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RESEARCH

Avian Formation on a South-Facing Slope along the Northwest Rim of the Argyre Basin

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Abstract—This is a description of an avian-shaped feature that rests below a network of cellular structures found on a mound within the Argyre Basin of Mars in Mars Global Surveyor image M14-02185, acquired on April 30, 2000, and released to the public on April 4, 2001. The area examined is located near 48.0° South, 55.1° West. The formation is approximately 2,400 meters long from the tip of its beak to the tip of its farthest tail feather. There is a minimum of six different variations in appearance of the surface material over this small area. Utilizing the public targeting request form provided on the Mars Global Surveyor (MGS) website, co-author Miller secured a second image of the area that was obtained on July 3, 2006, showing this feature under different conditions S20-00165. The new image was then released to the public on August 11, 2006. A third image of the formation identified as MGS S13-01480 was acquired on December 15, 2005, and although officially processed on June 20, 2006, it was not made available to the public until August 22, 2009, on NASA's Planetary Data System (PDS) website. All three of the MGS images reveal defining aspects of this avian feature, including a head, beak, body, eye, leg, foot, toes, wing, and feathers. When taken together, these components induce the visual impression of an avian-shaped formation that exhibits a unique set of proportional features. Adjoining this formation is a composite of complex cellular features that form a compartmentalized infrastructure. The three authors who are veterinarians provide a critical analysis of the avian features, and the geologist and geoscientist authors examine natural mechanisms that could contribute to the formation of this feature. An extensive search of comparable regions within and beyond the area of the Argyre Basin was conducted. A list of these sites is provided, and terrestrial comparisons are also offered.

Introduction

On March 7, 2002, independent researcher Wilmer Faust presented an odd hillock formation captured in MGS (Mars Global Surveyor) image M1402185 (MOC narrow-angle image M14-02185, 2001) to the first four authors of this paper (Figure 1). The rectangular areas along the upper edge of the hillock on a south-facing slope along the Northwest rim of the huge Argyre Basin interested him most. Faust noted compartmentalized structural features throughout the area's topography as well as a formation of entirely different geometry, suggestive of a gigantic profile of a bird. The avian-shaped formation has recognizable features in the appropriate size, shape, and anatomical orientation that include a head, beak, and body. Additional anatomical components include an eye, leg, foot, toes, wing, and feathers.

The original image and two subsequent images showing the feature for this study were obtained via the Malin Space Science Systems (MSSS) website and NASA's Planetary Data System (PDS) website. All images are presented as they were provided through those sites to the general public with only minor contrast adjustments. The first image M14-02185 became available to the public on April 4, 2001, and the second image, via the public targeting program, S20-00165, was released on August 11, 2006 (S20-00165, 2006) (Figure 2), and the third official release S13-01480 was on August 22, 2009 (S13-01480, 2009) (Figure 3) (Kuehnel, September 3, 2009). There are considerable differences in the telemetry, sun angle, resolution, and other factors of the three images; a comparison chart is presented as Table 1. The basic physical features persist throughout the three images, and some features that were obscured in the first two images are now visible in the third image.

The first MGS image of the formation M14-02185 was taken during the summer in mid-afternoon (4:33 PM) from a point almost directly overhead with a resolution of 3.41 meters per pixel. Image S20-00165 was taken in the winter season, very early in the morning (3:13 AM), from an emission or camera angle of 17.91 degrees off nadir with a resolution of 4.39 meters per pixel. The third MGS image S13-011480 is the clearest and most complete of all three images. It has the highest resolution, photographing the formation at 1.43 meters per pixel.

The Geological Context for the Avian Feature

The Argyre Basin is a large-impact crater located in the southern hemisphere of Mars between 35° and 61° South and 27° and 62° West. The impact basin is approximately 1,100 kilometers in diameter and is believed to have been created in the earliest period of Mars' geologic history about 4 billion years ago (Kiefer, Treiman, & Clifford, 2011). A rapid melting of the south polar ice cap is

Figure 1. A portion of Mars Global Surveyor image M14-02185 (2001).
Courtesy NASA/JPL/Malin Space Science Systems.
Contrast enhancement by Keith Laney.

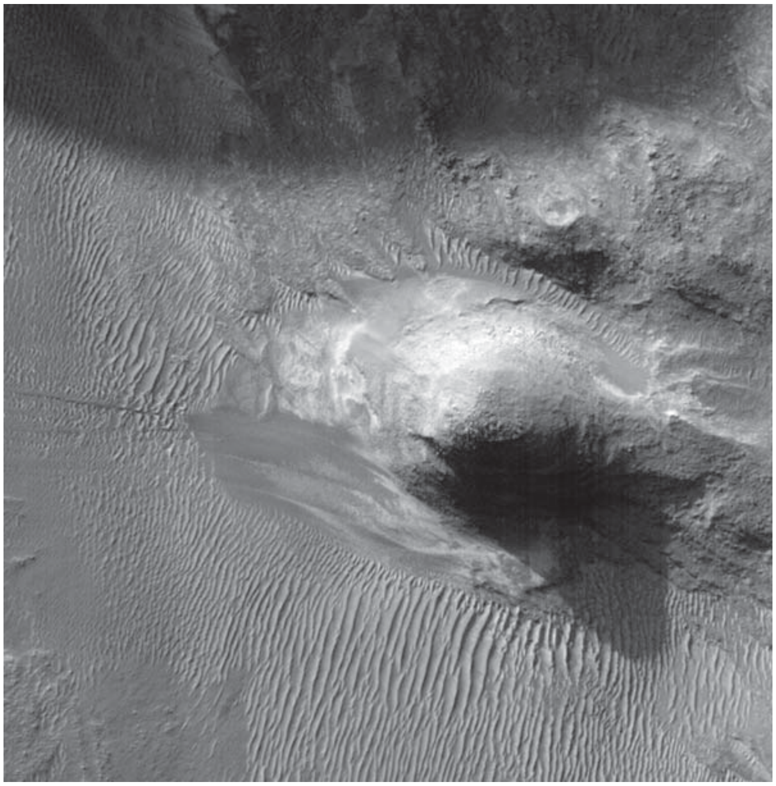

Figure 2. A portion of Mars Global Surveyor image S20-00165 (2006).
Courtesy NASA/JPL/Malin Space Science Systems.
Contrast enhancement by George J. Haas.

believed to be responsible for the basin being water-filled during the Noachian period (Hiesinger & Head, 2002:969).

As described in the Introduction, the main feature originally noted by Faust in MGS image M14-02185 was a network of cellular structures (Figure 4, item B) located directly below the contoured ridgeline of the adjacent landform (Figure 4, item A) and just above the avian feature (Figure 4, item C).

