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Planetary Paparazzo
Carolyn Porco

With Saturn still in the spotlight, NASA's photographer of the solar system sets sight on her smallest big challenge yet: Pluto and the Kuiper belt objects

INTERVIEW BY **MAIA WEINSTOCK**
PHOTOGRAPHY BY **JASON MADARA**

Carolyn Porco is the imaging team leader for NASA's Cassini mission to Saturn and director of the Cassini Imaging Central Laboratory for Operations in Boulder, Colorado. She is also an imaging specialist for the New Horizons spacecraft, currently near the start of its nine-year voyage to Pluto and the Kuiper belt.

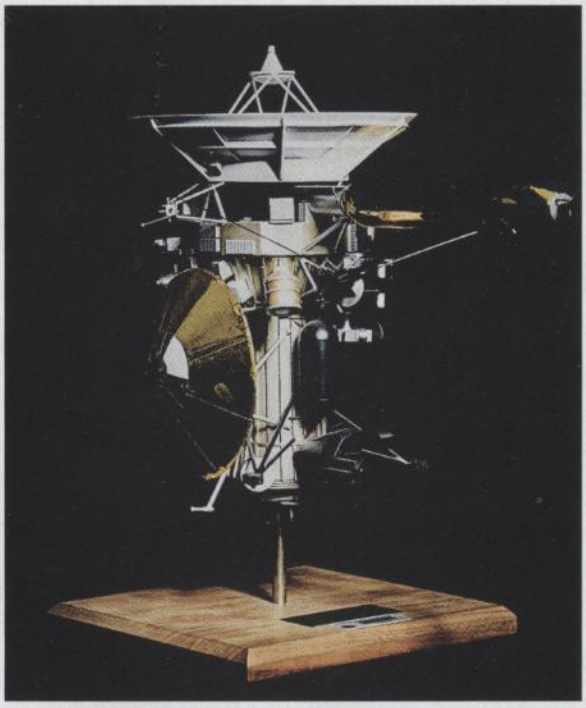
How did you get interested in planetary science?
I got started more or less on a spiritual quest. I read about Eastern religions, Hinduism, and Buddhism, even existentialism. I tried for a brief period of time to become very religious in the faith I was born into, which was Catholicism. At one point—it didn't take me very long—I just rejected the whole thing. I decided the answers were not there, and I started to look outward. I began questioning, literally, our cosmic circumstances. Where are we? What's out there? What is this great cosmos we live in? And that's how I got interested in astronomy. But it was the sight of Saturn with a telescope from a New York rooftop that clinched it for me.

Crescent Neptune shines behind Voyager 2, the only spacecraft to visit the eighth planet, in 1989. Carolyn Porco served on Voyager's imaging team during the mission's planetary encounters.

"With Cassini, we had to do many things in a hurry. It was crazy. To be frank, it's not the best way to run a project. You make yourself vulnerable to terrible mistakes."

What was it like working on the Voyager team?
Voyager was very special. It was a romantic adventure because we'd never been to the outer solar system before, at least not with the kind of instrumentation that Voyager carried. It was kind of mythic, almost Homeric. We spent years traveling through space. We got to one port of call, and there was this frenzy of activity, gathering information as quickly as possible, and then it was back into interplanetary space for years until the next port of call. It was an amazing privilege to be part of that.

How have interplanetary missions changed since Voyager?
Voyager was unusual in that there was, it seemed, plenty of money to support interplanetary exploration. We never really suffered from lack of funds the way we suffered on Cassini and the way many astronomy programs suffer these days. Programs today are really straining to do all that they're expected to do. With Cassini, we had to do many things in a hurry just before getting into orbit. It was crazy. To be frank, it's not the best way to run a project because you make yourself vulnerable to terrible mistakes.



A scale model of the school-bus-size Cassini-Huygens spacecraft sits in Porco's office at NASA. Opposite: A portrait of Jupiter, taken during the Cassini flyby in 2000, hangs outside her door.

