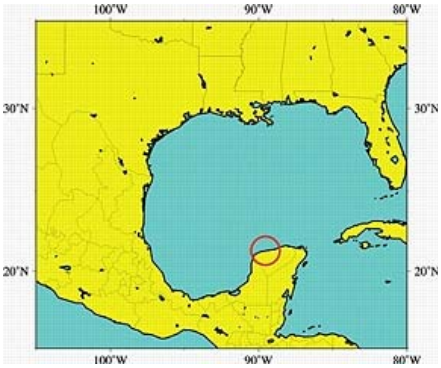
Dinosaur-Killing Asteroid Punched 22 Miles Through Earth's Entire Crust



Red circle represents the Chicxulub impact crater in northwestern Yucatan peninsula produced by the violent impact of an object about 6 miles (10 kilometers) wide when dinosaurs were alive on the earth 66 million years ago. Asteroid, or comet, it punched through 22 miles of the earth's crust and is thought to be the extinction event that annihilated more than 75% of all earth life. Map courtesy of marine geophysicist Gail L. Christeson.

January 7, 2001 Austin, Texas - Sixty-six million years ago more than 75% of all living earth creatures died. It was the end of a warm period called Cretaceous and the beginning of another named Tertiary. At that "K-T boundary," as scientists call it, there was a major, worldwide change that exterminated the dinosaurs. Experts have argued about the cause of the global extinction for at least two centuries. Twenty years ago physicist Luis Alvarez and his geologist son, Walter, reported the discovery of a worldwide layer of clay that has a high iridium content right at the K-T boundary layer in the earth's crust. Iridium is rare on earth, but abundant in some comets and asteroids, so the Alvarez team theorized that a comet or large asteroid must have hit the earth. When scientists looked for the greatest concentration of iridium, the data took them to the northwestern corner of the Yucatan peninsula in the Gulf of Mexico. There they found the massive 60-mile wide underwater crater called Chicxulub now thought to be the impact site.

Scientists have new and startling evidence from seismic technology that shows the earth's crust below the crater has been shattered and dented inward for 22 miles down to the earth's mantle. It's the first time anyone has documented such a deep impact. Recently at the December meeting of the American Geophysical Union in San Francisco, the new seismic data was presented by marine geophysicist Gail Christeson from the University of Texas at Austin. I asked her how such a deep puncture in the earth's crust can be defined.

Interview:

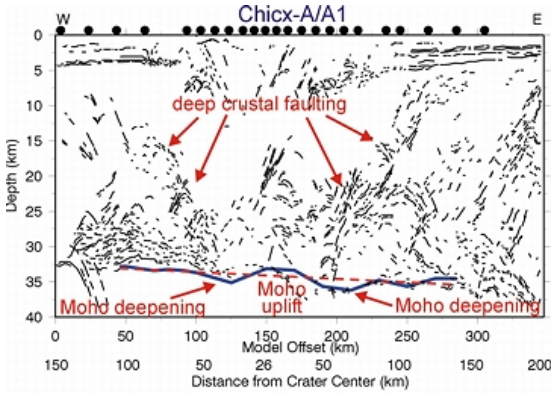
Gail Christeson, Ph.D., Research Associate, Institute for Geophysics, University of Texas at Austin, Texas: "The Chicxulub impact crater was

formed by an impact that was 65 million years ago, but has since been very well preserved because it happened in shallow water and there is about a kilometer of material on top of it of sediment that was laid on top of it in the past 65 million years. So, even though it happened that long ago, the structure itself is well-preserved. We think it is the best preserved large impact crater on the earth today.

BUT FROM YOUR WORK, ARE YOU SAYING THAT IF ANY OF US COULD GO UNDER THE WATER THAT WE WOULD BE SEEING A HOLE THAT WENT DOWN 22 MILES?

No, the way we look at the structure, we use a seismic technique and it's basically the same technique that has been used to look for oil. There are two different kinds, types of seismic techniques that we use: One is called seismic reflection and that's where you send a sound source into the earth and it bounces back and you get an image of the crust. And from that image, we can see deformation and faults that go through the entire crust that we think are related to this impact.

Two, and the other technique we use is called seismic refraction and that's where we do the same thing. We send sound into the earth, but we have receivers that are located both close to the source and far away. And from that we get a picture of the velocity structure underneath the earth. That's what I've been looking at to see what's happened at the base of the crust from the impact.



Line drawing of seismic reflection profile showing deep crustal faulting.
Also shown is position of Moho (crust-mantle boundary) showing relief associated with crustal deformation.
Graphic courtesy Gail Christeson.

