Measuring Impact Craters

FAULKES TELESCOPE

Asteroids, Comets and NEOs

Measuring impact craters on the Earth

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Introduction

In this activity, Google Earth will be used to observe and measure some real impact craters on the surface of the Earth. These craters vary in size from small (a few hundred metres) to very large (over 100km). The impacts causing this craters would, in turn, result in a variety of climatic changes - small impacts would generally affect only the local area, whereas larger impacts could have massive changes in the global weather systems.

This worksheet will guide you through how to download Google Earth, how to navigate to each impact crater, how to measure the diameter of each crater, and finally, to put the sizes of these craters into perspective, how to compare the sizes of craters with distances from school or home. You will then be asked to calculate the kinetic energies involved in some of the impacts which have created these craters.

Google Earth

Google Earth is a freely available program which allows you to look at satellite images of any region on the Earth's surface. The system requirements are given on the Google Earth download page, which can be found at:

http://earth.google.com/downloads.html

It can be used on a PC or a Mac.

To download Google Earth, click on the relevant version that you want to download, then click the 'Download Google Earth' button on the right hand side of the screen.

Follow the instructions to download Google Earth. The process of installing Google Earth should now be done automatically.

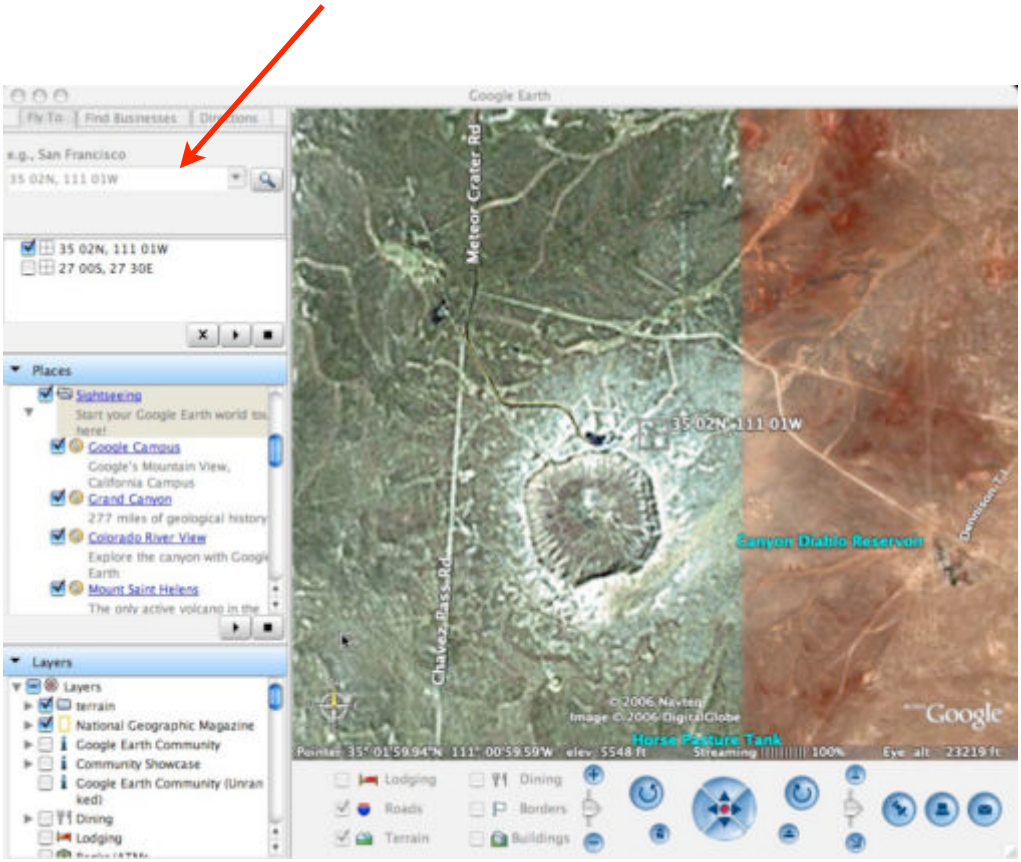
Finding Impact Craters

In order to find the impact craters that you will be measuring for this worksheet, you will have to enter the latitude and longitude of the craters into the 'Fly To' box in Google Earth. Once you have found a crater, you can save it's position in so you don't have to enter it's co-ordinates every time you want to view it. The steps for doing this are given below:

Marking a place in Google Earth

In the lat/long boxes, enter the co-ordinates of the place you wish to view. Enter the co-ordinates as, '00 00X, 00 00Y' where the '0' represent the numerical value of the lat/long, X should be replaced by 'N' or 'S' (i.e. North or South) and Y should be replaced by 'E' or 'W' (i.e. East or West).

For example, to view the Barringer Meteor Crater click in the 'Fly to' box and enter 35 02 N, 111 01 W as shown below.

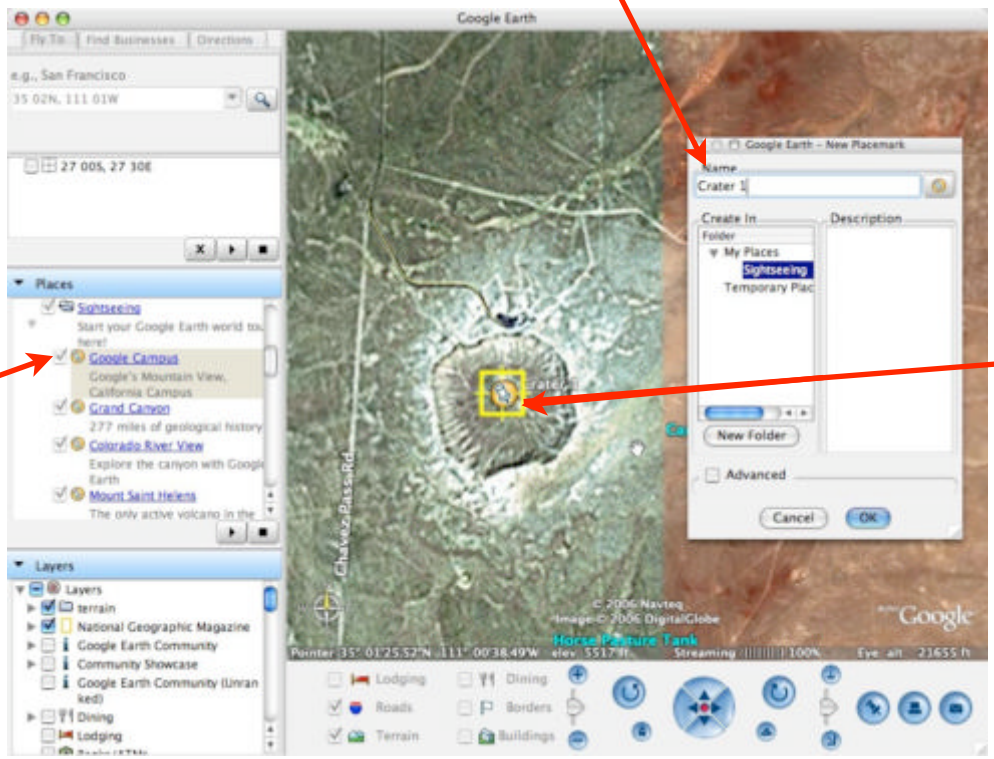


Google Earth will automatically fly across the Earth to the co-ordinates that you have sent it to. You can then add a placemark on your map by going to the main Google Earth menu at the top of the screen and clicking on Add > Placemark.

A pin symbol in a yellow box will then appear on your map.