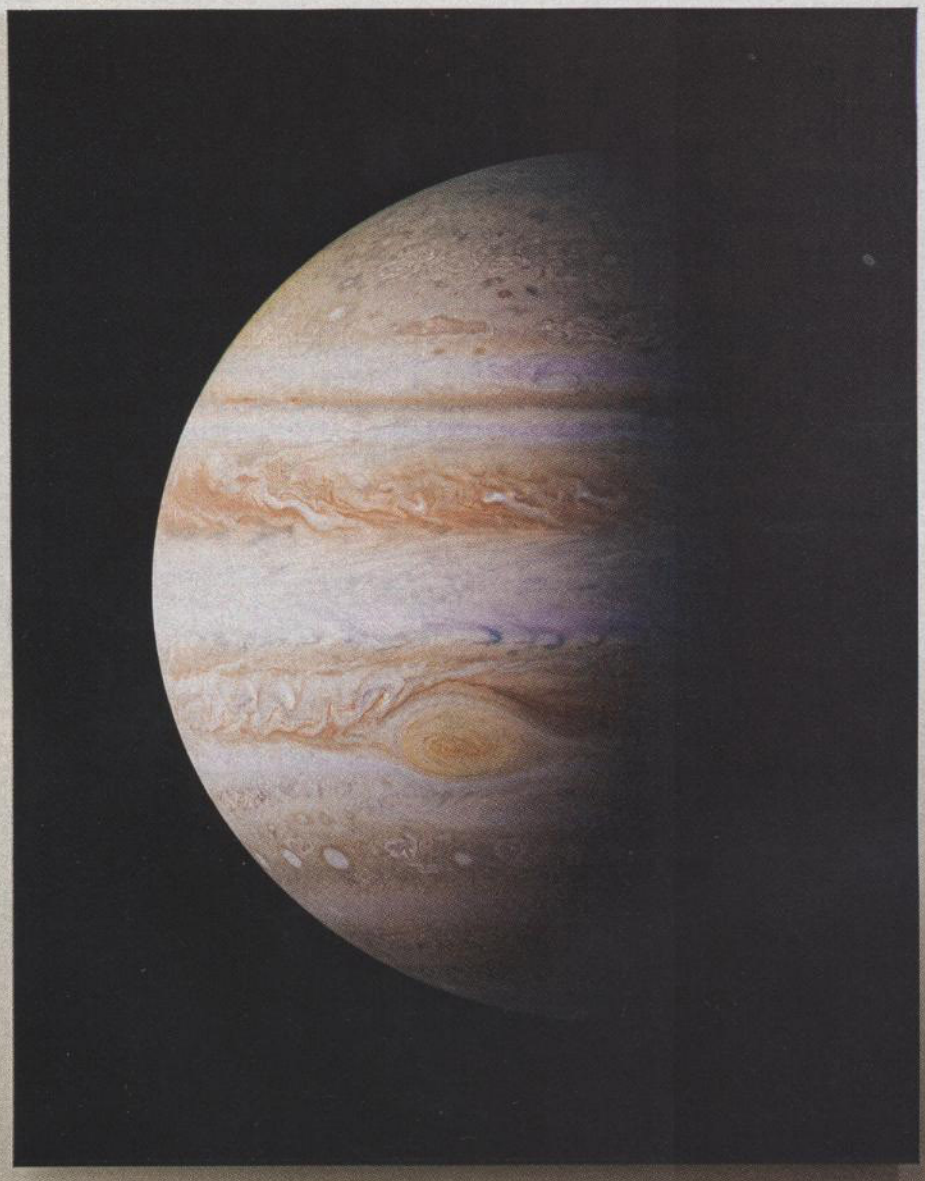
What are your thoughts on NASA's direction now?
I'm a firm believer in human spaceflight, and that can't be said for every planetary scientist. We are slowly but surely making our way into the solar system and eventually we'll make our way out. It's kind of our biological imperative. But I'm not in favor of conducting a human spaceflight program at the expense of the robotic program and of the scientific investigation of the solar system. You can have a robotic program without a human flight program but you can't do the opposite. We have to understand the environments we're sending people to. We can still do a great deal of the exploratory steps with robots. I'm a great believer in balance: I want to see both.

Is space exploration as expensive as people think?
Cassini has often been described as an expensive mission. But it's been going on, in round numbers, for 20 years. So if you take the money that we've spent on it and divide it by the 20 years, it turns out it's something like $160 million a year on average. That's like one opening weekend of a blockbuster movie. How can anyone call that expensive? It's expensive compared to the personal wealth of most people, but it's not an expensive endeavor.

