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The Cydonian Hypothesis

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Abstract—Evidence suggesting a past humanoid civilization has been found at several sites on Mars. In particular, what appear to be large carved faces, with similar details, have been found at two separate sites. Together with geochemical and geological evidence that suggests Mars was once more Earth-like in climate, the images of the objects support the Cydonian Hypothesis: That Mars once lived as the Earth now lives, and that it was once the home of an indigenous humanoid intelligence.

Introduction

Mars is a planet whose past is a mystery, but like all great mysteries, the keys to solving the puzzle may hide in plain sight. Mars, with its somber red surface, its vast and winding canyon systems displaying deep deposits of sedimentary rock, its great scablands telling of past awesome floods of water, and its windswept plains cratered like the Moon, is a planet that appears to tell two conflicting stories. One, of a small planet that was struggling for a long, indefinite period to have a climate like Earth; and another, of a planet battered by asteroids that lost all but a thin atmosphere early in its history and has been barren and Moon-like ever since. It has been found that in the middle of this planetscape of past desolation and destruction, there appears to be a carved humanoid face. What do all of these clues mean? In particular, is the face a spurious occurrence, irrelevant to solving the puzzle of Mars' past, or is it perhaps the key piece?

After many years of studying the whole array of data concerning Mars, we have decided to advance the hypothesis that the Face on Mars is in fact the "Rosetta stone," the key piece of evidence for understanding Mars' past climate. This hypothesis is termed the Cydonian Hypothesis since it hypothesizes that the face is in fact an image of a Cydonian, an extinct humanoid race indigenous to Mars who, before they perished, carved the face and created other objects found in Viking images.

The Cydonian Hypothesis

The hypothesis, that Mars, the home of a long-lived biosphere similar in scope and diversity to that of Earth, and that out of this biosphere evolved an indigenous humanoid race, termed Cydonians, that constructed large mon-

uments similar to those constructed by Old Kingdom Egypt, is based on three main points:

1. The Assumption of Mediocrity (Sagan & Shklovskii, 1960). The Assumption that neither the Earth nor its biosphere nor its humanoid denizens nor the civilization and artifacts they have produced are unique or even remarkable in the Cosmos. By this assumption, the discovery of a dead civilization on an Earth-like planet such as Mars would not be surprising.
2. Images of the surface of Mars showing, at several sites what appear to be three carved humanoid Faces (Brandenburg & DiPietro, 1986), of kilometer scale, and having similar anatomical and ornamental details between all three. Appearing with these objects are numerous other objects and surface features that resemble Earth-like archaeological ruins, of a Bronze Age culture, with no evidence of advanced technology or civilization.
3. Geological and geochemical data that are consistent with past conditions on Mars that were favorable to Earth-like life forms: Abundant liquid water (Masursky, Boyce, Dial, Selaber, & Strobell, 1977), and an atmosphere that was dense and warm, and possibly rich in oxygen (Toulmin III et al., 1977).

Modern Searches For Civilizations On Mars

Because of its close proximity and similarity to Earth, Mars has always been the subject of speculation about its capacity to support life and intelligence. Sagan and Fox (1975; Sagan & Wallace, 1971) examined the first high-resolution photographs of the Martian surface acquired by Mariner 9 for signs of a civilization of our technological level and extent. They were guided in this search by images of Earth at similar resolution (Sagan & Wallace, 1971). These pictures of Earth showed human civilization clearly. However, in the images of Mars, no signs of a civilization of our technological level and extent were found. Furthermore, in the Mariner 9 images, no objects that were strongly suggesting civilization of any known type were found. Other investigators reported objects resembling ancient pyramids of large size (Figure 1) in Elysium Planitia. When the Viking probes obtained high-resolution pictures of Mars in 1976, however, an object was found by Dr. Tobias Owen which resembles a mammoth carved head; this object was dubbed the "Face of Mars" (Soffen, 1980), (Figure 2).

Two of the authors (DiPietro and Molenaar) studied the original image from the Viking frame 35A72 and discovered a second image on frame 70A13. They enhanced the images using digital methods and copies of the raw data tapes, which were supplied by the Jet Propulsion Laboratory in Pasadena, California. The results of their investigations were published at a Mars science conference (Oberg, 1983) and in a series of pamphlets (DiPietro & Molenaar, 1980; DiPietro, Molenaar, & Brandenburg, 1988). A subse-

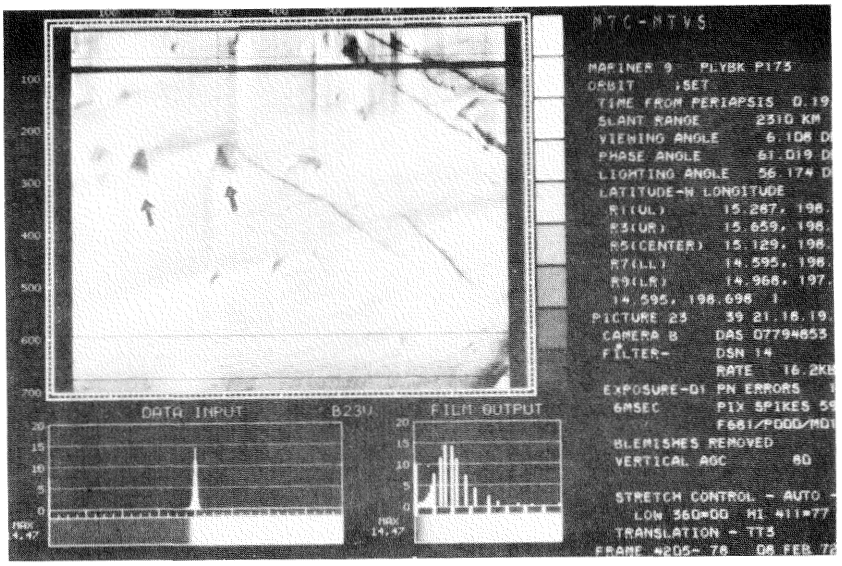

Fig. 1 The pyramids of Elysium imaged by Mariner 9 in 1971 are indicated by arrows at sunset on DAS 07794853 From *Unusual Martian Surface Features Edition IV (UMSF4)*, p. 46, (DiPietro, Molenaar, & Brandenburg, 1988). Copyright 1988 by Molenaar, Inc. Reprinted by permission

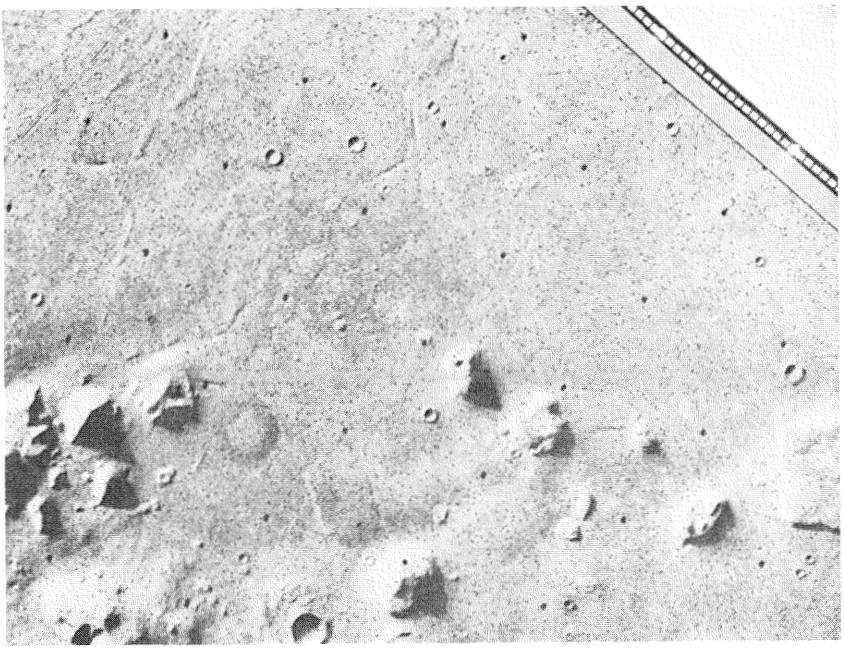

Fig. 2. The face of Mars discovery frame 35A72 found by Tobias Owen. From *UMSF4*, p. 12. (DiPietro, Molenaar, & Brandenburg, 1988). Copyright 1988 by Molenaar, Inc. Reprinted by permission.

quent investigation. called the Independent Mars Investigation Team (IMIT) (Pozos, 1986), confirmed the work of DiPietro and Molenaar and studied the geochemical data pertaining to Mars to determine the likelihood of a past Earth-like biosphere on Mars (Beatty et al., 1984). Faces and other strange objects at other sites on Mars were found (Figure 3), and their similarity of sire and detail to the Face of Mars was discovered and presented at a scientific conference (Brandenburg & DiPietro, 1986). Finally, other investigators have studied the Cydonia site and published work concerning it (Carlotto, 1988; Carlotto & Stein, 1990; O'Leary, 1990).

