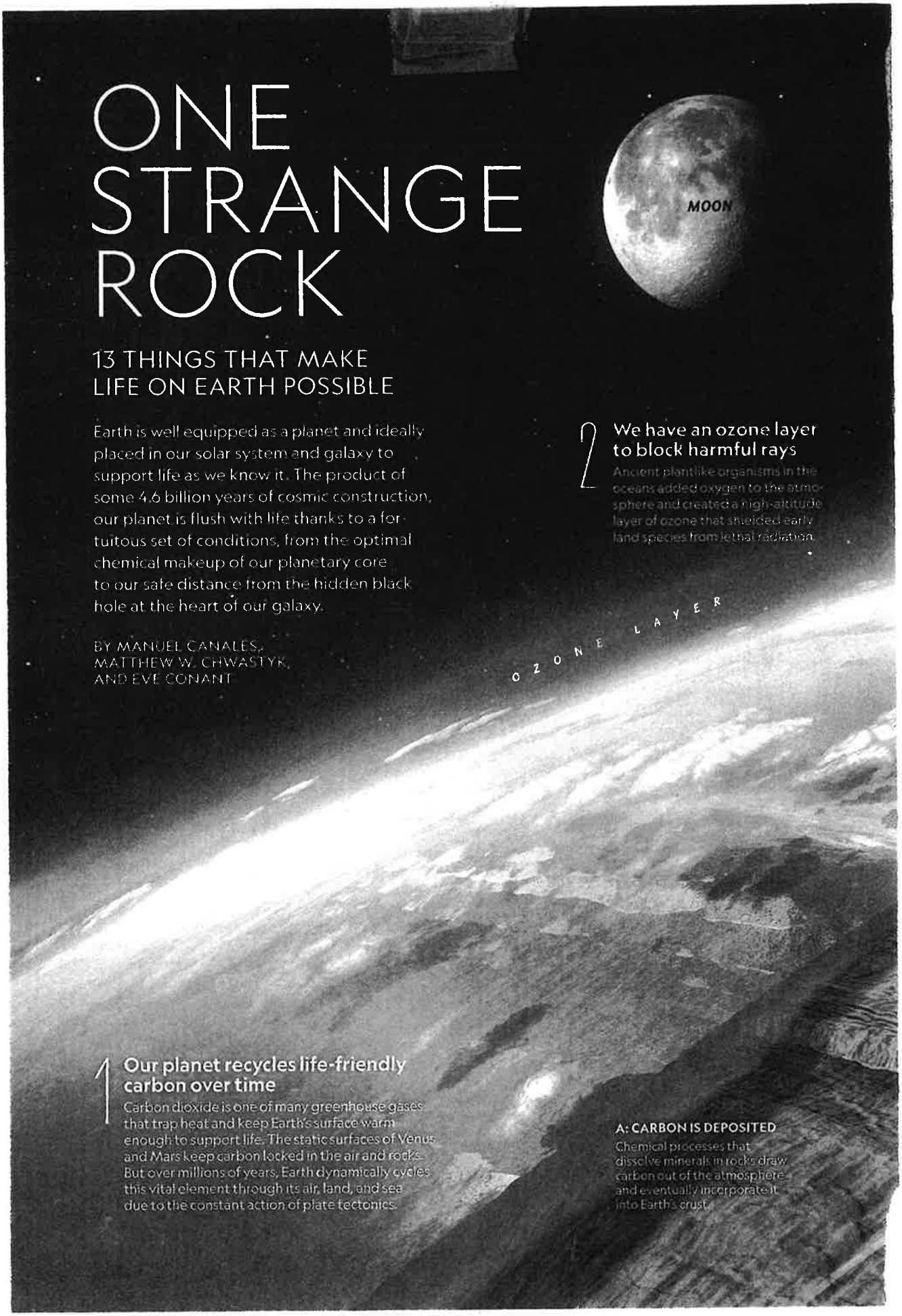
ONE STRANGE ROCK

13 THINGS THAT MAKE LIFE ON EARTH POSSIBLE

Earth is well equipped as a planet and ideally placed in our solar system and galaxy to support life as we know it. The product of some 4.6 billion years of cosmic construction, our planet is flush with life thanks to a fortuitous set of conditions, from the optimal chemical makeup of our planetary core to our safe distance from the hidden black hole at the heart of our galaxy.

