CLASSROOM ACTIVITIES

ACTIVITY I

LET'S MAKE AN IMPACT CRATER
by Len Sharp

INTRODUCTION:
Approximately 65 million years ago, at the end of the Cretaceous Period of the Mesozoic Era, a 10 km asteroid (bolide) came crashing into Earth's surface at an angle of about 20-30° [Schultz, 1996] and at an estimated velocity of 54,000 km/hr (15 km/sec) (compared to about 32,400 km/hr (9.0 km/sec) for the space shuttle) creating an impact crater with a 180 km diameter. The ejecta blanket extended for thousands of kilometers from ground zero. NOTE: The material, found in the Ocean Drilling Program (ODP) core recovered during Leg 171B, was brought up from the ocean's depths 1,920 km from Chicxulub Crater. Recently, similar tektite material was found in a core from a site at Bass River State Park, New Jersey which is even further away from Chicxulub. Debris from the impact, thrown many kilometers upward into Earth's atmosphere, took many years to fall earthward. Due to weathering and erosion processes, the crater is buried several kilometers beneath the surface of the present-day region, known as the Yucatan Peninsula, Mexico, at 21°20'N, 89°30'W.

KEY TERMS:
• meteorite • bolide • Leg • impact crater • asteroid
• ejecta blanket • rays • core • floor • ramparts
• central peak (generally in craters over 40 km) • walls • weathering • erosion

PURPOSE:
Describe and analyze the features created by a simulated meteorite impact.

MATERIALS:
- large aluminum pan (roasting pan)
- flour
- colored sands (aquarium stores)
- sandbox sand (fine-grained)
- colored tile grout or mortar mix
- several minerals or rocks, approximately 2-4 cm, such as; galena, pyrite, magnetite, basalt, limestone, etc. (ball bearings, glass marbles, etc. may be substituted)
- wooden paint stirrers (acquire at local paint store, cut to fit the width of the aluminum pan)
- metric ruler or tape
- triple beam balance
- newspapers or plastic drop sheet
- safety goggles
- OPTIONAL: Polaroid camera and film, flashlight or some other light source. A video camera set on slow motion is also a helpful means of analyzing simulated crater impacts.

PROCEDURE:
1. Create several Meteorite Evaluation Teams (METS) to produce and analyze impact craters.
2. Spread newspapers beneath the aluminum pan.
3. With a felt tip marker, measure one centimeter intervals along one side of the aluminum pan.
4. Place 4 or 5 cm of flour into the bottom of the large aluminum pan. Smooth the flour with the edge of your wooden stick.
5. Gently spread colored tile grout, mortar mix or colored sand over the flour to a depth of about 1 cm. A flour sifter works nicely to evenly distribute topmost layer onto flour.
6. Select one of the minerals or rocks (or an appropriate substitute) provided by your teacher.
   • Mass the object.
   • Find volume of the object.
   • Describe object's shape.
7. Drop the object(s) from a measured distance of 20, 40, 60, 80, and 100 cm onto the simulated "crustal" material.
8. Construct a chart for your impact data.
9. Diagram both a top and side view of the impact crater produced by each drop. (If a Polaroid camera is available, take a photo from directly above or at an angle. Also, use a video camera to record craters of all the METS.) Compare and contrast METS results collectively.