Overview

In the reminder of this report, the basic imaging data will be presented, and a brief overview of the geochemical issues will be given. We will discuss

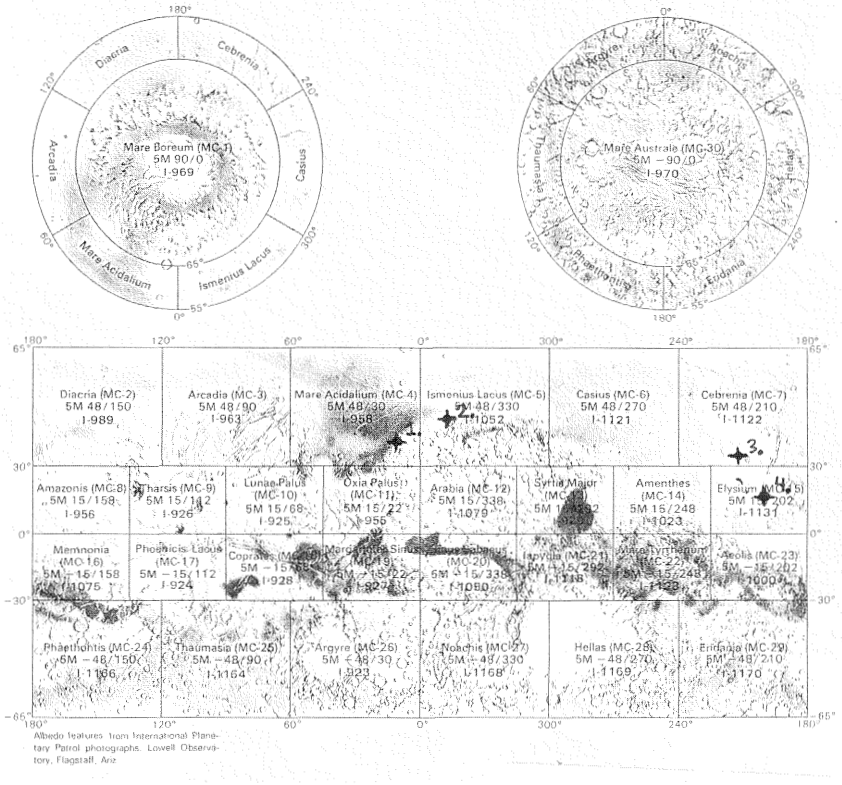

Fig. 3. A map of Man showing the locations of objects of interest investigated by the authors. (1) Cydonia Mcnsa (2) Deuteronilus Mensa (3) Hecates Tholus (Utopia) (4) The pyramids of Elysium

the formation of the Cydonian Hypothesis and its testability, and alternative hypotheses.

Imaging Data From Various Regions

The Cydonia Site. The Cydonia Mensa region of Mars is marked by a range of small mountains and mesas that runs North at approximately the low plain-highlands boundary, and then makes an abrupt right turn out into Acidalia Planitia (Figure 4). The Cydonia Mensa has been extensively photo mapped (Frey & Lowry, 1979; Guest, Butterworth, & Creely, 1977) and shows signs of abundant water in the past. The site of interest lies Just above the Zero Kilometer elevation line of Mars (Batson, Bridges, & Inge, 1979). At the corner of the range of mesas, at 9 degrees W, 41 degrees N lies the object known as the "Face of Mars." ""The Face of Mars" here referred to as "the Face in Cydonia," or simply the ""Face" appears in the Viking frame 35A72 taken at a range of 1,873 km, and 70A13 taken at a range of 1724 km. Both of these frames were taken during the course of photo mapping in the Cydonia region in the afternoon. DiPietro and Molenaar used digital techniques to enhance the images, and used a version of bilinear interpolation, which they developed and call the Starburst Pixel Interleaving Technique (SPIT) process, to enlarge and smooth the images, A thorough discussion of

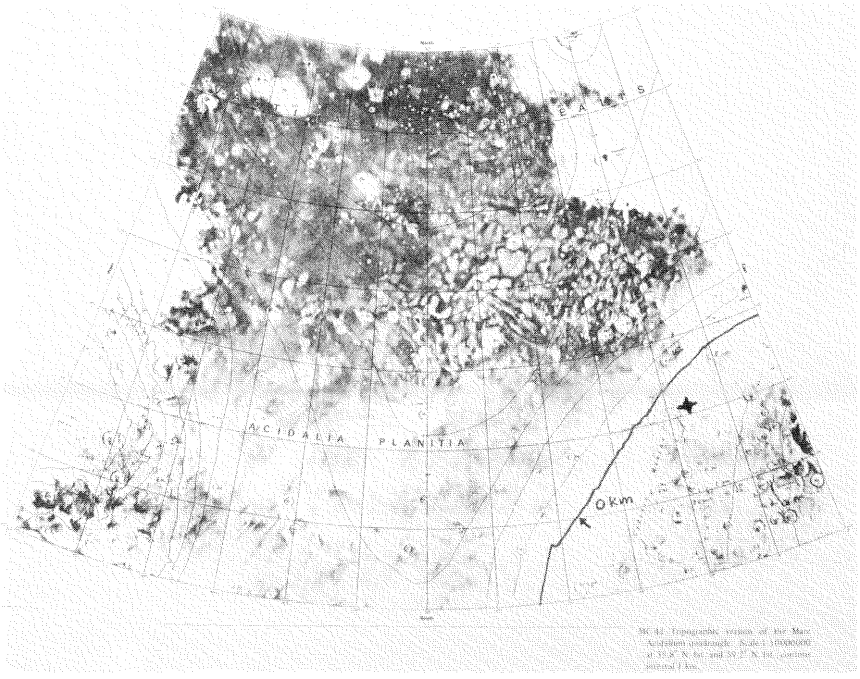

Fig 4. A map of the Mare Acidalium region showing the location of the face of Mars. Note the location of the 0 km elevation contour (Martian sea level) marked by an arrow.

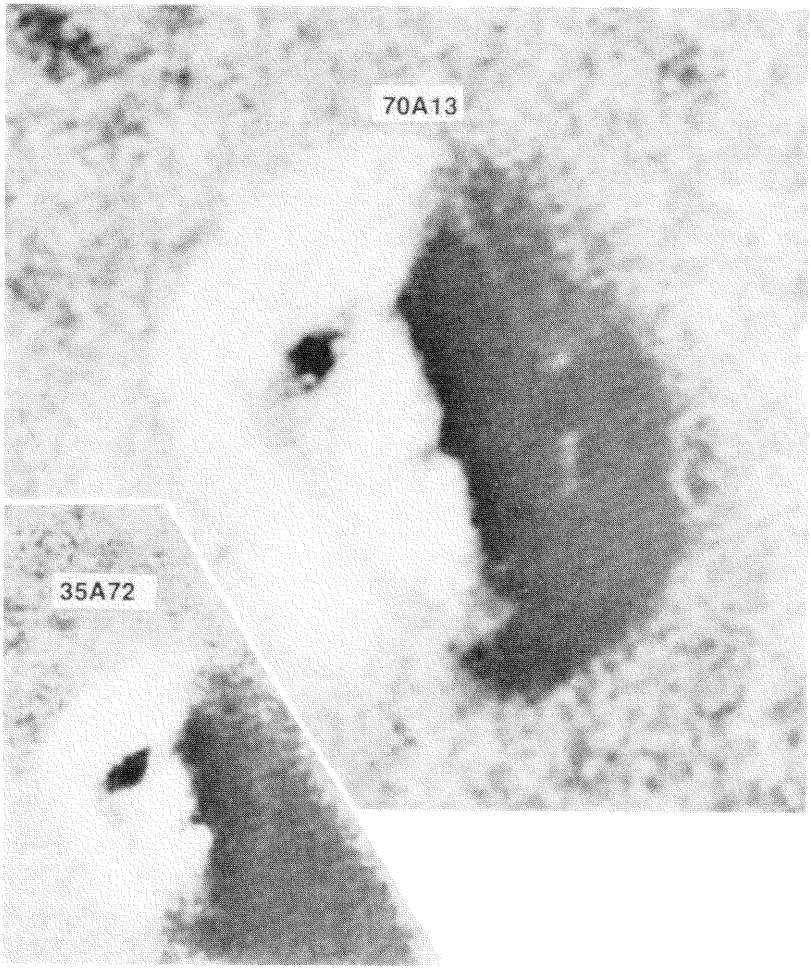

Fig. 5. The enhanced images of the Face produced by Dr. Mark Carlotto from both Viking frames 35A72 and 70A13. From *UMSF4*, pp. 90–91, (DiPietro, Molenaar, & Brandenburg, 1988). Copyright 1988 by Molenaar, Inc. Reprinted by permission.

these techniques is given in a booklet called *Unusual Mars Surface Features* (4th ed.).[1]

Further enhancement of the images was done by Dr. Mark Carlotto of The Analytic Sciences Corporation (TASC) in Reading, Massachusetts (Carlotto, 1988), using a technique that be has developed. His images appear to show teeth in the mouth area of the Face (Figure 5). Mark Carlotto and Brian O'Leary have also published further analyses of the Face (Carlotto & Stein, 1990; O'Leary, 1990).

[1] This pamphlet is available for $15 by writing to: Mars Research, P.O. Box 284, Glenn Dale, MD 20769.

The basic dimensions of the Face are 3 km from the chin to the top of the headdress or helmet, and 2 km from one side of the headdress to the other. The Face appears to have numerous anatomical and ornamental details, including eyes, nose, mouth, a helmet or headdress, as well as cheek ornaments, and an indentation over the right eye. Several other images of the Face in Cydonia were discovered (Pozos, 1986), all at much lower resolution: these are 673B56 and 673B54 at nearly the same sun angle as 70A13, at the local afternoon time; and 753A33 and 753A34 both taken at the local morning time. The latter two images are remarkable in that they show the Face illuminated from the right side rather than the left. These images support the premise that the Face is basically symmetrical. That is, it is a dome-shaped object, although the poor resolution and picture quality of the images limit their usefulness In the study of any details.

