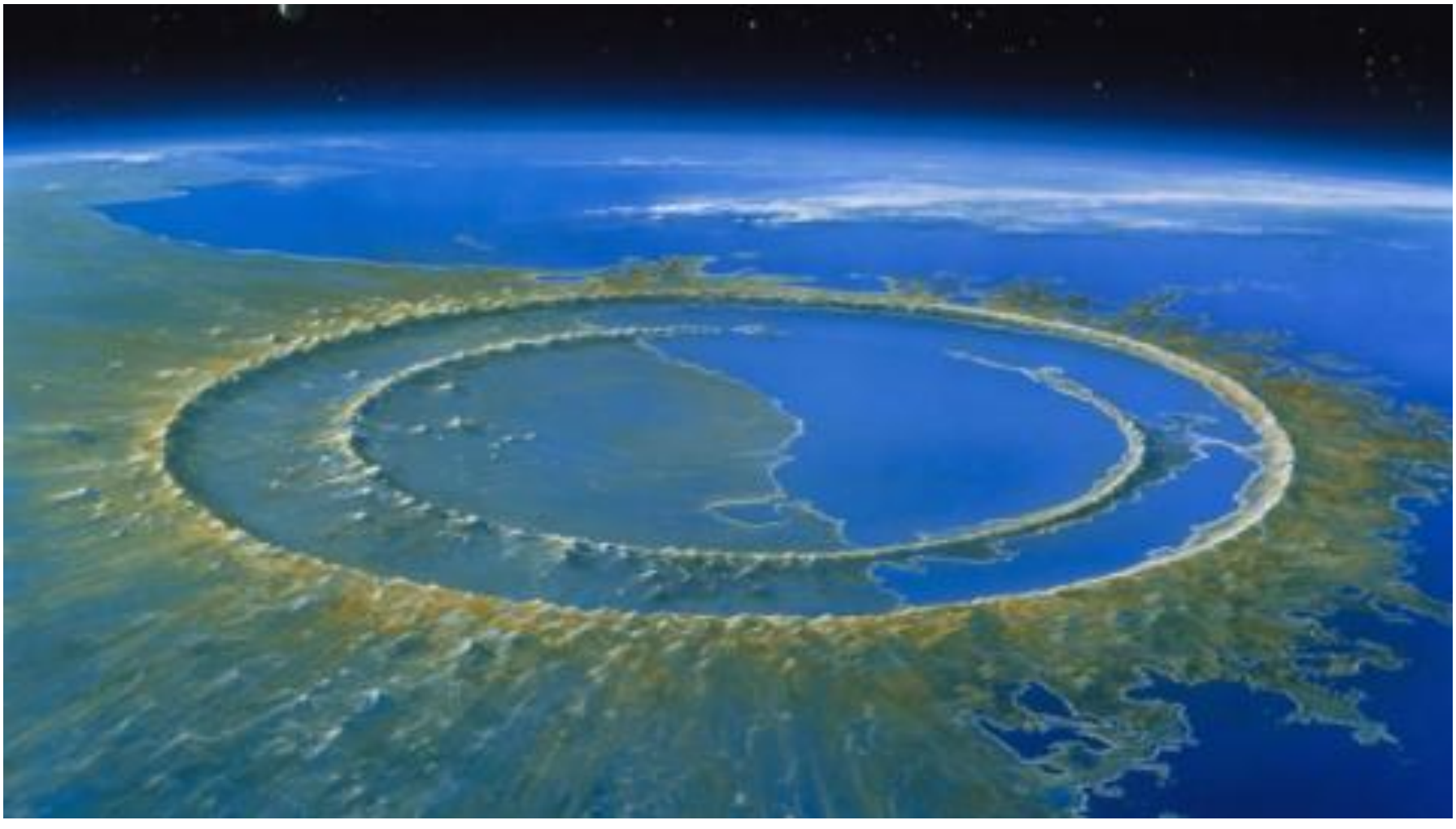


Artist's reconstruction of Chicxulub crater soon after impact, 66 million years ago.

