Mirage–Magic of the Air

By Jerry Laudermilk
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Everybody is interested in mirages. In the popular mind they are as closely associated with the desert as cactus and heat and rattlesnakes. Weird and fantastic are the tall tales stemming from a desert rat's experiences with these illusive images. But the explanation of this optical phenomenon is not so well known. Jerry Laudermilk. who can "make" a mirage at will in his laboratory in Claremont, California, tells Desert Magazine readers how mirages are formed. He warns. "This is going to sound like some of the yarns your grandfather used to tell about the wonders he saw in the sky when he crossed the plains in a prairie schooner. His story was true. This story also is true."

ONE DAY in the middle of June, I was returning with friends from a visit to Pisgah crater on the Mojave desert of California.

We had heard that the lava beds at Pisgah become really hot at this time of the year, and were curious to know just how it would feel to spend a couple of clays in the desert's most extreme temperatures.

We found out. Badly sunburned from our hike across the lava flow we discovered that the only kind of grease we had to rub on our faces was oil drained from a can of sardines. We smelled like a gang of Eskimos, and in order to delay our homeward trek we decided to make a side trip to Calico. So we turned north at Daggett.

Lateral mirage. Vertical sheets of air of different density, probably rising columns of warm air, sometimes distort distant mountain ranges so that they seem to be fantastic cities with tall buildings. Shapes waver and fade like things enchanted. This mirage is most common on a bright morning following a cold night.

The road to Calico crosses Calico dry lake directly west of Yermo. We were about half way across when, like a trick on the stage, over toward Yermo, there appeared a beautiful lake with the cottonwoods, water tank, depot and houses reflected exactly as they would have looked had the lake been full of water instead of an expanse of hard-baked clay. At times a passing breeze would make the reflection tremble as it would in actual water. It was realistic enough to have deceived anyone not familiar with mirages.

I always had wanted to run down a mirage. This looked like a perfect opportunity. The surface of the lake was like a racetrack. We headed straight into the mirage. We never caught up with it. The thing was always just out of reach. Soon we had crossed the lake. We stopped the car and there was little old Yermo mopping her brow in the heat and looking no different than usual.

Since then I have gone on many mirage hunts - and have found some beauties. One of the best was at Bristol dry Jake. I came down from Sheephole mountains and there was the mirage, apparently cool and peaceful expanse of water. On the opposite side stood a herd of what looked like giant giraffes. Sometimes they seemed to squat down, then stretch their necks upward high in the air. I drove on and was soon at the old Bristol salt works. My giraffes were the buildings twisted and changed by the heated air. The unusual thing about this mirage was that there really was water - a canal about three feet wide lined with beautiful salt crystals where two lone mud-hens, evidently stranded on their way to more friendly surroundings, paddled around in circles. The mud-hens and the water had nothing to do with the mirage.

THE INFERIOR IMAGE

My acquaintance with mirages had begun in Arizona many years ago. I learned that there were several distinct types of mirages. The one we saw at Yermo is the commonest kind and is called an inferior mirage. Here things are reflected base to base as in an ordinary reflection in water. In a superior mirage, the inverted image appears above the object, top on top. The Bristol dry lake appearance was a combination of these two types of mirage. In another type, distant mountains and buildings assume forms quite different from their own. This kind seems to have no name.

"Towering" is a form of mirage not often seen in the desert. In this case, a distant object is seen in its true position but apparently much larger - and closer than it actually is. I was once fooled by a mirage of this kind near Octave, Arizona. The assay office at the mine, although eight or ten miles away, appeared to be almost within calling distance, every detail standing out as clearly as if seen through a telescope.

Inferior Mirage. Here the inversion layer, air of different density, is below the eye level of observer. Effect is same as reflection from a horizontal mirror. This is the most common type of mirage.

Combinations of mirages sometimes produce fantastic results. Once I was on the morning train going from Wickenburg to Phoenix. The day was cool but the sun was shining brightly. There were cloud banks apparently dose to the ground. As the train was about to pass under one of these formations, the conductor came to my seat and said, "There is going to be a good show in a minute and I want you to see it." I went with him into the smoker, and for about 15 minutes that train plowed through pure fantasy.

This is going to sound like some of the yarns your grandfather used to tell about the wonders he saw in the sky when he crossed the plains in a prairie schooner. His story was true. This story also is true. At an altitude of about 500 feet there appeared line after line of shapes resembling soldiers marching in battalion front. These soon were replaced with what looked like a vast herd of buffalo. By using my imagination, I could see almost anything. The show ended with cloud formations resembling grotesque buildings and things without names drifting through the sky. The conductor was as proud of that mirage as if he had staged the whole thing for my benefit. This was probably a case of superior mirage combined with alto-cumulus clouds.