What are Cassini's biggest successes?
Certainly our most astonishing result is the discovery of the geologic activity in the south polar region of Saturn's moon Enceladus, and the inference that the jets of material issuing from the warm south polar fractures are erupting from subterranean near-surface chambers of liquid water. At Enceladus we have excess warmth, organics, and possibly liquid water, all in one place. It means we have stumbled upon an extraterrestrial environment that is potentially suitable for living organisms. It's the kind of paradigm-overthrowing discovery that scientists long to make and that has the power to make great changes in what we do from here on. Also, the affirmation that the surface of Titan is, in some respects, as Earth-like as we had envisioned was a spectacular find. You can spend many an enjoyable hour imagining what it might be like to fly over the surface of Titan.

Do you think NASA will extend the mission as they did with Galileo?
It would be colossally shortsighted for NASA and Congress to halt the Cassini mission in 2008 when it has been one of the most phenomenally successful endeavors we've ever undertaken. The problem is going to be funding. I think they will make the right decision and give us the go-ahead to continue.

The New Horizons spacecraft launched successfully in January. Why did it take so long for NASA to go to Pluto and the Kuiper belt?
The Pluto mission fell through the cracks in many of the deliberations that had been going on at NASA for years. On again, off again, on again, off again. I was the vice chair of the Solar System Decadal Survey Committee that was called together to deliberate on this particular issue: What do planetary scientists want to do? Do they want to go to Pluto? Do they want to go to Europa? One of our highest priorities was to conduct a mission to the Kuiper belt because it was a newly discovered region, although it had been hypothesized decades before. It's kind of the hinterlands of the solar system beyond the major planets. Many of the bodies there are believed to have formed at the same time that the planets formed. Also, it's the place where short-period comets come from, so we will get a chance to see what the primeval materials of the solar system were like. That's important because all the stuff close to the sun is altered. Also there was this large element of romance. We wouldn't be able to complete our reconnaissance of our solar system until we had investigated the Kuiper belt and Pluto as its main prototypical member.



What is your feeling about the new definition of a planet?
The International Astronomical Union got the right answer. The original proposal of defining a body as a planet based on its shape—round or not round—was observationally unverifiable for many of the bodies that might be discovered in the future, since in most cases we can't be certain what shape a body in the Kuiper belt is. The whole affair has been a brilliant demonstration of discipline of the scientific process. It may make people sad that we "lost" a planet. But reason prevailed in this decision, as it should.

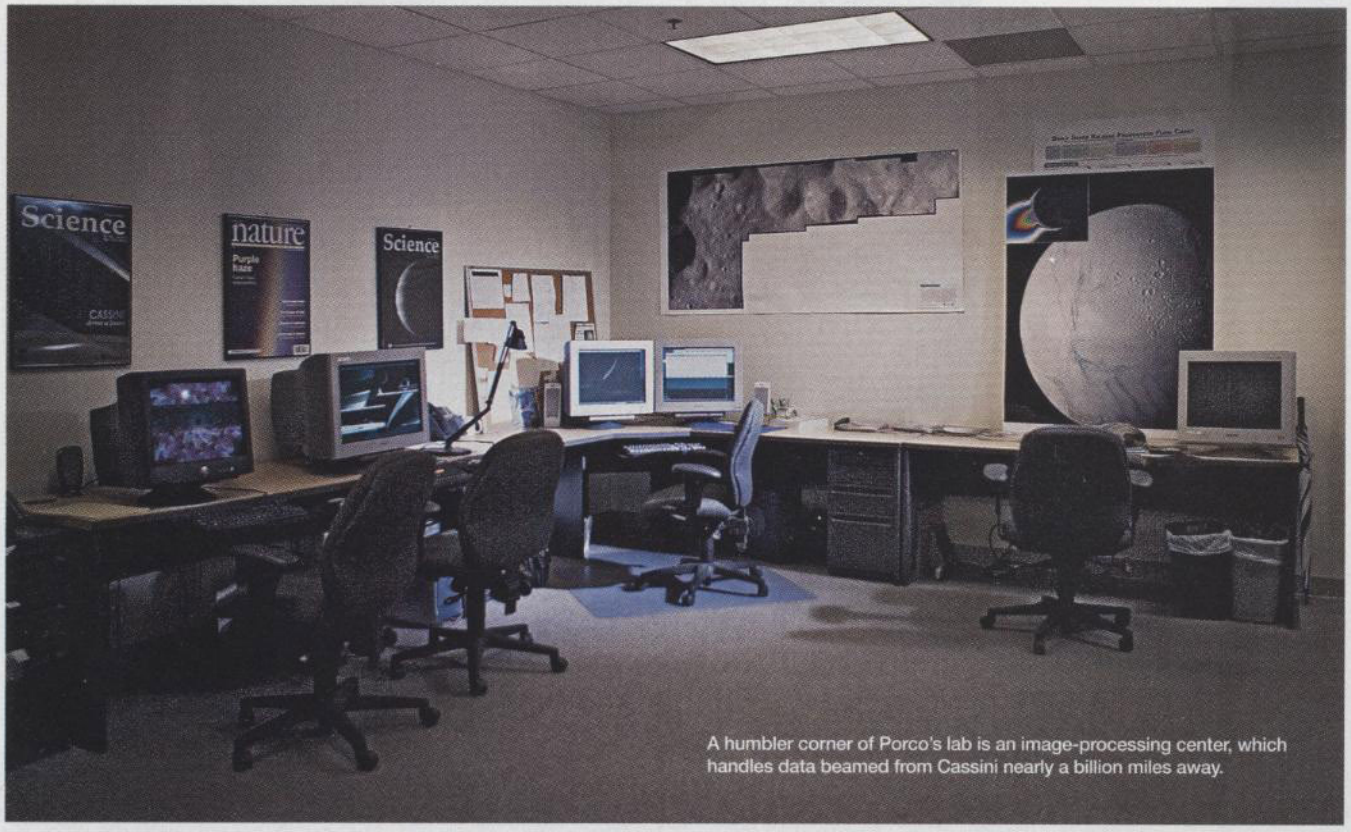
How does this new status affect the New Horizons mission?
It has no effect on the New Horizons mission whatsoever. Pluto is not a planet, but it is no less interesting than it was before. The scientific significance of Pluto and Charon, as members of a vast belt of material out beyond the orbit of Neptune, remains the same.

