

Photo Analysis of an Aerial Disc Over Costa Rica

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Abstract—An unusual image was photographically recorded by an official mapping aircraft of the Costa Rican government at 08:25 am (EDT) on September 4, 1971 while flying at 10,000 feet altitude over a body of water known as Lago de Cote. None of the flight crew or photographers saw the object. Second generation negative and positive black and white transparencies were obtained and analyzed by the authors. Both transparencies were photographically enlarged and printed on various contrast papers for purposes of making visual inspections and linear measurements. Computer enhancement showed variations in surface brightness. The preceding frame, taken 20 seconds earlier of the same ground region, did not show the disc. The angular position of the sun was determined for the date, time and location of the event and was found to be consistent with cloud shadow positions but not with the dark regions on the disc. A shadow of the disc could not be found. The oval image measured 4.2 mm on the negative and was enlarged to 41 mm (9.76 × magnification). If the disc was located 10,000 feet away from the camera, its maximum dimension would be 210 meters (683 feet). The various analyses failed to identify the image. The same body of water was the site of a visual observation of a partially submerged object on October 25, 1986.

Background

On September 4, 1971 a mapping aircraft of the government of Costa Rica with a crew of four recorded an unusual disc-shaped image as it was flying over the region of Arenal. It took several years for this photograph to find its way into the hands of a Costa Rican investigator, Mr. Ricardo Vilchez who

Editor's Note. Customarily, research articles are either accepted or rejected after review by the editor and two referees. However, one of the motivations for founding SSE was to provide a forum for open and scholarly discussion of anomalies which are sometimes controversial. Therefore, in cases where research methods are sound but disagreement arises regarding interpretation or conclusions, we may publish (after consultation with authors and referees) articles followed by dissenting referees' reviews.

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(along with his brother Eduardo) runs a civilian research group in San Jose. In 1980 Mr. Vilchez met in person with Sergio L. V., the specialist in aerial photography who was aboard the aircraft that day. They discussed the circumstances surrounding the flight and the photograph without reaching a conclusion regarding the nature of the object. One of the authors saw the photograph while attending a meeting in Costa Rica in 1985, and Mr. Vilchez was kind enough to provide a second-generation negative to be taken back to the United States for analysis. Later we requested and obtained detailed maps of the area in question, as well as copies of the immediately preceding and following frames, respectively numbers 299 and 301. These photographs did not show the disc that was present on frame number 300.

In spite of the lack of a first-generation negative, we felt several unusual factors justified a detailed analysis of this photograph, if only to refine our methodology in dealing with such evidence: (1) it was taken by a high-quality professional camera; (2) the camera was looking down, which implies a maximum distance, hence a maximum size for the object; (3) the disc was seen against a reasonably uniform dark background of a body of water; and (4) the image was large, in focus and provided significant detail.

Geographic Locale

The disc was located about 3 miles North of the town of Arenal and some 25 miles South of the border with Nicaragua. The precise site was at latitude 10.583 degrees North and longitude 84.916 degrees West in the province of Alajuela above a small lake called "Lago de Cote" measuring approximately 1800×1600 meters. Lake level is about 640 m above sea level and the surrounding countryside consists of rolling and sharp hills rising several 100 meters above the valley floors. The region is densely wooded, with some broad grassy patches. A dirt road which is only passable in summer runs along the southern edge of the lake. It connects the small town of Cabanga to the northeast with Aguacate to the southwest. When the photograph is carefully examined, a few houses or other structures can be seen along this road, as well as animals in the fields.

The location of the disc was about 800 meters due North of the boundary between the province of Alajuela and the province of Guanacaste.

Figure 1 is a black-and-white contact positive print of most of the aerial negative.

Figure 2 is a copy of the 1:50,000 chart in the region of Lago de Cote above which the disc was located.

Figure 3 is a copy of a geological chart with an arrow pointing to the Lago de Cote. A heavy long dashed line labelled "Fila Vieja Dormida" is seen passing almost directly through the location where the disc was recorded. This line represents a geological fault. The legend on the chart indicates that the dark areas are of volcanic origin.



Fig. 1. A black-and-white contact positive print of most of the aerial negative.

