

The 1908 Tunguska event and some mini-Tunguskas

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Dedicated to the blessed memory of my grandmother (Tuzlukova Anna Ivanovna) and my mother (Ol'khovatova Olga Leonidovna)

Abstract. This paper is a continuation of a series of works, devoted to various aspects of the 1908 Tunguska event. This paper is devoted to several events which can be called as mini-Tunguskas. Their manifestations are in some ways similar to the 1908 Tunguska event, only on a much smaller scale. Often initially such events were interpreted as meteoroidal bolides or even meteorite falls. However, the reality turned out to be different. The geophysical nature of these phenomena was revealed, and in several cases, they were clearly linked to earthquakes. When they are suspected of being associated with an earthquake, they are usually referred to as the earthquake lights. Probably, the meteorological factor also plays a certain role. The physical mechanism of the phenomena remains unknown, although, judging by indirect evidence, electromagnetic processes play a significant role. The author inclines to think the mechanism is connected to poorly understood coupling between subterranean processes and processes in external space (atmosphere, etc.).

1. Introduction

This paper is a continuation of a series of works in English, devoted to various aspects of the 1908 Tunguska event [Ol'khovатов, 2003; 2020a; 2020b; 2021; 2022; 2023a; 2023b; 2025a; 2025b; 2025c; 2025d; 2025e; 2025f; 2025g; 2025h; 2025i; 2026]. The works can help researchers to verify the consistency of the various

Tunguska interpretations with actual data. A large number of hypotheses about its causes have already been put forward. However, so far none of them has received convincing evidence. As it is written on the title web-page of the web-site created by KSE (see below about KSE) tunguska.tsc.ru/ru/ (translated by A.O.):

"About a thousand researchers have devoted years of their lives to the Tunguska phenomenon. However, there is still no well-founded scientific understanding of what happened over the Siberian taiga on June 30, 1908."

This is probably why new hypotheses appear almost every year, not only in the mass-media, but also in scientific literature. At the same time, any hypothesis should not contradict the known facts about the event. Unfortunately, the authors of new hypotheses, as well as the authors of popular science articles, often use data, many of which turned out to be not entirely accurate, or even incorrect (some examples can be read in [Ol'khovarov, 2025c]). The author of this paper hopes that it will help both the authors of various hypotheses and their readers to evaluate the validity of the proposed hypotheses.

Let's start with brief info about research of the Tunguska event. The Committee on Meteorites of the USSR Academy of Sciences (KMET) stopped research the area of the Tunguska event in the early 1960s. Later amateurs (consisting mainly of scientists, engineers and students) most of whom united under the name *Kompleksnaya Samodeyatel'naya Ekspeditsiya* (KSE) continued research (KSE started research in 1959). Since the late 1980s foreign scientists take part too.

Please pay attention that so called the epicenter of the Tunguska forestfall (the forestfall is named "Kulikovskii") is assigned to 60°53' N, 101°54' E.

In this paper its author (the author of this paper i.e. A.O.) for brevity will be named as "the Author".

The Author in [Ol'khovarov, 2026] already considered the 1935 Guyana event (please pay attention that Guyana was named as British Guiana at the time of the event considered), and the event in Brazil in 1930 (the 1930 Curuça event). In this paper some other and probably a bit less energetic events are considered. Their manifestations are in some ways similar to the 1908 Tunguska event, only on a much smaller scale. Initially the events were interpreted often as meteoroidal bolides or even meteorite falls. However, the reality turned out to be different. The geophysical nature of these phenomena was revealed, and in several cases, they were clearly linked to earthquakes. When they are suspected of being associated with an earthquake, they are usually referred to as the earthquake lights. The physical mechanism of the phenomena remains unknown, although, judging by indirect evidences, electromagnetic processes play a significant role in some of them. The Author inclines to think the mechanism is connected to poorly understood coupling between subterranean processes and processes in external space (atmosphere, etc.).

2. The mini-Tunguskas

-The Bala earthquake in 1974. The earthquake raised speculation about a meteorite fall, UFOs and an air crash. The general description with some accent on UFO can be read here:

(https://en.wikipedia.org/wiki/Berwyn_Mountain_UFO_incident)

The seismological aspect was considered in [Musson, 2006]. Here is its abstract:

"The earthquake that shook most of North Wales on the night of 23 January 1974 appears unremarkable from its entry in the UK earthquake catalogue. With a magnitude of 3.5M_L it represents the size of earthquake to be expected in the UK with a return period of about one year. However, the prominent atmospheric lights observed at the time of the shock led to speculation that an aircraft had crashed, and search-and-rescue teams were deployed. Since nothing was discovered, it was concluded that a meteorite was responsible; more imaginative members of the public decided (and still believe) that a UFO had crashed. In this paper the record of events is set out, and the nature of the earthquake is discussed with reference to its geological setting."

According to Musson [Musson, 2006], the earthquake with the epicenter ~53° N, ~3.5° W took place at 20.38 UTC Jan.23, 1974. Data of this earthquake is presented in the International Seismological Centre On-Line Bulletin

(http://www.isc.ac.uk/cgi-bin/web-db-run?event_id=752928&out_format=ISF2&request=REVIEWED).

In the December 2006 issue of the magazine "Astronomy & Geophysics" letters from readers of the article [Musson, 2006] were published. Here is from a letter by Ron Maddison (an astronomer, who took part in searching the area after the event):

"We interviewed many folk and I persuaded some TV reporters, who had descended by helicopter, to fly me around the area where the strange lights and flashes had been seen. <...> One report, from Mr RH Edwards of Pwllheli, was accompanied by a couple of remarkable paintings and his description is so vivid that I feel I should quote much of his letter: ..."

Some fragments of the Mr RH Edwards's report (taken from the Maddison's published letter) are below:

"The night of 23rd January last was the first night with a completely clear sky to be seen in this vicinity for quite a time. At...about 8.15 p. m. I went round to the south side of my house and commenced to scan the sky from

east to west.

Suddenly, from behind me and over my head I heard a whooshing sound like a large flock of crows passing over, As I raised my eyes to look upwards I saw a sort of fire ball passing above my head and against the background of the sky. I could see that it looked like a football at about twenty feet, I was able to view it for several seconds through my binoculars. It appeared to be round to start with. It was extremely pale yellow but had an almost white hot glow about it at the front of the sphere. However, just as the object changed direction I saw 'coals' detach themselves from the parent body. They did not explode away, but seemed to roll away rear-wards like boulders detaching themselves from a cliff face. They seemed to stretch away from the main body leaving an ever-thinning umbilical cord which eventually broke. Then the main object and the particles completely vanished. I repeat that at a point, possibly about 500ft up in the sky, both the fire ball in its diminished form together with its "exhaust" particles disappeared simultaneously.

