1. Martian Soil

3 hours

OBJECTIVES

- To plan different types of scientific enquiries to answer questions
- To identify scientific evidence that has been used to support or refute ideas or arguments
- To compare and group together everyday materials on the basis of their properties

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 1-3
- Images A-J from www.cciproject.org/topicBank/space.htm
- Role badges (optional)
- Soil samples A, B, C
- Magnifying lens
- 2 teaspoons
- 3 Petri dishes/shallow bowls
- Blue and red litmus paper (supplied by TTS or other suppliers)
- or vinegar and bicarbonate of soda (1/4 cup)
- 3 filter funnels and filter paper.
- 3 plastic cups
- 3 measuring cylinders
- Tea light and stand
- Foil evaporating dish
- Sand tray
- 4 pairs of safety glasses

ADVANCE PREPARATION

- Activity sheets 1-2 made into a set of cards
- Soil samples A,B, C (Appendix 1)
- Role badges (Appendix 1)

All the classroom sessions involve children working together in groups of four. A set of role badges for each group should be prepared before the lesson should the teacher wish to use them. (See page 56).

INTRODUCING THE ACTIVITY

The teacher uses the images A-D (see page 15 or website) to begin a discussion about the possibility of life on Mars and asks the children Can we see evidence of life on the surface? Where else could we look? 'Rovers' are being designed to search for signs of life on and below the Martian surface. Each pair in the group is asked to discuss how we know if something is alive. Pairs share their initial ideas with their group. Images of living/non living things (Activity sheet 1) can be used as a revision aid in a sorting activity to support discussions. The 'Snowball technique' (Appendix 2) could be used to share ideas between groups, before the class produces a consensus of key criteria for life.

The teacher describes conditions on Mars, using information in Appendix 3 and asks the children if they can suggest extreme places on Earth; they should consider examples of adaptations of living things in such environments. Images E-J of extremophiles and extreme habitats are shown. Considering this information about extremophiles, Is it possible that there has ever been life on Mars? What might that life look like? We need to find out as much as we can about conditions on Mars to answer these questions. They next consider the kinds of life (possibly microbial) and evidence that astrobiologists may be searching for on Mars.

ACTIVITY

The teacher explains that one day, space scientists hope that real samples of Martian soil will be brought back to Earth but in this activity, they will simulate the work of space scientists investigating 'mock samples'. The Space Agency has given each group three different samples of 'soil' and through observations and tests they must decide which might be most like Martian soil. Each child in the group is given a card from Activity sheet 2. The children should take turns at sharing their information with the rest of the group; the key facts will help them in their investigation. This activity is intended to be child-led and therefore they decide what evidence they need to collect and how they might record their observations, measurements and conclusions.

The children should be encouraged to observe each sample of soil closely, to feel the soil texture and note its characteristics. They use small quantities of each sample to carry out further tests. Activity sheet 3, if required, is provided for children to summarise their observations, results and conclusions.

SAFETY NOTES, PRACTICAL TIPS AND GUIDANCE

- Children should wear safety glasses to protect their eyes when evaporating water from salt solution, due to potential spitting.
- Tea light stands should be placed in a tray of sand for safety. Consult ASE's Be Safe! for further guidance.
- Teachers should ensure that each soil recipe is mixed thoroughly. It is recommended that eachers test the mixtures before the lessons.
- Litmus paper[1] can be used to show whether a liquid is acidic or not. Just add a teaspoon of soil to a cup, add water to cover the soil and mix. Then dip the paper into the liquid.

