Chapter 1

THE DIVE

JULY 12, 2022 | 8:11 A.M. (LOCAL TIME)
LAUNCH +0 HOURS, 0 MINUTES | DEPTH: 0 METERS

It's a bright summer morning on the seemingly infinite expanse of the western Pacific Ocean, just over 200 miles southeast of the island of Guam. From the deck of the DSSV *Pressure Drop*, nothing but lightly rolling waters can be seen in any direction—that is, except for a spot off the stern of the ship, where you might just make out a curvilinear white shape slipping beneath the surface.

Although, at first glance, it might look like something out of a mid-20th-century science fiction movie, this object is no anachronism. It's one of the most advanced underwater vessels ever devised, the DSV *Limiting Factor*. And this patch of sea, otherwise indistinguishable amid the vastness of the Pacific, is special, too: it's directly above—almost 11 kilometers (7 miles) above—the deepest point in all of Earth's oceans, a notch in the Mariana Trench known as Challenger Deep.

The Mariana Trench is a crescent-shaped chasm in the western Pacific Ocean, spanning more than 2,542 kilometers (1,580 miles); within it lies an even deeper groove, which owes its odd name to the British Royal Navy survey ship HMS *Challenger*, whose scientists first sounded its depths in 1875. Challenger Deep measures about 11 kilometers (7 miles) long by 1.6 kilometers (1 mile) wide and 10,935 meters (35,876 feet) deep. How deep is that, in human terms? It's hard to conceive, but, as an approximation, picture six Grand Canyons stacked on top of each other. Another way to think about it: it's much deeper than Mount Everest is tall.

The *Limiting Factor* is the first and only US-owned vehicle to make multiple descents to Challenger Deep with human beings aboard. (The only other sub that can currently accomplish this is *Fendouzhe*, or "Striver," operated by the Chinese

Dawn Wright prepares to enter the *Limiting Factor* submersible.

government.) Before its initial visit to Challenger Deep in 2019, only two other human-piloted expeditions had ever made it to such depths. But on this fine day a little more than three years later, the *Limiting Factor* is embarking on its 19th such dive. It's an indication of how far deep-sea exploration has come in such a short time that a trek to what was once the most difficult-to-reach place on the planet is now starting to feel almost routine, like catching a flight.

And yet there is nothing ordinary about this dive, especially not for the two people in blue jumpsuits who are sealed inside the submersible's Smart Car–sized cockpit. One of them, Victor Vescovo, is responsible for maneuvering the vessel on its way to and from the bottom of the ocean. It was his quest, launched in 2018, to personally visit the deepest point in every ocean that led to the formation of Caladan Oceanic—a science and technology firm dedicated to increasing humanity's understanding of the deep. (Strictly speaking, our planet has only one, connected ocean, but it's traditionally been divided into five major regions:

the Pacific, Atlantic, Indian, Arctic, and Southern Oceans.) He's piloted the *Limiting Factor* on 15 of its trips to Challenger Deep, but there's a chance this may be the last time he performs that feat. Having achieved his goal—and so much more—he's on the verge of selling the undersea exploration system that he envisioned and piloted through its many record-setting expeditions.