You have an asteroid named after you (asteroid 7231 Porco). How did that happen?
Many planetary scientists have asteroids named after them. But in my case it was an honor that was bestowed on me by Carolyn Shoemaker, because I succeeded in getting her husband's ashes to the moon [in 1999, on the Lunar Prospector mission]. I was thrilled. I can go on the Web and see where its orbit is. It's at a pretty stable orbit, but I like telling everybody: Don't piss me off, or I'll get it redirected!

What's it like being a woman in a field dominated by men?
Women have won the strategic battles. All the laws are in place to make sure that we don't get abused with gender bias and so on. But it's the tactical battles that are difficult for women. The way science is conducted is very combative. It's all done within the male culture: one-upmanship and "I'm smarter than you." At least in my day, women were not supposed to be aggressive. We were supposed to be cooperative and compliant. We were told all those things that don't help us win battles in these arenas where scientific discourse takes place. If a man behaves aggressively, he's a stud, he's admired. If a woman behaves that way, people are shocked. It turns people off. It's different cultural expectations that we are up against. I definitely feel that people have behaved toward me in ways that I did not see them behave toward male leaders. But it's something that I had to get used to.

It's been shown that girls do just as well as boys through high school in math and science. So what turns them away from careers in math and science?
Scientists have a reputation for being nerdy and ugly, with thick big glasses. It's not a cool thing to be. This is true for boys too. When they're young, they're so pressured to conform and to be cool, so you have to be a pretty strong individual to start with. I was so uncool it didn't even matter. I was always doing my own thing.

What are you most proud of?
That we pulled off the Cassini mission. I am so proud of every last one of our images. They are such incomparable planetary vistas. That's going to be my best legacy, all those beautiful images. Another thing I'm very proud of is how scientifically productive our experiment has been. We went there to learn about the bodies in the Saturn system, and that's exactly what we've done. I'm also proud of our European colleagues for their successes with the Huygens probe. I used to think that the leader was the guy who made sure everybody else was on track. On this mission, I've had to be very hands on, very much in the trenches with the troops. I didn't have the luxury to do otherwise. I feel now I could be a general in an army after having this kind of training. I feel like I could do anything. ■



A humbler corner of Porco's lab is an image-processing center, which handles data beamed from Cassini nearly a billion miles away.

