10 cool things we learned about Pluto from New Horizons

July 15 2020, by Tricia Talbert

Enhanced color global view of Pluto, taken when NASA's New Horizons spacecraft was 280,000 miles (450,000 kilometers) away. Credit: NASA/JHUAPL/SwRI

Five years ago today, NASA's New Horizons spacecraft made history. After a voyage of nearly 10 years and more than 3 billion miles, the intrepid piano-sized probe flew within 7,800 miles of Pluto. For the first time ever, we saw the surface of this distant world in spectacular, colored detail.

The encounter—which also included a detailed look at the largest of Pluto's five moons, Charon—capped the initial reconnaissance of the planets started by NASA's Mariner 2 more than 50 years before, and revealed an icy world replete in magnificent landscapes and geology—towering mountains, giant ice sheets, pits, scarps, valleys and terrains seen nowhere else in the solar system.

And that was only the beginning.

In the five years since that groundbreaking flyby, nearly every conjecture about Pluto possibly being an inert ball of ice has been thrown out the window or flipped on its head.

"It's clear to me that the solar system saved the best for last!" said Alan Stern, New Horizons principal investigator from the Southwest Research Institute, Boulder, Colorado. "We could not have explored a more fascinating or scientifically important planet at the edge of our solar system. The New Horizons team worked for 15 years to plan and execute this flyby and Pluto paid us back in spades!"

Scientists now know that, despite it being literally out in the cold, Pluto

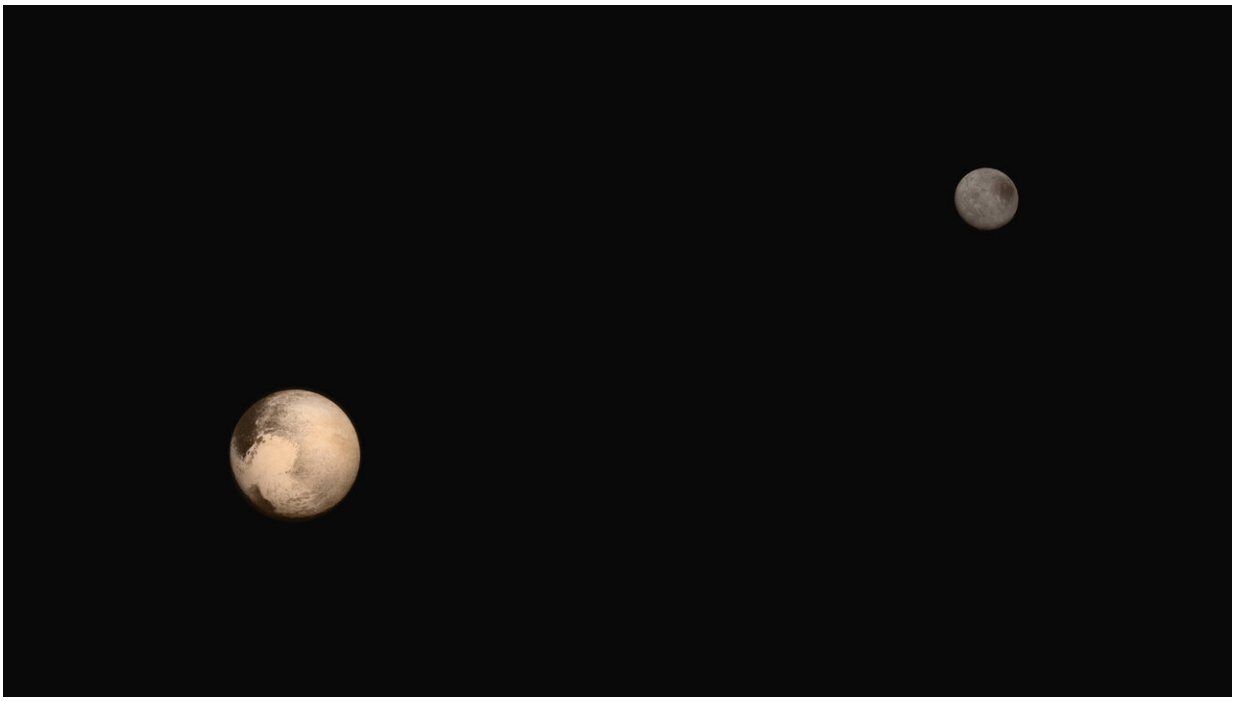
is an exciting, active and scientifically valuable world. Incredibly, it even holds some of the keys to better understand the other small planets in the far reaches of our solar system.