DETLEV VAN RAVENSWAAY/SCIENCE SOURCE

Scientists gear up to drill into 'ground zero' of the impact that killed the dinosaurs

By Eric Hand | Mar. 3, 2016 , 2:00 PM

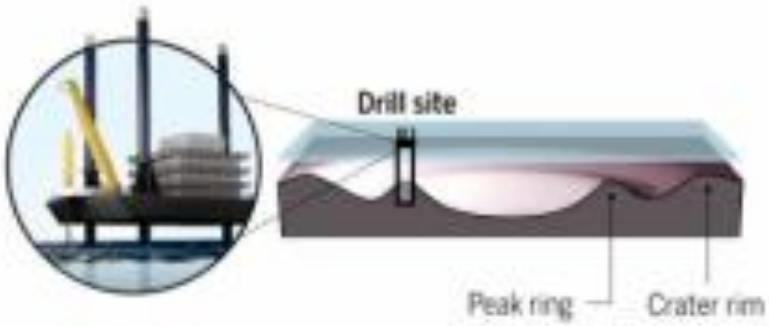
This month, a drilling platform will rise in the Gulf of Mexico, but it won't be aiming for oil. Scientists will try to sink a diamond-tipped bit into the heart of Chicxulub crater—the buried remnant of the asteroid impact 66 million years ago that killed off the dinosaurs, along with most other life on the planet. They hope that the retrieved rock cores will contain clues to how life came back in the wake of the cataclysm, and whether the crater itself could have been a home for novel microbial life. And by drilling into a circular ridge inside the 180-kilometer-wide crater rim, scientists hope to settle ideas about how such "peak rings," hallmarks of the largest impact craters, take shape.

"Chicxulub is the only preserved structure with an intact peak ring that we can get to," says University of Texas, Austin, geophysicist Sean Gulick, co–chief scientist for the $10 million project, sponsored by the International Ocean Discovery Program (IODP) and the International Continental Scientific Drilling Program. "All the other ones are either on another planet, or they've been eroded."

At the end of March, a specially equipped vessel will sail from the Mexican port of Progreso to a point 30 kilometers offshore. There, in water 17 meters deep, the boat will sink three pylons and raise itself above the waves, creating a stable platform. By 1 April, the team plans to start drilling, quickly churning through 500 meters of limestone that were deposited on the sea floor since the impact. After that, the drillers will extract core samples, in 3-meter-long increments, as they go deeper. For 2 months, they will work day and night in an attempt to go down another kilometer, looking for changes in rock types, cataloging microfossils, and collecting DNA samples (see figure, below). "We've got one shot to try and get this down to 1500 meters," says David Smith, the IODP operations manager at the British Geological Survey in Edinburgh, U.K.

Going deep

Using a three-legged lift boat to create a stable drilling platform, scientists will drill 1500 meters deep, and back in time. Some layers took millions of years to form, whereas others were laid down in minutes.



1 Switching of the bits (500 m)

At first, no cores will be taken in layers of limestone. After casing the hole with steel, scientists will switch from a tungsten-carbide roller cutter to a diamond-tipped system that can retrieve 3-meter-long cores.

2 Paleocene–Eocene Thermal Maximum (550 m)

A time 55 million years ago when Earth was 5°C warmer. The warmth may have triggered algal blooms that died and fell to the sea floor. These might show up in the rock record as black shales amid the limestone.

3 Life returns (550–650 m)

The scientists will look for life coming back after the impact, as the shelled animals that make up limestone return and evolve into new species. Moving downhole and back in time to the impact, the size and number of species of forams and coccolithophores is expected to shrink.