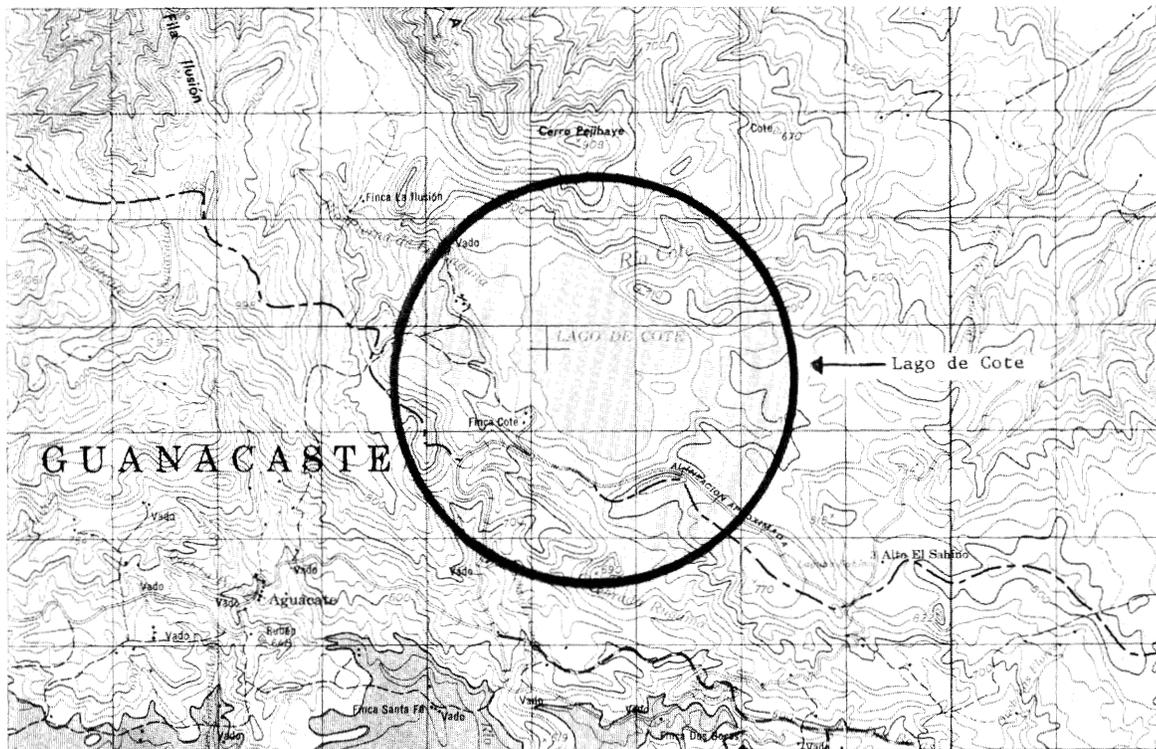
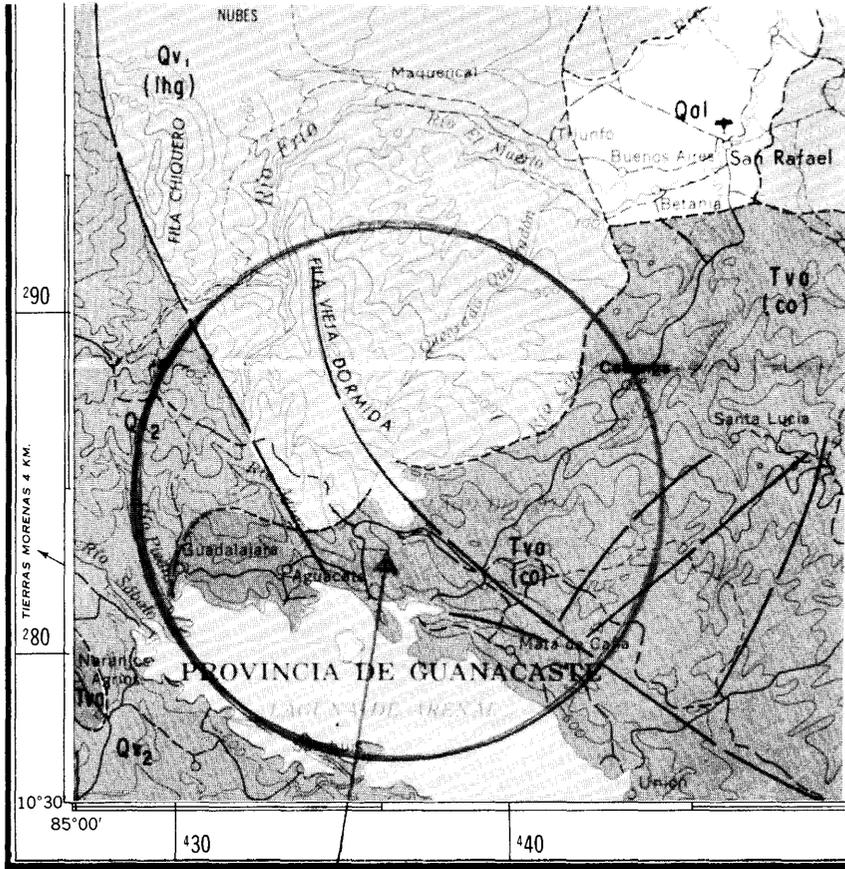


Fig. 2. Detail from the 1:50,000 chart in the region of Lago de Cote above which the disc was located.



Lago de Cote

Fig. 3. Detail from the geological chart with an arrow pointing to the Lago de Cote.

Parameters of the Photograph

According to Mr. Vilchez the camera used was an R-M-K 15/23. The lens would have featured a fixed focus and a 6-inch focal length. The shutter speed was 1/500 second at $f:5.6$. The intervallometer was set at 20 seconds between successive exposures.

The film used was black-and-white emulsion with an ASA speed of 80. This fine grain film produces a high resolution negative given a stable film plane and camera and sufficiently fast shutter speed.

The negative was printed on Kodak Safety aerial film, type 3665. The image measured 23 cm \times 23 cm (529 square centimeters) while the film base measured 25.3 cm \times 23.8 cm. Comparing the image area with the

reduced scale topographical chart indicated that the negative included a region of the earth measuring approximately 11.5 km on a side.