BY MANUEL CANALES, MATTHEW W. CHWASTYK, AND EVE CONANT



1 Our planet recycles life-friendly carbon over time

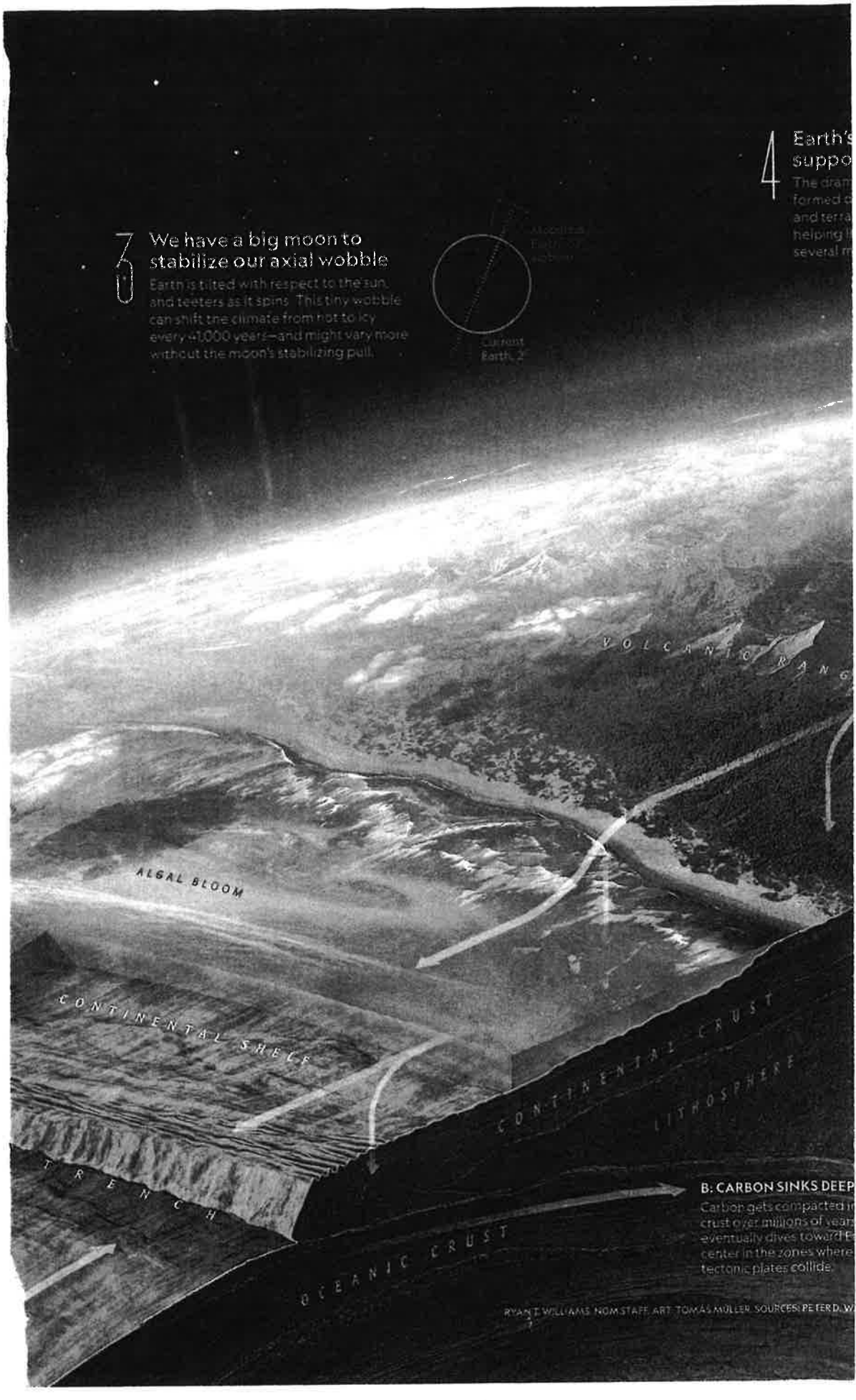
Carbon dioxide is one of many greenhouse gases that trap heat and keep Earth's surface warm enough to support life. The static surfaces of Venus and Mars keep carbon locked in the air and rocks. But over millions of years, Earth dynamically cycles this vital element through its air, land, and sea due to the constant action of plate tectonics.