4 Impact layer (650–800 m)

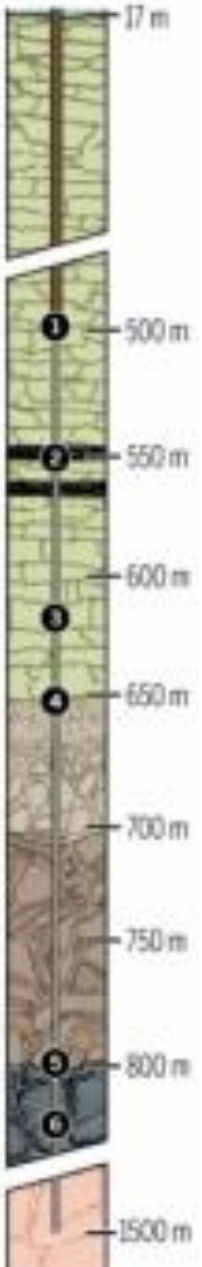
Rocks at the base may contain chunks of rock and impact melt. The ocean rushing in to fill the crater hole could have deposited overlying sediment, perhaps containing glassy impact spherules. Settling on top could be fine ash containing crystals of shocked quartz.

5 Peak ring (800–1500 m)

If formation models are correct, peak ring rocks—probably volcanic granites—could be sitting "out of order." Deeper granites, with darker minerals, could rest on top of granites with lighter minerals.

6 Microbial life (800–1500 m)

The peak ring is expected to be fractured and filled with mineral veins that were once part of a vast hydrothermal system. Scientists will look for DNA evidence that chemosynthetic microbes live in the cracks.



(DIAGRAM) V. ALTOUNIAN/*SCIENCE*; (PHOTOS) CHRIS JENSON, DES; DAVE SMITH, ECORD; MICHAEL RYMER; DAVID KRING; GEOLOGICAL SOCIETY OF AMERICA; ARTOGRAPHY/SHUTTERSTOCK; VILAX/SHUTTERSTOCK; HINRICH BAESEMANN/ALAMY

Although this is the first offshore attempt to drill into the crater, roughnecks have sunk wells into it on land—even before scientists knew a crater was there. In the 1950s, geologists for Pemex, Mexico's national oil company, conducted gravity and magnetic surveys of the Yucatán Peninsula and were intrigued to see underground circular structures—possible oil traps. They drilled several exploratory wells but lost interest when they got volcanic rocks instead of oil-bearing sediments. "When they found the igneous rocks, they said, 'Oh, this is a volcanic center,'" says Alan Hildebrand, a geologist at the University of Calgary in Canada.

In 1980, however, Nobel laureate Luis Alvarez and others called attention to a thin layer of iridium—possible material from an asteroid—found all over the world in rocks from the time of the dinosaur extinctions. It was the signature, they said, of a previously unsuspected cause of the extinctions: a giant impact. In 1991 Hildebrand and colleagues fingered the village of Chicxulub as the site of the cataclysm, finding quartz crystals shocked by an impact in samples from the Pemex wells—samples that had sat around for more than a decade. "Some people are a little embarrassed about that these days," he says.

The data from the Pemex wells were spotty, and so scientists have always wanted to go back for a detailed look at the impact and its aftermath, says co–chief scientist Joanna Morgan of Imperial College London. "It seems like a lifetime's ambition coming true," says Morgan, who first proposed a scientifically cored well to the IODP in 1998. Although offshore drilling is expensive, she says that working at sea means the team will face fewer hassles with environmental permitting and won't have to cope with the Yucatán's poor roads. In 2005, Morgan and Gulick led a $2 million remote-sensing campaign that used small seismic explosions to help illuminate the subterranean structures and pinpoint the best spot to reach the peak ring.

As the drill approaches the crater, 800 meters down, scientists expect to find fewer species of the shell-producing animals that make up the limestone, because life was just recovering from the impact. Some scientists think that carbon dioxide released by the impact would have acidified the oceans, contributing to the extinctions, so the drill team will look at whether seafloor animals just after the impact were species that tolerate low pH.