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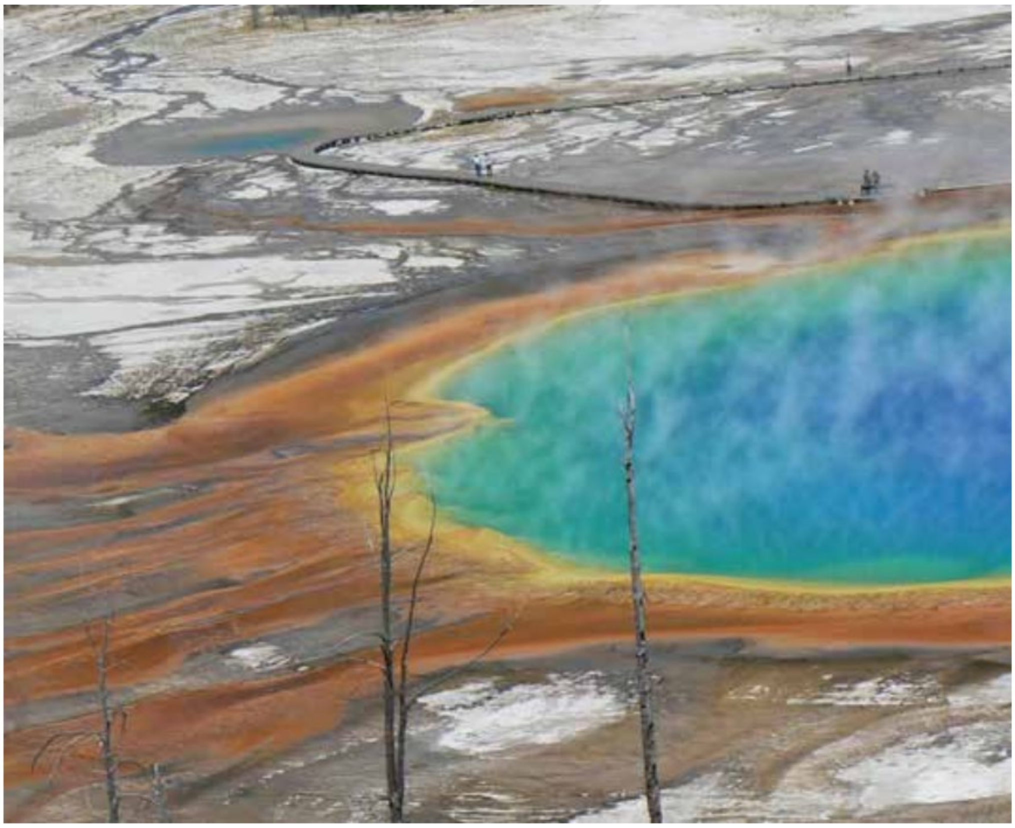
1 If you do not have litmus paper, put a teaspoon of soil into each of two containers. Then, add vinegar to one. If the soil bubbles or fizzes, it's not acidic. If there's no reaction, add water to the second sample and mix. Then, add two teaspoons of bicarbonate of soda. If the soil bubbles or fizzes the soil is very acidic.

PLENARY

The communications manager from each group reports their observations, measurements, results and conclusions to the class. The results may be collated on the whiteboard for display and discussion by the class. Unusual or unexpected results or observations may be noticed. The teacher can ask some of the following questions:

- *Did all groups identify the same sample as most like Martian soil?*
- *Were there any disagreements?*
- *How did you decide which sample was the most like Martian soil?*
- *Did you recover any salt crystals?*
- *What methods did you use and what evidence did you have?*



Hot springs in Yellowstone Park: a suitable extremophiles' environment.

