9. Identifying The Best Landing Site for a Mars Rover

3 hours

Children consider data from the viewpoint of scientists or engineers to identify the best landing site for the rover. They estimate the age of landing sites, identify landscape features such as craters, rocks, deltas, canyons, elevations and interpret scales, data and images. The class debates to decide the most appropriate location.

OBJECTIVES

- Identifying scientific evidence that has been used to support or refute ideas or arguments.
- To know that science is about thinking creatively to try to explain how living and non-living things work, and to establish links between causes and effects.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 13-19
- Image V
- Calculator
- Activity sheets 13-14 made into two sets of cards bullets

ADVANCED PREPARATION

- Laminate images W-Z (see page 51-54)
- Half the class in groups of 4 scientists
- Half the class in groups of 4 engineers

INTRODUCTION

To help the children to understand and identify craters and channels on Mars. Introduction Landing images 1-5 from the website should be displayed on the whiteboard and discussed. The table, on page 55, provides details of each of these images.

The teacher explains that the children have been asked by the Space Agency to identify the best landing site for a Martian rover. They are to study photographs from four different locations on Mars. The four photographs are real images, taken from space, of the surface of Mars. They are so detailed that if a car was parked on the surface of Mars, it could easily be seen! Image V is a topography map showing high and low areas on Mars and the positions of the four landing sites. The children are to analyse and interpret data from Mars. They are to consider the information from the viewpoint of either space scientists or space engineers when identifying the best landing site. The scientists are interested in finding evidence of life. Their main mission is to identify landing sites close to where water and/or heat may once have been. The engineers' main concern is to identify sites that are stable, without obstacles and are ow enough for the parachute on the lander to have enough time to slow down the rover's descent so that it makes a safe landing. Laminate images W-Z.

ACTIVITY

Small groups of children study the images provided to identify the best landing site for the next Mars mission. Children in turn share the information on their challenge cards within their group. Engineers and scientists have different aims and concerns about the mission. Scientists and engineers identify landscape features such as craters, rocks and elevation, interpret scale and calculate the age of the landing sites using crater concentration data (Activity sheet 15). The scientists must decide where the rover should take samples and why (Activity sheet 16). In addition, the engineers consider the safety of each site by extracting rock concentration data and calculating crater concentrations. (Activity sheets 17-19).

We suggest that the teacher runs through the task with the scientists and engineers in two separate groups. Each group uses different criteria to select a suitable landing site. Later, in class debate, each must provide evidence to justify this choice. It is important that the children pick out the key information contained in the challenge cards. They are looking for old sites; the older the site, the higher the number of craters. They use the scale and look for circular craters larger than 200m. Engineers need to use the table and rock safety chart provided, to determine the safety of the site. They should also look at the topography map of Mars to determine the elevations of each landing site. Answers are provided for teachers on Activity sheet 20 together with detailed information about each landing site to help the children to understand and identify craters and channels on Mars, Introduction Landing images 1-5 from the website.

PLENARY

Each group clarifies its reasons for its chosen landing site and begins to prepare a presentation to justify the choice. Groups should then have a whole class debate to decide the best landing site from both the scientists' and engineers' perspectives. This models current practice within the Space Agency, with one person then responsible for making the final decision.

Mars showing the polar cap

LANDING SITE DETAILS FOR TEACHERS

Landing site 1, Lat. Long. 47.5 S, 5.3 E

Engineering Constraints

Sunlight: too far south

Elevation: too high

Rock Concentration: parts are too rocky, category 10 on the chart in places

Crater Concentration: very safe, category 0 on the chart

Science Constraints

Life: Has very small gullies that were carved by water, possibly melted snow or groundwater coming from cliffs. If the source is groundwater, there is more potential here for life. Limited access to a lot of sediments deposited by water is a problem here.

Age: About 100 million years, very young surface for Mars (essentially modern). But, if the water came from underground, the water may carry with it evidence of much older things!

Secondary Science Objectives: Very interesting cliff of rocks here that will allow you to access millions of years of Mars history. This is the best landing site for secondary objectives.

Path Length: No matter where you land here, you can get to the gullies.

Landing site 2, Lat. Long. 13.2 S, 42 W

Engineering Constraints

Sunlight: OK

Elevation: OK

Rock Concentration: Safe, category 1-2

Crater Concentration: Safe, category 3

Science Constraints

Life: Landing site is centered on an amazing channel system that is cut into a large fan of sediment. Any place on this image is a spot where water has deposited sediment. Similar to landing site 1, the channel itself may not have had water in it for long but the sediments carried by the channel might have a variety of rock types carried from far away and therefore deposits that might contain fossilized evidence for life.

