

K-T Extinction

Iridium Layer

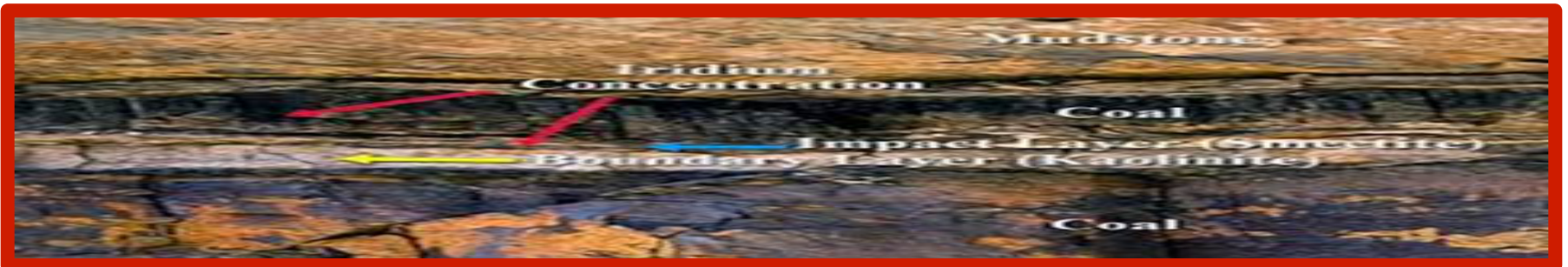
3 Meter Problem

What Happened

- ❑ What is the K-T boundary?
- ❑ K is the traditional abbreviation for the Cretaceous, and T is the abbreviation for the Tertiary.
- ❑ So the K-T boundary is the point in between the Cretaceous and Tertiary periods.
- ❑ Geologists have dated this period to about 65.5 million years ago.



- ❑ For many years, scientists believed that the K-T extinction was no great mystery: over millions of years, **volcanism, climate change**, and other events **gradually** killed off many forms of life.
- ❑ But, in the late 1970's, Walter Alvarez discovered that the KT layer was laced with unusually high amounts of the rare metal iridium.
- ❑ This was called the Iridium Anomaly
- ❑ They correctly hypothesized that the material was from the dusty remains of an asteroid impact.
- ❑ In 1980, they proposed that this impact was so large that it triggered the K-T mass extinction.