FLOATING FREE Just one of Saturn's dozens of moons, Dione drifts in front of the multihued cloud bands of the planet's northern hemisphere in this image from Cassini's wide-angle camera. Dione always shows the same face to Saturn, but crater patterns suggest that it once bared the opposite face.

Solar System Confidential

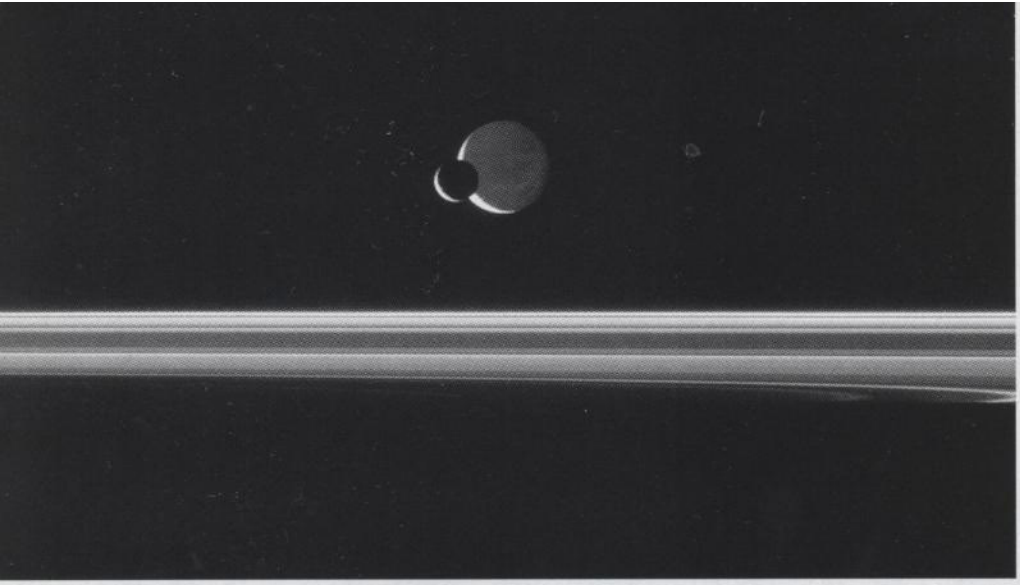
BY **KATHY A. SVITIL**

Dramatic new images reveal the true faces of nearby planets and their moons. The big surprise: Earth-like landscapes and weather are turning up in some of the most unexpected places

As astronomers get a much closer look at our neighbors in the solar system, they are developing an unnerving sense of déjà vu. In data beamed from spacecraft like the Mars rovers, the Mars Global Surveyor, and Cassini, they see hints of our own planet just about everywhere. The dusty, windswept, and once wet surface of Mars looks strikingly like parts of Arizona. Saturn's moon Titan has a multihued atmosphere and riverlike flows of frozen methane that make it a near twin of early Earth. Turns out the "alien" landscapes of our solar system and of the cosmos beyond could be a lot more like home than we ever dreamed.

Unlike 2003, which saw the launch of the phenomenally successful Mars Exploration Rover mission, and 2005, when Cassini began its spectacular tour of Saturn's neighborhood and the Deep Impact probe slammed headlong into a comet, few start-up missions grabbed headlines this year. New Horizons set off for Pluto, but the exciting part is still a decade away. This was instead a year of perseverance: The rovers carried on with their indefatigable treks, traversing new landforms and capturing microscopic images of rock patterns created by lava and water and wind, plus stark panoramas of desolate terrain; the Mars Global Surveyor beamed back high-resolution images from its orbit above the planet; and Cassini continued to loop around Saturn and its moons.

Nonetheless, we have been surprised. Take Mars, for example: The European Space Agency's Mars Express spacecraft detected ephemeral carbon dioxide clouds more than 60 miles above the planet, the farthest ever from a planetary surface. NASA's Mars Odyssey probe, from an orbit 400 miles up, spied unexpected activity: geysers of icy carbon dioxide, sand, and dust spewing from the planet's south pole. Two worlds away, at Saturn, Cassini discovered pools of liquid hydrocarbons in Titan's polar regions, lakes that are the source of the moon's dense, smoggy atmosphere. At Titan's equator, Cassini spotted long, dark dunes, some stretching for a thousand miles, built up over eons as hydrocarbons raining down from the sky were whipped into shape by persistent winds. At their edges, the dunes give way to hills, valleys, and river channels, all strikingly reminiscent of earthly geology.

