Mission 4
There's Power in Numbers! (Phase II)
Journey to Mars and Venus

Overview

In mission 4, students apply their understanding of scale to the search for life on other worlds. They see how scale is important in deciding what signs of extraterrestrial life to look for. In mission 4.1, students use ZOOM! Cards to journey to Mars. In mission 4.2, students use ZOOM! Cards to journey to Venus.

Notes

In mission 3, students simulated harsh conditions found on Mars and learned about the even harsher conditions found on Venus; In mission 2, they learned about strange worlds of the very small and the very big- Microworld Earth and Macroworld Earth.

Mission 4.1
Materials

For a Class of 30

- Journey to Mars script

For Each Team

- Transparency marker or grease pen
- ZOOM! Cards for Microworld and Macroworld Earth (19 cards total)
- ZOOM! Cards for Mars (11 cards)

Getting Ready

1. If you have not yet done so, cut apart the individual cards on the sheets of ZOOM! Cards for Mars and Venus. If possible, to preserve them for future use, laminate the sheets of ZOOM! Cards before cutting them. (Clear contact paper works well, but be sure to cut apart the cards apart and cover each one separately, leaving a border.) Cut the laminated illustration sheets into individual cards, and assemble six complete Mars decks and six complete Venus decks.

2. Test the markers or grease pens to be sure that they can be wiped off of the laminate or contact paper.

3. Study the Mars ZOOM! Cards to refresh your perception of distance and size. Read through the script Journey to Mars, anticipating students' questions.

Classroom Action

1. **Activity .** Divide the class into six equal groups Give each team a deck of Earth ZOOM! Cards (19 cards) and a deck of Mars ZOOM! Cards (11 cards). Ask students to line up the Earth cards in order along a table. Ask them to guess where each Mars ZOOM! Card belongs in relation to the Earth deck. For example, the 10^0 meters Mars ZOOM! Card should be placed by the10^0 meters Earth card. Finding the order for the Mars cards will be a challenge, because there are no familiar objects in the images, and because some scales are not depicted (i.e., cards for some powers of 10 are missing because scientists have not imaged Mars at the corresponding scales).

   Remind students that the view in each card represents a different scale: 8 cm (the width of each card) equals a distance in meter? that is a power of 10 (*e.g.*, 10^0meters, 10^4 meters, 10^{-4}meters). Each card has a different power of 10. On this scale, a power of 0 is used for a picture of a child (the 10^0 meters card), a power that is a positive number is used for something that is larger than a child (*e.g.,*. the 10^4 meters Earth card shows an entire city), and a power that is a negative number is used for something that is smaller than a child (*e.g.,* the 10^{-4}meters Earth card shows muscle and blood tissue).

   If necessary, review exponential numbers and scientific notation with the class. Ask them to examine their cards again, looking for clues to scale. Invite them to make guesses about the size of the pictured things. At this point, do not reveal the correct order, even if students do not know where to place each card, or exactly what each card shows.

2. **Stories.** A Journey to Mars script is provided. This is a fictional story written from the perspective of a young explorer who is traveling to Mars. You may wish to read this story to the class. Show students the correct placement of the Mars cards as you read. Or, have students write their own stories for the Mars cards based upon what they have learned, before or after they hear the provided script, either in class or as homework.

3. **Activity.** Have students use transparency markers or grease pens to mark the scale on each card.

4. **Activity.** Have students draw the missing ZOOM! Cards for Mars. Assign each student or each team a specific power of 10.

5. **Clean-Up.** Have students wipe off all their marks. Gather up all the ZOOM! Card decks.

Mission 4.2
Materials

For a Class of 30

- Journey to Venus script

For Each Team

- Transparency marker or grease pen
- ZOOM! Cards for Microworld and Macroworld Earth (19 cards total)
- ZOOM! Cards for Venus (13 cards)

Getting Ready

1. Study the Venus ZOOM! cards to refresh your perception of distance and size. Read through the script Journey to Venus, anticipating students' questions.

Classroom Action

1. **Activity.** Divide the class into six groups. Give each team a deck of Earth ZOOM! Cards (19 cards) and a deck of Venus ZOOM! Cards (13 cards). Have students line up the Earth cards in order along a table. Ask them to guess where each Venus ZOOM! Card belongs in relation to the Earth deck. For the Venus cards, an additional challenge is posed by the layers of clouds that prevent us from seeing the surface for much of the journey, and because some scales are not depicted (i.e., cards for some powers of 10 are missing because scientists have not imaged Venus at the corresponding scales). You may want to tell students that the lo4 meters card shows a view straight down into a volcano! This can help orient them for several other Venus cards.

2. **Stories.** A Journey to Venus script is provided. This is a fictional story written from the perspective of an extraterrestrial being named LARB who is traveling to Venus. You may wish to read this story to the class. Show students the correct placement of the Venus Cards as you read. Or, have students write their own stories for the Venus cards based upon what they have learned, before or after they hear the provided script, in class or as homework.

3. **Activity.** Have students use transparency markers or grease pens to mark the scale on each card.

4. **Activity.** Have students draw the missing ZOOM! Cards for Venus. Assign each student or each team a specific power of 10.

5. **Discussion.** Ask students to explain the differences between the Mars journey and the Venus journey. Which deck of ZOOM! Cards was easier to put in order, Mars or Venus? Point out

that, if a spacecraft were approaching an unknown world, sending back photographs at intervals, we could calculate the scale of each photograph, but we would still have to interpret the pictures without any direct experience of living on that planet.

6. **Clean-Up.** Have students wipe off all their marks. Gather up all the ZOOM! Card decks.

Going Further

Activity: More Powers of 10

Invite students to use the ZOOM! Cards to guess and discover how many powers of 10 steps it would take to get from Earth to Venus or Mars. How many steps would it take to be able to see the nearest star? The center of our galaxy? The nearest galaxy? The far side of the known universe?

Ask students to create a series of ZOOM! Cards for objects in their town or region. Or, have students create a series based on time instead of distance, which could range from 10 billion years ago to 10 billion years from now. In this time series, have students research or speculate times for the Big Bang, the beginning of the solar system, the origin of life on Earth, the age of the dinosaurs, early primates, early humans, hunters and gatherers in North America, the Middle Ages, the Industrial Revolution, the 1980s, last year, last month, eight hours ago, the present moment, the end of the solar system, the end of the universe either as a gnaB giB? (Big Bang in reverse) or a forever expanding universe?

Activity: Cameras and the Electromagnetic Spectrum

Discuss the use of cameras as tools for detecting life on Venus or Mars. Discuss the use of various magnifications (scales!), the use of still cameras or video cameras, and the use of various portions of the electromagnetic (EM) spectrum (such as infrared radiation) to make photographs. What kinds of cameras would be best to use when searching for life on an extraterrestrial world? Scale is not the only consideration when selecting a camera for a spacecraft or lander. Have students look for pictures in magazines taken by special kinds of cameras that use other portions of the EM spectrum than visible light. Have them find actual images taken with infrared cameras. Or, have them bring in such images to share with the class. Discuss what advantages an infrared camera would have when searching for life on an alien world. What portions of the EM spectrum would work best? Would a Martian see as visible light the same portion of the EM spectrum that we do? Does a rattlesnake or a honeybee see the same way that we do?

Activity: Comparative Planetology

Have students recall some of the images from the video show in mission 1. You may wish to show the images again: Discuss which power of 10 each image represents and correlate each image with a ZOOM! Card.

