# SOUTHERN CALIFORNIA'S BIGGEST WAVES— THE STORY OF CORTES BANK

Excerpted from ***Surf, Sand, and Stone: How Waves, Earthquakes, and Other Forces Shape the Southern California Coast***

by Keith Meldahl

There is a place 100 miles west of San Diego where—if the ocean is calm and the tide low—you can stand in waist-deep water on the summit of an immense underwater mountain. No land is visible anywhere. The nearest island, San Clemente, is 45 miles to the northeast and shrouded in fog. The seabed plunges more than 5000 feet off the flanks of the seamount. Deep currents run into the sides of the mountain, carrying nutrients up to the sunlit surface waters. The nutrients—dissolved nitrate, phosphate, and iron mostly—act like garden fertilizer, fueling the photosynthetic growth of tiny phytoplankton and forests of giant kelp. These form the base of a rich food pyramid that, via endless slaughter, ascends from zooplankton to fishes small then large, then seals and sea lions, and finally to Great White sharks, who patrol the shallows with the insouciance that comes from being an apex predator. The ocean is full of teeth here. But the bravest and most adrenaline-addicted members of the big-wave surfing community can't resist this place. This is Cortes Bank, home to some of the tallest surfable waves on Earth.

Cortes Bank is not a welcoming place: gusty and cold, swept by treacherous currents, and often thick with fog. If not for the clang of a Coast Guard marker buoy near Bishop Rock (the barely awash summit of the seamount), you might think yourself adrift in a world before humans—a Jurassic ocean perhaps, haunted by long-necked plesiosaurs.

Until recently, Cortes Bank remained virtually unknown outside of a handful of abalone fishermen and scuba divers, some of whom told of seeing colossal breaking waves. On January 23, 1990, two surf-seekers named Larry Moore and Mike Castillo decided to see what the big-wave rumors were about. A violent Aleutian storm had recently kicked up monster swells that were bombarding Hawaii and California with legendary surf. Moore and Castillo took off from Oceanside airport and aimed their small plane west-by-southwest at Cortes Bank. Passing San Clemente Island, which had been dampening the swells, the two men stared slack-jawed at the outsized corduroy pattern of the ocean. "The lines of swell were unbelievable. The interval on the swell was just huge," Castillo remembered. A Navy ship they flew over "just looked like a toy boat in those waves." Ten minutes later, they spied whitewater. Gigantic waves were rearing up and crashing down onto Bishop Rock, burying the marker buoy in violent cascades. Castillo dropped the plane low, and they looked *up* as wall after cerulean wall rose from the corduroy ranks to crest and tip forward at…60 feet high? …80 feet? It was hard to tell, but "if you surfed down there, there was a serious chance of death or dismemberment," Castillo decided. "It looked like nothing anywhere else, even Jaws over on Maui."[1]

[1] Quoted material is cited as told to Chris Dixon in his book *Ghost Wave*, or taken from interviews on Surfline.com.

Cortes Bank runs about twenty-five miles long and seven miles wide (figure 1). It's long axis lines up northwest-southeast. Lay a ruler along that axis, follow it 2000 miles northwest, and you'll find yourself in the center of the storm-wracked North Pacific—one of the world's great wave factories. The northwest alignment of Cortes Bank happens to be perfect for catching big swells arriving from the North Pacific and focusing them, like light rays through a magnifying glass, so that they bloat into azure monsters as they rise up over the bank.