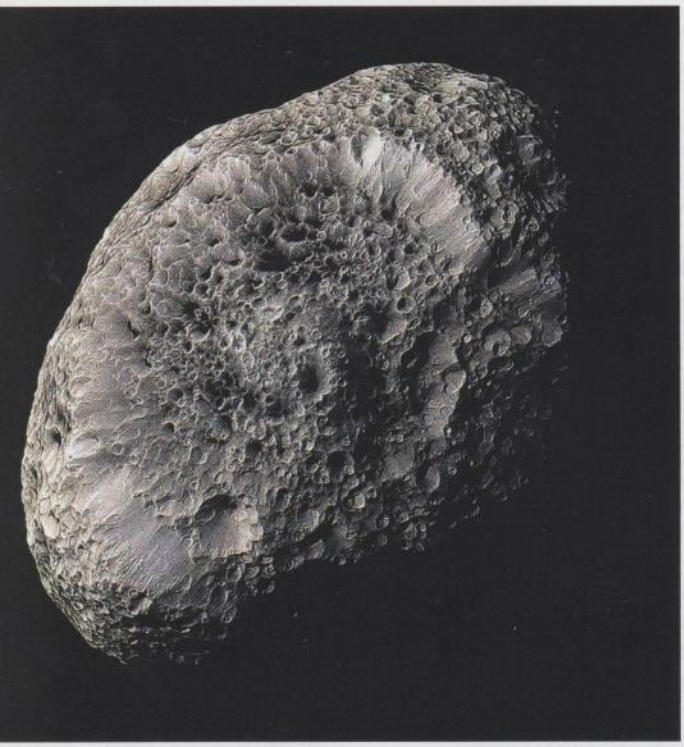


GLIDING BY In the vastness of space, distances can be difficult to gauge, particularly from certain vantage points. In this image captured by the Cassini spacecraft's narrow-angle camera in July 2006, Saturn's small moon Mimas, a low-density ball composed mostly of frozen water, appears barely to squeak by larger Dione—the second densest of the ringed planet's moons. In reality, the moons are separated by some 400,000 miles and are "passing" each other from orbital positions on opposite sides of Saturn.

Yet Cassini's most significant find occurred near the south pole of Saturn's icy moon Enceladus. There, the probe found hints of subterranean reservoirs of liquid water. The water, scientists suspect, is located close to the surface and seems to be associated both with a source of heat and with organic molecules. This raises the stunning possibility that Enceladus possesses the three key ingredients for life, a combination we've seen nowhere else in the universe so far, except Earth.

While we have been busy gazing at moons that seem a lot like planets, in August an international group of astronomers defined, for the first time, exactly what a planet is: an object orbiting the sun that is massive enough to be pulled into a sphere by its own gravity and that can knock smaller objects out of its orbital path. Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune fit the description. But Pluto, just one of many thousands of objects of similar size and composition that make up the Kuiper belt at the outer edge of the solar system, has not cleared its path of debris. Pluto will now be called a dwarf planet, like 2003 UB313 (known first as Xena, now officially as Eris), the slightly larger ice ball initially labeled a tenth planet when it was discovered in the Kuiper belt in January 2005.

Does it matter what Pluto is called? Not really. Its demotion may have been jarring to the public, and some scientists are disputing the decision, but it changes nothing. The planets, however many there are, tirelessly circle the sun in silent indifference to the curious eyes of humanity.



LOOFAH MOON Potato-shaped Hyperion, Saturn's tumbling moon, was snapped by Cassini's camera during a close flyby in September 2005. The largest irregularly shaped satellite in the solar system, Hyperion may have broken off a larger object during an impact. This view was created by combining images taken through ultraviolet, green, and infrared filters; the moon's natural reddish hues were toned down to enhance the color contrast. Subtle color changes across the surface may indicate variations in surface materials.