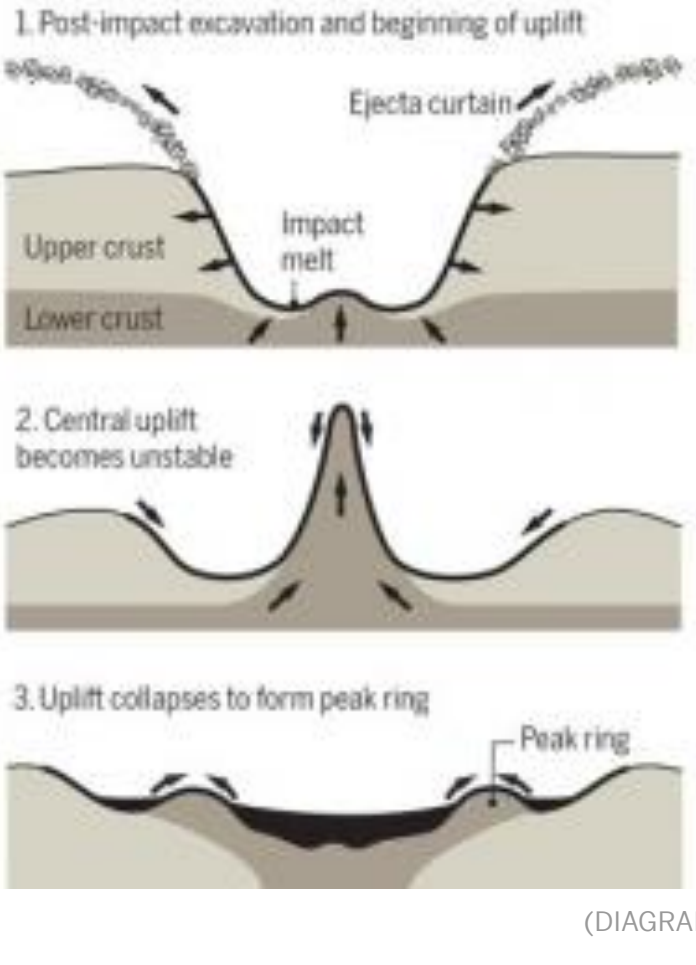
Just above the crater lies an impact layer, 100 meters or more thick, that would have been deposited in the weeks after the cataclysm. At its base, scientists expect to find a hodgepodge of chunks of bedrock blasted up by the impact and once-molten rock that fell back into the crater in the minutes after impact. Above that would be sediments, since hardened into rock, that were swept in as the ocean rushed into the vast new depression. The impact layer may be capped by hardened deposits of ash that persisted in the atmosphere for weeks or more before falling out.

Probing ground zero

In April, scientists will drill into Chicxulub crater, where an asteroid impact 66 million years ago led to one of Earth's biggest mass extinctions. They hope to reach a buried peak ring, Earth's only preserved example.

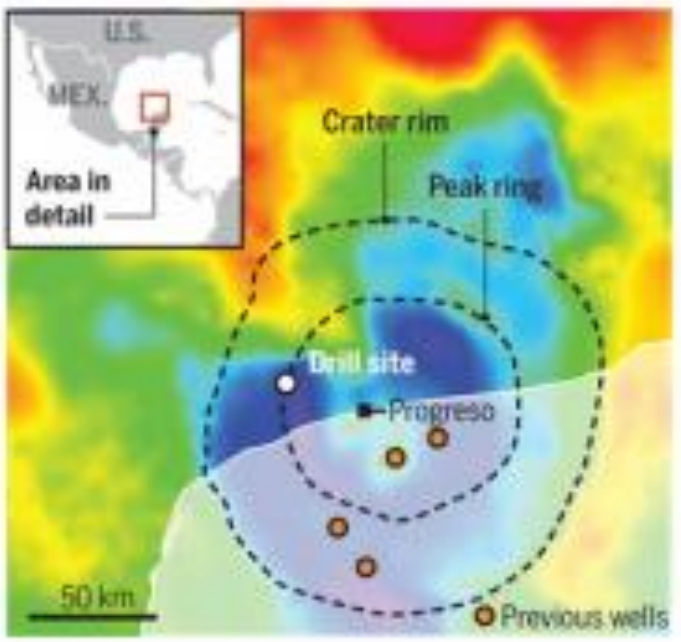
Making the mounds

Impact shocks could make rocks behave like fluids, piling deep crustal rocks on top of rocks of shallower origin.



