

# E.L.E

## (EXTINCTION LEVEL EVENT)

### *Project Report*

### *00IC28, 00IC27*

ELE stands for extinction level event. The term is self explanatory. It implies an event, in our case astronomical, which leads to extinction of all life or part of it on earth.

Before we understand as to what happens in an ELE lets try and see what causes it. The solar system apart from the 9 planets, sun and moons, also consists of dust and unaccreted material. A large portion of it is localized in 2 regions:

#### Asteroid Belt

Located between Mars and Jupiter, it is having a mean diameter of 200 AU. The main disturbance generator is Jupiter.

#### Oort-Opik Cloud

This belt lies beyond the orbit of Pluto and is 2000 to 200000 AU wide, carrying mostly comets. Disturbance occurs when a star passes by creating a gravitational flurry.

When any of the objects in these regions loses its original trajectory and starts a low perihelion orbit, it crosses the orbit of Earth and then becomes a possible threat to Earth.

#### **What can an asteroid impact do to earth?**

If an asteroid of size 200 meters hit the ocean (which covers 70% of the Earth), the tsunami (i.e., giant wave) it would create would inflict catastrophic destruction of coastal cities and substantial worldwide human casualties along coastlines. If an asteroid of size 1 kilometer hit Earth, it would cause a dust cloud which would block out sunlight for at least a year and lead to a deep worldwide winter, exhausting food supplies. The latter is what caused the dinosaur extinction, as well as other major extinctions of smaller creatures in geologic time scales. A mile-wide chunk of rock would hit the planet with the force of 500,000 megatons - far larger than any major earthquake or volcanic eruption & over 33,000 times the size of the bomb that destroyed Hiroshima.

On March 23, 1989, an asteroid with a kinetic energy of over 1000 one-megaton hydrogen bombs (i.e., about 5,000 times more powerful than the bomb dropped on Hiroshima) was recorded to have passed very close to Earth, using new technology equipment recently emplaced. Named 1989FC, this asteroid was detected only well after its point of closest approach, and we found out it had passed so close only after calculating backwards its orbital path after realizing its nearness.

The Meteor Crater in Arizona, measuring about a kilometer in diameter, was caused by a nickel-iron rock only about **30 meters across**, which isn't all that much larger than for the largest of the bolides we've seen over the past few decades. That's a very small asteroid which we couldn't see from telescopes on Earth's surface until it's right above Earth -- when it's much too late to do anything but duck for cover. The reason why the asteroid penetrated the atmosphere and hit Arizona is because it was a nickel-iron asteroid, not a volatile rich asteroid, and it came almost straight down rather than grazing.

For a land impact, it can be said in general that an object of roughly 75 meters diameter can destroy a city, a 160 meter object can destroy a large urban area, a 350 meter object can destroy a small state, and a 700 meter object can destroy a small country. A 100 meter tsunami would travel inland about 22 km (14 miles) and a 200 meter tsunami would travel inland about 55 km (34 miles)

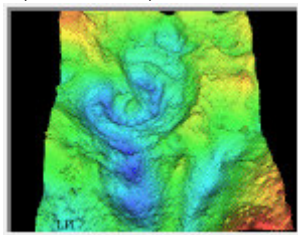
A one kilometer asteroid striking the Earth at a typical speed of 25 to 30 kilometers per second would on impact release the enormous kinetic energy into target rock in an explosion equivalent to 300,000 megatons of TNT. Flash and blast from the impact will destroy an area the size of Belgium. A 20 kilometer wide crater will be excavated in seconds, and debris will be ejected into sub orbital trajectories. This debris will later re-enter the atmosphere like a massive meteor shower all over the planet creating an intense global heat pulse, raising fires that will destroy a significant proportion of the biomass. The ozone layer will be obliterated. Major volcanism and seismic activity will occur as the shock wave from the impact ripples through the planet. Intense acid rain resulting from the ionization of the air as the impactor entered the atmosphere, and large quantities of pyrotoxins produced by global fires will fall world-wide. An impact at sea will produce a significant tsunami, capable of traveling considerable distances, and possessing enormous energy. Such surges will pose a substantial threat to low lying coastal areas. An impact in the Atlantic Ocean by a 1 kilometer asteroid will create a deep water wave 10 to 15 metres high. When it hits the continental shelf of Europe and North America, traveling at 600 kilometers per hour, it will run up a wave height of between 300 and 800 metres, depending on coastal topography. The main threat to life will be the vast amount of dust and debris injected into the upper atmosphere, combined with smoke from the firestorms. The surface of the Earth will be shrouded in darkness and it is this that will pose the greatest threat to the global ecosystem as photosynthesis stops, food chains collapse and cold and starvation set in. After a year, or perhaps two, the atmosphere will clear, but the Earth's albedo will be higher due to snow and ice, and it will reflect more of the Sun's radiation, leading to a runaway feedback situation, possibly leading to a new ice age. Statistically, we are hit by an asteroid of this size, not every 30 million years, but every 100,000 years.