A closeup view of this network of compartmentalized infrastructure (Figure 4, item B) is provided in Figure 5. The deformation of these ridgelines and compartments resemble joints or dikes filled with deposits of fine windblown materials. The area around the upper half of the cells appears to have been formed by water-filled channels (Hartmann, 2003).

According to a scientist from the American Astronomical Society, William

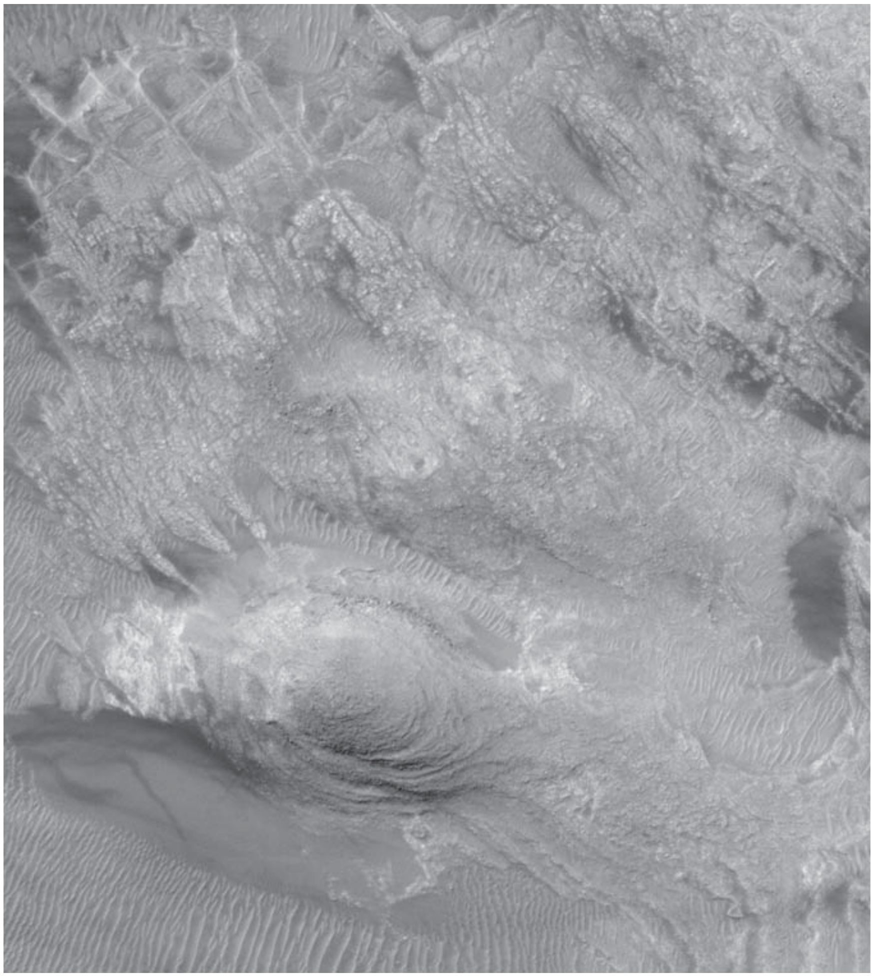

Figure 3. A portion of Mars Global Surveyor image S13-01480 (2009).
Courtesy NASA/JPL/Malin Space Science Systems.
Contrast enhancement by Keith Laney.

K. Hartmann, the data acquired by the Mars Orbiter Laser Altimeter (MOLA) in 2000 (Figure 6) revealed evidence that the area was part of an ancient waterway that connected with the Argyre Basin (Hiesinger & Head, 2002:969). In the online color version of Figure 6 in this *Journal* issue, the red and orange colors of the topographic map indicate the highest terrains, while the green areas indicate a lower terrain, and the blue area indicates the lowest (Hartmann, 2003).

TABLE 1
Comparative Ancillary Data for MOC Narrow-Angle Images M14-02185, S20-00165, and S13-01480

	Image Number		
	M14-02185	S20-00165	S13-01480
Image start time SCET	2000-04-30T 20:17:33.04	2006-07-03T 04:03:13.29	2005-12 5T 19:58:31.16
Image width	1024 pixels	672 pixels	(km) 2.94
Image height	4864 pixels	9216 pixels	(km) 9.89
Crosstrack summing	2	3	1
Downtrack summing	2	3	1
Scaled pixel width	3.41 meters	4.39 meters	1.43 meters
Pixel aspect ratio	1.60	1.01	N/A
Emission angle	0.29°	17.91°	9.75 °
Incidence angle	45.20°	79.88°	44.30°
Phase angle	44.93°	64.71°	49.67°
Center longitude of image	55.30°W	55.32°W	304.98E
Center latitude of image	48.07°S	47.93°S	-47.53°N
Line integration time (millisec)	0.7231	0.4821	0.4821
Gain mode	4A (hexadecimal)	4A (hexadecimal)	N/A
Offset mode	36 (decimal)	0 (decimal)	N/A
Compression type	MOC-PRED-X-5	MOC-PRED-X-5	N/A
Scaled image width	2.84 km	2.95 km	2.94 km
Scaled image length	21.64 km	40.86 km	9.89 km
Spacecraft altitude	370.76 km	374.58 km	N/A
Slant distance	370.77 km	391.62 km	N/A
North azimuth	94.39°	94.39°	93.27°
Sun azimuth	63.82°	59.34°	60.31°
Solar longitude	344.17°	74.18°	341.04 °
Local true solar time	13.41 decimal hrs (1:41 PM)	14.54 decimal hrs (2:54 PM)	13.50 decimal hrs (1:50 PM)
Release date	4/4/2001	8/11/2006	8/22/2009