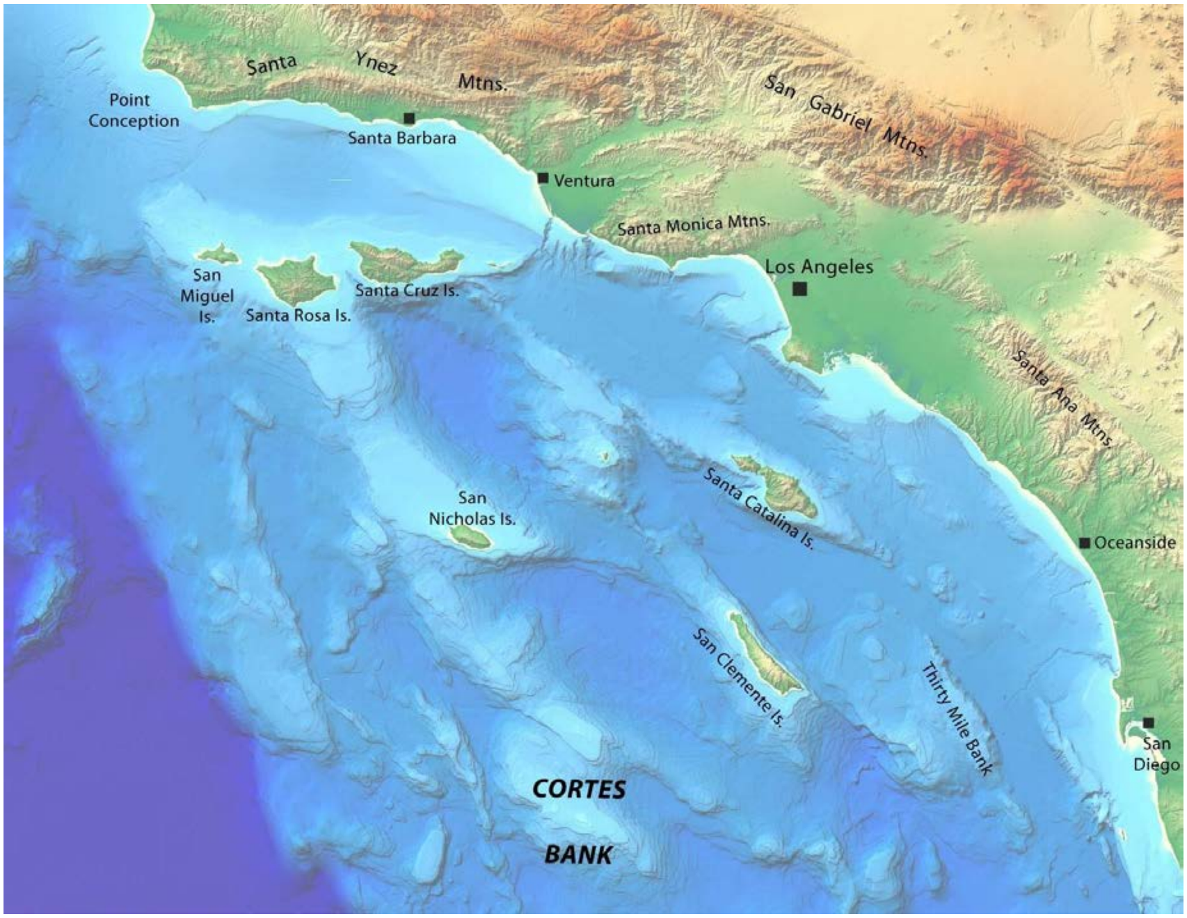


Figure 1: Cortes Bank is a shallow, northwest-southeast oriented seamount about 100 miles west of San Diego.

## Wave Birth

The life of a typical surfing wave begins in a storm and ends a few days later when the wave breaks on a beach, shoal, or seamount. During its short lifetime, a wave obeys the laws of physics, allowing us to predict its behavior with fair accuracy. I sometimes hear surfers speak of waves as if they were fickle, mysterious things. I think the feeling comes from their beauty, symmetry, and ceaseless motion—features we associate more, perhaps, with wild animals than with the physical world. But wave behavior is as predictable as gravity, electricity, or planetary orbits. You just have to know the variables.

Most ocean waves are formed by wind. Three factors control the size of waves that the wind can make: *wind speed, duration,* and *fetch*, meaning the distance of water over which the wind blows. The faster the wind speed, the longer it blows, and the greater the fetch across which it blows, the larger and faster the waves.   Local shore breezes don't make worthwhile surfing waves because they don't have enough speed, duration, or fetch.  The breeze gently blowing your hair at the beach didn't make those waves you see the surfers riding.  Local breezes make *chop*: the tiny waves you see riding on the backs of bigger swells.   On a gusty day, the chop might reach one or two feet—just big enough to make a mess of the worthwhile waves.  To make good surfing waves, you need storms that blow for several days across wide stretches of open ocean.