When I returned to my quarters near Wickenburg, I still had mirages on my mind. I rigged up an apparatus for producing the effect artificially. This consisted of a board platform covered with black building paper set up on saw-horses. At the forward end I modelled a miniature range of mountains in plaster of paris about two inches high and colored them brown with water from a rusty tin can. Since it was out of doors in bright sunlight, it did not take long for my apparatus to heat up. It worked perfectly. When I looked from above the hot layer, the mountains seemed to be reflected and inverted just as they are in an inferior mirage. By sighting up and down across the hot layer for a few fractions of an inch, I could see every stage of an inferior mirage from just the faintest suggestion to the perfect illusion.

Superior mirage. This time the inversion layer is above eye level. Things are reflected as if from a horizontal mirror overhead. An uncommon type, it may be mistaken for a strange cloud effect.

The "why" of mirages is rather simple. Sir David Brewster and others worked out forward and downward as they penetrate the hotter layers until at a certain point they begin to turn up again like a wooden coat hanger held horizontally with the rounded side toward the floor. In fact, a coat hanger with a straight bar to hold your trousers makes a good piece of apparatus to demonstrate just what I am explaining.

On cool bright days, the surface of the desert heats up and a layer of heated air extends upward for several feet. This is the thin or speeding-up layer. In the diagram, I show these layers like a cross-section through a layer cake. It is not exactly like that, because as the hot air rises it becomes mixed, so that beginning with a hot layer at the bottom it finally shades off into a layer of normal coolness and density at the top without any well defined cleavages. There actually is no well-defined stratification between the layers. I merely show it this way for convenience.

Light rays from a distant object shoot out in all the directions from which the object can be seen. Some go straight ahead like the straight bar on the clothes hanger, but others go slantwise like the curved side. In the case of an inferior mirage, what we see is the result of viewing the object by way of two sets of rays. The horizontal rays show the object in its true position. The oblique rays begin to bend the instant they strike the heated layers. They travel forward on a downward curving slant until finally they reach a point where they undergo total reflection and begin to be refracted out of the hot layer in another curve equal to their first bending. Finally, the image produced by the oblique rays will reach the eyes of an observer by way of the last of these rays to enter the eye and appear upside down as if reflected in a mirror placed flat before the object. This is all shown in the diagram.

THE SUPERIOR MIRAGE

Now for the superior mirage. It is called superior because the layer where oblique rays bend - the "inversion layer" - is rather high above the horizontal gaze of the observer. It is the coat hanger with the

straight side toward the floor. The effect is just as shown in the diagram. If you have remembered the conditions in the case of the inferior mirage, this type is just as simple.

Understanding these diagrams is far less difficult than it is to see how your wife can take some fantastically-shaped pieces of tissue paper and cut out a dress from apparently less cloth than she has paper. Studied from the purely mathematical side, mirages can be pretty tough. The explanations I have given are just the bare facts but provide a good working basis.

Multiple-Superior mirage. Several inversion layers above observer's eye level may produce weird effects. Distant objects are changed by the heated air into totally fantastic things.