The following information was recorded on one side of the film:

Frame counter: 909
 Altimeter: 10,000 feet
 Bubble level: Approx. level
 C = 152.44
 Nr 21186
 Clock: 08:25 am local time
 Notations: ARENAL
 10,000 feet
 4-9-71 (September 4, 1971)
 R.L.B.

Handwritten between the frame counter and the above information is the notation: 300 L-11 M-13.

On board the aircraft were four men, namely: Sergio L. V., specialist in aerial photography, as well as Omar A. (pilot), Juan B. C., geographer, and Francisco R. R., topographer. No member of the crew observed anything unusual during the flight.

The Disc Image: Analysis Results

Figure 4 is a photographic positive black-and-white enlargement of intermediate contrast of the disc, showing (a) a dark edge across the top and upper-right corner, which is the edge of the frame and fiduciary mark included for measurement purposes, (b) the shoreline, also for measurement purposes, and (c) the ellipsoidal disc. This figure is oriented with the true North facing up.

A number of features are worthy of note on Figure 4.

First, the disc image appears to possess light/dark shading that is typical of a three-dimensional object which is illuminated by sunlight. At this time and location, the sun's azimuth was 85.4 degrees (clockwise from true North) and altitude was 16.7 degrees which explains the lateral displacement of the cloud shadows from the cloud locations.

Second, the generally triangular dark region on the right-hand side of the disc cannot be a solar shadow cast by the (assumed) opaque disc from the right-hand side. If the disc is an opaque, flat conical section of revolution (the dark spot being the tip of the cone) and if the right side is tipped upward, then the entire surface of the disc should be dark. It is more likely that the light and dark regions are surface markings.

Figure 5 shows measured and calculated parameters for this image. The longitudinal axis of the disc was 7 degrees CW from true North. The total included angle of the dark triangular region was about 110 degrees arc with the most northerly edge of this shadow 38 degrees from true North. The

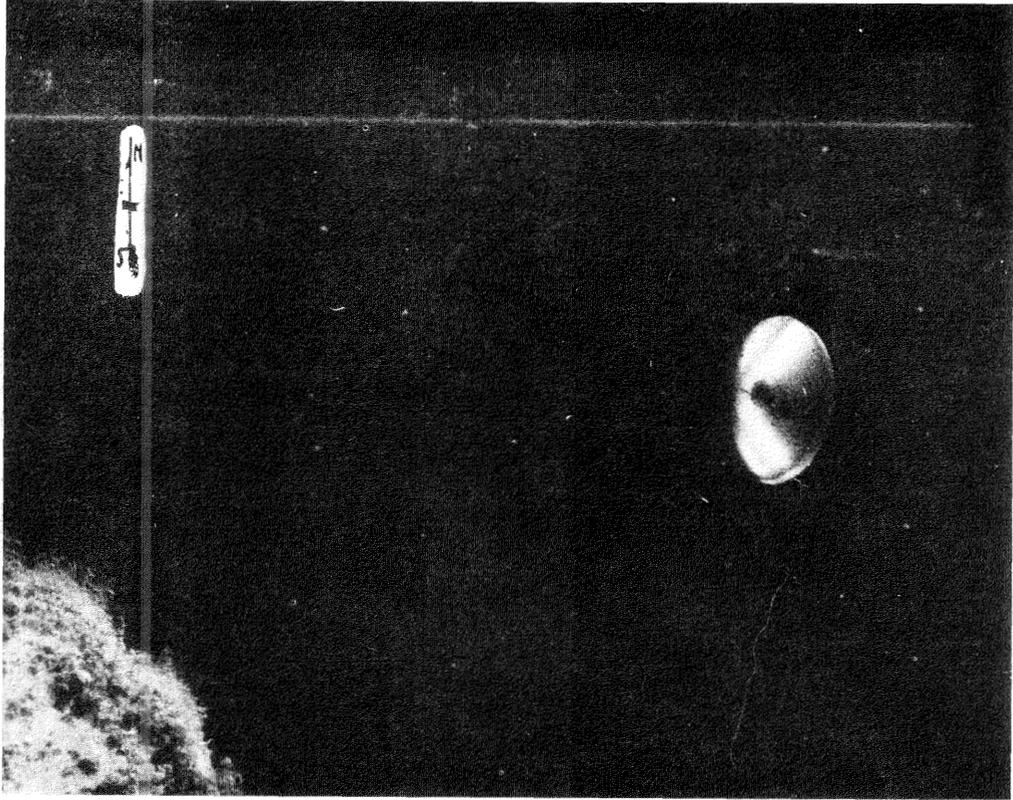


Fig 4 A photographic positive black-and-white enlargement of intermediate contrast of the disc.

