Schools Tune Into Mars

Topic IV External geology of Mars versus Earth

Landscapes shaped by the effects of dust tornadoes

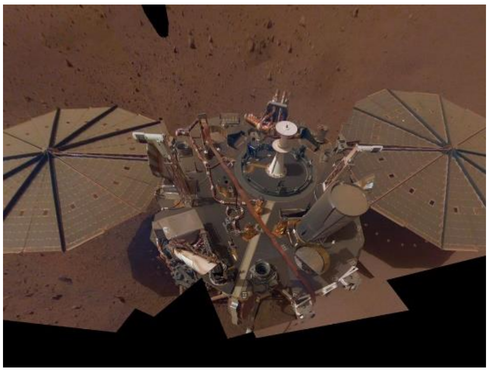
Volcanos compared: why a smaller planet has a bigger volcano?

Saltwater at the origine of the gullies on Mars : Information or Speculation?

Landscapes shaped by dust tornadoes

1. Introduction & Pb

Mars InSight lander captured a wind tornado that cleared the dust that has been piled on the lander's solar panels since its arrival.



« On the 1st of February 2019, two solar panels of the InSight lander that investigate the geology of planet Mars regained their previous power. This event was associated to a wind tornado which lifted a part of the dust particles covering the panels. It isn't an isolated event on Mars, but it is the first time this has been studied having complete meteorological parameters. »

Source : *Sciences and the future « A Martian passing dust wind swept over the pannels of InSight's solar pannels »*

Source : NASA/JPL-Caltech

The meteorological station APSS (Auxiliary Payload Sensor Suite) recorded a maximum wind speed of 45km/h. As the same time as the dust devil, there was a 13% drop of in atmospheric pression. According to the scientists in charge of the sensor, those conditions are consistent with the passing of a so-called "dust devil".

These tornadoes leave highly visible traces of their crossing on the Martian landscape and thus contribute to the particular geomorphology of the planet Mars, which is not the case on Earth.

Traces left by Dust Devils in the Richardson crater :

The dunes in the image are situated 72° to the south; on Earth, they would have been beyond the Antarctic circle. Due to their position being too close to the pole, enormous temperature variations appear throughout the Martian year. The image on the left was captured at the vernal equinox in the Southern Hemisphere which marks the end of summer and the beginning of fall.
There are still many visible **whirlwind traces**, displayed as subtle intersecting lines, but they will gradually be covered anew by the dry ice layer as austral winter settles in.

NASA/JPL/University of Arizona

Pb : How do these Dust Devil form on Mars ? Is there such a phenomenon on Earth?

2. Age of students: 13 – 15 years

3. Objectives

Understanding the physical laws that govern the movement of Air Masses, i.e. atmospheric convection. But also the process underlining Dust Devils' formation to further deduct the causes of traces left on the soil so representative of the planet Mars.

4. Primary subjects

Physics –Earth Sciences

5. Additional subjects

6. Time required: 2h

7. Key terms.

Dew point depression – Atmospheric convection –

8. Materials

Dust vortex modeling
- Incense
- Plexiglass sheet
- Candle
- Ice cube tray

Pressure sensor (see: Arduino Technical Data Sheet)

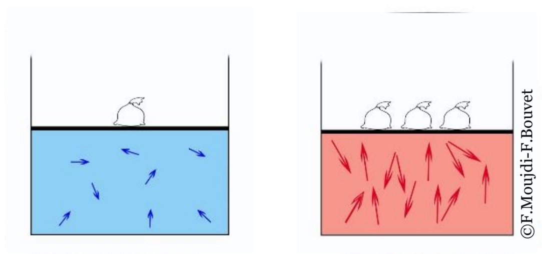
9. Background

Displacement of stable air masses by atmospheric convection :

The ratio between pressure values and temperature values (Gay-Lussac's Law) underlying the atmospheric convection principle:

French chemist and physicist Louis Joseph Gay-Lussac (1778-1850) proved that there is a connection between the pression and temperature values of a gas. For a constant volume and a given quantity of a gas, he observed that pressure of a given gas increases directly with the absolute pressure of the gas and vice versa. The mathematical relationship he deducted from his experiments is called Gay-Lussac's law.

« **Gay-Lussac's law** describes the relation between the pression and the temperature of a gas. It stipulates that, for a constant volume, pressure of a given quantity of gas is directly proportional to the absolute temperature of the gas. »



Temperature T Temperature 3T

According to this kinetic-molecular theory of gases, an increase in temperature should cause an increase in the kinetic energy of particles.

The molecular collision risk is higher, which causes a change in pression. If volume of the gas remains constant, its pressure will increase.

10. Procedures

Same as on Earth, winds on Mars are powered by solar thermal energy. Observations made by the Viking landers show that atmospheric dust particles on both Mars and Earth can be lifted by dust storms. These phenomena can reach significant dimensions. A tornado draws in the surrounding air masses and concentrates them in its core.

Amazonis Planitia

A large dust whirl projects a serpentine shadow on the Martian soil.
The photo covers an 644m wide area. The North is facing upwards. The dust wind reaches 800m altitude and 30m in diameter.
A westerly breeze half as high as the dust whirl produced a slight curve in the middle. The photo was taken when the planet is at its aphelion (farthest point from the Sun).

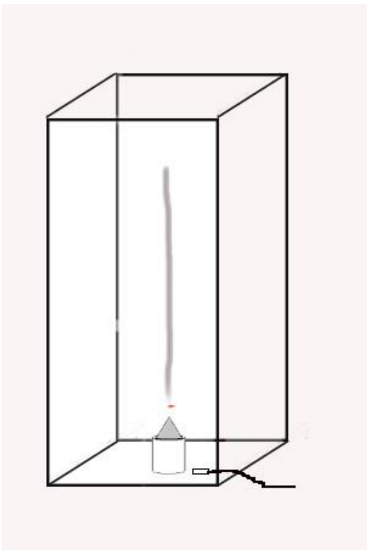
Satellite: Mars Reconnaissance Orbiter
Copyright: NASA/JPL-Caltech/University of Arizona

The same phenomenon happens on Earth, generally during summer. A dust devil is formed from the soil up when certain criteria is met. Dust tornadoes are whirlwinds of air masses entraining dust particles.