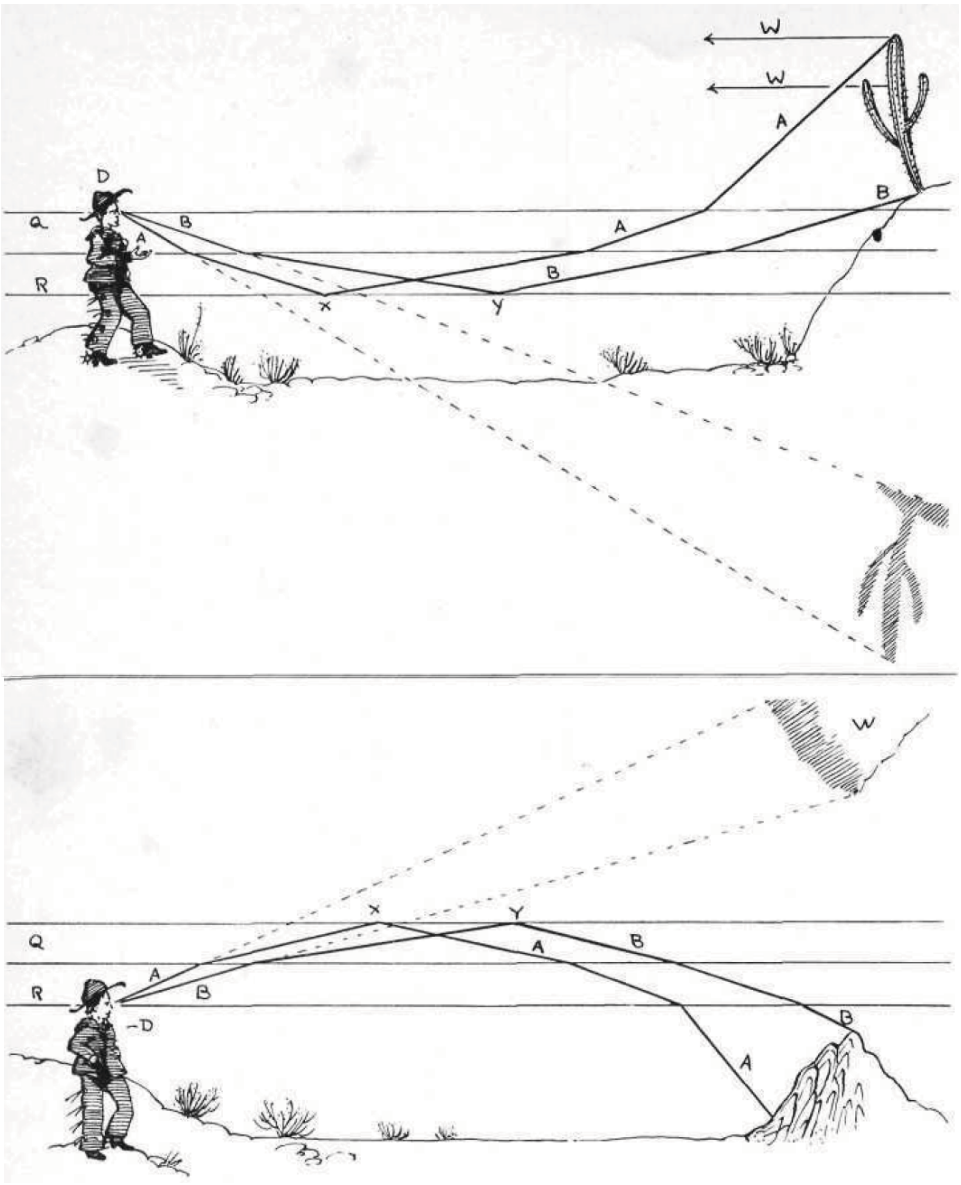
Mirages are not confined to the desert. In fact, the superior mirage is seen most frequently at sea. Some cases are recounted in an interesting book called "Elementary Meteorology" by John Brocklesby. Although this book was published in 1849, it is a fine work for the general reader who wants a painless initiation into the mysteries of the atmosphere. Brocklesby cites some remarkable cases of mirages.

For instance, at Ramsgate, England, on August 1, 1798, an observer, Dr. Vince, saw a ship low on the horizon, just the topmasts being visible. In the sky above the ship, which was practically invisible, were two perfect images of the entire vessel. One was upright, the other inverted, and the hulls were apparently touching. Even after the topmasts had passed out of sight the images were still distinct. This is a classic example.

At Ramsgate again, on August 6, 1806, Dr. Vince saw a remarkable mirage of Dover Castle. Ordinarily, only the turrets were visible from the Ramsgate side because a hill obstructed the view. On this day, the entire castle was to be seen from Ramsgate. Both these mirages were probably due to the effect of "towering" combined with the superior mirage.

Mirages, aside from the annoyance they cause prospectors and surveyors, sometimes have been of extreme importance. Humphries, in his book, "Physics of the Air" says that during a battle between the English and the Turks in 1917, the fight had to be called off because of a mirage which caused far distant objects to appear displaced from their true positions. So mirages have to be taken into account by artillerymen, surveyors, astronomers and others who have to make long telescopic sights.

Like all natural phenomena, mirages are capable of both a simple and a technical explanation. To go into the subject simply, as I have done leaves much unsaid but it dodges a lot of trigonometry and does give a groundwork for the study and appreciation of mirages.