IMAGES OF THE MARTIAN SURFACE

Images can be downloaded from www.cciproject.org/topicbank/space.htm

Image A

Mars through a telescope showing the canals

Image B

Surface of Mars taken from orbiting satellite

Image C

Mars Rover

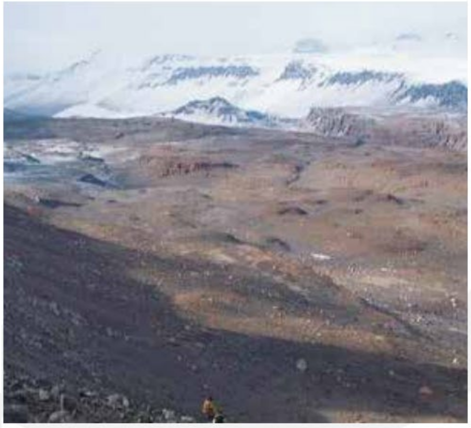
Image D

Surface of Mars taken from Rover

EXTREMOPHILE HABITATS

Images can be downloaded from www.cciproject.org/topicbank/space.htm

Image E



Antarctica

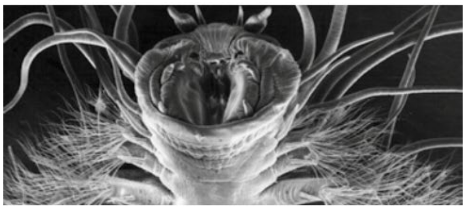
Image F

Volcanic lava

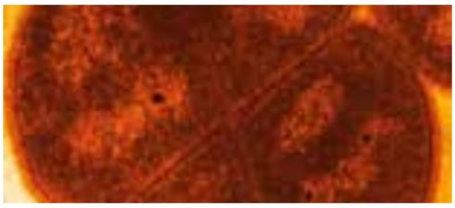
Image G

Volcanic ash

Image H



Methane worm

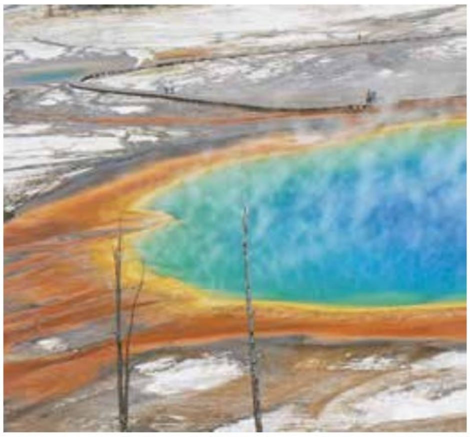


Deinococcus radiodurans

Image I

Ocean depths

Image J



Yellowstone hot springs

Appendix 1: Advance Preparation

ACTIVITIES 1 AND 2[1] SOIL TESTING

3 samples of 'Martian soil' in sealable sandwich bags, labelled A, B, C.

Sample A	Sample B	Sample C
2 tbs building sand	2 tbs building sand	2 tbs building sand
2 tbs rock salt	2 tbs rock salt	1 tbs fine grit
1 tbs table salt	1 tbs table salt	1 tbs gravel
1 tbs fine grit	1 tbs fine grit	1 tbs flour or talc
1 tbs gravel	1 tbs gravel	
	1 tbs flour or talc	

ACTIVITY 7 CHOCOLATE VOLCANO

Milk chocolate	White chocolate	Dark Chocolate
Any supermarket own Belgian chocolate	Any supermarket own brand	Any supermarket own brand
Green & Black, 34% Cocoa solids	Green & Black	Green & Black cooking chocolate 72% Cocoa solids
Ryelands	Ryelands	Ryelands

1 For the microorganism test, Activity 2, yeast should be added to sample C and it should remain salt free.

ADDITIONAL IMAGES FOR LANDINGS SECTION

Image number	Name of feature	Description of feature
Introduction Landing 1	Depositional fan of sediment.	Fan of material in unnamed crater.
Introduction Landing 2	Impact crater.	Well preserved 'simple' structure. 4 km impact crater.
Introduction Landing 3	Fissure formed by tectonic faulting with boulder-covered scree slopes coming down the fissure edges.	Boulder slopes in Cerberus Fossae. The Cerberus Fossae are a series of semi-parallel fissures on Mars formed by faults which pulled the crust apart. Ripples seen at the bottom of the fault are sand blown by the wind. The faults pass through pre-existing features such as hills, indicting that it is a younger feature. The formation of the fossaeis suspected to have released pressurised underground water.
Introduction Landing 4	Impact crater superimposed on a ridge formed by folding of lava.	Impact crater of top of wrinkle ridge close to the Viking 1 landing site.
Introduction Landing 5	Fresh impact crater with prominent rays.	Fresh impact crater formed February-July 2005.