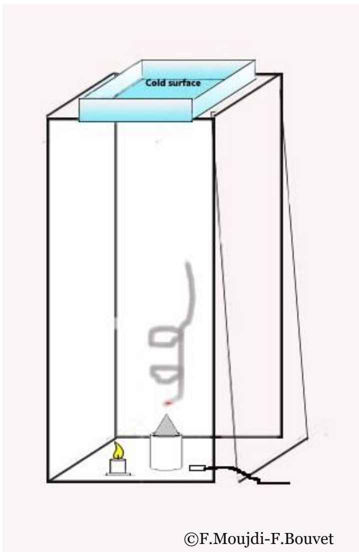
Air masses dynamics model :
Conduct the following experiment to emphasize the movement of air masses.

P° sensor on the inside and on the outside :

Without external disturbing factor



With external disturbing factor



1. Write down the results :

	Experiment 1		Experiment 2	
	T=0	**T=3'**	**T=0**	**T=3'**
Pression inside the tube				
Pression outside the tube				
Interpretation of laboratory results				

2. Using the obtained results, **explain** the phenomenon that took place during the experiment and what exactly allowed the movement of warm air masses.

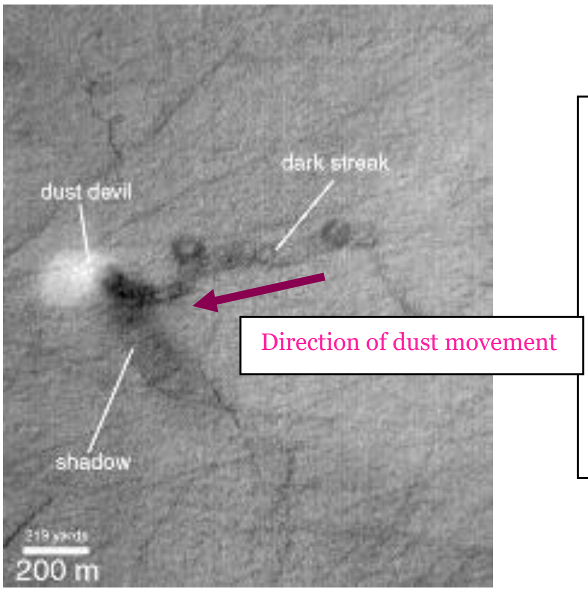
I. Tornado in action :

We have just shown that the ascent of hot air is the trigger of a tornado. This updraft also allows horizontal rotations to become vertical because of the tangential shear of vertical winds.

Afterwards, when the tornado is produced, air rises to its core, generating the violent suction of surrounding air and sustains the dew point depression.

When a dust devil travels on the surface of Mars, it can gather and disrupt the detached dust layers, leaving behind darker trails.

Dust in action, photographed on orbit by MGS on 11/12/1999 :



- Dark streak: The trace left by the passing of dust (70m wide) that swept the thin layer of clear dust particles covering the soil. Its sinuous form and dark color make the trace highly visible.

- Dust devil: Dust cloud

- Shadow: The shadow of the tornado on the soil.

11. Discussion of the results and conclusions

Dust devils on Mars are created in the same way they occur on Earth. The soil gets warmer during the day and heats the air just above the surface (through radiation). The mass of hot air rises and the colder mass of air above falls, thus creating vertical convection cells. A horizontal burst of wind will swirl the convection cells, which will then create a dust whirlwind.
Tornadoes that bring dust with them will contribute to the shaping of Martian landscape, leaving traces behind.
But these traces will gradually be covered once again by dry ice during austral winter. Mars' appearance changes depending on the season.

12. Follow up activities

- https://visionscarto.net/once-upon-a-thirst

13. Explore More (additional resources for teachers)

- **https://planet-terre.ens-lyon.fr/article/mars-2005-04-13.xml**

- https://www.nirgal.net/mars_science_atm.html
-

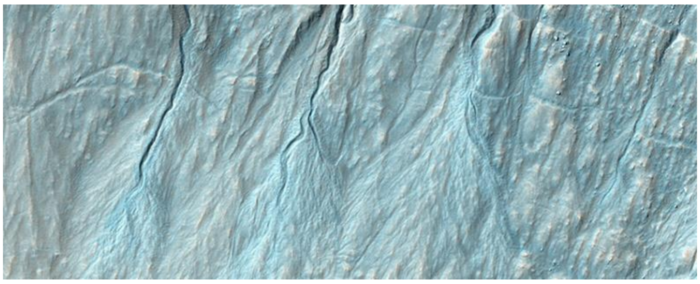
Saltwater - the source of ravines on Mars : Info or Hoax?

1. Introduction & Problem

Scientists believed that the process of soil liquefaction was responsable for the occurrence of ravines on Mars. That is, a process throughout which salts absorb atmospheric water-vapours when both temperature and humidity are elevated at the same time.
Such surface activity is also detected in the Antarctic, where similar water remnants are formed by trickling down brines on a shallow depth. But the night is a lot more cold on Mars than in the Antarctic and the active layer of ground that isn't freezing is a lot more shallow. This process, combined with the rarefied Martian air, can result in solely unnoticeable water quantities, certainly not enough for forming currents along the escarpment.

It seems that the process allowing ravines to be formed on Mars isn't due to the trickling of «saltwater » , but to another aspect.