Above - Section through an inferior mirage. At D, the Dude stands with his eyes at about the level where warm to hot layers. Q, R, shade off into cool layer. Rays from cactus are reflected in all directions from illuminated side. Some of these marked W travel straight toward the Dude and show cactus in its true position. Other rays, A and B, shoot obliquely downward into warm or refracting layers and bend downward and forward until at X and Y they undergo total reflection, bend upward on a concave path and finally carry an inverted or apparently mirror image to eye of Dude. Consequently he sees two images of cactus – the normal, by way of W rays, and those by the ben rays A, B. Drawing is exaggerated, as distance from Dude to cactus actually would have to be one half to several miles.

Below – Superior mirage. Here, the Dude stands in layer of cool air at about the level where this blends off into a warm to hot layer Q, R above his head. This layer may be several feet thick. Another cool layer lies on top. Rays from the butte in distance do the same thing that happened in case of the inferior mirage, but here total reflection layer is at the top ad conditions are reversed. The Dude sees a shadowy image of the butte in the sky at W. These two figures redrawn and adapted by the author from "Elementary Meteorology," by John Brocklesby.

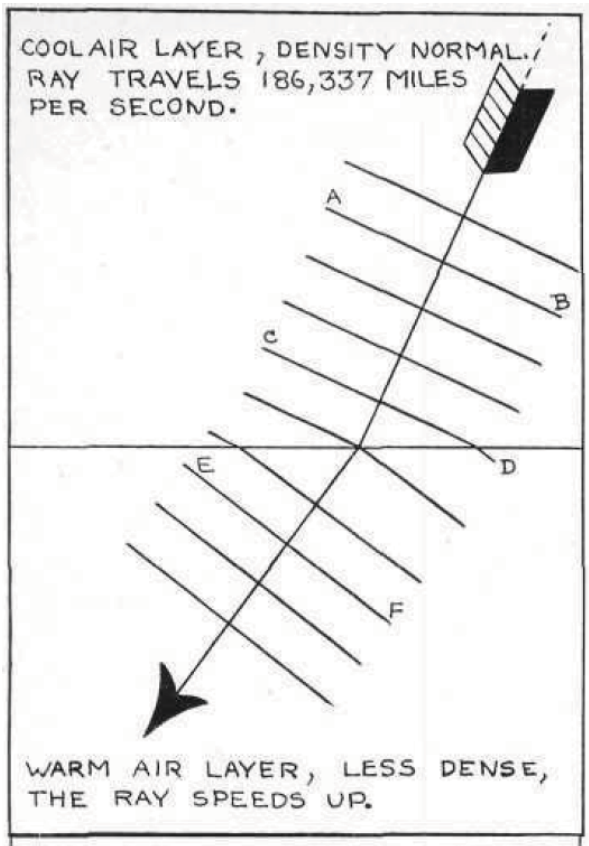


Figure 1 – Imagine a light ray from any illuminated object as being a sort of disturbance traveling forward as a cylinder that moves through the air of normal density at the rate of 186,337 miles per second. In warm, or less dense, air the ray travels slightly faster. Suppose A-B, C-D and E-F to be cross-sections of the ray. When the ray passes obliquely into the war or speeding up layer the edge D, which strikes the layer first, is bent forward as shown. As the ray passes deeper into the war layer t becomes entirely bent as at E-F, so the whole ray finally is bent forward in the direction of arrow. This bending of a ray is called refraction and the cause of 99 percent of a mirage.