ACTIVITIES:
1. Describe the pre-impact material and compare/contrast with the post-impact features. Label the parts of the crater and compare to an actual crater's photo. (Checkout the following web site: online.anu.edu.au/physics/nineplanets/meteorites.html.) Does your simulated "crater" have all of the features represented in a crater of 40 km or larger? Discuss your answer.
2. Compare your results with other METS. Write a brief summary of the METS discussion.
3. Select any one of the following variables and discuss how they could possibly change the shape, size and depth of your simulated crater. NOTE: The teacher may want to assign each METS another variable concerning the bolide's impact site petrology, mass, shape, composition (nickel-iron, stony, gaseous, etc.), velocity and/or land versus water impact. Each METS would be responsible for sharing their findings with the rest of the class.
4. METS devise a plan that could help track, as well as, possibly destroy and/or alter the course of potentially catastrophic meteorite impacts on present-day Earth. Do you believe that such a governmental agency now exists? Can you verify your answer? (Checkout the films Deep Impact and Armageddon to be released in May and July of 1998.)
5. Search the Internet for information concerning asteroids and/or comets that come very close to Earth's orbit. Compile a list of the potentially dangerous "bolides" with their respective orbital data. (Checkout NSTA's Craters, 1995.) (Web sites: http://ccf.arc.nasa.gov/sst/ or www.online.anu.edu.au/physics/nineplanets/meteorites.html)
6. Why is it difficult to find ample evidence of bolide impacts on Earth's surface? NOTE: Teacher may want to use a fan to gently blow across a simulated crater's surface and/or a salt shaker with water to lightly sprinkle water on simulated crater to illustrate weathering and erosion.
7. Compare and contrast the following impact craters. (To obtain photos of the craters checkout the following web sites: http://diamond.ge.ic.ac.uk/jbo3/jbo3/web/chix.html or http://online.anu.edu.au/physics/nineplanets/meteorites.html)
   • Barringer's Crater, Arizona, USA • Tycho Crater, Moon
   • Yuty Crater, Mars • Chicxulub Crater, Yucatan Peninsula, Mexico (gravimetric image)
   Why do these craters have different features associated with their respective impact sites? Does Barringer Crater or Tycho Crater resemble Chicxulub? Why do you think so?
8. How could you tell the difference between an impact and a volcanic crater using only a topographic map? (e.g., Barringer's Crater, Arizona, versus Mt. St. Helens)
9. Diagram, label and analyze both a top and side view of the impact crater produced by each drop. If a digital camera is available, take a series of photos from a variety of different angles, including a picture from overhead. Try a digital video camera to record size, shape, path and crater impact characteristics. Using digital technology is an ideal method for storing images into a computer for future use by the METS to create computerized "slide shows." Compare and contrast METS results collectively. (If digital technology is not available, consider using a Polaroid camera and/or a video camera).

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THE OCEAN DRILLING PROGRAM:

EXPLORING OUR DYNAMIC EARTH THROUGH SCIENTIFIC OCEAN DRILLING

The Ocean Drilling Program (ODP) is an international partnership of scientists and research institutions organized to explore the evolution and structure of Earth. ODP provides researchers around the world access to a vast repository of geological and environmental information recorded far below the ocean surface in seafloor sediments and rocks. By studying ODP data we gain a better understanding of Earth's past, present, and future.

The drill ship, JOIDES Resolution (pronounced joy-deez), is the centerpiece of the Ocean Drilling Program. With this ship, ODP can drill cores — long cylinders of sediment and rock — in water depths up to 8.2 km. Built in 1978 in Halifax, Nova Scotia, the drill ship was originally a conventional oil-drilling ship. She was refitted in 1984 and is now equipped with some of the world's finest shipboard laboratories. The ship's complement for each cruise is a mixture of 30 scientists from around the world, 20 engineers and technicians, and a crew (including drilling personnel) of 52.

Each year JOIDES Resolution departs on six scientific expeditions approximately two months in length. Every expedition has specific scientific goals chosen through a careful review process. The research ship has drilled in the Atlantic, Pacific, Indian, and Arctic oceans, including north of the Arctic and south of the Antarctic circles. Since January 1985, ODP has recovered more than 160,000 m of cores. Upon completion of an expedition, the cores are transported to one of four repositories for curation, storage, and future research. ODP scientists are able to use these repositories much as the general public uses a library.

ODP is sponsored by the U.S. National Science Foundation and international members.

SAMPLING THE SEAFLOOR

At any time during the day or night, operations aboard JOIDES Resolution are interrupted by the cry, "Core on deck!" With that summons, crew, technicians, and scientists rush to the drilling deck as a 9.5-meter section of ocean sediment or rock is hoisted from the water. Carefully, they carry the plastic-sheathed cylinder to the first of many shipboard laboratories in which the core will be studied.

A precise routine ensures that the core will be marked with its original location on the seafloor, coded to distinguish top from bottom, measured, and cut into smaller sections for study and storage. Each section of the core is sliced lengthwise. One half is used for nondestructive analyses before being stored in the ODP repositories. The other half is sampled by scientists seeking to reconstruct another chapter in Earth's history.

Within minutes, scientists in JOIDES Resolution's seven levels of laboratories begin to analyze the core. No aspect of the core is overlooked. Paleontologists examine microfossils in the cores to determine the age of the material. Other scientists measure physical properties such as density, strength, and ability to conduct heat. Paleomagnetists use state-of-the-art equipment to read the record of Earth's magnetic field changes — information that helps determine the ages and latitudes at which rocks were formed. The challenging process of interpretation has just begun.

