Meteorites, Asteroids and the Last Great Extinction Event

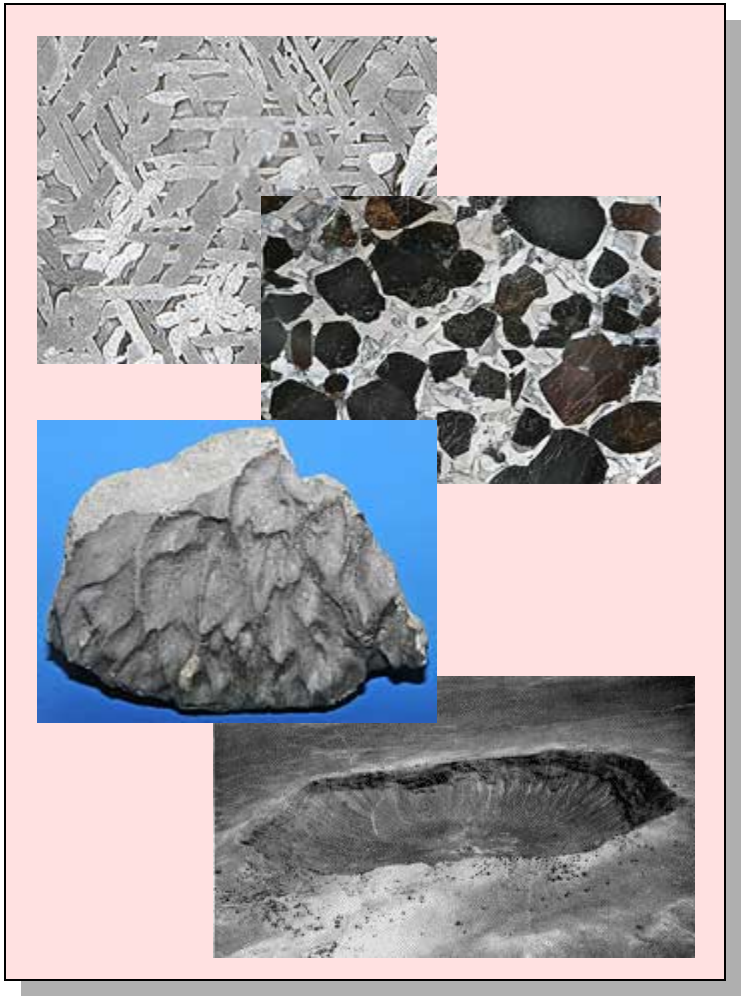
Rappahannock Astronomy Club

11 March 2009

Part 1 -- Meteorites

Presentation Agenda

- Introduction
- Meteorites
  - Origin & Types
  - Classification
  - Major Impacts
  - Identification
  - Collecting
- Conclusion

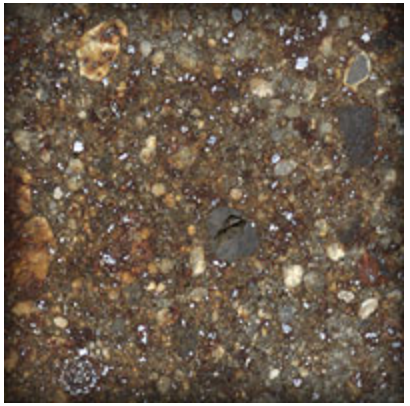


Introduction

- Meteorites are rocks from space:
  - Meteor Showers
  - Remnants of solar system formation
  - Cores of exploded stars & planets
  - Anyone can collect them
  - Many types and sizes

Meteorites - Origin

- The oldest meteorite specimens are remnants of the very first geologic processes to occur in our solar system 4.6 billion years ago.
- The solar nebula was formed from an interstellar cloud. It condensed to form our sun and planets.
- Dustballs encountered violent, high-temperature events and were melted, forming molten silicate and metal droplets.
- The molten droplets cooled quickly in the nebula and formed millimeter-sized spheres of rock called **Chondrules**. Meteorites containing these objects are called **chondrites**.

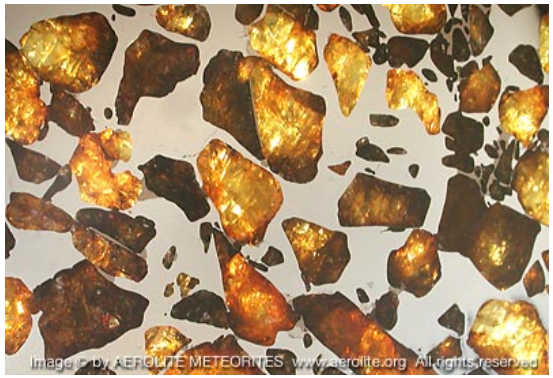


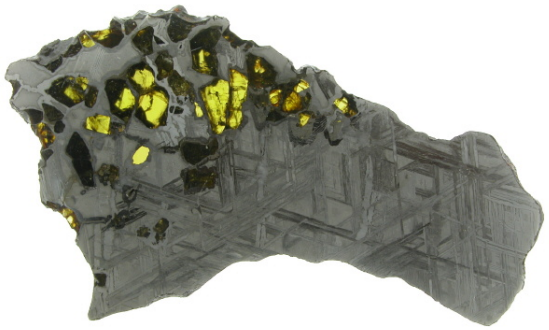
Meteorites - Origin

- In those cases where planetary bodies became large enough to have substantial gravitational fields, iron-rich metal, which is denser than the silicate portions of magma, may have separated from the partially or wholly molten bodies to form dense iron-rich cores inside shells of silicate material.
- This process is similar to that responsible for the differentiation of the Earth, and thus why **iron meteorites** are considered analogues for the Earth's core.