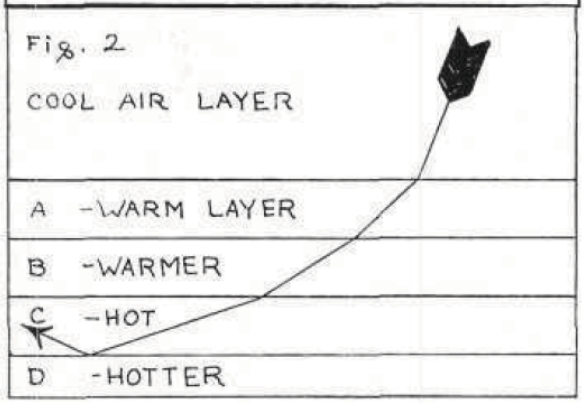
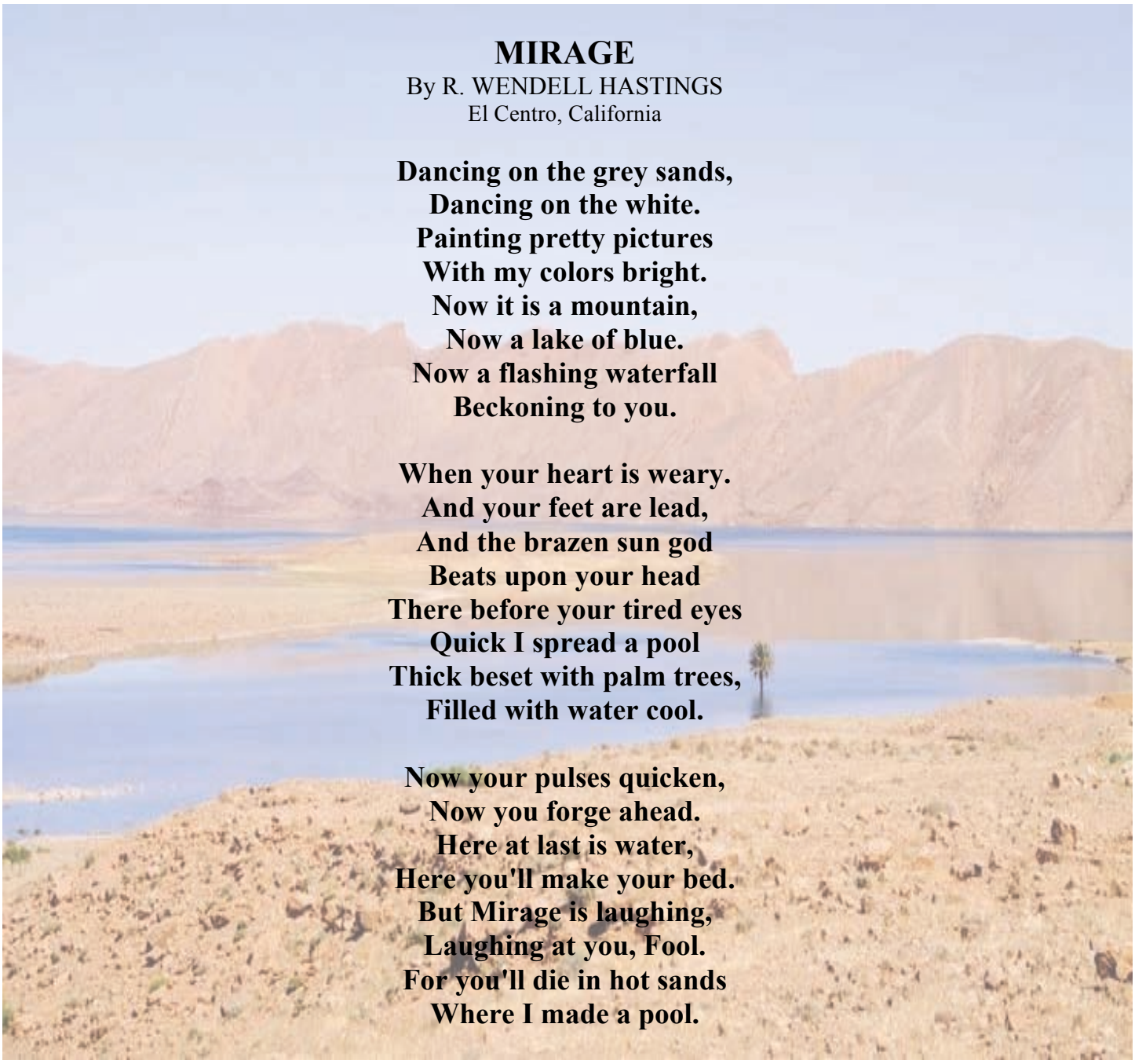


Figure 2 – At A, B, C, D a ray is shown passing into layers of air of decreasing density, traveling faster as it enters each layer. Finally, ray reaches a layer at such a small angle it no longer penetrates, just skims the surface and begins to turn up and be totally reflected at D. Actually, the layers are not as sharply separated as shown.



MIRAGE

By R. WENDELL HASTINGS
El Centro, California

Dancing on the grey sands,
Dancing on the white.
Painting pretty pictures
With my colors bright.
Now it is a mountain,
Now a lake of blue.
Now a flashing waterfall
Beckoning to you.

When your heart is weary.
And your feet are lead,
And the brazen sun god
Beats upon your head
There before your tired eyes
Quick I spread a pool
Thick beset with palm trees,
Filled with water cool.

Now your pulses quicken,
Now you forge ahead.
Here at last is water,
Here you'll make your bed.
But Mirage is laughing,
Laughing at you, Fool.
For you'll die in hot sands
Where I made a pool.