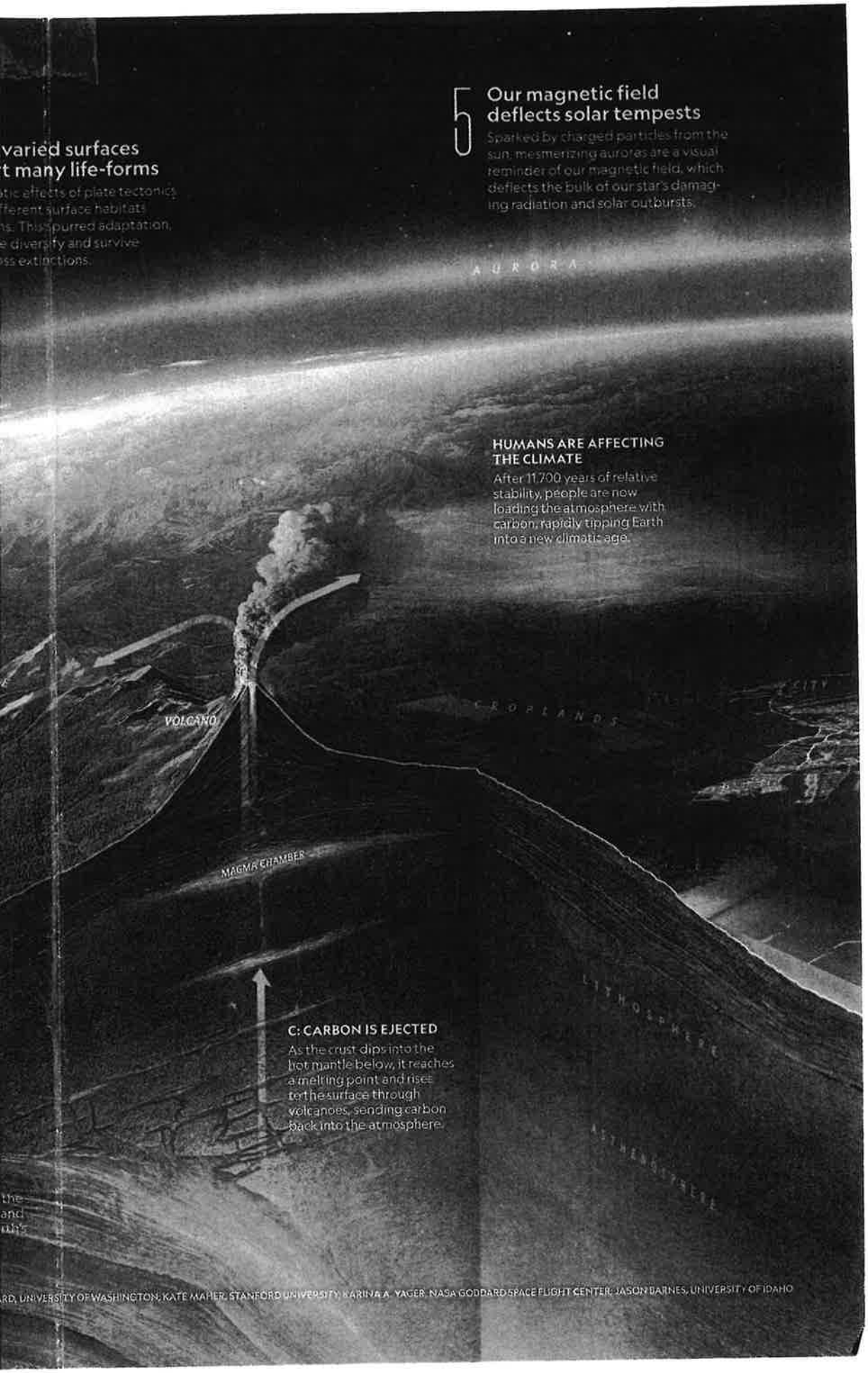
A: CARBON IS DEPOSITED

Chemical processes that dissolve minerals in rocks draw carbon out of the atmosphere and eventually incorporate it into Earth's crust.

2 We have an ozone layer to block harmful rays

Ancient plantlike organisms in the oceans added oxygen to the atmosphere and created a high-altitude layer of ozone that shielded early land species from lethal radiation.


