A Brief History of Mars

Overview

Age Range:

10-14

Lesson Time:

45 Minutes (including 1 video)

Equipment Needed:

Computer

Projector

Topics Covered:

- Chemistry
- Geological time
- Biology (Life in extremes)
- Astronomy (Mars surface conditions)

Activity Outline

Investigate how Mars has changed over its history and how that might affect the habitability of the Red Planet.

Learning Outcomes

After completing this activity, pupils will:

- Understand how Mars has changed over time.
- Hypothesise how this has affected its habitability.
- Draw a conclusion as to which era of Mars's history was most likely to be able to support life.

Background Material:

Slide 1 - Introduction	For this lesson, we will be looking through the history of Mars in order to identify whether it may have ever been a suitable home for life, as we know it here on Earth.
Slide 2 - Objectives	Can be seen above in Learning Outcomes.
Slide 3 – Mars Timeline	The geological history of Mars can be broken down into four main time periods: • The Pre-Noachian • The Noachian • The Hesperian • The Amazonian

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Slide 4 – Pre-Noachian Era	Firstly, we will begin with the Pre-Noachian era. This era takes place from the formation of Mars 4.5 billion years ago until 4.1 billion years ago. At this point, Mars had an extremely thick atmosphere and large, hot seas. Towards the end of this era, the thick atmosphere began to erode, causing the vast oceans of Mars to begin to cool. From what we know about the late Pre-Noachian seas, do you think this would be a suitable place to evolve life as we know it? (Take answers)
Slide 5 – What happens to water on Mars without an atmosphere?	Here is a video illustrating just what happened to the vast oceans of Mars: https://youtu.be/V2X3rW53YiE Video background information: This video shows the correlation between pressure and boiling point. As pressure decreases, so does the point at which a liquid will boil. This is due to the nature of states of matter. A liquid will boil when its molecules have enough kinetic energy to escape into the atmosphere in the form of vapour. The temperature of matter is a metric of its energy – at sea level on Earth, the boiling point of water is 100°C. The lower the pressure on a liquid, the less kinetic energy is required for the substance to vaporise, meaning that its boiling point is lower.
Slide 6 – In groups, think about...	In groups, please discuss what effects being under modern Mars pressure would have on your body, whilst also considering that the human body is approximately 70% water in total (with some individual organs being up to 90% water!). (Allow time for group discussion) (Take answers) Possible correct answers include the boiling of saliva, blood, brain, eyes, cellular cytoplasm, expansion of air pockets such as the lungs and the bursting of closed systems such as bronchili and blood vessels.
Slide 7 – Noachian Era	Secondly, we will look at the Noachian era, which took place between 4.1 and 3.7 billion years ago. This was a period of extreme volcanic activity on the surface of Mars. Boiling hot ash and gases poured into the atmosphere, once more thickening it and allowing for the formation of lakes inside of craters and basins on the surface. This cloud of dense ash and gas also warmed Mars significantly.
Slide 8 – Tharsis Region	Here is an area that shows the scarring of this time period, the Tharsis region. Tharsis is a vast volcanic plateau centred near the equator in

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	the western hemisphere of Mars. The region is home to the largest volcanoes in the Solar System, including the three enormous shield volcanoes: Arsia Mons, Pavonis Mons, and Ascraeus Mons, which are collectively known as the Tharsis Montes. Lower down on this image we can also see Alba Mons and the largest known volcano in the Solar System, Olympus Mons.
Slide 9 – Danakil Depression, Ethiopia	An effective analogue for the Tharsis region of Mars is the Danakil Depression in Ethiopia. The Danakil Depression lies at the triple junction of three tectonic plates and has a complex geological history. It has developed as a result of Africa and Asia moving apart, causing rifting and volcanic activity. Erosion, inundation by the sea and the rising and falling of the ground have all played their part in the formation of this depression. Sedimentary rocks, such as sandstone and limestone, are overlain by basalt which resulted from extensive lava flows.
Slide 10 – Hesperian Era	Next, we progress to the Hesperian era, which took place between 3.7 and 2.9 billion years ago. At this point here on Earth, life was just beginning to evolve, whereas on Mars this is when we see the average temperature of the planet plummet. Mars from this point onwards has had a very cold climate, with average temperatures of about -60°C and lows as cold as -120°C towards the poles. Not only this, but due to the settling of sulphur dioxide from previous volcanic eruptions, the substrate of Mars has been rendered acidic. By this point in the history of Mars, most remaining water is locked away in permafrost and subsurface ice.
Slide 11 – Amazonian Era	Lastly, we arrive at the current Martian geological time period, the Amazonian era. This has spread over more than half the time Mars has existed, from 2.9 billion years ago to the present day. By this point, Mars is a freezing cold, barren wasteland coated in toxic salts and bombarded with ultraviolet radiation due to its thin atmosphere.
Slide 12 – Habitability	Mars has changed enormously over the last 4.5 billion years, but which of these eras do you think would have been the most likely to support life? Discuss in your groups. (Allow time for discussion) (Take answers)
Slide 13 - Review	From this lesson, students should be able to answer these questions: • How does Mars differ now from how it was over 4 billion years ago?

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- What are some of the challenges hypothetic Martians would have had to endure?
- When do we think Mars would have been at its most habitable?
- Lastly, do you think there's any life on the Red Planet?

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