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Ball Lightning, Crustal Diagnosis, Hydrocarbons Deposits

Valentino Straser
Italian Ministry of Education, Italy

Abstract: Luminous phenomena in the atmosphere occurring in various zone of the world, and only few years ago the scientist are attracting from this. The physical mechanism that regulates the light phenomenon has not been fully understood yet. Various hypotheses that are being formulated about it. The anomalous luminous phenomena are connecting with the faults and magnetic anomalies. One of the hypothesis proposed this study, is the relationship between hydrocarbon reservoirs and luminous phenomena in the atmosphere, near the oil fields. This survey held in the Po Plain Valley in Italy for five years. The scope of this study is to analyze the different type of ball lightning distinguish on the base of energy emitted by the luminous globes, and the potential application for crustal diagnosis in tectonic areas and for the preliminary investigation of hydrocarbon deposits.

Key words: anomalous luminous phenomena in the atmosphere, crustal diagnosis, pre-seismic signals, hydrocarbons, plasmas

1. Introduction

The ball lightning (BLs) are luminous phenomenon in the atmosphere. They appear like “spheres” of variable diameter. They could be observed steady or on moving at variable speeds. BLs do not only appear in Italy, but they also occur in particular areas of the World [1].

The ball lightning, after appearing in the sky, rarely remain stationary in the same apparent position. In a lot of cases, they move in a straight line and then go out suddenly.

Recent studies [2] suggest that the shift of light balls follows, in most cases, fault lines in tectonic areas or, in other cases, occur on hydrocarbon deposits [3]. In Italy, in addition to the survey area, around Lendinara near Rovigo in Po Plain Valley (Fig. 1), there are frequent anomaly light phenomena in Central Italy (Sibillini Mountains), Adriatic Sea (Gabicce), in the Northern Apennines (Sassalbo, Taro Valley), Venice Lagoon. The Po Plain Valley, in the Northern Italy, between Rovigo and Venice, has been monitored by the 45 GRU Group for 17 years to detect the anomalous light phenomena in the atmosphere, where frequent sightings occur during the year.

Most cases of light phenomena occur near Lendinara, in the province of Rovigo, and these phenomena are usually detected in the Pradespin area (Lat.45, 115446 Long.11,584147) along the Adige River.

Usually the balls lightning are observed in the south direction, towards Emilia Romagna Region, and in some cases, the light phenomena have also occurred in the same area near Lendinara.

2. Aim of the Study

The research objectives are as follows:

(1) Collecting scientific data;

(2) Measure and quantify the phenomenon analyzed;

(3) Recognize the abnormal phenomenon among the known.

Corresponding author: Valentino Straser, Independent Researcher; research areas/interests: earthquake prediction. E-mail: valentino.straser@gmail.com.

3. Ball Lightning in the Survey Area

The sightings of anomalous luminous phenomena in the atmosphere are not exclusive of the Italian survey area, they are reported in various parts of the world, but they are not always frequent or easily observable, because they are visible especially during the night hours.

The colors taken by the balls of light in the study area are usually red, yellow-orange or white. The globes trajectories are recurring and generally horizontally. Sometimes a single globe can generate other small lights that sometimes orbit around the main one, or they can observe more than one.

The trajectories are not affected by the wind and they are sensitive to magnetic fields [4-7]. The sightings can occur at any time of the night, and seasons of the year, but are more frequent during the first four hours after sunset [8]. The apparent dimensions of the ball lightning are those of a grapefruit and, at least in one case, the energy calculated was 10-20,000 watts of visible wavelength power [9]. The duration of sighting reported was going from few seconds until 3 minutes.

Some types of appearances have been related to tectonic and seismic activity [2], as a response to an incipient stress, or to zones where hydrocarbon, petroleum or refinery emissions are known [3].

Fig. 1 Survey area, Pradespin di Lendinara – Rovigo, Italy, Lat. 45,115446 – Long. 11,584147.