Each 9.5-meter section is only a fraction of the entire length of core that will be extracted from each hole, so this procedure is repeated many times. The scene aboard JOIDES Resolution is far removed from the normal routines in researchers' land-based laboratories. Though exhausting, scientists relish the opportunity to work aboard this "floating university."

ADDITIONAL INFORMATION ON ODP SCIENCE:

More information on the Ocean Drilling Program is available from: Ocean Drilling Program, Joint Oceanographic Institutions, 1755 Massachusetts Avenue, NW, Suite 700, Washington, DC 20036-2102, e-mail: info@joiscience.org, phone: (202) 232-3900, or visit the web site at www.oceandrilling.org.

OTHER RESOURCES:

ADDITIONAL COPIES OF THE POSTER:
Additional copies of this poster are available from: Ocean Drilling Program, Joint Oceanographic Institutions, 1755 Massachusetts Avenue, NW, Suite 700, Washington, DC 20036-2102, e-mail: info@joiscience.org, phone: (202) 232-3900.

EDUCATIONAL CD-ROMS:
The JOI/U.S.Science Support Program's interactive, educational CD-ROMs are intended to bring scientific results of the Ocean Drilling Program into the classroom. In "ODP: From Mountains to Monsoons," the student is invited to join a scientific ocean drilling expedition to the Indian Ocean to investigate the hypothesis that there is a link between the uplift of the Himalayan Mountains and the intensification of the monsoons in Southern Asia. During the program, sediment cores from three sites on the ocean floor are analyzed. At each site, the student works with real scientists in a variety of virtual shipboard laboratories and then discusses the results with the Chief Scientist. Throughout the program the student learns about tools and techniques used by geoscientists and how to combine results from laboratory analyses into a viable theory.

The second CD-ROM, "ODP: Gateways to Glaciation," which has been developed for high school and undergraduate earth science classes, uses ODP data to explore the closing of the Panama gateway as one of the possible triggers of northern hemisphere glaciation about 2.6 million years ago. Using real ODP data in virtual shipboard laboratories, students can analyze sedimentological and isotopic evidence for glaciation within the sediments, date the glacial onset through paleomagnetics and micropaleontology labs, and explore evidence for Milankovitch cycles within the core.

Copies of both CD-ROMs are available free of charge from: U.S. Science Support Program, Joint Oceanographic Institutions, 1755 Massachusetts Avenue, NW, Suite 700, Washington, DC 20036-2102, e-mail: info@joiscience.org, phone: (202) 232-3900. Accompanying teacher's manuals for "ODP: From Mountains to Monsoons" and "Gateways to Glaciation" are available on the JOI web site: www.joi-odp.org/USSSP/CurrEnr/Curriculum.html.

ACTIVITY II

JUST HOW BIG WAS THE BLAST THAT CAUSED THE DINOSAURS TO BECOME EXTINCT?
by Len Sharp

INTRODUCTION:
This gargantuan crater in Mexico is known as Chicxulub (21°20'N, 89°30'W). Just imagine the sound and extent of the explosion that resulted from the impact! The bolide's force of impact has been estimated conservatively at about 108 megatons. Within a very small amount of time, a dust and debris pall (cloud) was violently ejected onto the surrounding existing landscapes with all of the indigenous life-forms that were present at that time. At the same instant, dust was thrown upward into Earth's atmosphere. This great cloud of dust was distributed throughout Earth's atmosphere. It has been estimated that almost 50%-80% of the plant and animal species present, before the impact, became extinct including the dinosaurs! Just imagine what an impact of the Chicxulub magnitude would do to a heavily populated area on present-day Earth's surface!

KEY TERMS:
• meteorite impact • bolide • impact crater • extinction • dust cloud
• Chicxulub • asteroid • scale • model

PURPOSE:
The students will be able to visualize the scale the Chicxulub asteroid impact as related to their own geographic environs using topographic maps and/or road maps.