... Suddenly high in the western sky I saw what I took to be a "shooting star" travelling in a shallow arc from the west to the east. It left a streak of yellowish luminosity behind it which indicated the trajectory. It was high in the sky, possibly at 20000ft, maybe more - maybe somewhat less... As I got the glasses on it it appeared to discharge rearwards lumps of yellow-hot material that... streamed out for a greater distance than I observed in the first demonstration.

Then, just as abruptly as in the case of the first object, the whole display simply disappeared... In this second case I heard no whooshing sound, and in neither case did I hear any sort of explosion!!!!"

In 2007 Ron Maddison kindly emailed to the Author (on the Author's request) scans of the remarkable paintings by Mr RH Edwards. The paintings are on Fig.1.



Fig.1

In the opinion of the Author, even if we ignore the eyewitness' opinion about the distance to the objects, then in this case the objects (and especially the first of the objects) look little like a meteoroidal bolide. Of course, the above does not exclude the possibility that an accidental meteoroidal meteor/bolide could be among the many reports of various luminous phenomena that evening. But the meteoroidal meteor/bolide cannot explain many reports about luminous phenomena.

Several years after the article was published, even more remarkable eyewitness accounts were released [Devine, 2013]. Here is an extract from [Devine, 2013]:

"Dr Clarke, 42, who lectures at Sheffield Hallam University, said: "What we know is that on that particular night there was a nurse who heard the explosion and thought something had crashed into the hillside. "She drove up on to Berwyn and she saw what she described as a big glowing object sitting on the mountainside with a load of lights circling around underneath it. There's been various attempts to explain what she saw, but even sceptics can't fully explain what the nurse saw.""

Indeed currently there is no accepted explanation of a physical mechanism of the phenomena. Anyway similar phenomena are known in association with earthquakes. Here are just several examples.

- From [Terada,1931]:

“A traveller on his way through Koisikaw at midnight saw some ‘dark air containing bluish luminosity’ which moved rapidly from NE to S accompanied with a sound like strong gusts of wind. Soon afterwards, the earthquake shock was felt.”

- The second example is about the 1995 Kobe earthquake in Japan in 1995 [Kamogawa, et al., 2005]:

“In Osaka Bay, many fishermen had been working before the main shock. They also saw an orange luminous object moving from the edge of Awaji Island toward Mt. Rokko. Since the luminous object was of an observable size from their locations (approximately 40 km distance) and close to the sea surface in their reports, the diameter and the height would be estimated to be around 100 m. They additionally claimed that the luminous object finally hit Mt. Rokko, causing lightning to strike from the sky toward the ground. Almost immediately after that, they also felt the sea surface moving up and down.”

These are the earthquake lights.

-The 1993 Jerzmanowice event in Poland. The Author made a description of the event in [Ol'khovator, 2025d].

-The 1993 Banjarn event in Australia. The event happened in the remote area of the golden mineralization in the Western Australia. The information on the event was sent the Author by Australian geologist/geophysicist Harry Mason, who also kindly answered some the Author's questions. Here is his description slightly adapted by the Author.

At 23 hours local time (15 UT) a large orange red spherical "fireball" with a very small bluish white conical tail had flown from low down in the south over observers travelling to the north. Some observers reported that the fireball was cylindrical in form and more yellow-blue-white in colour. It was heard as a pulsed roaring or loud diesel engine sound - well before it arrived, it dropped off no glowing fragments, and had no long luminous tail or sparks - as is common meteor activity. Its speed was similar to a 747 jet liner or a fast jet plane.

No sonic booms were reported, and no observer believed that any explosion

was heard until the "object" got to ground level - or very nearly so (behind low hills or tree line cover) - and exploded or impacted.

It flew apparently parallel to the Earth's curvature in a long "nap of the Earth" arcing trajectory at low altitude (some 1-2000 metres ?) from low down on the southern horizon, not with a "normal" meteor inbound high angle high altitude trajectory. The fireball lit up some observers and their vicinity as it passed overhead. Its flight trajectory was observed over a distance of least 250 km. It then appeared to arc down towards the ground and disappeared out of sight behind trees or low hills.

This was followed after a 5-minutes delay by a near blinding massive high energy burst of blue-white light that rippled for about 3-5 seconds. It lit up the night (windless, cloudless, and moonless) sky as if daylight. The energy intensity involved in this light flash was similar to the light flash generated by a significant nuclear blast, and in many respects the incident strongly resembled a night time nuclear test.

A huge red coloured flare then shot vertically skywards for some considerable distance (several kilometres ?), and this was immediately followed by a massive seismic ground wave that hit the observers nearest to "ground zero" such that rocks and beer cans vibrated off of tables and the ground shook violently so that persons tending a camp fire fell over. At the small gold mine (the Alycia Mine) underground 7.5 cm steel pipes sheared clean in half and collapsed underground drives and shafts.

A very loud major explosive blast then followed that was heard over a 250 km by 150 km corridor, minor quake damage was reported as far as 150 km southeast of the "ground zero" - the other directions (excepting Leonora to the southwest) being largely uninhabited.

A large deep red-orange coloured hemisphere of opaque light with a silver outer shell lining then rose from ground level to hover around over the "ground zero location". This structure when fully developed was approximately three times the size of a typical Goldfields setting Moon as seen by observers located 30-50km from it - (i.e. it was very big), and it bobbed around a bit for nearly two hours, before disappearing suddenly.

This "half soup plate structure" (looking like a "deep red very large and half set Sun") was seen by two observers from widely separated locations, one at the Banjawarn station buildings, and one at the Deleta station buildings.

Almost exactly one hour after the first big event three observers (located at the Banjawarn station buildings) also saw a second much smaller fireball - more blue-green-white in colour, which appeared to rise from ground level (?), but which definitely rose from behind distant trees well south of the station perimeter, and flew to the north in a high mortar shell type arc before coming down to ground level, behind distant bush. Its flight path was divergent to the north northeast when compared to that of the first major "fireball" event of that night.

This later event then created a second but very small explosion and concomitant minor ground shake - similar to the first event, but much smaller in size, and with no resultant rising hemisphere of opaque light. This second event does not

appear to have been of a magnitude sufficient to register on A.G.S.O. seismographs.

Next morning nothing unusual was seen from the hills nearby.

That was the Mason's description slightly adapted by the Author.. In 1995 H. Mason spent a considerable time in an airplane, but failed to find any crater or ground anomaly of any kind there or anywhere else in a 300 km diameter search area. Ground and air examination of the nearby Celia fault-lineament could find no evidence of any movement on this structure.

At about the same time H. Mason got a report by the three truckies seeing yet another fireball soon after starting work at 5.00 a.m. (exact date unknown) in May or June of 1993. Their "moon sized" fireball flew from south to north at low level (some 1000 metres) with a high speed jet plane velocity. It was yellow-orange-red in colour and had a very small blue-white tail, and lit up the early morning dark sky in an intense blue white light flash that silhouetted the countryside, as it too headed immediately west of Laverton directly for Banjawarn station. As they were sitting next to loud diesel engines of their own, it is unknown if this third Banjawarn fireball made any pulsed roaring noise. This third fireball held a course that, it would pass over Banjawarn.