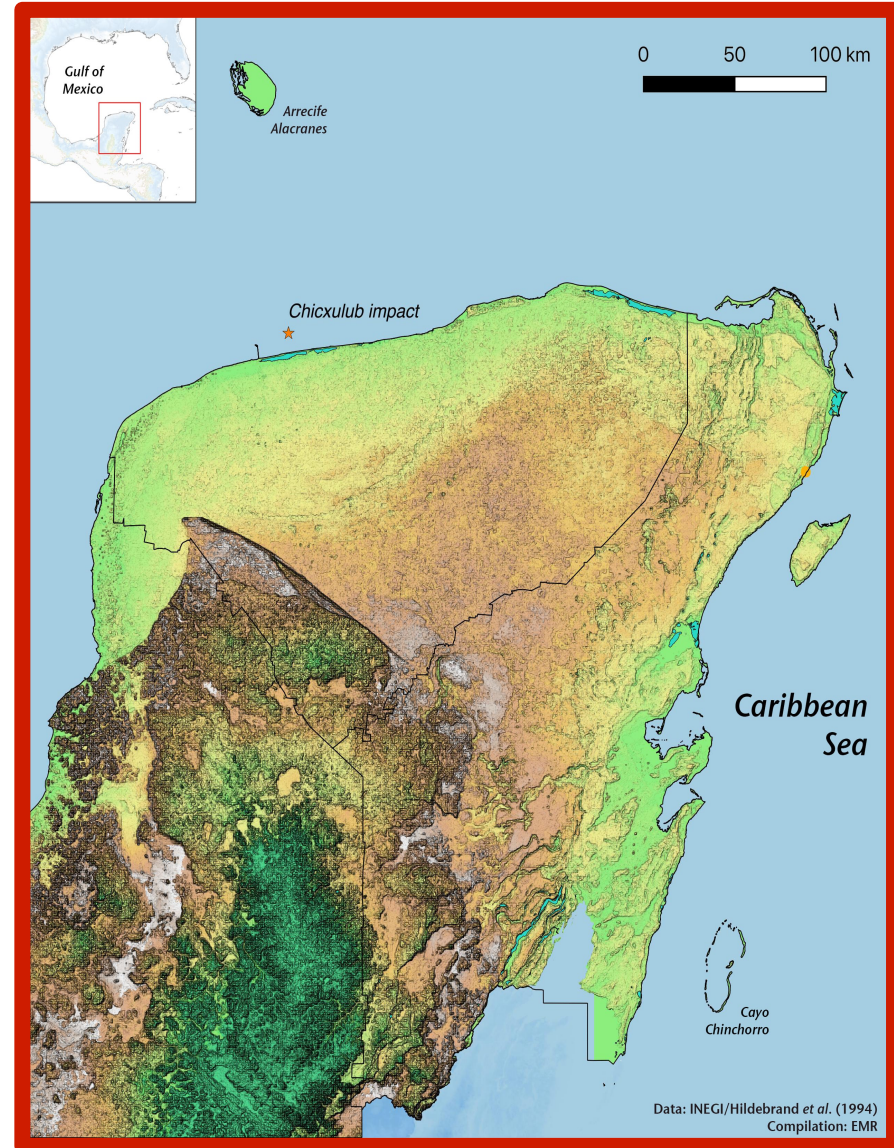


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- ❑ The term iridium **anomaly** commonly refers to an unusual abundance of the chemical element iridium in a layer of rock strata at the K-T boundary.
- ❑ Iridium is extremely rare in the earth's crust because it is a **siderophile**, and therefore most of it travelled with the iron as it sank into the earth's core during planetary differentiation.
- ❑ Iridium remains abundant in most asteroids and comets.
- ❑ Unusually high concentration of iridium is often taken as evidence for an extraterrestrial impact event.

□ The crater and the asteroid were named Chicxulub, after a small Mayan town near the epicenter..



AJYA-FYJA-ASJKA-YONA (E14)



Cheek

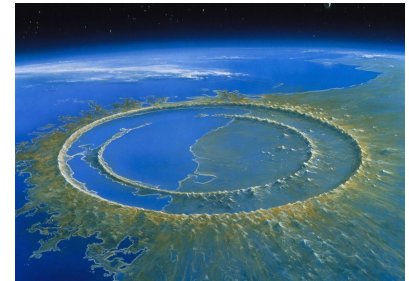
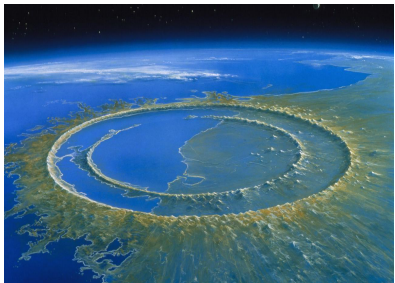


Saloub

CHEEK

SALUB

Chicxulub





- ❑ Imaging from space reveals part of the 110 mile diameter ring of the crater.
- ❑ This shaded relief image of Mexico's **Yucatán Peninsula** shows a subtle, but unmistakable, indication of the **Chicxulub impact crater**.
- ❑ This impact was the cause of the **K-T Extinction**, the event 65 million years ago that marked the sudden extinction of the dinosaurs as well as the majority of life then on Earth.

