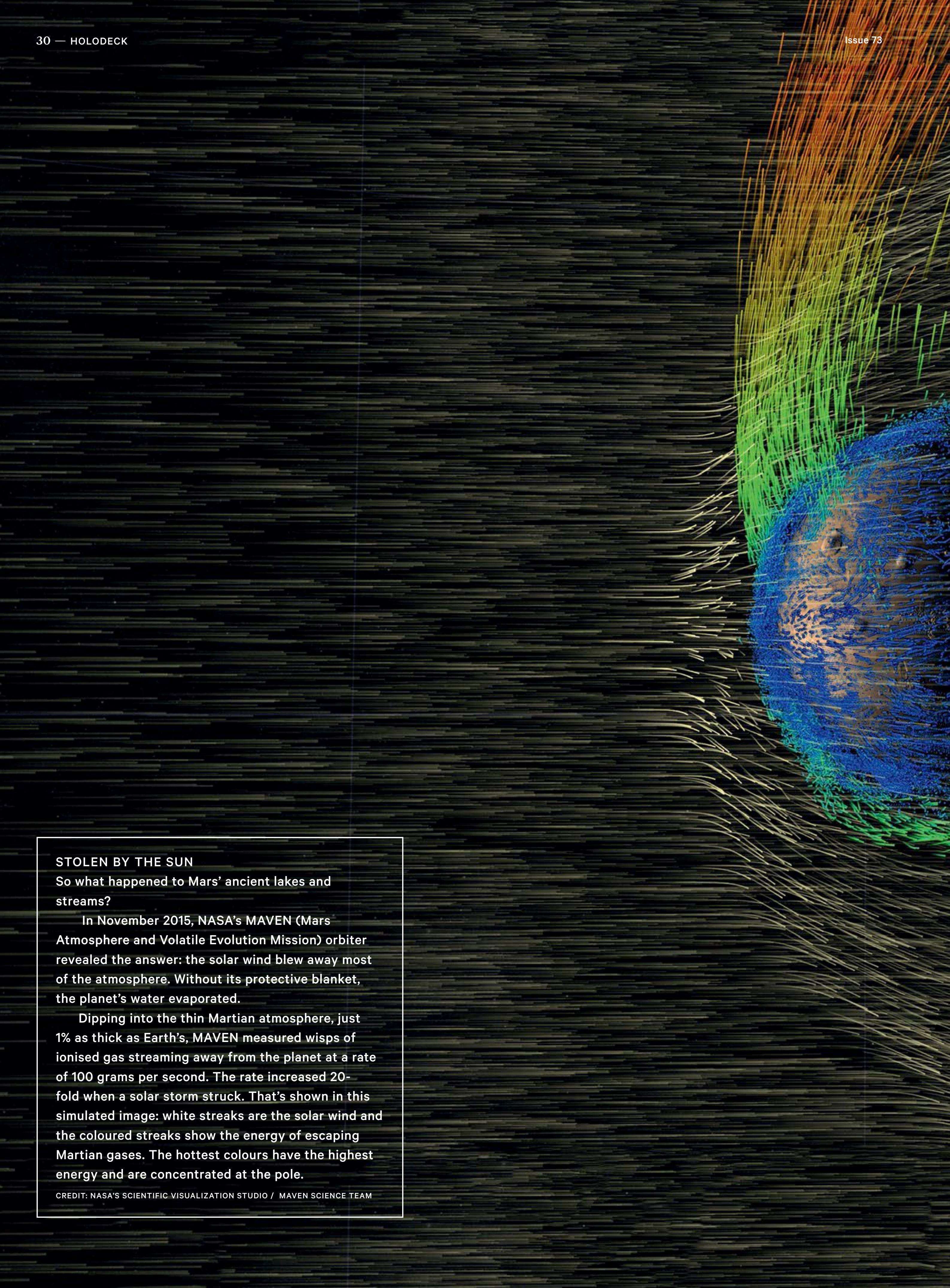
FOLLOW THE WATER

In September 2015, NASA's Mars Reconnaissance Orbiter had a better reason to grab headlines: it found evidence of flowing water. MRO's spectrometer showed that dark streaks on the slopes of some craters and canyons were composed of salts left by evaporating water. It also identified clay sediments on a canyon floor in the Nili Fossae region (far left), a candidate site for a future landing mission.

Two older orbiters, the 2001 Mars Odyssey and Mars Global Surveyor, identified ancient lakes and snowmelt-fed streams in the Arabia Terra region (left: white represents lowest elevation, yellow highest). Based on the number of craters, scientists estimate they held water until 2-3 billion years ago – a billion years later than previously thought.