3
We have a big moon to stabilize our axial wobble
Earth is tilted with respect to the sun, and teeters as it spins. This tiny wobble can shift the climate from hot to icy every 41,000 years—and might vary more without the moon's stabilizing pull.
Current Earth, 2
4
Earth's
suppo
The dram
formed c
and terra
helping l
several m
VOLCANIC RANG
ALGAL BLOOM
CONTINENTAL SHELF
CONTINENTAL CRUST
LITHOSPHERE
TRENCH
OCEANIC CRUST
B: CARBON SINKS DEEP
Carbon gets compacted i
crust over millions of year
eventually dives toward E
center in the zones where
tectonic plates collide.
RYAN T. WILLIAMS, NOM STAFF; ART: TOMÁS MÜLLER; SOURCES: PETER D. W


varied surfaces
t many life-forms
tic effects of plate tectonics
fferent surface habitats
s. This spurred adaptation,
e diversify and survive
ss extinctions.
5
Our magnetic field deflects solar tempests
Sparked by charged particles from the sun, mesmerizing auroras are a visual reminder of our magnetic field, which deflects the bulk of our star's damaging radiation and solar outbursts.
AURORA
HUMANS ARE AFFECTING THE CLIMATE
After 11,700 years of relative stability, people are now loading the atmosphere with carbon, rapidly tipping Earth into a new climatic age.
VOLCANO
CROPLANDS
CITY
MAGMA CHAMBER
C: CARBON IS EJECTED
As the crust dips into the hot mantle below, it reaches a melting point and rises to the surface through volcanoes, sending carbon back into the atmosphere.
LITHOSPHERE
ASTHENOSPHERE
the
and
ARD, UNIVERSITY OF WASHINGTON; KATE MAHER, STANFORD UNIVERSITY; KARINA A. YAGER, NASA GODDARD SPACE FLIGHT CENTER; JASON BARNES, UNIVERSITY OF IDAHO

IN THE SOLAR SYSTEM

NOT TOO HOT OR TOO COLD

Not every planet has what it takes to support life as we know it. Even though eight planets formed in the solar system, Earth is the only one where we know life emerged and thrived. Having the right ingredients coalesce in just the right zone around a calm, warm star seems to be crucial for creating a life-sustaining world.

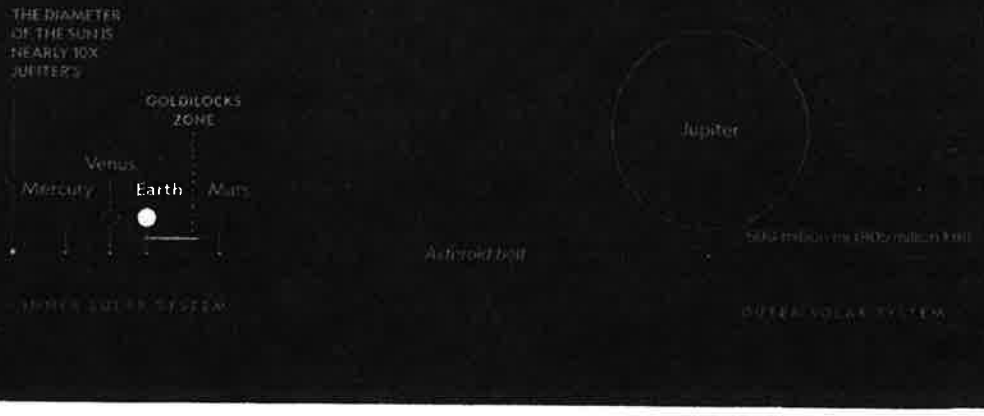
7 We're situated safely away from gas giants