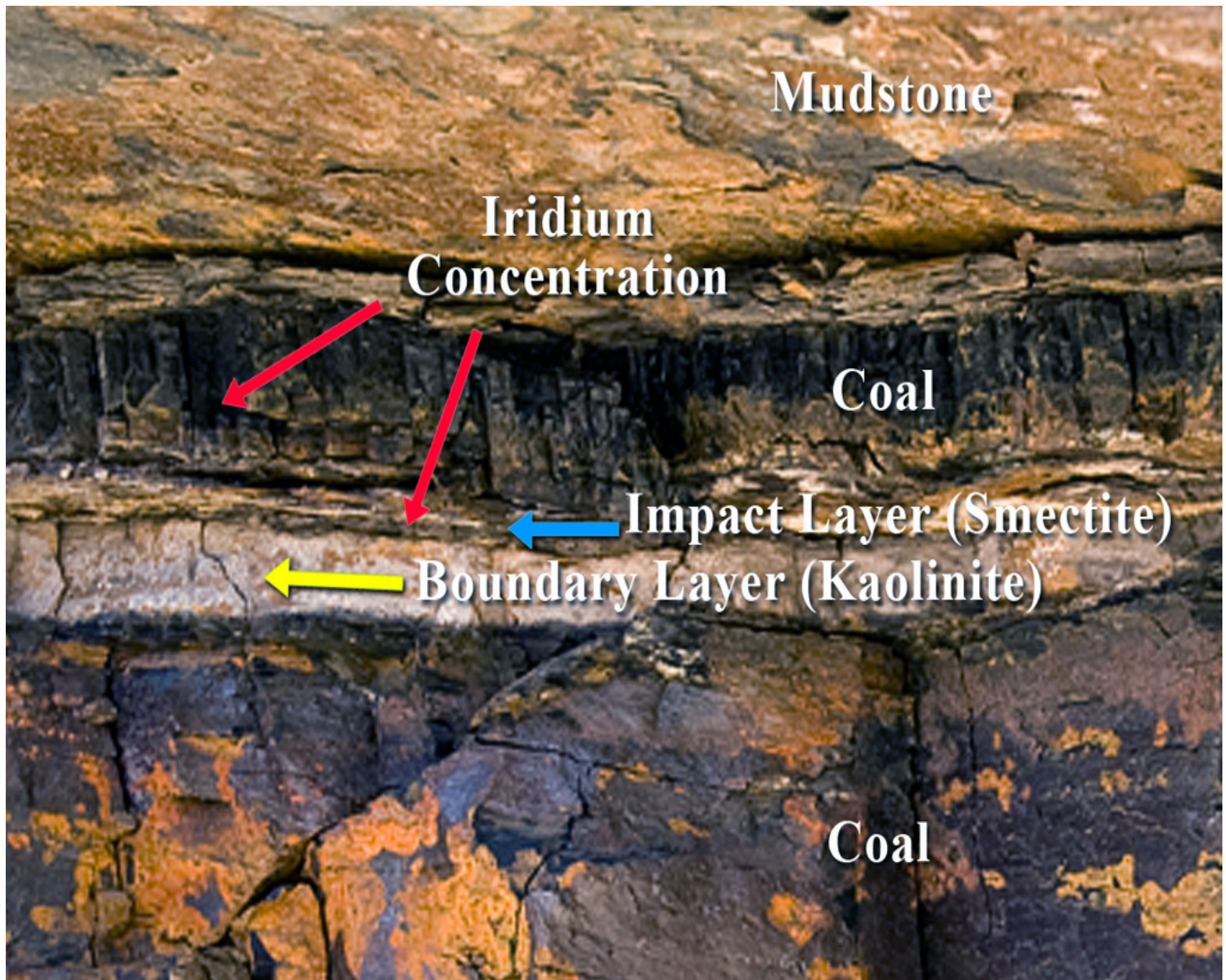
- ❑ One day sixty-six million years ago, life on Earth almost came to a shattering end.**
- ❑ The world that emerged after the impact was a much simpler place.**
- ❑ When sunlight finally broke through the haze, it illuminated a hellish landscape.**
 - ✓ The oceans were empty.**
 - ✓ The land was covered with drifting ash.**
 - ✓ The forests were charred stumps.**
 - ✓ The cold gave way to extreme heat as a greenhouse effect kicked in.**
- ❑ Life mostly consisted of mats of algae and growths of fungus: for years the Earth was covered with little other than ferns. Furtive, ratlike mammals lived in the gloomy understory;**

- ❑ One of the central mysteries of paleontology is the so-called “three--meter problem”.
- ❑ If dinosaurs were wiped out by the Chixcsulub incident there should be remains closer than 3 meters to the event.
- ❑ Despite assiduous searching, almost no dinosaur remains had been found in the layers three meters below the KT boundary.
- ❑ So paleontologists have argued that dinosaurs were on the way to extinction long before the asteroid struck, owing perhaps to volcanic eruptions and climate change.
- ❑ **BUT!**

- ❑ In 2013 fossils were found in North Dakota that seem to be direct victims of the asteroid.**
- ❑ At the K-T layer, tektites (glass globules that rained from the sky) were found, along with plants, trees, seeds, fish, mammals, and dinosaurs that shouldn't be there together.**
- ❑ Scientists think they were washed into the valley by a tsunami caused by the asteroid impact.**
- ❑ It would appear the whole KT event is preserved in these sediments.**
- ❑ Chicxulub seems directly responsible for the extinction events at the K-T boundary!!!!.**



Mind the gap!
Dinosaur bone he found just below fallout from an
asteroid impact (dark layers).