Meteorites - Origin

- Another group of meteorites called **pallasites** are intimate mixtures of iron-rich metal and silicate crystals, and appear to represent regions where achondrite and iron meteorite magmas were incompletely separated, such as the core-mantle boundaries of planetesimals.
- When sliced and polished, pallasites are among the most beautiful of meteorites. These specimens contain crystals of olivine, the semi-precious stone peridot, contained within a matrix of nickel-iron very much like the bits of fruit in a slice of fruitcake.





Meteorites - Origin

- There is a special group of meteorites that do not fit any of the other categories of origin.

Lunar Origin

Martian Origin

Mercurian Origin???

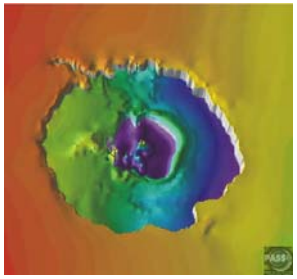
Meteorite Classification

- Iron Meteorites
  - Ataxites
  - Hexahedrties
  - Octahedrites
- Stony Meteorites
  - Achondrites
  - Chondrites
- Stony/Iron Meteorites
  - Mesosiderites
  - Pallasites

Meteorite Impacts

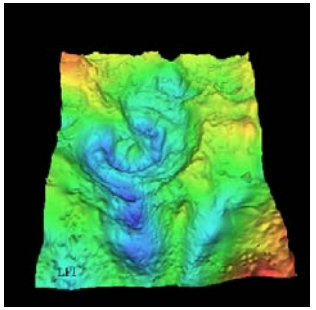
In North America alone there are Over 50 meteorite impact sites.

- Chesapeake Bay



- Barringer

- Chicxulub

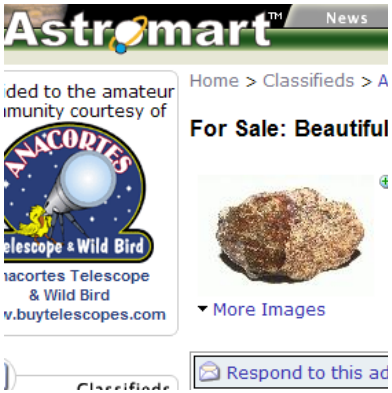


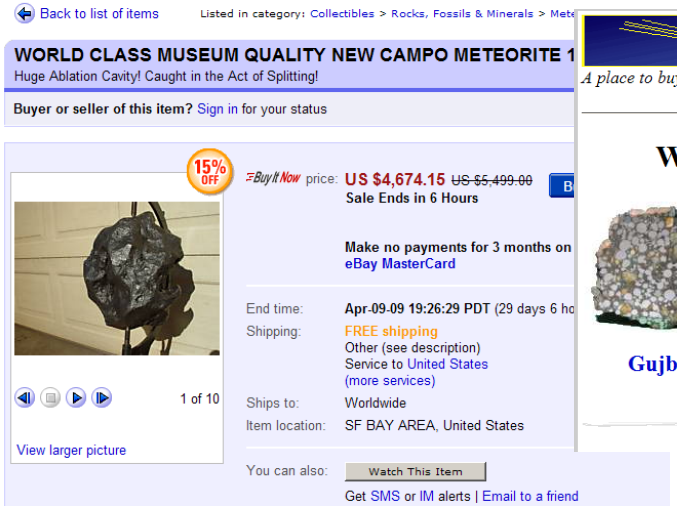
Meteorite Identification

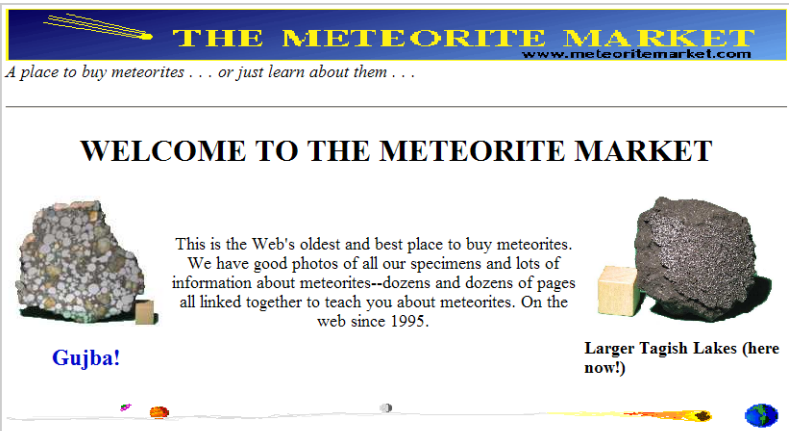
- Is it heavier than it looks?
- Does it have “thumb prints” (Regmaglypts)?
- Does it show signs of rust?
- If metal, does it pass the nickel test?
- Is it “angular” (i.e. having defined faces but with at least slightly rounded corners)?
- Is a magnet attracted to it?