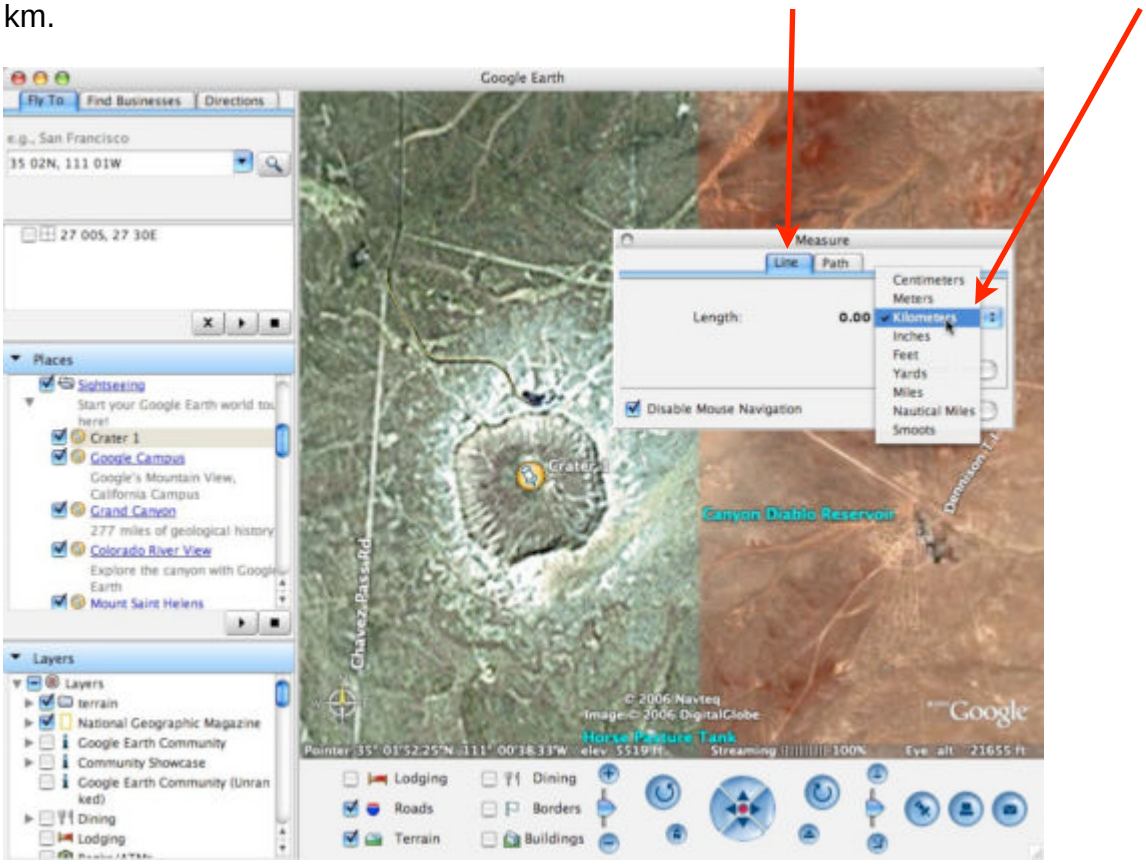
You can move this to the centre of your crater by dragging it with the mouse. Once positioned, you can enter its name in the pop-up box which has appeared, and this object will then be saved in your Google Earth folder under 'My Places'.

Whether the pin appears on the Google Earth image or not can be changed by clicking the blue box next to the object name on the left hand side of the screen.



Once you have found the craters that you will be studying for this worksheet, you must measure them using the Measure tool in Google Earth. In the main Google Earth menu, click on Tools > Measure.

A pop up box will appear in which 'line' is already selected. Click on the units box to select km.



You can now measure the diameter of each impact crater in Google Earth by using the left button of the mouse and dragging the line across the width of the crater. The distance measured is shown in the pop-up box.

Measuring the sizes of impact craters

Find the following impact craters using Google Earth, pinpoint them and measure their largest diameter (some of the craters are elliptical in shape, not round).