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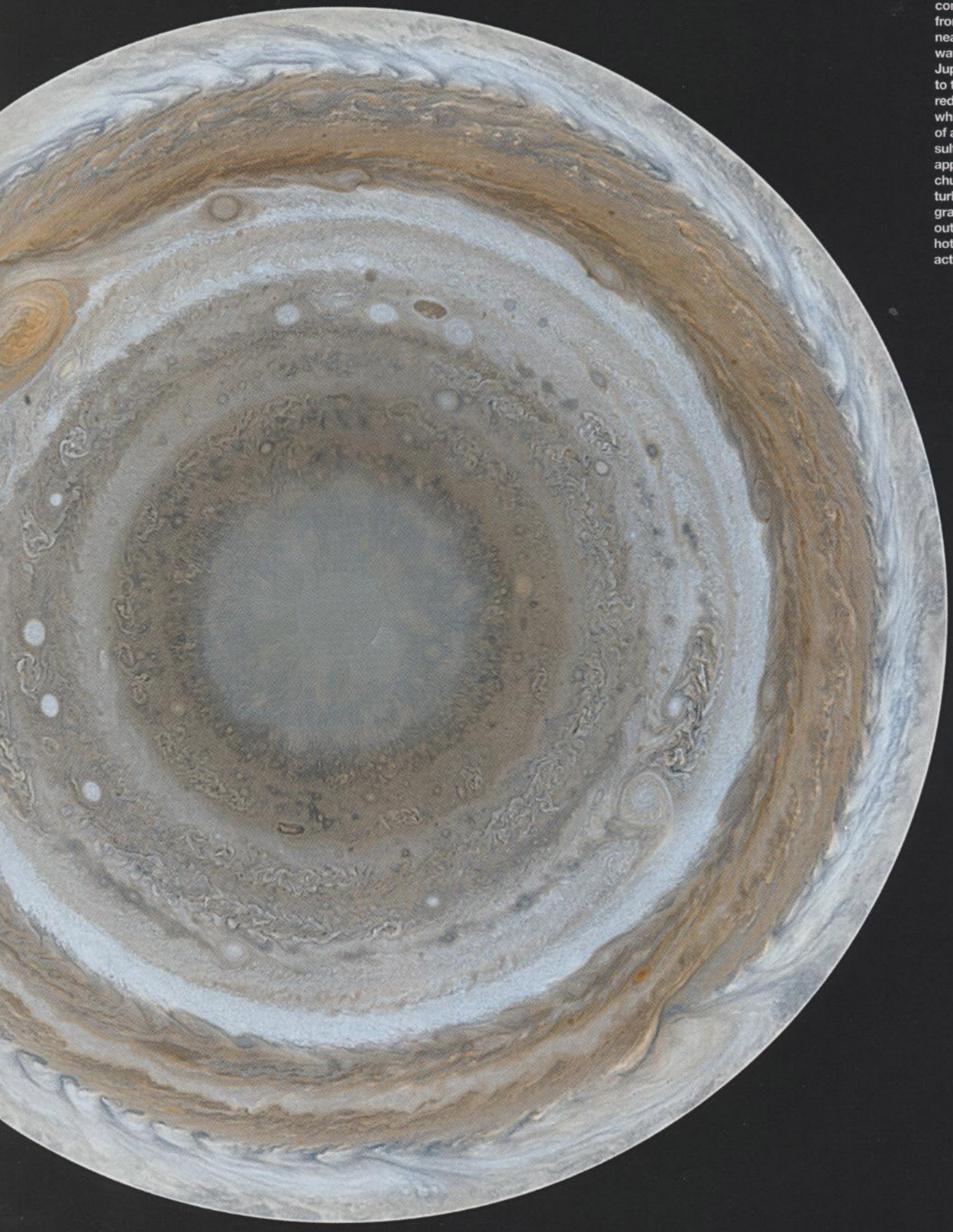
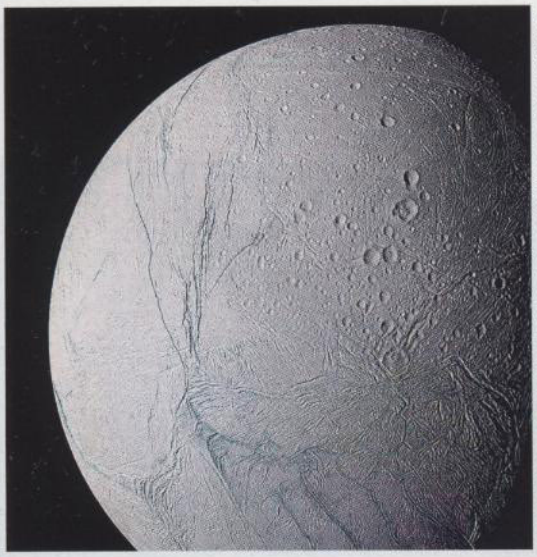
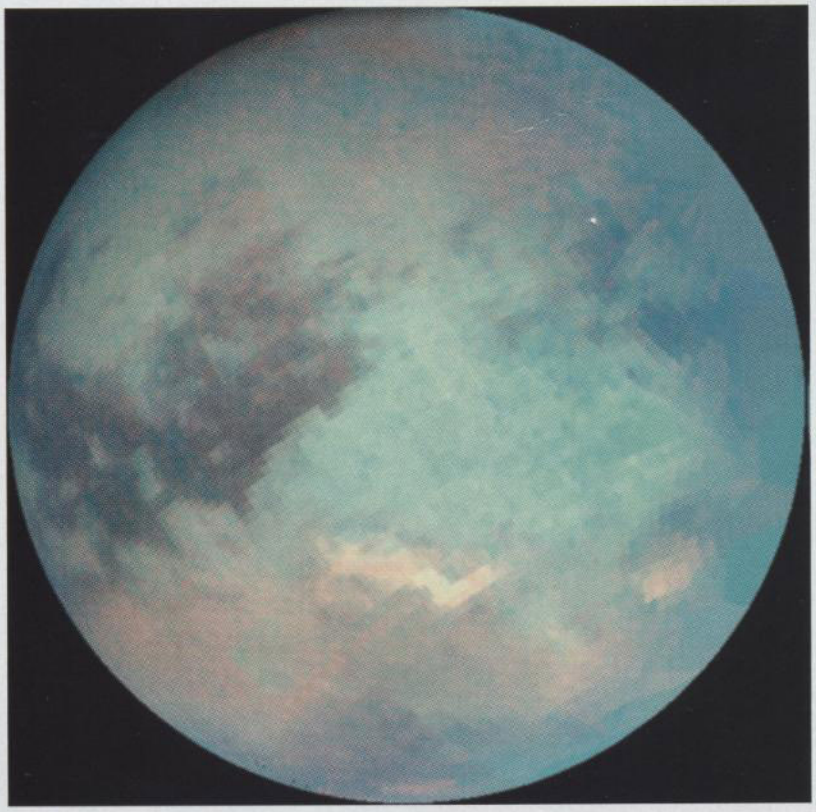