The reason the Pacific Ocean hosts so many world-class surf sites comes down to *fetch* and *storms*.  The fetch across the Pacific is second only to the Southern Ocean— the continuous belt of water wrapping around Antarctica (and home to the biggest open-ocean waves on Earth).  Three major Pacific storm centers send swells to Southern California (figure 2): the North Pacific (where storms form mostly from October through May), the tropical Eastern Pacific (which spawns hurricanes from June through October), and the South Pacific near Antarctica (most active from April through November, the Southern Hemisphere winter).  Of these, swells from North Pacific storms are the most important for Cortes Bank.

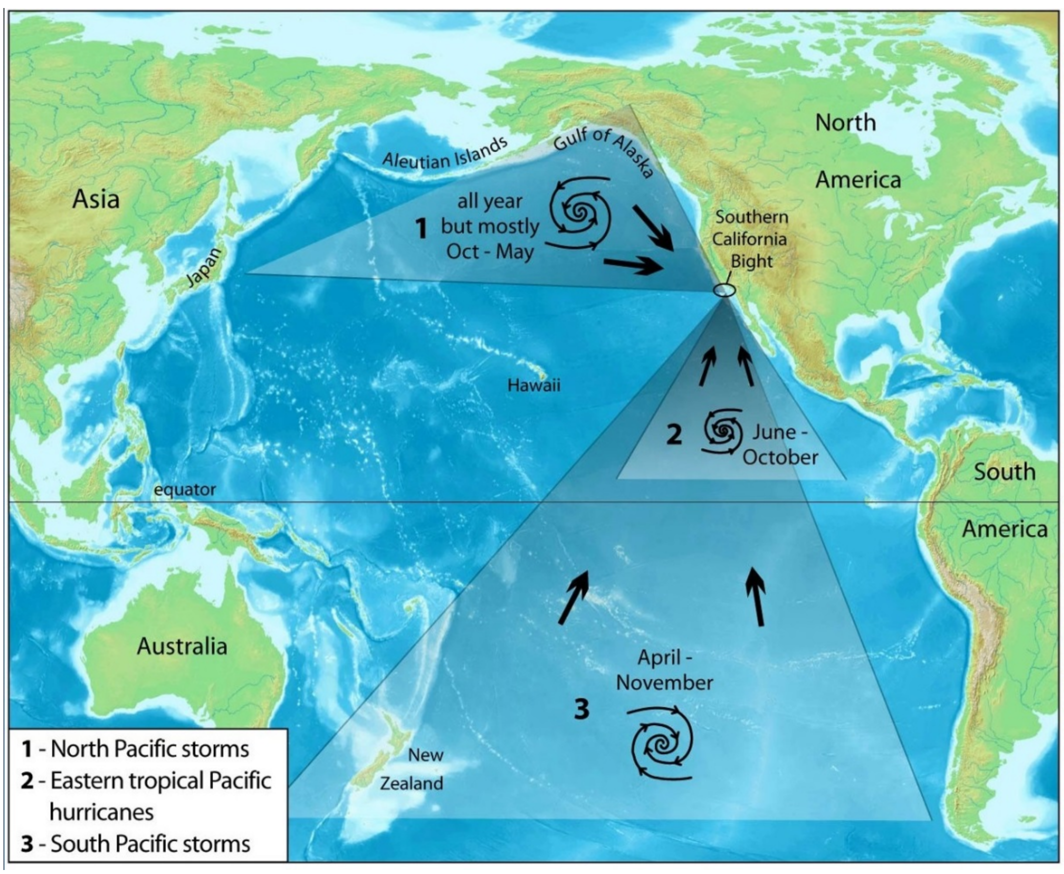

Figure 2: The three major storm centers that send swells to Southern California, including Cortes Bank.

Whatever their source, it's always fun to think about the long journey of ocean swells, some of which may have traveled halfway across the planet to give you a ride during the last moments of their existence.  In some ways, the journey is far greater than that.  A big swell arriving in Southern California represents energy that has traveled 93 million miles from the Sun to heat up the atmosphere and ocean, spawning a pin-wheeling storm whose fierce winds have converted the Sun's heat into big waves. When you ride far-flung ocean swells, you're grabbing, for a few seconds, your own little piece of solar fire.

**Wave Period: the Essential Number**

No measurement is more important for understanding waves and surf than the *wave period*: the time, in seconds, between wave crests as they pass a stationary point. Visualize standing on a pier with a stopwatch looking at swells rolling by. When one passes directly under you, you start the watch, and when the next passes, you stop it. Collect a bunch of readings, average them to even out measurement error, and you have the period. My students do this every semester on a local pier, and the periods they get using two-dollar stopwatches are usually spot-on with periods from high-tech automated buoys.