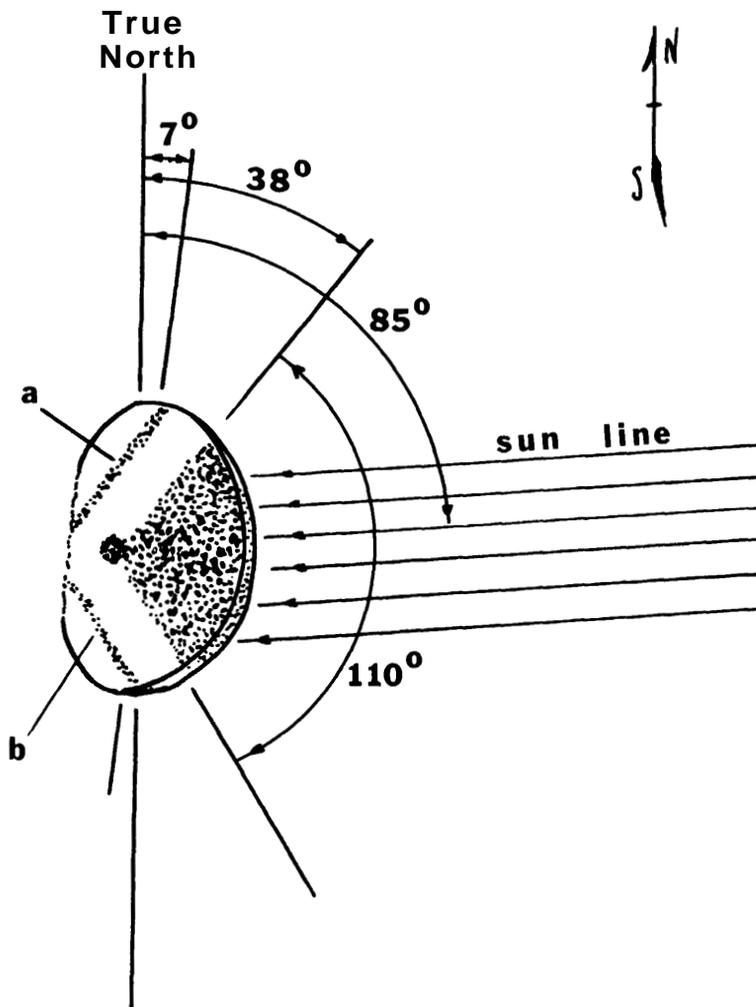


Fig. 5. An illustration of the measured and calculated parameters of the image.

approximate centerline of the triangular shadow region was 93 degrees CW from true North.

Third, the finite thickness of the disc is suggested by the curved thin dark line parallel to the right-hand side of the disc (facing East). Two straight, thin dark lines (a, b) are also visible spanning the top of the disc diagonally and pointed toward the West. Each line is generally parallel with an edge of the triangular darker shadow area.

Fourth, while the right-hand edge of the disc image is in very sharp focus, the left-hand edge is diffuse and appears to be an irregular boundary which

almost transmits the light of the background in a transparent manner. It is of interest to note that the general orientation of this left-hand boundary of the image runs North and South rather than being parallel with the visible longitudinal axis of the disc. This irregular edge is shown more clearly in following computer enhancement photographs.

The top (North facing) edge of the disc is in extremely sharp focus with not even the grain structure of the film being apparent. Whereas the entire top "surface" of the disc shows a mottled graininess which could be representative of a diffusely reflecting surface.

If the disc image was of a real object travelling at a high rate of speed relative to the film plane, then one would expect a blurred image on both the leading and the trailing edge. This did not occur here.

Fifth, the entire image is in sharp focus suggesting that (a) the shutter speed was fast, (b) the disc was not moving relative to the earth background, or both. It is known that the exposure lasted 1/500 second which would "stop" a slowly moving object but not necessarily a fast-moving one.

Of equal interest is the calculated maximum dimension of the disc if it was located at the earth's surface, 10,000 feet away from the camera. The 4.2 mm length of the image is equivalent to an object 210 m in length or 683 feet. The object cannot be farther away than this.

The apparent shadow structure on the disc deserves further comment. Using the location on the ground where defined clouds produce shadows, straight (sun) lines were drawn, all of which should point back toward the sun. Interestingly, these lines are not parallel but converge to a common point near the bottom left corner of the photograph. This suggests that the camera's optical axis was not pointed gravitationally down to the earth but at an oblique angle.

Figure 6 is a photographic enlargement of the negative contrast in which the film's grain structure is apparent. In this regard, there is no distortion of the grain anywhere around the disc's image which suggests that it was not the result of a double exposure. Nor is there any obvious indication of heat-produced atmospheric distortion around the object. There are no visible lines to or from the disc. The magnification is identical to that of Figure 4. It is noted that the finite thickness of the disc is apparent, as is the edge sharpness on its right and diffuseness on the left.