ON END Jupiter's south pole, impossible to view in its entirety from Earth, was captured by Cassini in December 2000. This composite shot comes from 36 images taken in near-infrared and blue wavelengths. It shows Jupiter as it would appear to the human eye. The reddish-brown and white bands are clouds of ammonia, hydrogen sulfide, and water, which appear streaked due to churning by Jupiter's turbulent winds. The bluish-gray features edging the outermost white band are hot spots of meteorological activity near the equator.



RING SHADOW Saturn's rings cast dark bands on the planet in this Cassini view, taken from a distance of 621,000 miles. Images captured with blue, green, and red filters were combined and then brightened to produce a portrait very close to what the human eye would see. The shifting of Saturn's hues, from familiar golds to less commonly seen blues, is not well understood. The blue colors may be tied to cold temperatures in the northern hemisphere, now in the throes of winter and shielded from the sun by the rings' shadows.

MOON ALIVE Ongoing geological activity is evident on Saturn's icy moon Enceladus. A high-resolution enhanced-color mosaic of the satellite's southern hemisphere (above left) reveals striking blue fractures along with folds and ridges indicative of a dynamic surface. Cassini's instruments discovered fine sprays of ice emanating from the fractured terrain, apparently shot out by geysers near Enceladus's south pole. During a July 2005 flyby, Cassini zipped within 129 miles of Enceladus's surface to snap high-resolution shots (right) that bring the tortured terrain into sharp focus.



EARTH'S WEIRD TWIN Titan, as large as Mercury and blanketed in a thick atmosphere, may resemble the early Earth in a deep freeze. This infrared Cassini image is processed in false color to highlight details. Tui Reggio, the brightest region, may be flecked with frozen water and carbon dioxide spewed by an ice volcano. Dark areas may be dunes of hydrocarbon particles that rain down from Titan's atmosphere.

CLOCKWISE FROM LEFT: COURTESY OF NASA/JPL/SPACE SCIENCE INSTITUTE (3); COURTESY OF NASA/JPL/UNIVERSITY OF ARIZONA.