Higher than Everest

An Adventurer's Guide to the Solar System

Paul Hodge
University of Washington

CAMBRIDGE
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, UK
40 West 20th Street, New York, NY 10011-4211, USA
10 Stamford Road, Oakleigh, VIC 3166, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa

http://www.cambridge.org

First published 2001

Printed in the United Kingdom at the University Press, Cambridge

Typeface Swift-Regular 9.75/14pt. *System* QuarkXpress® [HMcL]

A catalogue record for this book is available from the British Library

Library of Congress Cataloguing in Publications data

Hodge, Paul W.
Higher than Everest: an adventurer's guide to the solar system/Paul Hodge.
p. cm.
Includes bibliographical references and index.
ISBN 0 521 65133 6
1. Solar system–Popular works. I. Title
QB501.2.H63 2001
523.4–dc21 00-065145

ISBN 0 521 65133 6 hardback

Contents

Higher than Everest

This guidebook begins with some adventurous expeditions on the planet Mars. Though not the closest planet to Earth (Venus is closer), Mars seems the most Earth-like and it has long been the subject of romantic tales of alien beings and exotic lands.

We now know that Martians don't exist, but the exotic landscape of Mars does, beckoning for us to come, to map, and to explore. Mars has many spectacular features and a trip to any of these places on the surface of Mars will be a great adventure.

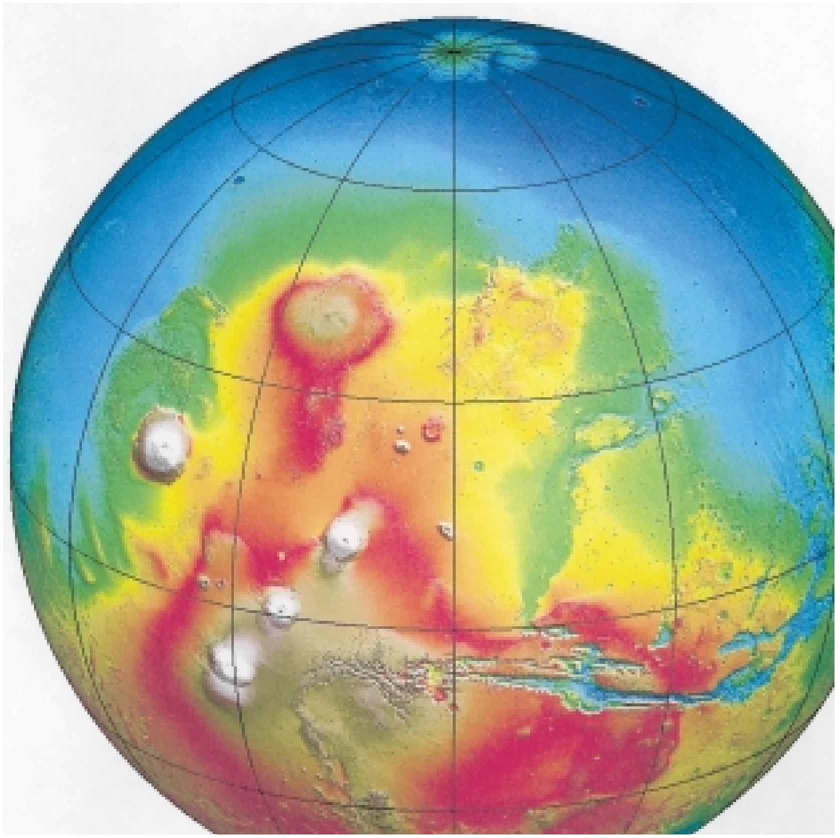
Our most massive mountain

Your first expedition will be to the highest volcano in the Solar System, the highest mountain known to Man. Mt. Olympus on Mars is far higher and vastly more massive than any mountain on Earth. It is the ultimate challenge of mountain-climbing among the planets. And yet, compared with climbing Mt. Everest or many other terrestrial peaks, reaching its top is not technically difficult. Following the route described here requires no tricky rock climbing, no glacier travel and no roping up.

Of course, for a mountain of this height a climber will need oxygen. Even the strongest and most daring free-climbing mountain-conqueror of the Himalayas needs oxygen tanks on Olympus, just as he or she needs them anywhere on Mars. Even down on the Martian plains the air is thin, less than 1% of the air at the Earth's sea level, and it contains no oxygen at all, mostly just carbon dioxide.

