Mars for Earthlings

LESSON 10: Meteorite and Impact Craters

In Class Activity 1

Is it a Meteorite?

Purpose: Discover the criteria used to identify meteorites.

Is it a Meteorite?

Observe the rocks provided by your instructor. Mark Yes or No for whether or not you think the rock is a meteorite. Also note if the rock is: igneous, metamorphic, or sedimentary.

	Yes	No	Lithology
Rock A			
Rock B			
Rock C			
Rock D			

What criterion/criteria are you using to identify whether or not a rock is a meteorite? Explain below:

How big will the crater be?

Observe Meteor Crater in Arizona (pictured below) measuring: 0.737 mi in diameter, and 550 ft deep

Figure 1: Photograph by David Roddy, United States Geological Survey.

1. Did scientists find any of the meteorite (you may need to do some outside research)?

2. What factors influence the size of the crater? List at least 5 below.

© 2015 University of Utah. This work may be copied on the condition that the following attribution is contained on all pages of the reproduced work: Chan, M.A., Kahmann-Robinson, J., Wheatley, D.F., Duncan, C.J. 2014. Mars For Earthlings.

Mars for Earthlings

Calculate your own crater size!

1. Using the below link, calculate the size of 3 craters with varying parameters. Record the parameters and results below. http://www.lpl.arizona.edu/tekton/crater_c.html

2. What parameter do you find to be the most influential in the size of a crater?

Google Mars & Craters

3. Using Google Earth, find the Mawrth Valles region (22.43_N 343.03_E) in the Mars navigation. Using the ruler tool, determine the average diameter of craters in the region. Write the average below.

4. What might this say about the ages of these craters compared to other regions? Is it more like the area to the South or to the North?

Testing your skills

Which image below is a meteorite, Figure 2 or Figure 3? List your criteria.

© 2015 University of Utah. This work may be copied on the condition that the following attribution is contained on all pages of the reproduced work: Chan, M.A., Kahmann-Robinson, J., Wheatley, D.F., Duncan, C.J. 2014. Mars For Earthlings.

Mars for Earthlings

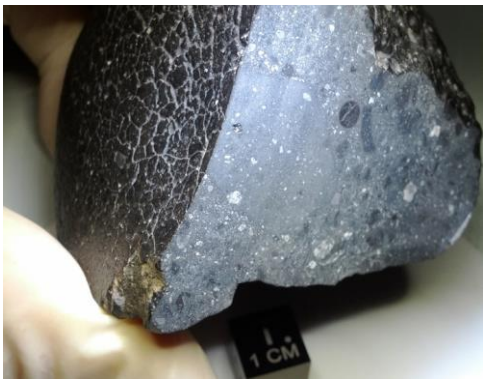

Figure 2 (Source: http://www.nasa.gov/mission_pages/mars/news/mars20130103.html)

Figure 3 (Source: Levi Huish, University of Utah)

© 2015 University of Utah. This work may be copied on the condition that the following attribution is contained on all pages of the reproduced work: Chan, M.A., Kahmann-Robinson, J., Wheatley, D.F., Duncan, C.J. 2014. Mars For Earthlings.

Mars for Earthlings

Homework 1
Ages and Times of Earth & Mars
Crater Counting

The number of craters on a planetary surface has age implications. Let's explore how this works!

1. We often use radiometric dating to determine the age of Earth's rocks. Is this technique applicable on Mars? What would be the challenges of preforming this technique on Mars?

2. What is the general assumption of age relative to the overall appearance of craters?

3. How can we roughly divide the history of crater formation into three periods, from oldest to newest (list size of crater and corresponding Mars Epoch with age constraints)?

