



# VII. Remarkable atmospheric phenomena in Ceylon

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To cite this article: Rev. R. Abbay M.A. (1876) VII. Remarkable atmospheric phenomena in Ceylon, Philosophical Magazine Series 5, 2:8, 58-61, DOI: [10.1080/14786447608639160](https://doi.org/10.1080/14786447608639160)

To link to this article: <http://dx.doi.org/10.1080/14786447608639160>



Published online: 13 May 2009.



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the last three years. As compared with the composition in 1853 and 1867, the most striking difference is exhibited in the quantity of potash, which is less than one seventh of the amount observed in the latter year. The amount of lime is also considerably less ; and the diminution in both constituents is accompanied by a corresponding decrease in the amount of chlorine. The amount of barium salt in the water is unusually large, and appears to be increasing. So far as is known, no mineral springs in this country or on the Continent contain so large a proportion of this substance as the Harrogate waters. The quantity, indeed, in the Old Sulphur Well is as large as the entire amount of soluble matter contained in many of the waters used for domestic supply in our towns. So potent an agent present in such large proportion must undoubtedly exercise considerable influence on the therapeutic action of the water ; and therefore it is highly desirable that the determination of its amount should be repeated from time to time.

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VII. *Remarkable Atmospheric Phenomena in Ceylon.* By the Rev. R. ABBAY, M.A.\*

ONE of the most startling and extraordinary of all atmospheric phenomena may be seen during fine weather from the summit of Adam's Peak in Ceylon. This mountain rises extremely abruptly from the low country, and by its elevation of 7200 feet above the sea commands a most extensive and map-like view of all the low lands to the south-west and north-west for a distance of 50 miles or more up to the sea coast. The upper part of the mountain is an acute cone of solid rock, some 2000 feet or more in height, that rises in perfect isolation above the range of which it forms a part, and also above all the neighbouring mountains to the east and north. The phenomenon, which is described by all who have witnessed it as of the most striking character, is seen at sunrise, and consists *apparently* of an enormous elongated shadow of the mountain projected to the westward, not only over the land but over the sea, to a distance of 70 or 80 miles. As the sun rises higher it rapidly approaches the mountain, and appears at the same time to rise before the spectator in the form of a gigantic pyramid of shadow. Distant objects, a hill or a river (or even Colombo itself, at a distance of 45 miles), may be distinctly seen through it, lighted up by the sunlight, diffused most probably by the surrounding illuminated atmosphere ; so that the shadow is not really a shadow on the

\* Communicated by the Physical Society (read May 27).

land, but a veil of darkness suspended between the observer and the low country. All this time it is rapidly rising and approaching, and each instant becoming more distinct, until suddenly it seems to fall back on the spectator, like a ladder that has been reared beyond the vertical; and the next instant it is gone. Of the accuracy of the above facts I have no doubt whatever. A great number of trustworthy witnesses have described it to me; and but for a sudden attack of fever at the foot of the peak, which prevented an ascent being made in the evening, I should have been able to describe it from personal observation. As it was I ascended next day and was able to form a very good idea of the conditions under which the phenomenon takes place; but I was, of course, unable to obtain accurate data as to the duration of the veil, the height to which its apex rises above the horizontal, the elevation of the sun, &c. If I am right in supposing that no explanation has ever been offered of this remarkable appearance, the following remarks, which appear to be fairly satisfactory, may perhaps not be uninteresting. The average temperature at night in the low country, during the dry season when Europeans ascend the mountain, is between  $70^{\circ}$  and  $80^{\circ}$  F., whilst that on the summit of the peak is from  $30^{\circ}$  to  $40^{\circ}$  F. Consequently the lower strata of air are much less dense than the upper; and an almost horizontal ray of light passing over the summit, must of necessity be refracted upwards and suffer total internal reflection as in the case of an ordinary mirage. This may be readily seen by a reference to fig. 1, where a

Fig. 1.

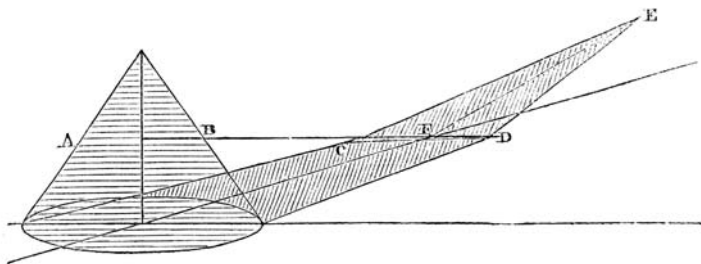


nearly horizontal ray passing over the summit of the peak P suffers total internal reflection at A, and is deviated upwards in the direction A B; or when a less horizontal ray is refracted at C, reflected at D, and refracted again at E, it finally issues along the line E F. It will be evident from fig. 1 that the shaded parts represent the veil of darkness at three different moments of time, and also that the veil appears to rise as its base approaches the mountain, *i. e.* as the sun rises and the rays fall less horizontally.