Activity: Postcards from Mars!

Use this activity as an optional substitute for (or an addition to) the Stories activity in mission 4.1. Have the class invent the story of the journey to Mars. Ask each team to divide up its Mars cards so that each person gets one or two. Each team should agree upon a story line in which they are the crew members of a mission to Mars: The cameras have broken down, and the cards are the only images that can be scanned and radioed back to Earth. Each person writes a postcard using his or her card (or cards) to illustrate some aspect of the story. Invite students to read their stories aloud. Discuss them and compare them with the prepared script to be sure that students' stories take into account the temperature and atmospheric pressure on Mars, as well as other features that students probably don't know at the outset of the mission (if they haven't heard the script).

Possible story lines:

The crew are on a crippled spaceship, looking for water on Mars.

The crew are on a life-seeking expedition to Mars.

The crew are looking for traces of a vanished Martian civilization.

The crew are geologists looking for Martian fossils.

The crew are founding the first human colony on Mars.

The crew are looking for a human colony on Mars that has vanished.

The crew is searching for Martian life-forms that resemble rocks.

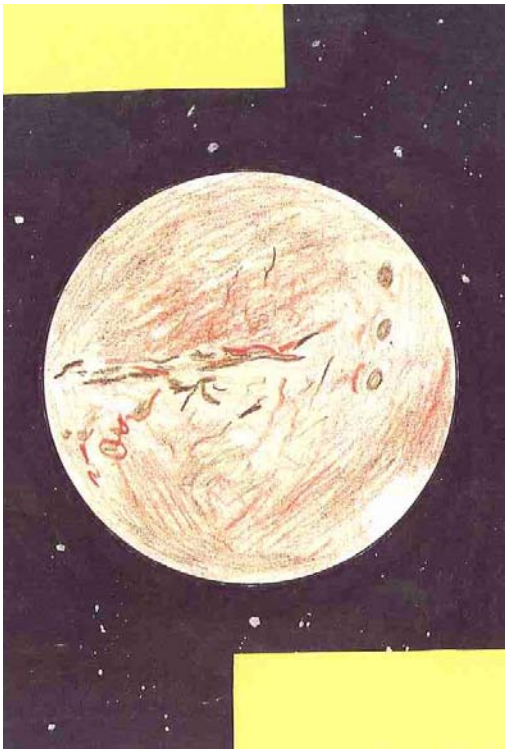
Script for ZOOM! Cards

Journey to Mars

The ZOOM! journey to Mars is not as complete as the journeys into Microworld and Macroworld Earth. Mars cards only show powers of 10 from 10^{7} meters to meters. This journey includes images that were seen from the *Viking* landers on Mars. The rest of Microworld Mars has never been seen. The 10^{-10}meters card has been included to stress the existence of the carbon atom on Mars. It has been detected, but not actually seen with any instruments.

Today we will see 11 snapshots from an imaginary photo album of a trip to Mars. For fun, we will consider these to be postcards sent back home to Earth by a young space explorer! The scientific comments made in this script are accurate to the best of current scientific knowledge. The young explorer's comments reflect a joyful, inquiring mind. They are a bit more enthusiastic than sober scientific predictions! But who knows?

Figure 4.1- Mars Card # 11- The Planet Mars.



SCALE: 8 cm =10^7 meters
10^7 meters = 10 million meters

Observed by: Interplanetary spacecraft.

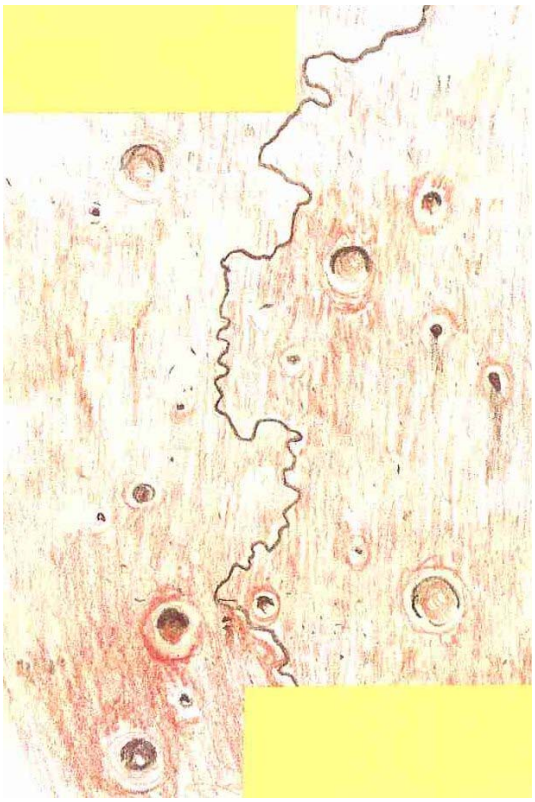
Description: Dear Mom and Dad, after a years travel, I've finally got a view of Mars from my own interplanetary spacecraft! Well, maybe it's not all mine. I guess it really belongs to Captain Kelley and the International Coalition of Space Explorers, but it sure *feels* like it's all mine! Mars is the fourth planet from our Sun. It is only about *112* the size of Earth, but because there are no oceans, there is just as much land on Mars as on Earth. From this distance, 10 million meters away, I can see the entire planet! It really *is* red! I wonder if there will be little green men on the little red planet!

Life or Signs of Life: Not at this distance!

Question: Why is Mars so reddish brown? *(The iron in the rocks combines with oxygen to make iron oxides, which are a rusty red color:)*

Comment: I can hardly wait to get to Mars!

Figure 4.2- Mars Card # 10- Martian Riverbed.



SCALE: 8 cm =10^6 meters
10^6meters = 1 million meters

Observed by: Orbiting spacecraft.

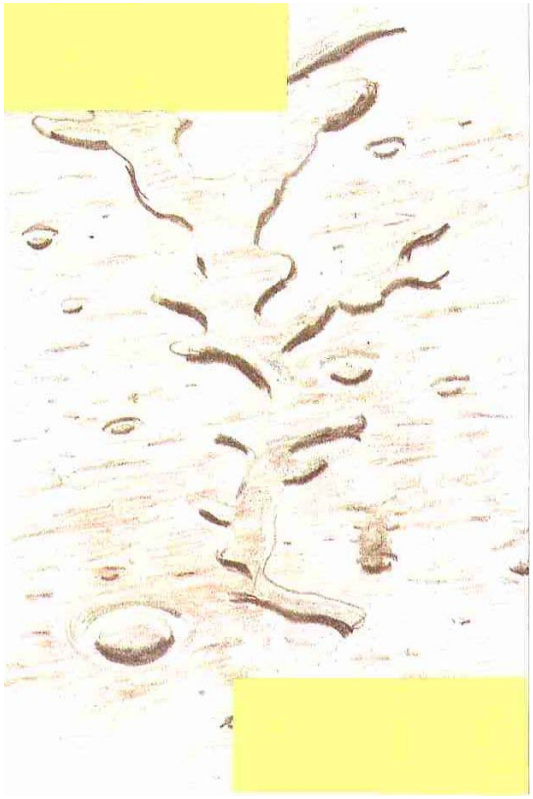
Description: I'm only 1 million meters from Mars now. What is that squiggly line? Could it be a canal? Captain Kelley says that there are no real canals on-Mars, but that robot missions to Mars discovered what look like ancient riverbeds. This riverbed is bigger than the Mississippi! Just imagine the amount of water it would take to fill that river! The robot's cameras also saw many craters, some of which had streaks of dark sand blown out behind them. From here, Mars looks as cratered as Earth's Moon!