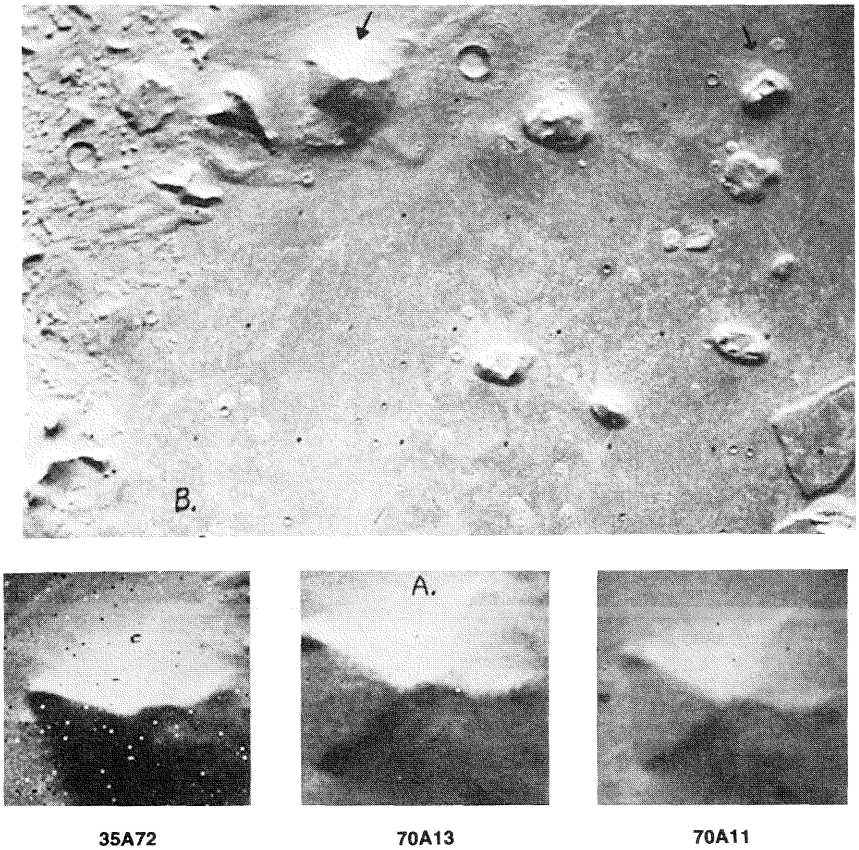

Fig. 6. (A) Images of the pyramid in Cydonia from three different Viking frames. (B) An enhanced version of frame 70A13 by Dipietro and Molenaar showing relative locations of the face and pyramid. From *UMSF4*, pp. 39 & 44, (DiPietro, Molenaar, & Brandenburg, 1988). Copyright 1988 by Molenaar, Inc. Reprinted by permission.

DiPietro and Molenaar also discovered an object appearing like a five-sided pyramid. The pyramidal object appears in 3 different Viking frames, and lies 10 km from the Face (Figure 6). The dimensions of this pyramid are 3 km on each facet, and 1 km high. These dimensions are similar to the large pyramids at Elysium. The exact symmetry of the object, if it has a symmetry, is difficult to assess due to a landslide on one part of the object.

The Utopia Site. The Utopia site was originally found as part of the IMIT investigation by looking for a site similar to Cydonia Mensa. The site in Cydonia Mensa is found at the boundary of the low northern plain system of Mars and the rugged highlands, It was located at slightly above the zero kilometer elevation contour that follows this plains-highlands boundary in the northern hemisphere. The Cydonia site was locally prominent and shows evidence of abundant water in the past. If the objects found at the Cydonia site were signs of a dead civilization, such a civilization might have created similar objects at other sites on Mars that shared characteristics with the Cydonia site. Following this "archeological site model," Brandenburg chose a site on the edge of Utopia Planitia for investigation.

The Utopia site was found by following an ancient water channel known as Hrad Vallis up to its "head waters" at the base of Heccates Tholus (Figure 7). The site is characterized by a range of cliffs and outlying mesas bordering

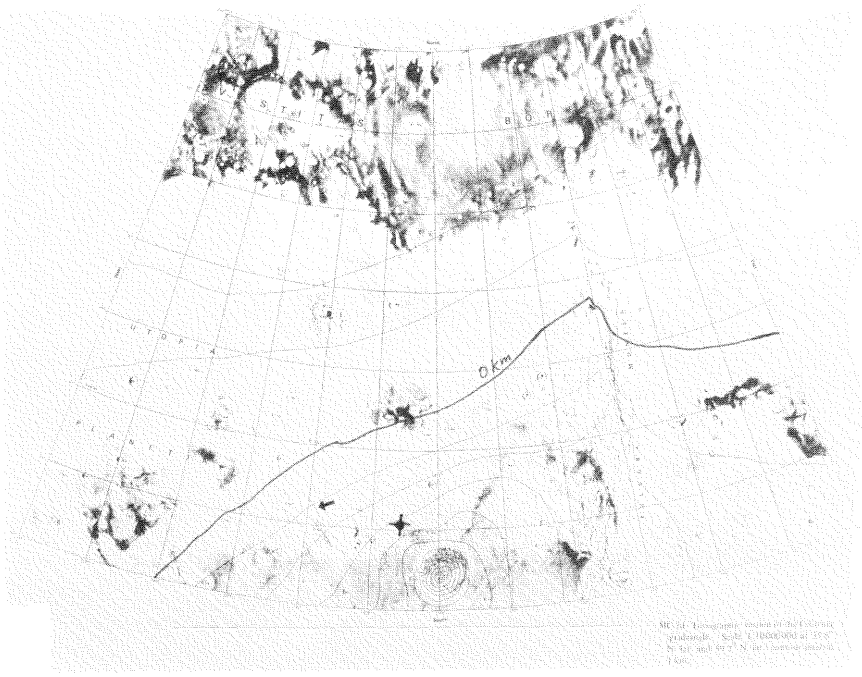

Fig. 7 A map of the Utipia region of Marc, showing the location of the faces in Utopia. An arrow marks the course of Hrad Vallis, and old water channel.

what may have been a large bay or lake. This area has been studied by Mars geologists because it shows signs of extensive permafrost (Carr & Schaber, 1977).

Two objects having a detailed resemblance to the Face in Cydonia were found at the Utopia site on Viking frame 86A10 (Figure 8). This frame was taken at a range of 1,576km, a closer range than in Cydonia. The objects are slightly smaller than the objects in Cydonia at approximately 2 km from the chin to the top of the head and 1.5 km across. As shown in Figure 9, the

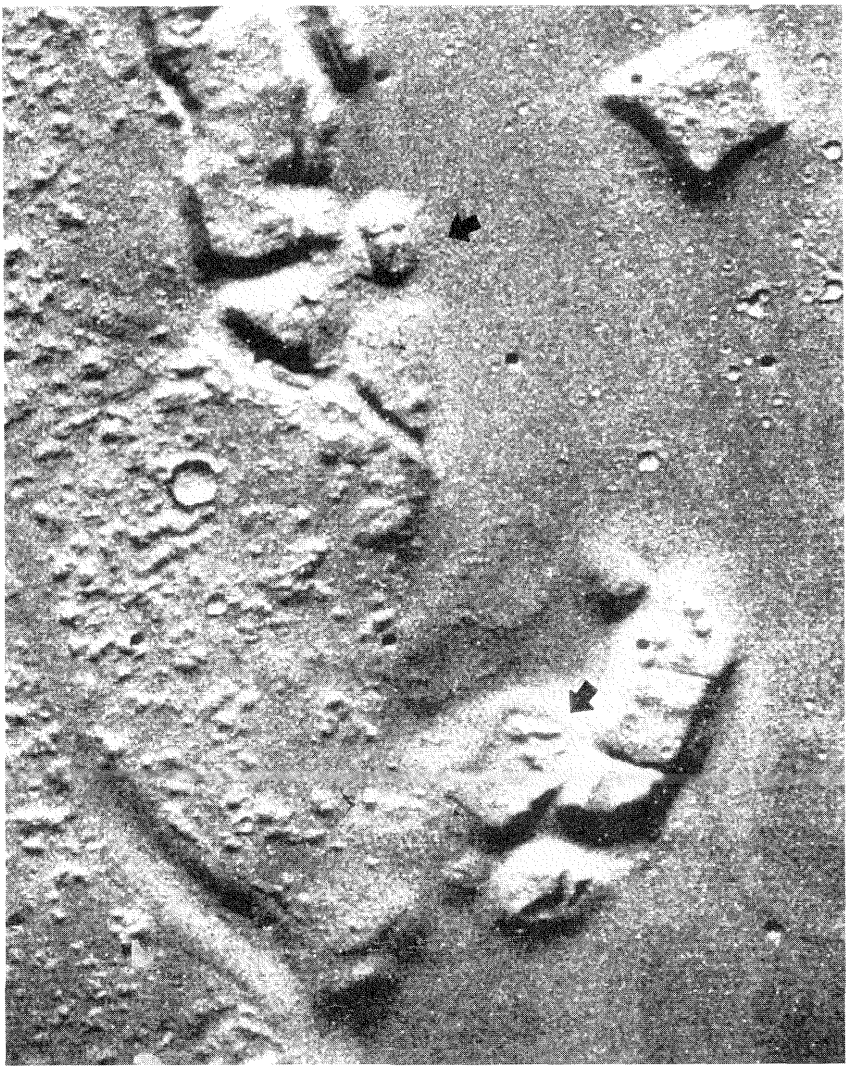

Fig 8 A portion of frame 86A10 on which two objects resembling faces were found Note the presence of indentations on the cheeks and above the left eye of the faces.