4. Using the map of Mars below, sketch the basic boundaries of the three Mars Epochs that are based on crater counts (Labels: Noachian, Hesperian, Amazonian) For help use http://www.msss.com/http/ps/age2.html (**NOTE: This map is centered at a different location than the map below, so you need to be sure to match up appropriate geographic locations)

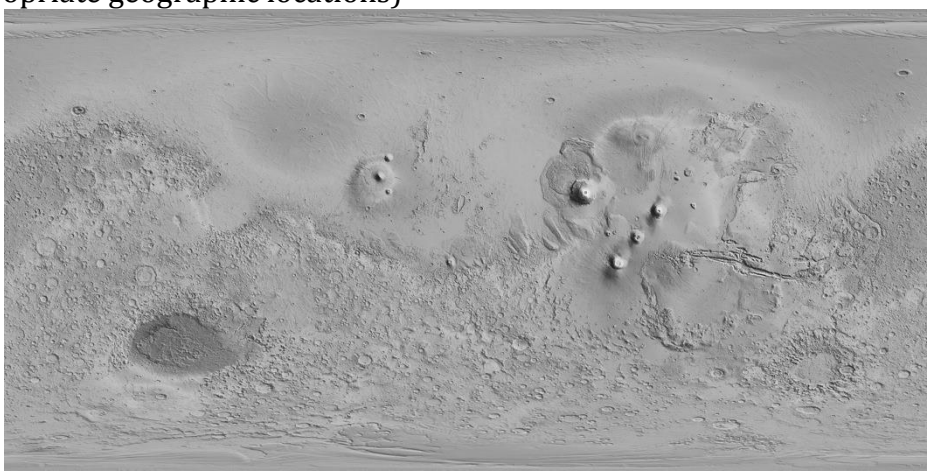

Figure 1 MOLA colorized elevation map in grayscale.

© 2015 University of Utah. This work may be copied on the condition that the following attribution is contained on all pages of the reproduced work: Chan, M.A., Kahmann-Robinson, J., Wheatley, D.F., Duncan, C.J. 2014. Mars For Earthlings.

Mars for Earthlings

Crater Counting:
Review this tutorial in order to use the Crater Counting layer in JMARS:
http://jmars.asu.edu/crater-counting-layer

5. Measure the diameter of as many craters you can using JMARS *Crater Counting* layer. Choose craters that are roughly the same size. Use a 128 zoom OR larger (to give you at least 30 or more craters) and fill in the average crater diameter and # of craters you measured. If you can separate out sizes, do so. Use the measure tool located in the tool bar at the top of the window to measure the x and y dimensions of the area you're counting in, then calculate area by Area = x*y.

Region	**Size 1:**		**Size 2:**		**Size 3:**	
	Ave diameter *(X-axis)*, **#**	**#/ area** = *plot on Y-axis*	**Ave diameter** *(X-axis)*, **#**	**#/ area** = *plot on Y-axis*	**Ave diameter** *(X-axis)*, **#**	**#/ area** = *plot on Y-axis*
Amenthes Rupes Area =	Dia: X=		Dia: X=		Dia: X=	
Vichada Valles Area=	Dia: X=		Dia: X=		Dia: X=	
Mawrth Valles Area=	Dia: X=		Dia: X=		Dia: X=	
Astapus Colles Area=	Dia: X=		Dia: X=		Dia: X=	

© 2015 University of Utah. This work may be copied on the condition that the following attribution is contained on all pages of the reproduced work: Chan, M.A., Kahmann-Robinson, J., Wheatley, D.F., Duncan, C.J. 2014. Mars For Earthlings.

6. Use the isochron diagram on the following page to determine the age of the terrain. **PLOT your points on Figure 2.** To scale the Y-axis correctly: use proportions and be sure to square the area you investigated.
   Example: 20 counted craters, diameter 4km in a 200km by 200km counted area-
   $20/ (200)^2 = 0.0005$ which gives you a y-axis value of 10^{-5}
   Use the diameter of 4km that you measured for the x-axis and plot.
   Does your age coincide with the sketch you made in #4?

   Amenthes Rupes- Epoch: _____

   Vichada Valles- Epoch: _____

   Mawrth Valles- Epoch: _____

   Astapus Colles- Epoch: _____

7. What are the difficulties you faced in crater counting on Mars? Do you feel like it is too "averaged" and some terrains are not accounted for? Why or why not?

© 2015 University of Utah. This work may be copied on the condition that the following attribution is contained on all pages of the reproduced work: Chan, M.A., Kahmann-Robinson, J., Wheatley, D.F., Duncan, C.J. 2014. Mars For Earthlings.