It's also pretty cold on Mars. Temperatures at night on the plains drop to −200 °F and fall even lower on the heights of Olympus. But a standard Martian space suit should suffice for maintaining reasonable comfort for the climb. The hardships and the dangers that are standard for the Earth's famous climbs are much worse than what a well-equipped climbing expedition to Olympus can expect. The mountain is huge, but its slopes are not steep, except in a few, rather surprising places. For the most part it is a gentle giant.

Mt. Olympus is located near the tropics of Mars, at a latitude of 18° north, similar to Earth's Hawaiian Islands. But even its base never gets



The Tharsis region of Mars. In this map, based on elevations measured by the Mars Global Surveyor, elevations are color-coded. The Tharsis Dome is red and yellow and the high volcanoes are white. Olympus is the peak at the left of the bulge. Mariner Valley extends across the bottom of the picture to the right (NASA).

warm, as the mountain rises from the edge of a high, cold upland area called the Tharsis Dome. This huge, volcano-rich plain averages a height of some 10,000 feet above Martian "sea level," a reference level roughly equivalent to Earth's sea level. The Tharsis Dome is immense, spanning some 4,000 miles. On Earth it would cover most of North America. Its round dome shape is the apparent result of concentrated up-welling of molten rock from Mars' interior, and the dome is punctuated with giant volcanoes of various ages, ranging from about 200 million years for Olympus up to 2 or 3 billion years for the collapsed giant known as Alba Petera ("White Pan"), located northeast of Olympus.

Geologists point to the similarity of the Tharsis Dome to the Hawaiian Islands chain on Earth. Both are the result of volcanic activity, pinpointing a deep "hot spot" from which molten rock is pushing up. The resulting mountains are remarkably similar in shape, forming what are

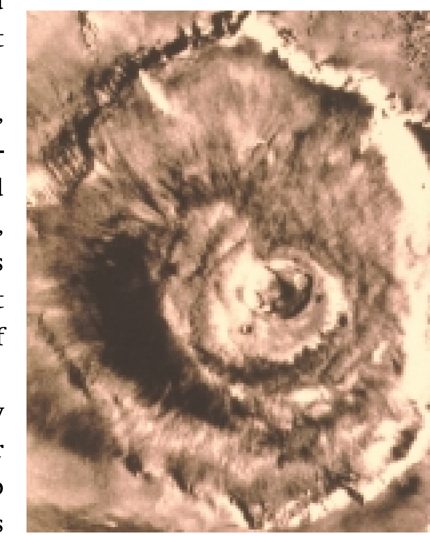
Mauna Loa, a shield volcano in Hawaii that rises 13,680 feet above sea level, is similar in its gentle slope to the Martian shield volcanoes (author photo).

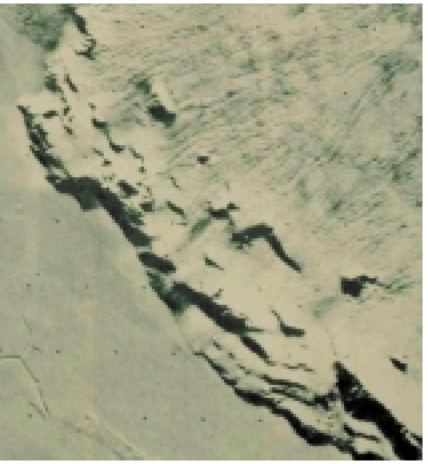
called "shield volcanoes," smooth, gently sloped mountains made from freely-flowing lava, not the viscous, explosive lava of a Vesuvius or a Mt. St. Helens. But the Hawaiian Islands are a long chain of volcanoes, extending all the way from Midway Island at one end to the Big Island of Hawaii at the other. This long chain results from the slow movement of the Earth's skin, which in the mid-Pacific is sliding northwestward. The old islands are at the tip of the chain, while the youngest, the Big Island, now sits over the hot spot and is still growing. Its highest volcanoes, Mauna Loa and Mauna Kea, rise over 13,000 feet above sea level and about 20,000 feet above the ocean floor.

On Mars, things are different. The Tharsis Dome lies over a hot spot, but there is no movement of Mars' skin – no "plate tectonics," as geologists call it. The Dome has been in the same place for billions of years and has grown to immense dimensions. Mt. Olympus, to one side of the Dome, is 80,000 feet high above Martian sea level, nearly three times as high as Everest. It is 500 miles across at its base. Were it set down on the US, it would smother all of New England, from New York to the northern tip of Maine.