Age: About 1 to 2 billion years, this is not the time of the ancient 'Earth-like' Mars but it is much older than landing site 1 and a better candidate for being a time when Mars had a thicker atmosphere.

Secondary Science Objectives: Sediment fans like this are excellent for accessing a variety of rock types. The channel carried with it materials that were eroded from distant mountains. These rock types can tell us something about the geologic history of the planet but without layers we don't know the exact origin of the rocks.

Path Length: If you land at the north part of the image, you will not be able to access the southern-most fan. If you land to the south, you might not be able to access the northern most fans. But, there are other things that can be sampled here, such as the sediment in and surrounding the channel.

Landing site 3, Lat. Long. 23.8 S, 33.6 W

Engineering Constraints

Sunlight: OK

Elevation: OK

Rock Concentration: Not very rocky, highest between 10 – 20, category 1 - 2

Crater Concentration: very safe, category 0-1

Science Constraints

Life: This landing site contains a large fan of layered materials that can be sampled by the rover. Space scientists believe that the meandering features are the remnants of channels. The pattern is most similar to a river delta where channels enter a lake or sea. The obvious bonus of this landing site is that it not only contains channel sediments, but because it is a delta, there must have been a standing body of water here. The rover can now access river and lake sediments to look for life. Life enjoys calm water environments, so the lake is an ideal setting.

Age: Almost 1 billion years. This is a fairly young surface so it might not capture the early "Earth-like" period. Also, it's a fairly unique feature on Mars. However, we know there was a river here and a lake. These are ideal ingredients for life.

Secondary Science Objectives: The delta contains river sediments that were carried from far away. This might be a good way to access multiple rock types.

Path Length: No matter where you land here, you can access the delta.

This is Eberswalde delta. It was a finalist landing site for the Mars Science Laboratory mission. All the issues raised above are the reasons why the site was not chosen in the end. It was considered too young, and did not capture the period of warm-wet Mars.

Landing site 4, Lat. Long. 29.9 S, 81.8 E

Engineering Constraints

Sunlight: OK

Elevation: OK

Rock Density: parts are too rocky, category 10 on the chart in places to the south of the image

Crater Concentration: safe, category 4-5 on the chart

Science Constraints

Life: This is a fairly ancient surface of the crust of Mars, almost 3 billion years old (or older as the craters are not well preserved here). The image contains a series of very poorly-preserved intersecting streams. This is an indication of ancient surface water flow, possibly by rainfall. The sediments in these streams may have been carried from far away sources, but it's unclear in the image where these sediments are or if water was here long enough for life to have arisen or survived. The channels here are very hard to see; they are very poorly preserved. This means they were present at the surface of Mars for a very long time and were subject to wind and water erosion. Compare these channels to the channel in landing site 2 for example.

Age: 2-3 billion years, the oldest of the landing sites.

Secondary Science Objectives: Little or no evidence of sediment deposited by the channels. Also, there are no obvious exposures of bedrock apart from the small boulder pile to the south of the image.

Path Length: Access to all the channels.