Meteorite Collecting

- Rock and Gem Shows
- Reputable meteorite dealers (IMCA)
- Ebay
- Private collectors

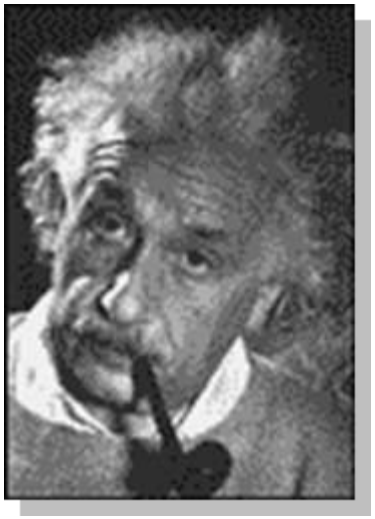


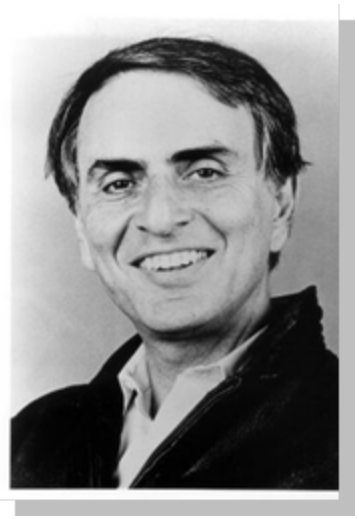
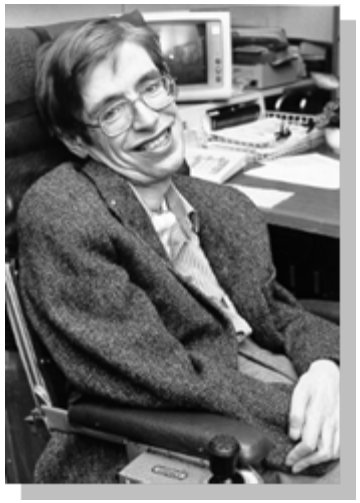




Conclusion – I mean really!!

Questions???



“Do you feel lucky punk? Go ahead, make my day.”

Meteorites, Asteroids and the Last Great Extinction Event

Rappahannock Astronomy Club

8 April 2009

Part 2 -- Asteroids

Presentation Agenda

- Introduction
- Asteroids
  - Origin
  - Descriptions
  - Major Impacts
  - Extinction Events
- Conclusion

Introduction – Part 1

- Meteorites:
  - Origin & Types
  - Classification
  - Major Impacts
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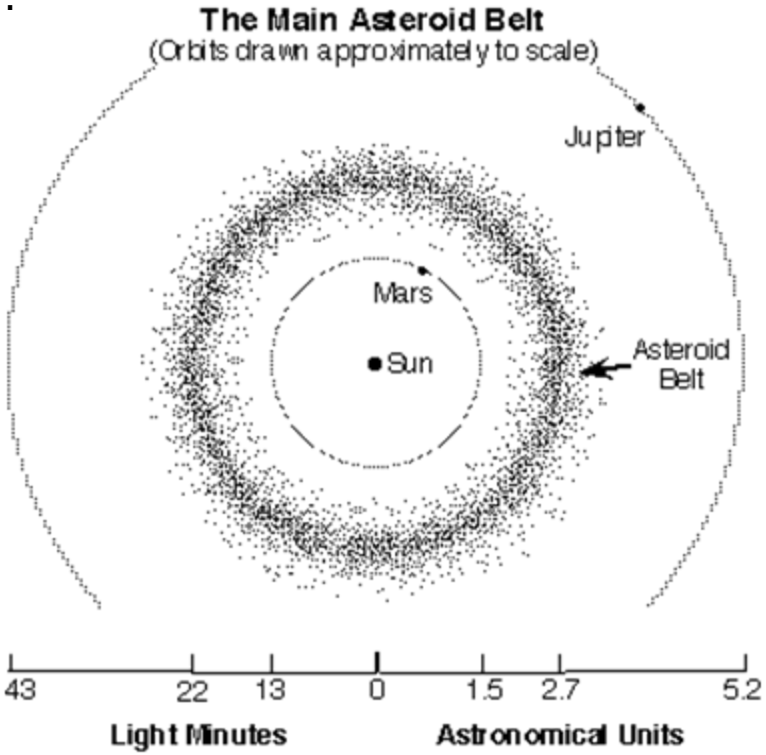
  - Collecting

Introduction – Part 2

- Asteroids:
  - Origin
  - Descriptions
  - Explorations
  - Major Impacts
  - Extinction Events