Crater Name	Latitude	Longitude	Size (km)
Barringer Meteor Crater This meteor crater was formed about 50,000 years ago by an iron meteorite impact. It is very easy to find in Google Earth.	N35 02	W111 01	
Manicouagan This impact crater is one of the oldest known craters on Earth. It was formed about 200 million years ago, and although some of the crater has been worn away by erosion, it is still very clear and easy to find in Google Earth.	N51 23	W68 42	
Clearwater Lakes These 2 impact craters were formed by a pair of asteroids hitting the Earth's surface. In one of the craters, a circular area of islands can clearly be seen. This is an elevated part of the crater, as seen in a complex crater. The central part of the second crater cannot be seen however as it is below the water.	N56 13	W74 30	
Chicxulub This is a fairly difficult impact crater to find on Google Earth, as most of the crater is buried below sediment. However, if you zoom out of the co-ordinates enough to see the top of the peninsula, part of the crater can be seen as a dark shadow on the land.	N21 24	W89 31	

Crater Name	Latitude	Longitude	Size (km)
Upheaval Dome Originally thought to be a collapsed salt dome, this crater has all the features of a typical impact crater - a central peak, an inner crater and outer concentric shock rings. This makes it easy to identify in Google Earth.	N38 26	W109 54	
Rio Cuarto The depressions in the land at Rio Cuarto do not look like typical impact craters. They are elliptical in shape, suggesting that they formed as a result of a group of very low angle impactors 'scratching' the ground as they came down. However, there is some doubt of the validity of these scars as impact craters, with some scientists believing that they are nothing more than features formed by winds on the Earth's surface.	S32 52	W64 14	
Gosses Bluff This impact crater in Australia is believed to have been formed over 140 million years ago. The central raised ring is not the rim of the crater - this lies much further out.	S23 50	E132 19	
Tenoumer This crater in Africa actually lines up with two other craters in the region. It is easy to identify in Google Earth - once located, try finding the larger crater to the South West.	N22 55	W10 24	
Vredefort This impact crater has a multiple ring structure which can be seen by zooming out of the town of Vredefort in Google Earth.	S27 00	E27 30	

Comparing the sizes of impact craters with local distances

Once the size of each impact crater has been determined in Google Earth, a comparison can be made with distances local to your school or home. This will give a some perspective on the sizes of these objects.

1. Enter the street name or postcode of your school/home in the ‘fly to’ box in Google Earth.

2. Once Google Earth has flown to your location, choose the measure tool once again by going to the main Google Earth menu and clicking on Tools > Measure.

3. Using the mouse, left click on your location to mark the point where you would like your line to be drawn from. Make sure your units are in ‘kilometres’ again so you can make a proper comparison with the impact craters.

4. Zoom out of your location in Google Earth so that you can fit a line the size of one of the impact craters, onto your map.

5. Click on the green box at the end of your drawn line to extend the length of the line.

6. Finally, extend your line until its length equals the size determined for each impact crater previously. This puts into perspective how big the impact craters really are!

Calculating the kinetic energies of impacts

The amount of Kinetic Energy released during an impact is given by:

$$K.E = \frac{1}{2}mv^2$$

where m = mass of the impactor in kg

v = velocity of the impactor in m/s

K.E. = kinetic energy released in the impact, measured in Joules.

The mass of an impactor can be calculated by:

$$Mass = Density \times Volume$$

and the volume of an impactor can be calculated by the following equation (if we assume a spherical impactor):

$$Volume = \frac{4}{3}\pi r^3$$

1. The Chicxulub Crater was formed by a rock impactor (density =2700 kg/m^3) with a diameter of 17.5km.

a) Calculate the volume of the impactor, assuming it was spherical.

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b) Calculate the mass of the impactor which created the Chicxulub Crater.

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c) Finally, calculate how much Kinetic Energy was released in the impact, given that it was travelling at 20km/s.