Life or Signs of Life: Not at this distance!

Question: Where do these craters come from? *(Some are impact craters from meteorites, and some are small volcanoes.)*

Comment: I wonder if that river is full of fossil fish?

Figure 4.3-Mars Card # 9- Riverbed.



SCALE: 8 cm =10^5 meters
10^5meters = 100,000 meters

Observed by: Orbiting spacecraft.

Description: We are in orbit around Mars at an altitude of 10,000 meters. Soon we will pick a landing site! From here, I can get a better view of that riverbed. It truly is dry! There is no water at all in this Martian Mississippi! Captain Kelley says that the air on Mars is so thin today that liquid water cannot exist. Any water would immediately evaporate. But Mars might have been more like Earth long ago. Maybe there once *were* living creatures in a *real* river at one time. Maybe there is water in solid form beneath the soil surface.

Life or Signs of Life: Not at this distance!

Question: How long ago did the riverbed form? *(About 3.5 billion years ago.)*

Comment: Maybe I'll find plant and fish fossils in the ancient riverbed!

Figure 4.4–Mars Card # 8 – Surface of Mars

SCALE: 8cm = 10^4 meters
10^4 meters = 10,000meters

Observed by: Spacecraft during descent to the surface.

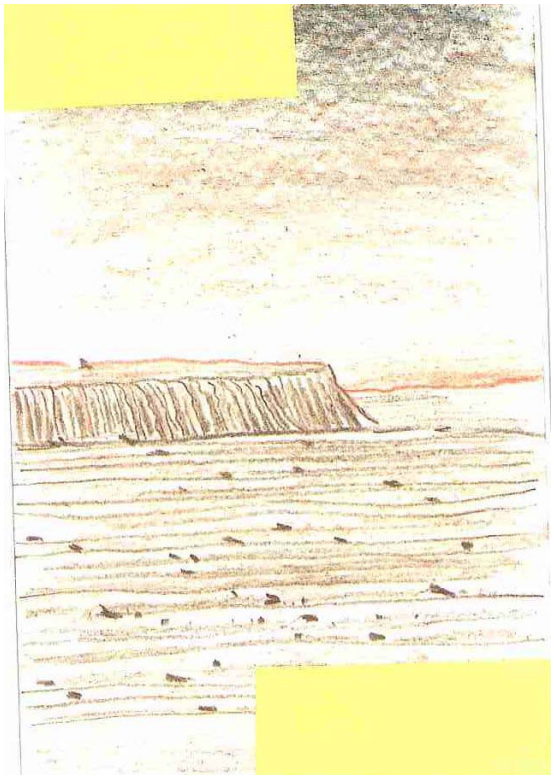
Description: We've picked a spot to land! We're going to check out that old riverbed! As I get closer to Mars, I can see that the surface truly is reddish brown. Captain Kelley says that there is iron in the rocks that combines with oxygen from the thin atmosphere to form iron oxides, which are a rusty red color. Mars is covered with rust! Captain Kelley says that the canyons, valleys, and volcanoes on Mars are *much* larger than any on Earth.

Life or Signs of Life: Not at this distance!

Question: How is Mars like or unlike Earth? *(Compared to the gas giant planets, Mars is like Earth in many ways, but there are differences too. It is colder; drier; and has a very thin atmosphere.)*

Comment: I'm sure getting tired of space pizza and astronaut ice cream!

Figure 4.4– Mars Card # 8 – Surface of Mars



SCALE: 8cm =10^3 meters
10^3 meters = 1,000 meters (1 kilometer)

Observed by: Spacecraft during descent to the surface.

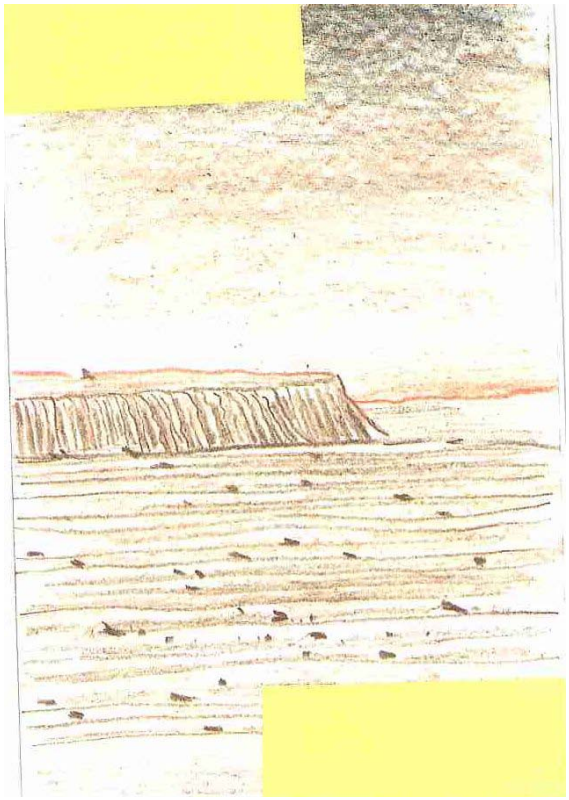
Description: We're almost down! We are only 1,000 meters from the surface. From here, Mars looks like a vast desert of sand and rock. Captain Kelley says that strong winds blow through the thin atmosphere, sandblasting the surface. One canyon, the Valles Marineris, is as long as the United States! I wonder how big that cliff over there actually is. Oh, now I see that the cliff is actually the bank of the river! Captain Kelley says that water probably was more responsible than the sandblasting winds for forming this canyon!

Life or Signs of Life: Not at this distance!

Question: Where does the sand come from? *(As on Earth, the rocks break apart.)*

Comment: I hope there isn't a sandstorm where we land.

Figure 4.6—Mars Card # 6 - Landscape



SCALE: 8 cm = 10^2 meters
10^2meters = 100 meters

Observed by: Spacecraft during descent to the surface.

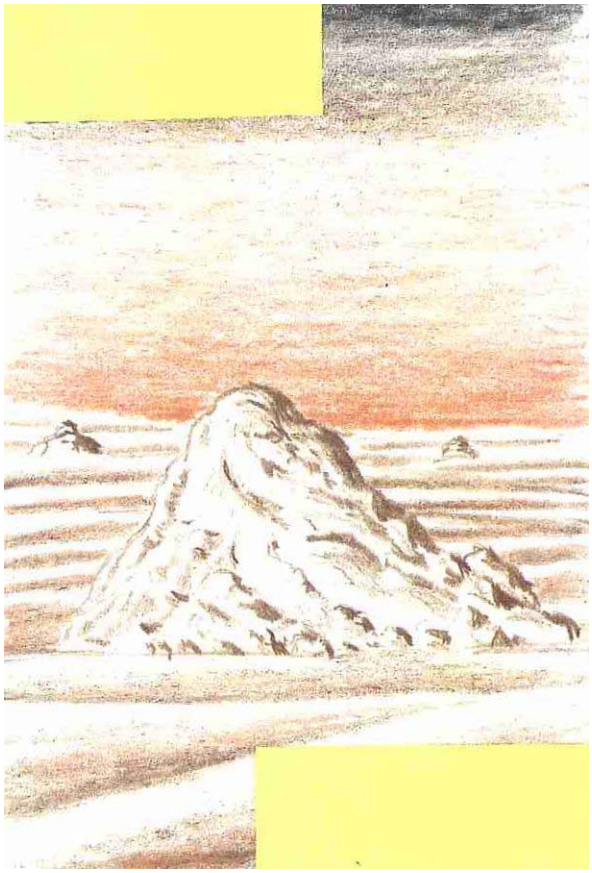
Description: Still closer! We're only 100 meters from the surface! I can see a large field of sand dunes. Captain Kelley says that they are formed by the wind. Lots of red dust is blown into the atmosphere, where it stays for a long time. The sand gives the sky a pale brownish orange color. Mars is truly a red planet, complete with a rusty red sky! They say that the sunsets on Mars are fantastic! I'll bet we kick up a lot of red dust when we land! Maybe some Martian will see us land and come to welcome us!

