



Ancient Crash, Epic Wave

Dallas Abbott

The Fenambosy chevron, one of four near the tip of Madagascar, is 600 feet high and three miles from the ocean.

By [SANDRA BLAKESLEE](#)

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At the southern end of Madagascar lie four enormous wedge-shaped sediment deposits, called chevrons, that are composed of material from the ocean floor. Each covers twice the area of Manhattan with sediment as deep as the Chrysler Building is high.

On close inspection, the chevron deposits contain deep ocean microfossils that are fused with a medley of metals typically formed by cosmic impacts. And all of them point in the same direction — toward the middle of the Indian Ocean where a newly discovered crater, 18 miles in diameter, lies 12,500 feet below the surface.

The explanation is obvious to some scientists. A large asteroid or comet, the kind that could kill a quarter of the world's population, smashed into the Indian Ocean 4,800 years ago, producing a tsunami at least 600

feet high, about 13 times as big as the one that inundated Indonesia nearly two years ago. The wave carried the huge deposits of sediment to land.

Most astronomers doubt that any large comets or asteroids have crashed into the Earth in the last 10,000 years. But the self-described “band of misfits” that make up the two-year-old Holocene Impact Working Group say that astronomers simply have not known how or where to look for evidence of such impacts along the world’s shorelines and in the deep ocean.

Scientists in the working group say the evidence for such impacts during the last 10,000 years, known as the Holocene epoch, is strong enough to overturn current estimates of how often the Earth suffers a violent impact on the order of a 10-megaton explosion. Instead of once in 500,000 to one million years, as astronomers now calculate, catastrophic impacts could happen every few thousand years.

The researchers, who formed the working group after finding one another through an international conference, are based in the United States, Australia, Russia, France and Ireland. They are established experts in geology, geophysics, geomorphology, tsunamis, tree rings, soil science and archaeology, including the structural analysis of myth. Their efforts are just getting under way, but they will present some of their work at the American Geophysical Union meeting in December in San Francisco.

This year the group started using Google Earth, a free source of satellite images, to search around the globe for chevrons, which they interpret as evidence of past giant tsunamis. Scores of such sites have turned up in Australia, Africa, Europe and the United States, including the Hudson River Valley and Long Island.

When the chevrons all point in the same direction to open water, Dallas Abbott, an adjunct research scientist at Lamont-Doherty Earth Observatory in Palisades, N.Y., uses a different satellite technology to

look for oceanic craters. With increasing frequency, she finds them, including an especially large one dating back 4,800 years.

So far, astronomers are skeptical but are willing to look at the evidence, said David Morrison, a leading authority on asteroids and comets at the [NASA](#) Ames Research Center in Mountain View, Calif. Surveys show that as many as 185 large asteroids or comets hit the Earth in the far distant past, although most of the craters are on land. No one has spent much time looking for craters in the deep ocean, Dr. Morrison said, assuming young ones don't exist and that old ones would be filled with sediment.

Astronomers monitor every small space object with an orbit close to the Earth. "We know what's out there, when they return, how close they come," Dr. Morrison said. Given their observations, "there is no reason to think we have had major hits in the last 10,000 years," he continued, adding, "But if Dallas is right and they find 10 such events, we'll have a real contradiction on our hands."

Peter Bobrowski, a senior research scientist in natural hazards at the Geological Survey of Canada, said "chevrons are fantastic features" but do not prove that megatsunamis are real. There are other interpretations for how chevrons are formed, including erosion and glaciation. Dr. Bobrowski said. It is up to the working group to prove its claims, he said.

William Ryan, a marine geologist at the Lamont Observatory, compared Dr. Abbott's work to that of other pioneering scientists who had to change the way their colleagues thought about a subject.

"Many of us think Dallas is really onto something," Dr. Ryan said. "She is building a story just like Walter Alvarez did." Dr. Alvarez, a professor of earth and planetary sciences at the [University of California, Berkeley](#), spent a decade convincing skeptics that a giant asteroid wiped out the dinosaurs 65 million years ago.

Ted Bryant, a geomorphologist at the University of Wollongong in New South Wales, Australia, was the first person to recognize the palm prints of mega-tsunamis. Large tsunamis of 30 feet or more are caused by volcanoes, earthquakes and submarine landslides, he said, and their deposits have different features.

Deposits from mega-tsunamis contain unusual rocks with marine oyster shells, which cannot be explained by wind erosion, storm waves, volcanoes or other natural processes, Dr. Bryant said.

"We're not talking about any tsunami you're ever seen," Dr. Bryant said. "Aceh was a dime. No tsunami in the modern world could have made these features. End-of-the-world movies do not capture the size of these waves. Submarine landslides can cause major tsunamis, but they are localized. These are deposited along whole coastlines."

For example, Dr. Bryant identified two chevrons found over four miles inland near Carpentaria in north central Australia. Both point north. When Dr. Abbott visited a year ago, he asked her to find the craters.

To locate craters, Dr. Abbott uses sea surface altimetry data. Satellites scan the ocean surface and log the exact height of it. Underwater mountain ranges, trenches and holes in the ground disturb the Earth's gravitational field, causing sea surface heights to vary by fractions of an inch. Within 24 hours of searching the shallow water north of the two chevrons, Dr. Abbott found two craters.

Not all depressions in the ocean are impact craters, Dr. Abbott said. They can be sink holes, faults or remnant volcanoes. A check is needed. So she obtained samples from deep sea sediment cores taken in the area by the Australian Geological Survey.

The cores contain melted rocks and magnetic spheres with fractures and textures characteristic of a cosmic impact. "The rock was pulverized, like it was hit with a hammer," Dr. Abbott said. "We found diatoms fused to tektites," a glassy substance formed by meteors. The molten

glass and shattered rocks could not be produced by anything other than an impact, she said.