Here are 10 of the coolest, weirdest and most unexpected findings scientists about the Pluto system that scientists have learned since 2015, thanks to data from New Horizons.

1. Pluto has a "heart," and it drives activity on the planet

Sometimes you just have to follow your heart, and Pluto seems to have taken that advice quite literally.

Pluto's heart—one of the signature features New Horizons observed on approach and imaged in high resolution during the flyby—is a vast, million-square-mile nitrogen glacier. The heart's left ventricle, called Sputnik Planitia, literally forced the dwarf planet to reorient itself so the basin now faces almost squarely opposite Pluto's moon Charon.



Natural-color view of Pluto and its large moon Charon, compiled from images taken by NASA's New Horizons spacecraft on July 13 and 14, 2015. Credit: NASA/JHUAPL/SwRI

"It's a process called true polar wander—it's when a planetary body changes its spin axis, usually in response to large geologic processes," said James Tuttle, a planetary scientist and New Horizons team member at the Jet Propulsion Laboratory in Pasadena, California.

Sputnik Planitia's current position is no accident. It's a cold trap, where nitrogen ices have accumulated to make an ice sheet that's at least 2.5 miles (4 kilometers) thick. The constant imbalance of that hefty mass, combined with the tidal yanks and pulls of Charon as it orbited Pluto, literally tipped the dwarf planet so the basin aligned more closely with the tidal axis between Pluto and Charon.

"That event was also likely responsible for cracking Pluto's surface and creating the many gigantic faults in its crust that zigzag over large portions of Pluto," Tuttle said.

The basin is thought to have formed to the northwest of its present location, and closer to Pluto's north pole. And should ices continue to accumulate on the basin, Pluto will continue to reorient itself.

But there's more to that story…

2. There's probably a vast, liquid, water ocean sloshing beneath Pluto's surface

Gathered ices may not be the only thing that helped reorient Sputnik Planitia. New Horizons data from the basin indicated there may be a heavier mass beneath it that played a part, and scientists suspect that the heavier mass is a water ocean.

"That was an astonishing discovery," Tuttle said. "It would make Pluto an elusive 'ocean world," in the same vein as Europa, Enceladus and Titan." Several other lines of evidence, including tectonic structures seen in New Horizons imagery, also point to an ocean beneath Pluto's crust.

Sputnik Planitia was likely created some 4 billion years ago by the impact of a Kuiper Belt object 30 to 60 miles (50 to 100 kilometers) across that carved out a massive chunk of Pluto's icy crust and left only a thin, weak layer at the basin's floor. A subsurface ocean likely intruded the basin from below by pushing up against the weakened crust, and later the thick of nitrogen ice seen there now was laid on top.

Recent models based on images of the planet suggest that this liquid ocean may have arisen from a rapid, violent formation of Pluto.