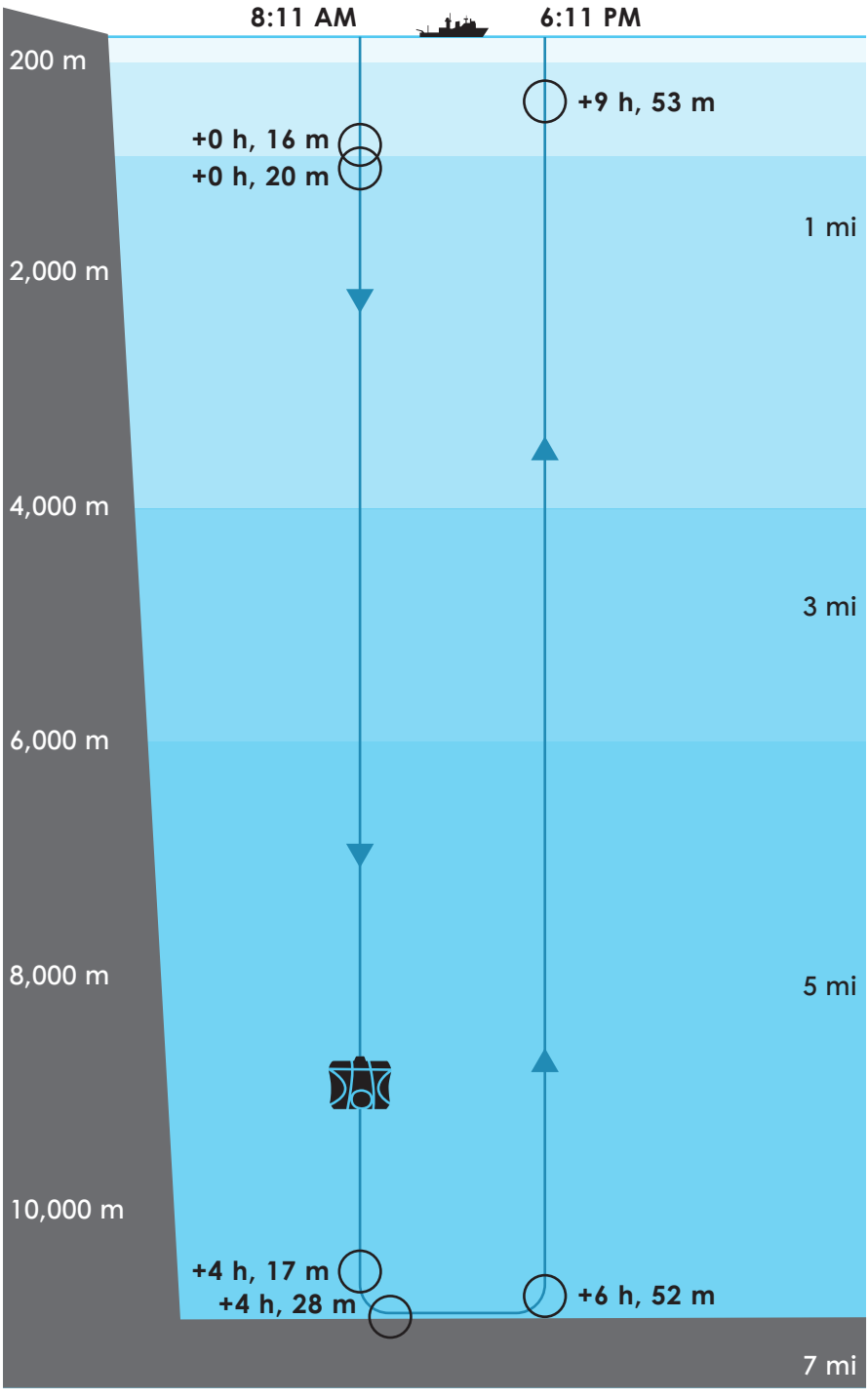
Victor's companion on this descent is the oceanographer Dawn Wright, aka Deepsea Dawn. Now the chief scientist of Esri®, the world's leading geographic information system (GIS) software firm, Dawn has dedicated her life to learning about the ocean—and working to ensure that knowledge of the deep is more widely shared. For Dawn, experiencing Challenger Deep firsthand will be the opportunity of a lifetime.

+0 HOURS, 16 MINUTES | −931 METERS

Darkness comes quickly beneath the ocean's surface. Sunlight penetrates only the uppermost 400 meters (1,312 feet) of water, a threshold the *Limiting Factor* blows through within minutes of sinking under the waves. The next 600 meters (1,968 feet) are fittingly called the twilight zone. This region is believed to be home to more marine life than the rest of the ocean—and much of it provides its own radiance to make up for the lack of natural light. As Dawn says, "It's exhilarating, and it never gets old, the fact that you're descending through the lit zone of the ocean, which is beautiful aqua blue, then things slowly turn to gray and then pitch black."

As the *Limiting Factor* nears the lower extent of the twilight zone, a glow appears through Victor's porthole, off to the sub's left. Believing the source to be some kind of bioluminescent life-form, probably jellyfish or siphonophores (wormlike organisms), Victor flashes the sub's lights. Much to the delight of their human visitors, the creatures respond in kind. This conversation of sorts between nature and machine serves as a fleeting example of the magic of the ocean—a magic that Dawn has felt deeply since her childhood in Hawaii.

Dawn, now 62, moved to Hawaii from the East Coast at the age of six, when her mother accepted a teaching position there. She recalls spending much of her time at the beach, swimming and exploring: "That is part of the culture of Hawaii," she says, "to enjoy but also to hold the ocean as sacred, as life giving. It's a natural part of everyday life there." By the age of eight, inspired by watching Jacques Cousteau on TV, Dawn had decided to become an oceanographer. And yet today,



Dawn and Victor's dive path.