Landing Site Images

MAP OF MARS

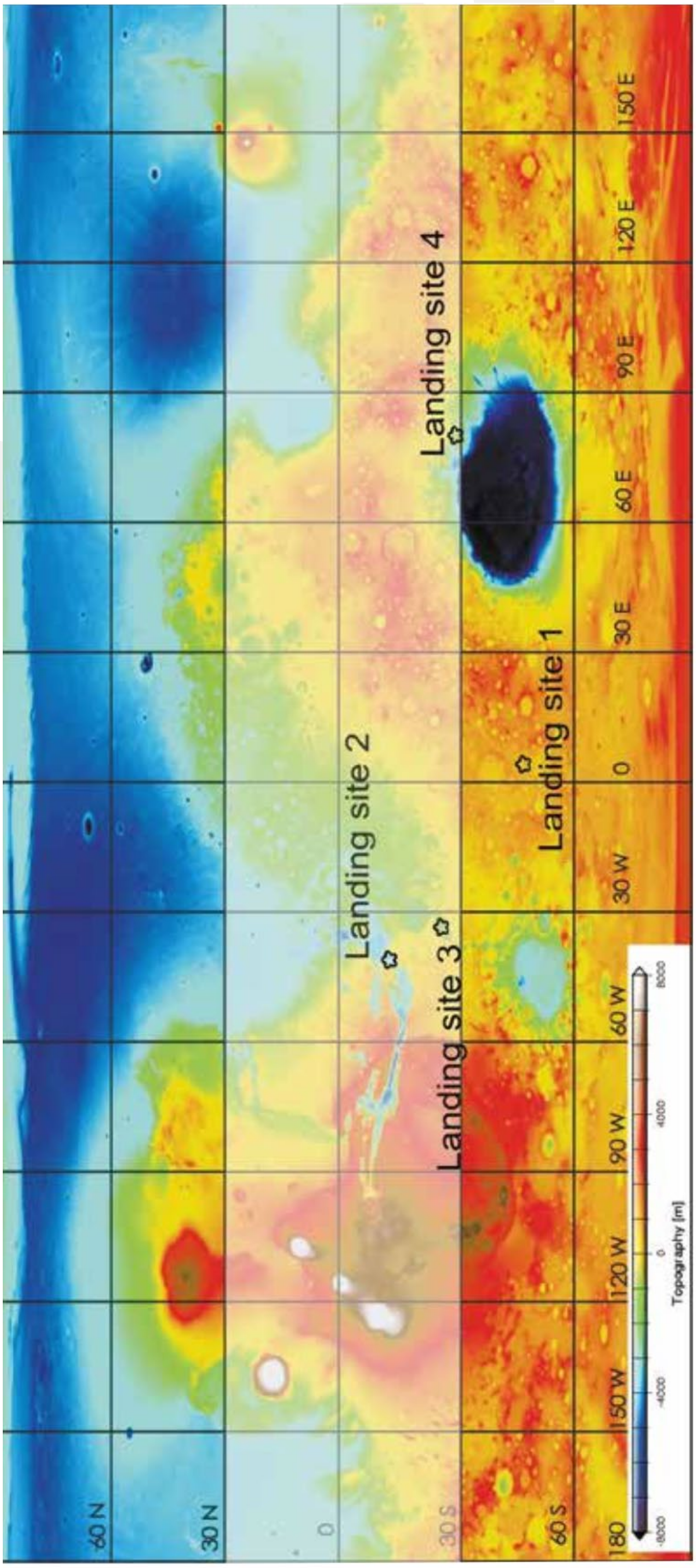


Image V