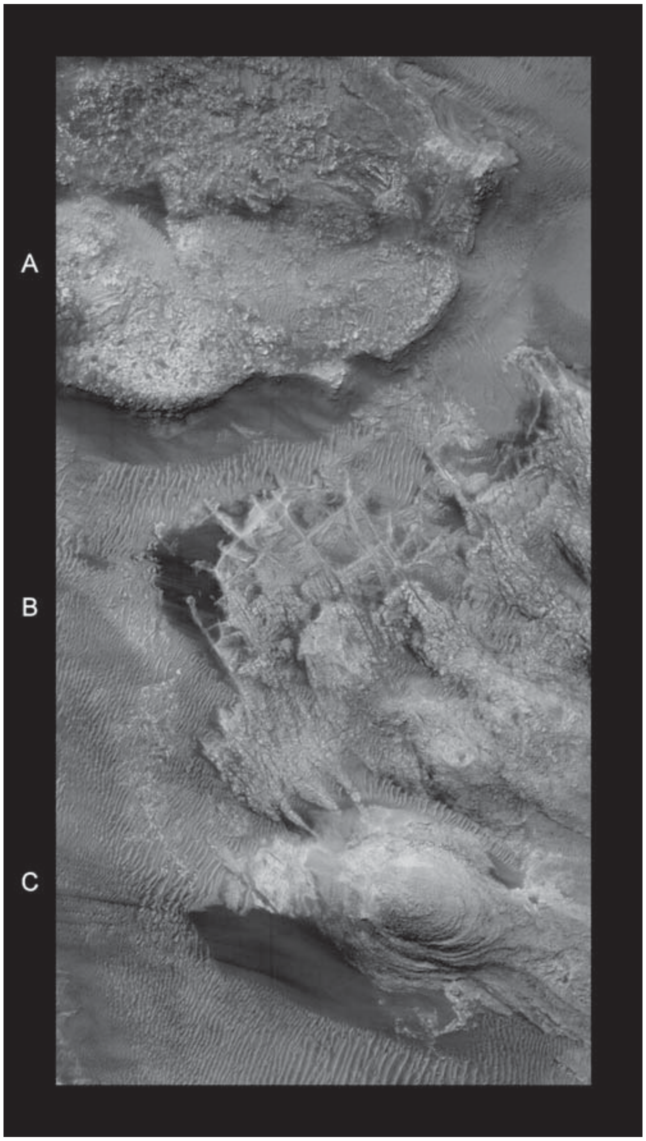

Figure 4. Mars Global Surveyor image M14-02185.
(A) Shows an adjacent landform to the structures in B & C.
(B) Shows a network of cellular structures.
(C) Includes the avian feature item.
Courtesy NASA/JPL/Malin Space Science Systems/Keith Laney.
Contrast enhancement by Keith Laney. Notated by the authors.

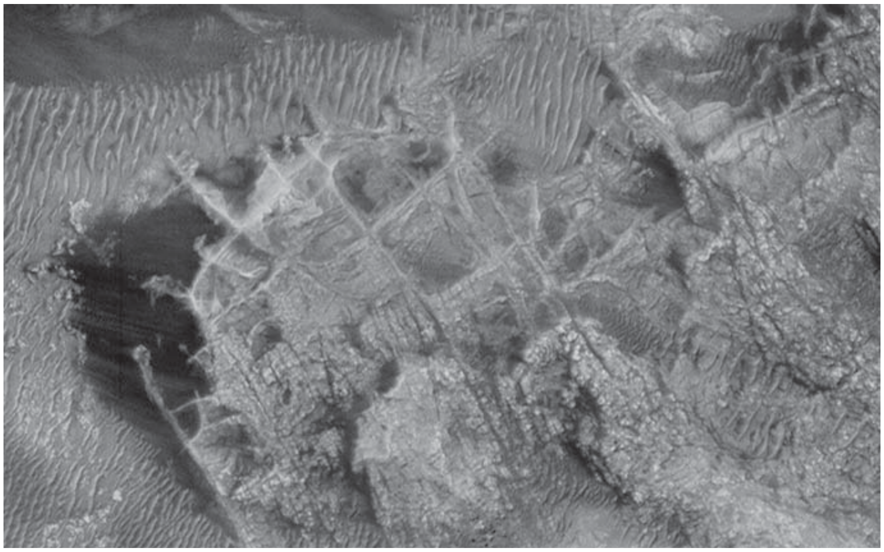

Figure 5. MGS M14-02185 cropped area of cellular compartments. Closeup of Figure 4, section B.
NASA/JPL/Malin Space Science Systems.
Contrast enhancement by Keith Laney.

Topography and Morphology of the Avian Feature

The purpose of this segment is to assess the geomorphology of the avian-shaped structure in question and determine what natural processes are needed to create its structure.

The feature is located on the northwest side of an ancient impact crater known as the Argyre Basin. The regional overview provided in the Mars Orbital Camera (MOC) image M14-02185 and S13-01480 reveals three separate features unique to one another on the edge of a plain. The plain is the remnants of channel beds covered with furrows and dunes most likely created by wind action after the water disappeared. Pockets of a darker and perhaps less dense eolian detritus in some areas overlie the dunes, suggesting the dunes were solidified enough not to have been reworked a great deal after their deposition. It has been argued that glacial and fluvial/lacustrine processes in conjunction with eolian modification were probably most important in the evolution of the interior of the Argyre Basin (Hiesinger & Head, 2002:940). What is immediately apparent regarding the three features (Figure 4A, Figure 4B, and Figure 4C) on the edge of the plain is that they have a disparate appearance and erosional expression

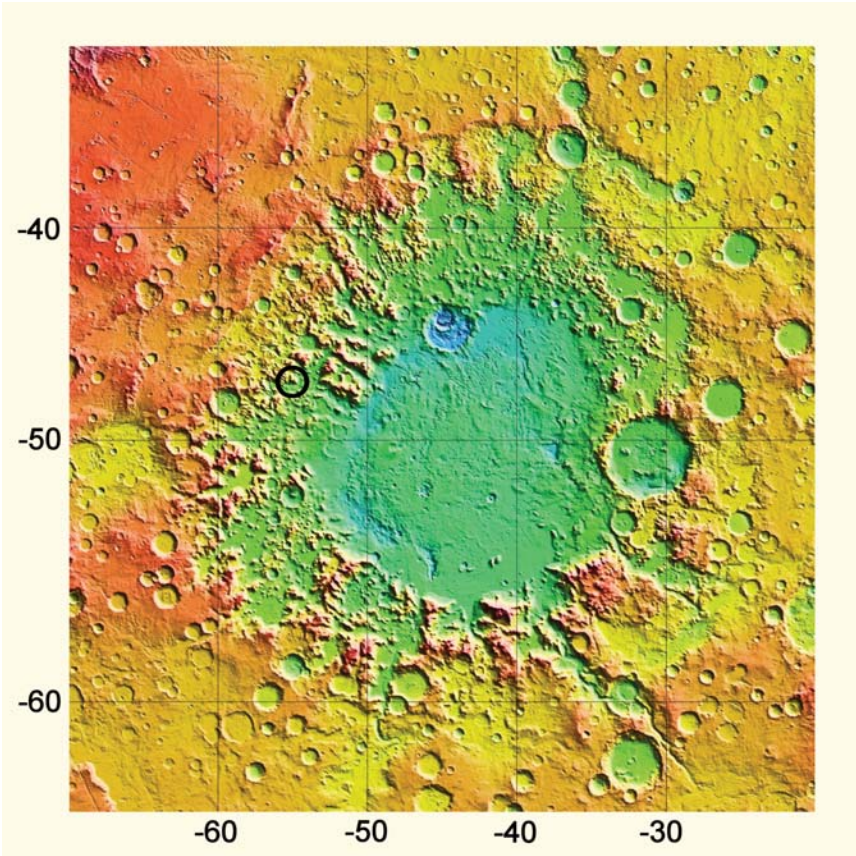

Figure 6. Argyre Basin NASA Mola Data map. Notated with the approximant location of the avian-shaped formation.
Courtesy NASA/JPL/Malin Space Science Systems/The Cydonia Institute.
Annotated by the authors.

inferring different lithological composition (Figure 4). Structure A (Figure 4) has a rounded edge but no striations or major visual evidence of erosion from wind or water action. The composite feature marked B (Figure 4) consists of numerous rectilinear segments along its periphery and an interior with massive rectilinear expression and fracturing. The initial impression for the genesis of such a structure would be dike-like features. It also has an irregular, rather spiked, perimeter showing no indication of lateral water action but may have undergone some wind erosion and deposition within its cellular cavities.