Mudstone

**Iridium
Concentration**

Coal

Impact Layer (Smectite)

Boundary Layer (Kaolinite)

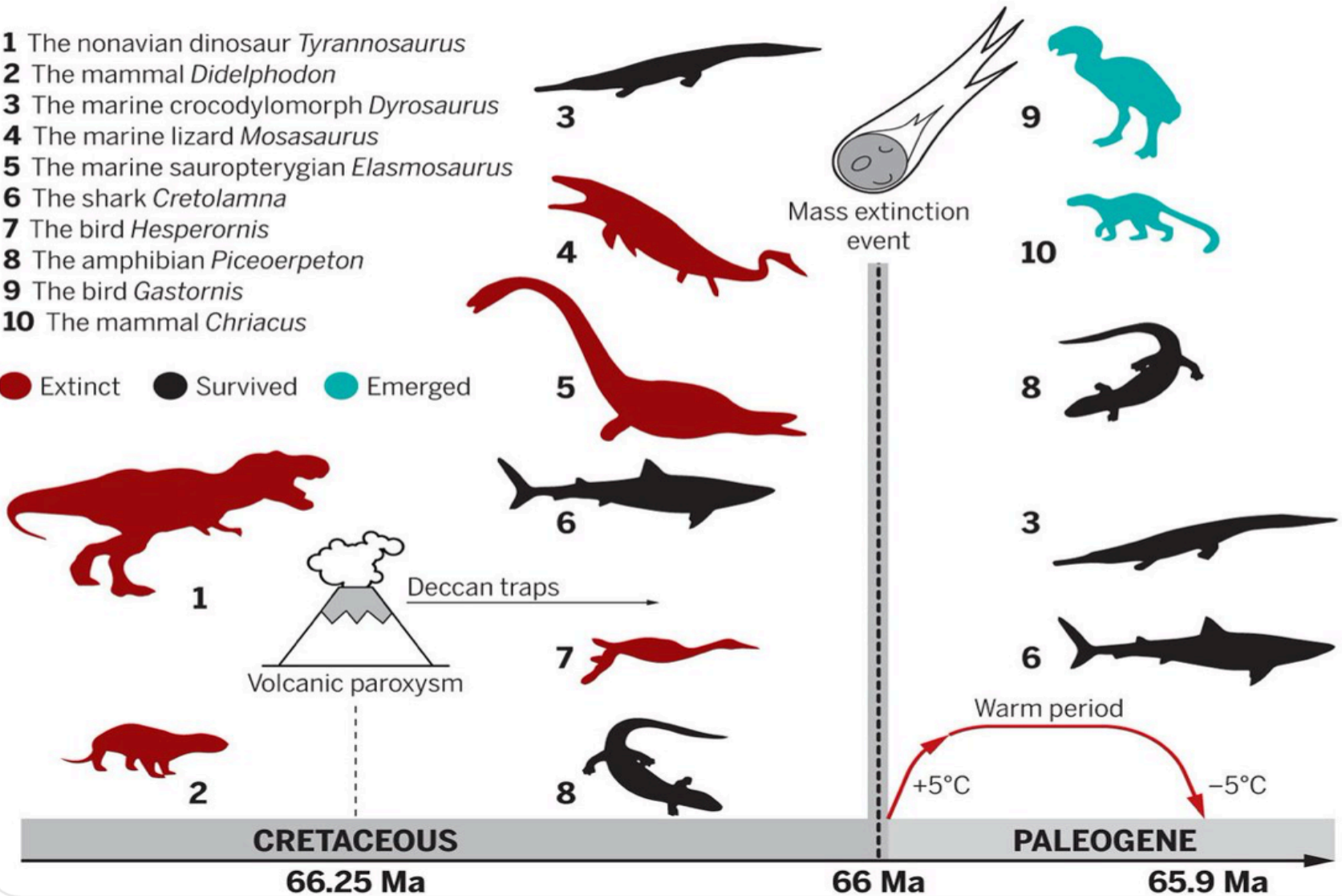
Coal

Learning from past climatic changes

66 million years ago, sea temperatures rose rapidly as a result of environmental perturbations. The result was a mass extinction event that led to the demise of nonavian dinosaurs and the rise of mammals and birds.

- 1 The nonavian dinosaur *Tyrannosaurus*
- 2 The mammal *Didelphodon*
- 3 The marine crocodylomorph *Dyrosaurus*
- 4 The marine lizard *Mosasaurus*
- 5 The marine sauropterygian *Elasmosaurus*
- 6 The shark *Cretolamna*
- 7 The bird *Hesperornis*
- 8 The amphibian *Piceoerpeton*
- 9 The bird *Gastornis*
- 10 The mammal *Chriacus*