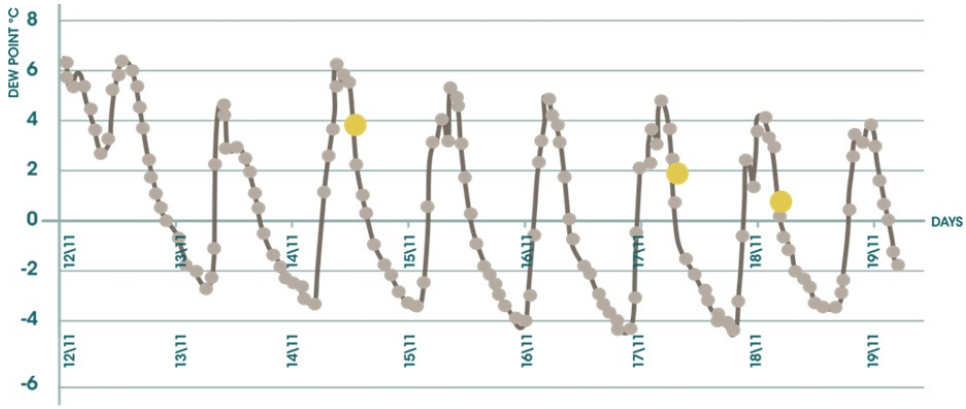

Fig. 2 Condensation points in 12-19 November 2011. Squares denote the number of luminous objects seen.

4. Hypothesis on the Genesis of Light Phenomena in Relation to Tectonic Stress and Hydrocarbon Deposits

Usually, anomalous light phenomena occur in areas subject to tectonic stress [10] or, in the case of Hessdalen (Norway) to isostatic reassembly [11], coincide with magnetic anomalies or they are associated to hydrocarbon deposits, gaseous or primary and secondary magmatic phenomena [12].

Laboratory experiments have shown that tectonic stress can produce magnetic anomalies and gaseous elements can give rise to low-pressure ground plasmas [13-15]. Plasma is a fourth state of the matter where one or all of the particles are ionized. The plasmas are molecules of gas are sufficiently hot, composed from

atoms with more or less electrons (i.e., charged particles, positive and negative ions).

The plasma, like gas, has no defined shape or volume but, unlike gas, plasma is very sensitive to magnetic fields and this may explain the ability of anomalous light in the atmosphere to withstand wind currents and move horizontally at low altitude.

The plasmas, upon reaching the atmosphere, transfer heat into the cold air of the night disrupts the plasma energy components that burn by capturing atmospheric oxygen to form water molecules to give visible light.

Further laboratory experiments and field observations have made it possible to associate the anomalous luminous phenomena in the atmosphere in organic remains, animal and vegetable, and polymers [16-20].

5. Methodology

The method is grounded on the comparison between the plasmas of the survey area, where there is a certain presence of hydrocarbons, compared to those observed in tectonically active areas. Anomalous phenomena in the atmosphere are not all of the same type, shape, duration and color, such as the sightings of Hessdalen (Norway), Marfa (Texas), Min Min (Australia) and Po Plain Valley (Italy).

6. Instruments

6.1 Optical

Nikon F65 reflex camera with zoom;

Fuji Finepix S5600 digital camera;

Fuji Finepix S5Pro, digital camera 12.34 Mpx;

Fuji Finepix S3Pro, digital camera 12.34 Mpx;

Infra-red and UV filters for reflex cameras;

Rainbow Optical Spectroscope (ROS) filters for medium resolution spectroscope;

Star Analyzer 100 filter for low resolution spectroscope;

1000x114 altazimuth frequency telescope, computerized for lunar video shots.

6.2 Video Equipment

Video cameras for astrometry and radio apparatus;

Micro CCD color TV cameras for astronomical shots through a telescope; 3ccd video cameras, 600 lines;

Analogue – digital converter.

6.3 Software

Spectrographic software to detect radio signals;

Spectrographic software to detect audio signals;

Spectrographic software to detect ELF/VLF signals.