ROLE BADGES

All of the classroom sessions involve children working together in groups of four.

Each child is responsible for a different job or role within the group and wears a badge to identify this. The images below may be photocopied onto card and made into badges, by slipping them in to plastic badge sleeves. Keep sets of badges in 'group' wallets, to be used on a regular basis in all science lessons.

Children should be encouraged to swap badges in subsequent lessons; this will enable every child to experience the responsibilities of each role.

Administrator keeps a written and pictorial record for the group.

Resource Manager collects, sets up and returns all equipment used by the group.

Communications Officer collects the group's ideas and reports back to the rest of the class.

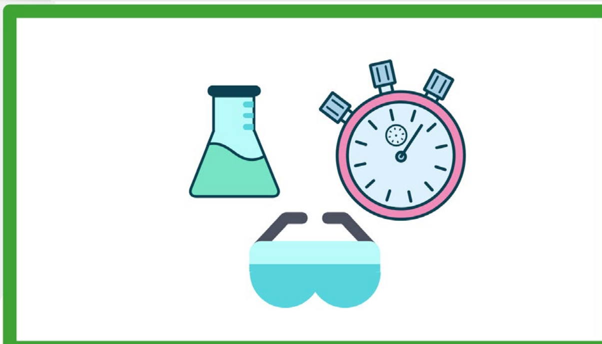
Health and Safety Manager takes responsibility for the safety of the group, making sure everyone is working sensibly with the equipment.

Where groups of 5 are necessary, the following role can be used:

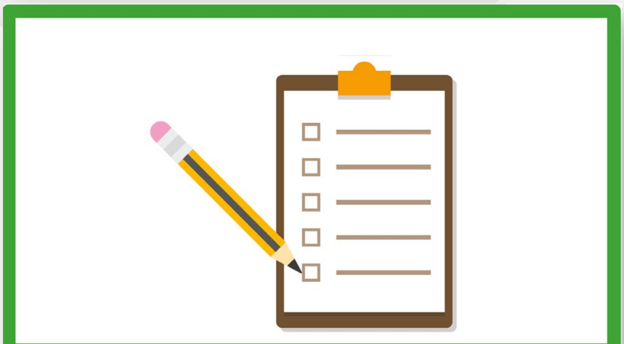
Personnel Manager – takes responsibility for resolving disputes within the group and ensuring the team works cooperatively.