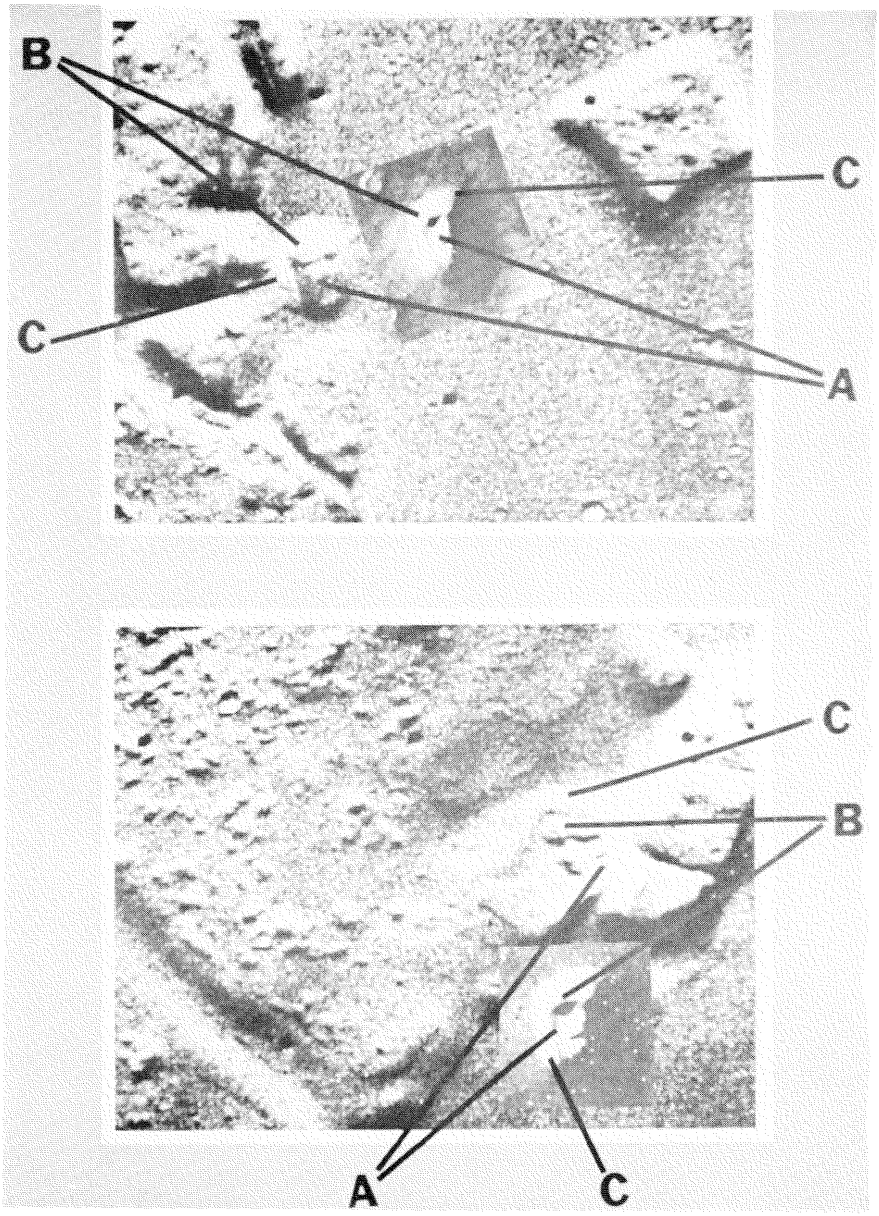

Fig. 9. Comparisons of the faces in Utopia with the Face in Cydonia imaged on frames 70A13 and 35A72. Similarities noted: (A) cheek notches (B) indentation above left eye (C) helmet or headdress.

objects appear to share details with the Face in Cydonia shown in Figure 5. While the objects are not as startling as the face in Cydonia, we have included them in this discussion because they resemble the Face, are of similar size, and lie in close proximity to each other, suggesting similar forces may have

Fig. 10. A digitally smoothed, enlarged, and contrast stretched version of the upper Utopia "Face" seen in Figure 8A. This image was obtained from a NASA supplied data tape of Viking frame 86A10. White and black starbursts are produced by static in the original data. This object, though not as startling in appearance as the Face in Cydonia, appears to share many of its characteristics. Note the presence of dark central spots in the eye sockets, as well as the helmut structure that appears to surround the head. Note also the apparent indentation over the left eye and cheek mark below it.

shaped all three objects. The existence of the Utopia Faces is thus relevant to discussions of whether the Cydonia Face is artificial, and who might have carved it.

Images of the two Faces have been enlarged digitally, smoothed, and contrast stretched by the authors. These processed images reveal what seem to be humanoid anatomical details (Figures 10 and 11) such as eye pupils and a jowl line. Also, cheek ornaments and an indentation over the left eye appear to be shared by the face in Cydonia. (Figure 9). The sun angle of the Utopia picture, close to noon, and the objects smaller sizes make it difficult to improve on the NASA versions of the images, since contrast stretch seems already near optimum in the NASA shots and the pixel size is larger compared to the face size, relative to the Cydonia Face. The Faces appear less distinct, which could mean they are either an intermediate form of an erosion formed face or also are true artifacts that are simply smaller and more eroded than the Face in Cydonia.

The lower Face is imaged at moderate resolution with light coming from the bottom on Viking frame 243S01, and both Faces are imaged on Viking frame 541A14 at moderate resolution. These images confirm our under-

Fig. 11. A digitally smoothed, enlarged, and contrast stretched version of the lower Utopia Face seen in Figure 8. White and black starburst are produced by static in the original data. This image was obtained from a NASA supplied data tape of Viking Game 86A10. Note the apparent jowl line, prominent cheekbone or mark and an indentation over the left eye. Note also the apparent dark central areas of the eye sockets.

standing of the basic shape and symmetry of the Faces. Additional low-resolution images are found on 844A13 and 846A14.

Additional surface features, appearing to be the result of intelligent activity, are found in the immediate vicinity of the Faces (Figure 12).

The Deuteronilus Site. Deuteronilus Mensa forms a series of mesas bordering Vastitas Borealis. Near the mouth of the Mamers Vallis is a very flat region that is above the zero kilometer elevation contour (Figure 13). On this plain are many so-called "pedestal craters" thought to be formed by meteorite impacts into water-logged soil (Carr, Crumpler, Cutts, Creely, & Masursky, 1977). One pedestal crater attracts particular attention in this area because it is associated with an object that is higher than any landform for a 100 km radius. This object is located at 353 degrees W and 46 degrees N. The object is imaged on three Viking frames at high resolution, 43A01, 43A03, 43A04 (Figure 14). The ranges at which these frames were taken are listed as 2,109 km, 2,108 km, and 2,093 km, respectively. This makes the resolution of these frames slightly poorer than those taken in Cydonia and Utopia, Low-resolution images of the object are found on Viking frames 673B38 and 675B53 under much different lighting conditions and are very important because they allow cross-checking of models of the objects' geometric structure from shadowing. The suggestion that this object might owe its appear-

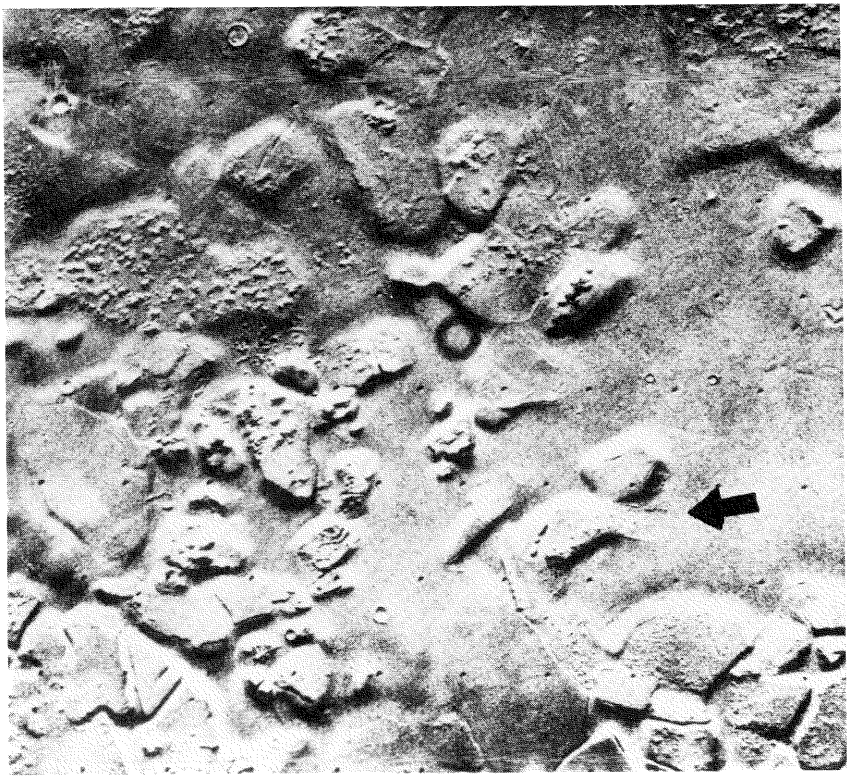

Fig. 12. Objects imaged on 86A08 near the Utopia Faces. What appears to he a ramp leading up to the top of a mesa is seen with large rubble at the edge of the mesa. A long linear feature that resembles an aqueduct or wall is also seen on the ground nearby. Dark circle is merely a water spot on lens.