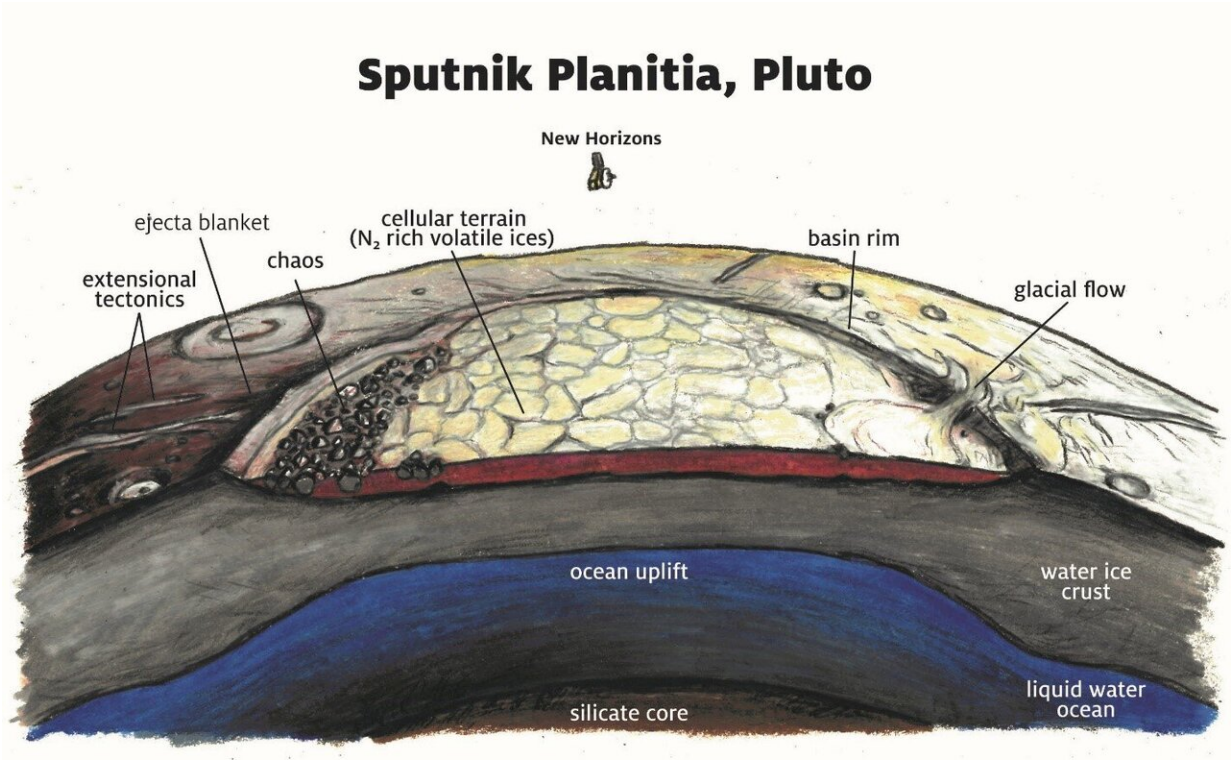


Illustration of Sputnik Planitia at Pluto. Credit: James Tuttle Keane

3. Pluto may still be tectonically active because that liquid ocean is still liquid

Enormous faults stretch for hundreds of miles and cut roughly 2.5 miles into the icy crust covering Pluto's surface. One of the only ways scientists reason Pluto got those fissures, though, is by the gradual freezing of an ocean beneath its surface.

Water expands as it freezes, and under an icy crust, that expansion will push and crack the surface, just like an ice cube in your freezer. But if the temperature is low enough and the pressure high enough, water crystals can start to form a more compact crystal configuration and the

ice will once again contract.

Models using New Horizons' data showed Pluto has the conditions for that type of contraction, but it doesn't have any known geologic features that indicate that contraction has occurred. To scientists, that means the subsurface ocean is still in the process of freezing and potentially creating new faults on the surface today.

"If Pluto is an active ocean world, then that suggests that the Kuiper Belt may be filled with other ocean worlds among its dwarf planets, dramatically expanding the number of potentially habitable places in our solar system," Tuttle said.

But while Pluto's liquid ocean likely still exists today, scientists suspect it's isolated in most places (though not beneath Sputnik) by almost 200 miles (320 kilometers) of ice. That means it probably doesn't contact the surface today; but in the past, it may have oozed through volcanic activity called cryovolcanism.

4. Pluto was—and still may be—volcanically active

But maybe not "volcanic" in the way you might think.

On Earth, molten lava spits, drools, bubbles, and erupts from underwater fissures through volcanoes sitting miles high in and protruding from the oceans, like on Hawaii. But on Pluto, there are numerous indications that a kind of cold, slushy cryolava has poured over the surface at various points.

Scientists call that "cryovolcanism."