Appendix 1: Role Badges

Space Engineer:
Personnel Manager



Space Engineer:
Resources Manager



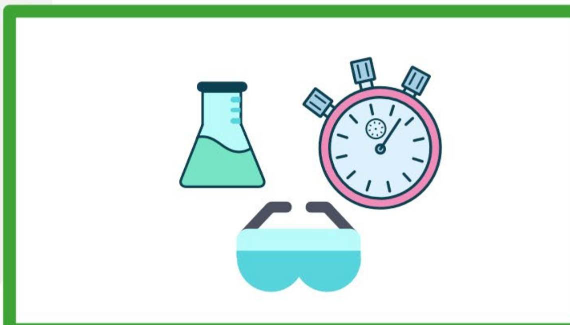
Space Engineer:
Administration Officer

Space Engineer:
Health and Safety Manager

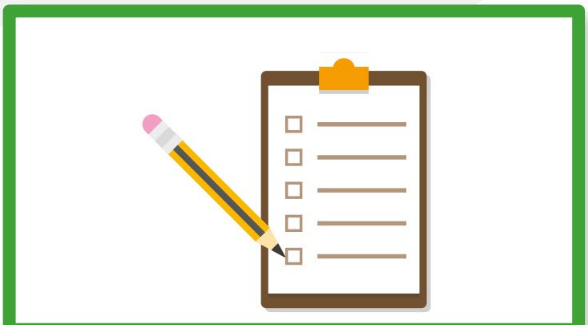
Space Engineer:
Communications Officer

Appendix 1: Role Badges

Space Scientist:
Personnel Manager



Space Scientist:
Resources Manager



Space Scientist:
Administration Officer

Space Scientist:
Health and Safety Manager

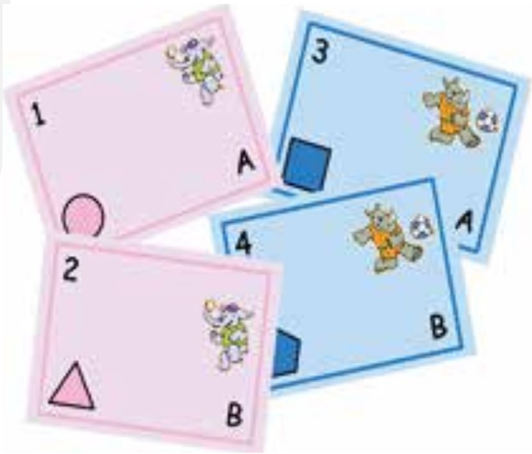
Space Scientist:
Communications Officer

Appendix 2: DIPS STRATEGIES

DISCUSSION STRATEGIES

The following strategies are used extensively as part of the Discussions in Primary Science (DiPS)[1] project, and have been proven to be successful when developing children's independent thinking and discussion skills.

Use of these strategies is strongly recommended during the activities on this website. Icons shown here with a description of each strategy are provided on each activity's web page, suggesting the type of discussions best suited to each activity.



TALK CARDS

Talk cards support the teacher in facilitating these discussions, with the letters, numbers, pictures and shapes enabling the teacher to group children in a variety of ways.

The example provided here shows one set for use with four children. The set is copied onto a different colour of card and talk groups are formed by children joining with others who have the same coloured card.

Children can then pair up by finding a partner with the same animal or a different letter eg. elephant, rhino or a + b pair. Each TALK pair would then have a card with a different number or shape.

The numbers or shapes may then similarly be used to form alternative groupings and pairings.

Note: The example talk cards are provided in MS Word format so you may make changes if you wish.

ITT (INDIVIDUAL THINK TIME)

Each child is given time to think about the task individually before moving into paired or group work.

TALK PARTNERS

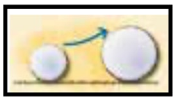
Each child has a partner with whom she/he can share ideas and express opinions or plan. This increases confidence and is particularly useful where children have had little experience of talk in groups.

A > B TALK

Children take turns to speak in their pair in a more structured way, e.g. A speaks while B listens B then responds. B then speaks to A while A listens and then A responds to B.

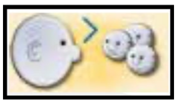
1 For more information go to www.azteachscience.co.uk

SNOWBALLING



Pupils first talk in pairs to develop initial ideas. Pairs double up to fours to build on ideas. Fours double up to tell another group about their group's ideas.

ENVOYING



Once the group have completed the task, individuals from each group are elected as 'envoys', moving on to a new group in order to summarise and explain their group's ideas.

JIGSAWING

Assign different numbers, signs or symbols to each child in a group. Reform groups with similar signs, symbols or numbers, e.g. all reds, all 3s, all rabbits and so on. Assign each group with a different task or investigation. Reassemble (jigsaw) the original groups so that each one contains someone who has knowledge from one of the tasks. Discuss to share and collate outcomes.