“We think these two craters are 1,200 years old,” Dr. Abbott said. The chevrons are well preserved and date to about the same time.

Dr. Abbott and her colleagues have located chevrons in the Caribbean, Scotland, Vietnam and North Korea, and several in the North Sea.

Heather Hill State Park on Long Island has a chevron whose front edge points to a crater in Long Island Sound, Dr. Abbott said. There is another, very faint chevron in Connecticut, and it points in a different direction.

Marie-Agnès Courty, a soil scientist at the European Center for Prehistoric Research in Tautavel, France, is studying the worldwide distribution of cosmogenic particles from what she suspects was a major impact 4,800 years ago.

But Madagascar provides the [smoking](#) gun for geologically recent impacts. In August, Dr. Abbott, Dr. Bryant and Slava Gusiakov, from the Novosibirsk Tsunami Laboratory in Russia, visited the four huge chevrons to scoop up samples.

Last month, Dee Breger, director of microscopy at Drexel University in Philadelphia, looked at the samples under a scanning electron microscope and found benthic foraminifera, tiny fossils from the ocean floor, sprinkled throughout. Her close-ups revealed splashes of iron, nickel and chrome fused to the fossils.

When a chondritic meteor, the most common kind, vaporizes upon impact in the ocean, those three metals are formed in the same relative proportions as seen in the microfossils, Dr. Abbott said.

Ms. Breger said the microfossils appear to have melded with the condensing metals as both were lofted up out of the sea and carried long distances.

About 900 miles southeast from the Madagascar chevrons, in deep ocean, is Burckle crater, which Dr. Abbott discovered last year. Although its sediments have not been directly sampled, cores from the area contain high levels of nickel and magnetic components associated with impact ejecta.

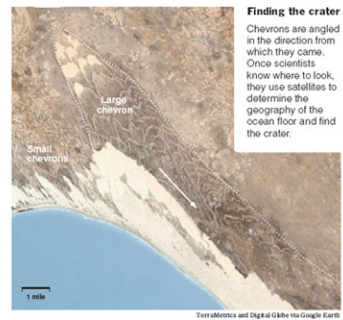
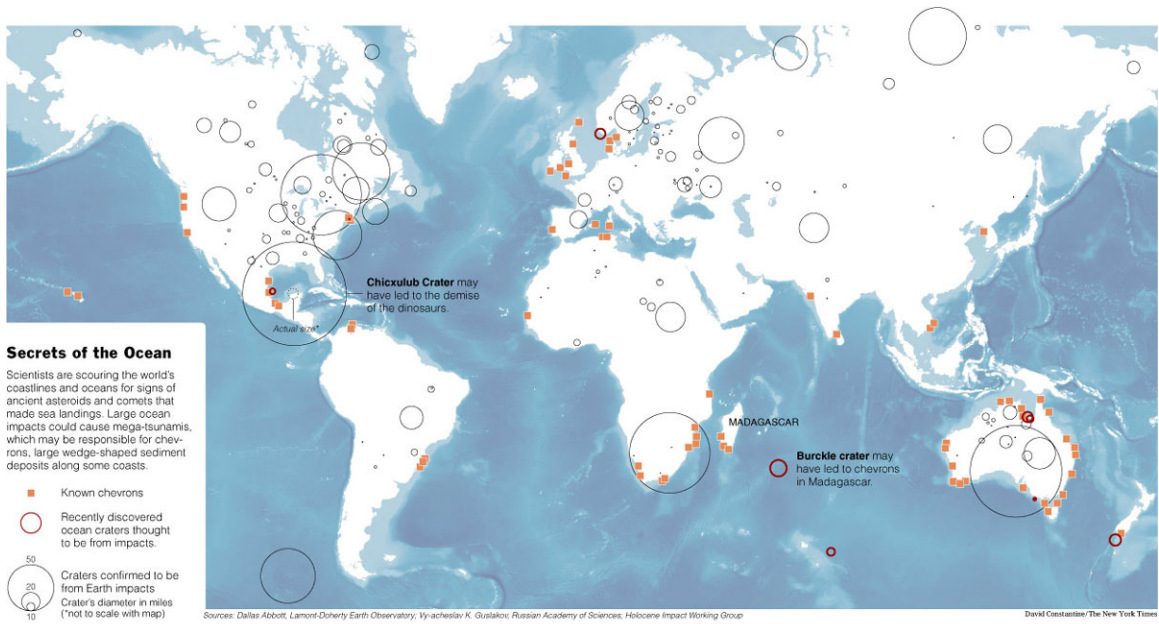
Burckle crater has not been dated, but Dr. Abbott estimates that it is 4,500 to 5,000 years old.

It would be a great help to the cause if the [National Science Foundation](#) sent a ship equipped with modern acoustic equipment to take a closer look at Burckle, Dr. Ryan said. "If it had clear impact features, the nonbelievers would believe," he said.

But they might have more trouble believing one of the scientists, Bruce Masse, an environmental archaeologist at the [Los Alamos National Laboratory](#) in New Mexico. He thinks he can say precisely when the comet fell: on the morning of May 10, 2807 B.C.

Dr. Masse analyzed 175 flood myths from around the world, and tried to relate them to known and accurately dated natural events like solar eclipses and volcanic eruptions. Among other evidence, he said, 14 flood myths specifically mention a full solar eclipse, which could have been the one that occurred in May 2807 B.C.

Half the myths talk of a torrential downpour, Dr. Masse said. A third talk of a tsunami. Worldwide they describe hurricane force winds and darkness during the storm. All of these could come from a mega-tsunami.



Of course, extraordinary claims require extraordinary proof, Dr. Masse said, "and we're not there yet."