Buried treasure

Offshore from Progreso, Mexico, scientists will drill into the crater's peak ring, partially seen in geophysical remote sensing data (below). Onshore wells have been drilled into the crater before, but few were cored and none reached the peak ring.



(DIAGRAM) V. ALTOUNIAN/*SCIENCE*; (MAP) SEAN GULICK, UNIVERSITY OF TEXAS

For many of the IODP scientists, the main event will be reaching the peak ring. Peak rings abound on the moon, Mercury, and Mars. But on Earth, there are just two craters larger than Chicxulub that should also have peak rings: the 2-billion-year-old Vredefort crater in South Africa, and the 1.8-billion-year-old Sudbury crater in Canada—yet they are so old that the peak rings have eroded away.

The IODP team wants to test a leading model for peak ring formation, in which granite from Earth's depths rebounds after a major impact, like water struck by stone, to form a central tower, taller than the crater rim. In minutes, the tower would collapse and collide with material slumping in from the rims to form the peak ring. Confirmation for the model could come from finding rocks "out of order": deep rocks, probably granite, brought up in the central tower, lying atop originally shallower younger rocks. "They're going to test whether our numerical models are making any sense or not," says Jay Melosh, a planetary scientist at Purdue University in West Lafayette, Indiana, who helped develop the model.

The team is interested not just in the structure of the peak ring rocks but in what life they might host. Remote sensing has already suggested that the peak ring is less dense than expected for a granite—a sign that the rocks are porous and fractured in places. It is possible that these fractures, in the wake of the impact, were filled with hot fluids. "Those

will be preferred spots for microbes to grow, but it depends whether the fractures have energy and nutrients," says Charles Cockell, an astrobiologist on the IODP team at the University of Edinburgh. When the drill bit encounters mineral veins or other fracture zones in the peak ring, Cockell and his colleagues will take a subcore from the core: a biopsy on the geopsy. They will count and culture any microbes still living in the fractures, and sequence DNA to look for the genes responsible for metabolic pathways.

Those genes might show that peak ring microbes—descendants of those that lived after the impact—derive their energy not from carbon and oxygen, like most microbes, but from iron or sulfur deposited by hot fluids percolating through the fractured rock. And that would mean the impact crater, harbinger of death, was also a habitat for life.

Posted in: **Technology**

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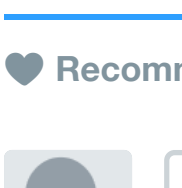

Eric Hand

Eric Hand is a staff writer who covers Earth and planetary science.

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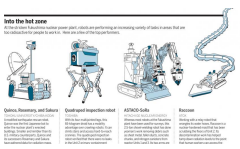

Trial by meltdown

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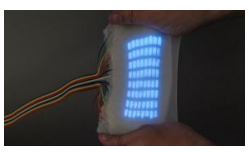

Video: Robot worm glows in rainbows as it crawls

Foggydogbreath · 2 days ago

This is a science publication, but it states: "Scientists will try to sink a diamond-tipped bit into the heart of Chicxulub crater—the buried remnant of the asteroid impact 66 million years ago that killed off the dinosaurs, along with most other life on the planet."

There's not a shred of evidence that it was the impact site of the meteor that killed off most life on this planet. It's a hypothesis. State it that way like a good scientist would until there's proof enough to state otherwise.

9 · Reply · Share ›

gazzang ↗ Foggydogbreath · 2 days ago

It is not an hypothesis. It is one of several theories well supported by evidence. The drilling may shed further light on the formation of massive craters whether it will shed more light on the extinction event is an open question.

9 · Reply · Share ›

pjsx ↗ gazzang · 14 hours ago

Theories should not be stated as facts until they are facts.

Reply · Share ›

gazzang ↗ pjsx · 7 hours ago

Theories are what explain facts not vice versa. Without facts you have no theory. The evidence for a large asteroid impact coinciding with the extinction of the dinosaurs is a fact supporting the theory that such an impact wiped out the dinosaurs.