ance to intelligent activity was first made by Richard Hoagland during the IMIT investigation (Pozos, 1986). The object is geologically anomalous and would completely dominate the landscape as seen by ground observers. The object is on, or immersed in, the debris apron of a large crater, yet it does not appear lo have deflected or disturbed the flow ot debris (Figure 15). This would suggest that the object was emplaced AFTER the crater-forming impact. Alternatively, the debris could have fallen in a blanket rather than jetting outward from the impact. This would leave only the base of the object burled and would allow the object to predate the impact. No similar feature is seen on other debris aprons of pedestal craters in the neighborhood, although such craters are commonplace in this region. The only object even remotely similar to this feature, and known to the authors, is in the Cydonia Mensa region 30 km northeast of the Face in Cydonia. This object is called simply the "wall" (Figure 16). Like the Deuteronilus object, it was found by Richard Hoagland, and appears to have been emplaced after the cratering impact. It is at right angles to the debris flow, yet does not disturb it.

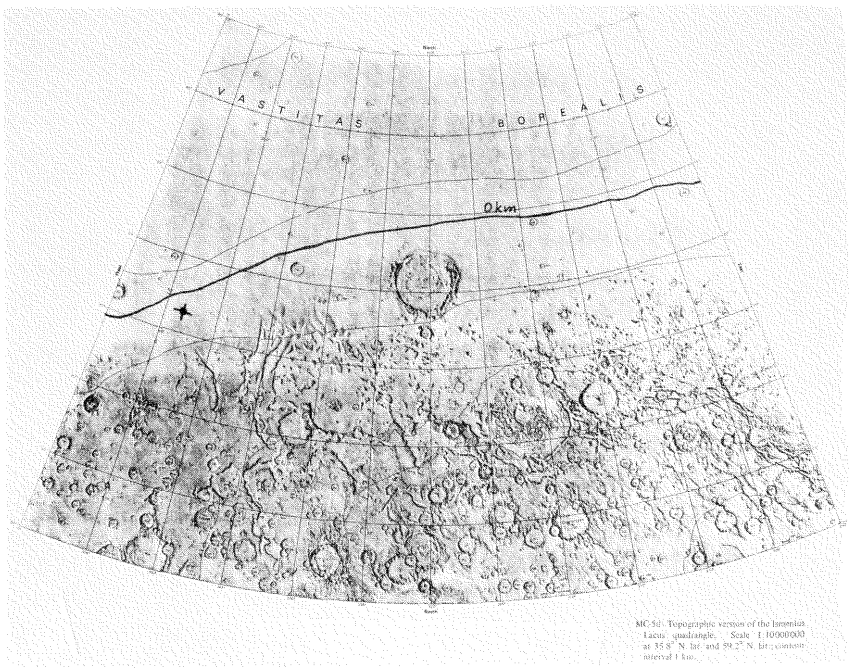

Fig. 13. A map of the Ismenius Lacus region of Mars showing the location of the object at Deuteronilus, also called "The Crater Pyramid." The object is found to be the tallest feature for a radius of 100 km. From *UMSF4*, p 29. (Batson, Bridges, & Inge. 1979). Copyright 1979 by Molenaar, Inc. Reprinted by permission.

The Deuteronilus object's true shape is difficult to discern from its appearance alone, because its albedo (reflectivity)apparently varies strongly across its surface. The highest point on the object, approximately 0.6 km higher than the surrounding plain, is not the vertex of the triangular brightly lit region. The highest point on the object is known from shadow measurements to be in the low albedo region as is shown in Figure 15. The object is approximately 3 km in its lateral dimensions, making it rather flat and dome shaped. The pointed appearance of the shadow is due to the extremely low sun angle (84.5 degrees from vertical). A refined understanding of the object's shape is elusive because of the low resolution of the images.

In a manner similar to the other sites, other surface features at the Deuteronilus site suggesting intelligent activity are found in the nearby vicinity of the object: A large area of crosshatched walls or embankments is seen on the debris apron of a nearby crater as is shown in Figure 15. Such lines are not found on other crater debris aprons in the area. Also, a series of embankments or albedo variations ("Furrowed Ground," Figure 14) is found on a nearby region of higher ground that resembles agricultural terracing. Purely geological explanations such as permafrost features (Carr & Schaber, 1977) are also possible.

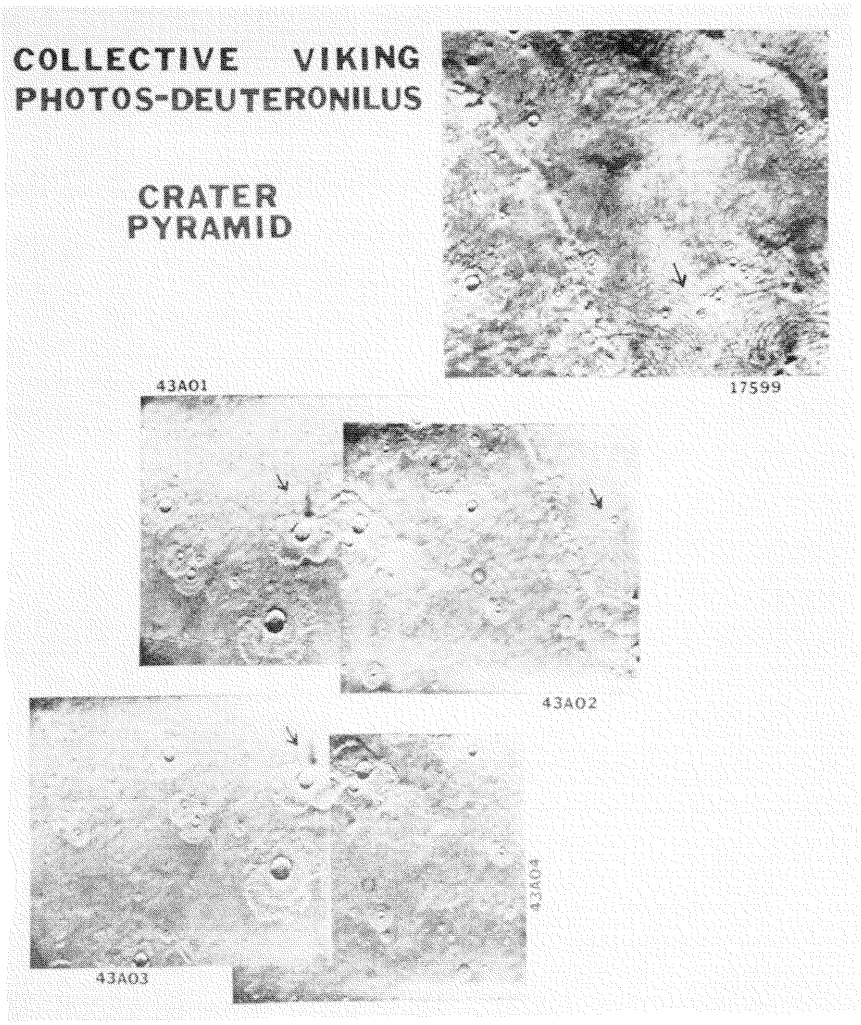

Fig. 14. Viking images showing the object in Deuteronilus and its surroundings. Arrows mark the object and a nearby feature called "Furrowed Ground" that resembles agricultural terracing. Picture 17599 is from the 53A series of images taken on a different orbit. From *UMSF4*, p. 107, (DiPietro, Molenaar, & Brandenburg, 1988). Copyright 1988 by Molenaar, Inc. Reprinted by permission.

