

# Lesson 6: Olympus Mons and Igneous Rocks

## Summary

This learning module and related laboratory exercise exposes students to volcanic styles, eruptions, igneous rock textures and their evidence in the Martian landscape.

## Learning Goals

### Students will be able to:

- Differentiate between pahoehoe and a'a lava flows through USGS video and subsequent discussion. Students will then observe Mars imaging of lava flows and hypothesize which lava flow is more likely on Mars.
- Observe a columnar joint experiment using cornstarch, observe the process and discuss its potential formation on Mars. Students will observe columnar jointing on Mars using HiRISE imaging and compare the features to the Columbia River basalts on Earth as an analog.
- Use Google Mars and JMARS software, students will increase their literacy with the software packages as well as recognize and analyze different mineralogies on Mars and the nature of Olympus Mons in comparison to Earth analog volcanoes.

## Context for Use

This learning module is meant for adaptation in an introductory earth science course and/or planetary science course. Before engaging in the In-Class Activities and/or Homework, students will need to be provided with an overview of igneous rocks (see Teaching Notes and Tips). All In-Class Activities can be adapted to a homework set if desired. Online access is essential for video viewing in association with the In-Class Activities.

## Description and Teaching Materials

### *In-Class Activity*

In-Class Activity 1: Lava flows

In-Class Activity 2: Cornstarch columnar joints

### *Homework/Lab*

Homework 1: Google Olympus Mons

Homework 2: Basalt & JMARS

## Teaching Notes and Tips

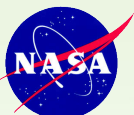
1. Provide students with a background in the rock cycle, igneous rock textures, volcanic styles, and rates of cooling for *In-Class Activity 1*.

## Mars for Earthlings

2. Instructors may choose to develop their own cornstarch experiment by the adaptation of the following published experiment and results:  
[http://www.physics.utoronto.ca/~nolin/papers\\_mud.html](http://www.physics.utoronto.ca/~nolin/papers_mud.html)
3. Make sure students are familiar with both Google Mars and JMARS software. The introduction module “Introduction to Mars and Earth Analogs” provide homework and/or In-Class activities to expose and orient students to the software packages.

### Assessment

- One of the goals of MFE is to have students become familiar with Mars imagery and navigating the mission online archives as well as software programs available to explore Mars imagery. The homework assignments, if completed, will provide students with increased competence in navigating both Google Mars and JMARS software.
- Through comparison of various Mars images students will be asked to identify common minerals on Mars, their abundance in terms of geographic location, as well as style of igneous rock formation.



## Mars for Earthlings

### References and Resources

1. Image file: [Igneous Rocks and Volcanics](#)
2. Rock Cycle Background:  
[http://www.classzone.com/books/earth\\_science/terc/content/investigations/es0602/es0602page02.cfm](http://www.classzone.com/books/earth_science/terc/content/investigations/es0602/es0602page02.cfm)
3. Columnar Joint Experiment Video: [www.youtube.com/watch?v=CJWfneKdv08](http://www.youtube.com/watch?v=CJWfneKdv08)
4. Columnar Joint Article:  
<http://www.sciencedaily.com/releases/2008/12/081216104325.htm>
5. Columnar Jointing in Columbia River Gorge Oregon:  
[http://www.youtube.com/watch?v=WLGXmJZ\\_KIU](http://www.youtube.com/watch?v=WLGXmJZ_KIU)
6. Mars columnar jointing discovery by HIRISE in Geology:  
<http://geology.gsapubs.org/content/37/2/171/F1.expansion.html>
7. HIRIES columnar jointing image:  
[http://www.nasa.gov/mission\\_pages/MRO/multimedia/mro20090225.html](http://www.nasa.gov/mission_pages/MRO/multimedia/mro20090225.html)
8. Pahoehoe lava flow video:  
<http://www.youtube.com/watch?v=qTTLyX4Xo2k&feature=related>
9. A'a lava flow video: <http://www.youtube.com/watch?v=bWswq8PmRII>
10. Basalt on Mars (Hawaii): <http://www.psrc.hawaii.edu/May09/Mars.Basaltic.Crust.html>
11. Athabasca Spiral lava flows: Discovery news article: <http://www.space.com/15446-mars-lava-volcanoes.html>  
Image source: <http://www.space.com/15446-mars-lava-volcanoes.html>
12. Mars Plagioclase mineralogy animation:  
<http://www.youtube.com/watch?v=FRU0cHb31JM>



## Mars for Earthlings

**Homework 2**

Igneous Rocks &amp; Volcanics\_MFE

Basalt &amp; JMARS

**Discussion/Questions**

1. The following are common igneous/mafic rock forming minerals. For each mineral, list its chemical formula:
  - a. Olivine
  - b. Pyroxene
  - c. Amphibole
  - d. Biotite
  - e. Plagioclase (anorthite)
2. Compare the chemical formulas and their elements to the element abundance list for Mars below. Which minerals do the students think will be more common on Mars? Have the students explain their choices below next to the list.
  1. oxygen
  2. silicon
  3. iron
  4. magnesium
  5. calcium
  6. aluminium
  7. sodium
  8. potassium
  9. chloride
3. Open JMARS. Using the *Nomenclature* layer, zoom to Valles Marineris to gain a geographical bearing. Add and compare the following layers (Add New Layer → Maps by Instrument → TES Mineral Maps): Basalt Abundance, Plagioclase Abundance (Bandfield, 2002), any olivine abundance map, and Carbonate Abundance. Warmer colors denote greater abundance.
  - a. Which map has the most coverage? Why might this be? What complications might arise from collecting this type of data? Could anything distort the data?



## Mars for Earthlings

- b. Where does the abundance of Plagioclase generally increase on the surface of Mars? Use geographical points of references or lat/long to explain.
  
- c. Compare the following animation for plagioclase abundance on Mars to the JMARS mineral map. Which perspective do the students prefer?  
<http://www.youtube.com/watch?v=FRU0cHb31JM>
  
- d. Are they surprised about the abundance of plagioclase on Mars in comparison to other minerals? Why or why not?