Dawn (*left*) and Victor Vescovo ready to board the *Limiting Factor*.

at one of the high points of her career, she's feeling a little wistful, because her mother, who died just months ago, isn't there to witness it.

> *The ocean has always just been such a natural part of my life … it's a sacred place to me. When I'm in the ocean, I feel as though I am part of the ocean.*
> —Dawn Wright

But Dawn's participation in this dive is about more than checking an item off a personal bucket list. Her main motivation is the ambitious goal of mapping the entire ocean—70 percent of our planet, which remains largely uncharted. Although creative cartography may mislead us into thinking otherwise, only about a quarter of the seafloor has been mapped, to date, in high resolution.

On this mission, Dawn is acting as a flag-bearer for three initiatives:

- Seabed 2030, an international effort that aims to map every inch of the ocean in detail by the year 2030.
- Map the Gaps, a nonprofit that seeks to increase awareness, accessibility, and equity in ocean mapping.
- Adding data and maps from the deepest ocean to ArcGIS® Living Atlas of the World's extensive collection. ArcGIS Living Atlas is an ever-growing collection of authoritative geographic information, including maps, apps, and data layers, from around the globe.

During her expedition, Dawn (*left*) simultaneously promotes two ocean mapping initiatives with a banner and a T-shirt. She is pictured here with Rochelle Wigley (*right*), representing Map the Gaps, also a major flag-bearer for Seabed 2030 and the official mapper on Dawn's expedition, collecting and processing all the bathymetry for inclusion in the Seabed 2030 compilation.

Victor and Caladan are also fully engaged with these ocean-mapping efforts, having donated more than 1.5 million square kilometers (579,153 square miles) of bathymetric data collected over four years of expeditions.

And then, of course, there's the fact of who Dawn is: She's the first Black person and just the fifth woman ever to make the descent to Challenger Deep. She's acutely aware of the significance of that fact, and she hopes it will serve to inspire women and people of color to enter realms of science and exploration that were once inaccessible to them, by common practice if not by policy.

Dawn (*third from left*) poses with three other women who were part of Caladan's 2022 expedition: (*from left*) Nicole Yamase, the first Pacific Islander to make the descent to Challenger Deep; Kate Wawatai, a Maori New Zealander who is the first female pilot of the *Limiting Factor;* and Tamara Greenstone Alefaio, program coordinator for the Micronesia Conservation Trust.

Dawn is heartened, though, by the number of women who have made, and continue to make, enormous contributions to Caladan's efforts and to her dive in particular. But she notes that only seven of the 43 people aboard the *Pressure Drop* during this expedition are women. So, she says, there's still plenty of work to do, to ensure equitable access to science and technology education—and to encourage women and people of color, like her, to enter the field.

+0 HOURS, 20 MINUTES → +4 HOURS, 4 MINUTES
−1165 METERS → −10400 METERS

If not for its running lights, the *Limiting Factor* would be engulfed in total darkness for the remaining four-hour descent to the seafloor. The sub traverses three more vertical zones, each with an increasingly foreboding name: the midnight zone (down to 4,000 meters/13,123 feet), the abyssal zone (to 6,000 meters/19,685 feet), and finally, beneath that, the hadal zone, named after Hades, the Greek god of the underworld. This is the most tedious part of the adventure, but fortunately,

Dawn (*left*) and Victor at the controls of the *Limiting Factor*.

there's plenty to talk about. Some of it is critical to the mission, such as making sure Dawn is familiar with the basic controls of the *Limiting Factor* in the unlikely event that Victor should become incapacitated.

Dawn is well versed in submersibles, having done her PhD work using *Alvin* to study hydrothermal vents in mid-ocean ridges and *Pisces V* to study deep coral reefs in American Samoa. (Though they're both called subs, a submersible differs from a submarine in that it needs to be launched from a support vessel, whereas a submarine can launch itself and return on its own.) As a result, Dawn's able to settle in and approach a dive of this magnitude as she would any other, as a professional. With that mindset, she barely notices when the *Limiting Factor* floats past the 2,500-meter (8,202-foot) mark, making this now the deepest she has ever descended.

Compared with her shallower dives, the major difference in Dawn's preparation was a fasting regimen, since there's no latrine aboard the *Limiting Factor*. The round trip to and from Challenger Deep often takes at least 10 hours, so Dawn had to reduce her food consumption over two days, with a final snack and sip of water a few hours before launch.