Life or Signs of Life: Not at this distance!

Question: Why does it take longer for dust to settle on Mars? *(There are constant winds and the gravity is weaker than back on Earth.)*

Comment: I wonder if Mars will be anything like the desert in Arizona?

Figure 4.7—Mars Card # 5- Boulder



SCALE: 8 cm = 10^1 meters
10^1 meters = 10 meters

Observed by: Spacecraft or an observer on Mars.

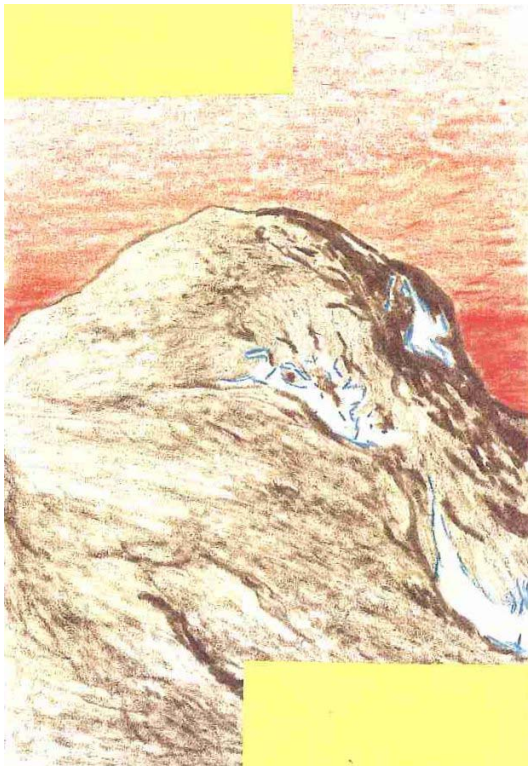
Description: We've landed! We're actually on the surface of Mars! I can see a big boulder, or is it a mountain? I can't wait until I can put on my space suit and go out there and see! It looks like there are many boulders scattered throughout the field of sand dunes. They might be the tops of large rocks that have been buried by sand. Maybe they just *look* like rocks! Maybe they are Martians made out of silicon!

Life or Signs of Life: Can't be sure.

Question: Why is the rock rounded at its top? *(The sandblasting winds smooth off the surfaces of rocks.)*

Comment: What's taking so long, Captain Kelly? Let's *go!*

Figure 4.8—Mars Card # 4- Ice and Dry Ice.



SCALE: 8 cm = 10^0 meters
10^0meters = 1 meter

Observed by: Spacecraft or an observer on Mars.

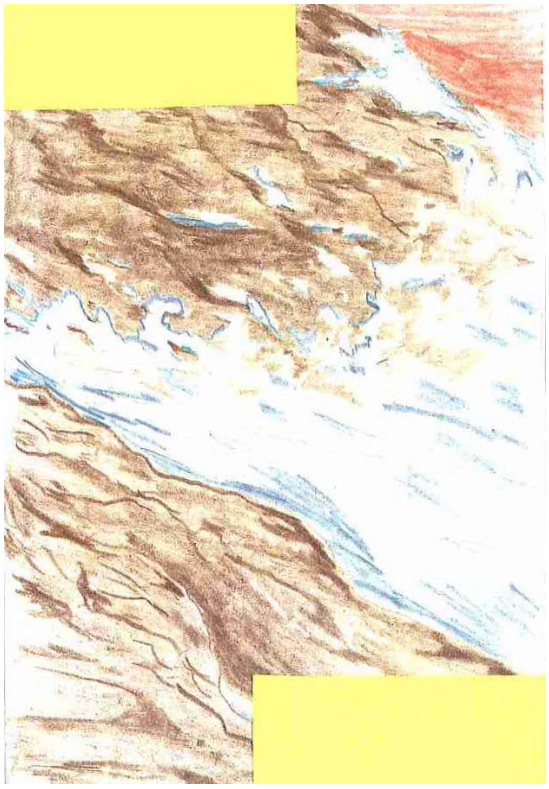
Description: I'm outside the spaceship, on the surface of Mars! It sure feels odd to walk around in this gravity after being in space for six months. I'm warm enough in my space suit, but this is one *cold* desert. Captain Kelley says that those patches in the shaded portions of the rock are dry ice. Dry ice is frozen carbon dioxide (CO_2)! Do you know how cold it has to be to keep dry ice frozen? About -57º C! There are also huge ice caps at the poles of Mars. The North Pole contains both dry ice and frozen water. So there *is* water on Mars! It's just frozen. (The South Pole is only CO_2.)

Life or Signs of Life: Nothing definite; carbon exists in living and in nonliving things. Water may be necessary for Earth life, but its presence here doesn't that there is life.

Question: Why is there no dry ice at the poles of Earth? *(The Earth is too warm, even at the South Pole. Tell that to a penguin!)*

Comment: I'm actually *walking around* on another planet!

Figure 4.9–Mars Card # 3- Ice and Dry Ice.



SCALE: 8 cm = 10^{-1} meters
10^{-1}meters = .1 meters

Observed by: Spacecraft or an observer on Mars.

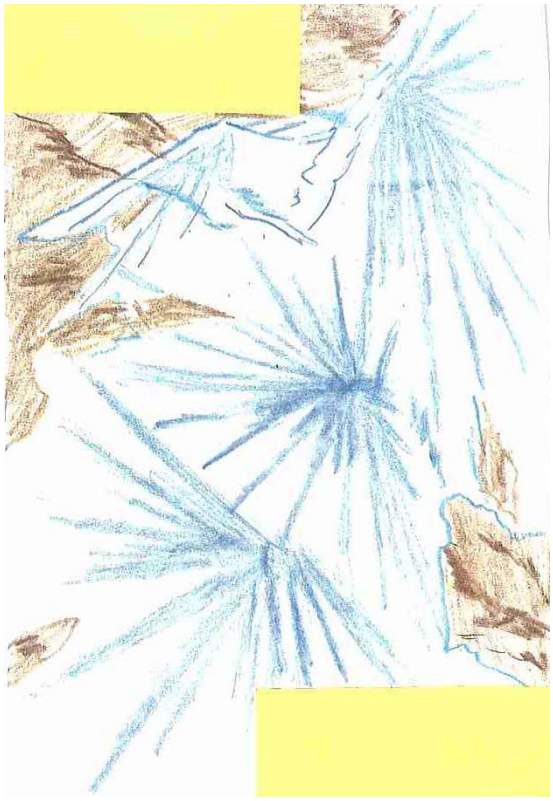
Description: I can't find any fossils, and those rocks sure look more like rocks than Martians! The patch of dry ice looks white and kind of powdery. Captain Kelley says that if all the ice on Mars evaporated, Mars would have a thicker. warmer atmosphere. Water could flow as a liquid and form riverbeds. I wonder if we could melt the ice and terraform Mars? Maybe one day we could even bring fish from Earth! Imagine catching a rainbow trout on Mars!