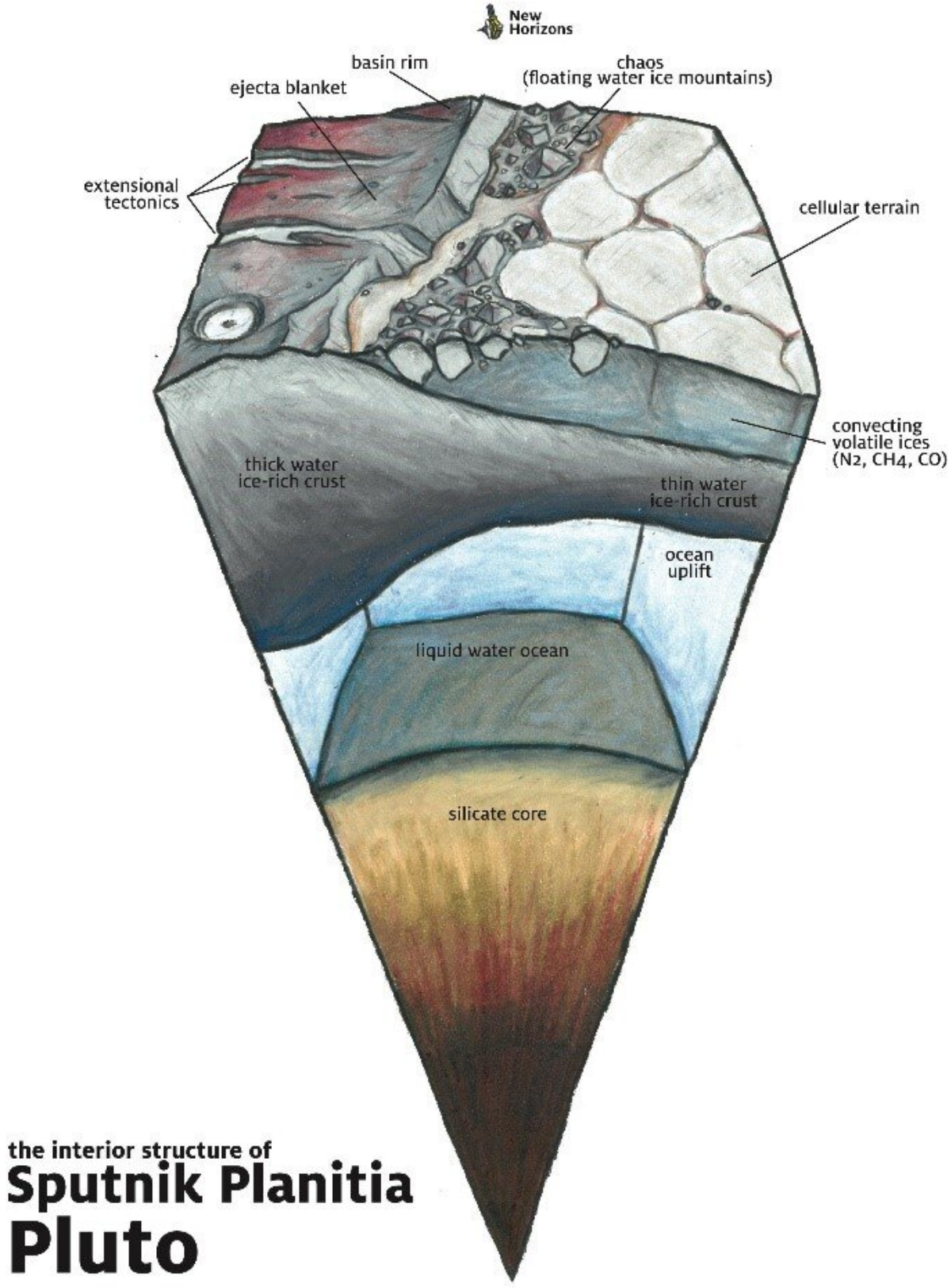

New Horizons
basin rim
ejecta blanket
chaos
(floating water ice mountains)
extensional tectonics
cellular terrain
convecting volatile ices (N2, CH4, CO)
thick water ice-rich crust
thin water ice-rich crust
ocean uplift
liquid water ocean
silicate core
the interior structure of
Sputnik Planitia
Pluto

Illustration of the interior structure of Sputnik Planitia at Pluto. Credit: James Tuttle Keane

Wright Mons and Piccard Mons, two large mountains to the south of Sputnik Planitia, each bear a deep central pit that scientists believe are likely to be the mouths of cryovolanoes unlike any others found in the solar system.