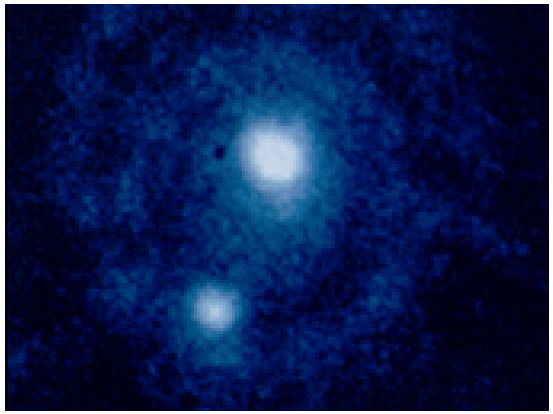
Asteroids - Origin

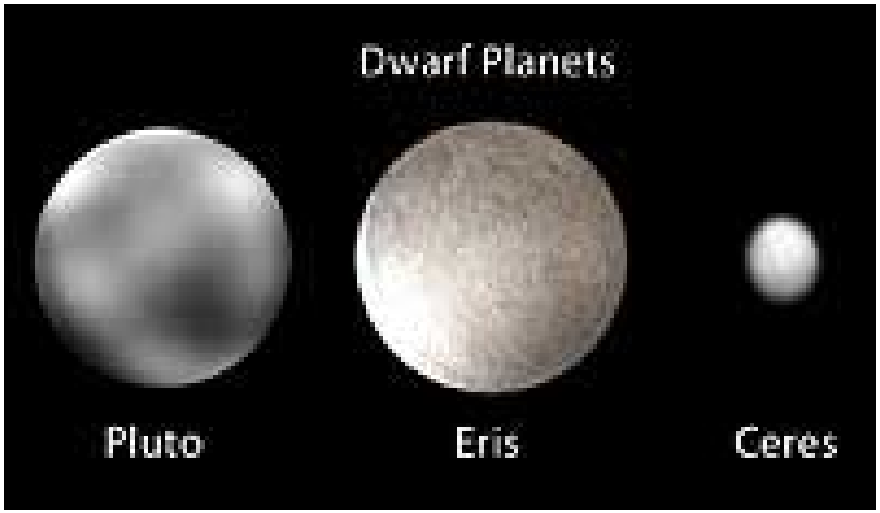
- Asteroids are material left over from the formation of the solar system.
- Asteroids are material that never coalesced into a planet.
- They are the remains of a planet that was destroyed in a massive collision.



Asteroids - Descriptions

Pluto

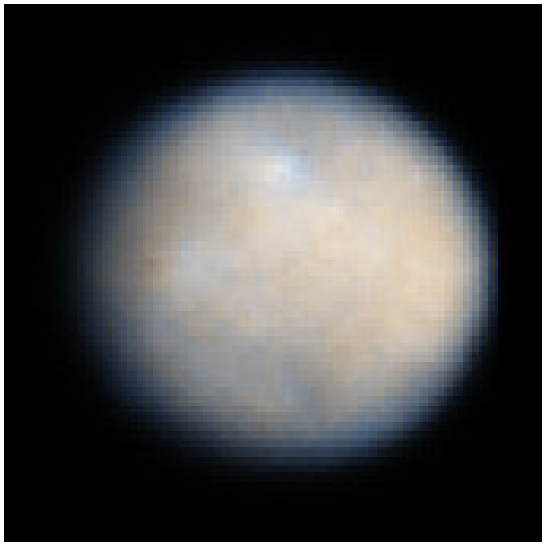




Although Pluto was discovered in 1930, limited information on the distant object delayed a realistic understanding of its characteristics. Pluto is the second largest known dwarf planet and tenth largest orbiting the Sun. From its time of discovery in 1930 to 2006 it was considered to be the ninth planet in the solar system, but because additional objects have been discovered including Eris which is 27% more massive, the IAU reclassified Pluto and the other objects as dwarf planets. The New Horizons spacecraft was launched on January 16, 2006 and will make its closest approach to Pluto on July 14, 2015. This mission will provide an increased amount of information about this peculiar dwarf planet. The uniqueness of Pluto's orbit, rotational relationship with its satellite, spin axis, and light variations all give it a certain appeal.