MATERIALS:
- road maps of the students' country, state or local area
- world map (preferably large wall map)
- piece of 8.5 x 11.0 plastic sheet
- compass
- transparency markers (red, yellow...)
- scissors
- 30 cm ruler
- world atlas

PROCEDURE:
1. Using the scale of the given map, draw a circle on the plastic sheet with a diameter of 1,920 km.
2. Draw a circle with a scaled diameter of 180 km within the center of the first 1,920 km circle.
3. Color the inner circle with a light-colored transparency marker.
4. Carefully cut out the larger circle from the plastic sheet.
5. Find your town, school if possible, and allow the center of the town or your school to be "ground zero" of a bolide impact with the size of the Chicxulub event 65 million years ago. Place the center of the plastic sheet at "ground zero." The outer circle is your "ejecta" blanket, equal to the distance of the Chicxulub Crater to the site of the "Blast from the Past" core.
6. Sketch the outline of both circles onto your map.
7. On an appropriately scaled map of the USA and/or of the world, follow steps 1-6 for U.S. cities such as:
   • New York City • Atlanta • Miami • Chicago • New Orleans
   • Phoenix • San Francisco • Seattle • Honolulu
   Or cities of the world, such as:
   • London • Paris • Cairo • Bombay • Singapore
   • Mexico City • Buenos Aires • Tokyo • Hong Kong

THINGS TO DO:
1. What major population centers are within the "impact area?" Approximately how many people would be affected by the crater alone? If the ejecta blanket extends outward for 2,000 km, what areas around your hometown would be affected? How many people in the "extended area" of the impact are going to be affected? CONSIDER: What would happen if the bolide struck an area in the middle of the North Pacific or North Atlantic oceans?
2. Cooperative Learning Exercise (role playing): Develop an "Emergency Preparedness Plan" for the safe evacuation of the population from an area predicted to be impacted by a large meteor. Create several "City Councils" representing cities of various sizes, such as: student's hometown; New York, NY; Helena, MT; Little Rock, AK; Flagstaff, AZ; Astoria, OR; etc. Develop an Emergency Preparedness Plan suitable for their city. NOTE TO THE TEACHER: Have the Student Civil Defense Teams (SCDTS) make a scale model of Chicxulub Crater's diameter as described in Activity I and place on an appropriate scale map to observe the area that is going to be impacted.
   Each City Council should have at least the following individuals
   • mayor • police chief • fire chief • utilities representative • "average" citizen
   • doctor • astronomer • psychologist • media representative
3. With two or three other students, devise a plan that could help in the tracking as well as possibly destroy and/or alter course of potentially catastrophic meteorite impacts on present-day Earth. (http://ccf.arc.nasa.gov/sst/)
4. Search the Internet for information concerning asteroids and/or comets that come very close to Earth's orbit. Compile a list of the potentially dangerous "bolides" with their respective orbital data. In your opinion, based upon the data you collected, what are the chances of Earth being struck by a meteor and/or comet in the near future that nearly equals the Chicxulub Crater on the Yucatan Peninsula, Mexico? (Checkout the following web site and its similar links: www.lpl.arizona.edu/spacewatch.)
5. Research the Shoemaker-Levy Comet's disruption and ultimate collision with the surface of Jupiter.
   A. What were some of the results of the Shoemaker-Levy impacts on the Jovian atmosphere and surface?
   B. What do you speculate would have happened if the Shoemaker-Levy "bolides" had struck Earth?
   C. Is it possible that an event such as the Shoemaker- Levy comet could ever threaten Earth? If so, how frequently may such a collision take place?
   D. What could be done if a Shoemaker-Levy incident was predicted to strike Earth?

SUGGESTED READING/MEDIA LISTS:

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ACTIVITY III

"THE BLAST FROM THE PAST" LEAVES A RECORD OF A MAJOR CATASTROPHE IN THE ATLANTIC OCEAN:
Making a scaled model of the Ocean Drilling Program Leg 171B core
by Len Sharp

INTRODUCTION:
The previous activities have focused on "what surface features does a meteorite impact produce" and "how big was the crater and surrounding ejecta blanket?" During the winter of 1996-97, the Ocean Drilling Program (ODP) research vessel, JOIDES Resolution, retrieved sediments from beneath the Atlantic's seafloor. Embedded within the 130 m of core from Leg 171B, at the 112 meter level, was an approximately 17 cm layer of greenish sedimentary material (tektites and bolide remains). The ODP Leg 171B core contains by far the most convincing evidence that there was a huge meteorite (bolide) impact in the region 65 million years ago. This asteroid is believed to have been the deadly messenger from space that brought about the extinction of all the dinosaurs and an estimated 50-80% of other Cretaceous species. Please note the several distinct layers easily distinguishable in the sediment section that is referred to below as the "ODP Leg 171B core."