To the west of Sputnik sits Viking Terra, with its long fractures and grabens that show evidence of once-flowing cryolavas all over the surface there too.

And farther west of Sputnik Planitia is the Virgil Fossae region, where ammonia-rich cryolavas seem to have burst to the surface and coated an area of several thousand square kilometers in red-colored organic molecules no more than 1 billion years ago, if not even more recently.

And speaking of recently…

5. Glaciers cut across Pluto's surface even today, and they've done so for billions of years

Pluto joins the ranks of Earth, Mars, and a handful of moons that have actively flowing glaciers.

East of Sputnik Planitia are dozens of (mostly) nitrogen-ice glaciers that course down from pitted highlands into the basin, carving out valleys as they go. Scientists suspect seasonal and "mega-seasonal' cycles of nitrogen ices that sublimate from ice to vapor, waft around the dwarf planet and then freeze back on the surface are the source of the glaciers ice.

But these glaciers are not like our own water-ice glaciers here on Earth. For one, any melt within them won't fall toward the bottom of the glacier—it will rise to the top, because liquid nitrogen is less dense than solid nitrogen. As that liquid nitrogen emerges on top of the glacier, it potentially even erupts as jets or geysers.

Additionally, there is the fact that some of Pluto's surface is composed of water ice, which is slightly less dense than nitrogen ice. As Pluto's glaciers carve the surface, some of those water-ice "rocks" will rise up through the glacier and float like icebergs. Such icebergs are seen in several New Horizons images of Sputnik Planitia the largest of Pluto's known glaciers, which stretches more than 620 miles (1,000 kilometers) across—about the size of Oklahoma and Texas combined.

This detailed image of the glaciers in Pluto's Sputnik Planitia, about 50 miles wide, shows thousands of pits in its surface of nitrogen ice as well as larger circulation patterns. Scientists suspect the "Islands" are floating bergs of water ice, or perhaps the tips of ice mountains. Credit: NASA/JHUAPL/SwRI

6. Pluto has heat convection cells on its giant glacier Sputnik

Zoom in close to the surface of Sputnik Planitia and you'll see something unlike anywhere else in the solar system: a network of strange polygonal

shapes in the ice, each at least 6 miles (10 kilometers) across, churning on the surface of the glacier.

Although they resemble cells under a microscope, these aren't; they're evidence of Pluto's internal heat trying to escape from underneath the glacier, and forming bubbles of upwelling and downwelling nitrogen ice, something like a hot lava lamp.

Warm ice rises up into the center of the cells while cold ice sinks along their margins. There's nothing like it in any of Earth's glaciers, and or anywhere else in the solar system that we've explored!

7. Pluto has a beating "heart" that controls its atmosphere and climate

Cold and far-flung as Pluto may be, its icy "heart" still beats to a daily, rhythmic drum that drives Pluto's atmosphere and climate much in the way Greenland and Antarctica help control Earth's climate.

Nitrogen ices in Pluto's heart-shaped Tombaugh Regio go through a cycle every day, subliming from ice to vapor in the daytime sunlight and condensing back on the surface during the frigid night. Each round acts like a heartbeat, driving nitrogen winds that circulate around the planet at up to 20 mph.

"Pluto's heart actually controls its atmosphere circulation," punned Tanguy Bertrand, a planetary scientist at NASA Ames Research Center in Mountain View, California.

Sophisticated weather forecast models Bertrand has created using New Horizons data show that as these ices sublime in the northern reaches of Pluto's icy heart and freeze out in the southern part, they drive brisk

winds in a westward direction—curiously opposite Pluto's eastward spin.