Compared with Mt. Everest, Mt. Olympus would not be a particularly imposing site from its base, in spite of its great height. In fact, a climber would spend much of the time climbing the peak without being able to see the summit, which would be beyond the horizon. The top of Everest is

Mt. Olympus, the largest shield volcano on Mars, rises more than 80,000 feet above Mars' equivalent of sea level. This view is looking straight down. The large caldera is at the center and the high basal cliffs are at the edges of the picture (NASA).




The cliff at the base of Mt. Olympus is as high as many famous mountains on Earth. This view from above shows the high slopes of the mountains on the right and the flat plains below the cliffs at the left (NASA).

nearly always visible (weather permitting) from near its base, as it rises 13,000 feet above the traditional base camp on the Khumbu Glacier, only 9 horizontal miles from the summit. Olympus' summit, though it is more than 60,000 feet higher than its base camp, nevertheless lies 150 miles away, out of sight beyond the nearby rocky slopes.

The great wall

Though the summit can't be seen from the base camp for Mt. Olympus, it does have a remarkable and intimidating view. A great basal cliff surrounds this massive mountain, averaging about 10,000 feet high. This steep cliff forms a pedestal upon which Olympus sits, and is the first obstacle for any climbing expedition.

Olympus' remarkable basal cliff is a major Martian mystery. Terrestrial geologists have many guesses about what might have caused it, but no one knows for sure. Perhaps your climbing party will have time to do a little investigating while camped at its foot and will find evidence to solve the mystery. If you do so, the first clue that you will notice is that the cliff face shows layering, indicating that the various sheets of lava that flowed from the summit over time were abruptly sheered off when the cliff was formed. But how?

One possible explanation is that it resulted from an elevation of the entire mountain, which was pushed up from below, leaving its edges as a cliff formed at a circular fault zone in the Martian crust. Another idea is that erosion (most likely wind erosion, as there is no liquid water on Mars at present) wore away softer, older surface material, but left the harder volcanic rocks of the mountain. A third idea is that the lower flanks of the mountain simply slid away as landslides, spilling the rock out over the surrounding plains. A more exotic suggestion is that Mt. Olympus' pedestal was formed at a time when it was near the Martian north pole. Mars wobbles on its axis, as does the Earth, and there is evidence that the Tharsis Dome was near the pole when Mt. Olympus was being formed. At that time, the volcano would have been under the northern ice cap. A volcano that forms under a glacier will have a different history from those on dry land, especially at its edges, where the lava melts the ice. The gentle slope of the upper reaches of the mountain will change to a steep slope at the bottom, where the melting ice will break up and carry away the hot lava rocks, leaving an abrupt edge.

Maybe there's another explanation, not yet considered. The puzzle will probably only be solved by a team of adventurers, such as yours, that makes a careful study right there at the base of the cliff.