The avian structure (Figure 7) is composed of six segments that include an

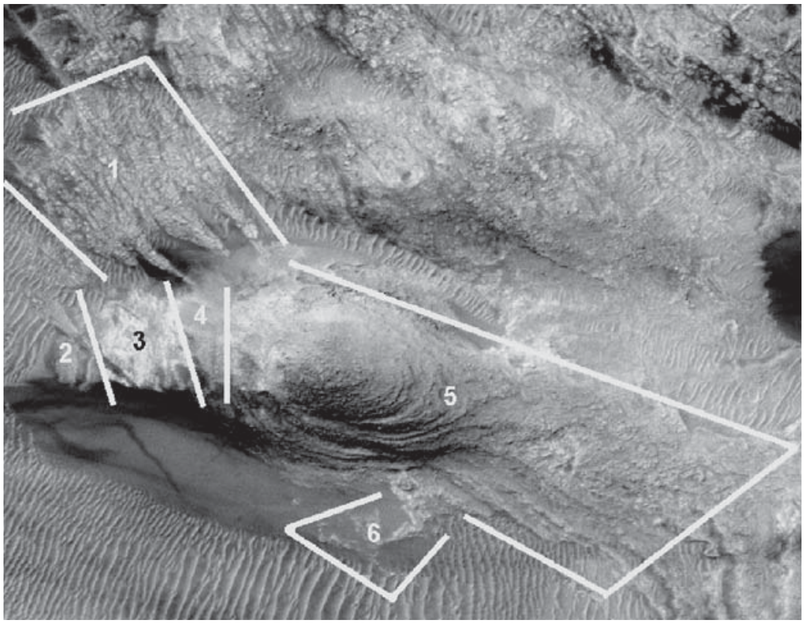

Figure 7. Six Segments of the Avian Formation. Detailed crop of M14-02185. 1) extended right wing, 2) beak, 3) face, 4) neck, 5) body with left wing and tail feathers, 6) legs/feet.
NASA/JPL/Malin Space Science Systems.
Contrast enhancement by George J. Haas. Notation added by the author.
Line annotations by William R. Saunders.

extended right wing (1), a beak (2), face (3), neck (4), the body with left wing and tail feathers (5), and the legs/feet (6). These segments are differentiated by height, color, patterning, contour, and lithology (Figure 7). We shall address the main feature, the body (Figure 7, section 5) first.

The central mound that forms the body, left wing, and tail are sedimentary in appearance. Since the height of the mound is roughly 175 m, and sand dunes on Mars are typically only 10–25 m in height (Greeley, Lancaster, Lee, & Thomas, 1992), an eolian depositional feature can likely be ruled out. The southwestern quadrant of the Argyre crater is suggested to have numerous glacial features including eskers (Hiesinger & Head, 2002:944). Although the avian feature is in the northwest quadrant, subglacial deposition in the form of a drumlin or esker that has undergone lithification would be the most likely candidates for the formation of the avian feature's body. The layered or stratified appearance that gives the visual impression of bird feathers is similar to what could be formed through wind or water action with the feature undergoing post-depositional

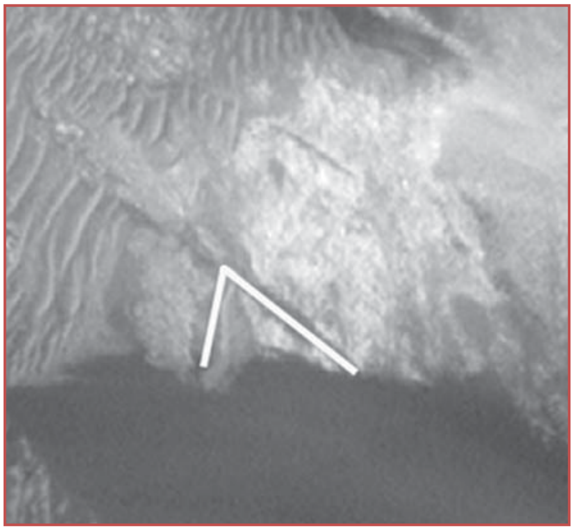

Figure 8. Possible Block Faulting (avian head). Detailed crop of M14-02185.
NASA/JPL/Malin Space Science Systems.
Contrast enhancement by George J. Haas. Line annotations by William R. Saunders.

erosion. The extended right wing (Figure 7, section 1) is highly textured in appearance with longitudinal and shorter perpendicular and slightly angular fractures. This is obviously different lithology than the body, and its extensive fracturing is likely due to rapid cooling. The composition of the beak (Figure 7, section 2) could be composed of the same material as the body (Figure 7, section 5) having been separated by the removal of material from the face area.

What appears to be a block fault also separates the beak from the face forming the mouth (Figure 8). Post-faulting depositional material is the most probable natural explanation for the tongue identified within the fault cavity. The avian-shaped mound is truncated at the neck leaving the portion of the structure between the neck and the beak structurally lower and forming the face (Figure 8) by the exposure of an older underlying material, possibly from a lava flow.

Interestingly, there is no wind-deposited material covering the face; however, wind action may be responsible for a darker material that appears to have been deposited up against the truncated body forming the hood or neck (Figure 7, section 4). The truncated and irregular edge at the juncture of the face and neck raises the question as to whether further erosion over the face occurred after this material was laid down.

Possibly the most interesting feature in the aspects of its structure and exposure is the leg and foot (Figure 7, section 6). The lighter color and structural level is similar to the face, indicating it likely consists of the same lithology. Interestingly, it as well is exposed and has no windblown material obscuring it. The angular nature of the leg and toes would most conceivably be due to multidirectional faulting occurring prior to the deposition of the mound that forms the body.