Those westward winds, bumping up against the rugged topography at the fringes of Pluto's heart, explain why there are wind streaks on the western edge of Sputnik Planitia, a remarkable finding considering Pluto's atmosphere is only 1/100,000th that of Earth's, Bertrand said. They also explain some other surprising desert-like features…

Scientists from NASA’s New Horizons mission used state-of-the-art computer simulations to show that the surface of Pluto’s Sputnik Planitia is covered with churning ice "cells" that are geologically young and turning over due to a process called convection. Credit: NASA/JHUAPL/SwRI

8. Pluto has dunes

It's not the Sahara Desert, or the Gobi Desert. This is Pluto. Hundreds of dunes stretch over at least 45 miles (75 kilometers) of the western edge of Sputnik Planitia, and scientists suspect they formed recently.

Dunes require small particles and sustained, driving winds that can lift and blow the specks of sand or whatever else along. And despite its weak gravity, thin atmosphere, extreme cold and entire surface composition of ices, Pluto apparently had (or still may have) everything needed to make dunes.

Water-ice mountains on the northwest fringes of the Sputnik glacier may provide the particles, and Pluto's beating nitrogen "heart" provides winds. Instead of quartz, basalt and gypsum sands blown by sometimes gale-force winds on Earth, though, scientists suspect the dunes on Pluto are sand-sized grains of methane ice carried by winds that blow at no more than 20 mph, although given the size of the dunes, the winds may have been stronger and atmosphere much thicker in the past.

9. Pluto and Charon have almost no little craters, and that has some big implications

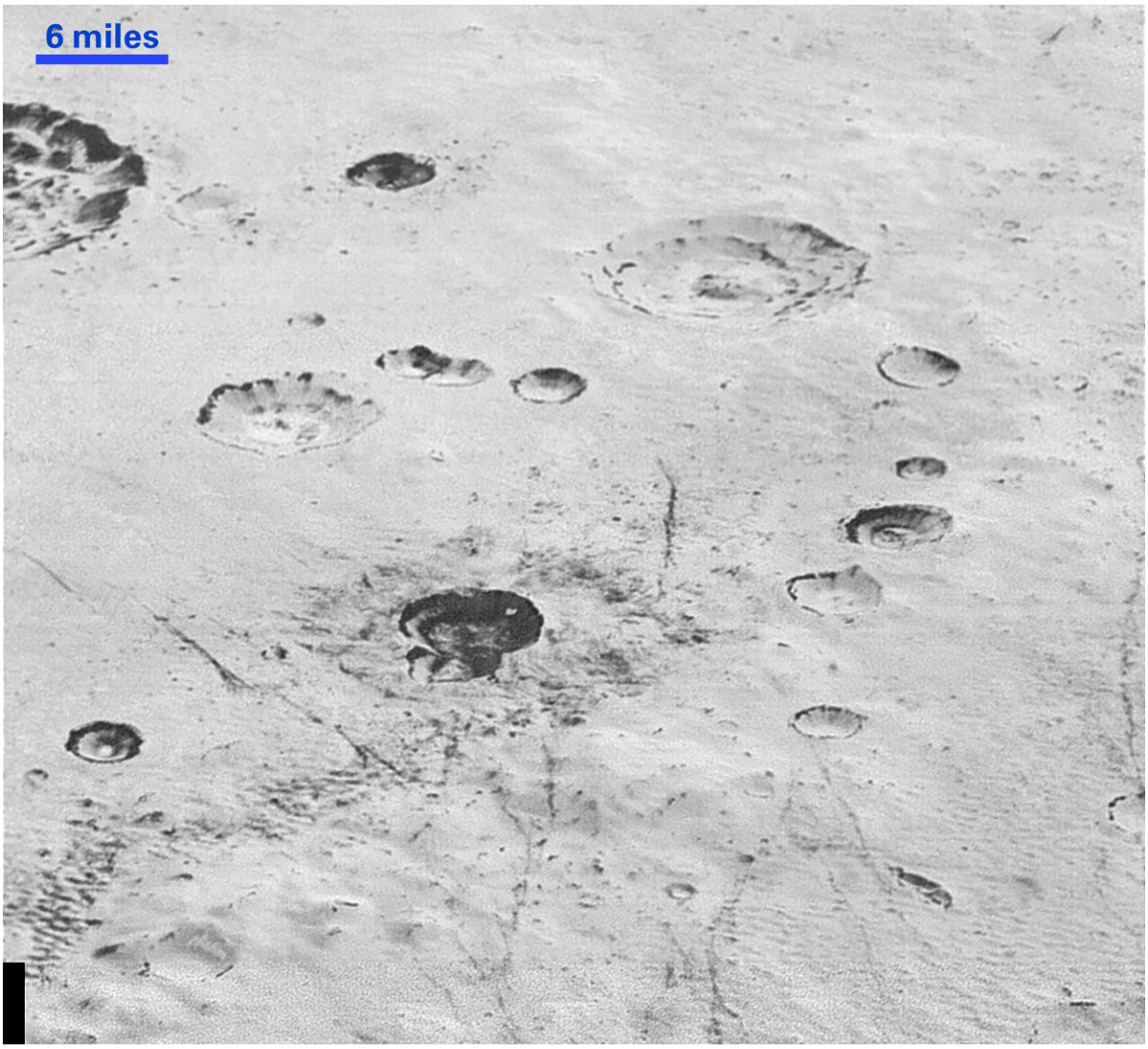
Finding craters on the surface of planets is kind of the norm in space. But if there's one abnormal thing about the Pluto system, it's that neither Pluto nor Charon have many small craters—they're almost all big.