Ground Shadows

All available photographic evidence was studied for the existence of a shadow of the disc. Since the lighting geometry is known, the existence of a shadow would make it possible to calculate the linear size of the disc. The sun-line extending from the disc's location was traced on the negative, positive prints, and digital enhancements and any evidence for an approximately symmetrical shadow was sought. None was found. In this regard it

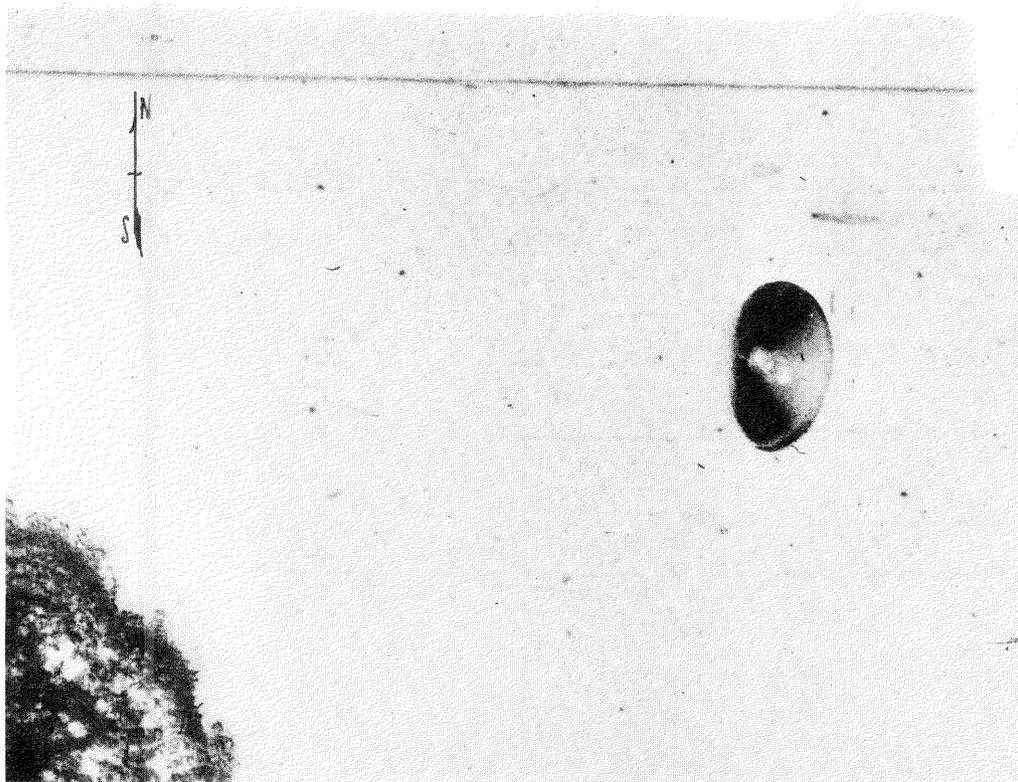


Fig. 6. A photomicrographic enlargement of the negative contrast in which the film's grain structure is apparent

may be pointed out that the atmosphere was relatively clear (between the clouds) so that the 32' arc solar collimation angle should produce a sharply defined shadow on the ground. Of course, the greater the altitude of the disc above the ground the more diffuse would be the shadow edge due to light scatter/diffusion effects. It should also be emphasized that if the disc was located at the earth's surface one would not expect to find a significant shadow.

Digital Enhancement

This negative was also subjected to digital enhancement. A region measuring 13×13 mm centered on the disc was digitized using an aperture of approximately 1 micrometer diameter and 16 bit resolution. A number of color assignments to the density distribution were made to emphasize different features. Unfortunately, the following 4 figures are printed in black and white and do not show all of this rich detail.

Figure 7 is a high reverse contrast image to illustrate two features. First, the density gradient on the left-hand side of the disc which is not visible on the photographic prints (Figures 4 and 6). The same density was found on the left and right sides of the disc. The left side of the disc is not a circular extension of the rest of the disc but is flattened to some unknown extent. Second, the brightness of the lake behind the disc varies regularly from the top of the photograph to the bottom which is consistent with its reflection of collimated sunlight over the range of angles involved.

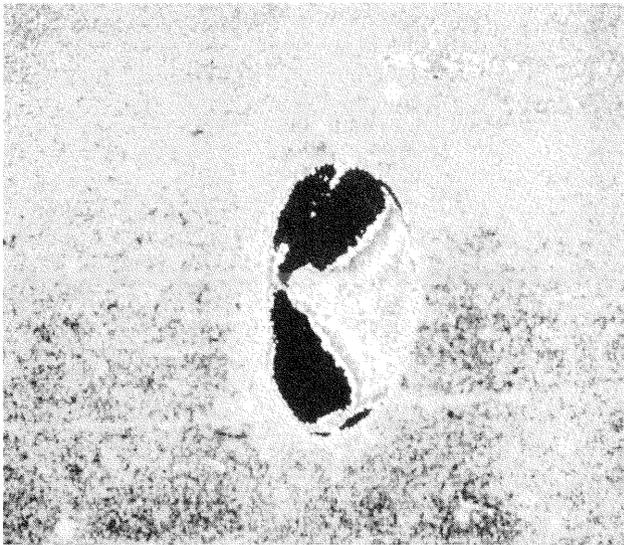


Fig. 7. A high reverse contrast image ($f = 4$, $t = \frac{1}{8}$ sec.).



Fig. 8. The original densities of 100 to 125 were mapped or expanded to 1 to 256 levels of grey ($f = 4$, $t = \frac{1}{8}$ sec.).

In Figure 8 the original densities of 100 to 125 were mapped or expanded to 1 to 256 levels of grey to demonstrate extremely subtle optical density changes, mainly in the area of the disc's dark regions and edge.