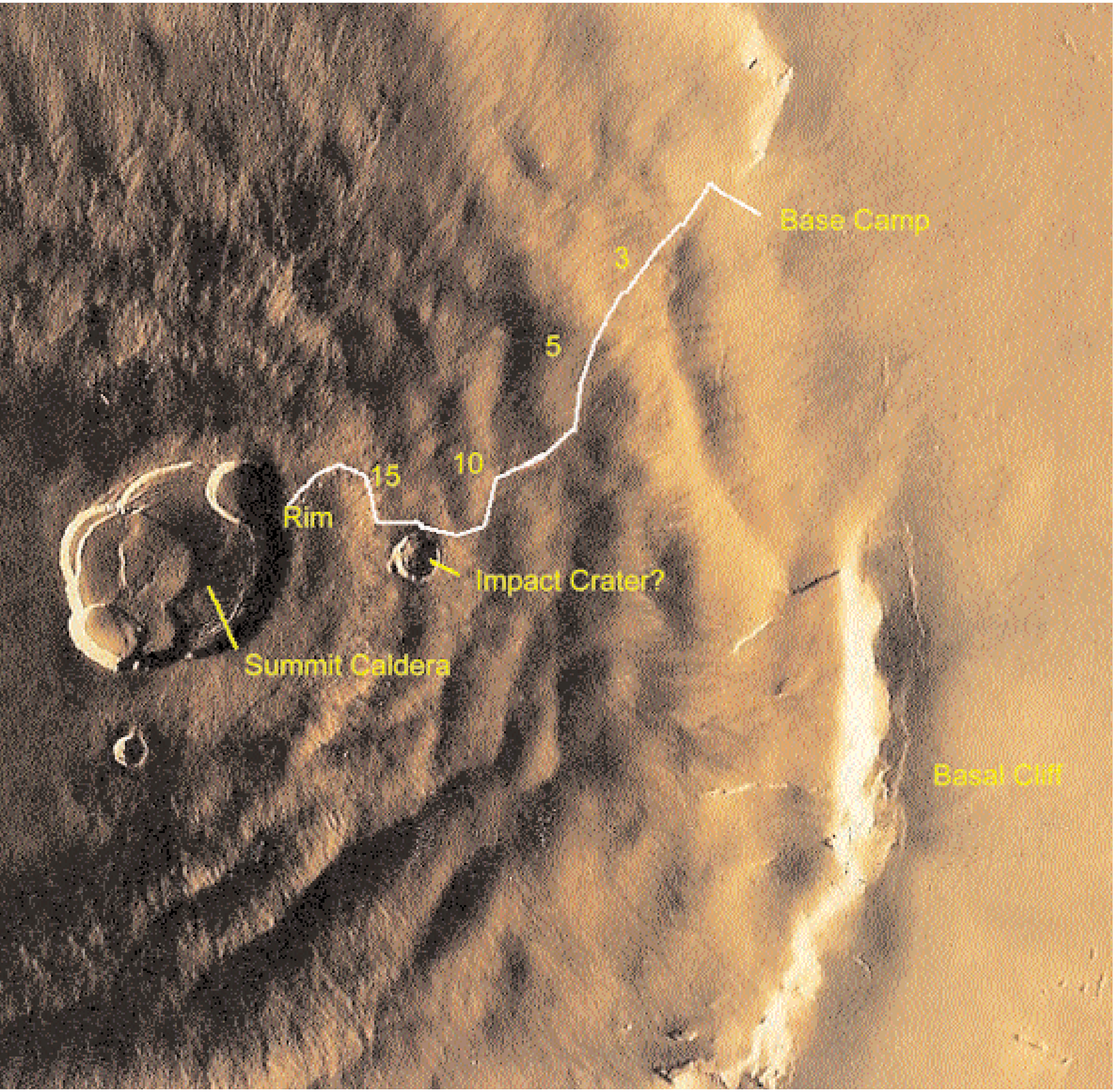
Establishing a base camp

For your first climb of Olympus, it is probably best to avoid the challenge of the steepest parts of the basal cliff. We know that it can have an average slope as steep as 35 ° from the top to bottom, but there probably are much steeper sections at various levels, not yet seen by Martian spacecraft. A climbing party ascending the cliff might be delayed by days if it encounters a long, unbroken vertical edge of a lava layer, hundreds or thousands of feet high. Therefore, it is recommended that the ascent be made from either the south or the east, where there are places where the cliff has a more gentle slope. A preferred base camp position in the east would be on the smooth high plains at longitude 129.5 ° west, latitude 21 ° north. From there the distance to the summit is at a minimum, only 150 miles in a straight line, but this means a somewhat steeper climb in total. However, except for the basal cliff, which this route avoids, steepness is not the main problem at Olympus, distance is. Even for this relatively short route, the entire operation will take nearly a full Earth month.

Speaking of months, before describing the route and plan, it is good idea to review the kinds of days, months and years that one finds on Mars. The days are not a problem. Mars turns on its axis in just over 24 hours, so that we Terrestrials will feel quite at home with the passage of day and night.

Months on Mars are another matter. There are two moons, Phobos and Deimos, both much smaller and nearer to their planet than our Moon. Because it is so distant, about 250,000 miles from the Earth, our Moon orbits slowly, making a complete circuit (with respect to the Sun) in 29 days, the basis for our month. Phobos is a little less than 6,000 miles from the center of Mars. It orbits the planet so fast that a Phobos month is only 9 hours long. Three times each day it zips up above the western horizon, speeds across the sky and sets in the east. Although a very small moon, only about 15 miles across, its proximity to Mars means that, as seen from the Martian surface, it will look almost as large as our Moon as seen from the Earth.