CREDIT: (LEFT) NASA / JPL-CALTECH / UNIV. OF ARIZONA

(RIGHT) NASA / JPL-CALTECH / ASU



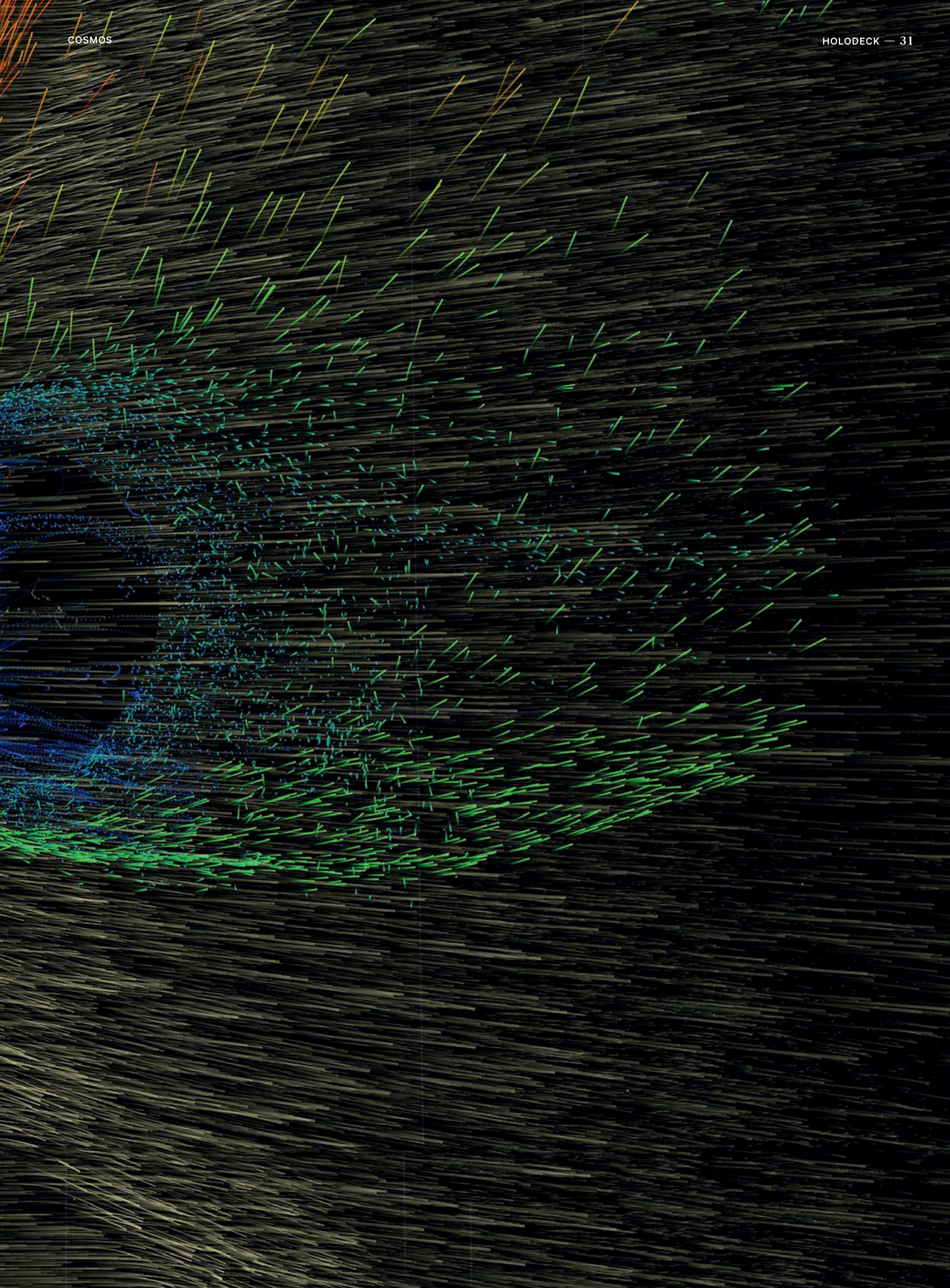
STOLEN BY THE SUN

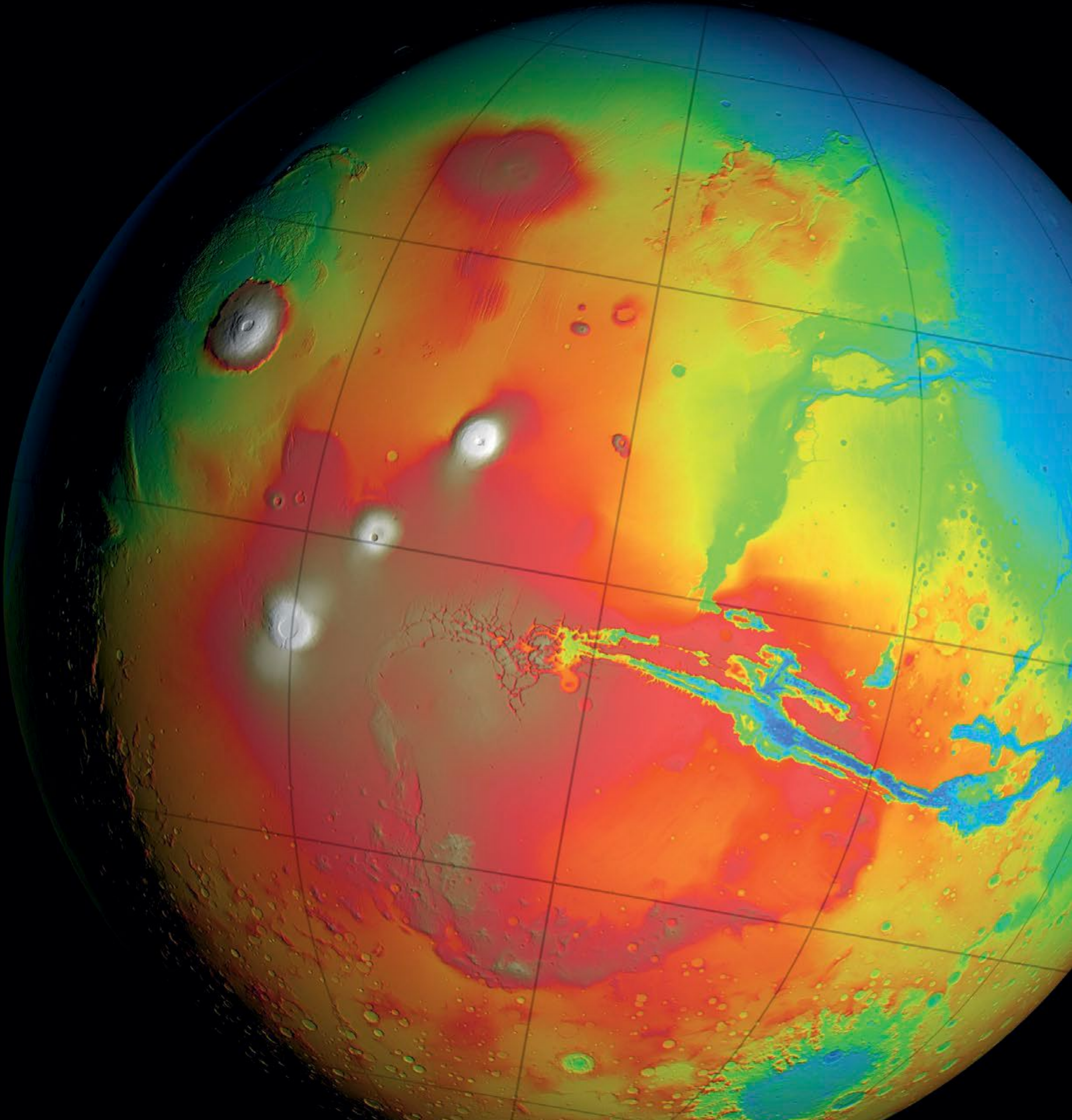
So what happened to Mars' ancient lakes and streams?

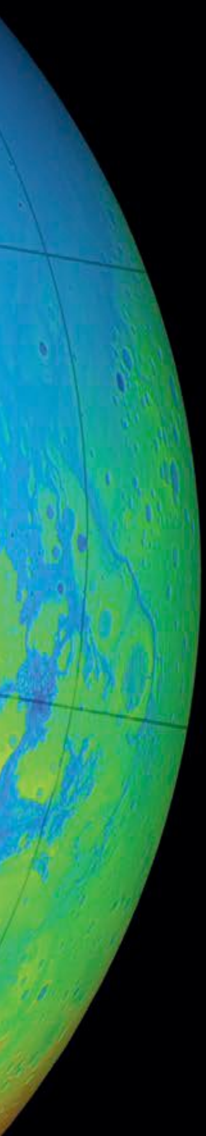
In November 2015, NASA's MAVEN (Mars Atmosphere and Volatile Evolution Mission) orbiter revealed the answer: the solar wind blew away most of the atmosphere. Without its protective blanket, the planet's water evaporated.

Dipping into the thin Martian atmosphere, just 1% as thick as Earth's, MAVEN measured wisps of ionised gas streaming away from the planet at a rate of 100 grams per second. The rate increased 20-fold when a solar storm struck. That's shown in this simulated image: white streaks are the solar wind and the coloured streaks show the energy of escaping Martian gases. The hottest colours have the highest energy and are concentrated at the pole.

CREDIT: NASA'S SCIENTIFIC VISUALIZATION STUDIO / MAVEN SCIENCE TEAM







GRAVITY MAP

Mars is pockmarked by towering mountains such as Olympus Mons – three times the height of Mount Everest – and craters 9 km deep. The mass differences in the crust mean spacecraft experience tiny changes in gravitational tug as they orbit Mars. These wobbles are measurable and can be used to calculate the changing gravity and mass. For instance, they revealed that the mass of the CO_2 icecaps varies seasonally by 4 trillion tons.

Scientists pooled measurements from three orbiters to build this gravity map of the planet in 2016. Low-gravity canyons like Valles Marineris in blue (centre) stand out from the high-gravity reds and whites of Tharsis Montes, the three aligned volcanoes left of centre and Olympus Mons, above and left. This 'gravity' map will help future craft chart their orbit with greater precision.

CREDIT: NASA'S SCIENTIFIC VISUALIZATION STUDIO