● Extinct ● Survived ● Emerged



Big Things From Space

Ancient 'dust-up' altered life on Earth

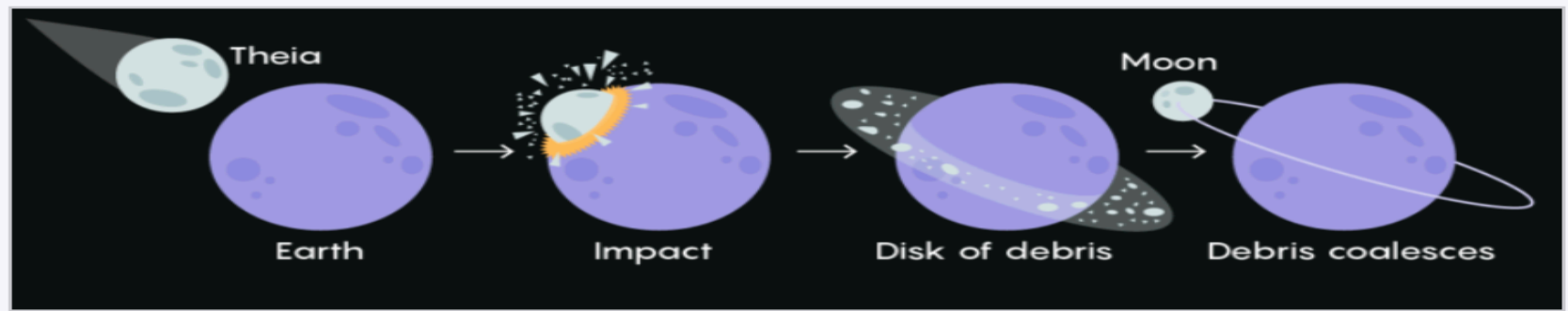
**Impact in
asteroid belt
400 million
years ago
triggered
major ice age
that ushered
in a
significant
increase in
marine
biodiversity**



2nd interstellar visitor to our solar system



- An unusual object detected streaking across the sky last month was a comet that originated outside our solar system, becoming only the second observed interstellar object to cross into our solar system.
- It has been named [2I/Borisov](#)
- It is anywhere between 1.2 and 10 miles in diameter.
- The comet has the most hyperbolic orbit out of the thousands of known comets.