### Has it happened before?

Yes, here are a few examples:

#### Chicxulub, Yucatan Peninsula Mexico

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



The impact basin is buried by several hundred meters of sediment, hiding it from view. NASA scientists believe that an asteroid 10 to 20 kilometers (6 to 12 miles) in diameter produced this impact basin. The asteroid hit a geologically unique, sulfur-rich region of the Yucatan Peninsula and kicked up billions of tons of sulfur and other materials into the atmosphere. Darkness prevailed for about half a year after the collision. This caused global temperatures to plunge near freezing. Half of the species on Earth became extinct including the dinosaurs.

#### Aorounga, Chad Africa

19°6'N, 19°15'E; diameter: 17 kilometers; age: 200 million years.



The impact of an asteroid or comet several hundred million years ago left scars in the landscape that are still visible in this space borne radar image of an area in the Sahara Desert of northern Chad. The original crater was buried by sediments, which were then partially eroded to reveal the current ring-like appearance. The dark streaks are deposits of windblown sand that migrate along valleys cut by thousands of years of wind erosion. The dark band in the upper right of the image is a portion of a proposed second crater. Scientists are using radar images to investigate the possibility that Aorounga is one of a string of impact craters formed

by multiple impacts.

#### Wolfe Creek, Australia

19°18'S, 127°46'E; rim diameter: 0.875 kilometers (.544 miles); age: 300,000 years



Wolfe Creek is a relatively well-preserved crater that is partly buried under wind blown sand. The crater is situated in the flat desert plains of north-central Australia. Its crater rim rises ~25 meters (82 feet) above the surrounding plains and the crater floor is ~50 meters (164 feet) below the rim. Oxidized remnants of iron meteoritic material as well as some impact glass have been found at Wolfe Creek.

### Barringer Meteor Crater, Arizona

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

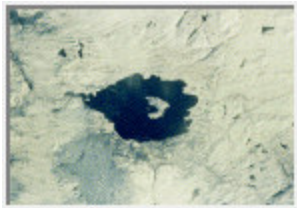


dramatic expression of the crater in the arid landscape

The origin of this classic simple meteorite impact crater was long the subject of controversy. The discovery of fragments of the Canyon Diablo meteorite, including fragments within the breccia deposits that partially fill the structure, and a range of shock metamorphic features in the target sandstone proved its impact origin. Target rocks include Paleozoic carbonates and sandstones; these rocks have been overturned just outside the rim during ejection. The hummocky deposits just beyond the rim are remnants of the ejecta blanket. This aerial view shows the

### Mistastin Lake, Newfoundland and Labrador, Canada

55°53'N, 63°18'W; rim diameter: 28 kilometers (17.4 miles); age: 38 +/- 4 million years

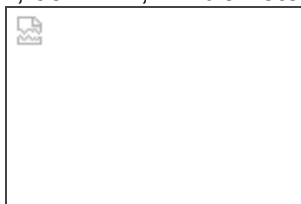


Precambrian crystalline target rocks. Just beyond the margins of the lake are vestiges of the impact melt sheet that contains evidence of meteoritic features in quartz, feldspar and diaplectic glasses.

This shuttle image shows a winter view of the Mistastin Crater, a heavily eroded complex structure. Eastward moving glaciers have drastically reduced the surface expression of this structure, removing most of the impact melt sheet and breccias and exposing the crater floor. Glacial erosion has also imparted an eastward elongation to the crater that is particularly evident in the shape of the lake that occupies the central 10 kilometers (6 miles) of the structure. Horseshoe Island, in the center of the lake, is part of the central uplift and contains shocked

### Manicouagan, Quebec, Canada

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



of the crater floor. Although the original rim has been removed, the distribution of shock metamorphic effects and morphological comparisons with other impact structures indicates an original rim diameter of approximately 100 kilometers (62 miles).

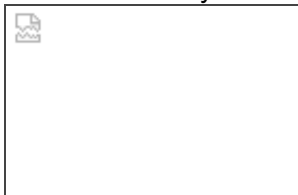
The Manicouagan impact structure is one of the largest impact craters still preserved on the surface of the Earth. This shuttle view shows the prominent 70 kilometers (43 miles) diameter, ice-covered annular lake that fills a ring where impact-brecciated rock has been eroded by glaciation. The lake surrounds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

### Clearwater Lakes, Quebec, Canada

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



submerged.