By referring to fig. 2 it will be seen how the aerial shadow of the upper part of the peak, *i. e.* the part above A B, suffers total internal reflection, and is thrown upwards into the air as C E D. It will also be evident, by comparing the two figures,

that as the veil of darkness approaches it must tend to assume a more vertical position until it reaches the critical angle

Fig. 2.



when total internal reflection ceases and the veil suddenly disappears. Its apparent tilting over on the spectator I imagine to be merely an illusion produced by the rapid approach and rising of the dark veil without any gradual disappearance which can be watched and estimated. It will be evident that it is the illumination of the innumerable particles floating in the atmosphere, and capable of reflecting light, that causes this aerial shadow to be visible by contrast.

Another atmospheric phenomenon visible in Ceylon, of great interest but not so striking in character as the above, admits of an equally simple explanation. Not unfrequently in the mountain districts broad beams apparently of bluish light may be seen extending from the zenith downwards, converging and narrowing as they approach the horizon. This ray-like appearance is very similar to that seen before sunrise; only the point from which the rays proceed is *opposite* the sun: the rays themselves are very broad and blue in colour; and the spaces between them have the ordinary illumination of the rest of the sky. If we suppose in this instance that the lower strata of air are colder than the upper (a condition of the atmosphere which not unfrequently occurs in a tropical mountain district like that of Ceylon, where large currents of heated air sweeping up a valley cross another valley nearly at right angles and at a considerable elevation above it), the refraction spoken of in the case of Adam's Peak will be downwards instead of upwards. If, too, the observer be *below*, the veil of darkness will appear to him like a very elongated triangle apex downwards, or broad ray, through which the blue sky beyond may be seen free from the palish illumination of the atmosphere, whilst on either side the ordinary illuminated sky will be seen. If now we suppose several isolated masses of cloud to partially obscure the sun, as was the case when I witnessed the phenomenon,

we may have several corresponding inverted veils of darkness, like blue rays in the sky, all apparently converging towards the same point below the horizon. This apparent convergence of the beams is merely an effect of distance, as in the case of parallel rays of light from the rising or setting sun, the blue rays being practically parallel bands in the atmosphere devoid of illumination. It will be evident that conical-shaped clouds are not necessary to produce this effect. Isolated clouds of any massive form would be sufficient to throw the bands of shadow through the illuminated atmosphere, and refraction and perspective would do the rest. The above phenomenon is called by the Singhalese "Buddha's rays;" and though according to Sir Emerson Tennent it is very varied in character and appears in different parts of the sky, yet I have only seen it when the sun was low at evening and when the rays converged to a point, apparently directly opposite the sun; and I do not think it possible for the phenomenon to be seen in any other position.

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VIII. *Formation of the Ocean-beds by Deformation of the Spheroid.* By ROBERT MALLET, F.R.S.\*

IN a paper read before the Cambridge Philosophical Society, February 22, 1875, by the Rev. O. Fisher, entitled "On the Inequalities of the Earth's Surface as produced by Lateral Pressure, upon the hypothesis of a liquid substratum" (Camb. Phil. Trans. vol. xii. part 2), for a copy of which I have been quite recently indebted to the politeness of the author, I find the following:—"If solidification of our globe from a fluid state commenced at the surface, the amount of radial contraction in the solid parts beneath the surface of the mountain-region has been less than in the parts beneath the sea-bed. In fact it is this unequal contraction which appears to have caused the hollows in the external surface, which have become the basins into which the waters have flowed to form the ocean." These views of Archdeacon Pratt's (*Figure of the Earth*, 1871) appear to be adopted by the author, who proceeds:—"Mr. Mallet, in his paper on Volcanic Energy (see Phil. Trans. Roy. Soc. 1873, part 1, paragraphs 52 to 56), takes a similar view. He thinks that the land and sea boundaries were shaped out by radial contraction during the first great stage of the operation of refrigeration, while the crust was thin and flexible, owing to the rapid contraction of its viscous portion which must then have been much thicker than the solid sheet above it." It seems to me that I am thus, when taken in connexion with the rest of

\* Communicated by the Author.