Deimos is farther away, a little more than twice as far from the center of Mars. It orbits more slowly than Phobos, with a period just over a



Martian day. About half Phobos' size, Deimos appears as a small, dim moon that creeps slowly across the sky from east to west.

The Martian year is nearly twice as long as Earth's, a result of its greater distance from the Sun, meaning a smaller solar gravitational pull. If any members of the climbing expedition are on salary, it might be a good idea to stick to terrestrial time. Otherwise, those paid on a yearly basis will be badly underpaid on Mars, while those on a monthly salary will get paychecks every nine hours!

Mars has seasons like Earth's because its axis is tilted by nearly the same amount as Earth's. It is best to plan a climb of Olympus for the Martian summer to take advantage of the longer and warmer days. Even in summer, however, the Martian cold is severe, with expected daytime temperatures never above 32 °F at base camp, and nightly lows near −200 °F. High on Olympus, the temperatures will be much lower.

Supplying a Mt. Olympus climbing party requires a lot of advanced planning. Of course there are no Swiss chalets along the way, no trout streams to fish, and no water to add to a mountaineer's dried macaroni and cheese. Food, water and oxygen must be brought along. And there are no yaks to carry it and no Sherpas to lead the yaks and to find the climbing route. Carrying enough food and water for a month's excursion in a backpack would be impossible even in Mars' lower gravity (two fifths of Earth's), especially for a climber wearing a cumbersome Mars Environment Suit. The solution to this problem will not be easy.

Just as it is now considered reprehensible for climbers of Everest to be carried or "short-roped" to the summit, so is it considered cheating to climb Mt. Olympus accompanied by motor vehicles carrying supplies. And it would hardly be considered a first ascent if you were to send someone on ahead in a Martian rover to leave food in caches along the route to the summit. Air drops are considered OK for some of the more lengthy terrestrial ascents, but Mars' thin atmosphere doesn't support normal aircraft. An ordinary plane or helicopter – even a U-2 – simply can't get off the ground, even at Mars' sea level, because the atmospheric density is so low.

One possibility would be to have several small rockets launched ahead of time from a Mars space base. If each carried a payload of food for five days, six of them would be enough, spaced on the slopes so that you would reach them on both the ascent and descent.

Another idea is to use a remote-controlled blimp. A huge, cumbersome one will be required to carry your materials, as even a large volume of

[opposite] The climbing route up Mt. Olympus from the east (at right) can be traced on this image (NASA).

A lava tube in Oregon, looking out of an opening formed by collapse of part of the ceiling. Similar lava tubes have been found on the slopes of Olympus, especially near the lower northeast flanks (author photo).

hydrogen has limited carrying power on Mars. The advantage of a blimp, however, is that it can be steered close enough to the ground that your well-padded supply boxes can be dropped from only a short distance, decreasing the chances of damage.

In either case, it must be remembered that refuse must be removed from Mt. Olympus following the climb. Experience at Everest in the twentieth century vividly and disturbingly demonstrated the importance of such a rule.

The plan

Here is a possible day-by-day plan for the ascent from the eastern base camp position. Of course, the size of the group, the nature of the equipment, the physical condition of participants, and individual taste will dictate departures from this basic plan. On the ascent it is best to plan a daily distance of only 10 miles or so, allowing time for exploration, geological research and any unforeseen difficulties. For the descent 15 miles a day probably will be possible.

Day 1. Leave base camp as the Sun rises in the east. Head northwest, past several small craters (are they meteorite craters or volcanic vents?), towards a smooth breach in the basal cliff.

Day 2. After camping near the crest of the lava flow that tumbles over where the cliff should be, continue up, now to the southeast.

Day 3. Make camp near the base of a moderate slope. Explore the "mysterious" linear feature to the south — probably a lava tube or channel.

Days 4 and 5. Camp on fairly steep lava fields. Here the slope averages about 25°.

Days 6 and 7. Turn more southward along the foot of a lava rise to the west.

Day 8. Camp in a valley that leads southwesterly up through the next lava step.

Days 9, 10 and 11. Follow the wide lava valley up to the base of a shoulder. The altitude of Camp 11 is 60,000 feet!