Life or Signs of Life: Nothing definite; only carbon and frozen water.

Question: Why does Mars have such a thin atmosphere? *(Its volcanism stopped as the planet cooled.*
Many of the elements in the atmosphere combined with the soil. Its small size and weak gravity allowed some of the atmosphere to escape into space.)

Comment: Nothing looks alive; I only see sand and rocks and ice.

Figure 4.10— Mars Card # 2 – Ice and Dry Ice.



SCALE: 8 cm = 10^{-2}meters
10^{-2}meters = .01 meters (1 centimeter)

Observed by: Spacecraft or an observer on Mars.

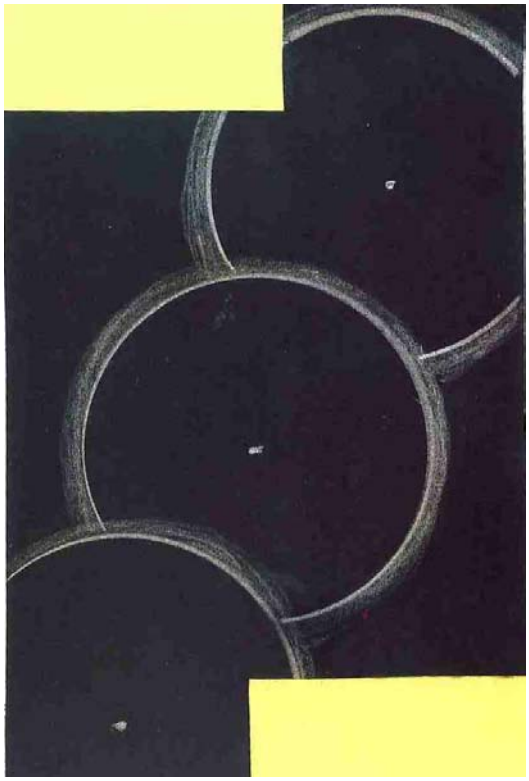
Description: Captain Kelley says that the dry ice here freezes and evaporates like water does on Earth. The water on Mars is always frozen because it melts at a higher temperature than dry ice. On Earth, there are bacteria and even insects that live on the ice and snow, and even in glaciers. And polar bears and penguins like the icy regions of Earth just fine. Maybe there are cold-loving critters living here. Maybe they're just too small for me to see with my eyes.

Life or Signs of Life: Nothing definite.

Question: If Mars once had a thicker atmosphere, could life have evolved there at that time? *Wes. As far as we can tell, all the necessary conditions for life were present when Mars had an atmosphere.)*

Comment: I wish that I had a microscope to look for bacteria and other tiny life-forms.

Figure 4.11—Mars Card # 1- Atoms



SCALE: 8 cm = 10^{-10}meters
10-^{10} meters = .0000000001 meters

Observed by: Imagination!

Description: This is a picture that Captain Kelley showed me. We should have brought a tunneling electron microscope with us so we could look for atoms on Mars! But we know that dry ice is made of molecules of CO_2. This picture shows one carbon atom between two oxygen atoms. It's neat to think that carbon atoms just like this one are inside me right now!

Life or Signs of Life: Nothing definite.

Question: Is this carbon atom any different from the carbon atoms on Earth? *(No. A carbon atom, is a carbon atom.)*

Comment: I guess it's time to go back to Earth now. Hey, wait a minute! I did get a round-trip ticket, didn't I? Captain Kelley! Captain Kelley! Where are you? Oh, there you are! I'm sure glad to see you. Mars is a great place to visit, but I'm starting to miss Earth. It will take another year of travel time, but I'm ready to go home.

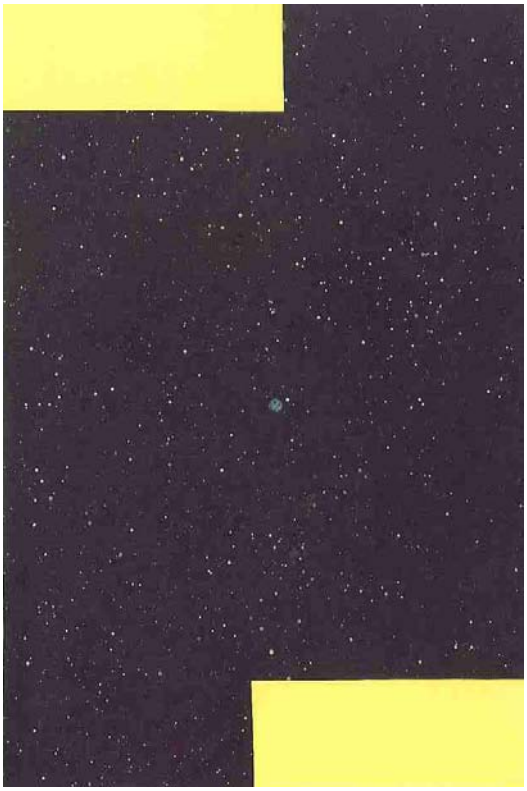
Script for ZOOM! Cards

Journey to Venus

The ZOOM! journey to Venus begins at 10 meters, jumps to 10^8 meters, and then includes views from 10^8 meters to meters. This journey includes images that are created based on data from the *Magellan* mission and the Russian *Venera* landers. However, the rest of Microworld Venus has never been seen by spacecraft instruments. The "10^{-10}meters card has been included to stress the existence of carbon atoms on Venus. They have been detected, but not actually seen with any instruments.

In this scenario, an imaginary extraterrestrial explorer named LARB pilots a spacecraft into our solar system. LARB sees the three Earth-like planets, and decides to take a closer look at Venus. Who knows? Maybe the conditions on Venus will seem like home to this extraterrestrial! Consider the ZOOM! Cards of Venus to be a series of images sent home by Commander LARB. This scenario assumes that LARB has a sensory ability that approximates human vision, as well as technology that is similar to ours! These may not be good assumptions. This scenario also assumes that this extraterrestrial can travel across the galaxy! Such travel is purely science fiction. The scientific comments about Venus are accurate to the best of current scientific knowledge. LARB's comments reflect a non-human, inquiring mind. They may be a bit odd from a sober, scientific Earth perspective! But who knows?

Figure 4.12—Venus Card # 1- Venus, Earth, and Mars.



SCALE: 8 cm = 10^{11} meters
10^{11} meters = 100 billion meters

Observed by: LARB's interplanetary spacecraft.

Description: Report from Commander LARB to Proxima Centauri Base. I have been traveling for over 20,000 glaxes, which is a long time to be alone. I have finally arrived at the target star. As our scientists predicted, there is a planetary system here! There are nine planets orbiting Sol I. From my view screen I can see three planets, all about 100 billion meters away. There is a planet closer to Sol I than these three, but it is too close, and far too hot for liquid water and life as we know it to exist.

Life or Signs of Life: Not at this distance.

Questions: What planets can LARB see? (At this distance, LARB can see Venus, Earth and Mars; in this view, these planets can be seem because each is in a suitable position in its orbit around the Sun.) Can you tell which dot is Earth? Which is Mars? Which is Venus? (This can be determined by size and position).

Comment: The yellow planet, which is the second closest planet to Sol I, looks promising.

