Landsat 7 Educational Activity Date: _____
Finding Impact Craters with Landsat

Student Name: _____ Class Period: _____

Student Reading for Step 2:
Known Effects of Impact Events

When an object from space hits the Earth…

- There's a huge explosion.

- The impact makes a big hole or crater with a raised rim and *sometimes* a central peak.

  The hole is many times larger than the impacting object.

- There is a rapid release of a tremendous amount of kinetic energy as the object comes to a stop in about one hundredth of a second.

- The impact releases extreme heat. Usually, the object itself is vaporized. Sometimes it melts completely and mixes with melted rocks at the site.

- If the impact occurs in water, a whole column of water is vaporized.

- The impact also produces a super-hot blastwave – a shockwave – that radiates rapidly outward from the impact point through the target rocks at velocities of a few kilometers per second.

  The shockwave is stronger than any material on Earth. It deforms rock in ways that are characteristic of an impact event. No other event on Earth deforms rock in these ways.

- Tiny glass droplets can form during the rapid cooling of molten rock that splashes into the atmosphere.

- Large impacts also crush, shatter, and/or fracture the target rocks extensively beneath and around the crater. See diagram at: http://cass.jsc.nasa.gov/expmoon/science/craterstructure.gif

- Hot debris is ejected from the target area, and falls in the area surrounding the crater. Close to the crater, the ejecta typically form a thick, continuous layer. At larger distances, the ejecta may occur as discontinuous lumps of material.

- Large impact events can blow out a hole in the atmosphere above the impact site, permitting some impact materials to be dispersed globally by the impact fireball, which rises above the atmosphere. The resulting extensive dusk and smoke clouds can cause darkness lasting for a year.

- Special carbon molecules called Buckminsterfullerenes or (Bucky-balls, after Buckminster Fuller) can travel to the Earth in the impactor. They can hold special gases called "noble" gases that are indicators of extraterrestrial origin.

- Large impacts can trigger earthquakes and initiate volcanic eruptions.

- The heat ignites fires, and they may rage across a large region.

- Impact events can alter the chemical composition of the atmosphere. The extreme heat can generate large amounts of nitrogen oxides (NOx). NOx is easily transformed into nitric acid, resulting in acid rain.

More About …

More About Impact Events in General

Impact craters are geologic structures formed when a large meteoroid, asteroid or comet smashes into a planet or a satellite.

A very large number of meteoroids enter the Earth's atmosphere each day, amounting to more than a hundred tons of material. They are almost all very small, just a few milligrams each. Only the largest ones ever reach the surface. The average meteoroid enters the atmosphere at between 10 and 70 km/sec. All but the very largest are quickly decelerated to a few hundred km/hour by atmospheric friction, and they hit the Earth's surface with very little fanfare. However meteoroids larger than a few hundred tons are slowed very little; only these large (and fortunately rare) ones make craters.

All the inner bodies in our solar system have been heavily bombarded by meteoroids throughout their history. The surfaces of the Moon, Mars and Mercury, where other geologic processes stopped millions of years ago, record this bombardment clearly. On the Earth, however, which has been even more heavily impacted than the Moon, craters are continually erased by erosion and redeposition as well as by volcanic resurfacing and tectonic activity. Thus only about 120 terrestrial impact craters have been recognized, the majority in geologically stable areas of North America, Europe and Australia. Spacecraft imagery has helped to identify structures in more remote locations that can be explored for positive identification.

More About the Energy Released by Impact

Energies of impact are almost incomprehensibly large. They come chiefly from the kinetic energy of the impacting object. An object only a few meters across carries the kinetic energy of an atomic bomb as it strikes another object at high velocity. The impact of an object only a few kilometers across (smaller than many known asteroids and comets) can release more energy in seconds than the whole Earth releases (through volcanism, earthquakes, tectonic processes, and heat flow) in hundreds or thousands of years.

More About Extraterrestrial Objects in the Solar System

Thousands, possibly millions, of objects move throughout the solar system, orbiting the Sun. They range from microscopic dust particles to objects tens of kilometers across. Each object moves in its own orbit. We don't know how often they have hit the Earth in the past.

More About Impact Velocity

The minimum impact velocity for collisions with Earth is 11.2 km/s. This is equal to the escape velocity for an object launched into space from Earth's surface.

More About the Sizes of Craters

Objects of less than half a kilometer in diameter can make craters 10 km in diameter.

More About Crater Shapes

Nearly all impact events result in circular craters. In rare cases where the angle of impact was very low (0-10 degrees from the plane of the horizon), craters can be ovoid in shape.

More About Finding Impact Craters on the Ground

When looking for impact craters in satellite images, first pay attention to circular features in topography or bedrock geology. Look for lakes, rings of hills, or isolated circular areas.

On the ground, look for changes in the physical properties of the rocks in and around impact structures. Fractured rock is less dense than unaltered target rock around the structure. Also look ejecta and shocked rock fragments on the original ground surface outside the crater, and for fragments of the meteorite.