7. Discussion

From field analysis, using a portable weather station, it has been observed that the appearance of ball lightning occurs predominantly when the dew point and the air temperature decay after passing a relative peak (Fig. 2). The ball lightning phenomena appear singularly or in groups of 2 or 3, in precise physical conditions in the atmosphere: decreasing temperature after a sharp fall of over 13°C, and sometimes even greater, during the day, in an interval between 1° to 4°; a wind speed generally equal to or lower than 1 m/sec, and a condensation point between 2° and 4°C.

Contrary to the areas of the oilfields (Fig. 3), the balls of light detected in the tectonically active areas, generally occur close to the ground with vertical or horizontal movements (Fig. 4), a few times a year, and precede earthquakes with the epicenter located near the area of appearance of the BL, usually within a radius of 50 km. In this case, the movements of the balls of light are done without noise and last for about one minute before dissolving. The trigger mechanism of the balls of light is assumed may result from particular atmospheric conditions and the concomitant presence of gas in the atmosphere and ions, without neglecting additional elements such as, for example, the natural radioactivity or generated electromagnetic anomalies, in fact, by crustal stress.

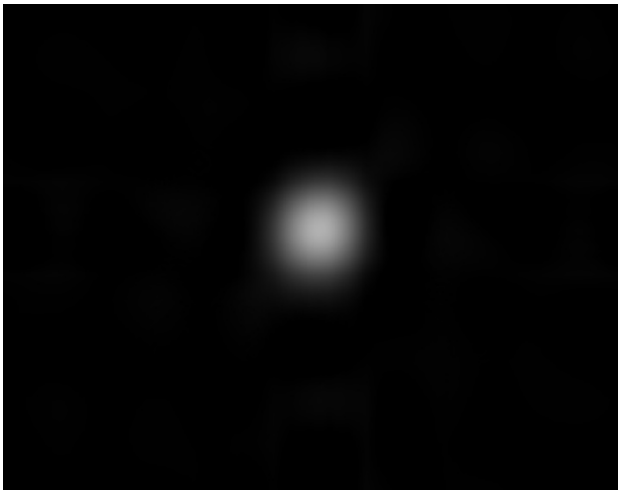

Fig. 3 Picture of ball lightning sightings associated by oilfields or hydrocarbon deposits.

Fig. 4 Ball Lightning observed near Rovigo on August 15, 2016, before the seismic sequence in Central Italy.

From a physical point of view, for a correct comparison of the luminous phenomena in the atmosphere, the radiant energy level (**P**) of the light sphere obtained from the image can be calculated using the equation proposed by Maccabee [21] and recovered from Teodorani [22]. In equation (1), d is the distance in m, **E = I x A** (lm/sec) is the total energy received by the film (100 ASAs), **I** is the energy per unit area of the image **L** is the area of the image (m^2), **V** is the optical visibility distance (m), τ the duration of the light phenomenon expressed in seconds, **F** and **f** indicates the focal length, **D = F/f** lens aperture diameter and **T** lens transmission factor. The method proposed in this study is experimented for the first time and indicates a mode of investigation for the correlation between light phenomena in the atmosphere and the presence of hydrocarbons in the subsoil but not the extent and volume of the field.

$$P = 4\pi d^2 \cdot \frac{E}{T \cdot \tau \cdot \frac{\pi}{4}} \cdot \frac{1}{\frac{F^2}{f^2}} \cdot e^{\frac{3.9\,d}{V}} \qquad (1)$$

The energies are relatively high and, at least in one case, it has been found that the light phenomenon can shine with a power of about 20 KWatt [22]. The power calculated by the aerospace engineer James Bunnell and the astrophysicist Massimo Teodorani is around 5-100 kW. If we presume maximum power, a duration of one minute, an approximate diameter of 50 centimeters and a density similar to that of the air equal to 1.22 kg/m^3, there is an energy density of around 75 (MJ/kg) and a power density of 12 MW/kg [3].