Mars



A New Gully Channel in Terra Sirenum
Source: *NASA/JPL/University of Arizona*

Earth

Gully erosion in mudstones, PACA region
Source: www.lithotheque.ac-aix-eille.fr/Affleurements_PACA

How are ravines formed on Earth and on Mars ? Is soil erodibility the same ?

2. Age of students 13 - 15

3. Objectives

Explain ravine shaping on Earth and Mars and determine the soil erodibility factor (also known as the k-factor) and explain the sediment transport and deposition process.

4. Primary subjects

Physics –Geoscience - Chemistry

5. Additional subjects

6. Time required: 2h

7. Key terms

Ravine – Erosion – Soil erodibility factor– Sediment transport and deposition

8. Materials

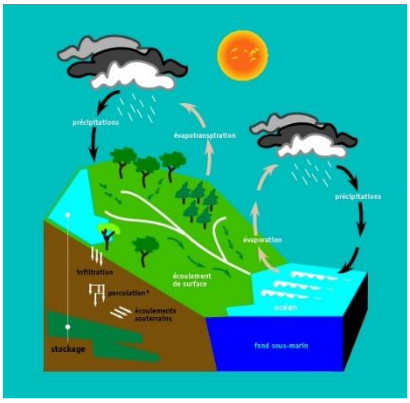
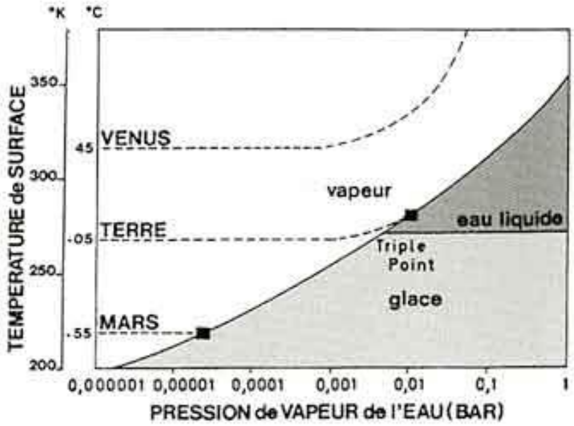
Ravine creation on Earth	Franklin Flask	Image processing
- Laboratory basin sink - Water - Wedge - Sand	- One Franklin flask (laboratory vessel) - Water - Arduino Temperature Sensor - Hot plate - Laboratory stopper - Support stand	- Qgis software - Satellite Images obtained from Hirise

9. Background

The fundamentals of the hydrologic cycle and CO2 cycle on Earth.

10. Procedures

On Earth :

Hydrologic Cycle	**Pressure-Temperature phase diagram for water** and the position of planets:
	
Source : Water Cycle on Earth (© DocSciences – P. Veyret)	***Author :*** *(Van Vliet-Lanoë, 2005)*

Ravines on Earth simulation:
- Simulation protocol, in A. Prost, *The Earth, 50 experiments to discover our planet*, Belin, 1999.

1 – Equally spread the sand in the basin sink (0,2 mm) and level the surface.

2 – Give the bowl a slight slope by placing a wedge on one side.

3 –Place the hose at the highest point of the bowl.

4 – Gently turn on the tap and lead the water jet to the bottom of the basin (downstream) : the trickle of water infiltrates in the sand.
Increase water flow until water stays on the surface.

1. **Use the available documents and the modeling protocol for the process of ravine formation on Earth (Erosion – Transport - Deposition)**

On Mars :

Tens of thousands of such ravine formations, having at times the length of many kilometers, cross slopes situated at Mars' mid-lattitudes. Their formation involved great quantities of liquid, which are very hard to explain. But the planet's atmospheric pressure is so low that any pure surface water inevitably freezes, evaporates or quickly boils. In fact, temperature and pressure conditions (see phase P° and T° diagram for water) are really close to pure water's critical point.

Isn't actually water that digs ravines on Mars ? What is in fact the factor responsible for this process ?

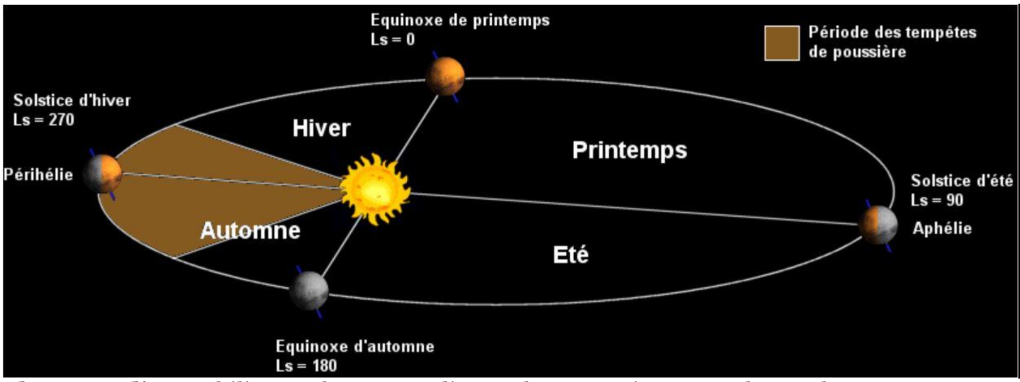
Index:
Martian atmosphere composition and Earth's atmosphere composition:

Gas	Mars (%)	Earth (%)
CO2	95,97 %	0,035 %
Ar	2 %	0,93 %
N2	1,89 %	78 %
O2	0,146 %	20,6 %
CO	557 ppmv	0,2 ppmv
H2O (varying)	0,021 %	0,4 %
O3 (varying)	0,01 – 5 Dobs	300 Dobs

2. **Formulate a plausible hypothesis:**

Hypothesis : CO2 could be responsible for ravine creation on Mars.