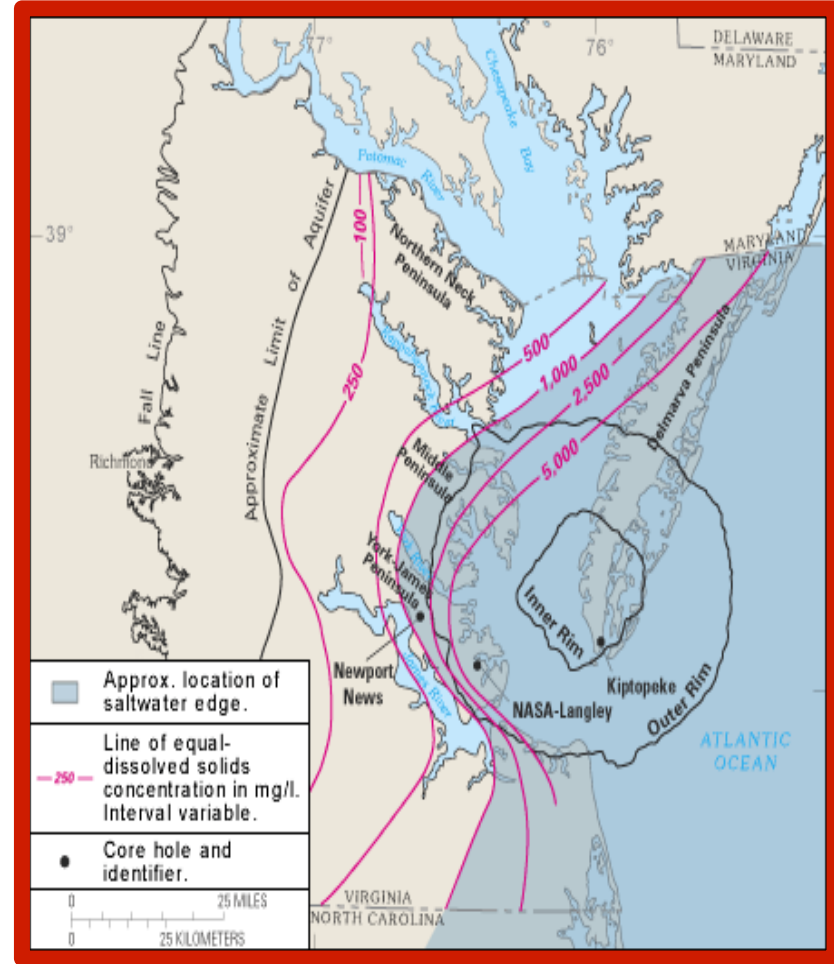
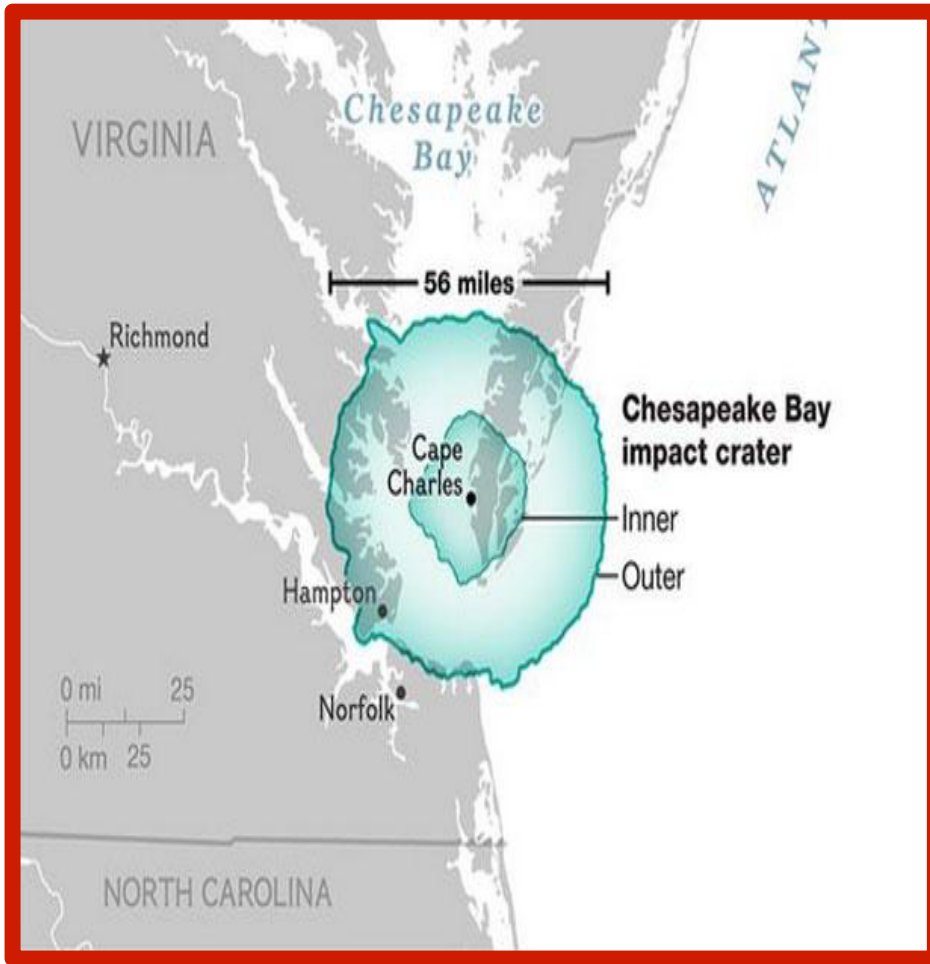