The Formation of a Hypothesis

To be useful, a hypothesis must satisfy Karl Popper's requirement of falsifiability. That is, it must be testable. Given the data presented in the previous sections, three hypotheses seem admissable:

(1) *The Null Hypothesis:*

The objects discussed are the result of random geological and erosional forces. The apparent resemblance of the objects to carved humanoid Faces, and other archeological monuments found on Earth, is both fortuitous and a

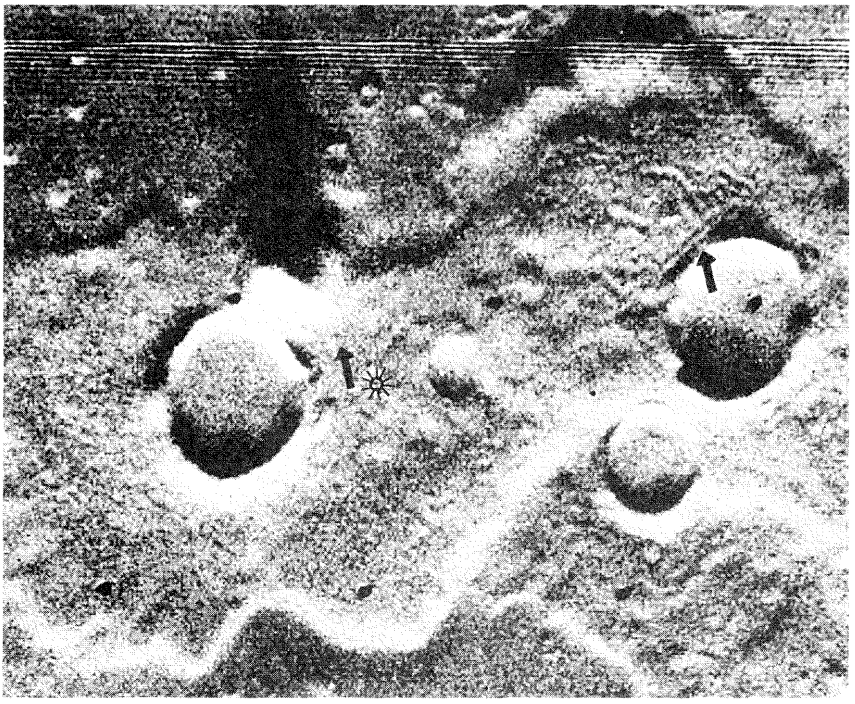

Fig 15. The "Crater Pyramid" is seen, in this enlargement from 43A04, as an object casting a long shadow Shadow analysis shows that the object is actually dome shaped Sun angle is marked by an arrow. An arrow also marks the location of the "cross hatching" near the object

sign of the human tendency to find familiar patterns in data even when they are not present and to reject data that does not fit the familiar pattern. This is also known as the fallacy of the enumeration of favorable circumstances. The fact that the objects are similar in size and geometry is due only to the fact that all are found in the plains-highlands transition region of Mars where mesa outlyers and knobs of this size and shape are ubiquitous. This hypothesis is not strictly falsifiable but is complementary to the other hypotheses.

(2) The Cydonian Hypothesis:

The Face of Mars is a portrait of a Cydonian, that is, the objects discussed are a product of a humanoid civilization indigenous to the Cydonia region of Mars, Mars was once the home s f an indigenous race of intelligent humanoid beings which constructed monuments similar to those found in old Kingdom Egypt. The motivation for this construction of large Faces and Pyramids was similar to the God-King worship of ancient Egypt. The Faces thus resemble the Cydonians themselves. Under the Cydonian Hypothesis, the objects look familiar to us because they were constructed by a race of beings similar in appearance and psychology to ourselves, Such a hypothesis is totally in keeping with the Assumption of Mediocrity. 'The similarity in

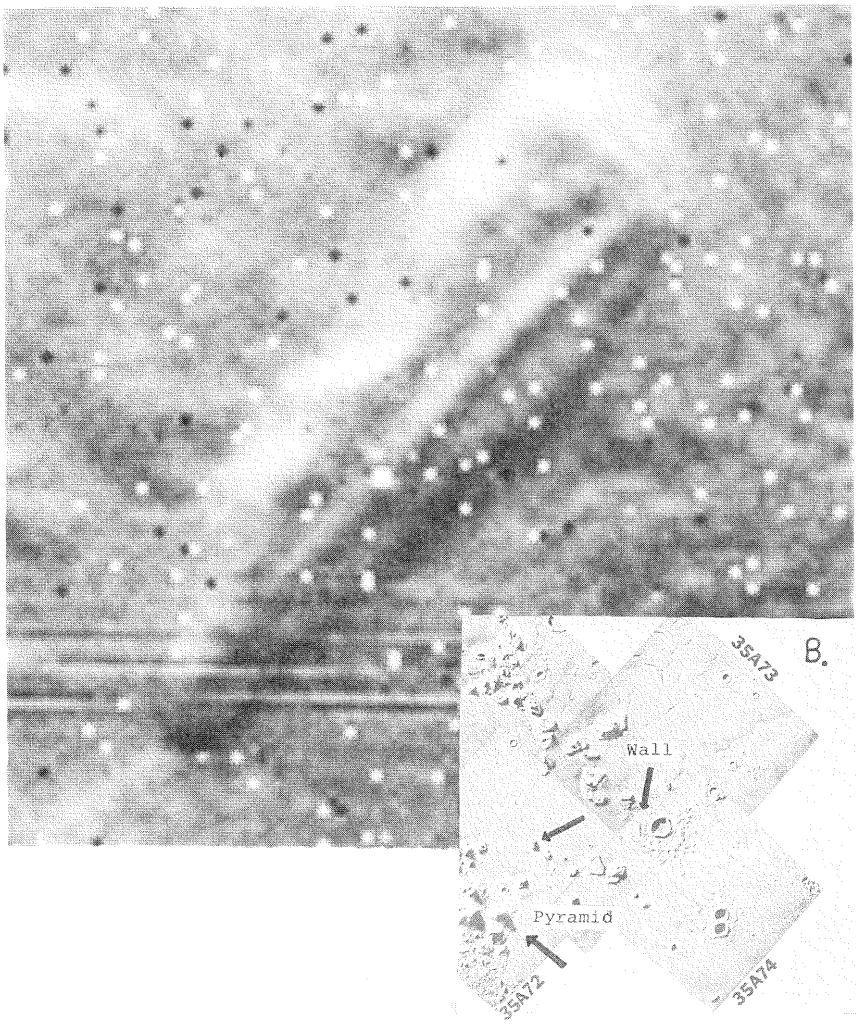

Fig. 16. An enlargement from frame 35A74, smoothed and enhanced, showing the "Wall." A photomosaic shows the location of the Wall near the Face of Mars in Cydonia.

detail and size found between the Faces is merely a reflection of extensive communication and cultural equilibration between the centers of the hypothetical civilization in the northern hemisphere of Mars. This hypothesis requires Mars to have had a long-lived Earth-like biosphere to allow the formation and evolution of indigenous intelligence. Such a hypothesis also requires the death of a planetary biosphere, since Mars is presently hostile to Earth life. The hypothesis is testable by a closer inspection of the objects found at the sites, and by a more complete understanding of Martian climatic history.

(3) *The Prior Colonization Hypothesis:*

The objects in question owe their appearance to a culture that was not indigenous to Mars. Such a hypothesis does not require a long-lived Earth-like biosphere to have been present on Mars nor its subsequent death. Since the civilization would possess capabilities that we do not or have not possessed in recorded history, i.e., colonization of other planets and interstellar travel, its nature and cultural forms would be unknown, as would its motivations for construction large humanoid Faces. Such a hypothesis is very difficult to test, since it involves so many unknowns. In particular, reimaging of the Face in Cydonia at higher resolution might not reveal more detail if the object was only crudely "bulldozed" into the Martian surface to be viewed from space. This hypothesis is not favored by the authors, however, it has been proposed by other investigators (Hoagland, 1987). However, this hypothesis does not require a long-lived Mars biosphere and thus would be supported if the objects appear to be artificial but no sign of such a past biosphere is found.

Discussion

The hypotheses listed in the previous section have the virtues that they explain what is seen on Mars in a plausible manner, and do not contradict known facts. However, in the opinion of the authors, only the first two hypotheses are truly testable. For this reason, we will restrict our discussion primarily to the Cydonian Hypothesis and its complement—the Null Hypothesis. The Cydonian Hypothesis is testable because it states that processes that occurred on Mars are similar to those that have occurred on Earth. Because of this, the next generation of space probes to Mars may gather enough data to provide significant support for either the Null or Cydonian Hypothesis. In particular, the Mars Observer Spacecraft could reimage the Face in Cydonia at much higher resolution than the Viking images, and perhaps reimage the objects at other sites as well. Archaeological monuments found on Earth almost always display more detail at higher resolution, even when eroded. This is because the objects of Earth were meant to be viewed from close range on the ground. If the Face in Cydonia does not display greater detail in images at higher resolution than the Viking images, then the Cydonian Hypothesis would be considerably weakened, if not refuted. Other hypotheses would then have to be considered more likely, such as the Null Hypothesis, or the possibility that the objects where constructed to be viewed from space, but not highly finished so as to give an impressive appearance from the ground, such as under the Prior Colonization Hypothesis. It has been pointed out by other investigators that the fact that the Face faces upward suggests it was meant to be viewed from above. This might indicate it is a sign of an advanced civilization capable of flight. However, construction of such a large face is only possible if it faces upward, regardless of technological ability of the constructing civilization and on Earth the

presence of patterns at Nasca shows that even low-tech civilizations will construct objects that can only be fully appreciated from above. Therefore, the fact that the Face faces upward does not weaken the Cydonian Hypothesis, but lack of new detail in high-resolution images would weaken it. If, on the other hand, brickwork, stairways, or writing on the objects became visible in higher resolution images, then the Cydonian Hypothesis would be greatly strengthened. If, in addition, evidence of a long period of favorable climate and biosphere on Mars, such as coal or petroleum deposits, deep sedimentary formations, and fossils were to be detected by the Mars observer or other probes, then the Cydonian Hypothesis would also be strengthened.