The third MOC image of the formation (S13-01480) covers more of the area to the east and reveals a complete depiction of the tail section. In Figure 9, the avian-shaped head, body, feet, and tail are highlighted in a color wash (bottom photo) [color in online journal only] to note the location of individual features.[1]

Conclusions for the Topography and Morphology of the Avian Feature

This investigation has concluded that the processes that were needed to produce this avian structure include glaciation, deposition from water and wind, erosion from water and wind, and faulting. Using the available data provided by the Mars Orbital Camera and the Mars Orbiter Laser Altimeter aboard the Mars Global Surveyor, as well as the studies done by numerous researchers, it is apparent that the necessary geological and geomorphological processes to produce the avian-shaped feature took place in the Argyre Basin. What is most intriguing, however, is the procession of the events and their precise distribution that is necessary to produce all the avian features in their present form and proportion. A random search of the surrounding area of Argyre Basin was conducted and no suitable comparative features were found within the proximity of the observed avian-shaped feature. The search included the north-facing slope of a crater in MOC image M04-00606, a rim feature in MOC image M04-00926, the north central region in MOC image R15-01672, a northwestern area in MOC image M13-00036, the northeastern area in MOC image R15-01194, and a sample of terrain seen in the southwestern area in MOC image M20-00992. The expansive search also included the southwestern area of Argyre Basin in MOC image M13-00220 and a traverse of mountains located in the western region in MOC image M13-00471.

Veterinarian Analyses of the Anatomical Features of the Avian Formation

Three veterinarians (coauthors Cole, Friedlander, and Orosz) have examined this avian feature exhibited within the Argyre Basin. They impartially and independently evaluated the features of the proposed avian formation, having access to both a printed hard copy and computer-displayed image of the complete formation as obtained in NASA MGS photographs M14-02185 (2001), S20-00165 (2006), and S13-01480 (2009). Each veterinarian was provided with an

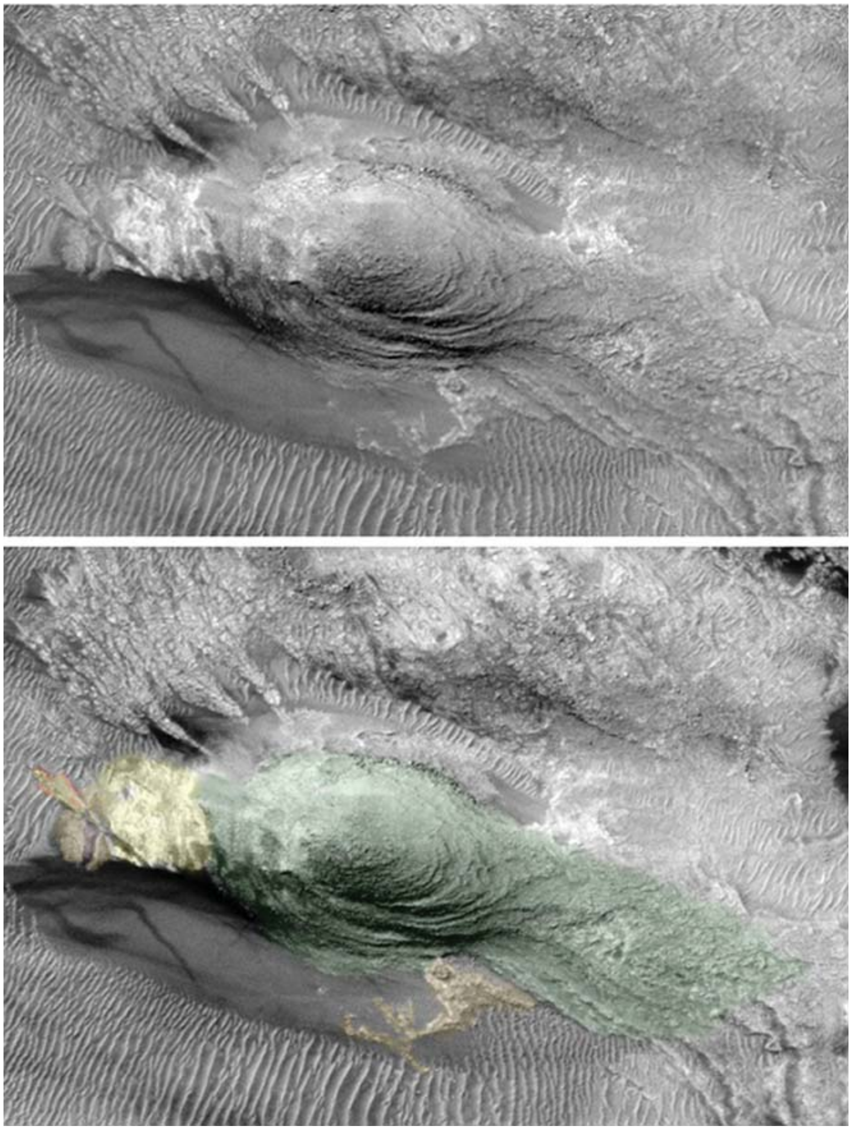

Figure 9. Avian-shaped formation with colorized features.
Cropped from MOC S13-01480.
(Top) Original.
(Bottom) Colored [online journal only].
Contrast enhancements by George J. Haas. Coloration by William Saunders.

analytical drawing of the avian feature produced by author George Haas (Figure 10), and they approved of the notations and details presented. A. J. Cole was aware of prior theories of artificial objects on Mars, while Joseph Friedlander and Susan Orosz had no prior awareness of any theories of artificial objects on Mars. Orosz's contribution to this article is directed mainly at classification of the type of parrot observed.

Anatomical Analyses of the Avian Formation

There are distinct anatomical similarities between the features found on the formation located at Argyre Basin (Figure 1 and Figure 3) and avian species. Centrally there appears to be a midstructural breast and abdomen with protruding structures resembling primary flight feathers with feather shafts attached to the dorsal aspect of the image. On the left (rostral) aspect of the structure there is a resemblance to head and facial features ending at the nape of the neck. The head includes a lateral left eye, and a hinged beak with a blunted tongue between a parted lower mandible. Between the eye and beak there is an arching structure resembling a cere without evidence of a nostril that may be obscured by a crest or comb feature. Below the abdomen (ventrocaudally) there appears to be a claw consisting of a three- or four-toed foot with a bend at the equivalent of the tarsus. There is only a hint of a paired second foot, which is unresolved. The structural formation to the far right of the body (caudally) resembles tail feathers.

The analytical drawing in Figure 10 identifies a set of 17 points of confirmation that veterinarian Cole believes provides evidence that the formation at Argyre Basin not only represents an avian creature, but that its sculptured features appear anatomically correct.

Examination of the formation at Argyre Basin (Figure 1 and Figure 3) reveals features of the avian species. Rostrally (left), one can visualize the beak with its maxilla mandible surrounding the tongue. Features of the head are clearly visible. The cere is noted dorsal to the maxilla. The orbit, papillary margin, and opening of the external ear canal are evident. The head looks featherless. Down feathers are seen in the cervical area. Visualized in the thoracic region is the left wing folded in a natural position. Primary feathers cover this region. Ventrally is the pectoral area ending at the point of the keel. Caudally (to the right) is the abdomen and left pelvic limb. Three digits, tarsometatarsus, and tibiotartus are visible. The photograph includes the proximal portion of tail feathers. Just rostral and dorsal to the tail feathers is a change in feather pattern of the pygostyle (preen gland).