Mars for Earthlings

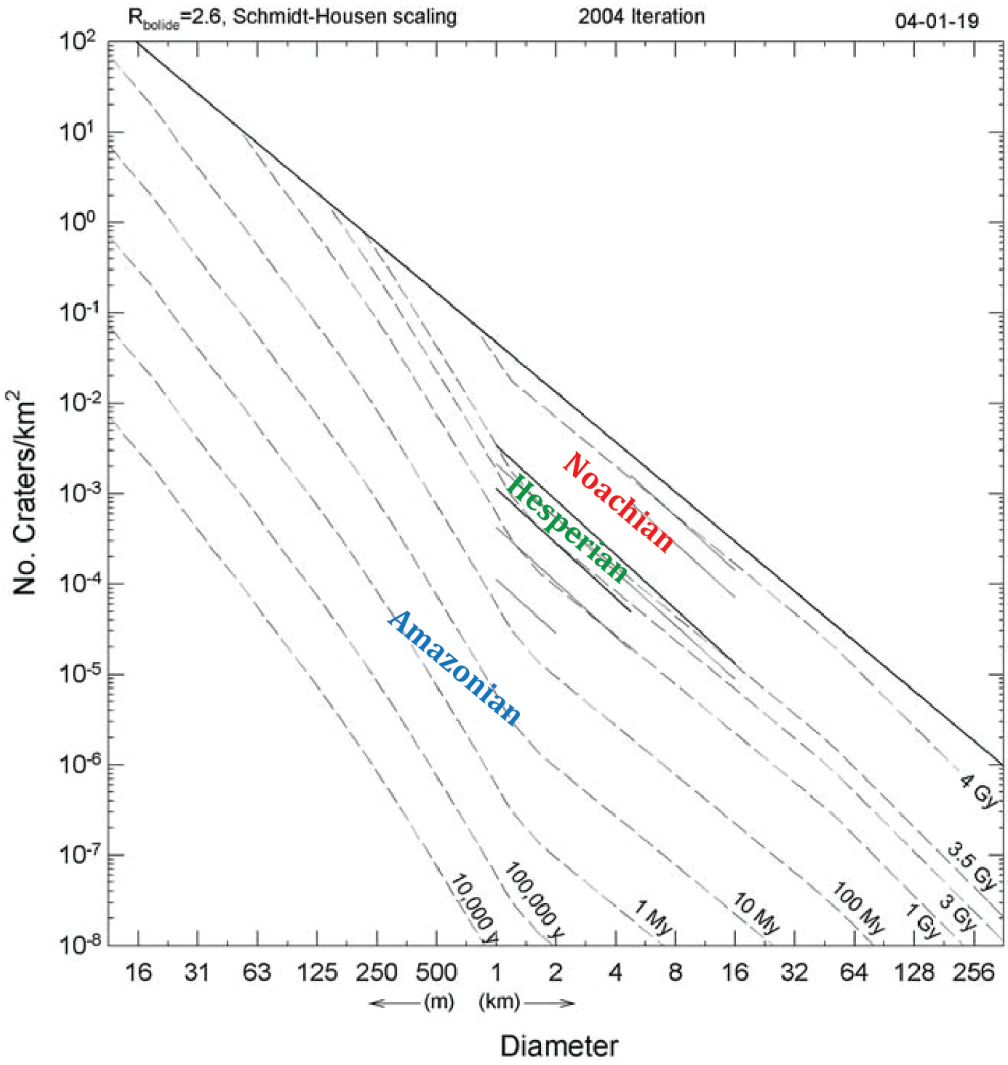

Figure 2. Final 2004 iteration of Martian crater-count isochron diagram. Upper solid line marks saturation equilibrium. Heavier short solid lines (1 km < *D* < 16 km) mark divisions of Amazonian, Hesperian, and Noachian eras; lighter nearby solid lines mark subdivisions of eras all based on definitions by Tanaka (1986). Uncertainties on isochron positions are estimated at a factor ~ 2, larger at the smallest *D*. 100 m (total uncertainties in final model ages, derived from fits at a wide range in *D*, including uncertainties in counts, are estimated a factor ~ 3).

Figure source: http://www.psi.edu/sites/default/files/imported/research/isochrons/mc8/fig6.jpg

© 2015 University of Utah. This work may be copied on the condition that the following attribution is contained on all pages of the reproduced work: Chan, M.A., Kahmann-Robinson, J., Wheatley, D.F., Duncan, C.J. 2014. Mars For Earthlings.