As H. Mason has informed the Author, the 95% of eyewitnesses of the luminous phenomena and seismic effects gave the epicenter at 121 deg 10 min East, 27 deg 05 min South. The distance from the Celia Lineament is 10-15 km on harmonic parallel linear. The rest 5% of eyewitnesses (just seismic effects) and the seismic monitoring network gave the epicenter a several dozens km to the south, right on the Celia Lineament, where it crosses with another fault.

It is interesting to note, that the Laverton town water supply pumping station is quite close to the latter epicenter and there was a drought at that time, while several following years there was enormous flooding.

In 1994 there were a few reports from the region of the "luminous epicenter" about strange 'explosive' sounds accompanied with minor seismic effects (in the Author opinion - brontides, probably). Moreover, two other large orange-red hemisphere static light form structures have also been observed at night northwest of Banjawarn (in 1988 and in October 1992).

H. Mason takes into account 5 possible origin of the event. He admits that it is an unknown natural event, but, rejects 'earthquake lights', because, as he writes "of their usually very low energy output". But as he discovered strong correlation of this and other similar events in Australia with geology (tectonic faults) and earthquakes, he is supposing that the most probable it was the experiment with electromagnetic weapon for inducing earthquakes. Anyway in August 2000 H. Mason e-mailed the Author that he has in mind several possible origins of similar events, including natural ones.

The event was 'loud' enough to be mentioned in the world's mass-media: (www.nytimes.com/1997/01/21/science/seismic-mystery-in-australia-quake-meteor-or-nuclear-blast.html).

Soon after the event the U.S. Senate's Permanent Subcommittee on Investigations requested IRIS (Incorporated Research Institutions for Seismology) to determine the nature of a seismic event. Here is from [Hennet et al., 1996]:

"On 28 May 1993, the Mundaring Seismic Observatory recorded a seismic event in western Australia with epicenter at 28.47 S, 121.73 E (Figure 1). The event occurred at 11:03 p.m. local time and was registered by regional analogue stations as a magnitude 3.6 event at 1 km depth. That evening, a group of aboriginal prospectors camping in close vicinity to the epicenter reported seeing a star-like object low on the horizon. According to their accounts, the object seemed to travel with the speed of an airplane. The object appeared to emit a bright yellow-blue light and went out of view behind a low ridge. Shortly after the object had disappeared behind the ridge, the group of prospectors reported seeing the sky lit up in a bright flash of white light from the direction in which the flying object had disappeared. The flash of light was followed by a large explosion that lasted several seconds. The explosion was heard by miners, engineers, and others over large distances. The witnesses described the explosion as similar to a large mining blast, only bigger and longer in duration. Truck drivers in the area also observed a bright object traverse to the east; and several people called the Mundaring Observatory to report a whistling fireball-like object low in the sky.

<...>

For the Senate Select Committee on Investigation, we analyzed tire following two scenarios:

- a) relying on the seismic evidence alone, is the seismic event more likely caused by an earthquake or an explosion; and
- b) could a meteorite travel through the atmosphere and impact in western Australia to cause the series of events? "

Some data on the seismic event can be found, for example, in International Seismological Centre (http://www.isc.ac.uk/cgi-bin/web-db-run?event_id=235203&out_format=ISF2&request=REVIEWED).

Here is some analysis of the seismic event by IRIS [Hennet et al., 1996]:

"On the NWAO recordings, the signal appears to have a high frequency content, although we see only a small range of signal frequency from about 2 Hz to 10 Hz, the nyquist frequency of the instrument. <...>

This distribution of P/Lg ratios may indicate that the source for the May 28, 1993 event is more consistant with an earthquake-like source than with an explosion-like source, although many more regional earthquakes would be needed to appropriately calibrate the data."

IRIS also considered the meteoritic version [Hennet et al., 1996]:

"Iron meteorites in this energy range typically impact Earth's surface, whereas stoney and carbonaceous objects explode at altitudes above 10km. A low altitude explosion is therefore unlikely.

<...>

Ultimately, the meteorite scenario could be confirmed if a meteorite was known to have entered the atmosphere over western Australia at the time the events occurred, or if an impact crater could be found in the vicinity of the epicenter. The impact of a meteorite with radius 1.6 meters would generate a crater more than 90 meters in diameter. Despite some preliminary searches, no impact crater has yet been found."

And the impact crater was not found still...

The Author discovered in internet some interesting additional info in the Straight Dope (<http://w.straightdope.com/21343424/did-the-aum-shinrikyo-cult-detonate-an-atom-bomb-in-australia>), and its date/year is 2001. Correspondence with Clive D.N. Collins (Urban Geoscience Division, AGSO – Geoscience Australia, Canberra, Australia) is presented in there. Here are some fragments from the correspondence:

"We are not aware of any further information that has come to light since the analyses undertaken between 1993 and 1997.

The event was analysed by the Incorporated Research Institute for Seismology (IRIS). They concluded that it was consistent with the impact of an iron meteorite with a radius of between 0.5 and 1.6 m. However, a search by light plane shortly after the event failed to locate any impact crater, which could be expected to be 90 m or more in diameter. They also concluded the seismogram which was recorded was inconsistent with a mine explosion, but were inconclusive as to whether it was a local earthquake.

As no impact crater has been found it is most likely that the event recorded by the seismic network was a small magnitude 3.6 earthquake, which is not unusual in this region and consistent with the seismograms. Since 1993, two earthquakes occurred in an area of 50 km around the epicentre of the 28 May 1993 event. The seismic records of these earthquakes were compared with the seismic records of the 1993 event, and showed similar characteristics consistent with typical seismic activity for Western Australia. <...>

As we do not have any information other than what was recorded on our seismic network we are unable to comment on reports of phenomena in the

atmosphere. We do however note that there is no evidence of atmospheric sound waves (a 'sonic boom' for instance) visible on the seismic records. Evidence for these waves have been observed on records associated with known meteor sightings."

It should be noted that the accounts provided by H. Mason are inconsistent with the meteoroidal version. This primarily concerns relatively moderate brightness, the lack of a long trail, the low speed (more precisely, the angular velocity), and the five-minute delay. The second fireball (one hour after the first one) also looks suspicious...

Moreover, the instrumental data provided by IRIS make it possible to exclude the version of aerial destruction of a hypothetical meteoroid. The reason is that the aerial destruction would result in seismic waves of low frequencies [Svettsov, 2007]. For example, the 2013 Chelyabinsk meteoroid generated a seismic event with magnitude's evaluation as ~ 4 (see [Wei, et al., 2018]). By the way, the 2013 Chelyabinsk bolide had peak brightness of -27.3 ± 0.5 magnitude [Popova et al., 2013], i.e. was brighter than Sun. A remarkable feature of the generated seismic waves by the 2013 Chelyabinsk meteoroid is [Heimann, et al., 2013]:

"Unlike tectonic earthquakes or underground explosions, the body waves are almost absent, and sharp onsets cannot be identified even at the closest station, ~ 220 km away. Almost no seismic energy is detected above 0.1 Hz, or on transversal components, in contrast to tectonic earthquakes with similar seismic moment."