Twin impact craters, which are formed simultaneously by two separate but probably related meteorite impacts, are very rarely recognized on Earth. This pair is situated in crystalline bedrocks of the Canadian shield. The larger Clearwater Lake West (left) shows a prominent ring of islands that has a diameter of about 10 kilometers (6 miles). They constitute a central uplifted area and are covered with impact melts. The central peak of the smaller Clearwater Lake East (right) is

### Deep Bay, Saskatchewan, Canada

56°24'N, 102°59'W; rim diameter: 13 kilometers (8 miles); age: 100 +/- 50 million years



This crater consists of a near-circular bay, about 5 kilometers (3 miles) wide and 220 meters (720 feet) deep, in the otherwise shallow Reindeer Lake. Such deep circular lakes are unusual in this region, which is dominated by the shallow



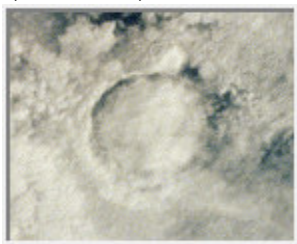
gouging of glacial erosion. The circular shoreline, at a diameter of 11 kilometers (6.8 miles), is partially surrounded by a ridge with heights to 100 meters (328 feet) above the lake surface. The diameter of this ridge, ~13 kilometers (8 miles), is likely the outer rim of the impact structure. The structure was formed in

Precambrian metamorphic crystalline rocks with a conspicuous northwest trending fabric. Although not obvious from the surface, Deep Bay is a complex impact structure with a low, totally submerged central uplift. Samples obtained in the 1960's from drilling into the central structure revealed shocked and fractured metamorphic rocks flanked by deposits of allocthonous, mixed breccias.

---

### **Bosumtwi, Ghana**

06°32'N, 01°25'W; rim diameter: 10.5 kilometers (6.5 miles); age: 1.3 +/- 0.2 million years

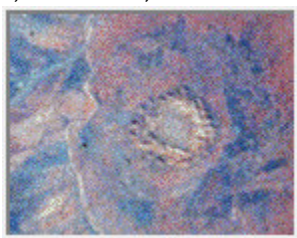


This crater is situated in crystalline bedrocks of the West African Shield and is filled almost entirely by Lake Bosumtwi. Chemical, isotopic, and age studies demonstrate that the crater is the most probable source for the Ivory Coast tektites, which are found on land in the Ivory Coast region of central Africa and as microtektites in nearby ocean sediments. In this photo the crater lake is partly obscured by clouds.

---

### **Gosses Bluff, Northern Territory, Australia**

23°50'S, 132°19'E; rim diameter: 22 kilometers (13.7 miles); age: 142.5 +/- 0.5 million years

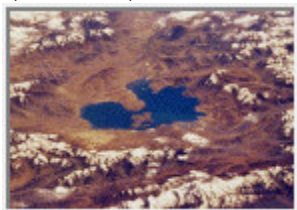


This highly eroded structures is situated just south of the MacDonnell Ranges (top of picture) in the arid Missionary Plain in the Northern Territories, Australia. Although it could be mistaken for the crater rim, the central ring of hills (5 kilometers or 3 miles diameter) results from differential erosion of the central uplift within this large complex crater. The rim itself has been eroded and is no longer visible, but the circular, grayish colored drainage system outside the inner ring of hills probably marks the original extent of the structure before erosion.

---

### **Kara-Kul, Tajikistan**

38°57'N, 73°24'E; rim diameter: 45 kilometers (28 miles); age: <10 million years



The spectacular Kara-Kul structure is readily apparent in this oblique view. Partly filled by the 25-kilometer (16-mile) diameter Kara-Kul Lake, it is located at almost 6,000 meters (20,000 feet) above sea level in the Pamir Mountain Range near the Afghan border. Only recently have impact shock features been found in local breccias and cataclastic rocks.

---

### **Roter Kamm, South West Africa/Namibia**

27°46'S, 16°18'E; rim diameter: 2.5 kilometers (1.55 miles); age: 5 +/- 0.3 million years



Located in the Namibia Desert, the raised crater rim is clearly visible against darker background vegetation. Target rocks include primarily Precambrian crystalline rocks and modest amounts of younger sedimentary rocks. Outcrops of impact melt breccias are found exclusively on the crater rim. The crater floor is covered by broad, shifting sand dunes. This image shows an oblique view of the crater, from about 150 meters (492 feet) above ground looking southeast.