Key Point #1: ***The wave period directly reflects the amount of energy that the wind puts into the ocean. The longer the wave period, the more energy the wave carries.***

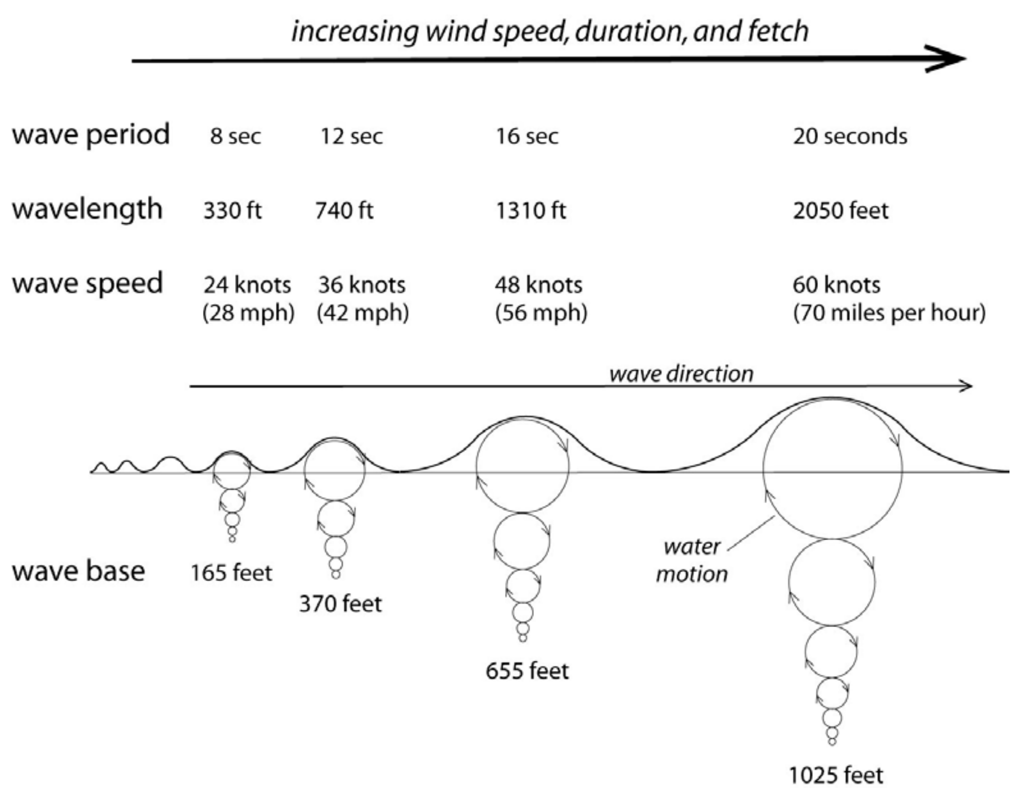


Figure 3: The growth of ocean swells with increasing wind speed, duration, and fetch. Wave period, wavelength, wave speed, and wave base all increase as the wind transfers more of its energy to the ocean.

As figure 3 shows, the more energy that the wind puts into the ocean, the longer the wave period. Waves with longer periods travel faster, have longer wavelengths (meaning the distance between adjacent wave crests), and cause the water to move at greater depths. Notice on figure 3 that the water doesn't travel across the ocean surface with the wave. Instead, the water moves in a circle called a wave orbit. The longer the wave period, the larger the wave orbits, and the deeper the orbits reach below the surface. The *wave base* is the depth where this orbital motion stops, and it increases in direct proportion to the wave period. This gives us:

Key Point #2: ***The longer the wave period, the deeper the wave base.*** As we'll see, the wave base is essential to understanding how and where good surfing waves form.