At the same time, as can be seen from the above IRIS-data, a powerful high-frequency part was present in the spectrum of seismic waves of the 1993 Banjawarn event.

Remarkably that the area of the 1993 Banjawarn is the area of the golden mineralization, like the area of the 1935 Guyana event [Ol'khovarov, 2026], and the area of the 1908 Tunguska event. The Author inclines to think that it is not just accidental coincidence - see [Ol'khovarov, 2026].

Let's consider the H. Mason's argument that those weren't the earthquake lights as they are usually of very low energy output. In the opinion of the Author, in such argument, cause and effect are reversed - it was not the earthquake lights that generated the earthquake, but the earthquake (more precisely, the tectonic processes associated with it) gave birth to the earthquake lights.

By the way, in the Author's opinion, it would be unfounded to consider the earthquake lights harmless. It's incorrect to draw such conclusions about a phenomenon whose physical nature science has yet to establish. For example, maybe the earthquake lights are merely the visible tip of an iceberg of activity involving as-yet-unknown processes. In any case, the intensity of the light emitted by some earthquake lights hints at the levels of energy involved. Moreover there is an interesting observation in relation with an earthquake in Japan in 1931 [Musya,1931]:

"A fishing-boat called the "Ikedamaru" was engaged in fishing on the sea about 50^{km} of Utiumi, a town on the coast of Hyûganada. At about 7 p. m. the boat began to pitch so heavily all of a sudden that they thought she was near being capsized. At the same time, to the crew's consternation, a large pillar of fire shot up from the surface of the sea near the boat."

By the way, there are other examples when the earthquake lights appear from the surface of sea. Here is from [Musya,1931]:

"In the Itô swarm earthquakes in 1930. a fisherman observed a fire-ball burst out of the sea off Itô-mati."

Remarkably that the earthquake lights can sometimes move even under the water. Here is from [Whitehead and Ulusoy, 2015]:

"[From fisherman, Observer #3, Figure 3, 4 km from the port of Lyttelton from the open sea, early afternoon, 11-July-20 11.]

"I was looking out the front of the boat and I saw a couple of blue flashes down in the water, was definitely a flash, a dim blue flash.

"The blue flashes were about 100 meters to the side of the vessel and shot from left to right in a straight line across us. Then the next minute it was like the boat hit something."[earthquake shock wave from a M6 aftershock (Gorman, 2011)].

The flashes were also described as rather milky blue, like the subaerial September events, but visible in daylight. There were two "rays" about 10 m apart which vanished into the distance. The depth was less than 12.4 m, (Port Company, 2013) and the surface is soft sediment. The time between the observation and the shock was a few seconds. The earthquake was M6.0 and 10 km under Lyttelton, on the Port Hills fault zone ."

So the earthquake lights can exist and move in gas and liquid, and a question may arise: what about the solid body?...

-The 1994 Cando event in Spain. The Author read about this event in [Docobo et al.,1997].

-The 2001 burning fireball event in Jordan. The event occurred in ~32.43° N, ~35.71° E at about 16.30 UTC, 18 April, 2001. In 2001 the Author met in internet and saved the following news-story (unfortunately while preparing this paper the Author failed to find the original source) of AFP of April 24 (or 23), 2001:

"Meteorite crashes near mourning Jordanian village

AMMAN (AFP) - Residents of a Jordanian village attending a funeral got an unwelcome surprise when a fiery meteorite crashed down in their midst, one of them told AFP Monday. "More than 100 of us were gathered Wednesday at sundown to bury a village resident when we saw a strange object that looked like a ball of fire," said Mohammed Nawaf Mikdadi, mayor of Beit Eidess, some 85 kilometers north of Amman. "The meteor shot through the sky from west to east before a part of it came down a half kilometer (quarter mile) from the village, sparking an explosion and then a fire with four-meter flames for 10 meters straight," Mikdadi told AFP. "The villagers thought it was a missile, but when we went to the spot there weren't any metal scraps," he said. The mayor expressed relief the meteorite fell on a rocky area near Beit Eidess and not in a nearby forest, which could have spelled disaster for the village."

Also some info appeared on the web-page of the Jordanian Astronomical Society (<http://www.jas.org.jo/mett.html>). Unfortunately nowadays this web-page does not exist, but can be accessed via web.archive.org (<https://web.archive.org/web/20030217111810/http://www.jas.org.jo/mett.html>).

Here is a fragment from the web-page:

"Meteorite Over Jordan? By Mohammad Odeh

On 18 April 2001 around 19:30 Local Jordanian Summer Time (UT+3), Mr. Jamal Al-Halabi, the editor in chief of the Associated Press (who is already a friend of JAS), called JAS member Mohammad Odeh asking him about an object he saw in the sky from Amman few minutes ago! From his description it seemed that what he saw was a fireball! Or better a huge fireball! Anyhow, later on a Jordanian Newspaper mentioned that residents of a Jordanian village called Bayt Eides saw a meteorite crashed down in front of more than 100 persons of the residents.

One of the eyewitnesses was Mr. Mohammad Nawwaf Miqdadi, mayor of Bayt Eides. So JAS had directly phoned him asking him about some details, and later on JAS decided to visit that place.

A delegation of JAS consisting of Eng. Khalil Konsul (President of JAS), Mohammad Odeh, and Mohammad Katbeh went to Bayt Eides on Tuesday 24 April. JAS reached the site around 15 Local Time (LT). Where Mr. Miqdadi welcomed JAS and joined JAS to the location.

As JAS arrived the site, we made an interview with him asking him

about the details, and JAS took some photos, as well as determining the coordinates of the site. According the GPS, the site is 54.4 Km to the North of Amman (Azimuth 345). Regarding the details, Mr. Miqdadi said:-

On Wednesday 18 April around 07 pm, which is before sunset (Sunset occurs around 07:10 pm) at sundown to bury a village resident, more than 100 persons saw a bright object moving in the sky with a dark yellowish color. The object was moving from west to east, and then it broke up into two parts, which fell on a nearby hill (which is about 1.5 Km from the place at which we were watching!). As the two pieces hit the ground we saw a fire, initially with a greenish color, and then the fire reached up to 5 meters! On the very next day I (Mr. Miqdadi) went to that place and I saw the two locations at which the two parts fell. (Let's call the first location A, and the second one B).