LANDING SITE 1

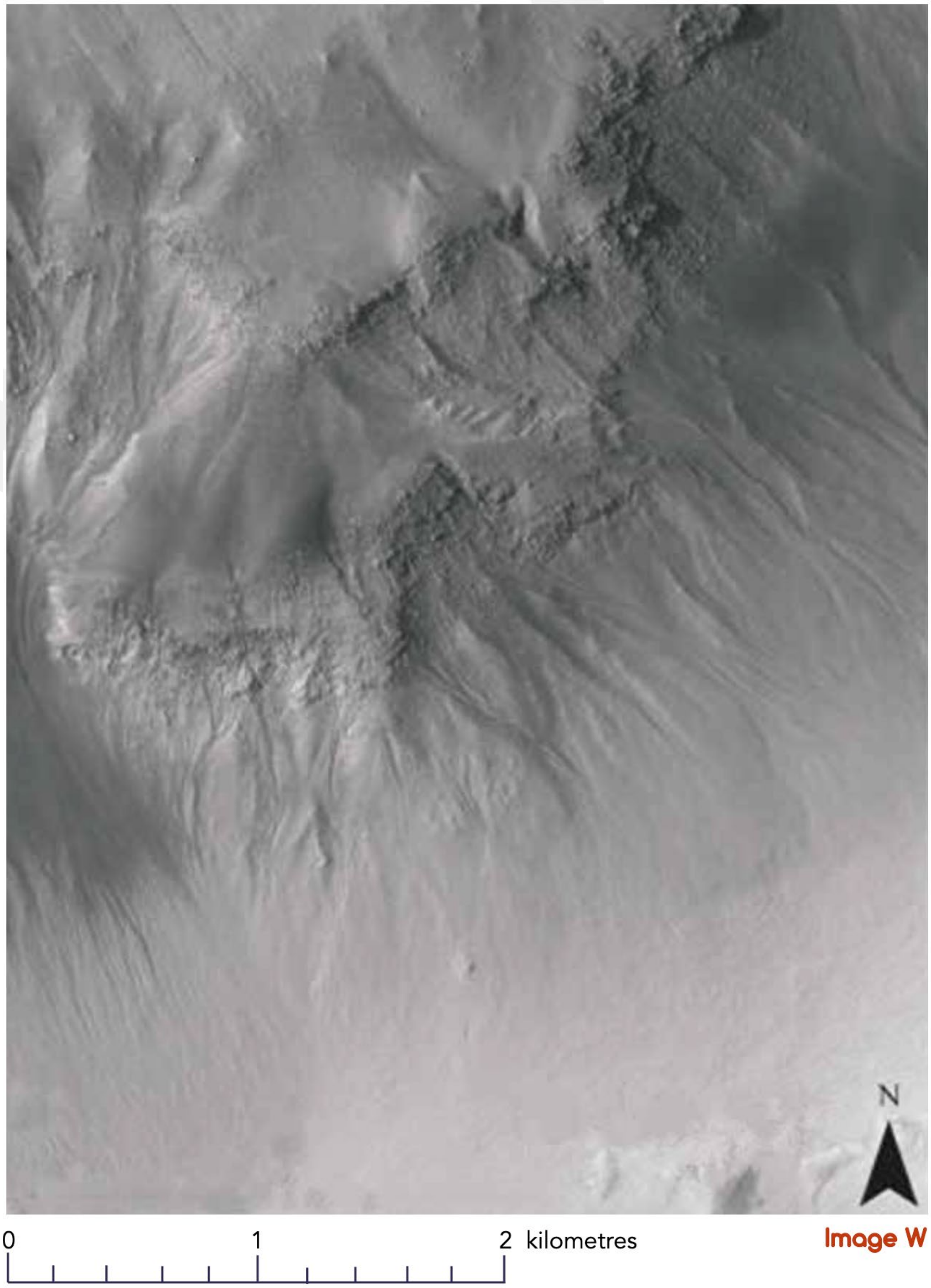
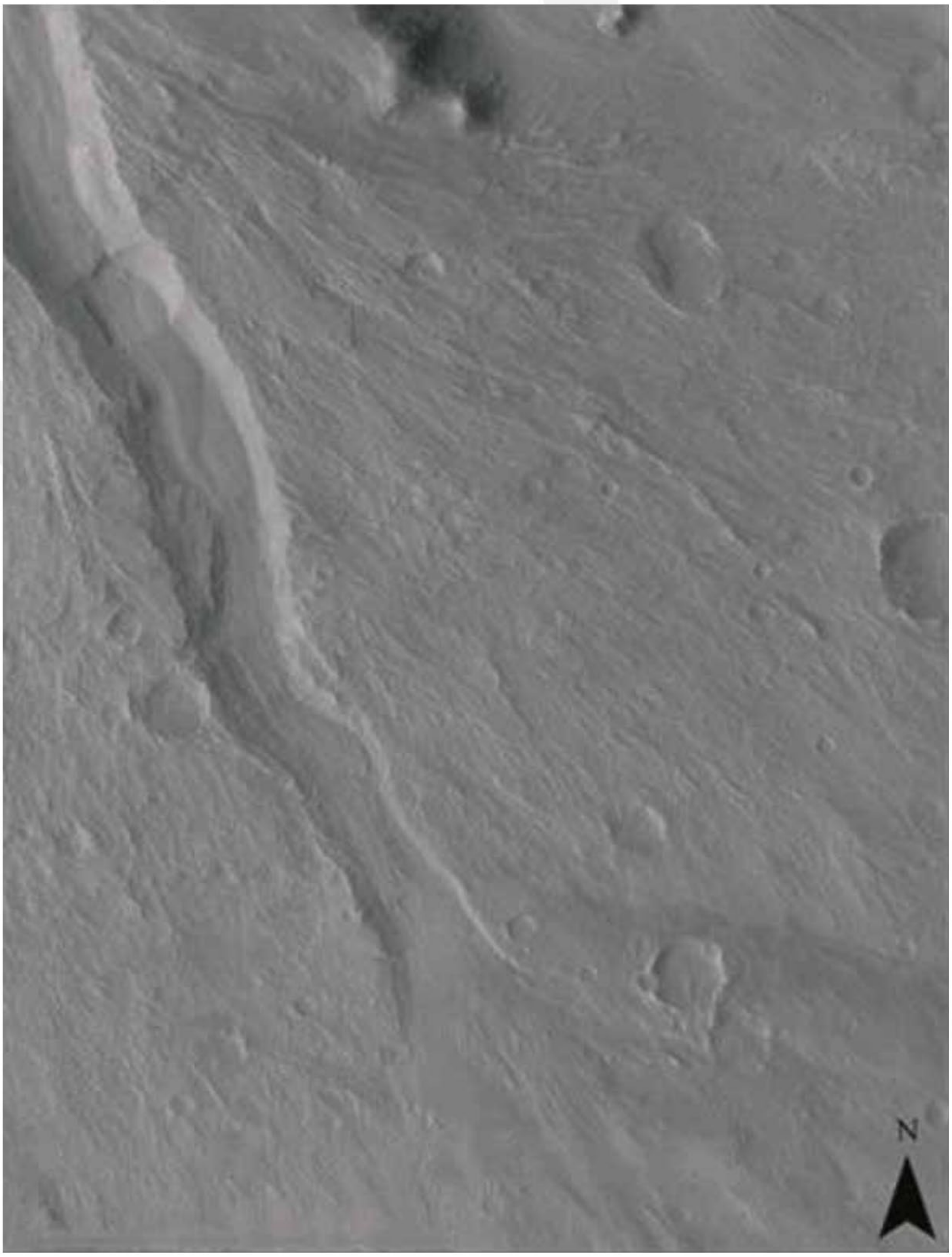