Reply · Share ›

Brandon ↗ gazzang · 7 hours ago

You do realize that Hypothesis and Theory are both synonyms of each other right?

Reply · Share ›

Liz ↗ Foggydogbreath · 2 days ago

Exactly, this may be the thing that finally confirms it 100% for certain.

4 · Reply · Share ›

Charles Barnard ↗ Foggydogbreath · a day ago

The only unknown here is how much of the die-off was due to this impact, and how much was due to the massive lave flows which started 250,000 years BEFORE the impact and continued for another 500,000 afterwards...plus other contributors.

Humans have a built in need to explain things--regardless of how much sense the explanation makes. As creatures who create things, one of our earliest assumptions was that the world must have a creator...not based upon anything other than a need to explain.

We greatly prefer single explanations for things, thus our science (a very new way

of explaining) has it's roots in reductionism--find a single explanation. Our previous system was based in "authority says" to the point of ridiculousness. (For hundreds of years people believed that we saw by means of light beams from our eyes--despite being unable to see in the dark--because "Aristotle said so."

Unfortunately the universe is seldom that simple. Everything is interacting.

Equally unfortunately our legal system is based upon theological law, and in theology there are no gray areas--it's either correct or heresy. Since in the real world people can be partially right or wrong as well as totally, and there are also multiple ways to arrive at the same situation, our courts are still unbalanced to deliver justice on any regular basis (so much so that the vast majority of disputes never see court--though there are no statistics.)

The difference is that depending upon authority is unchallengeable, and science can be challenged by new information. If authority is wrong, it will remain wrong for far longer than beliefs based upon evidence.

2 · Reply · Share ›

Jbar ➚ Charles Barnard · 20 hours ago

Such wisdom is refreshing!

· Reply · Share ›

ZeeXenon ➚ Foggydogbreath · 2 days ago

Maybe this is why they are going to check it out. FYI, our weather and other natural phenomenon have erased most craters, except more can be seen by applying the correct wavelength using satellite. For sure, Scientist-A and Scientist-B will never agree on whatever evidence they find. But, then there is that worldwide iridium geologic layer which is an uncommon (limit--> 0) element in the earth's crust. Also, I have been told, unequivocally, based on your car purchases and voting record that you are incomplete.

3 · Reply · Share ›

ts ➚ ZeeXenon · a day ago

Can you say more about the "worldwide iridium ... layer"; not familiar with that. I think it's great that they are drilling, be it hypothesis, theory, whatever...

· Reply · Share ›

Stannous Flouride ➚ ts · a day ago

Iridium is an element that is rare on earth but common on asteroids so the discovery of it at the K/T boundary pointed to an outside source.

Look up "Luis Alvarez iridium" online. It's a quite fascinating bit of scientific detective work. And part of it is that the layer of it varies in thickness around the earth but is thicker in areas adjacent to the northern tip of Yucatan.

5 · Reply · Share ›

David Ocame ➚ Stannous Flouride · a day ago

Ok, good. I was just going to say that part of the "shreds of evidence" is the variable thickness of this layer, starting out thicker near the crater and getting thinner further away.

2 · Reply · Share ›

halodule ➚ ts · a day ago

From the article...
"In 1980, however, Nobel laureate Luis Alvarez and others called attention to a thin layer of iridium—possible material from an asteroid—found all over the world in rocks from the time of the dinosaur extinctions. It was the signature, they said, of a previously unsuspected cause of the extinctions: a giant impact."

Basically though, it's one of the rarest elements on earth, but is commonly found in asteroids/meteors. Therefore they hypothesize the only way an iridium layer could be found on all of the rocks that are at least as old as the dinosaur extinction is if a giant asteroid hit the earth and deposited particles after impact. Such a large impact would likely have left ash and other particles in the atmosphere for days, if not weeks, making it possible for iridium to be deposited all over the world.

2 · Reply · Share ›

Charles Barnard ➚ ts · 16 hours ago

Wikipedia /wiki/Cretaceous%E2%80%93Paleogene_boundary

· Reply · Share ›

bob ➚ Foggydogbreath · 2 days ago

You don't know what you're talking about.