**Getting to the Bottom of a Great Wave**

"It's hard to get an epic wave without an epic bottom," the surf forecaster Sean Collins once remarked. Recall that the wave base is the depth of water where the orbital motion of passing waves stops. Swells moving through water deeper than their wave base don't feel the bottom. But once swells come into water shallower than wave base, the orbital motion of the waves begins to feel the seabed, and the waves slow down. Key Point #3: ***The deeper the wave base, the sooner that waves approaching shore will begin to feel the bottom and slow down.***

Why is that important? The answer is that, the more waves slow down the more they can *bend* (refract) around bottom topography and concentrate their energy to form good surf. The key to making good surf is to bend swells in such a way as to focus their energy into a small area. Hold your right arm out with your fingers straight, as if you were going to shake someone's hand, like in the left photo in figure 4. Sweeping your hand in the direction of the arrows mimics the straight line of a moving wave. Now curve your palm and fingers like in the right photo. That shape—concave in the direction the swell is traveling—is an ideal way to make good surfing waves. When the seabed bends waves into that shape, it focuses their energy into the center—represented by the middle of your curved hand—forming bigger, more powerful surfing waves.

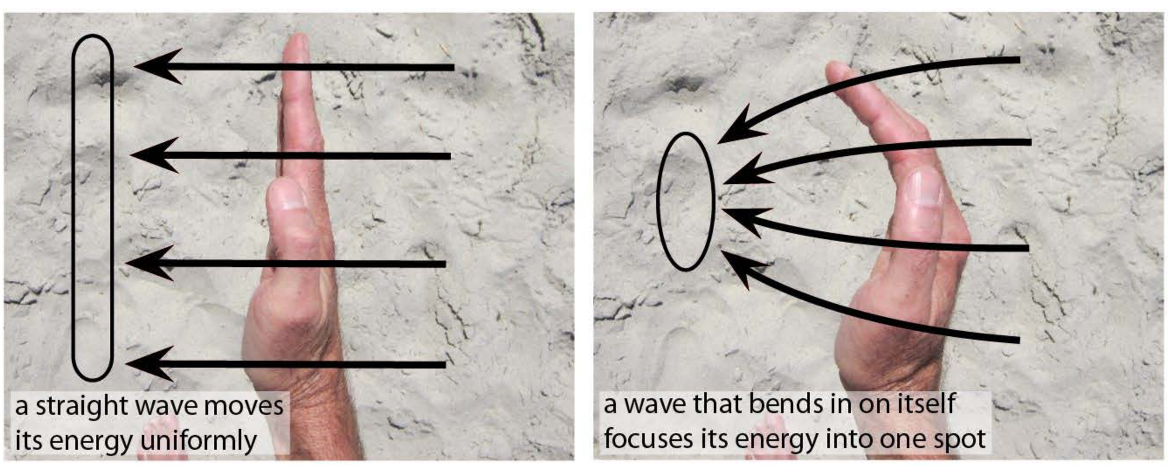


Figure 4: The best surfing waves often form where waves refract (bend) concave as they approach shore. Such bending focuses the waves' energy into a small area, making them bigger and more powerful when they break.

*Undersea ridges* are particularly good at focusing wave energy this way. To see what I mean, look at figure 5. Refraction always bends waves toward shallower water, so that they conform somewhat to depth contours. But notice on figure 5 how the long-period waves (upper part of the figure) start bending sooner over the ridge than the short-period waves (lower part of the figure). The long-period waves bend much more as they approach shore, conforming or "wrapping" more closely to the depth contours. Key Point #4: ***The more waves bend, the more they can focus their energy into certain spots to make bigger surfing waves.***