Appendix 3: Mars Facts and Missions

INFORMATION FOR TEACHERS

Mars is the fourth planet from the sun and the seventh largest. It has two tiny saellites Phobos and Deimos. Mars' orbit is 227,940,000km, its diameter 6,794km and mass 1/10th of Earth's. Early in its history, Mars was much more like Earth. Most of its carbon dioxide was used to form carbonate rocks but as it cannot recycle any of this back into the atmosphere, it is much colder than the Earth would be at that same distance from the sun. Mars' orbit is elliptical. Its average temperature is approx -55°C but surface temperatures range widely from as low as -133°C at the winter pole to almost 27°C on the day side during summer. Mars is much smaller than Earth but its surface area is similar to Earth's land surface. Mars has a very thin atmosphere composed of a tiny amount of carbon dioxide, nitrogen, argon and traces of oxygen and water. The average pressure is 1% of Earth's but it is thick enough to support very strong winds and huge dust storms that cover the planet for months. Early telescopic observations revealed that Mars has permanent ice caps at both poles. We know they are composed of water ice and solid carbon dioxide (dry ice). Mars has some of the most highly varied and interesting terrain of any of the terrestrial planets, including;

- Olympus Mons - the largest mountain in the solar system rising 24km above the surrounding plains
- Tharsis - a huge bulge on the surface 4000km across and 10km high
- Valles Marineris - a system of canyons 4000km long and 2-7km deep
- Hellas Planitia - an impact crater in its southern hemisphere over 6km deep and 2000km in diameter

Much of the Martian surface is very old and cratered but there are younger rift valleys, ridges, hills and plains. None of this can be seen in detail with a telescope, not even the Hubble telescope but can be seen from spacecraft.

There does not appear to be any current volcanic activity but it is likely to have tectonic activity in the past. There is evidence of erosion in many places including large floods and small river systems. At some point in the past there was clearly some kind of fluid on the surface. Liquid water is a likely fluid but other possibilties exist. There may have been large lakes or oceans. Scientists believe that there were wet episodes that occurred briefly but very long ago.

Canals of Mars are apparent systems of long straight markings on the surface of Mars that we now know are caused by the chance alignment of craters and other natural surface features, observed through telescopes when the telescopes are nearly at the limit of their resolution. The Italian astronomer Giovanni Virginio Schiaparelli reported observing about 100 of these markings in 1877 and described them as canali (Italian for channels) but did not imply anything about their origin. Around the turn of the 20th century, American astronomer.

Percival Lowell described canal networks covering most of the planet. Many believed them to be bands of vegetation bordering irrigation ditches dug by intelligent beings to carry water from the polar caps. The controversy was finally resolved only when close-up images of the Martian surface were taken from spacecraft beginning with Mariner 4 (1965), 6 and 7 (1969). These images showed many craters and other features but nothing resembling networks of long linear channels.

Since 1960, the Russians and American Space Agencies have sent many spacecraft to Mars; some have been very successful. Mariner 4 was the first mission to make it successfully to Mars. Mariner 4, 6, 7 and 9 missions took many phot graphs of Mars and its moons. Then, the Russians sent Mars 2- 6, bringing back data about the Martian surface, atmosphere, temperature and gravity. The Viking missions were very successful in the 1970s, providing in excess of 50,000 images. After a quiet decade, Martian exploration took off again in the 1990s. In April 2001, the Mars Odyssey was launched. It has been successfully collecting data about the minerals and chemicals that make up the Martian surface.

In December 2003 the European Space Agency's Mars Express Mission, including Beagle 2 Lander, arrived at Mars. NASA's Mars Exploration Rovers, landed in 2004 and have been sending back information ever since!

The UK Space Agency is providing 165M Euro contribution to the European ExoMars programme, in addition to 25M for the development of instruments to search for signs of past or present life on Mars. The instruments are part of the scientific payload on a new rover currently being developed. Rovers have to be designed and built from materials that will not contaminate the planet in any way. The new rover is a robotic scientist which will search for evidence of past and present life and study the local Martian environment to understand when and where conditions that could have supported the development of life may have prevailed.