Now JAS is watching and examining the location A, which no one entered yet! The ground is full of ash and it is rather black (from the fire) and so are the stones! What directly brought our attention were two things, the first was a tree trunk which is broken into two parts (See Photo). Mr. Miqdadi said this must be from the object which hit the tree! Actually the appearance of the broken tree trunk is very strange! I don't guess it is a man-made break! The other thing was a half burnt tree (See photo)!

Concerning the location B, which was visited by two persons before JAS, it was also full of ash and black. "The location was full of small rock, but when the object hit the area it made a crater as you can see", Mr. Miqdadi said. Actually there was no real crater! But it was clear that at certain place the level of the rocks is lower than the surrounding, and there is a shape of an arc. Also, a half of a large rock was burnt, while the other half is normal (See Photo)!

We did our best to find a meteorite but I must say that we failed! So the question is what fell then? Did the object totally burn up? Is this ash the meteorite remnant! Eng. Khalil Konsul said, this is not possible, because if the ash is a meteorite remnant, then the meteorite would be very large and this will make a real trouble! Which was not the case! JAS took a sample of the ash and soil, and we shall send it for analysis.

Lastly, the coordinates of the of the locations are:-

Location A:-

- Longitude: 35:42:55 E
- Latitude: 32:26:09 N
- Elevation: 707 m

Location B (Which is about 50 meters only away of A):-

- Longitude: 35:42:56 E
- Latitude: 32:26:08 N
- Elevation: 714 m"

Also on the web-page several possible explanations were presented, including one by the Author.

The web-page also presented results the analysis of the ash. Sample of the ash was sent to Museum National d'Histoire Naturelle in France. Dr. Claude from the Museum emailed the following (a fragment):

"Yes your sample arrived some time ago. It seems to be combustion residues (carbon) and ashes (calcium and potassium carbonate), together with local stones. What caused the fire, I have no idea. but it is certainly not a meteorite. ..."

The web-page also contained several photos, 2 of which are shown below. Figure 2 shows a photo that had the following caption on the web-page: "Location A (Notice the half burnt rock)".



Fig.2

Figure 3 shows a photo that had the following caption on the web-page: "Exfoliation of a rock, due to heat!".



Fig.3

Remarkably that on April 25 an earthquake took place not far from the impact place (http://www.isc.ac.uk/cgi-bin/web-db-run?event_id=3523263&out_format=ISF2&request=REVIEWED).

Phenomena looking similar to ball-lightnings are known in association with

earthquakes. Here is from [Ikeya, 2004]:

“Many people observed strange lightning at the time of the Zenkoji Earthquake in 1847. In addition to a pillar of fire (or fire rod) and a trumpet of fire extending upward from the source of light, luminous variously shaped, moving objects like fireballs (ball lightning) were reported. On the ground dried grasses were burned in the flames. <...>

For several days after the quake balloons of bright light came out of the sea over the Gulf of Izmit and the northeastern Marmara Sea and sounds of explosions were heard from the gulf area (Barka, 1999). Fire balls (presumably ball lightning) were observed several times during a period of two or three months before the earthquake, according to a fisherman (Ulusoy and Ikeya, 2002). Some fishermen described a co-seismic undersea explosion and light ascending out of the water into the sky. Fishing nets were found burned.”

Here is from [Enomoto and Zheng, 1998] regarding the Kobe earthquake of 1995:

“A fisherman at Tonouchi on Awaji Island (Figure 1a), stated that he saw several electric streaks of bluish-white color spread out for about a second from a localized area near the Nojima fault...

<...>

We found unusual features in the fault in the Hirabayashi district where it crossed an unpaved road.

<...>

The unusual features were: 1) vegetation roots exposed on the wall of the fault were extraordinarily charred as shown by arrow A in Figure 1b;

2) sharp and blackened veins marked the weathered granite fault wall as shown by arrow B in Figure 1b; and 3) the clayey fault gouge under the part where the charred roots were found was highly lithified and showed a lamellar structure.

<...>

Furthermore, chemical analyses by an induction coupling plasma (ICP) method showed that the contents of metal elements such as Fe, Ti, Al, Mn etc. in the charred roots was about 10 times as large as that of the non-charred roots of the same vegetation.”

So phenomena associated with the earthquake lights sometimes are not powerless.

-The 2003 Tyukalinsk earthquake in Siberia. This event takes us to Siberia.

Sometime in the middle of the year 2003, the Author came across news stories about a large meteorite falling near the city of Omsk (or more precisely, the town of Tyukalinsk) in February 2003, causing an earthquake. At least one of the news-stories exists online nowadays <http://omsknews.ru/?p=16528> . Here are several fragments from it translated by A.O.:

"That night was a restless one for the residents of the villages of Starosoldatskoye, Kabyrdak, and Sarybaly. Young people strolled the streets until dawn, wishing each other a Happy Valentine's Day. The older generation slept very lightly, awaiting the return of their children. At about four o'clock in the morning, a strong rumble filled the surroundings. The light bulbs swayed, the dishes in the cupboards rattled. Stoves have cracked in the school. A bright light flashed, blinding people for a moment. Then a strong blow (in some villages there were four of them) - and everything went quiet. <...>

Specialists led by an astronomer Vladimir Krupko (director of the planetarium) went to the scene of the event. <...>

— We immediately put forward the version of a fallen meteorite, — says Vladimir Nikolaevich {Krupko - A.O.}. — The first inspection of the area and inquiries of the observers confirmed our assumptions.

Zhenya Akulov, 16 y. old, provided very valuable information. <...>

Zhen'ka {i.e. Zhenya Akulov - A.O.} walked that night almost until morning. He was returning home around four o'clock in the morning. Suddenly, a bright streak of fire appeared in the sky. Soon the glow disappeared. There was a loud crash. <...>

Fyodor Kuznetsov saw the phenomenon through the window. He couldn't sleep, he was drinking tea and watching TV. When the bright light flooded the kitchen, the old man rushed to the window and very clearly saw the direction of flight of the glowing object. He did not understand what it was..

People who were sleeping could hear the impacts on the ground. The number of impacts varies from one to four in different villages. <...>

— Lake Dubrovnoye freezes almost to the bottom in winter, — continues the story Vladimir Nikolaevich, but after that restless night, the fishermen found three large washouts. It is impossible to explain this by saying that someone cut down an ice hole - they are too big, there is no need for fishermen or anyone else in such {washouts -A.O.}. Maybe "walruses", but they are not found here. In addition, large blocks of ice — more than 60 centimeters thick — were broken off and turned over. Large frozen patches of silt mixed with shells stood out clearly on the surface of the lake. <...> The radar did not detect anything in the center of the lake, but a meter-sized body was found at the edge, at a depth of 12 meters. The

Omsk astronomers are not even trying to solve the problem of how to get the find."

It should be added that, to the Author's knowledge, at least six expeditions were undertaken in 2003-2004 (three of which used motorized paragliders), but no traces of the meteorite's impact were ever found. The Author is unaware of whether subsequent expeditions took place, but it is known that no traces of the meteorite fall were found.