2 · Reply · Share ›

nothingnessx2 ➚ bob · 2 days ago

you don't know what you're talking about!

· Reply · Share ›

David Ocame ➚ Foggydogbreath · a day ago

There's actually a big shred of evidence. Have you been breathing too much of your doggybreath? :)

· Reply · Share ›

Phoghat ➚ Foggydogbreath · 2 days ago

if only they got to "M" in the dictionary, so they could have put the words "may have"

Reply · Share ›

mitchell costa ➚ Phoghat · a day ago

But they put words like remnant and tipped, which is well past M

Reply · Share ›

Charles Barnard ➚ mitchell costa · 16 hours ago

Some people have trouble alphabetizing...

Reply · Share ›

eddiestardust ➚ Foggydogbreath · 2 days ago

I agree that you don't know what your talking about Foggy:(

Reply · Share ›

Juan Jose Trillado Melendez · a day ago

Yucatán's poor roads? Have you ever been to Yucatán? Yucatán has best roads in Mexico.

2 · Reply · Share ›

Stannous Flouride ➚ Juan Jose Trillado Melendez · a day ago

And the road between Merida and Progreso is an arrow-straight smooth, six lane highway.

Though the road to the village of Chixculub is a bit bumpy.

Reply · Share ›

Woof! · 2 days ago

Woof!

2 · Reply · Share ›

Blake Hebb ➚ Woof! · 2 days ago

Are you having a ruff day?

1 · Reply · Share ›

Yeet · 2 days ago

actually that is a crop circle, dinosaurs died from a virus that ate their protective shells, the carapace that encased the dinosaurs were susceptible to silicate eating microbes, which inevitable ended in the demise of the dinosaurs in the late crustaceous period

3 · Reply · Share ›

Jbar ➚ Yeet · 19 hours ago

I thought smoking killed them
according to Larson, et al.

Reply · Share ›

winston ➚ Yeet · 2 days ago

In real life it looks nothing like the illustration above.

Crop circles are the work of artists and hoaxers are usually created in fields of crops,, so i guess youre trolling.

Reply · Share ›

Addison · 3 days ago

Good luck with that. I'm just as eager as anyone to find what's down there. However, 1) drilling may not go smoothly given the nature of the rocks (fractured and/or re-melted into crystalline rock) and 2) I honestly think what they find is hardly going to be as simple as "Here are sediments deposited directly after the impact that prove how devastated Life was) - given the more likely scenario of erosion of the impact scene before preservation, I bet they only end up more confused than ever as to how the K-T mass extinction took place (the Deccan basalt eruptions already have proven, through Gerta Keller's work, that their timing fits not just the end K-T extinction but also the pulses of extinction that occurred throughout the Late Cretaceous).

4 · Reply · Share ›

PseudokuScience ↗ Addison · 2 days ago

Gee, if only they had consulted Addison from the internet before embarking on a 10 million dollar project being headed by PhDs who have dedicated their life to research in the field. I'm sure none of them even considered the potential complications you've listed!

20 · Reply · Share ›

Dave Leppert ↗ PseudokuScience · 2 days ago

I've been the geologist and provided oversight on drilling hundreds, if not thousands, of core holes and Addison is correct in stating that it could be very difficult to complete this hole. Also, the PhD's who have dedicated their life to research in this field very likely do not have extensive drilling experience though they undoubtedly consulted with people who do have that experience. Either way, it will be a difficult project to complete and I wish them the best of luck.

3 · Reply · Share ›

Jbar ↗ Dave Leppert · 18 hours ago

No you see, that's the problem with cutting edge research. You don't know exactly what you'll find.
That is WHY you do it!!

1 · Reply · Share ›

Dave Leppert ↗ Jbar · 18 hours ago

Of course you never know what you'll find. That's why you put the bit to the ground.