In Figure 9 the original densities of 175 to 200 were mapped to 1 to 256 levels of grey. The dark and light regions on top of the disc become more evident here as does the apparent third dimension of the object.

In Figure 10 a wider variety of colors were used to better emphasize the disc's surface density differences as well as the lake's luminance distribution. Located above the disc is a generally oval shaped region of higher density (darker). However, it cannot be the shadow of the disc on the water's surface because it is in the wrong position relative to the sun.

Subsequent Ground Sightings

On October 25, 1986 at about 9:00 am, by clear weather, two men saw an object at the surface of the Lago de Cote. They are Joaquin U.A., 40 years old, a farm manager, and Ronald-Alberto L.A., a 23-year-old farmer, Their sketch of what they saw is presented as Figure 11.

Interviewed at the site 2 weeks after the observation by Ricardo and



Fig. 9. The original densities of 175 to 200 were mapped to 1 to 256 levels of grey ($f=4$, $t = \frac{1}{8}$ sec.).

Carlos Vilchez, they gave a detailed description of the events: First they saw, about 1,800 feet away, a row of three or four post-like cylinders rising to about 3 feet above the surface of the lake, which was quiet and flat as a mirror. These cylinders appeared to be attached to a structure that remained submerged. Later they again saw a series of objects sticking out about 3 feet above the water and 3 feet apart. By then they had driven their tractor much closer to the lake, and they could clearly observe the cylinders which were of a dark hue, either grey or coffee-colored.

After 5 or 10 minutes these objects disappeared, the emerged portions again tilting together as if they were attached to a single submerged structure, and the whole object disappeared back into the lake with significant turmoil and waves.

It should be noted that such observations of submerged objects, although rare, are not unknown in the UFO literature. For example, on September 27, 1978 at 6:40 pm two Italian fishermen in Falcone (Piombino) saw a luminous, bell-shaped object come out of the sea with a metallic sound and fly to within 150 feet of their location, as reported in the February 1979 edition of *Notiziario UFO*.

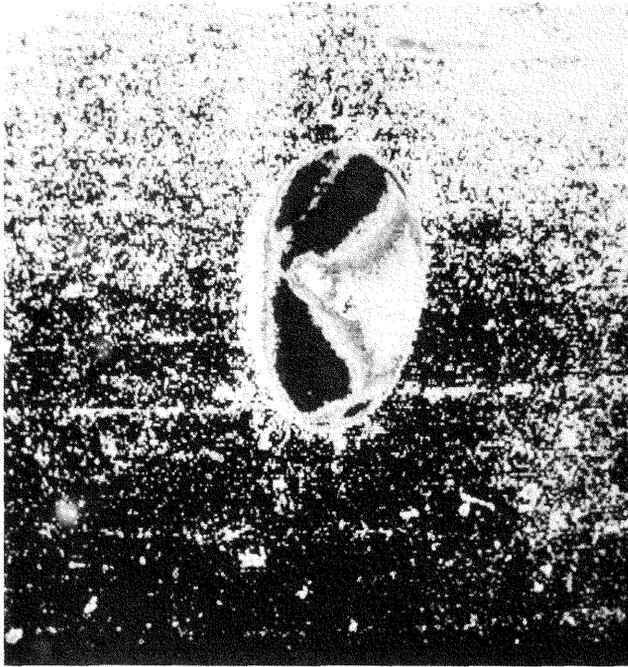


Fig. 10. Emphasis on the disc's surface density differences as well as the lake's luminance distribution ($f = 2.8$, $t = \frac{1}{8}$ sec).

Discussion

A number of questions are raised by this analysis. In particular, we have not been able to provide an interpretation for the fact that the disc's image has a sharply defined edge on the sun's (right) side and a fuzzy edge on the opposite side. The possible significance of the proximity of a geologic fault line is unknown. There is no indication that the image is the product of a double exposure or a deliberate fabrication.

Computer enhancement (cf. Figures 7 and 10) emphasizes extremely small variations in background brightness. Several horizontal lines are most likely printing artifacts rather than real, environmental-related effects. Another feature of interest has to do with the edge of the dark triangular region on the disc's right-hand side. Figures 7 through 10 all show that the top edge of this dark region is more convex than is its lower edge, as would be expected if the disc presented a generally conical surface of revolution.

In summary, our analyses have suggested that an unidentified, opaque, aerial object was captured on film at a maximum distance of 10,000 feet. There are no visible means of lift or propulsion and no surface markings