Distribution of seasons during a Martian year:

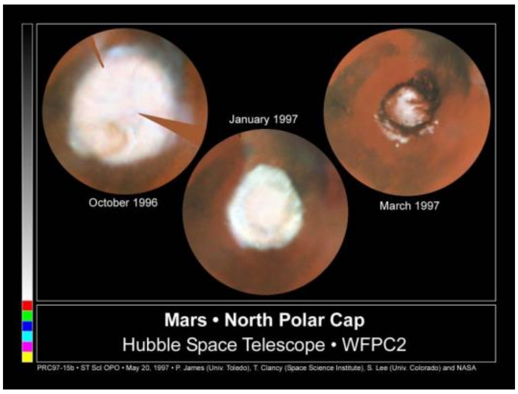


Sl : means Solar Longitude, measured using angles. One Martian year equals 360 degrees, i.e. one complete rotation around the Sun.

One degree in solar longitude matches the angle between the planet and the Sun on the day of Boreal spring equinox.

Photo Credit: © Philippe Labrot, according to the Dynamic Meteorology Laboratory diagram. Little by little by Calvin J. Hamilton

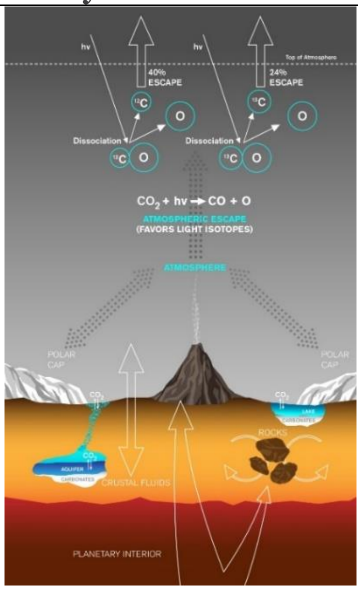
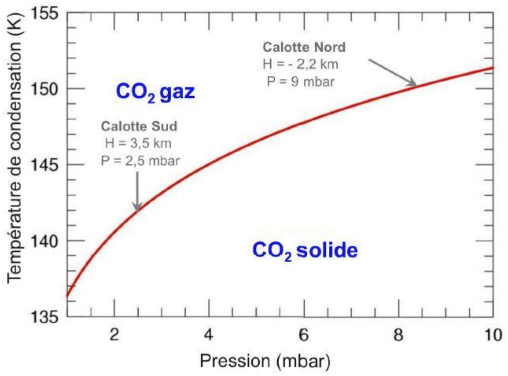
There is also the **seasonal variation of global surface pression**. Whenever there is a large residual cap to the north or to the south (winter and summer solstices), the pression is 75 Pa times weaker than the anual mean value. In absence of residual nothern or southern polar caps (spring and autumn equinoxes), the global pressure is 75 Pa times stronger than the mean value. This variation of 150 Pa between the equinox and solstice (25% of the average pression) shows that 25% of atmospheric CO_2 undergoes condensation and transforms into dry ice during winter and sublimes back the following spring. This transfer of 25% atmosphere between the north and the south that takes place 2 times during a martian year could be the cause of peculiar and generalized storms.



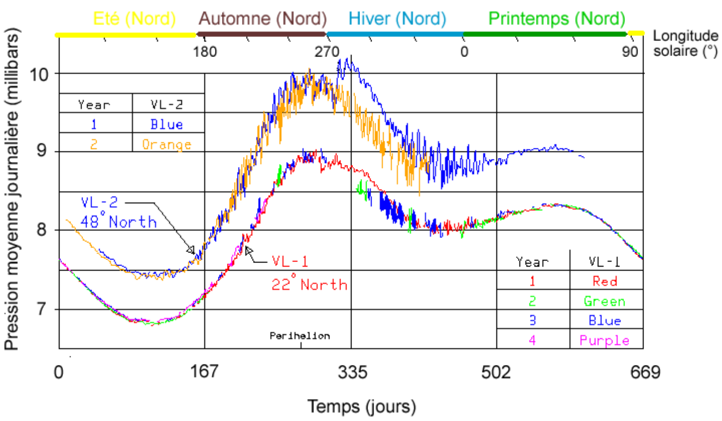
Droits réservés - © 1996-1997 Phil James (Univ. Toledo), Todd Clancy (Space Science Inst., Boulder, CO), Steve Lee (Univ. Colorado), NASA

These white polar caps fluctuate in size depending on seasons. Towards the end of summer, only the so called **permanent** or **residual** polar caps remain, formed of "eternal ice fields". The surfaces of white polar caps grow in autumn and winter as they restore and surround by a layer of frost, frost that undergoes condensation in autumn and winter and then sublimation in spring and summer. We thus refer to them as **temporary or seasonal caps.**

Temporary caps, thin layers of frost, seem mainly formed of dry ice (carbon dioxide ice). But what do those dry ice caps become and what do they transport?

CO2 cycle on Mars :	Phase diagram for CO2
 ***Source :*** doc. Lance Hayashida/Caltech	 H : average elevation of the surface P : equilibrium surface pressure *Source : Thesis « Seasonal condensates on Mars » Florence Grisolle.* **Frost** occurs when the **temperature** of air falls below **-125°C, temperature at which CO_2 changes its state of matter in this range of pressure.**