Asteroids - Descriptions

Ceres

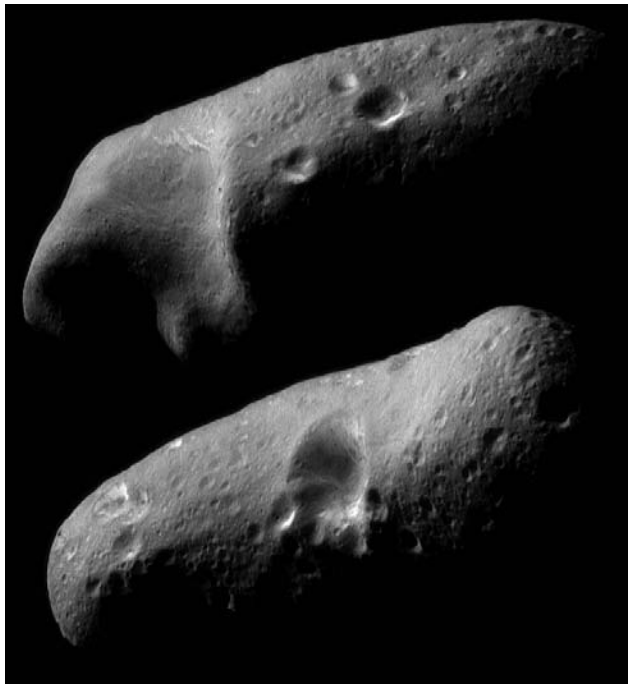


Ceres was named after the Roman goddess of the harvest, of growing plants, and motherly love. It is the smallest of the dwarf planets, a new category of astronomical bodies created by the International Astronomical Union in 2006. Dwarf planets currently includes Pluto, Eris, and Ceres.. Pluto's demotion from the list of solar system planets grabbed front-page headlines in 2006. But the debate over the qualifications for planethood reaches back to the discovery of Ceres.

Ceres was discovered on January 1, 1801 by astronomer Giuseppe Piazzi, a monk in Sicily and the founding director of the Palermo Astronomical Observatory. Ceres was found within a gap between Mars and Jupiter where a planet was expected to reside, based on the spacing of the known planets in the solar system.

Asteroids - Descriptions

Eros



On February 14, 2000 at 10:33 AM EST the NEAR spacecraft was successfully inserted into orbit around 433 Eros, becoming the first artificial satellite of an asteroid. Just over an hour later, NEAR pointed its camera at the asteroid and took the above picture from a range of 210 miles (330 km) above the surface.

Eros is approximately 33x13x13 kilometers (20x8x8 miles) in size and resembles a "fat banana." It is the second largest near-Earth asteroid and spins on its axis once every 5 hours, 16 minutes. Eros exhibits a heavily cratered surface with one side dominated by a huge, scallop-rimmed gouge, and the opposite side by a conspicuous sharp, raised rimmed crater.

Asteroids - Descriptions

Gaspra

Gaspra (Asteroid 951) was discovered by Grigoriy N. Neujamin in 1916. Neujamin named Gaspra after a Black Sea retreat that was visited by contemporaries such as Tolstoy and Gorky. Gaspra was just another small asteroid that was given very little attention until it was discovered that the trajectory of the Galileo spacecraft would take it close to Gaspra. Following this discovery, observers through out the world made Gaspra a prime target of study. Gaspra was found to have an elongated shape with a rotational period of 7.04 hours.

On October 29, 1991, Galileo came within 1,600 kilometers (1,000 miles) of Gaspra. They passed each other at 8 kilometers (5 miles) per second. This was the first time that a spacecraft made a fly-by of an asteroid. Gaspra is an irregular body with dimensions of about 20 x 12 x 11 km (12.5 x 7.5 x 7 miles). Its surface reflects approximately 20 percent of the sunlight striking it. Gaspra is classified as an *S-type* asteroid and is likely composed of metal-rich silicates and perhaps blocks of pure metal. It is a member of the Flora family.

Asteroids - Explorations

Mathilde

On June 27, 1997 the Near-Earth Asteroid Rendezvous (NEAR) spacecraft flew past asteroid 253 Mathilde. NEAR was the first mission of NASA's low-cost discovery missions and the first discovery spacecraft to return scientific data from an encounter. The primary mission of NEAR is an encounter with the asteroid 433 Eros in February 1999. The encounter with Mathilde was frought with difficulty. A year before the launch mission designers discovered that NEAR would pass close to the asteroid Mathilde on its way to Eros. Should the trajecotry of NEAR be modified to encounter Mathilde and use some of the precious fuel needed for the Eros encounter? Scientists were also concerned about possible dust particles damaging the spacecraft as NEAR and Mathilde crossed paths at a speed of 10 kilometers per second.

Previous to the encounter, very little was know about Mathilde. It was discovered by Johanna Palisa on November 12, 1885 in Vienna, Austria.

Asteroids – Major Impacts

On the date of June 30th, 1908, at about a quarter after 7:00 a.m., a very mysterious explosion occurred in the skies over Tunguska, Siberia, located in Russia. This explosion happened at anywhere between six-to-eight kilometers from ground zero, and the resultant action in this was to lay waste to a vast region of pine forest of 2,150 square kilometers, felling more than 60 million trees. This was seen as a brilliant burst of light from the inhabitants of the region of 50 kilometers around. Witnesses claim that the explosion was so loud and powerful as to blow-out windows, temporarily blind and knock people to the ground, and sounded like a deafening roar. Had it happened fifty years later, it is surmised by scientists, (placing it within that time-frame of the Cold-War) it would most likely have spurred that nation into a nuclear war.