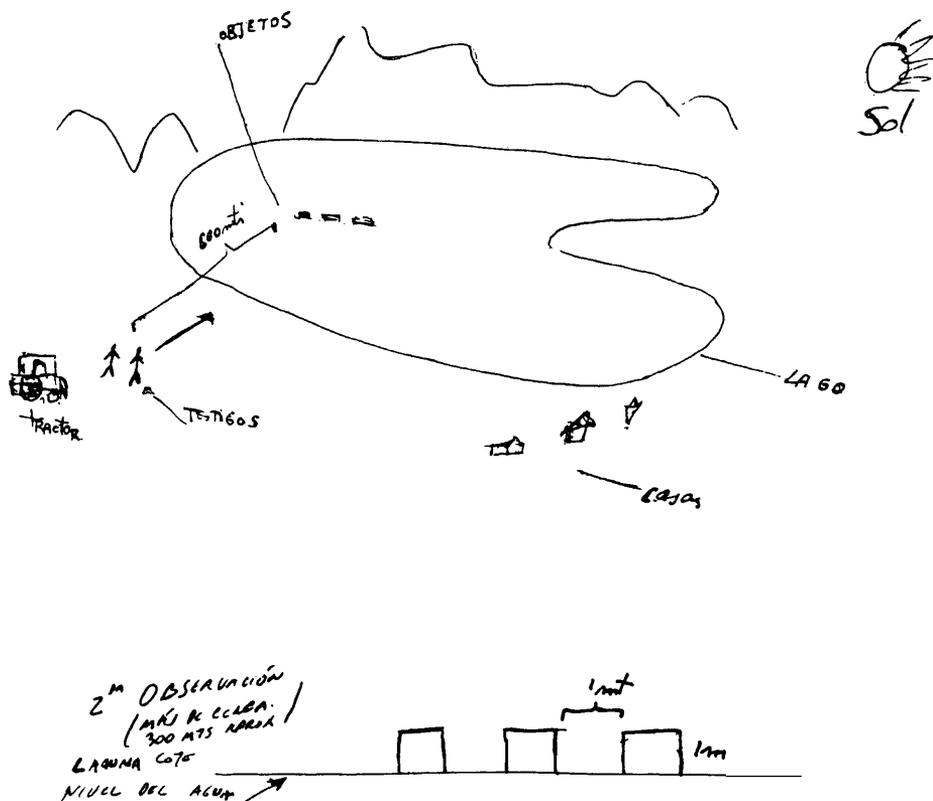


Fig. 11. Sketch by the witnesses.

other than darker regions that appear to be nonrandom. This case must remain "open" until further information becomes available.

**Referee's Review of "Photo Analysis of an Aerial Disc Over Costa Rica,"
by Haines and Vallee, prepared by Marilyn E. Bruner,
Sr. Staff Scientist, Lockheed Palo Alto Research Laboratory**

I have examined the photograph exhibited in the paper submitted by Haines and Vallee and read their discussion with considerable interest. While I agree that the image seen in Figure 1 is very suggestive, my impression is that it probably does not represent a physical object. This impression is based primarily on a visual inspection of the negative (Figure 6) under levels of magnification ranging from $3 \times$ to $12 \times$. The following observations were noted:

- The grain patterns in the northern edge of the oval image appear to be of a different character than those in the remaining parts of the field. Grains are smaller and more closely packed. The photographic density is quite high, appearing to be nearly saturated at the northern boundary.
- The northern edge of the image is abnormally sharp; much sharper, for example, than any physical feature on the coastline.
- There is no evidence of light diffusion or halation that would normally be found adjacent to an image formed by a bright light source. The light areas on the negative (i.e., the "portholes" on the positive image) appear to have the same photographic density as the surrounding water.

The most troubling point is probably the very high density and unusual sharpness of the northern edge of the image. It appears to be a step function. The only other features of comparable sharpness are obvious scratches and other artifacts on the negative. If the high density were due to a bright source, at least some level of flaring, some evidence of lens aberrations, and some diffusion in the emulsion should have been seen. This is certainly the case for the trees, shrubs, and rocks seen along the coastline. I suspect that a quantitative analysis of the image would show that the steepness of the step function exceeds the resolving power of the lens, a point that could easily be tested. The strong variations in sharpness with position around the image boundary are also quite difficult to explain in terms of a photograph of a physical object.

On the basis of these observations and on the authors' discussion of the inconsistent shadow patterns, it is my opinion that the oval image is more likely to be an artifact such as a pressure mark than a photographic image of a physical object. Such a mark could have been caused by a foreign particle trapped between two layers of the film on the supply spool. The gradations in density across the image (the "shadow patterns") could easily be due to thickness variations in the particle; these, of course, would bear no relation to the direction of scene illumination. Thickness variations could also explain the sharpness variations around the perimeter of the image. The doubled appearance of the image on the southeast edge could result if the particle shifted and made a second impression while it was being spooled or being transported in the camera. I did a simple experiment with pencil and tracing paper that suggests that the appearance is consistent with rotation of the postulated particle about a point on the northern boundary of the image.

Obviously this part of the discussion is based largely on conjecture, since the original film was not available for inspection. The particle hypothesis could, in principle, be tested by examining the original negative under strong, glancing incidence illumination. If the image is a pressure mark, it may be possible to find marks or scratches on the emulsion or local deformations in the film base.

To summarize, there are enough inconsistencies in the appearance of the image to raise doubts that it represents a physical object. The most serious of these is that the image's sharpness appears in places to exceed the resolving power of the lens. This issue can and should be evaluated quantitatively. If the resolving power has, in fact, been exceeded, then the observation must be rejected as representing a photograph of an aerial disc. A hypothesis has been advanced to explain the image as a photographic artifact, proposing a method for its formation and a suggested test of its validity.