The analytical drawing in Figure 10 identifies a set of 16 points of confirmation that veterinarian Friedlander believes provides evidence that the formation at Argyre Basin not only represents an avian creature, but also that its sculptured features appear anatomically correct.

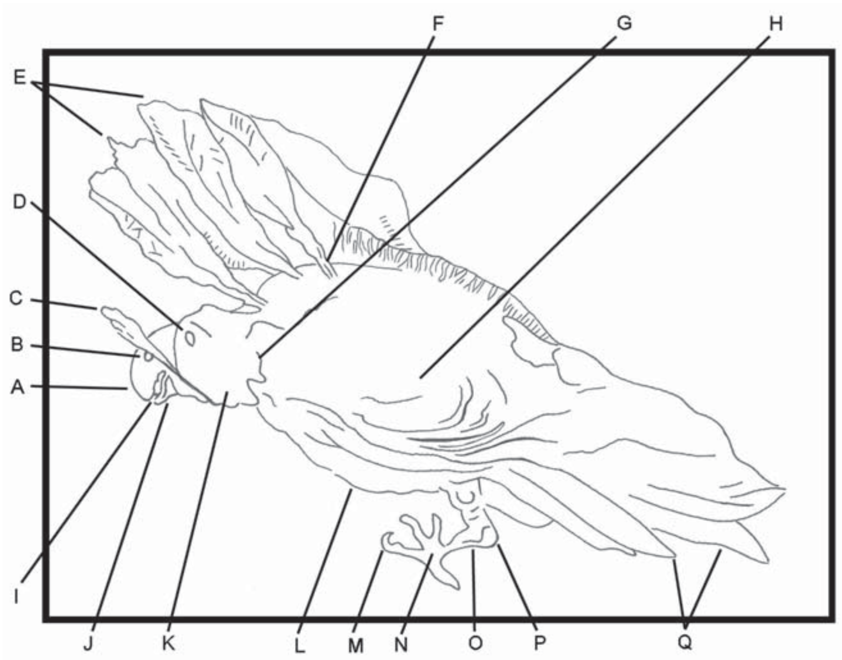

Figure 10. Avian formation. A) Beak. B) Cere. C) Crest. D) Eye. E) Primary flight feathers (right wing). F) Feather shafts. G) Hood line (neck). H) Body (folded left wing). I) Tongue. J) Jaw. K) Head. L) Abdomen. M) Claw. N) Foot and toes. O) Tarsus joint. P) Tibia. Q) Tail feathers.
Analytical drawing by George J. Haas with notations by A. J. Cole. Image source: S13-01480, 2009.

Avian Feature Comparison to Terrestrial Specimens

In viewing the avian formation in Figure 1 and Figure 3, we note that the body type looks very similar to the Psittacines or parrot. The presentation of the bird seems to be that you are looking at the left wing up or extended over the body with the margin on the right on the underside of the body and the medial ventral surface rolled so that the keel is pointing up toward the viewer. The beak is psittacine-like and not passerine, as the thickness and the downward curve to the maxillary ramphotheca has the characteristics of the psittacine (or hook-billed) beak. A distinct upward formation on the beak suggests the presence of a crest or caruncle. Although unusual in this genus, it is quite plausible that this feature is a remnant modeled after the fleshy wattle found on the upper mandibles in the prehistoric taxonomy of Psittaciformes. Although there are many gaps in the fossil history, the earliest fossil of parrot-like birds dates to

Figure 11. King Parrot (*Alisterus Scapularis*).
Image courtesy of Phil Hart.

the late Cretaceous about 70 million years ago (Grzimek, 2003). Therefore, any classification of the avian formation as presented here is variable and subject to change when new images resolve some of the open questions, such as plumage color and the extent of the tail and the formation of the second foot. For that reason, this classification should be treated as preliminary. Considering the identifiable characteristics of external features observed in the available images obtained by NASA, it is reasonable to suggest that, of the 353 species of parrots, the avian formation on Mars derives its anatomical template from the terrestrial King Parrot.

Figure 11 provides a comparative image of the King Parrot (*Alisterus Scapularis*) native to Australia. It averages 14″ or 35.56 cm in length including the tail. The variety of parrots is quite large, and therefore one specimen was selected that closely resembled the avian feature discussed in this paper.

Since no proportional measurements relating various parts of the body to each other have been reported in the literature, the sample parrot was measured and segregated into its components including the head, body, and leg pelvic limb with nails or talons. These measurements are compared to the features of the avian formation. This analysis strongly correlates to the proportions as presented in Table 2.

TABLE 2
Comparison Chart of Anatomical Measurements of Avian Formation and King Parrot Measurements

	Avian Feature Measurements Utilizing M14 & S13	Comparisons	King Parrot Measurements	Comparisons
Body full length	From S13 2042M X=103, Y=4891		14", 35.56cm X=36, y=44 X=493, y=346	
Body length no tail	1346m X=250, y=227 X=733, y=291	Body is 66% of full length	8.72", 22.15cm X=36, y=44 X=325, y=250	Body is 63% of full length
Body width	541m X=528, y=351 X=603, y=172	Width is 40% of length	3.21", 8.15cm X=157, y=245 X=233, y=151	Width is 37% of length
Head to shoulders or scapula	477m X=250, y=227 X=422, y=227	Head is 35% of body length	2.47", 6.27cm X=36, y=44 X=112, y=96	Head is 33% of body length
Thigh or leg	213m X=612, y=362 X=637, y=430		.81", 2.06cm X=200, y=273 X=184, y=245	
Crus or lower leg	183m X=581, y=443 X=637, y=430	8% difference in length of lower and upper legs	.88", 2.24cm X=200, y=273 X=164, y=282	7% difference in length of lower and upper legs
Claw nails or talons	336m X=504, y=397 X=598 y=478	16% difference in the length of the claw and the total length of the lower and upper legs	1.87", 4.75cm X=188, y=285 X=116, y=285	11% difference in the length of the claw and the total length of the lower and upper legs

The avian feature cropped from Figure 2 and the King Parrot in Figure 11 were measured by author Miller using Scion Image for Windows software by Scion Corporation based on an NIH image for Macintosh by Wayne Rasband of the National Institutes of Health USA, release Alpha 4.0.3.2. This is the software used by NASA to measure surface features on Mars starting with the Viking mission. Both the M14 and S20 images were measured utilizing the aforementioned software. Only the S20 image provided a shadow which was used to establish the height via the formula provided in the tutorial for the software, that being y (height or depth) = x (length of shadow) tan (90 – INA), (INA is the incidence angle which is 79.88° as noted in Table 1). With the use of the S13 image, an approximate overall length is established for the feature as

TABLE 3
Basic Anatomical Measurements of Avian Formation

Body length	=	1,570 meters
Body width	=	685 meters
Length of shadow	=	975 meters
Height of body	=	175 meters

illustrated in Table 3. The comparisons in Table 2 are extremely close regardless of the fact that starting and ending points are confined by pixel selection. The knowledge of the differences could have prompted re-selection of the points to bring the totals closer. However, it carries more meaning to arrive at the numbers by selecting points the eye considers correct.