The fact that, at present, Earth provides the only known example of a civilization in space, limits our ability to form testable hypotheses concerning possible civilizations on other planets. All present searches for signs of extraterrestrial civilization rely on an Earth reference. That is, the Assumption of Mediocrity is always implicit even if it is not stated. For this reason, any statement that an object looks like an artifact really means that it resembles artifacts found on Earth. There is, therefore, no truly "generic" test for intelligent origin of an object at this time. Since the civilization of Earth is indigenous and artifacts found here represent only the products of low to present technological levels, products of a more advanced or truly alien culture might not be recognizable to us. Someday, data on extraterrestrial civilizations will be available to assist us in the search for signs of civilization on other planets. Data from several civilizations, including our own, could be used to create a generic test for intelligent origin of an object seen on a new planet. However, testable hypotheses concerning extraterrestrial artifacts are, presently, restricted to processes that are known, and this means they must involve processes that are terrestrial.

The Null Hypothesis says that the objects on Mars were shaped by geologic processes similar to those known on Earth. Wind and water erosion, faulting, and meteor impacts are known to shape landforms on Earth and some of these landforms resemble human artifacts even though they are natural. The objects in Cydonia are found in an area that abounds in landforms of roughly similar size and shape. These objects are called "knobs" and mesas. The details of the "Face" that distinguish it from its neighboring landforms could have been formed by a series of meteor impacts, landslides, and faulting events that produced somewhat symmetrical facial features by chance. The probabilities of this occurring seem remote and are difficult to model, however, the number of knobs and mesas is large on Mars. Therefore, it seems reasonable that out of all the pictures taken of this and similar regions of Mars, the probability of finding one object resembling a face would be high. The same can be said for the nearby "Fortress" and "Pyramid." However, the geologic forces that would create these objects are nonlocal so one would not expect them to produce an object as different from a face as a pyramid, yet so near to it. Similarly, the geologic forces are blind, so that a face would not be expected to have a high level of symmetry, propor-

tions, and anatomical detail. For these reasons, the Null Hypothesis has difficulty explaining the association of the "Face" and "Pyramid" in Cydonia and their degree of detail.

Accordingly, the occurrence of other "Faces" in Utopia with similar size and details seems an unlikely event if only geologic forces are involved. Like the Cydonia site, the Faces in Utopia are associated with other objects that look like artifacts, such as the linear feature found in an adjoining image. The object found in Deuteronilus also looks like an artifact and similarly to the objects in Cydonia and Utopia, is associated with other features, the "Furrowed Ground," whose appearance leads one to believe they might be artificial. Therefore, it is not just the objects themselves, but their similarities of form and association which require alternatives to the Null Hypothesis to be considered. This leads us to consider the Cydonian Hypothesis, which proposes that the objects are artifacts.

Given evidence of Earth-like conditions in Mars past, the presence of ancient archeological monuments on Earth that resemble the Mars objects, and the lack of signs of advanced civilization similar to Earth's at the sites, the Cydonian Hypothesis seems the simplest possible hypothesis involving an artificial origin of the "Face" and other objects on Mars. Like the Null Hypothesis, it involves only processes demonstrated on Earth. Like the processes involved in the Null Hypothesis, however, it is difficult to calculate the probabilities of the processes involved, or the exact way by which these processes produced the objects in question. That is, the processes are poorly understood but they are known. The main virtue of the Cydonian Hypothesis is that it can be tested, since it involves only known processes.

The Cydonian Hypothesis states that Mars was once Earth-like and remained so for a long period—long being enough time, billions of years—for something like humanity to appear. This would necessitate a planet with large amounts of liquid water and, at some point, an oxygen rich atmosphere sustained for a prolonged period of time by photosynthesis. Such an environment on Mars would leave abundant, though perhaps subtle, clues to its past existence. The evidence both for and against this aspect of the Cydonian Hypothesis is worth discussion. Mars has an abundance of water channels indicating past conditions of a warm dense atmosphere (Masursky, Boyce, Dial, Selaber, & Strobell, 1977). Mars is red; this redness is due to highly oxidized iron in its soil (Toulmin III et al., 1977). It has been suggested by Huguenin that this oxidation was due to oxygen from water released by the action of ultraviolet light on the water (Huguenin, 1974). An earlier suggestion by Carl Sagan was that this high oxidation state was produced by an oxygen atmosphere produced by photosynthesis (Sagan, Phanouf, & Ihnat, 1965). The apparent presence of superoxides in the soil (Oyama & Berdahl, 1977) tested by the Viking landing indicates that some process of oxidation is occurring now on Mars, although such a process cannot preclude any earlier period of photosynthesis.

Mars shows evidence of having an ocean in its past (Brandenburg, 1986; Parker et al., 1986). This ocean would have filled the northern plains region

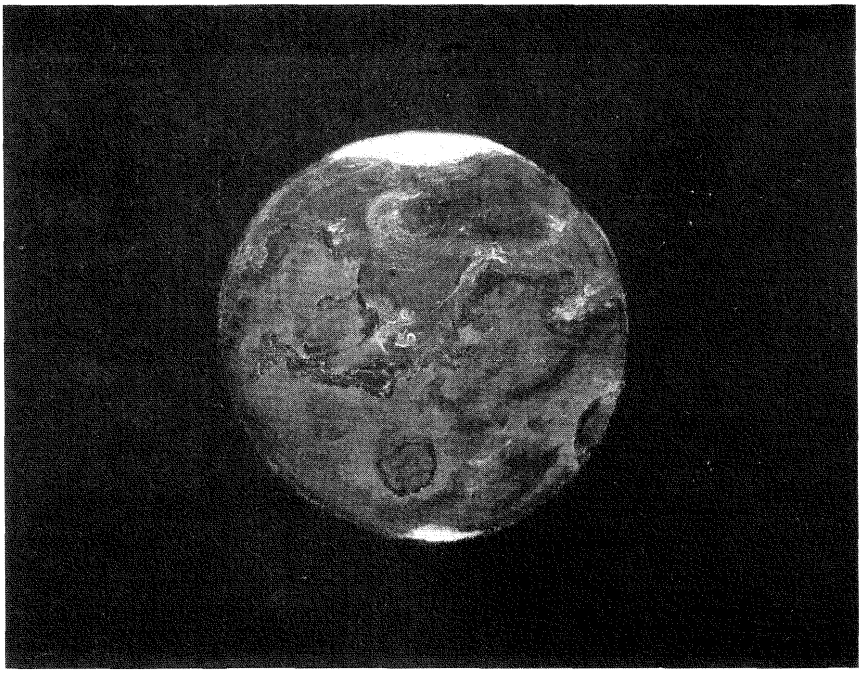

Fig. 17 Mars as it may once have looked. An ocean ringed the north portion of the planet with smaller seas in the southern region. The northern region probably had a moist, temperate climate while the south was mostly desert. The sites of possible archeological remains appear to have been on the shoreline of the northern ocean, which was probably near the 0 km elevation contour

of Mars and formed a ring around the northern polar cap (Figure 17). The approximate shoreline of the ocean appears to have been the zero kilometer elevation contour. The sites of apparent civilization appear to have been on the coasts of this ocean. The past existence of an ocean on Mars argues for a Mars that held some form of life since life began in the oceans of Earth very quickly after they formed. Therefore, there is geochemical evidence that supports the Cydonian Hypothesis; however, there is also evidence that seems to argue against it.

The most powerful argument against the Cydonian Hypothesis is the estimates of the age of the Martian surface by crater count dating (literally counting meteorite craters). Estimates made using this method indicate Mars surface ages from 3 billion–.5 billion years old (Mazursky, Boyce, Dial, Selaber, & Strobel, 1977). This method compares the number of craters on a given area of Mars with that on a given area of the Moon. Our astronauts brought back samples of rock from areas of the Moon and we have radioactively dated them. So we know that a certain number of craters per given area on the Moon translates to a given age, There are fewer craters on Mars than on the Moon because of erosion, but we can still get an estimated age for a place on Mars by counting craters and comparing it to the Moon.

A three billion year estimated age for Mars surface would mean that any period of Earth-like conditions would have lasted only a billion years. This is far too short by Earth standards for any advanced life to appear. If the cratering derived ages on Mars could be calibrated by sample returns from Mars and verified at this three billion-year-old value, then the Cydonian Hypothesis would be clearly weakened. One would have to suggest a highly accelerated evolution on Mars relative to Earth, and the Cydonian Hypothesis argues for a similar process. Thus, commonly suggested interpretations of cratering data suggest that any past-life bearing period on Mars would be short. Mars looks heavily cratered like the Moon, so how could it have once lived?

Methods of crater counting to determine the age of the Martian surface are built on a crucial number: an estimated magnitude of the rate of cratering on Mars relative to that on the Moon. This estimated magnitude is the key to the whole scheme, and it is full of uncertainties. Mars is near the asteroid belt, the source of most meteorites, much closer to it than the Moon, and so one would expect that the rate of cratering impacts by asteroidal rubble would be somewhat higher—but how much higher? A higher estimated rate of cratering means a younger Martian surface and thus a longer period of erosion and Earth-like conditions. Such a younger Martian surface would support the Cydonian Hypothesis, since a long-lived biosphere on Mars could support an Earth-like evolutionary time scale of three billion years. A recent model "Neukum and Hiller III" (Neukum & Greely, 1988) indicates Earth-like conditions may have existed on Mars until .5 billion years ago. Such an estimated age strongly supports the Cydonian Hypothesis and is based on estimates that the Martian cratering rate is high relative to the Moon.