Authors' Reply to Referee's Review

We are grateful to Marilyn Bruner for her reading of and technical observations on our paper "Photo Analysis of an Aerial Disk over Costa Rica." She raises several points which deserve further comment. These will be addressed in the same order as in her critique. We sympathize with her difficulty in making judgments about our analysis solely on the basis of a third-generation *positive* contrast print since its grain pattern might well misrepresent what is found on earlier generation negatives. In her first paragraph she suggested that she had the negative to study which she did not. We only had a second-generation *negative* to work from. Fortunately, a careful examination of the entire area on this negative under various levels of magnification provides the basis for several clarifications of the points she raises.

Bullet One. We could find no significant change in grain size or spacing anywhere around the outside of this disk on this negative; this is what we said in the original text with regard to Figure 6.

Bullet Two. We agree that photographic density is high along the northerly boundary of the negative suggesting a high level of exposure. Of course this fact, by itself, does not point toward an optical artifact. Based upon optical density measurements alone, the brightest part of the disk is still lower in luminous intensity than sunlit cloud (i.e., $<13,500$ ft-L).

Bullet Three. Another point she raises is the "abnormally sharp" step function of density on the northern edge of the image which, she states, is "much sharper, for example, than any physical feature on the coastline." This is true. However, careful inspection of the entire negative shows several roofs on houses having significantly sharper edges. This fact indicates clearly that the edge of the disk's image has not exceeded the resolution limit of the lens. It is unfortunate that Dr. Bruner could not have inspected the negative prior to making this observation.

The differential sharpness of the disk's image around its circumference is more difficult to explain, at least in terms of a solid, three-dimensional object. One speculative explanation for the diffuse edge on the left side is

that the object is partially submerged so that the water interface produced an irregular boundary.

Bullet Four. Her comment that one would expect more light diffusion or halation around the bright disk than is found here is interesting and raises a number of technical questions that requires far more space than is available to discuss. Suffice it to say that there are several other objects in the field of view that are brighter than the disk which possess extremely sharp edges (viz., roof tops of various buildings). In none of these regions is there significant light spillover from the roof area onto darker, adjacent areas of the film.

The absence of a shadow from the disk remains a puzzle to us. As stated in our article, an obvious explanation is that the object is at the surface of the earth where no shadow would be expected. Another possibility is that the object is opaque, small, and much nearer the airplane so that its shadow's reduced size and darkness would be difficult or impossible to locate on the ground.

Bullet Five. Her reference to light areas on the negative, that is, "the "portholes" on the positive image" is unclear. We did not use the term "porthole" or "portholes" and do not refer to any such areas. Perhaps she is referring to the single circular shaped region at the approximate center of the disk which is a good deal lighter than the average luminance of the disk (on the negative). That particular region is approximately the same density as is the surface of the lake surrounding the disk.

Concerning the Possibility of a Trapped Foreign Particle

We have two major comments concerning this possibility. The first has to do with the kind of an optical image that could be produced purely by a "pressure mark" caused by a "foreign particle trapped between two layers of the film on the supply spool," in the words of Dr. Bruner. If the particle merely produced a dimple in the unexposed film and then came off the film prior to exposure then one would not expect such a highly geometric pattern of light and dark regions produced by the incoming rays from ground-reflected sunlight. It is also unclear how such a film deformation could occur without leaving an oval shaped region of deformation in both the size and spatial distribution of the film grains in that region. A careful examination of the second generation negative shows no such grain deformation. Second, if the particle somehow remained attached to the unexposed film as it rapidly spooled forward within the camera, it would have had to be located on the lens side of the film so its shadow could have differentially exposed the film. Subsequently, as the roll of continuous film spooled on top of itself on the take-up reel, it would have produced another (smaller) dimple there on adjacent film. It is likely that this secondary dimple would have produced a slight physical (and optical?) distortion either on preceding and/or following frames in an equivalent position on the film. The linear distance be-

tween these successive dimples would be approximately the same and a function of the circumference of the film reel at that point. Linear distances between successive dimples would range from 9.42" to 14.1" corresponding to take-up reels with film having diameters of from 3" to 4.5", respectively. A careful examination of frames 299 and 301 show no areas of distortion at the same distance from the edge of the film and between 9.42" and 14.1" on either side of the disk's image position.

In order for thickness variations of an adhered particle to account for the present disk image detail the particle must remain stuck to the film during its initial exposure and must possess a highly geometric pattern of light transmission. While this is possible, it is considered highly unlikely.

If the particle somehow shifted position it would have to have occurred during the optical exposure period of 1/500th second. Several issues arise: (a) Why isn't there a set of double edges on the opposite side of the disk as well? (b) Also, the disk's off-optical axis location on the film would have produced a continuous differential density within the two boundaries on the easterly side of the image rather than only a set of two darker lines with lighter region between them. (c) Finally, a differential blur of these two lines should occur at intermediate points around its circumference. There does not appear to be any such blur.

Dr. Bruner's suggestion to examine the original negative using oblique illumination is an excellent one. However, her suggestion that the disk is due to an optical effect produced by an adhered foreign particle is not supported by a careful analysis of the negative that is in our possession. We are continuing to try to obtain the original negative for further study.