The x and y coordinates are provided in Table 2 as guidelines so that interested researchers may make their own measurements; however, it should be noted that even minor deviations can produce differences of several meters at this scale, and the main point of Table 2 is to provide an overall comparison of proportions as opposed to any standardization of measurements for parrots, as the variations are simply too large a sample to gather valid interpretations for the species. It is also noted that in using a flat image, beginning and ending points on both examples are somewhat capricious, and that precise measurements could be obtained only during a physical examination of beginning and ending points such as neck to head and leg to body on actual physical subjects. The conclusion can be reached, however, that the avian feature on Mars and the terrestrial King Parrot compare in their overall relative dimensions.

Aesthetic Analysis

The formation at Argyre Basin appears to be the result of a composite structure of unrelated geological materials that have been transformed into a sculptural relief that express the prominent features of an avian creature when observed from above (Figure 9). The topographical features observed in MOC images M14-02185, S20-00165, and S13-01480 include an oval-shaped mound that conforms to the shape and size of a bird's body including a folded left wing. Adjoining features to the left side of the body-shaped mound suggest a composite of structural elements that resemble a bird's head (Figure 10, point K). The head includes an eye formation (Figure 10, point D) and a parted beak with evidence of a tongue (Figure 10, point A). The beak has a feather-like protuberance, referred to as a crest by both authors Cole and Orzos that extends from the beak

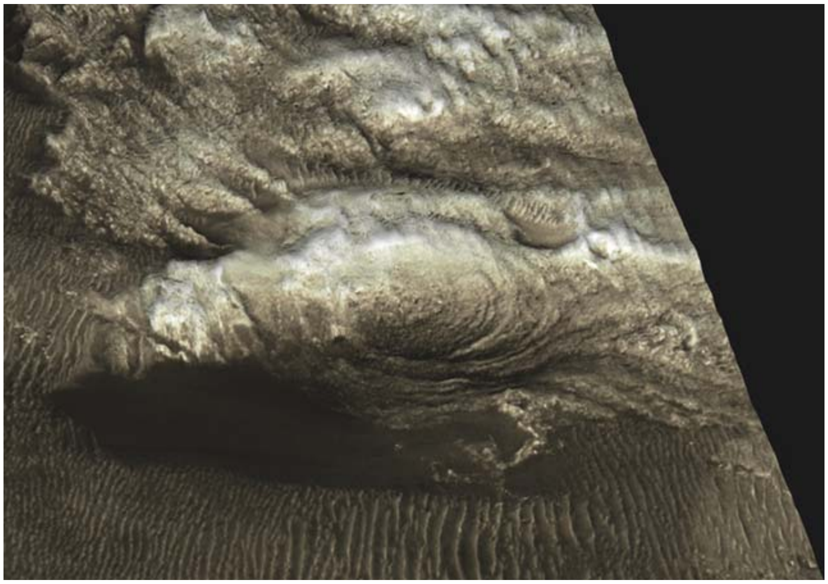

Figure 12. Three-dimensional perspective view of the avian feature. Created by Robert Brunete utilizing M14-02185.
NASA/JPL/Malin Space Science Systems.

and projects out from the head (Figure 10, point C). The modeling of the head is complex in its expression of texture and shading. The foreshortened orientation of the eye is remarkable in its proportion to the sightline expected within a profiled perspective. The plasticity of the beak appears hard and mantled, while the overall head and neck has a soft cauliflower look. Additional elements form an extended left leg (Figure 10, points O & P) and clawed foot with exceptional adherence to muscular definition (Figure 10, points M & N). The sculptural process of the leg appears to be fashioned in low relief and in effect has allowed sediment to cover portions of the detail (Figure 12). Attached to the body is an extended right wing along the back (Figure 10, points E) and tail feathers (Figure 10, points Q) that are again sculpted in low relief. The tail feathers extend from the body ending with splayed tips.

The simulated relief highlights the sculptural perspective of the avian-shaped formation (Figure 12). The image also exhibits additional anatomical structure to the leg and toe, including the appropriate form to the tarsus joint and tibia formation (Figure 13).

The following image in Figure 14 is a drawing of a hammered copper plaque of an avian form that was produced by the Hopewell Indians of Ohio about 400 BC (Thomas, 1994). It is presented here as a comparative image for the

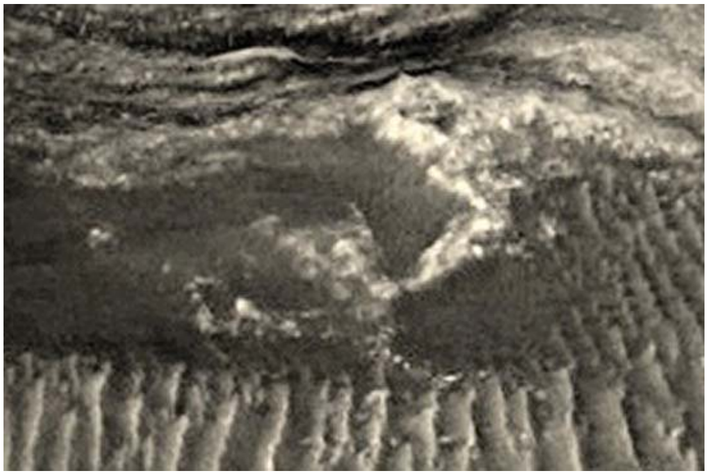

Figure 13. Three-dimensional perspective views of leg and toes. Cropped from MOC image M14-02185.
Figure 13 by the author.

avian feature found at the edge of the Argyre Basin on Mars. In reviewing this Hopewell plaque, avian specialist and author Orosz in 2006 identified the form as representing an indigenous parrot. She acknowledges the overall profiled posture of the Hopewell parrot with its extended wing motif is reminiscent of the design expressed within the avian feature on Mars. She also notes the shape of the parrot's head and beak shares a common form with the avian feature on Mars, while the shape of the clawed foot, the round belly, and the stylized tail feathers are also analogous.