Figure 4.14—Venus Card # 3-Close to Venus

SCALE: 8 cm = 10^7meters
10^7 meters = 10 million meters

Figure 4.14- Venus Card # 3 – Close to Venus.

Observed by: LARB's interplanetary spacecraft.

Description: Report from Commander LARB to Proxima Centauri Base. I am approaching Venus, which is only 10 million meters away. The planet fills the entire view screen. There are no rings or moons present, and there are still no details of the surface to be seen. Am I still too far away to see details? No, but the surface of Venus seems to be completely hidden by thick, yellowish clouds. I can see them swirling, but I can't detect anything through them. These clouds may provide shielding for any life on the planet. I'm going in for a closer look.

Life or Signs of Life: Not at this distance, because of those clouds.

Question: How did the *Magellan* spacecraft see through these clouds? *(Magellan used radar to penetrate the clouds; computer program generated images from the radar data.)*

Comment: Will those clouds be a problem?

Figure 4.15–Venus Card # 4- CLouds

SCALE: 8 cm = 10^6 meters
10^6meters = 1 million meters

Observed by: LARB's spacecraft during descent to the surface.

Description: Report from Commander LARB to Proxima Centauri Base. The churning, dense, yellow clouds are well below me. Some of the storm systems look like they are moving five or six times as fast as hurricanes back home. There seems to be a strong movement from the west to the east, against The planetary rotation. There are two permanent vortices at the poles. These clouds are moving fast enough to circle the planet in only four days!

Life or Signs of Life: Not at this distance.

Question: What kind of acids are in the clouds? *(Mainly sulfuric and hydrochloric acids.)*

Comment: Will I be able to go below these clouds?

Figure 4.16—Venus Card # 5 10^5meters =

SCALE: 8 cm =10^5 meters
10^5 meters = 100,000 meters

Observed by: LARB's spacecraft during descent to the surface.

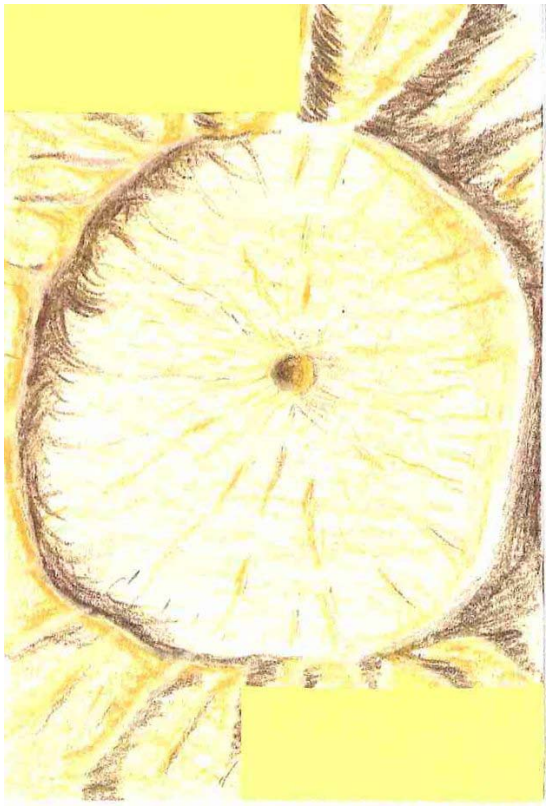
Description: Report from Commander LARB to Proxima Centauri Base. I am about to delve into the midst of the dense Venusian atmosphere. The clouds start at 70 kilometers above the surface. It's starting to heat up, and the pressure is building. I'm not sure what I'm in for, but my intrepid adventurous spirit will lead the way! (I think.) I sure hope that these clouds end a good distance above the surface. It will be hard to land without being able to see.

Life or Signs of Life: Not at this distance.

Question: What are the weather systems in the clouds? *(There are two convection cells, one in each hemisphere.)*

Comment: Will I land in a volcano, or in an ocean? Planetary exploration can be pretty risky.

Figure 4.17—Venus Card # 6 – Below the Clouds.



SCALE: 8 cm = 10^4 meters
10^4 meters = 10,000 meters

Observed by: LARB's spacecraft during descent to the surface.

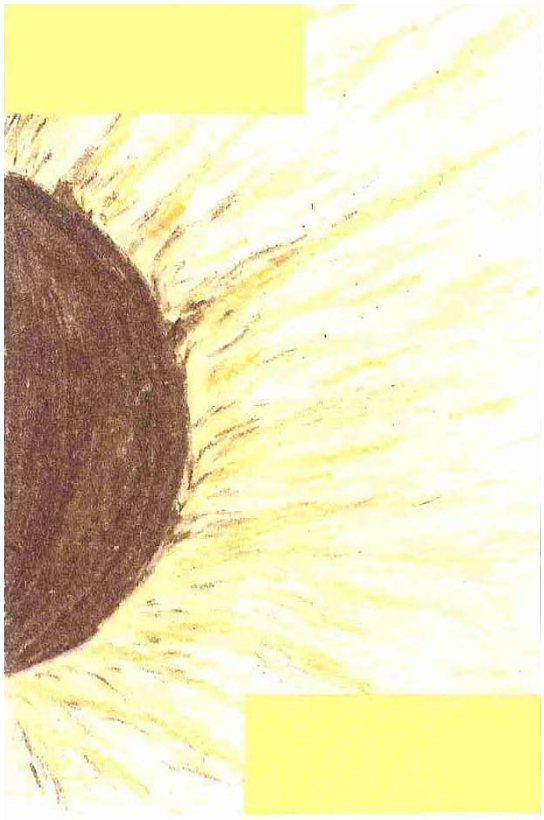
Description: Report from Commander LARB to Proxima Centauri Base. What torture! My instruments are going crazy! The temperature and-pressure are both off the scale! The external chemical sensors read very low pH levels, which means that these clouds must be composed of *acids.* It's a good thing that my spacecraft has protective armor! I actually went through two cloud layers: one from 75 to 55 kilometers above the surface and another from 50 to 40 kilometers above the surface. The landscape below me is fantastic! There are pits and craters and lava flows all over There is a huge volcano right below me. There are no cities, nor are there any signs of roads, spaceports, or agriculture. In fact, there is no vegetation of any kind. The entire surface appears to be lifeless.

Life or Signs of Life: None.

Question: Are the volcanoes on Venus still active? *(Scientists don't know yet. The detection of energy bursts and steep slopes leads to some interesting speculation.)*

Comment: Could there be a thriving civilization below the surface?

Figure 4.18—Venus Card # 7- Crater's Edge.



SCALE: 8 cm =10^3 meters
10^3meters = 1,000 meters (I kilometer)

Observed by: LARB's spacecraft during descent to surface.