After reading initial media reports, the Author had the opinion that a meteorite fall was extremely unlikely, and that it was an earthquake. The Author informed L. S. Chepkunas (an employee of the Central Experimental and Methodological Expedition of the Geophysical Service of the Russian Academy of Sciences), about this event. After some time, seismologists analyzed the data from the seismic stations and confirmed that it was a tectonic earthquake. They presented some data on the earthquake, for example, in [Gabsatarova et al., 2006]. In [Gabsatarova et al., 2009] more detailed analysis of the earthquake is presented. Here is a fragment from [Gabsatarova et al., 2009] translated by A.O.:

"A rare event of this kind in this region was felt by local residents in several settlements. The epicentral zone of this phenomenon was not surveyed. All information about the perceptibility of the earthquake was gleaned from local newspaper reports, although their reliability is low, as they turned out to be conditionally time-stamped. For example, the local newspaper "Tyukalinskii Vestnik" of April 30, 2003, in an article entitled "Something Like an Earthquake Was Recently Recorded in the Tyukalinskii District of the Omsk Region," reported: "One day in February, residents of the villages of Kabyrdak, Starosoldatskoye, Koshkul, Sarybaly, and Kumyra were awakened by an incomprehensible, loud rumble (it was 3-4 a.m.). It resembled the roar of a caterpillar tractor. But, according to eyewitnesses, that night not a single agricultural machine in the village vicinity was working; all the equipment was stored in garages. The signs of the earthquake were abundant: the floors shook, the chandeliers on the ceiling swayed, and dogs howled loudly, even though there was no wind.""

According to [Gabsatarova et al., 2009] the earthquake had $MS=3.6$, $MPSP=4.2$, and its depth was $\sim 15-18$ km.

There were some other data on accounts in various mass-media and internet writings, most of which is probably originated from the "Omsk astronomers". Here is a digest of the data taken mostly from <https://trampin.media/news/2/1995> and some other internet-sources (please note some discrepancies in details):

-Most eyewitnesses heard buzzing, rustling, and impacts before the ground began to shake.

-16-year-old Evgeny Akulov from the village of Kumyra, observed a large luminous ball flying in the night sky, which roared as it passed over his house,

followed by a terrible explosion, and then everything went silent.

-16-year-old Evgeny Akulov from the village of Kumyra saw a bright ball move, then fade, followed by an explosion.

-A few people from the village of Kabyrdak noticed light phenomena. An unnamed man said he observed a fireball flying, followed by small spheres and a long tail. Schoolgirl Anya Lomova saw a flash and a glow behind the forest. Lyubov Sheveleva from the village of Korshunovka and Alexander Zhuravlev from Osh also noticed the glow.

-Vasily Kuznetsov, a pensioner from the village of Kabyrdak, saw a huge fireball in the sky from his window, like the setting sun:

"I stood there and admired it: it was such a huge circle. It stood still, and stripes seemed to radiate out from it. I looked and looked, and then nothing happened—so I went to bed."

The Author discovered that there was a strong upsurge of cloudiness in the region within several hours after the event, which in the Author's experience is favorable for the earthquake lights.

Data of this earthquake is presented in the International Seismological Centre On-Line Bulletin http://www.isc.ac.uk/cgi-bin/web-db-run?event_id=6586829&out_format=ISF2&request=COMPREHENSIVE

The attitude of some media outlets towards this event is remarkable. The Author contacted the editorials of several newspapers, including those that promoted the "meteorite fall" and informed them that there was an opportunity to inform readers "how it really was", so that the "Tyukalinskii meteorite" would not go in the history of science, and also to inform residents of the Omsk region that earthquakes are possible in their region. However, none of the mass-media showed interest. And in one of them, they answered something like this: if, on the contrary, the earthquake had turned out to be a meteorite, then we would have written about it!...

-**The 2003 Elma event in USA.** This remarkable event was described by the Author in [Ol'khovarov, 2020b].

-**The 2004 Babol event in Iran.** In 2004 the Author met in internet and saved the following news-stories (unfortunately while preparing this paper the Author failed to find the original source, only the secondary re-prints in internet):

"Meteorite hits Iran

Fri 2 January, 2004 15:48

TEHRAN (Reuters) - A meteorite has hit northern Iran causing minor damage to property but there were no immediate reports of casualties, state radio has said.

It said the impact sent locals in panic onto the streets in the northern town of Babol in Mazandaran province.

"A meteorite which hit Babol on Friday morning caused only some minor damage to residential units," radio said, without giving further details or citing any source.

It said the impact was felt up to one kilometre away.

Iranians are currently mourning at least 30,000 people killed by an earthquake measuring 6.8 on the Richter scale which struck southeastern Iran on December 26."

And here is some mass-media follow-up:

"Comet falls on house in Northern Iran

Sunday, January 04, 2004 - c2003 IranMania.com

Tehran, Jan 4(IranMania) - The fall of a comet on a residential unit in Babol, Northern Iran on Friday morning spread a wave of fear in the entire district.

A member of the family on whose house the comet fell tells the story:

"I woke up in the morning and suddenly saw an amazing light which was moving toward the house, just then I heard a horrible crash and when I came to myself I found our house totally destroyed."

Following the incident, the house of this Baboli family was ruined and damages were inflicted on the neighboring houses.

However no casualty has been reported."

The event took place near the town of Babol (36.53° N, 52.7° E) at about 2 am UTC on January 2, 2004.

Soon the Author got an e-mail from Mr. Pouria Nazemi (Jam-e-Jam Daily Science Journalist www.jamejamdaily.net, Nojum Magazine News Editor www.nojum.net, Tel: +98 (021) 737 97 44, P.O.Box:16535-479 , Tehran, Iran, to the Author's knowledge Pouria left Iran later). Pouria helped the Author a lot to obtain info on the event.

According to the Pouria's info (e-mailed on January 3, 2004), at about 5:30 Friday morning (2 a.m. UTC) a great explosion happened in the big house in the Moalem kelay in north of Babol. There are 9 people live in this house and one of them

woke up before this event. She said that she had seen a very bright white light in and out of house and she had heard an increasing sound and then a great shake happened. Other people in the house and other neighborhoods woke up in panic and thought that an earthquake happened. The people felt this shake in a radius of 1 Km from the house and many glasses were broke in a few 100 meters around. In the house there are some sign as if a great source of heat acted, but every gas lines and electric instruments are good and don't have any problem. Also no fire happened.

Some people saw a great fire ball that passing sky from top to the house.

It is very important that source of explosion must be in the house because of direction of destroyed instruments to out of the house. One of Nojum reporters that visited the place said that it is like that you put an unlimited energy in the room and closed all the doors and this energy would like to free itself. This reporter is an active amateur astronomer and recorded and photographed all meteor showers.