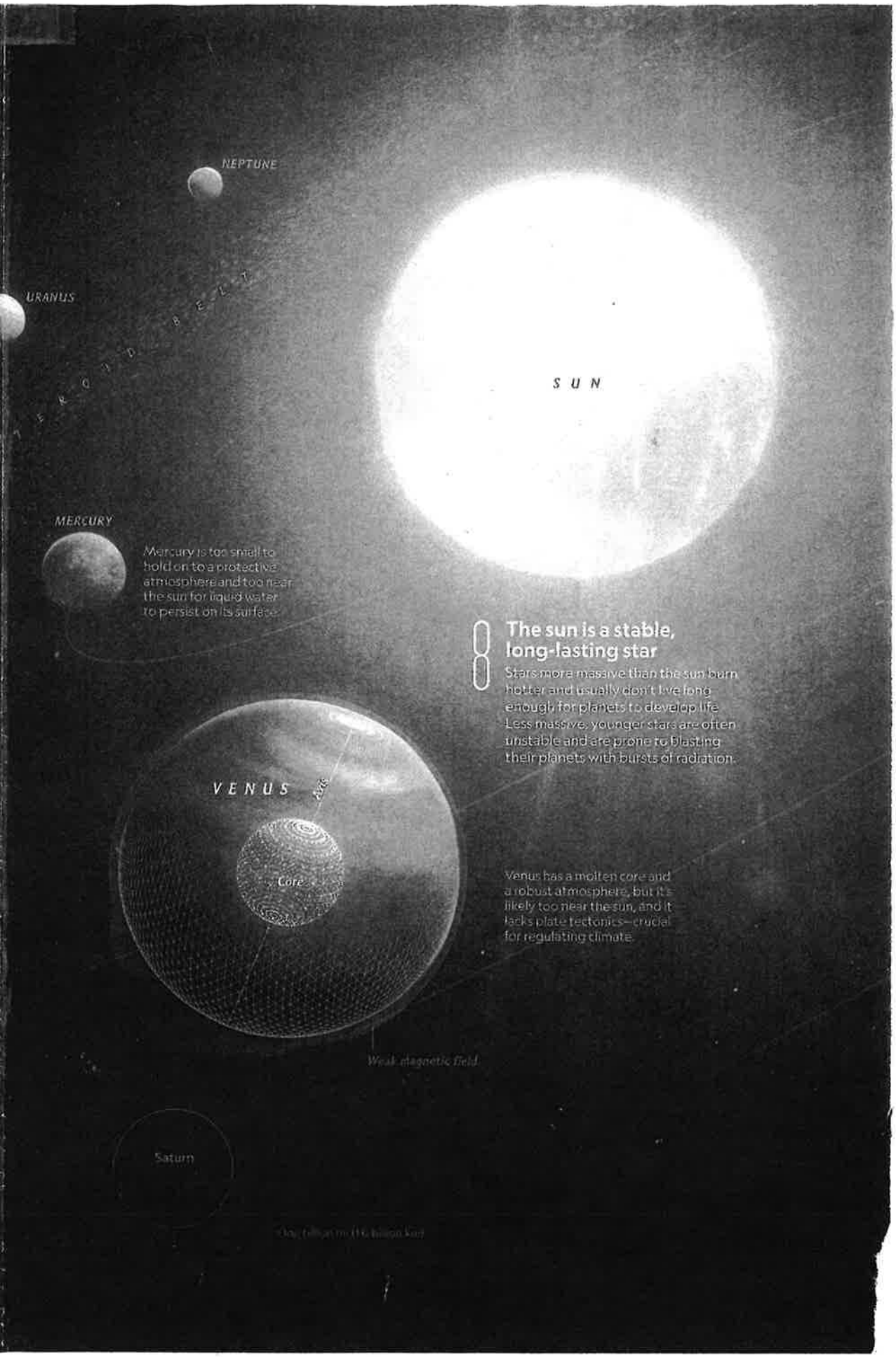
If the orbits of the solar system's biggest planets were much closer, tugs from their powerful gravity could cause disastrous fluctuations in Earth's distance from the sun.