Apart from that, there is little difference in the experience of the slow, dreamlike descent. If anything, it's more comfortable than her past dives, given the length of the dives the *Limiting Factor* has been designed for. Even the pressure outside the sub, increasing to almost unimaginable levels, is imperceptible to the

occupants of the *Limiting Factor*. At the full depth of Challenger Deep, the pressure is 16,000 pounds of force per square inch, equivalent to a school bus sitting on top of every cubic inch of water (or to the atmospheric pressure on the planet Venus!)—but Dawn and Victor, inside the sub's meticulously engineered chamber, are protected from the ocean's crushing force.

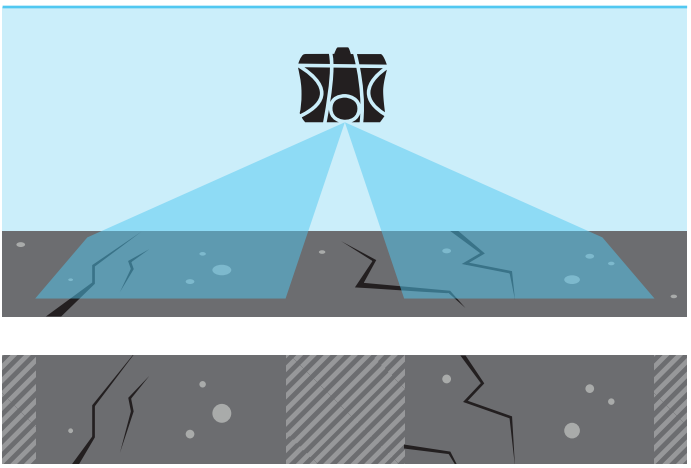
Outside the hatch of the *Limiting Factor*, the crew have placed a handful of Styrofoam cups decorated with colorful doodles in a mesh bag. As the sub descends, the cups are fully exposed to the tremendous water pressure. When the sub returns to the surface, the cups are retrieved—warped and compressed to a fraction of their original size, but, amazingly, mostly intact.

One of the Styrofoam cups that rode all the way to Challenger Deep inside the hatch of the *Limiting Factor*, compared with a fresh Styrofoam cup.

Not even a year later, in June 2023, the tragic loss of OceanGate's *Titan* submersible near the wreck of the *Titanic* provided a sobering reminder of the perils of deep-sea exploration and the potentially catastrophic consequences of extreme underwater pressure. At the depth where the *Titan*'s hull suffered its deadly implosion, the pressure was an estimated 5,500 pounds of force per square inch, enough to crush a soda can to the size of a marble. Fortunately, unlike the *Titan*, the *Limiting Factor* has been constructed and certified to the highest industry standards.

+4 HOURS, 17 MINUTES | −10451 METERS

Apart from the expedition's symbolic importance, as a first for a Black woman, Dawn's dive has an immediate, tangible goal: pushing the science of seafloor data collection to new limits.



Above: An illustration depicting how a submersible like the *Limiting Factor* can obtain seafloor data using portable sidescan sonar. *Below*: How that data might be represented in two-dimensional form.

Multibeam sonar systems, such as the one attached to the bottom of the *Pressure Drop*, are effective for capturing the bathymetry (depth data) of large swaths of the ocean floor. Portable sidescan sonar systems, on the other hand, are used to produce more detailed images of the seafloor. These sidescan devices are often deployed closer to the seafloor and can more accurately read differences in material and texture down below. They do this by measuring the intensity of the return signals, rather than merely the time it takes for the signals to bounce back, as multibeam sonar does. This capability makes sidescan particularly effective for purposes such as finding shipwrecks, determining the state of underwater infrastructure, or locating mineral deposits.

But portable sidescan sonar has never been deployed deeper than 6,800 meters (22,309 feet); its circuitry generally doesn't hold up well against the immense pressure of the deepest sea. Now, though, a Mauritius-based company called Deep Ocean Search has developed a sidescan sonar apparatus that is designed to withstand the pressure and work at full ocean depth. Victor and Dawn have arranged for this new device to be attached to the outer shell of the *Limiting Factor*. If it functions successfully in Challenger Deep, it will represent a game changer in the field of seafloor mapping.

At about 10,450 meters (34,284 feet), still roughly half a kilometer above the floor of the trench, the moment of truth arrives. Cradling a laptop computer, Dawn powers up the sidescan for the first time. Much to her relief, the sonar's signals are reading clearly.