THAT'S WHERE YOU HAVE PRESENTED IN THE PAPER THAT THE IMPACT 66 MILLION YEARS AGO PENETRATED THE CRUST OF THE EARTH DOWN 22 MILES, RIGHT?

Yeah, the impact itself. It didn't remove material that deep, but faulting related to the impact did penetrate through the entire crust. It hit and was pulverized and didn't remain a coherent object crashing through the crust. It's something that kind of spread out, the shock waves from it spread out over a much larger area and that's what caused most of the damage.

Further out, we see underneath the ground, we see faulting that is out to 200 kilometers diameter (121 miles) and these are the faults that go through the entire earth, the entire crust. So, from the ground all the way down 35 kilometers (22 miles) to the base of the crust. And associated with this deformation, we see faulting down at the crust/mantle interface.

MEANING LIKE IT'S SUNK IN?

Yeah. Well, you see the faulting, inwards faulting, and where that comes in it looks like the crust/mantle interface is depressed. And then inward of that at the epicenter of the crater it looks like the crust/mantle interface is uplifted a bit. And the 200 kilometer outer ring, we call it, seems to be equivalent to what we

see on the moon or other planets. The largest craters are called multi-ringed basins like Orientale on the moon. So, this is the first time where we can see what this outer ring looks like underneath the other dimension. So, the faulting that is linked all the way down to the crust/mantle interface will help us understand these other craters on the moon and Venus.

IT IS EQUIVALENT TO THROWING SOMETHING REALLY HARD LET'S SAY AT ADOBE AND IT HITS AND ENTERS THE ADOBE AND CRACKS FAR OUT WHERE IT HAS HIT?
Right. The deformation extends much further than the actual excavation.

HOW BIG AN OBJECT WAS THIS THING THAT COULD GO SO DEEPLY AND CAUSE SO MUCH VIOLENCE IN THE CRUST?
We think it was about 10 kilometers in size.

THAT'S ABOUT 6 MILES.
Yes.

TEXAS AND THE SOUTHERN UNITED STATES - WOULD ALL OF THAT AREA HAVE BEEN EXCAVATED BY THIS OBJECT COMING IN 66 MILLION YEARS AGO?
No, the part that is excavated is actually quite small, but the environmental consequences are very large because what would happen is, first of all, the heat of this large body traveling through the atmosphere would heat up the atmosphere and cause a fireball. So, you would have a burning of forests, certainly in Texas and across North America. So, first of all you have this heat.

Then the material from the crater that is brought up into the atmosphere would change the chemical composition and it actually ends up causing global cooling, the sulfur that is released. So, for about 10 years, it was quite a bit colder than it had been.

WAS THE SKY NEARLY DARK FROM ALL OF THIS?
Yeah, I guess it's like what people call nuclear winter. So, that happened and lasted for about a decade where you have it much cooler. And then you have global warming after that on top of the global cooling from all the CO2 that was put in the atmosphere, the greenhouse effect. So, it's very hot. Then it's cold for about a decade. And then it's warm for about a thousand, 2000 years. So, it's all of these effects together is what we think led to the extinction of the dinosaurs and all the other extinctions that happened at the K-T boundary.

DO YOU HAVE NOW SOME KIND OF 3-D GRAPHIC INTERPRETATION OF THAT HOLE YOU'VE DONE FROM RADAR IN A COMPUTER?
Well, we're still working on the full picture, but we can see some 3-D structures. We see the uplift. You can imagine this impact comes in and it removes a lot of material and so the material that is deeper down is uplifted in response. So now, we are getting a picture of what that uplift looks like and even all the way down to the crust/mantle boundary in 3 dimensions.

THE FORCE THAT IT WOULD TAKE TO LIFT THE MATERIAL 22 MILES DOWN UP, IS THERE ANY COMPARISONS YOU CAN MAKE THAT WOULD HELP PEOPLE UNDERSTAND WHAT KIND OF FORCE WE'RE TALKING ABOUT?
What the press release said is that it's a force that makes a nuclear blast seem like a firecracker. Because the amount of energy that's in a nuclear blast, those types of meteorites enter the atmosphere quite often, but they are not big enough to penetrate the atmosphere. So, these are really big events.

IS ANYONE SPECULATING ABOUT WHETHER A COMET COULD DO THIS, OR WHETHER IT HAS TO BE SOMETHING EXTREMELY STONY OR MADE OF IRON?
People do, there is some controversy over whether it was an asteroid, meteorite or comet, and that issue is still not resolved.

YOU DO NOT YET HAVE A CORE SAMPLING DEEP ENOUGH FROM WHATEVER THE OBJECT WAS THAT MIGHT STILL BE THERE?
Well, the problem is that the object itself is pulverized, so what remains is not the object. What people do look at is things like the iridium layer that is found throughout the earth from this impact. They look at that and based on the iridium that's found, some people say it has to be a comet based on that. But other people have found a little piece of a meteorite at the K/T Boundary and show that as proof that it had to be a meteorite.