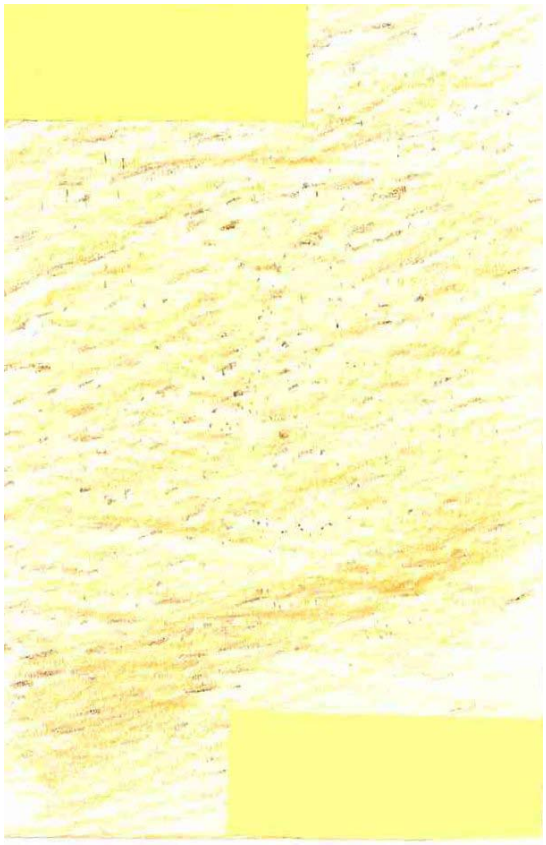
Description: Report from Commander LARB to Proxima Centauri Base. I'm preparing my spacecraft for landing. It looks like its going to be rough. Maybe I can scoot on over past the volcano, onto those flat plains created by the lava flows. The Figure 4.18- Venus Card # 7- volcano looks inactive and the lava is solidified. Crater's Edge. The lava looks like it oozed out of the volcanoes. Because the atmospheric pressure is so high here, the lava probably didn't erupt into the air! There is no wind this close to the surface; this will simplify my landing. I'm sure glad to be out of those clouds, but the temperature and pressure are still rising.

Life or Signs of Life: None.

Question: What are the mounds? *(Pancake domesflat, circular volca,noes about 25 kilometers in diameter and 750 meters high.)*

Comment: I don't want to land on the rim; it looks like a steep drop into the crater.

Figure 4.19—Venus Card # 8- Flat Plains



SCALE: 8 cm = 10^2meters
10^2 meters = 100 meters

Observed by: Landing spacecraft.

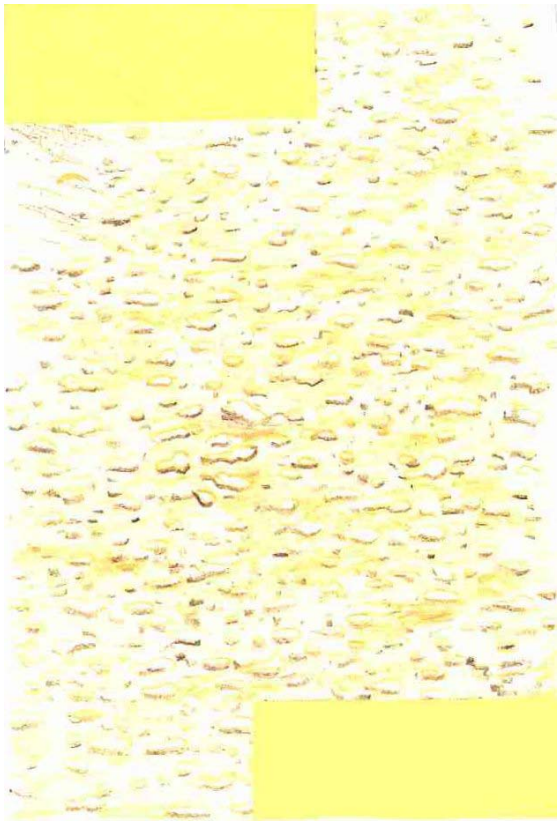
Description: Report from Commander LARB to Proxima Centauri Base. I'm on my final approach. Small rocks litter the plain, but this craft is designed for that. Right? I don't see any animals or plants of any kind. In other places, I saw rift valleys, but now I'm cruising over rolling plains. Some of them appear to be rift-valley trenches filled with lava flows. The surface appears to be a mixture of loose grainy rocks and larger, flatter rocks.

Life or Signs of Life: None.

Question: Is the surface of Venus solid? *(The former Soviet Union landed two spacecraft,* Venera *9 and* Venera 10*, on the surface, which proved to be solid. Only one craft survived the landing; however, it was overcome by the pressure and temperature within an hour.)*

Comment: I'm all set for a perfect landing.

Figure 4.20—Venus Card # 9 – 10 Meters Up!



SCALE: 8 cm = 10^1 meters
10^1 meters = 10 meters

Observed by: Landing spacecraft.

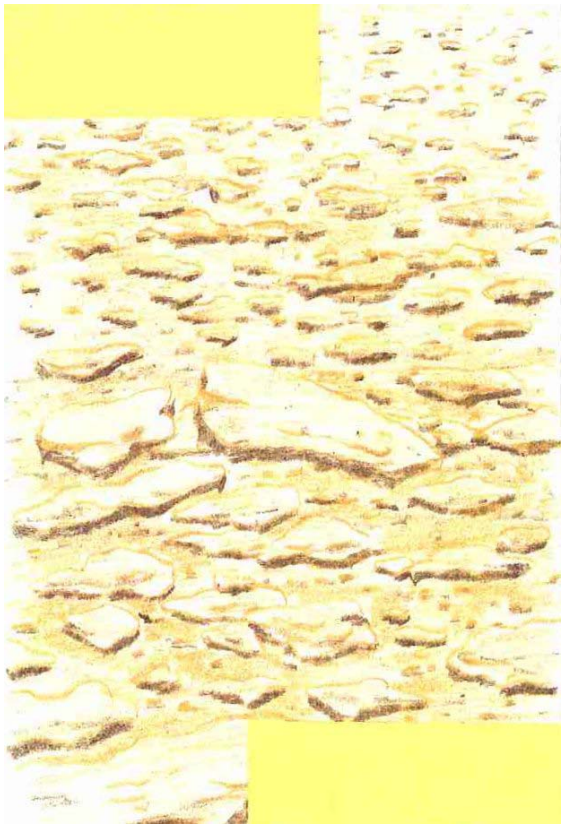
Description: Report from Commander LARB to Proxima Centauri Base. My retro-rockets are firing. I'm going to need all of my tentacles to manipulate the landing controls! I see slab-like rocks about half a meter long littering the surface. Some are granite-like rocks while others appear to be like basalt, which has volcanic origins. I also see clustered, rocky outcroppings. I don't want to land on one of those! My ship could tip over, and I would never be able to launch off this planet; the pressure and temperatures are too high for me to go outside and reposition my spacecraft for a launch.

Life or Signs of Life: No.

Question: Is the surface made of young rocks or old rocks? (A *mixture-granite, an older, metamorphic rock that is a conglomerate of other rocks; and basalt, a younger rock of volcanic origin.)* Comment: I sure hope this spacecraft can land here.

Comment: I sure hope this spacecraft can land here.

Figure 4.21—Venus Card # 10- Landscape.



SCALE: 8 cm = 10^0meters
10^0 meters = 1 meter

Observed by: Spacecraft on the surface of Venus.