Image W

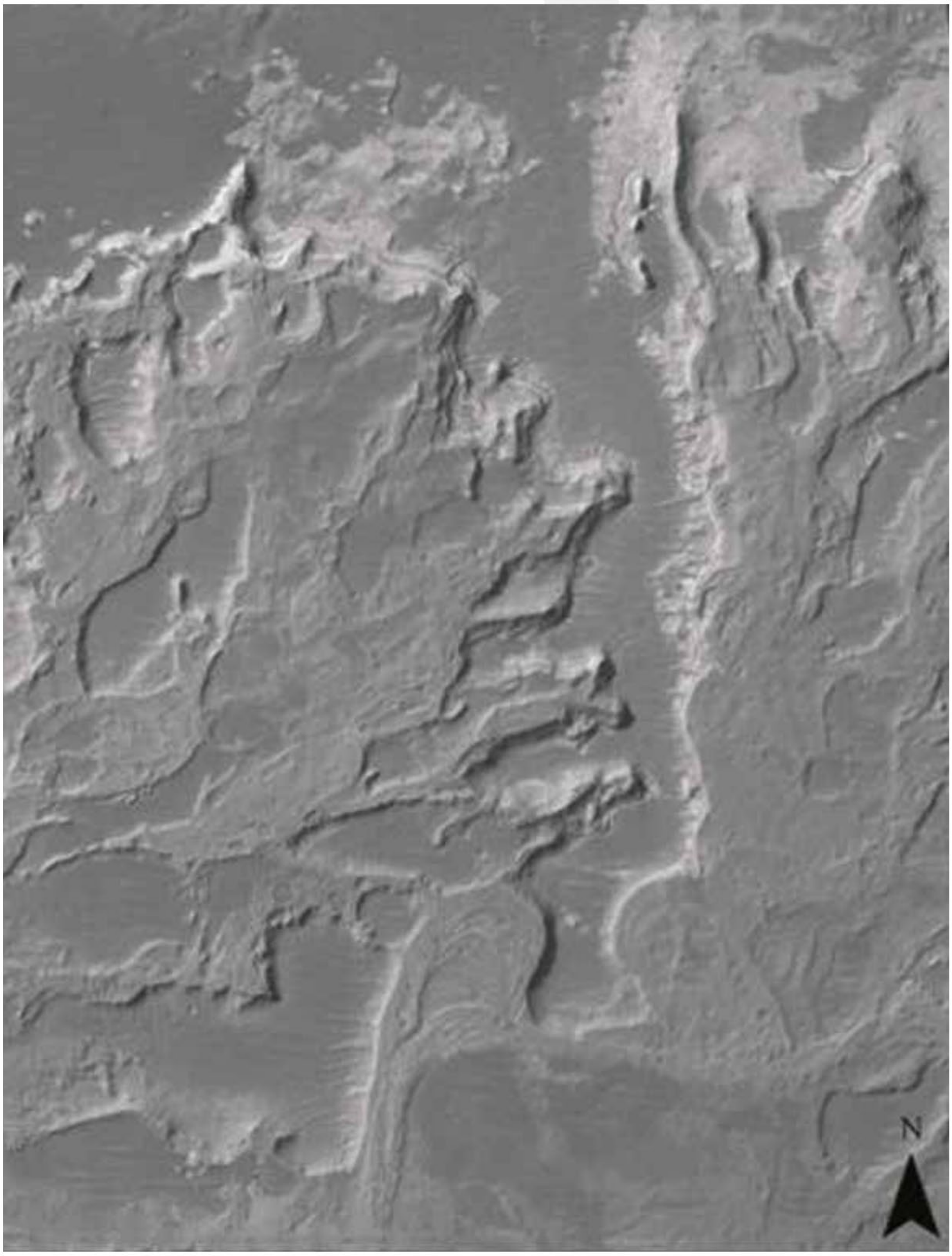
LANDING SITE 2



0 1 2 kilometres

Image X