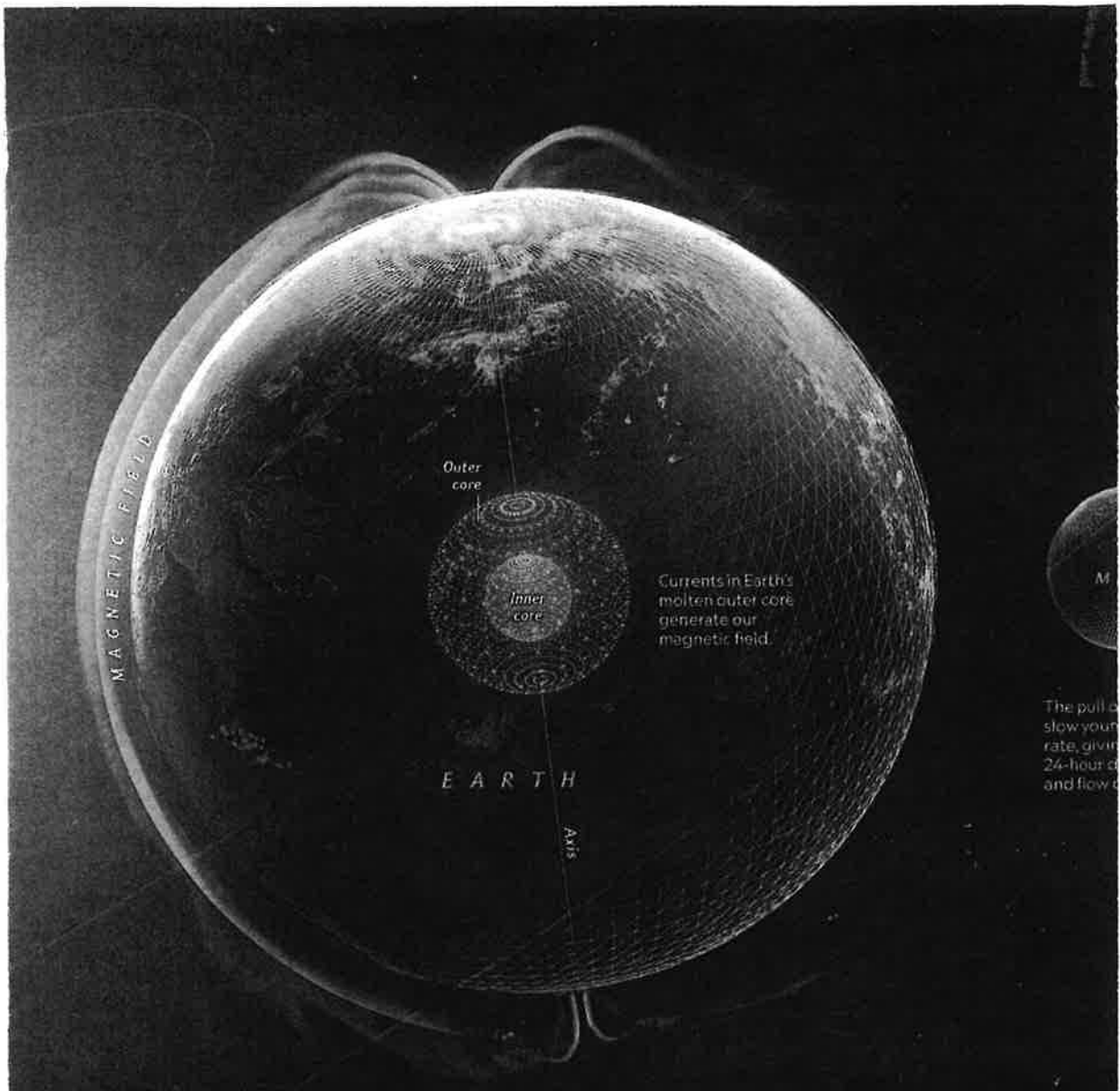
8 We're at just the right distance from the sun

Earth orbits in the so-called Goldilocks zone, where it's not too close and not too far from the sun for water to be liquid on its surface.

Planets in the diagram below are drawn to scale. Planetary distances are scaled separately.