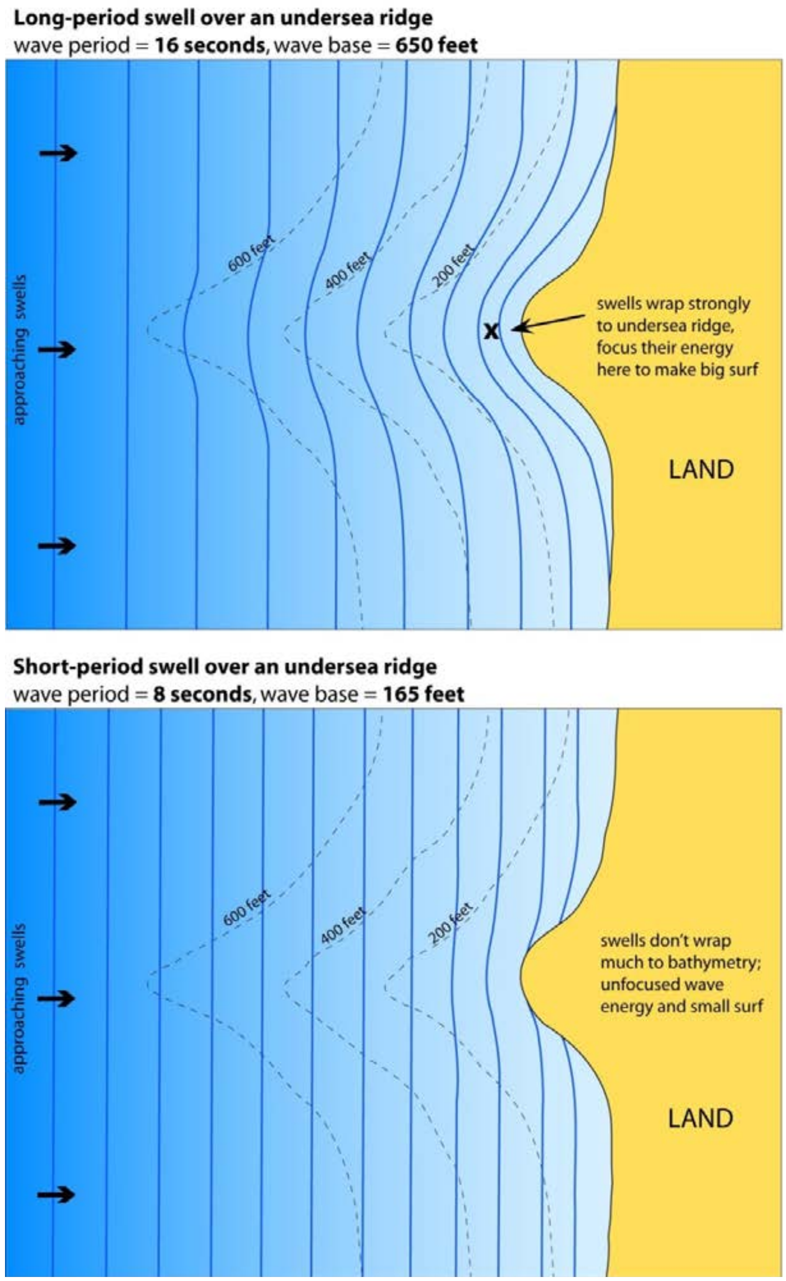


Figure 5: The effect of wave period on refraction of waves over an **undersea ridge**. Long-period waves (upper image) feel the bottom in deeper water and wrap more toward the ridge, focusing their energy to form big surf at the spot marked X. Short-period swells (lower image) don't feel the bottom until closer to shore. Their energy remains unfocused, and their surf is uniformly small.

With that background, we now return to Cortes Bank—home to some of the largest surfable waves on Earth.

**Riders between the Storms**

New Year's Day, January 2008. A huge low-pressure system off the Aleutian Islands is vacuuming in air from across a half-million square miles of ocean. The storm soon bloats into a humungous pinwheel that takes up most of the North Pacific. On January 3, the storm slams with hurricane strength into Washington and Oregon. It reaches San Francisco the next day, ripping up hundred-year-old oaks as if they were garden weeds, and dismantling the power grid to plunge 2.1 million people into darkness. Weather stations in the Sierra Nevada record wind gusts up to 165 miles per hour.

Rolling outward from the storm, the swells look like outsized versions of the expanding rings made where you toss a rock into a pond—only this pond is the largest ocean on Earth, and the rings will reach New Zealand in a week. Their heights decrease as they spread out, but even after several thousand miles the waves are an awesome sight: 23 feet high from trough to crest, rolling along at about 70 miles per hour, with 20-second periods and wavelengths stretching more than a third of a mile. They are some of the most powerful waves of the decade: moving mountains of pure, long-period energy, destined to explode somewhere.

Traveling through deep water, the swells move unimpeded by the ocean floor, and thus hold their shape and speed. Their orbital energy reaches down 1000 feet, but the open Pacific averages more than two miles deep, so the waves don't feel the seabed. Approaching mainland California, the swells rise up into colossal breakers that the storm winds tear to unsurfable shreds. But at Cortes Bank, things are different. The massive swells arrive, on January 5, during a short interval of clear skies and calm air.

