Earth 351, Forming a Habitable Planet Name____________________________
Problem Set #**4** – **Impact Craters** Due: Mon., April 24, 2017

1. Geologists studying impact craters have combined measurements of craters on the earth, moon, and planets with laboratory experiments to develop approximate relations between the depth of a crater (d), its diameter (CD), and the diameter of the impacting body that produced the crater (ID). To explore these relations

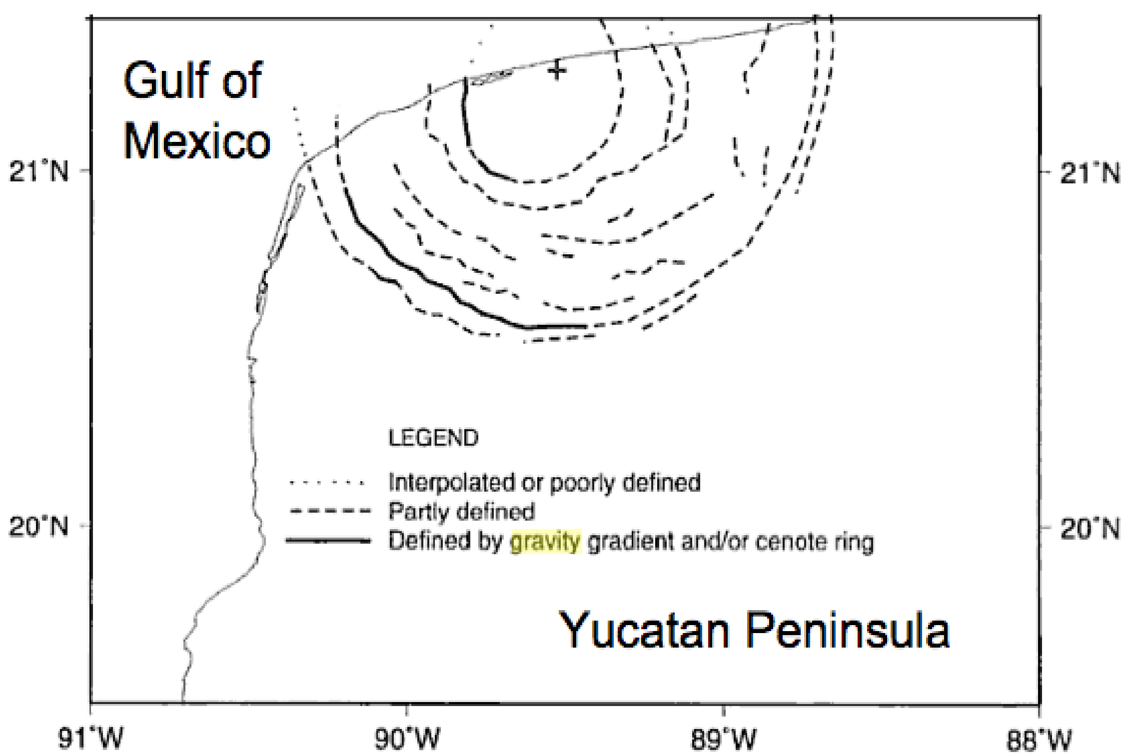
a) Use the data for Arizona's Meteor Crater shown in the class handout to estimate d/CD.

b) With that result and the laboratory observation d/ID ~ 7 develop a relation between the diameter of a crater and the diameter of the impacting body.

c) Why does any single such relation for all craters serve as only an approximation?

d) Use the result to estimate the size of the impactor that produced Meteor Crater and compare it to the estimates for the dimensions given in the class handout.

e) The map below shows the gravity field above the buried Chicxulub crater in Mexico's Yucatan peninsula. The crater was produced by an impact about 65 m.y. ago, proposed to have caused the extinction of the dinosaurs, the "K–T event", the geological boundary between the Cretaceous and Tertiary periods. (However, some paleontologists challenge this impact-scenario.)



From the map estimate the diameter of the crater and the impacting body.

2. With the “Earth Impact Effects Program”:http://impact.ese.ic.ac.uk/ImpactEffects/ (*Collins et al., 2005*) determine the effects of an impact at Chicxulub on the final dinosaurs at Hell Creek, Montana. Assume an 18-km stony impacting with a velocity of 20 km/sec, at 45° hitting a sedimentary target. Compare with the effects for a comet of the same size, but hitting with 3 times the speed. Would deep water mitigate the effects?

3. The Earth Impact Program was developed to calculate the effects on impacts on Earth. How do scenarios differ for neighboring planets Mars and Venus? (Cite the relevant equation # and relation to planet property, as documented in *Collins et al., 2005,* with "”References”", on class website, under Impact Craters.)

4. A body can escape from the surface of a planet with mass M and radius r if it is launched with the escape velocity $v= (2GM/r)^{1/2}$

a) Derive this relation by setting the kinetic energy of the escaping body equal to the gravitational energy binding it to the planet.

b) Compute the escape velocity for Earth.

c) Compute the escape velocity for Mars and compare with Earth's. What advantage does this low velocity offer for jump-starting life on Earth?

d) Meteorites can result when a large impact on a planet causes rocks to be ejected into space. Using b) and c) explain from which planet would it be easier for rocks to escape.

5. View the 2012 Whipple Lecture, Fall AGU meeting: Steve Sqyures “Clues to a hot, wet and violent ancient Mars”: http://www.agu.org/sections/planets/lectures.php. What evidence for hot, wet and violent conditions have the rovers discovered on the surface of Mars? What bonanza ensued when the front right wheel failed? https://www.youtube.com/watch?v=VYtkTbF5gRs&index=97&list=PL7Ihm2Mh3MZ53pOYu9KB-IcNAkuFWwR0o

6. Dark matter has been proposed to account for what discrepancy? (See HP, Chapter 2, or source on historical Astronomy). Experiments underway hunt for dark matter. How would this be measured? (Read Nature article on dark matter controversy.)