Another important thing, according to Pouria, that the reporter can't found any evidence of meteoritic remains or its crater. There is no hole on the roof or walls. Also it wasn't from normal explosion like gas or oil or other things like this (there is no fire reported).

Pouria also e-mailed the Author photos from this place which his friend Iman Naderi took on January 3. Naderi went there with the order of government for searching the place. The collage of the photos is presented on Fig.4, 5 (thanks to Iman Naderi for his permission to use them).



Fig.4



Fig.5

On Jan.4, 2004 Pouria e-mailed the Author a map of the damage in the house. It is on Fig.6.

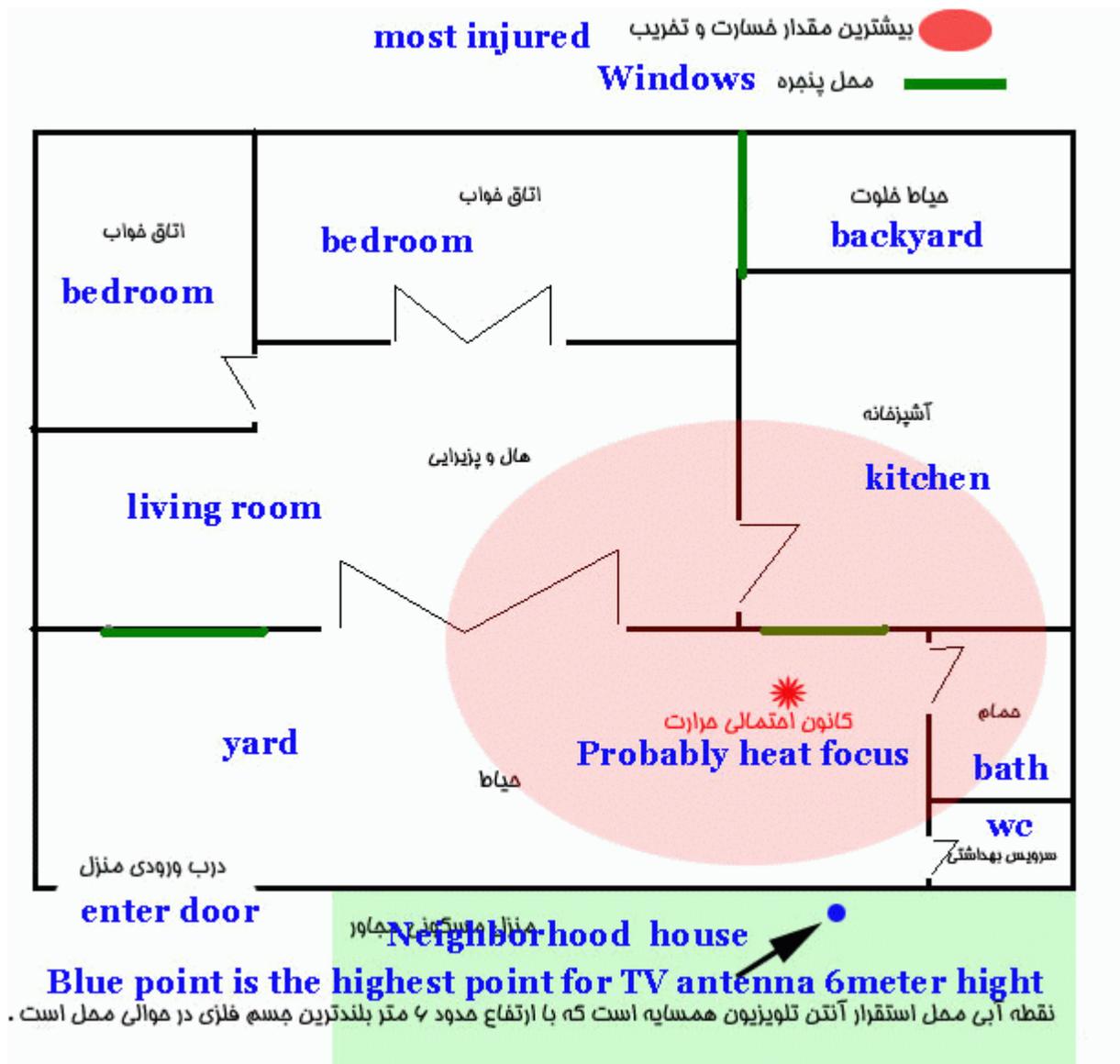


Fig.6

Finally Iman, Pouria and the Author compiled the following preliminary brief description of the event (below), based on witness' accounts.

a) Witnesses who were in the house reported the following.

On January 2, 2004 a woman in the house woke up before 5 am local time (1.30 am UTC), because her baby was crying and she was going to get milk to him.

After a short time she saw that the space of room became bright, but she did not see the source of the light. She inclines to think that it was outside her home. She says that her impression is that the source of the light was approaching the ground and closer to her house with increasing of illumination in her room (however there is some possibility that the illumination of the room at least partly was caused by glowing of the air inside the room, but currently this can not be proved now).

After she saw the light for about 2-4 seconds, the ground became to shake. About 2-3 seconds later the shaking increased significantly, and an explosion occurred, which damaged the house.

Other people in the house (a family of 8) woke up with the explosion (they said that they were thrown up from ground with the power of the ground shaking).

When a father of the family and his great son woke up and felt that the ground continued to shake, they guided other members of family out of the house. Within 4-5 seconds the great son ran to the yard before other family to switch off gas, and other members of the family followed him in a few seconds.

In the yard they saw a very bright red fireball (about 2 meters in diameter) that was firing in the yard at the height of 1.5 to 2.5 meters above the ground. It looked like a small volcano, and many small bright particles were falling out from it.

Also they felt a kind of heat on their faces. The great son, who was the first in the yard felt it especially strong (they can't remember feeling of the heat being inside the house, because they were in shock). The feeling of the heat continued with the great son for several days later at least. The great son felt heat on his face like a kind of sunburn.

The ground shaking continued in the yard too. Members of the family who woke up with the sound of the explosion said that ground shake accompanied with low sounds continued for about 10 sec. in total. And no any smell.

Finally the shaking stopped, and the fireball disappeared.

b) Witnesses who were outside the house reported the following.

Research discovered only two persons who saw this event from out of the house, and what is one of them said. His house is about 500 meters far from the main (damaged) house. He was sleeping when his wife woke up him with squeaking "Earthquake!". Then they heard a loud sound of an explosion and felt that shaking of the ground increased after the explosion. So in 3-5 seconds after the explosion, he ran on a balcony of his house, and from there he saw a bright object that was falling down vertically with high speed into approximate position of the above-mentioned 'main' house.

Apparently he can saw the last part of this object moving for about 1-2 sec. The fireball fall was accompanied with continuous monotonous loud sound without increase or decrease. The fireball left no trail. (There is also another witness who saw the fireball fall, accompanied with the sound.)

c) Damage.