A single boat arrives the same day, just after noon. It is a 36-foot, 550 horsepower catamaran owned and piloted by surf photographer Robert Brown. His cargo, loaded before dawn at Dana Point Harbor, includes two jet skis and four surfers: Mike Parsons, Brad Gerlach, Greg Long, and Grant Baker. All are at the pinnacle of the big-wave profession, regularly winning top awards. In January 2001, Mike Parsons set a record at Cortes Bank by riding a 66-foot wave. But today is different. "Compared to the wave Mike had out there in 2001, this was so much bigger," Greg Long remembered. "I saw a lot of 80-foot-plus waves. It was the most incredible thing I've ever seen in my life."

Big ocean swells approaching Cortes Bank from the northwest encounter a sea bottom that rises, in just a few miles, from 5000 feet deep up to a broad, shallow ridge perfectly aligned to impale the swells and bend them inward over the bank. Figure 6 shows my prediction of how 20-second period waves from the northwest will wrap and focus their energy over Cortes Bank. You can see that the greatest wrapping—and thus the largest surf—will occur as the waves approach the shallowest part of the bank near Bishop Rock.

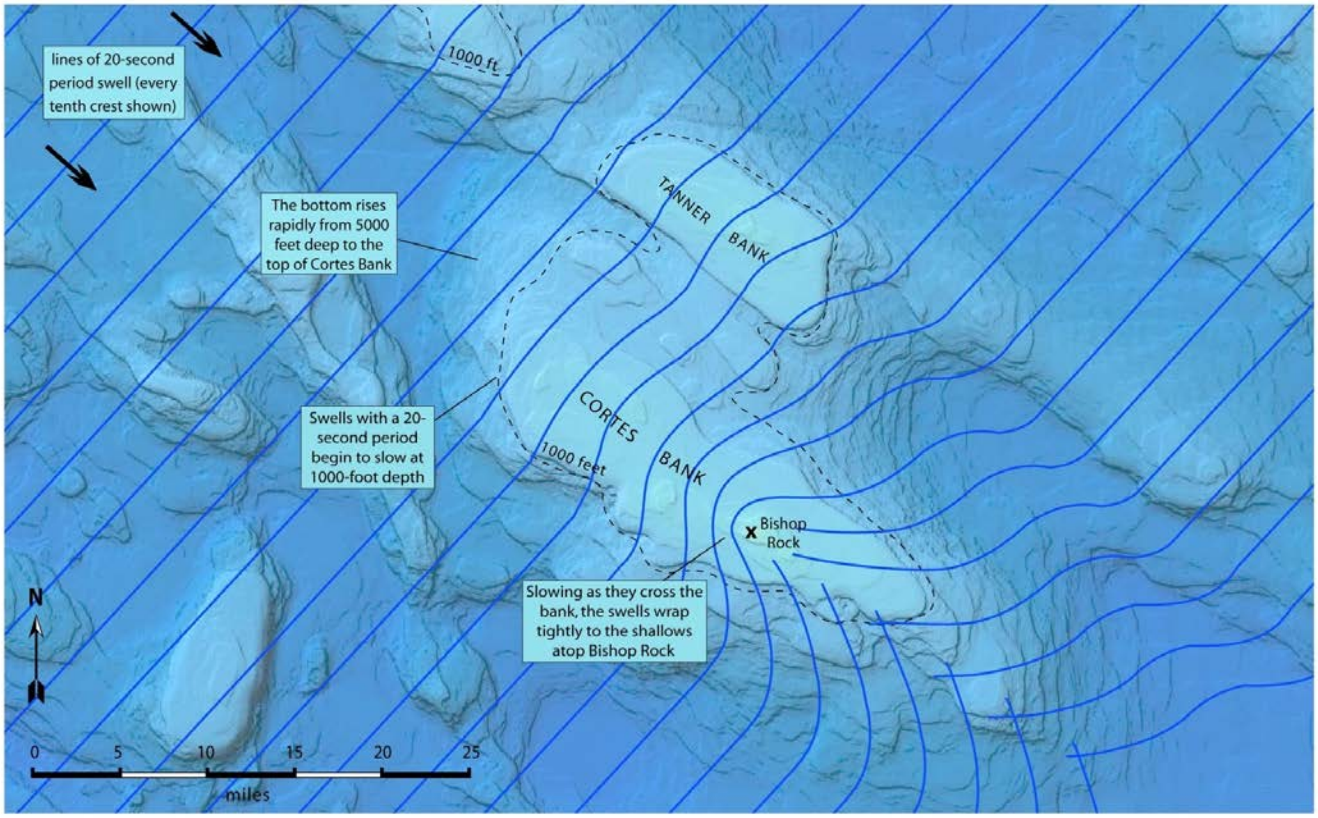

Figure 6: Refraction of 20-second period northwest swells over Cortes Bank. At the scale of the diagram, the blue lines represent every tenth wave crest. The wrapping and focusing of big storm waves over Cortes Bank can create breaking waves over 100 feet tall near Bishop Rock.