1 · Reply · Share ›

Scott Hart ↗ Dave Leppert · a day ago

Seems Addison was just pointing out that the odds of finding

something inconclusive are significant, not that they shouldn't try - maybe they will find something conclusive, or at least compelling. I don't think those providing $10 mil in funding would not vet the potential problems and risk, just that they felt it was an acceptable risk for that investment.

Reply · Share ›

Dave Leppert ➚ Scott Hart · 21 hours ago

Only way to find out is to give it a try. The truth is in the core.

Reply · Share ›

Betty T. ➚ PseudokuScience · 2 days ago

Shadiest shade ever shaded....

3 Reply · Share ›

James Rafferty ➚ Addison · 2 days ago

I would like to ask you one question about Gerta kellers work. I haven't read any of it, but does this person's study give proof of HOW the deccan traps basalts caused the extinctions?

The volcanic CO2 output from these eruptions although very high, only resulted in a small increase in atmospheric levels and therefore accounted for a relatively low 1 -2 degree Celsius increase in global land surface temperature. The reason for this is the feedback systems that are in place globally such as increased weathering (carbon sink) and increased oil and coal production (also carbon sink).

The small increase in temperature wouldn't have been the cause of a mass extinction event of this amplitude, although the increased mid ocean ridge production from mid to late cretaceous times over 40 Ma would certainly have developed an actual long term climate change with temperatures increasing from that CO2 output.

Another source for the extinction is
needed aside from volcanism.

Reply · Share ›

Jbar · 20 hours ago

So many knowledgeable people in this thread. I'm verklempt!

1 Reply · Share ›

Michael Eversole · 2 days ago

I would love to go on this study.

1 Reply · Share ›

Neo Racer · 2 days ago

Climate change killed them! Bcus Obama said so!

2 Reply · Share ›

Phoghat ↗ Neo Racer · 2 days ago

such a shame that you're drinking again

1 · Reply · Share ›

dentcj ↗ Neo Racer · 2 days ago

Thanks Obama!

1 · Reply · Share ›

zloppolz · 17 hours ago

Will they find diamonds, perhaps precious metals?

· Reply · Share ›

i9 · 21 hours ago

Article needs edits to reflect that the Chicxulub crater is one theory-- not proven fact.

· Reply · Share ›

Charles Barnard · a day ago

"...on Earth, there are just two craters larger than Chicxulub that should also have peak rings..."
No. The crater under Antarctic ice which broke the primordial single continent into fragments also should also have such rings--its at least twice the size of Chicxulub.

· Reply · Share ›

Jbar ↗ Charles Barnard · 20 hours ago

References? Would love to read up on that!

· Reply · Share ›

Charles Barnard ↗ Jbar · 17 hours ago

Search "ancient antarctic meteor crater"

· Reply · Share ›

Lex_Z · 2 days ago

I'm curious about the composition of the debris from the KT boundry. We know which elements are present now but, taking into account the standard progression for the decay of elements, what was the probable composition when the materials were originally layed down?
It cannot be as it is at present as 66M years is longer than that of uranium for instance so, the abundance of iridium seems interesting.
I'm definitely not an expert but if any work has been done to determine the original composition, I would definitely like to know more and perhaps have someone point me in the direction of said info.

· Reply · Share ›

Caela Bialek ↗ Lex_Z · 2 days ago

Stable isotopes of iridium don't decay :) also, half-lives of different radioactive

isotopes (even of the same element) vary - U-238 has a half-life of more than 4.4 billion years.

4 ^ | v · Reply · Share ›

peterjohn936 · 2 days ago

I am surprised. I would have thought that the scientists would have been drilling the crater like fiends. There must be a lot of interest things to find considering how the crater was formed.

^ | v · Reply · Share ›

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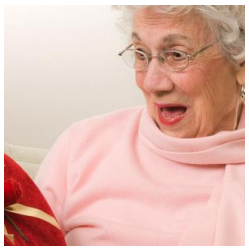

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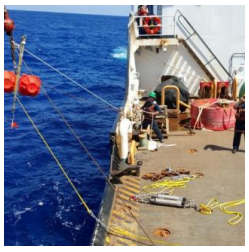

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