Simplistic representation of the giant-impact hypothesis.

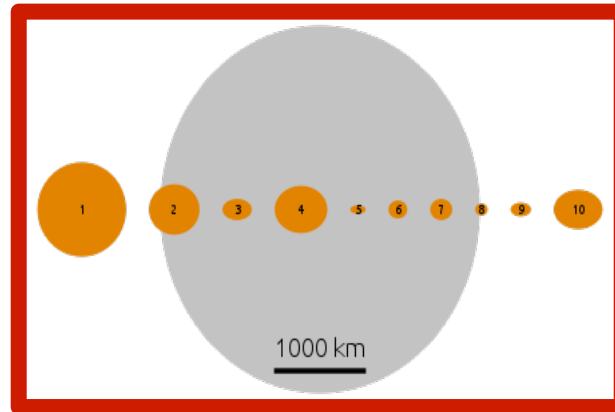
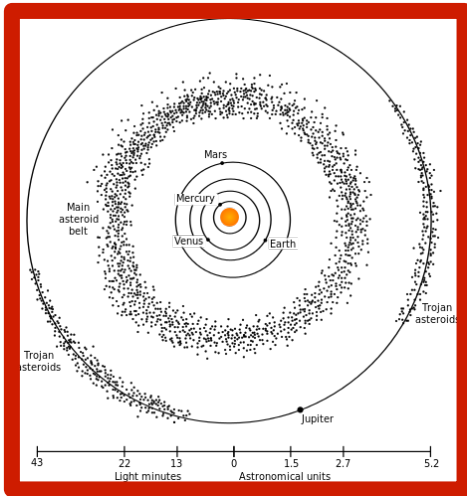


The **giant-impact hypothesis** is currently the favored **scientific hypothesis** for the **formation of the Moon**. Supporting evidence includes:

- ✓ Earth's spin and the Moon's orbit have similar orientations.
- ✓ Moon samples indicate that **the Moon's surface was once molten**.
- ✓ The Moon has a relatively small iron **core**.
- ✓ The Moon has a lower density than Earth.
- ✓ There is evidence in other star systems of similar collisions, resulting in **debris disks**.
- ✓ Giant collisions are consistent with the leading theories of the **formation of the Solar System**.
- ✓ The stable-isotope ratios of lunar and terrestrial rock are identical, implying a common origin.



- The Chesapeake Bay impact crater was formed by a **bolide** that **impacted** the eastern shore of **North America** about 35.5 ± 0.3 million years ago, in the late **Eocene** epoch.
- It is one of the best-preserved "wet-target" **impact craters** in the world.



Sizes of the first ten asteroids to be discovered, compared to the Moon

- ❑ There are now more than 150 asteroids known that come nearer to the Sun than the outermost point of Earth's orbit.
- ❑ These range in diameter from a few meters up to about **8 kilometers**.
- ❑ There are some **2,100** such asteroids >1 km and perhaps **320,000** > 100 meters, the size that caused the the Arizona Meteor Crater.

- ❑ An impact by one of these larger meteors in the wrong place would be a catastrophe, but it would not threaten civilization.
- ❑ However, an impact by an asteroid larger than **1-2** kilometers could degrade the global climate, leading to widespread crop failure and loss of life.
- ❑ In addition there are many comets in the **1-10** kilometer class, **15** of them in short-period orbits that pass inside the Earth's orbit, and an unknown number of long-period comets.
- ❑ Virtually any short-period comet among the **100** or so not currently coming near the Earth could become dangerous after a close passage by Jupiter