Bobbing over huge, butter-smooth swells in deep water south of Bishop Rock, the men on Rob Brown's boat stare thunderstruck at the scene to the north. Waves 80 feet high or higher rear up and topple over, squirting geyser-like explosions of whitewater nearly twice as high into the air. "You could count the seconds from when you saw one throw out as it fell," cinematographer Matt Wybenga remembered of the waves. "One thousand one, one thousand two, one thousand three, one thousand four—till it detonated. It was so loud." As they curl over, the waves create almond-shaped tubes big enough to hold a six-story building. They were "these giant, giant tubes," Brad Gerlach recalled, and "you'd look at it and you're like, *maybe I could ride that.* Then it would clamshell and explode, and you're like, *oh no, OH NO.*" The waves have stirred up a terrifying cauldron of whitewater around Bishop Rock, and have heaped so much water onto the mesa-like summit of the rock that the ocean pours off in all directions, as if off a table. As the big waves collapse, they sling forth smaller waves that charge through the whitewater mess. It all adds up to a perfectly murderous scene—the last place on Earth you would want to be, but where a surfer might end up if he wipes out. "If you lost your guy in there, he was just *gone*," Grant Baker remembered thinking. "He would have been lost in that expanse and you would never find him. It was just so scary."

As the swells rise up onto Cortes Bank, they slow from their deep-water speed of roughly 70 miles per hour to less than 40 as they crest and begin to break. Such speeds—far faster than anything most of the world's surfers will ever experience—demand tow-surfing, where the surfer, his feet inserted tightly into straps on his board, is slung into the wave by his partner on a jet ski. At first, the teams are cautious, with the surfers catching the far right shoulders of the waves and staying well away from 60-foot-high tubes detonating to the north. The trick, of course, is not to fall. As big waves break, they take so much air down with them that the water's density drops to something like beer foam. A body that will float in water will sink in foam. This, along with the waterfall-like force of the breaking wave, produces what surfers call a hold-down, which can trap you in swirling blackness for a minute or more. On top of this, of course, is the risk of being swept into the murderous whitewater near Bishop Rock.

As the afternoon wears on the winds settle, so that the hazardous chop crossing the faces of the big waves flattens out. The surfers begin to ride with more confidence. Mike Parsons catches a 65-footer and rides it more than a mile. Soon after, a behemoth begins to stand up to the west. Brad Gerlach, driving the ski, slings Parsons in at full throttle. Parsons plummets down the face, going faster than he ever has on a surfboard—so fast, in fact, that a frightening turn of physics takes over. The fins on his board are slicing the water so quickly that pockets of pure vacuum, known as cavitation bubbles, form around them, creating drag. It's like pulling an emergency brake, and now Parsons is moving slower than the wave, which is rearing and lifting him from behind. Relative to the wave, he's going *backwards* up the face. Closer and closer to the crest he goes, his board angle steepening to nearly straight down. He's nearly at the lip—the worst place to fall. Whitewater begins to chandelier down on him. "It's gonna hit you, but you gotta make this. Point it. Just stay on. You can't fall. You can't die," Parsons thinks. Suddenly, the cavitation bubbles release. Parsons rockets forward just as the tube begins to collapse, and aims for safety along the wave's shoulder a half-mile away.

Parson's wave, officially measured at 77 feet, becomes a world record at the time. But Parsons concedes that his was not the biggest wave ridden at Cortes that day. That distinction went to Greg Long, who rode un-photographed—and thus unofficial—on a wave that was easily 80 feet and perhaps 90 feet high. "I guarantee you there will be a 100-foot wave ridden out there," Parsons says of Cortes Bank. "If you put yourself in the right place at the right time, it will happen."