Days 12 and 13. Pass around a lava mound to the north and then ascend to the northern rim of a large impact crater, about 9 miles in diameter. From Camp 13 at its rim, look down at its patterned floor. Steep walls will make a descent hazardous, but perhaps someone in the party will want to explore at least partway down. Morphologically this crater is somewhat different from volcanic craters and vents. It has a sharply raised rim and a bowl-shaped floor, although this example seems to have a lot of debris on its floor. Look for samples of impact-deformed rock, such as impact breccia, a coarse mix of fragments of rock and melt that is formed when a meteorite hits the ground. If you find nothing but volcanic rocks instead, we may have to revise the claim that this feature is not a volcanic side crater of Mt. Olympus.

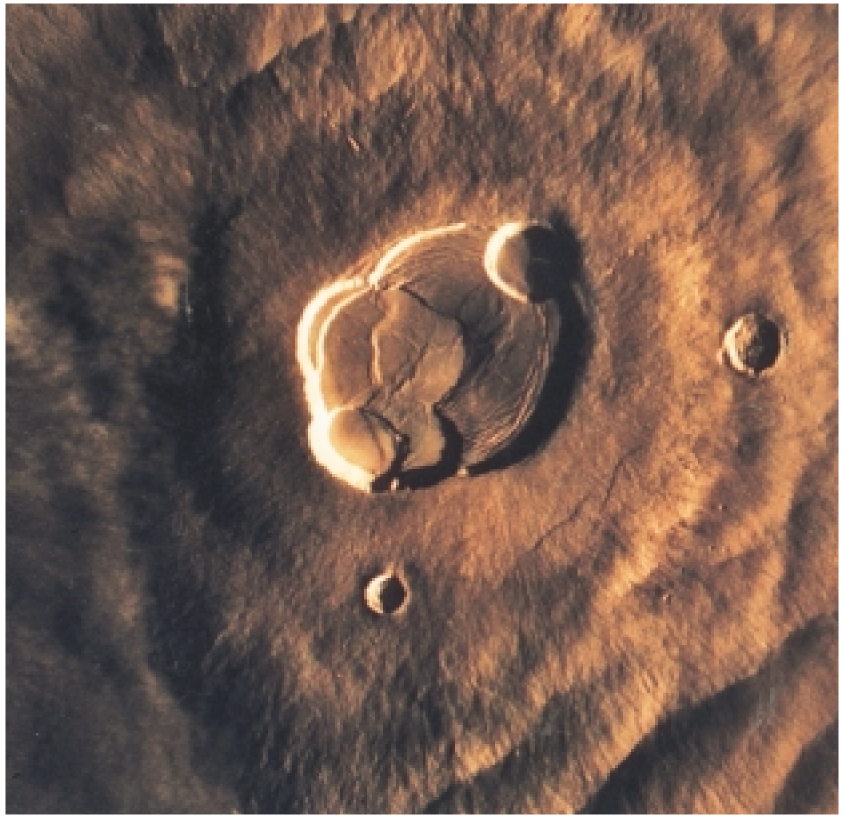
Day 14. Camp near the base of a steepish slope that is marked by linear lava flows and several intriguing small crater-like features.

Days 15 and 16. Skirt around the northern side of the slope to the west, the last steep rise before the summit.

Day 17. Pass upwards along a row of small pit craters, about a mile across. These are probably similar to the ones found in Hawaii Volcanoes National Park along the Chain of Craters Road, but the Martian ones are much larger.

Days 18 to 20. Reach the summit rim. Stretched out below you is the giant summit caldera, many times larger than terrestrial examples such as that on Mauna Loa, though very similar in structure. The caldera is a complex of frozen lava lakes from which molten rock issued during the periods of the building of the mountain. At least six different lakes, frozen at different levels, can be seen, but the vastness of the caldera, nearly 50 miles across, permits only a part of it to be appreciated from the rim. The walls are very steep and the floor is marked by channels, wrinkles and cliffs between lake levels. To the north is one of the two deepest and most recent lava lakes, about 9 miles across. Off to the southeast is the other deep lake, which is less round. Three days are scheduled here to allow time for exploration along the rim and possibly a little ways down into the caldera. The best route down is probably a comparatively gentle slope just to the west of the edge of the northern, deep lava lake.

Days 21 to 32. Descend to base camp, following the route up and revisiting the supply caches for the food that was left in them. At base camp



The complex caldera at the top of Mt. Olympus (NASA).

celebrate having climbed the highest mountain in the Solar System. But be careful when you open the bottle of champagne. At Mars' low atmospheric pressure, the cork can become a dangerous missile!