KEY TERMS:
• core • leg • extinction • foraminifera • iridium
• strata • species • sediments • ooze • Cretaceous

PURPOSE:
Interdisciplinary scientific Core Analysis Teams (CATS) composed of students will construct, collect and collate data, as well as, analyze a stratigraphic model of the "Blast from the Past" ODP Leg 171B core. NOTE: The transition from "normal" ocean sediment layers to the tektite-rich and iridium anomaly layers (strata) coincides with the mass extinction of numerous Late Cretaceous microfossil species. In the ODP Leg 171B core the transition layer was discovered between 112-113 m below the seafloor. The transition between layers is known as the K/T (Cretaceous/Tertiary) boundary.

TEACHER PREP:
OPTIONS:
- Teacher may pre-measure material for students to slowly pour into plastic columns/tubes which are attached to ring stands.
- Assign four students per stratigraphic column.
- Or, teacher may desire to setup one "Blast from the Past" stratigraphic column per four students in order to save time.

MATERIALS:
- 81 cm plastic column with a 3.0 cm aperture (Wards cat.no.36H4191)
- ring stand
- clamps
- No. 8 rubber stopper
- metric ruler
- magic marker
- map of the Gulf of Mexico, Caribbean Sea and North Atlantic area
- hand lens
- very fine white playground sand
- coarse green sand or small gravel (aquarium store)
- gray or tan-colored sand (aquarium or craft store)
- fine brownish-color sand (craft store)
- four 500 mL beakers
- alternatives to sand: clay, jello, small jelly beans (various sizes, etc.)

PROCEDURE:
1. Teacher marks the side of a plastic column at the given sediment thicknesses below.
2. A. Before the arrival of the students, use a graduated cylinder to pour the appropriate amounts of colored sands into column to the measured thickness of each respective sediment.
   B. Or, pre-measure the amounts of colored sand per given layer and have the students gently pour sands into the column. Be sure there are no visible markings on the outside of the plastic column.

GEOLOGIC EVENT	SEDIMENT THICKNESS	MODEL COLOR
~~Pre-extinction Cretaceous layer (bottom)~~	~~20 cm~~	~~white~~
Tektite and meteor debris layer	17 cm	green
Iridium anomaly and surviving species from the Cretaceous Period	4 cm	grey-tan
Deposition of modern-day sediments and evolving new species of the Tertiary (top)	20 cm	brownish

NOTE: Below is a set of data illustrating an example of pre-measured "model layers" of K/T Layers of ODP Leg 171B core. Please note that amounts are particle size dependent!

Pre-extinction Layer	fine sand	110 cm	white
Tektite-rich Layer	gravel (5 mm)	180 cm	green
Iridium anomaly Layer	very fine sand	45 cm	gray
Post-extinction Layer	fine sand	110 cm	brown

3. Set aside a sample of the four model sands into four separate 500 mL beakers for the students to examine the characteristics of the "sediments."

THINGS TO DO FOR CATS:
1. Using your magic marker, clearly mark the interface (contact point) between the layers in your column.
2. Label the respective layers (strata).
3. CATS measure the thickness of each layer.
4. Examine the beakers with the model sediments (sands). CATS will describe some of the following sediment characteristics:
   • texture • particle size • color • thickness
5. CATS research the following:
   • Using the map of the Gulf of Mexico, Caribbean and North Atlantic area.
     - Locate the site of the ODP Leg 171B core drilling site.
     - Locate Chicxulub Crater on the Yucatan Peninsula, Mexico.
     - Measure the distance in kilometers of the drilling site from Chicxulub Crater.
     - Draw a line on the map connecting the drilling site and Chicxulub Crater.
   • How deep was the water that ODP Leg 171B core was retrieved from?
   • How long was the entire core of Leg 171B?
   • What was the depth of the core below the seafloor when it first encountered the K/T boundary?
   • What are foraminifera?
   • How are foraminifera used by scientists to analyze past climates?
   • Does Earth cool equally worldwide with respect to land and water regions? NOTE: think specific heat.
   • What is a bolide?
   • Describe the major effects of a bolide impact on water versus land.
   • What kind of meteorite (bolide) impacted at Chicxulub Crater, Mexico?
   • What are tektites? What does the tektite layer in the ODP Leg 171B core suggest about the impact that occurred at Chicxulub Crater on the Yucatan Peninsula, Mexico?
   • What is the K/T boundary?
   • What is the iridium anomaly?
   • Where does the iridium in the K/T boundary core come from?
   • Discuss the following results of the meteorite (bolide) impact at Chicxulub. The cause and effect of:
     - acid rain - tsunamis - distribution of sediment materials in oceans
     - fire storms - shock wave - distribution of sediment materials on land areas
     - forest fires - size and shape of crater - vaporization of the bolide
     CHALLENGE: Calculate volume of material ejected from crater.
   • What are the job descriptions of the following scientists that would makeup a team exploring, researching and analyzing discoveries like the ODP Leg 171B core?
     - geologist - micropaleontologist - chemist - astronomer - biologist
     - paleontologist - sedimentologist - climatologist - physicist
6. Dr. Brian Huber, a micropaleontologist at the National Museum of Natural History and a member of the team on board JOIDES Resolution who recovered the ODP Leg 171B core said that the "Blast from the Past" 'profoundly changed the course of life on Earth. If it had not happened, evolution would have followed a different path and in all likelihood we would not be here today.' What do you think Dr. Huber meant by this statement? (NMNH, June 1997)
7. Diagram and label the model of the ODP Leg 171B core. Use colored pencils.
   • pre-extinction Cretaceous layer – 113 m to 139 m below seafloor
   • K/T boundary
   • tektite and meteor debris layer
   • iridium anomaly layer with surviving foraminifera of the Cretaceous Era
   • evolving new life forms (Tertiary-Paleocene) – seafloor to 112 m below
8. CATS members cooperatively develop a written scientific report to present to their fellow classmates concerning the "Blast from the Past" K/T layers of the ODP Leg 171B core.

