



example causing scintillation, especially near the horizon. Occasionally temperature inversions, where a layer of warm air lies over a colder one, cause mirages of bright objects near the horizon, not excluding astronomical objects. Such mirages can be greatly enlarged due to a lens effect in the atmosphere, although distortion is to be expected. Inversions can also cause double images, with an inverted image under an upright one, and these two images can merge into one another. Inversions are usually horizontal, stationary and plane. But if they are curved and dynamic, the mirage image can be seen anywhere in the sky and moving about it! Protean images are characteristic of mirages.

What Barauna's pictures appear to show is a double-merged magnified mirage of Jupiter! The two 'domes' on the object are the upright and inverted images of the same part of a magnified image of Jupiter.

Viegas's estimate of the size of the image can be checked from the pictures. From the focal length of the camera (80mm) and the film size (60mm<sup>2</sup>) we can calculate that the central 'dome' on the clearest image is about 0.5° high and about 1° wide. The full moon is about half a degree wide. Consequently the magnified image is, at least, the size of the full moon, indicating magnification by a factor of 50 times in the vertical direction and 100 times in the horizontal!

The movement of the image indicates that a temperature inversion had folded down to the south-west so that its surface was nearly vertical. Thus the vertical component of the thermocline (the zone of rapid temperature change) could contain a wave which drifted first one way and then another. The accounts indicate that the wave moved to the south and then back again to the north, taking the mirage with it. The concave part of the thermocline could duct the image around until the change in curvature allowed it to be seen by anyone in the line of

sight. The exact line of the thermocline cannot be determined but it is evident that the ship lay at a point that enabled the crew to see the image. Whether there was only one such point we cannot tell. The thermocline would have been curved in two directions, like a shallow bubble. This is why the mirage is elevated as well as being displaced laterally. The image reached a maximum elevation of about 22°. The regular 'course' of the image indicates regular curvature of the thermocline, the radius of curvature decreasing with increasing angle from Jupiter. Necessarily, the curvature of such a thermocline must be gradual and the inversion responsible must have been spread out across the ocean. The bat-like movement of the image indicates that there were ripples in the inversion layer. Whether the image was dark grey as Barauna suggested, or 'brighter than the moon' as Viegas put it, an enlarged image of Jupiter in daylight may well have looked like reflecting grey metal. The pictures do not show a bright object, but that could be due to the glittering or flashing reported by Barauna. If the image flashed very brightly occasionally (and of course at the moment of exposure) then a dark image could be recorded due to the Clayden effect — a failure of the high intensity reciprocity law. Such flashes could be due to strong focusing in the thermocline or an interference effect known as Raman brightening. The green cloud was probably caused by differential refraction, very noticeable near the horizon. Although the sky was cloudy, it was not completely obscured, as some of the pictures show, and it must be assumed that Jupiter was not obscured on the horizon. All the clouds must have been at a height greater than the inversion.

## Conclusions

It cannot seriously be considered that the object was

a flying craft, certainly not that it came from another planet. Not only is this hypothesis unlikely in extreme, there is no evidence to support it. In fact the apparent changes in shape exclude it.

Nor can one take the allegations of a UFO seriously. The photographer was not alone, nor was he with just a few friends. His witnesses included Brazilian sailors, some of them senior officers. The pictures show an object that appears to agree with what was described and there is a consistent sequence of pictures. Faked pictures are rare and consistent. A photographer who took what he thought was a series of faked UFO pictures is unlikely to pretend to miss two of them and to make different models for each picture. Those who believe it is a hoax must explain how it was done, why it was done and why the images change shape from frame to frame. Photographs released by the President of Brazil must surely be taken seriously.

Few alternative explanations are available and one is driven to conclude that the object was a mirage of Jupiter (however unlikely that may seem). Such a mirage completely explains the object's appearance (especially its changeable appearance) and behaviour. It explains why it was seen when it was and why its appearance was so fleeting and why the object made no noise.

If the pictures do show such a mirage, they are very valuable. I know of no similar pictures. I show a rare natural phenomenon, one that has hitherto yet been catalogued by science. The original negatives are probably still in Brazil; one hopes they are in a safe place.

## References

- Fontes, Olavo T. UAO Sightings Over Trinidad. *The APRO Bulletin* Jan and Mar 1960.
- Smith, Willy Trindade Revisited, *International UFO Reporter* Jul/Aug 1983.