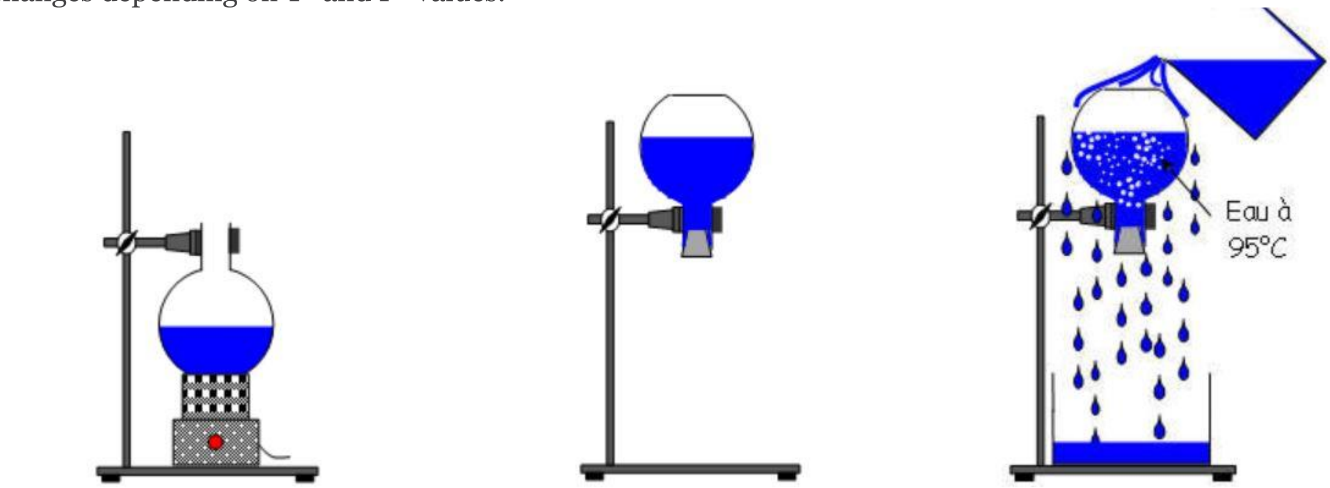
Atmospheric pression variation on Mars during different seasons



Reserved rights- © 1985-1988-1993 J.E. Tillman, modified

Experiment :

CO2 behaves differently on Mars because of T° and P° values.
Franklin Flask Experiment with T° Arduino to prove that the state of matter of chemical species changes depending on T° and P° values.



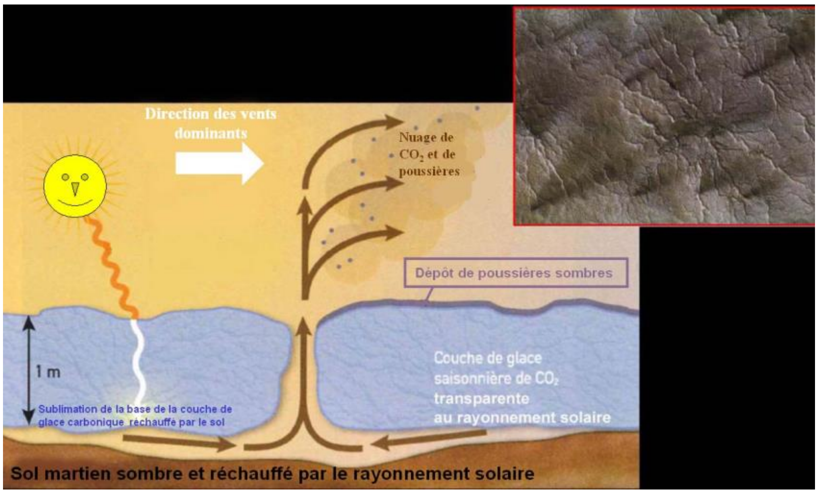
Chauffage de l'eau jusqu'à ébullition 100°C. | Retournement du ballon bouché | En arrosant d'eau froide, l'ébullition reprend

Source : https://applilocale.ac-besancon.fr/geogebra/labo/films/franklin/bouillant.htm

In winter, a layer of carbonic frost forms on the martian regolith. During spring, this layer that is translucent to solar rays is heated from its base.

The ice sublimes: i.e. transitions directly to the gas phase. Gaseous CO_2, trapped underneath the ice layer, is dispersed into regolith pores where the pression increases. The pression can then generate the fracturing of the top ice layer and the swift decompression of the regolith made of broken rock and dust drifted CO_2 thus allowing the drainage of a part of soil by digging a network of channels more or less convergent (woven meshes).

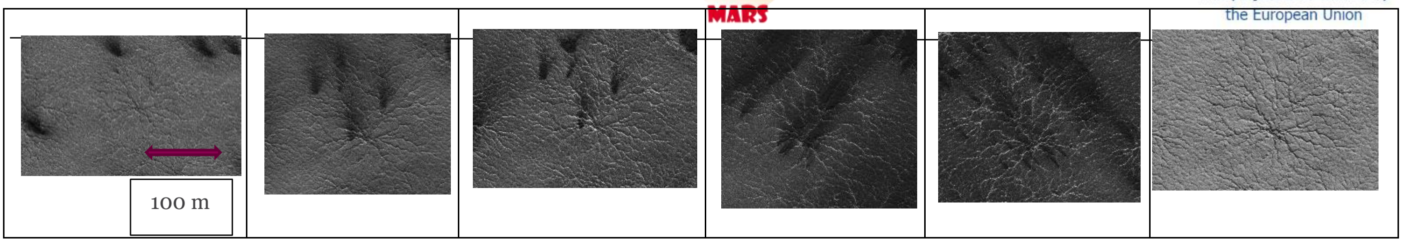
Dust brought to the surface will be deposited in the surrounding area, shaped by the dominant winds. (les éventails).
Source : https://planet-terre.ens-lyon.fr



Rights reserved - © 2003 Piqueux et al. ;NASA/JPL/University of Arizona

To exemplify the phenomenon : Present the sequence of images using Qgis software
You can open these image from a Qgis rendered file and thus overlay the layers to see the evolution of woven webs.

End of Winter	Start of Spring	Middle of Spring	End of Spring	Start of Summer	Summer



This sequence is a part of a December 2007 AGU presentation : "Spring at the South Pole of Mars". The sequence of events is studied in a series of images taken during spring and summer in the southern hemisphere and depicts the sublimation of a specific woven web.