EXTENSION:

MAKING A FULL-SIZED MODEL OF THE OCEAN DRILLING PROGRAM LEG 171B CORE

PURPOSE:
Construct a full-sized clay model of the K/T boundary (aka, the "Blast from the Past") layer from the ODP Leg 171B core.

MATERIALS:

A. White clay or plasticine	pre-extinction layer	6 cm thick (bottom most)
B. Green sand mixed with green clay	tektite layer	17 cm thick
C. Gray clay	iridium anomaly layer	4 cm thick
D. Brown clay	new life forms evolving (Paleocene)	6 cm (topmost)

• one shoe box (12/13 shoe size) • metric ruler • string or duct tape • wooden mallet
• plastic column/tube (50 cm) • knife • one block of wood (2" x 4" x 8")

PROCEDURE:
1. Stand the shoe box on its end.
2. Stack the layers of clay into the shoe box in the order and thickness listed above in materials.
3. Place the top back onto the box.
4. Secure the lid to the shoe box with either string or duct tape so that the contents cannot fall out.
5. Stand the box back on its end.
6. Using a knife, cut the end of the shoe box off, exposing the topmost post-extinction, Paleocene layer.
7. Position the 50 cm plastic tube over the topmost layer.
8. Place the block of wood at the top of the plastic column and gently strike the top of the block, driving the column/tube through the clay layers until you hit the bottom of shoe box.
9. Lay box on its side and cut away other end.
10. Push the column all the way through the box and remove column. (There should be enough material to make three cores.)
11. Place the model of the ODP Leg 171B core onto a ring stand.
12. Refer to "Things To Do" for CATS.

Definition of "Leg" as used in this activity: "...any of the stages of a journey or other course or the run made by a vessel..." Webster's New World Dictionary, 3rd ED., Simon & Schuster, New York, NY, 771, 1994.

SUGGESTED WEB SITES:

1. **www.nmnh.si.edu./paleo/blast/asteroid_hyp.htm:** National Museum Natural History's description of the ODP core and its implications about the asteroid impact that might have caused the disappearance of the dinosaurs.
2. **www.nasa.gov:** NASA's main web site, contains info about all of NASA's programs.
3. **http://education.nasa.gov/:** NASA Education web site.
4. **www.quest.arc.nasa.gov:** Classroom activities on the internet.
5. **www.spacelink.nasa.gov:** Everything NASA offers to the educator about the space program is found at this superb site.
6. **http://impact.arc.nasa.gov:** Asteroid and comet impact hazard web site. Other links are provided to similar web sites.
7. **http://neo.jpl.nasa.gov/:** Near-Earth Object (NEO) Program information.
8. **www.lpl.arizona.edu/spacewatch:** Spacewatch Project web site.
9. **www.mov.vic.gov.au/planetarium/constetour/dds/dds1.html:** Melbourne, Australia, Planetarium offers a simplistic explanation of the impact theory and its effects.
10. **www.anu.edu.au/physics/nineplanets/meteorites.html:** Terrific source for meteorite information plus a wide variety of similar linked sites.
11. **www.rci.rutgers.edu/~geolweb/brimages.html:** Good source for general information about craters and Chicxulub.

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