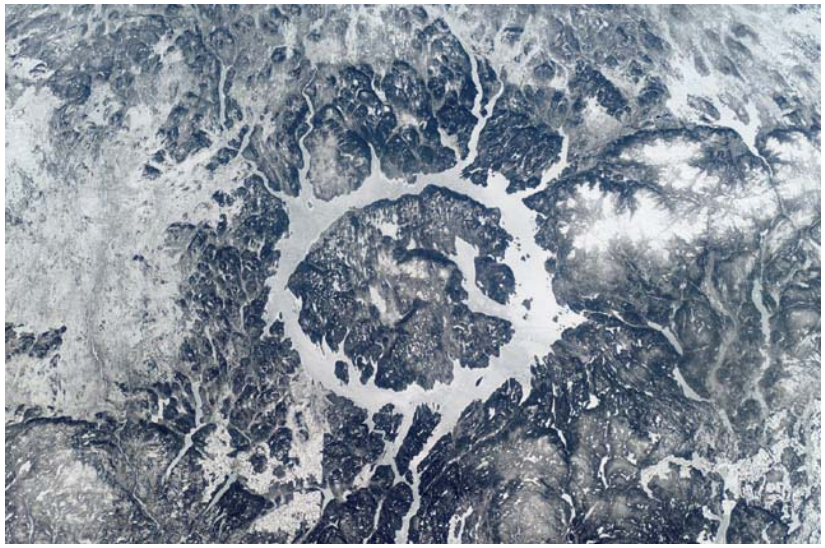
Asteroids – Major Impacts


Barringer Crater

Meteor Crater (also know as Barringer Crater) in Arizona was the first-recognized terrestrial impact crater. It was identified in the 1920s by workers who discovered fragments of the meteorite impactor within the crater itself. Several other relatively small craters were also found to contain impactor fragments; for many years, these remnants were the only accepted evidence for impact origin. However, scientists have come to realize that pieces of the impactor often do not survive the collision intact.

35°02'N, 111°01'W; diameter: 1.186 kilometers (.737 miles); age: 49,000 years

Asteroids – Major Impacts

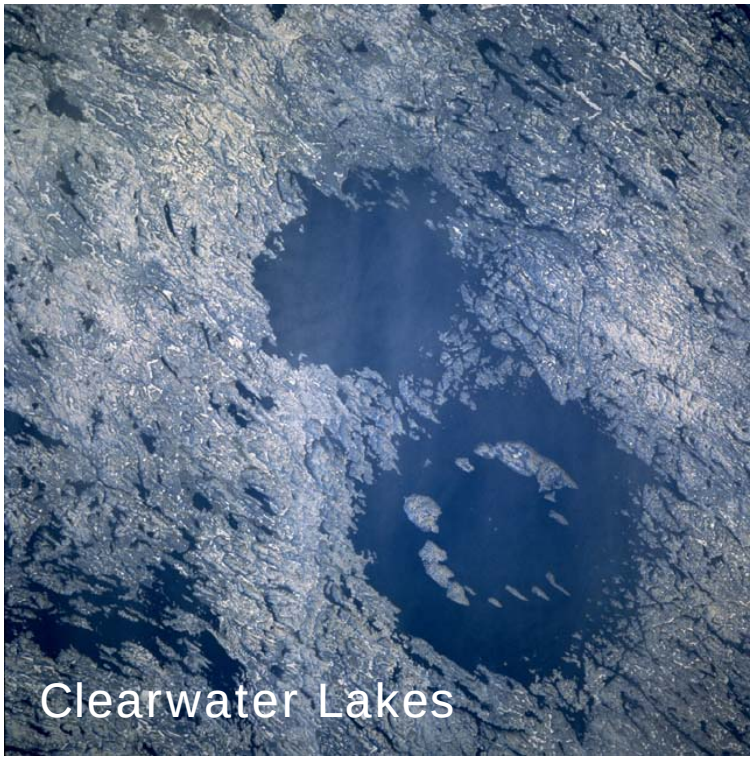


Manicouagan impact structure

The Manicouagan impact structure is one of the largest impact craters still preserved on the surface of the Earth. This shuttle view shows the prominent 70 kilometers (43 miles) diameter, ice-covered annular lake that fills a ring where impact-brecciated rock has been eroded by glaciation. The lake surrounds the more erosion-resistant melt sheet created by impact into metamorphic and igneous rock types. Shock metamorphic effects are abundant in the target rocks of the crater floor.).

51°23'N, 68°42'W; rim diameter: ~100 kilometers (62 miles); age: 212 +- 1 million years

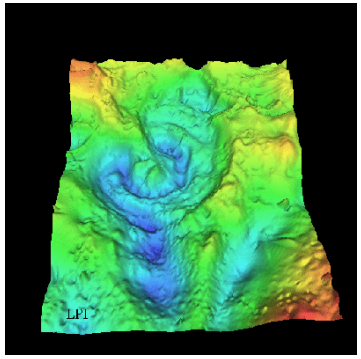
Asteroids – Major Impacts

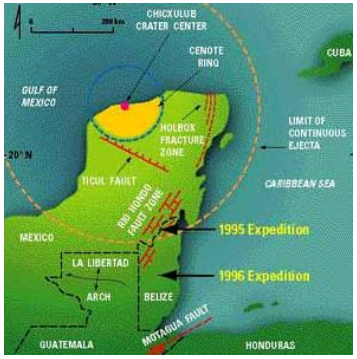


These twin circular lakes (large dark features) were formed simultaneously by the impact of an asteroidal pair which slammed into the planet approximately 290 million years ago. The lakes are located near the eastern shore of Hudson Bay within the Canadian Shield in a region of generally low relief in northern Quebec province. Notice that the larger western structure contains a ring of islands with a diameter of about 10 kilometers that surrounds the center of the impact zone. They constitute a central uplifted area and are covered with impact melts. The central peak of the smaller Clearwater Lake East is submerged. The lakes are named after their exceedingly clear water. Also notice that the surrounding terrain shows widespread scarring from glaciation. The multitude of linear and irregular shaped lakes (dark features) are the result of gouging or scouring action caused by the continental ice sheets that once moved across this area.