MEANING THAT IT WAS MADE OUT OF IRON AS OPPOSED TO WHAT?
Yeah, a comet is more...

ICY SNOW BALL, BUT IT COULD HAVE DUST AND ROCK IN A COMET, I THINK.
Yeah, I think that's why it's still up in the air as to whether it was a comet or not.

WHAT IS THE RELATIONSHIP OF IRIDIUM TO COMETS?
Iridium isn't found on earth in the same quantities and ratios that you find in a comet or asteroid.

THERE'S MORE FROM EXTRATERRESTRIAL OBJECTS?
Yeah.

WHAT HAS BEEN THE MOST SURPRISING ASPECT OF DOING THIS RESEARCH FOR YOU PERSONALLY AS A MARINE GEOPHYSICIST?
I think what surprised me the most about this research is that the faulting that we observed that extends throughout the entire crust down to the crust/mantle interface and seems to actually have affected the topography at that interface by several kilometers is definitely what surprised me the most.

WHY WOULD THAT SURPRISE YOU?
I guess that most processes that I've worked with are of a much smaller scale. So, to see something that has effected the entire crust is...

ALL THE WAY DOWN 22 MILES.
Yeah, it's exciting and surprising.

THAT IS A HORRENDOUS AMOUNT OF ENERGY RELEASED.
Yeah, well, it gives you an idea of what happened to the dinosaurs.

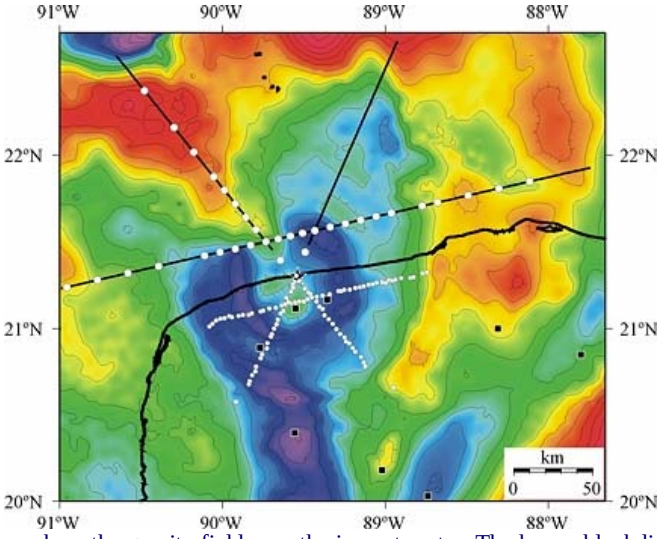
WHY IT CAUSED EXTINCTION.
Yeah, and not just the dinosaurs, but all the other life on earth. Most of it was wiped out."

More Information:

Other Research:

Gail Christeson: "It's kind of a strange environment where it hit, a shallow underwater sea. So, people ended up finding it by kind of zeroing in, by looking at how thick these impact layers were. They are thickest around North America, Central America. They started looking around there. It actually shows up in the gravity signature over the Yucatan, it's a circular structure that people now realize is from that impact.

You can measure very precisely the gravity and if you're over something hard, you actually have more gravity than over something soft. And with the crater because you have this big hole that was in-filled with soft sediment, you get the circular structure.



The colors show the gravity field over the impact crater. The heavy black line is the coastline of the Yucatan.
The asterisk at the center shows approximate center of Chicxulub crater. Thinner black lines show locations
of seismic reflection profiles. White circles show positions of onshore and offshore seismic receivers from
1996 seismic experiment. Gravity data courtesy Alan Hildebrand and Mark Pilkington, Geologic Survey of Canada.

IF YOU WENT STRAIGHT DOWN WITH CORE DRILLING, LET'S SAY 20 MILES OR SOMEWHERE IN THAT VICINITY, IS IT STILL POSSIBLE TODAY THAT YOU MIGHT CORE DRILL RIGHT INTO WHAT WOULD BE LEFT OF THE SOLID ASPECT OF THIS OBJECT NEAR THE BOTTOM OF THE 22 MILES?

I think the object itself was so pulverized and spread out, I don't think you're going to find a chunk of it. People are going to drill in certain spots on the crater and what you want to look at is the material that was replaced from the impact and see what's beneath that as well. Because the more we can tell about what was there helps us understand better in the modeling about the environmental consequences."

More Information:

In 2001, an international team of scientists plans to drill a deep hole into the Chicxulub crater.

Credits