The majority of comparative examples of manipulated terrestrial geology come to us in the form of earthworks that were created by ancient cultures throughout North and South America. These huge mounds and earthworks were shaped like animals and geometric symbols, while others were formed like ceremonial platforms and step pyramids. It is estimated that the amount of earthworks found throughout North America number in the hundreds of thousands. However, over time almost all of these monuments have been either destroyed by natural erosion or by the rapid expansion of rural and urban development. Because there are a limited number of examples of animal and figurative earthworks in the available database, only two meet the criteria of this study with comparable detail and content.

The first is a 5,000-year-old, eagle-shaped geoglyph located in the town of Eatonton, Georgia. At the site, an eight-foot-high bed of white quartz stones

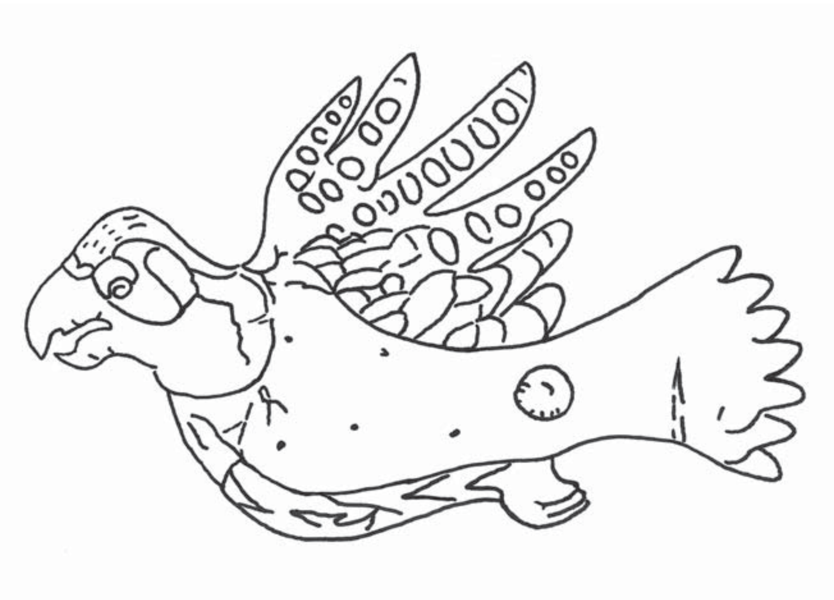

Figure 14. Parrot—Hammered copper plaque (Hopewell Indians). Drawing by George J. Haas.
Image source: *Exploring Ancient Native America, An Archaeological Guide* by Davis Hurst Thomas, Macmillan, 1994, p. 135.

form a silhouette of an eagle hovering within a circular mound. The apex of the mound forms the eagle's abdomen, which creates a similar elevation as seen in the mound-shaped abdomen of the avian formation on Mars. The body of the eagle effigy measures more than 100 feet from head to tail and has a wingspan of more than 120 feet (Figure 15) (White, 2002). The overall shape of the eagle effigy is symmetrical in design, featuring a set of outstretched wings, tail feathers, and a head that faces eastward. As seen in the illustration, its contours project only the simplest form of a bird without providing additional details.

A second example of an avian earthwork is etched on a hillside in the Peruvian Andes, not far from the famous Nazca lines (Longhena & Alva, 1999). The Peruvian pictograph is formed by a set of conjoined lines that create the impression of a standing bird (Figure 16). Although the awkward shape of the Peruvian pictograph is not proportioned or anatomically correct, the overwhelming consensus is that it indeed represents the generic form of a small bird.

Accepting the consensus that this simple mound and hillside rendering are accepted as intentional works of art by the limits of aerial observations, it would be reasonable to suggest that the formal organization expressed within the avian feature on Mars conflicts with the randomness of mere chance. There are no

Figure 15. Eagle Effigy Mound: Eatonton, Georgia. Drawing by George J. Haas.
Image source: *National Geographic, 142*(6), 784.

terrestrial geoglyphs that induce such a visual impression that approaches the refined modeling of relief sculptures as seen in the avian formation at Argyre Basin.

Conclusion

The overall impression of this area of the Mars photographs (Figure 9) is that regardless of the nature of the varied lithology or the nature of depositional and erosional agents, the avian-shaped formation is indeed exceptional in its physical appearance and anatomical completeness. While there are known geological mechanisms that are capable of creating the anatomical accuracies presented in this formation, the natural creation of a formation with 17 points of anatomical correctness seems to go well beyond the probability of chance.

With respect to the modeling of these anatomical features, visual perception of the avian formation, which has been documented over a six-year period by the Mars Global Surveyor's orbital camera, appears to have permanence and is not the result of a transient phenomenon or an illusionary projection. One interpretation is that this formation was originally a natural landform

Figure 16. Bird pictograph (Nazca). Drawing by George J. Haas.
Image source: *The Incas and Other Andean Civilizations* by Longhena and Alva, San Diego: Thunder Bay Press, 1999, p. 201.

that was modified to illustrate the required features of a recognizable bird. However, although the authors find this as an intriguing possibility, we also acknowledge that the current dataset is not of sufficient resolution to warrant a conclusive analysis, and additional high-resolution images of this feature are needed. Therefore, it is with our combined fortitude[2] that we have requested the cooperation of both NASA and the imaging team at the University of Arizona, to direct the HiRISE camera aboard the current Mars Reconnaissance Orbiter (MRO) to photograph this enigmatic feature at its next available opportunity.

Notes

[1] The addition of color is an accepted tool utilized to highlight features observed in NASA space images of Martian geography. See Michael Malin, *Fossil Fans in Melas Chasma, Captioned Image Release No. MSSS-2—13 April 2007*, Malin Space Science Systems. http://www.msss.com/msss_images/2007/04/13/

[2] Although both author Miller and Keith Laney filed a targeting request for the avian formation with the HiRISE public targeting program between 2007 and 2009, the new HiWish program which began in January 2010 has no record of their requests. Previous targeting suggestions may have been lost when the HiRISE team reconfigured the new

targeting map. Therefore, during April 2011 Keith Laney filed a new targeting request for the avian formation on the HiWish Public Suggestion Page. The request is titled "Layered massifs and rectilinear ridges in NW Argyre" with the ID number 59392.

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We would like to recognize the late Wilmer Faust for bringing this avian feature to our attention in 2002 and for all of his input that was offered toward the early drafts of this paper. We also acknowledge and thank NASA and Malin Space Science Systems for the use of Mars Orbiter Camera images that are available at http://www.msss.com/moc_gallery/ as well as the image data. A special thanks goes to Robert Brunete for his 3-D image of the avian feature and to Phil Hart for the use of his photograph of a King Parrot. The authors are also extremely grateful to digital-imaging specialist Keith Laney for providing us with his rich enhancements of the NASA photographs presented here, and we also thank him and the members of The Society for Planetary SETI Research (SPSR), Horace Crater, and Greg Orme for their comments and reviews of early drafts of this paper.

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