Clearwater Lake West: 56°13'N, 74°30'W; rim diameter: 32 kilometers (20 miles)
Clearwater Lake East: 56°05'N, 74°07'W; rim diameter: 22 kilometers (13.7 miles)
age: 290 +- 20 million years

Asteroids – Major Impacts





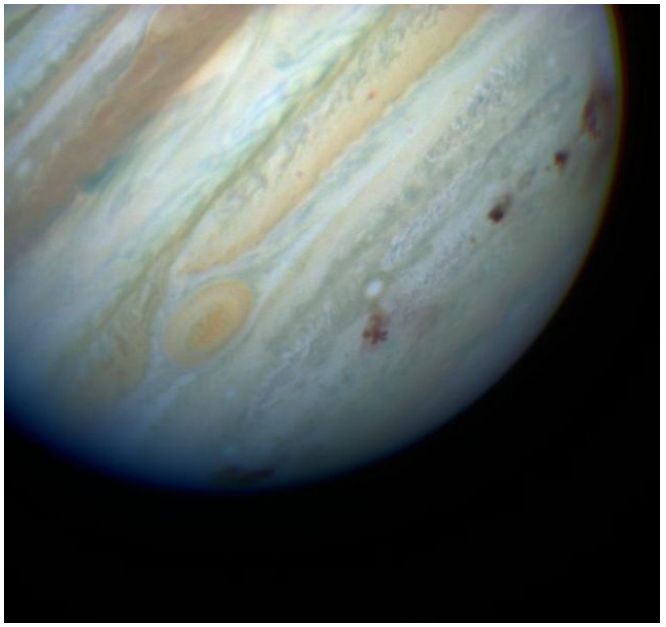
It is thought that 65 million years ago in what is now Yucatan the impact at a velocity of 11 km/second of a 10-kilometer wide asteroid is what helped to bring about the K-T extinction, whereas no land animal with a size greater than the size of a small chicken was able to survive.

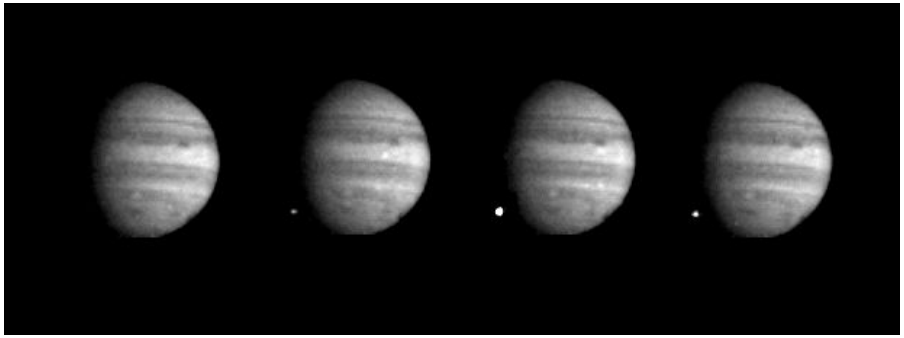
Those that study this time frame believe that if man had inhabited the planet at this time, he surely would have been destroyed by this particular event. This event threw huge amounts of matter into the atmosphere in addition to this, it caused 2000 foot waves that may have all but completely emptied the Gulf of Mexico. This event created months of darkness (which interfered with photosynthesis) and much cooler temperatures globally, and the resulting harsh conditions which in turn led to the extinction of many species, including the last of the dinosaurs.

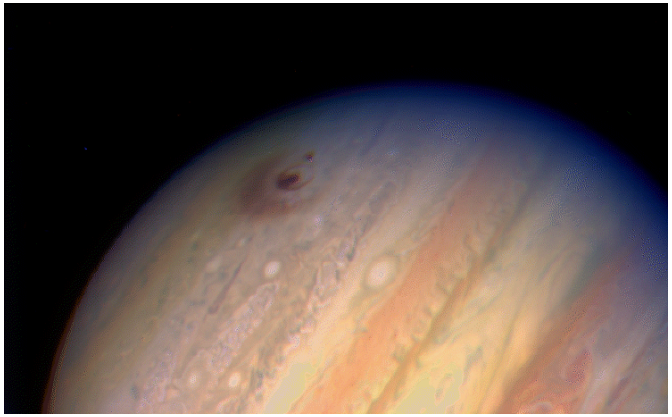
21°20'N, 89°30'W; diameter: 170 km; age: 64.98 million years

Asteroids – Extinction Events

Comet Shoemaker-Levy 9 (**SL9**, formally designated **D/1993 F2**) was a comet that collided with Jupiter in 1994, providing the first direct observation of an extraterrestrial collision of solar system objects. This generated a large amount of coverage in the popular media, and SL9 was closely observed by astronomers worldwide. The collision provided new information about Jupiter and highlighted its role in reducing space debris in the inner solar system.