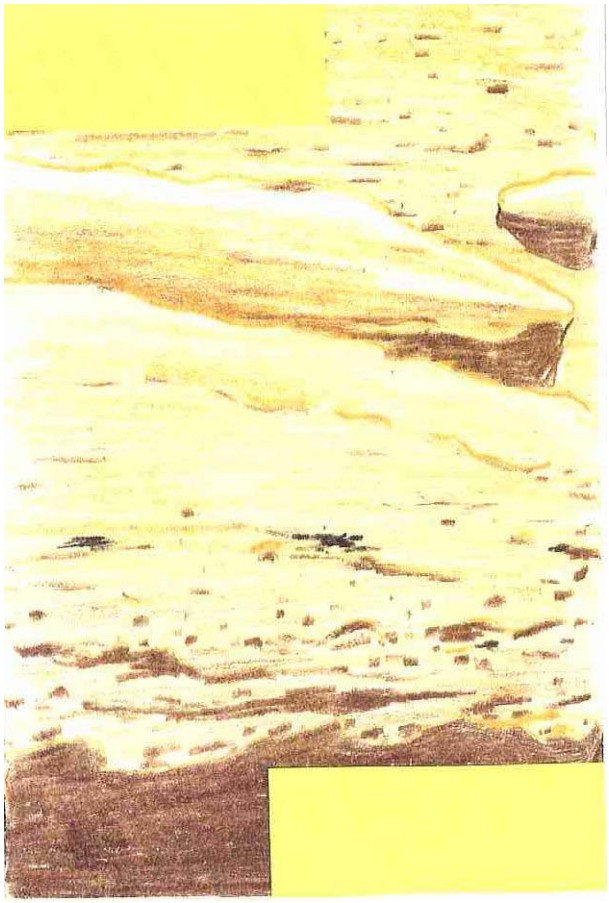
Description: Report from Commander LARB to Proxima Centauri Base. I have landed successfully! Phew!!! This is a well-built spacecraft; it has withstood a temperature that would melt lead and a tremendous atmospheric pressure. The surface of Venus shows volcanic rocks and a desert-like landscape. Some of the rocks have small holes that may have been filled with gas. Other rocks show blunt landscape is yellow. There is no water anywhere; at this temperature, any water would vaporize instantly!

Life or Signs of Life: No.

Question: In Earth terms, how great is the atmospheric pressure on the surface of Venus? *(The atmospheric pressure on Venus is 90 times greater than on Earth .)*

Comment: I made it!

Figure 4.22—Venus Card # 11 Volcanic Rocks.



SCALE: 8 cm = 10^{-1} meters
10^{-1} meters = .l meters

Observed by: Spacecraft on the surface of Venus.

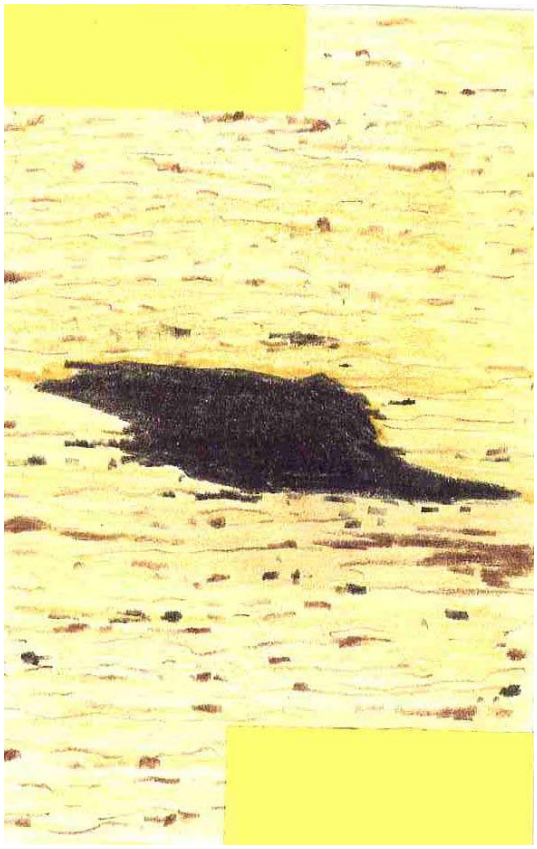
Description: Report from Commander LARB to Proxima Centauri Base. It is so still here. There is nothing moving anywhere. This is a close-up of the volcanic rocks in the last image. There are little black spots all over the rocks. Could they be lifeforms? I will look more closely. Wow! The analyzer says that they are made of darbon atoms! iMaybe they *are* a life-form. If they are, they're sure funny looking.

Life or Signs of Life: Can't be sure. Carbon atoms exist in living and in nonliving things.

Question: Do you think that LARB is a carbon based life-form? *(This extraterrestrial is very excited by the presence of carbon. LARB must know of the existence of carbon-based life-forms. However, we can't know for sure whether or not LARB is carbon-based.)*

Comment: Maybe the black spots think that I'm funny looking!

Figure 4.23—Venus Card # 12- Black Diamonds.



SCALE: 8 cm = 10^{-2} meters
10^{-2}meters = .01meters (1 centimeter)

Observed by: Spacecraft on the surface of Venus.

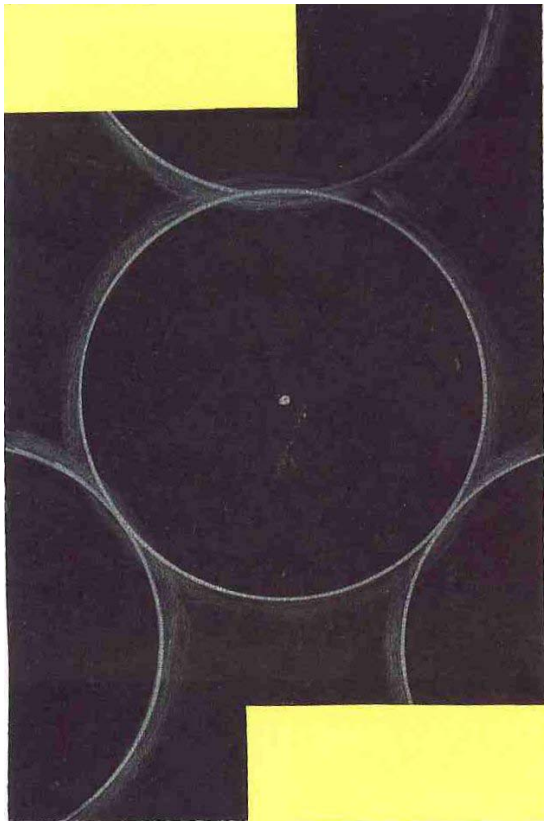
Description: Report from Commander LARB to Proxima Centauri Base. This is a close-up of the back spots seen on the rocks. Analysis shows them to be black diamonds. I will map the planet to see how many diamonds there are, but there probably isn't much sense in mining a planet so far from home, especially for an element as common as carbon. The transportation costs, and the time involved, would be prohibitive.

Life or Signs of Life: No. Black diamonds are carbon, but they are not alive.

Question: Do we really know that there are black diamonds on Venus? *(This idea is based upon conjecture: Because most volcanoes 012 Earth produce black diamonds, it is likely that the volcanoes on Venus produce black diamonds, too.)*

Comment: I'd still like to have my own black-diamond mine!

Figure 4.24—Venus # 13 Carbon Atoms



SCALE: 8 cm = 10^{-10} meters
10^{-10}meters = .0000000001 meters

Observed by: Imagination!

Description: Report from Commander LARB to Proxima Centauri Base. As expected, there are carbon atoms within the black diamond. Although carbon atoms are characteristic in living things, they are also found in nonliving things, such as carbon dioxide gas, dry ice, and black diamonds! Soon I will finish my survey here. Next, I plan to go to the third planet from Sol I. I don't expect to find any life there, though, because the planet is probably far enough away from its star that its water freezes! I'll look anyway. Wish me luck!

Life or Signs of Life: No. Carbon is not proof.

Question: What will LARB find on the third planet? *(Us!)*

Comment: I think I'll name the third planet after me. LARB-I like the sound of that!