---

### **How can we prevent an ELE?**

The methods to prevent an impact can be split into two categories -

## Destruction

## Deflection

Destruction means assuredly breaking up the object into small enough pieces so that none can penetrate the Earth's atmosphere. For example, if done by nuclear detonation, the dispersion of the fragments would mean that most pieces would miss the Earth, but some pieces could still hit Earth. The further away the detonation, the more dispersed the pieces by the time they arrive in Earth's vicinity. As you can see, blowing up the object is actually a combination of destruction and deflection -- the dispersion is a sort of deflection. The problem with destruction is the uncertainty of explosions -- success is risky.

Deflection means nudging the body so that it misses Earth. The further away the object is from Earth, the less we need to nudge it because the change in its trajectory adds up over time. For an asteroid on a trajectory to hit the Earth in the middle (as seen from its approach), we would need to deflect it a minimum of about 8000 km or 5000 miles (since Earth has a radius of 6400 km or 4000 miles) in the direction perpendicular to its trajectory. If we were to land on the asteroid roughly 6 months (4300 hours) before it would impact, then we would need to nudge it by accelerating it roughly 2 km/hour (about 1.2 miles/hour) in a quick thrust, or about 4 km/hr (2.5 miles/hr) for a slow 6 month thrust. We'd probably want to accelerate it even more just for the sake of safety, and would certainly want to rendezvous with it further in advance if possible. While a few km/hr speed seems small, keep in mind that we are moving mountains, not little cars and pulverizing a rock the size of Icarus (~200 meters) would require a 1,000 megaton bomb.

### Blowing it up by nuclear bomb --

This option is generally unfavored because it seems unlikely that it would completely break up most objects into small enough pieces, or assuredly move all pieces into a non-impact trajectory. It's still considered because it is economical and technically feasible -- it might work, and it might be all we can do if given very short notice.

### Nudging it by nuclear bomb --

This option explodes a nuclear bomb above the surface of a volatile rich asteroid or comet to cause intense heat at the surface in order to create gas jets which would thrust it away from Earth. Another nuclear nudge option is to chip off a piece by a subsurface explosion along an existing natural fracture -- split it into two but so that both dangerous pieces miss Earth in a straddling way. The drawback to both options is the risk that it would work. However, it very well might work, and it might be the most reasonable option if given very short notice.

### Nudging it by kinetic impact --

This option simply has a sizeable object strike the asteroid or comet at high speed in order to nudge it, possibly with an explosion upon impact to enhance the effect. This could work with small objects. The risk is that it will fragment the target and put a sizeable chunk on a collision course with Earth.

### Thrusting the object --

This option is attractive for very small objects whereby it would be feasible to launch up the required fuel propellant with a very high performance engine, or for small to medium sized objects known to be rich in water which we could use as fuel propellant in a thermal rocket. Nuclear rockets (which use a small nuclear reactor to heat any kind of propellant) would be preferred for their simplicity and high performance. Notably, solar ovens would not be preferred in the immediate future compared to a nuclear thermal rocket (simplicity, performance, and the possible need to clean mirrors getting dirty). The advantage of thrusting is that the object won't be fragmented and we have more control. The disadvantage is that it won't handle very large objects in a short time frame.

Now a body 100 metres in diameter if intercepted a year ahead of impact, it could be deflected with a tiny nuclear explosion, equivalent to just 100 tonnes of TNT. The purpose of the Near-Earth Object Program is to coordinate NASA-sponsored efforts to detect, track and characterize potentially hazardous asteroids and comets that could approach the Earth. The NEO Program will focus on the goal of locating at least 90 percent of the estimated 2,000 asteroids and comets that approach the Earth and are larger than 1 kilometer (about 2/3-mile) in diameter, by the end of the next decade. In addition to managing the detection and cataloging of Near-Earth objects, the NEO Program office will be responsible for facilitating communications between the astronomical community and the public should any potentially hazardous objects be discovered.

## What is being done?

The main task at hand is to identify the Near Earth Orbit Objects also classed as the Apollo-Amor objects. Many programs run by NASA and ESA and other countries regularly track and identify new objects. The noteworthy ones are NEAT (Near Earth Asteroid Tracking Program) and NEOP. Once a rogue asteroid is identified the necessary actions can be determined depending on the amount of time we have before the impactor enters our atmosphere.

### **What should we do?**

It is not necessarily the end of the world as we know it, but a reminder that whatever we do in our daily life is not necessarily very important in the astronomical play involving objects unimaginably larger than us and . We're nothing special in the great scheme of things. We are not the masters of the planet any better than the dinosaurs that died out before us.

Source: <http://www.hawastsoc.org/solar/eng> <http://abob.libs.uga.edu>

No copyright infringement intended. Only for information purposes.

[Back Home](#)