End of Winter: We zoom on a single "web". There is a bunch of channels radially organized on the surface, covered by a slab of seasonal translucent carbon dioxide ice (dry ice).

The "date" is Ls = 181.1 (Ls being the unit of time on Mars : at Ls = 180, the Sun crosses the Equator to the south ; at Ls = 270, the Sun reaches its southernmost latitude and Summer begins.)

Start of Spring: obtained at Ls = 195,4. Four dust winds escaped from the woven channels. Translucent ice is warmed from the ground up and evaporated under the seasonal frost layer. Gas finds a weak spot and escapes to the top of the frost layer, transporting the surface dust across the ice. Dust is then swept away by the dominant wind.

Middle of Spring: calculated at Ls = 199,6. The dust is stuck in the channels.

End of Spring: obtained at Ls = 226 shows that the winds' direction changed, that the existing "fan system" is now elongated and an increasing number of new dust winds (éventails) originate from the channels as the frost layer gets thinner.

Start of Summer: established at Ls = 233,1, when a great part of surface frost disappears. The channels are translucent because the Sun shines more directly on their walls. A slim layer of darker dust can be seen on the bottom of the largest channels.

Middle of Summer: calculated at Ls = 325,4, in the middle of austral summer. All seasonal ice disappeared. It's obvious that the channels were dug in the surface and not into the seasonal frost layer. The dust storms eventeils disappeared, meaning that they no longer contrast with the surface material from which they originated. The surface material is dirt solidified by iced water covered by a layer of approximately 5 cm of dried out silt, whici is redistributed every season within this process of éventail creation and transport.

Written by: Candy Hansen (12 December 2007) – **Source :** NASA/JPL/University of Arizona

11. Discussion of the results and conclusions

Water is the factor of erosion in the case of ravine creation on Earth; on Mars, that factor is CO2.
This activity allows students to understand that the action of chemical species depend on Temperature and Pression values.

It is important that students develop a sense of critical thinking so that they remain unbiased and inquiring with every paper published in the scientific field.
Science is not a fixed discipline, it rather evolves depending on technological and scientific progresses.
"Billions of years ago, our planet was once surrounded by a layer of carbon dioxide, wherein the majority of it is now trapped on the bottom of oceans as limestone. During the era of its formation, the violent seismic activity unfolding on Earth tackled the entrapment of carbonates. In subduction areas, where the oceanic crust sinks under the continental crust, the slabs are affected by increasingly higher temperature values. The carbonates end up melting and thus create carbon dioxide which then returns to the atmosphere escaping the volcanoes's vent.
In constrast to Earth, Mars isn't familiar with the tectonics of plates. If Mars could have interlocked nonetheless, the cooling of the planet must had certainly stopped it. Without tectonic plates capable of putting carbonates back into circulation by thermal decomposition, Mars' atmosphere became increasingly thinner. The greenhouse effect diminished and the planet slowly but inevitably cooled off to finally become an icy world."
Source : https://www.nirgal.net/atmosphere.html

12. Follow up activities

Show the effect of erosion by CO2-enriched water: Karst landforms

Source : http://www.lithotheque.ac-aix marseille.fr/Affleurements_PACA/13_allauch/carte_geologique_allauch250.htm

—Massive coherent, non-porous carbonate rocks form rocky slopes in the geological landscape. Vertical limestone walls and talus slopes of marly limestone are displayed in an alternate matter. These rocks are deeply eroded by the water flow and form the so called Pepino hills or Lapiaz: grooves with a circular shape formed on tilted slopes. The dissolution process is also the starting process for rock shelter formation or glacial potholes carved into the rocky bed of a watercourse. The erosion is caused by rock blocks transported by temporary water flows.

— Limestone erosion helps enlarge vertical or tilted joints that affect limestone bedding plane. The phenomenon causes rock blocks to detach from cliffs and collapse at the bottom of bedding planes.
—The karst erosion depicted here formed under a vegetation cover, as water rich in carbon dioxide percolates the soil and slowly dissolves the chalk to give it the characteristic shaping of calcareous massifs. Nowadays, this chemical erosion has little to no effect on the rock outcrops.

13. Explore More (additional resources for teachers)

- https://www.uahirise.org/
- https://applilocale.ac-besancon.fr/geogebra/labo/films/franklin/bouillant.htm
- http://www.lithotheque.ac-aix-marseille.fr
- A. Prost, *La Terre, 50 expériences pour découvrir notre planète*, Belin, 1999.
- https://planet-terre.ens-lyon.fr/

Volcanos compared: why a smaller planet has a bigger volcano?

1. Introduction & Pb

The size and shape of a volcanic cone on the Earth allows the volcanologists to learn many things of the

history of the volcano as well as to know about the composition and other related physical properties of the magma that originated it, as for instance, its viscosity.

Many students know that a volcano on the planet Mars, Olympus Mons, is the biggest mountain in the Solar System, or at least, its highest volcano. It size (almost 22,000 m high) more than doubles the highest mountain on the Earth: another volcano located in Hawaii (Mauna Kea, 10,000m high).