The value of the energy density, of a chemical nature, if compared with the reference scale, turns out to be compatible, in order of magnitude, with that of methane or natural gas, i.e., in line with the hypothesis advanced in this research [3]. The calculation was done using the Ragone Diagram [23].

Ball lightning produces confined energy.

Basic calculation:

Basically, halving the diameter, volume and then mass (assuming the same density) fall to a factor 8 (2 per cubic). Consequently, since the emitted energy is always that, both the specific power and the specific energy increase by a factor 8. It may seem high but not because the Ragone diagram is logarithmic.

Starting hypothesis:

(1) The energy emitted by the ball lightning is caused by reactions between the elements contained in the zone without the introduction of new reagent masses outside it (in part reasonably because the sphere does not disperse then at least one of the essential elements of the reaction must remain confined (if it were not so specific power and actual specific energy would be lower than those estimated here, but probably within an order of magnitude or not seen the confinement).

(2) Matter in the ball has a medium density similar

to that of the air (reasonable since it is suspended but there may be other unknown mechanisms that support it) (if the density was higher specific power and specific energy would be lower of those estimated here, even visibly, but this would mean an important support mechanism)

Calculation based on the above hypotheses:

V_max: Maximum volume of the active area equal to the size of the light sphere (according to hypothesis 1)

R: sphere radius

$$\text{Vs max} = \frac{4}{3}\pi R^3$$

d_reaz: average density of the reaction zone

d_reaz = d_aria (according to hypothesis 2)

M_max: maximum reaction mass

$$M\ max = d\ reaz \cdot V\ max$$

E: total energy (J) emitted from the sphere of light all over his life

P_max: maximum power (J/s or W) emitted by the sphere at the time of maximum activity

P_media: average power (J/s or W) emitted by the sphere throughout the life of his life

t: life span (s) of the sphere

$$P\ med = \frac{E}{t}$$

P_max> = P_medium (by definition of P_max)

Es: specific energy

$$\text{E spec} = \frac{E}{M}$$

$$\text{M max} <= \text{M max},$$

hence:

$$\text{E spec} >= \frac{E}{M\ max}$$

Substituting:

$$\text{E spec} >= \frac{E}{d\ air \cdot \frac{4\pi R^3}{3 \cdot}} \quad (2)$$

Ps: Specific power

$$\text{P spec} = \frac{P}{M}$$

Ps = P/M]

As seen above:

$$\text{Ps max} = \frac{P\ max}{M} >= \frac{P\ med}{M}$$

Substituting:

$$\text{Ps max} >= \frac{E}{t \cdot d\ air \cdot \frac{4\pi R^3}{3 \cdot}} \quad (3)$$

The two important formulas that are relevant in this context are (2) and (3) because the Ragone diagram has the specific power (Ps) in abscissa and the specific energy (Es) in ordinate. In the Ragone diagram, a variety of energy sources/accumulators (mechanical like flywheels, electrical, such as capacitors, chemists of various kinds and even nuclear ones) are often put together to compare their characteristics. Ragone's graph shows that there are maximum levels of energy: for example, if an energy source (even of unknown nature) is found to have specific energy or specific power abundantly beyond the more intense chemical reactions known, it is by force of nuclear nature. And, from calculations, this does not seem to be the case, but it is necessary to understand the compatibility and exclusion arguments that can be made in this context, still at the pioneering stage.

8. Conclusion

This study has made it possible to conclude that it is possible to discriminate at least two types of anomalous light phenomena in the atmosphere. The first, red, emit a lower energy, at least when compared to the wavelength compared to the white ones. The proximity to the ground is believed to be fueled by radioactive gases, such as radon, or natural radioactivity. The other type of BLs is brighter, white-colored globes that appear at higher altitudes, hundreds of meters above the ground, more confined energy, and associated with organic materials or methane. From the point of view of application, the first typology can be used to diagnose crustal stress and pre seismic phenomena, while the second to the preliminary investigation into the identification of hydrocarbon deposits. Being still pioneering, these

hypotheses can be confirmed or denied by future interdisciplinary studies.

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