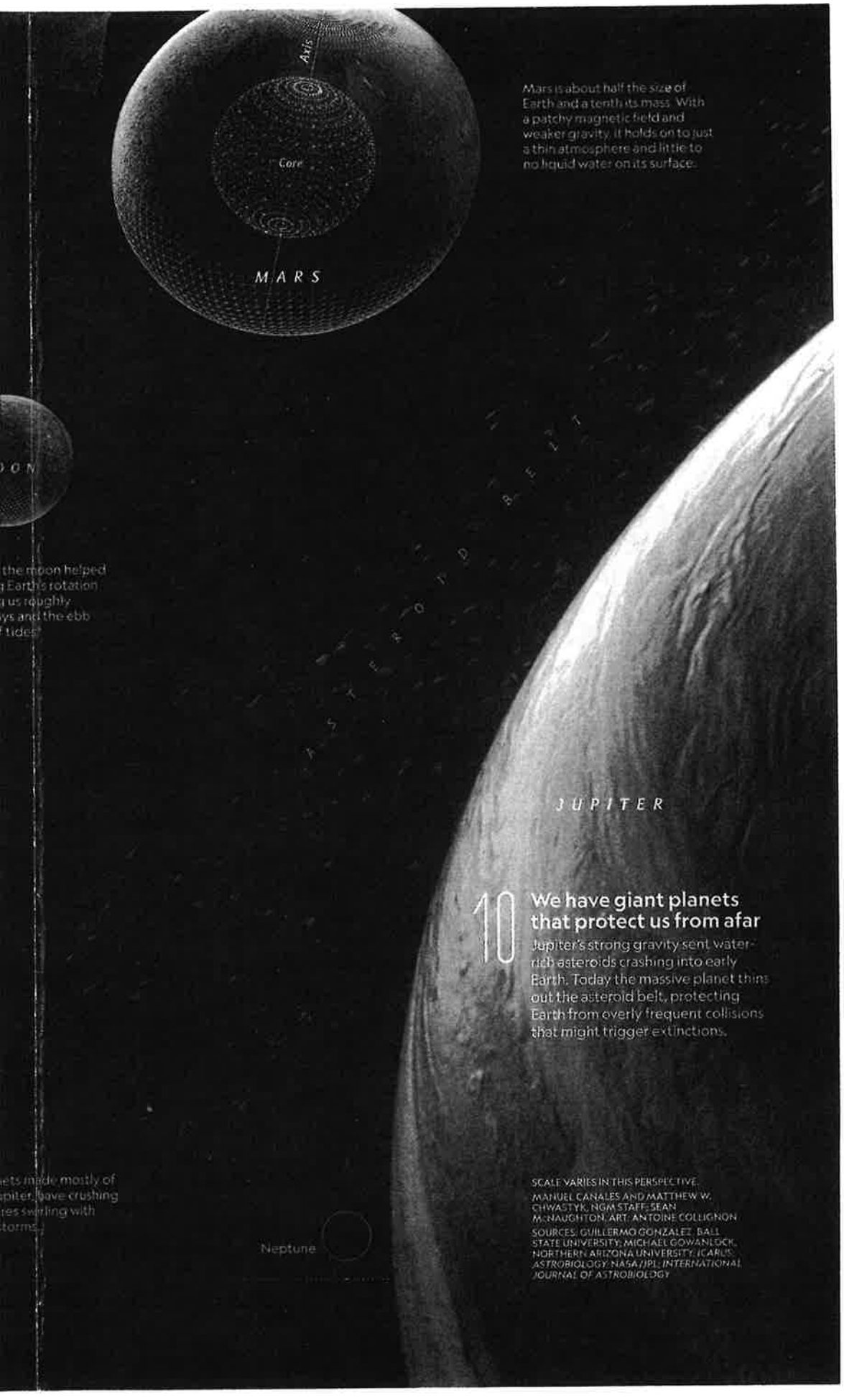



NEPTUNE
URANUS
ASTEROID BELT
SUN
MERCURY
Mercury is too small to hold on to a protective atmosphere and too near the sun for liquid water to persist on its surface.
8
The sun is a stable, long-lasting star
Stars more massive than the sun burn hotter and usually don't live long enough for planets to develop life. Less massive, younger stars are often unstable and are prone to blasting their planets with bursts of radiation.
VENUS
Core
Venus has a molten core and a robust atmosphere, but it's likely too near the sun, and it lacks plate tectonics—crucial for regulating climate.
Weak magnetic field
Saturn



9 We have the right stuff to host a dynamic core

The interstellar cloud of gas and dust that gave rise to Earth contained enough radioactive elements to power a churning core for billions of years. This creates a magnetic field that protects the planet from dangers like solar flares.



the moon helped
Earth's rotation
us roughly
ys and the ebb
tides.

ets made mostly of
piter. Wave crushing
res swirling with
storms.

10

We have giant planets that protect us from afar

Jupiter's strong gravity sent water-rich asteroids crashing into early Earth. Today the massive planet thins out the asteroid belt, protecting Earth from overly frequent collisions that might trigger extinctions.

SCALE VARIES IN THIS PERSPECTIVE.

MANUEL CANALES AND MATTHEW W. CHWASTYK, NGM STAFF; SEAN MCNAUGHTON, ART; ANTOINE COLLIGNON

SOURCES: GUILLERMO GONZALEZ, BALL STATE UNIVERSITY; MICHAEL GOWANLOCK, NORTHERN ARIZONA UNIVERSITY; *ICARUS*; *ASTROBIOLOGY*; NASA/JPL; *INTERNATIONAL JOURNAL OF ASTROBIOLOGY*