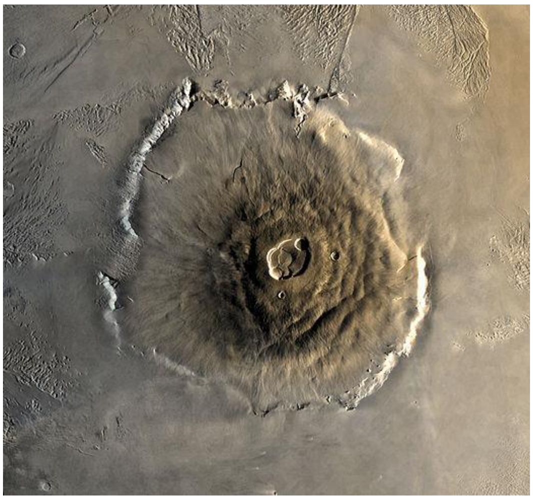


Figure 1: Olympus Mons
© NASA

2. Age of students 16 to 18 years old.

3. Objectives

Through this activity, students can:

- compare the sizes of the two planets (Earth and Mars);
- compare the sizes of the highest volcanoes on both planets, Mauna Kea on Earth and Olympus Mons on Mars;
- be aware that Olympus Mons is not only the biggest volcano in the Solar System, but also its biggest mountain;
- make calculations to calculate the volume, mass, density and weight of the two volcanoes;
- compare the eruptions of both volcanoes and to understand that both are shield volcanoes formed by lavas with a basaltic composition.

4. Primary subjects

General science, Geology, Maths, Physics, Geometry

5. Additional subjects

Arts (drawing)

6. Time required

30 minutes plus 30 minutes more for the "Follow up activities"

7. Key terms.

Volcanoes, basalt, shield volcanoes, volume, density, gravity, weight, scale, equivalence of units, asthenosphere, deformation

8. Materials

- graph paper,
- ruler,
- compass,
- pencil

9. Background

Figure 2: Olympus Mons compared to France. Published under Creative Commons Attribution-Share Alike 4.0 International

Many students find difficult to compare the dimensions of the different planets in the Solar System, as well as the relative size of the volcanos of both planets.

Through a series of simple calculations, they learn about the size of its biggest mountains. From its volume, composition and density, they can calculate their respective weights.

They can produce, then, theories to explain the differences in size as well as to better understand the dynamics of a planet with tectonic plates moving upon a plastic asthenosphere compared to another one with no active tectonic plates in the present.

10. Procedures

Before starting the activity, ask the students to use an engine search (i.e. Google™) in order to find out which are the biggest mountains on Earth and Mars as well as its dimensions (height and maximum diameter.

Their results should be:

PLANET	MOUNTAIN	TYPE	HEIGHT	DIAMETER
Earth	Mauna Kea (Hawaii)	Volcano	about 9,100m*	about 180km*
Mars	Olympus Mons	Volcano	about 25,000m*	about 600km*

*Results may differ from one source to another because of the *reference surface* to calculate the height as well as the shape of the basis that is not circular and therefore the measure of the diameter approximates the *mean diameter*.

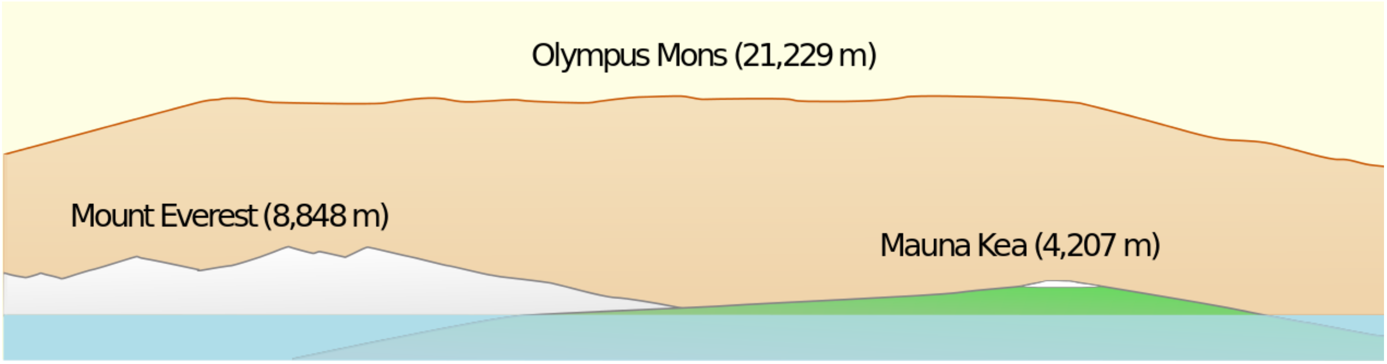


Figure 3: Olympus Mons compared to Mount Everest and Mauna Kea.
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Now give them a graph paper and ask them to represent a cross section of both volcanoes.

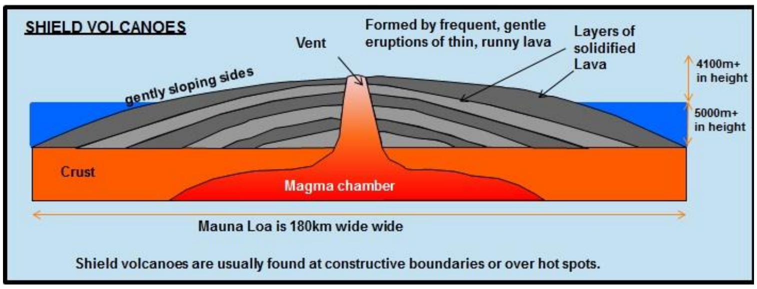
Scales suggested are: - horizontal: 1:2,500,000;

- vertical: 1:1,000,000.

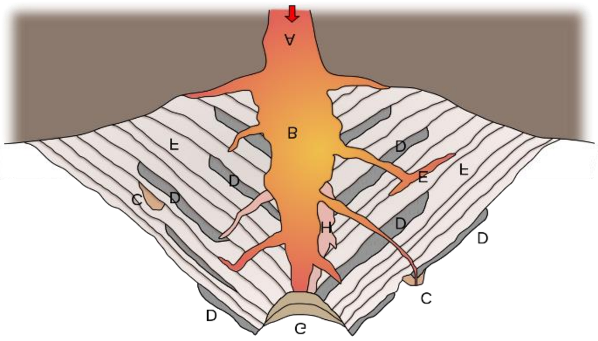
Then, ask the students to calculate the tangent of the slopes of both volcanoes using the following formula:

Tangent = height / radius

It is expected both results to be quite similar. As the Mauna Kea is a typical shield volcano formed by runny, basaltic high temperature lavas, with low angle slopes, we can find out that Olympus Mons is a Martian shield volcano also formed by basalt type lavas. The samples analysed in Mars confirm this theory.