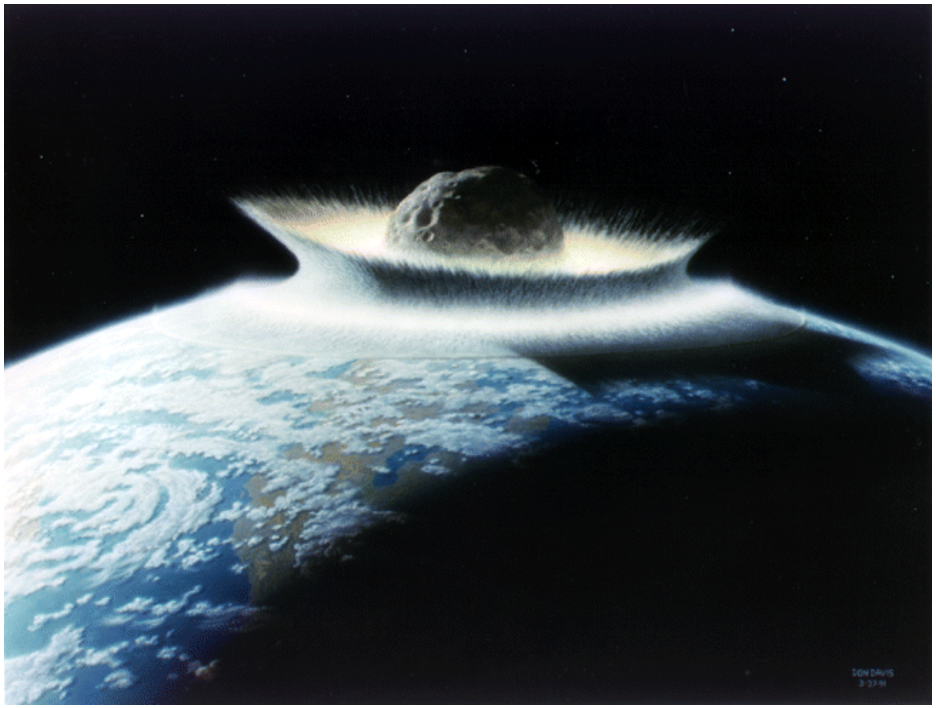






Asteroids – Extinction Events

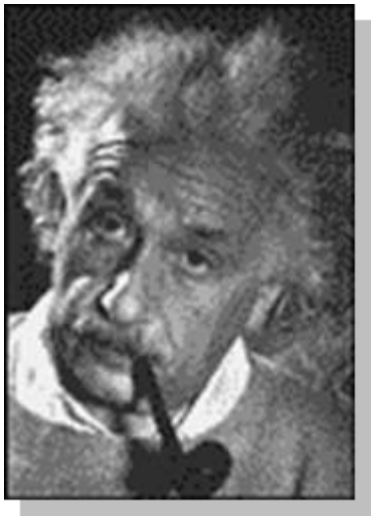
It's called **Apophis.**
It's 390m wide.
And it could hit Earth in 31 years' time

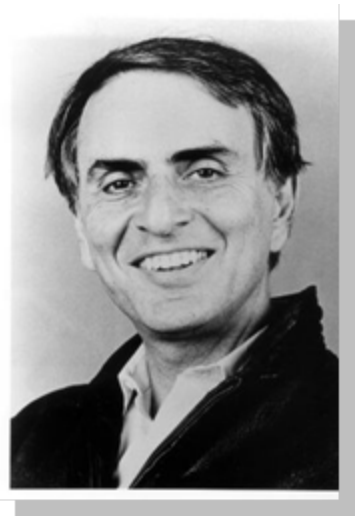
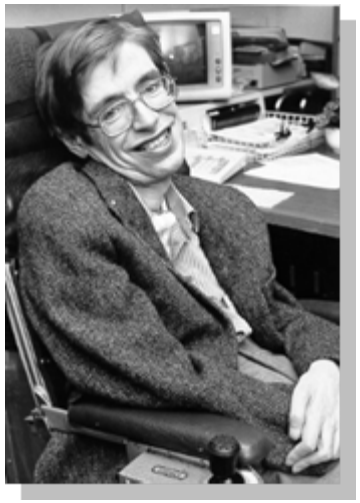


In Egyptian myth, Apophis was the ancient spirit of evil and destruction, a demon that was determined to plunge the world into eternal darkness.
A fitting name, astronomers reasoned, for a menace now hurtling towards Earth from outerspace.
Scientists are monitoring the progress of a 390-metre wide asteroid discovered last year that is potentially on a collision course with the planet, and are imploring governments to decide on a strategy for dealing with it.

Conclusion – I mean really!!

Questions???



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