IN THE MILKY WAY

A SAFE LOCATION

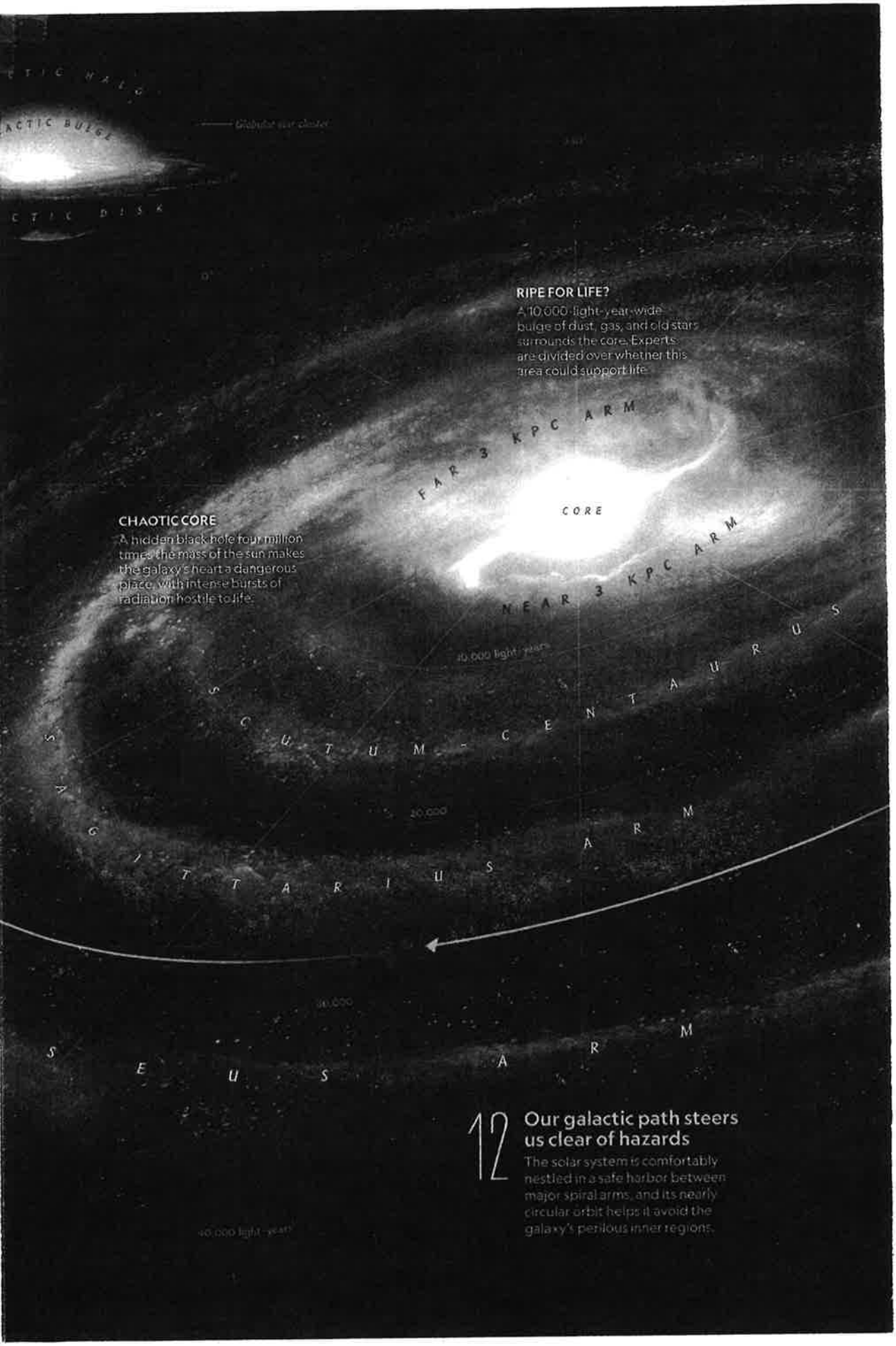
The Milky Way is a spiral galaxy with gracefully curving arms and a bright, central bar of stars passing through its core. To sustain life, planets embedded within the galaxy must avoid catastrophic threats such as close supernovae, gamma-ray bursts, and active black holes. They also can't be crowded in star clusters that would jostle them around too much. Luckily, Earth is in an ideal place for its inhabitants to thrive.

GALAXY HALO
Loose stars and some 150 dense stellar clusters orbit within the Milky Way's halo. Life-sustaining planets are unlikely here, because heavy elements are too sparse to build Earthlike worlds.

The Milky Way's arms are filled with hazards to habitability, including radioactive clouds, areas of active star formation, and sterilizing blasts from dying stars.

11 Our sun offers protection from galactic debris

The sun engulfs its planets in a bubble of charged particles that repel dangerous radiation and harmful materials coming from interstellar space.



12 Our galactic path steers us clear of hazards

The solar system is comfortably nestled in a safe harbor between major spiral arms, and its nearly circular orbit helps it avoid the galaxy's perilous inner regions.


Small, rocky planets like ours can't form without elements heavier than hydrogen and helium, which become less common at the far edges of the galaxy.
Direction of rotation
SAGITTARIUS ARM
PERSEUS ARM
ORION SPUR
YOU ARE HERE
SOLAR SYSTEM
SUN
13
Our location is far from stellar crowds
There are relatively few stars near the sun, reducing risks to Earth from gravitational tugs, gamma-ray bursts, or collapsing stars called supernovae.
MANUEL CANALES AND MATTHEW W. CHINATTI A. NOMSTAFF, SEAN MCNAUGHTON, ART: ANTOINE COLLIGNON
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