Shield volcano (Wikimedia commons)



Stratovolcano (Wikimedia commons)

Figure 5: A shield volcanoes compared to a stratovolcano.

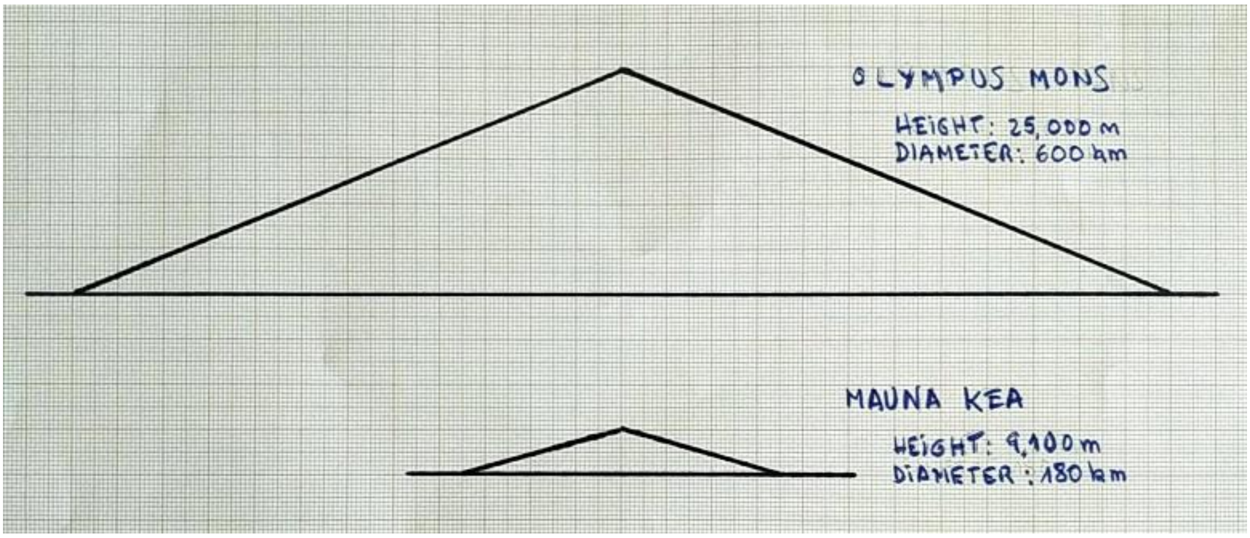


Figure 6: The two volcanoes plotted on a graph paper. Scales: horizontal 1:2,500,000; vertical: 1:1,000,00
Drawing: Xavier Juan

11. Discussion of the results and conclusions

A final discussion about the results should lead to the question: why Mars (a smaller planet than the Earth) has such an enormous volcano compared to the Earth volcanoes?

Possible answers are:

- *In Hawaii, the movement of the Pacific plate upon a unmoving plume causes the formation and extinction of successive volcanos that don't have time enough to grow very high*.
- *In Mars an unmoving plume feeding the volcano for a long time causes a higher volcanic building*.
- *A lower gravity in Mars seems to favour a higher volcanic activity*.

12. Follow up activities

Calculating the volume of the two volcanoes:

Accepting that the approximate shapes of the two volcanoes is a cone, and knowing its height and radius, students could calculate both volumes by using the formula:

$$V = 1/3\ \pi r^2 h$$

Where r is the radius of the base an h, the height of the cone.

Calculating the mass of the two volcanoes:

Now, knowing the volume of both volcanoes and the average density of basalt (about 3,000 kg/m^3), the students should be able to calculate the mass of the two volcanoes by using the following formula:

$$\rho = m / V$$

where ρ is the density, m the mass and V the volume.

Calculating the weight of the two volcanoes:

Now, provided that the average gravity is for the Earth and Mars ($9.8 m/s^2$ and $3.7 m/s^2$, respectively), pupils should be able to calculate the weight of both volcanoes:

$$W = mg$$

Where W is weight, m the mass and g the acceleration of gravity.

Discussing the results:

Knowing the weight of Mauna Kea upon the Earth crust and Olympus Mons upon Mars, ask the students to propose explanations for the fact that the Earth's crust is depressed around Mauna Kea because of its weight and that there's no evidence of such a sinking of Mars surface around Olympus Mons.

Possible answers are:

- The pressure (= weight (force) / surface) is less on Mars than on the Earth.
- As the outer layer of the Earth (lithosphere) is broken in several tectonic plates, the Pacific plate behaves apart from the rest of plates to the pressure caused by Mauna Kea.
- Mauna Kea is not a single volcano in the Hawaii area, but one of a complex of volcanoes with a resulting weight bigger than the one that they have calculated.
- In the Earth, the existence of a plastic layer below the lithosphere (asthenosphere) allows the Pacific plate deformation because of the weight of
  the Hawaii volcanoes. This is not the case for Mars where it seems that there's not a plastic layer like in the Earth.

All the possible answers could be true but, probably, the most significant is the absence of asthenosphere in Mars

13. Explore More (additional resources for teachers)

NASA Mars Exploration Program: https://mars.nasa.gov/

A flight simulation over Olympus Mons : https://www.youtube.com/watch?v=OTazRNGXSC8

Olympus Mons *(largest volcano in the solar system!)*: https://mars.jpl.nasa.gov/gallery/atlas/olympus-mons.html