LANDING SITE 3



0 1 2 kilometres

Image Y

LANDING SITE 4

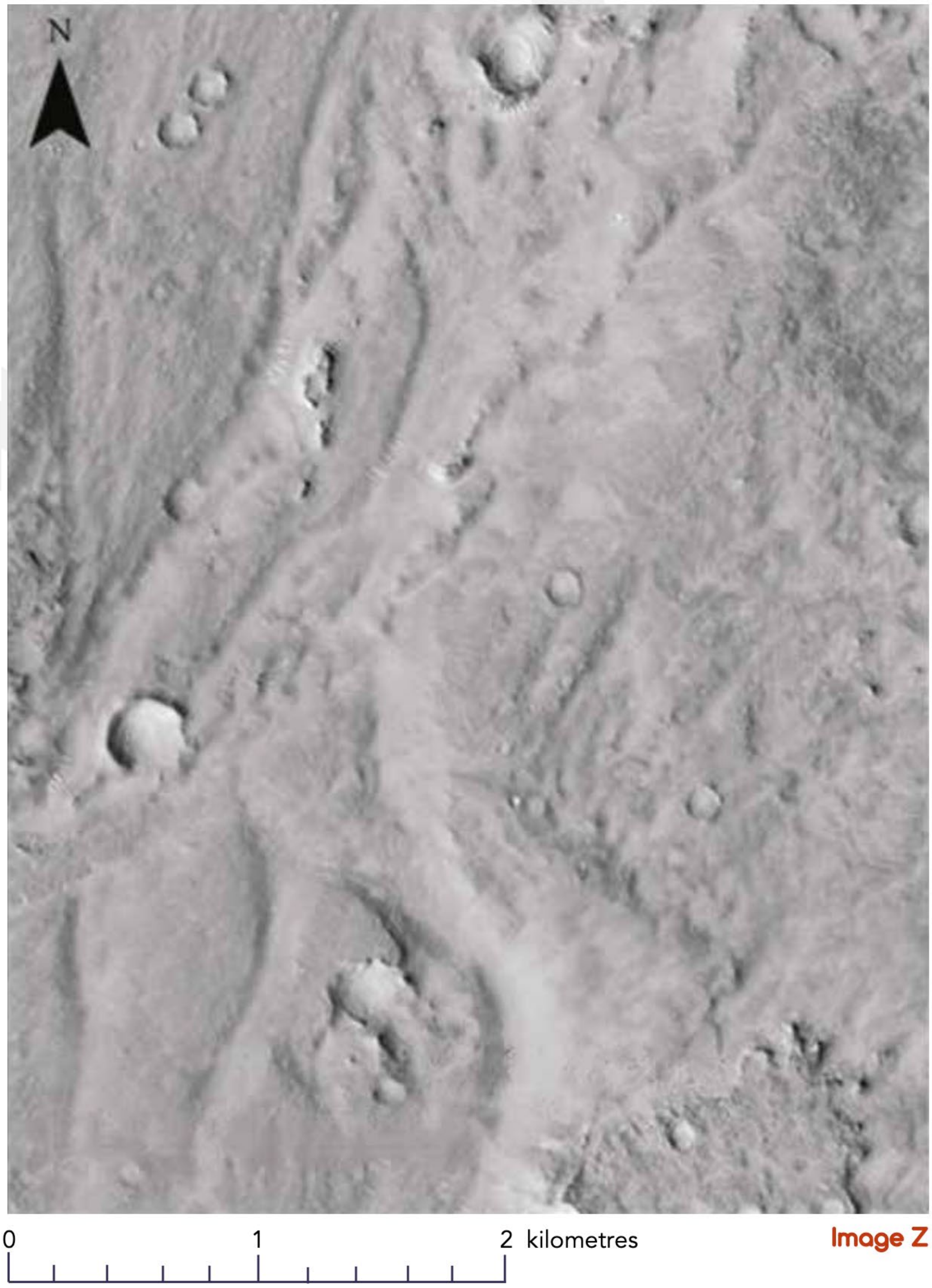


Image Z