"That surprised us because there were fewer small craters than we expected, which means there are also fewer small Kuiper Belt objects than we expected," said Kelsi Singer, a New Horizons deputy project scientist and coinvestigator from the Southwest Research Institute in Boulder, Colorado.

Analyses of crater images from New Horizons indicate that few objects less than about a mile in diameter bombarded either world. Because scientists have no reason to believe tectonic activity would have preferentially wiped the surface clean of these small craters, It could mean the Kuiper Belt is mostly devoid of very small objects.

"These results give us clues about how the solar system formed because they tell us about the population of building blocks of larger objects, like Pluto and even perhaps Earth," Singer said.

"Every time we go somewhere new in the solar system, we find surprises that challenge current theories," Singer added. "The New Horizons flyby did just that, and in many ways!"



9. Close up of the rugged icy cratered plains in Pluto's Burney Basin. Credit: NASA/JHUAPL/SwRI

10. Charon had a volcanic past, and it could be key to understanding other icy worlds

New Horizons also captured stunning images of Pluto's moon Charon, and they revealed some surprising geology there too.

On the side of Charon that New Horizons imaged in high resolution, Charon has two distinct terrain types: an immense, southward-stretching plain officially called Vulcan Planitia that's at least the size of California, and a rugged terrain colloquially called Oz Terra that stretches northward to Charon's north pole. Both seem to have formed from the freezing and expansion of (you guessed it!), an ancient ocean beneath Charon's crust.

Moderate expansion in the north created the rugged, mountains terrain of Oz Terra seen today, whereas the expansion in the south forced its way through vents, cracks and other openings as cryolava, spilling across the surface. In fact, Vulcan Planitia is thought to be a giant cryoflow that covered the entire region early in Charon's history.

Similar features exist on some icy satellites all around the solar system, including Neptune's giant moon Triton, Saturn's moons Tethys, Dione and Enceladus, and Uranus' moons Miranda and Ariel. And thanks to the detailed images of Charon from New Horizons, the models of Charon's past be a Rosetta Stone to aid in understanding the volcanic and geologic activity of those other icy worlds too.

"New Horizons transformed Pluto from a fuzzy telescopic dot, into a living world with stunning diversity and surprising complexity," said Hal Weaver, New Horizons project scientist at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland. "We were all astounded by the range of phenomena in the entire Pluto system, from Charon's polar coloring and giant chasm, to the 'iceball' makeup of the four smaller satellites that offered valuable clues to the system's origins. The Pluto encounter was exploration at its finest, a real tribute to the vision and persistence of the NASA New Horizons team."

Provided by NASA