Two pieces of evidence suggest a higher cratering rate and thus suggest a younger Martian surface. The first is the discovery of pieces of Mars that have fallen to Earth as meteorites. These meteorites are termed the Shergottite, Nakhlite, and Chassigny (SNC) meteorites (Vickery & Melosh, 1987) and have been found along with pieces of lunar material recovered as meteorites. In both cases, these meteorites have come to Earth because they are secondary fragments blasted off of the Moon or Mars by meteorite impacts on those bodies. The fact that Mars has a much higher escape velocity and is further away from Earth than the Moon, plus the fact that much more Martian material than Lunar is recovered, argues that the Martian cratering rate must be much higher than that on the Moon. This would mean Mars surface is younger than it looks, it is simply being hammered by meteorites so it looks old.

The second piece of evidence that supports high-cratering rates and, hence, younger Martian surface estimates is the discovery of deep sediments on Mars in the Martian canyon system (Nedel & Squyres, 1986). These sediments are 5 km thick. This is very thick by Earth standards. Sediments exposed in the Grand Canyon are only 2 km thick and go down to rock formed at the origin of Earth's oxygen atmosphere. This would again argue

that long periods of erosion on Mars, similar in scope and duration to those seen on Earth, must have occurred. However, these arguments concerning the SNC meteorites and the sedimentary layers that support erosive history on Mars are presently quite controversial, although not as controversial as the objects in Cydonia and Utopia.

In any case, the view of Mars' past as Earth-like for long periods, that is implicit in the Cydonian Hypothesis, can be accommodated within our present understanding of Mars, given its present uncertainties. However, it can be accommodated only with difficulty. In general, the issues central to the validity of the Cydonian Hypothesis are also central to our understanding of the past climate and atmosphere on Mars. For this reason, the Cydonian Hypothesis is testable in the near term, as the exploration of Mars continues and answers to the riddle of its past climate are answered.

Summary

The Cydonian Hypothesis and a brief summary of the data that supports it has been made. The Cydonian Hypothesis seems bold and perhaps even speculative at this time, for it hypothesizes something unprecedented: that a race similar to humanity once lived on a nearby planet. However, the fact that the hypothesis seems bold is only an accident of this present time. At some point in the future, we will know of many other civilized species besides humanity occupying the Cosmos either past or present. In that future time, responding to the sight of an object resembling a large carved face on some distant planet with hypotheses of its intelligent origin, will not seem bold, but obligatory. Looked at from that future perspective, the Cydonian Hypothesis will be viewed as merely part of an early period of human ignorance about the universe we dwell in. This period will be marked by many successful and unsuccessful hypothesis. In this sense, the Cydonian Hypothesis is like all hypotheses, it is a question.

The Cydonian Hypothesis is a response to the facts that objects resembling Earthly archeological movements have been found on Mars surface and past Earth-like conditions on Mars cannot be ruled out at this time. Based on these facts, the Cydonian Hypothesis seems the simplest hypothesis that can be presently formulated. It is the simplest because it hypothesizes processes known from Earth occurred on Mars, rather than unknown processes. Thus, it is only the new locale of the processes not the processes themselves which are being hypothesized. Humanity will soon send new probes to Mars and reimage the Face on Cydonia and other objects and gather other data relevant to these discussions. Hopefully, the data gathered by these probes will provide strong evidence supporting one of the hypotheses discussed.

In anticipation of the eventual arrival of such new data, the Cydonian Hypothesis has been articulated; that is, the reason Mars is red, and covered with old water channels and deep sediments, and in some places shows what appear to be large carved humanoid faces, is that Mars once lived. It lived even as the Earth lives now and it perished even as the Earth could perish

now if we are not better stewards of it. We believe this hypothesis to be the simplest explanation for the appearance of these features of Mars that we have found. This hypothesis is falsifiable. Therefore, let anyone who can, put it to the test.

References

Batson, R. M., Bridges, P. M., & Inge, J. L. (1979). *Atlas of Mars: The 1:5,000,000 map series,* p. 25–38. Washington, D.C.: U. S. Government Printing Office.

Beatty, W., Brandenburg, J. E., DiPietro, V., Dolphin, L., Hoagland, R. C., Pozos, R. R., & Rautenberg, T. (1984, July). The preliminary findings of the independent mars investigation team, new thoughts on unusual surface features. *Proceedings of the Case for Mars 11 Conferen e.* pp. 33–34. Boulder, Colorado: University of Colorado at Boulder.

Brandenburg, J. E. (1986). The paleo-ocean of Mars. In *Symposium on Mars: Evolution of Its Climate and Atmosphere* (V. Baker et al., eds., pp. 20–23). LPI Tech Rpt. 87–01. Houston, Texas: Lunar and Planetary Institute.

Brandenburg, J. E., & DiPietro, V. D. (1986). Observations concerning some unusual surface features in the Cydonia, Deuternonilus, and Utopia regions of mars. *EOS,* 67, (16), 402.

Carlotto, M. (1988, May). Digital image analysis of unusual Martian surface features. *Journal of Applied Optics, 27,* 1926–1933.

Carlotto, M., & Stein, M. C. (1990). A method for searching for artificial objects on planetary surfaces. *Journal of the British Planetary Society, 43,* 209–216.

Carr, M. H., Crumpler, L. S., Cutts, J. A., Greely, R., Guest, J. E., & Masursky, H. (1977). Martian craters and emplacement of ejecta by surface flow. *Journal of Geophysical Research, 82,* 4055–4076.

Carr, M. H., & Schaber, G. G. (1977). Martian permafrost features. *Journal of Geophysical Research, 82,* 4039–4053.

DiPietro, V., & Molenaar, G. (1982). *Unusual martian surface features, 3rd ed.* Willmar, Minnesota: Molenaar Inc. Press.

DiPietro, V., Molenaar, G., & Brandenburg, J. (1988). *Unusual martian surface features, 4th ed.* Willmar, Minnesota: Molenaar Inc. Press.

Frey, H., Lowery, B., & Chase, S. A. (1979). Pseudocraters on Mars. *Journal of Geophysical Research, 84,* 8075–8086.

Guest, J. E., Butterworth, P. S., & Greeley, R. (1977). Geological observations in the Cydonia region of mars from Viking. *Journal of Geophysical Research, 82,* 4111–4120.

Hoagland, R. C. (1987). *The monuments of Mars, A city on the edge of forever* Berkeley, California: North Atlantic Books.

Huguenin, R. L. (1974). The formation of geothite and hydrated clay materials on Mars. *Journal of Geophysical Research, 79,* 3895–3905.

Masursky, H., Boyce, J. M., Dial, A. L., Selaber, G. G., & Strobel, M. E. (1977). Classification and time of formation of martian channels based on Viking data. *Journal of Geophysical Research, 82,* 4016–4038.

Nedell, S. S., & Squyres, S. W. (1986). Formation of the layered deposits in the Vallis Marineris, Mars. In *Symposium on Mars: Evolution of Its Climate and Atmosphere* (V. Baker et al. eds.) pp. 20–23. LPI Tech Rpt. 87-01, Houston, Texas: Lunar and Planetary Institute.

Nuekum, G., & Greely, R. (1988). Mars sample return and cratering chronology models: Consequences for the Martian climatic history and landing site selection. In *Proceedings of the 19th Lunar and Planetary Science Conference,* (Tanaka, *K. L.,* ed., pp. 852–853.) Houston, Texas: Lunar and Planetary Institute.

Oberg, J. E. (1983). *Mission to mars,* pp. 108. First Meridian Printing, New York: New American Library.

O'Leary, B. (1990). Analysis of images of the "Face" on Mars and possible intelligent origin. *Journal of the British Planetary Society, 43,* 203–208.

Oyama, V. I., & Berdahl, B. J. (1977). The Viking gas exchange experiments from Chryse and Utopia surface samples. *Journal of Geophysical Research, 82,* 4669–4676.

Parker, T. J., Schneeberger, D. M., Pieri, D. C., & Saunders, R. S. (1986). Geomorphic evidence for ancient seas on Mars. In *Symposium on Mars: Evolution of Its Climate and Atmosphere* (V. Baker et al. eds., pp. 96–97.) LPI Tech. Rpt. 87-01. Houston, Texas: Lunar and Planetary Institute.

Pozos, R. R. (1986). *The Face on Mars: Evidence for a lost civilization?* Chicago, IL: Chicago Review Press.

Sagan, C., & Fox, P. (1975). The canals of Mars: An assessment after Mariner 9. *Icarus, 25,* 602–612.

Sagan, C., & Shkolovskii, I. S. (1960). *Intelligent life in the universe.* San Francisco, CA: Holden-Day.

Sagan, C., Phanouf, J. P., & Ihnaut, M. (1965). Total reflection spectrophotometry and thermogravimetric analysis of simulated Martian surface materials. *Icarus,* 4, 43–61.

Sagan, C., & Wallace, D. (1971). A search for life on Earth at 100 meter resolution. *Icarus, 15,* 515–554.

Soffen, G. (1982). Life on Mars. In *The New Solar System, 2nd Edition,* (Beatty, J., O'Leary, B., & Chaikin, H., eds., pp. 93–96.) Cambridge, MA: Cambridge University Press and Sky Publishing Company.

Toulmin, III, P., Baird, A. K., Clark, B. C., Keil, K., Rose, H. J., Jr., Christian, R. P., Evans, P. H., & Kelliher, W. C. (1977, Sep.). *Journal of Geophysical Research, 82,* 4625–4634.

Vickery, A. M., & Melosh, H. J. (1987). The large crater origin of SNC meteriorites. *Science,* 237, 738–743.