Many houses at the distances up to several hundred meters from the 'main' one were slightly damaged (glasses broken, etc.). Damage of the 'main' house is seen on the photos. It should be marked that there are numerous signs of a heat in the 'main' house and in the yard. For example, many plastics tools were crumpled.

Also, it is interesting, that no damage on electric and radioelectronic devices was discovered. No apparent damage was discovered in an antenna attached to the house, and in a small transistor radio, which was in the house.

In February 2004 a press-release appeared which is preserved by archive.org (<https://web.archive.org/web/20040427085827/http://www.nojum.net/news/newse.asp?newsid=34>).

An interesting aspect of the 2004 Babol event is absence of signs of strong electromagnetic manifestations.

-The September 14-15, 2004 fireball's events in Argentina. This event resembles the 1935 Guyana event (and even the 1908 Tunguska event), only much smaller.

The main event occurred on September 14, 2004 about 20.30 local time (~ 23.30 UTC). A forestfall (or possibly even two forestfalls) was discovered at 54.7° S, 68.4° W, near the town of Ushuaia. A "fireball (or even "fireballs") were reported. Fortunately there is a preserved copy of an article from at least one news outlet "Botella al Mar" (in Spanish)

https://web.archive.org/web/20050415000000*/http://www.botellaalmar.com.ar/detalle_nota.php?Id=270&tipo=4

Here are some points from the story (in English). It was written that the strange object that fell from the sky a few days ago, behind the Martial mountain range, and which was witnessed by a dozen residents of the city, caused damage to a forest area of one hundred and fifty square meters located within the National Park. However, upon impact with the ground, it left no visible traces. The "fireball" destroyed a considerable number of trees as it fell to the ground, turning the impact site into a landscape resembling a deforested or felled area, with trees split at a height of about eight meters. The area was described by eyewitnesses as "roughly square, forty meters on each side"(from this point the Author thinks that the area is ~1600 sq.m). A new visit by 2 researchers confirmed the existence of "thirty to forty trees uprooted, some broken in half and others exploded, all lying on the ground from south to north." The news outlet wrote that apparently, the researchers arrived at the same location discovered by a police patrol, but only a few meters away, meaning there are at least two impact sites, which increases the number of clues regarding the event they are trying to clarify. The news outlet noted that residents of Ushuaia witnessed two strange objects falling to Earth on two consecutive days and made numerous calls to the Municipal Civil Defense Directorate and the police to report the event, described at the time as "a multicolored fireball that fell behind Martial Glacier." All the calls were made after 8 p.m., and the descriptions of the object were similar to those provided the previous day by people who had observed a similar phenomenon at the same time and place.

A couple of photos from the preserved publication is presented of Fig.7 and Fig.8.



Fig.7



Fig.8

Subsequently, one of the researchers spoke to the media (unfortunately, the Author was unable to find nowadays active links to the original publications on the Internet). The researcher said the area looked as four walls and in the middle, all of the trees (some of them had a diameter up to 70 centimeters) were overturned, fallen, all of them piled exactly from north to south. In the north the tree trunks were sheared off at a height of six to eight meters, from greater to lesser, as the "object" came at an angle. The fallen trunks were in perfect state. Their bark was intact. There was no trace of anything being burned, no dust, nothing. The ground vegetation was in perfect conditions. The breaks in the trees were no more than four days old. In some parts it was possible to see tree sap, because the trunks had exploded. There were tree-trunks that appeared to have been blown away from within by a stick of dynamite.

These were excellent years to track such phenomena - the Internet had just become widespread, researchers from various countries were actively communicating with each other, fakes were rare, and the "general" situation was favorable....

3. Discussion

When the considered lights appear as moving fireballs, they are often confused with meteoroidal meteors and bolides. The Author prefers to call such cases geophysical meteors [Ol'khovtov, 2000].

Some of the considered events were related with seismic phenomena, so they can be called as the earthquake lights.

Until recently, a significant portion of the scientific community doubted the existence of the earthquake lights, suggesting they were a psychological effect caused by stress during an earthquake. This belief stemmed from the fact that science could not offer a reliable explanation for the earthquake lights. However, in recent years, the situation has changed. The earthquake lights have been photographed and even recorded on video, although a definitive explanation for them remains elusive.

However, in some cases, no clear connection with earthquakes is apparent, but a probable link with atmospheric processes, particularly cloudiness, is discernible. Moreover, similar phenomena (ball-lightnings) are known to occur in connection with thunderstorms. By the way, couldn't they be somehow related?

A question about possible relations between atmospheric and endogenic processes appeared many centuries ago. Here are, for example, titles of 3 book chapters by famous F. Arago [Arago, 1855]:

"When the Atmosphere is tempestuous there are simultaneously great Perturbations in the Interior of the Earth and at the Surface or below the Surface of Waters";

"The Exceptional State in which Atmospheric Storms place the Solid Part of the Globe sometimes manifests itself by Fulminating Explosions, which, without any Luminous Appearance, produce the same Effects as Thunder and Lightning properly so called";

"The particular State which an Atmospheric Storm communicates to the Solid and Liquid Part of the Globe by its Influence, is sometimes manifested by broad and brilliant Phenomena of Light, of which the Earth is at first the Seat, and which, after an Explosion has taken place, disappear, either by vanishing on the Spot where they were first seen, or by a more or less extensive, and more or less rapid Change of Place".

Later, interest in the study of such phenomena faded somewhat. Fortunately, in recent years, it has resumed, primarily in terms of investigating possible mechanisms of connection between earthquakes and atmospheric (including ionospheric) phenomena. The lithosphere-atmosphere-ionosphere coupling (LAIC) model has appeared - see, for example, [De Santis et al., 2026].

Moreover, there are evidences that the connection can take place even without accompanying earthquakes. Here is an abstract from [Kutinov et al., 2022]:

"To summarize the data of long-term monitoring observations, the authors created models of intergeospheric interaction at the level: mantle-lithosphere; basement-sedimentary cover-modern relief; lithosphere-atmosphere and, partially, ionosphere. In general, the authors conducted studies of 18 first-order tectonic nodes on the area of the Arkhangelsk region. The research included: - analysis of geological and geophysical materials, - digital modeling of the relief of the roof of the basement and the surface of the modern relief, - monitoring observations of the quantitative characteristics of abiogenic (electromagnetic emission, atmospheric pressure, inflow of deep gases, the rate of precipitation of solid and liquid precipitation, etc.) and biogenic processes (structure and composition of vegetation cover, the content of chemical elements in soils and vegetation cover) in tectonic nodes. Seismotomography data from the Canadian Diamond Province were also used to clarify the deep structure of the nodes. Analysis of the results obtained allows us to assert that the depth of tectonic nodes have 400 km or more. They are reflected in reduced temperature values in the lithosphere, from a depth of at least 200 km and asthenosphere and almost to the surface of relief; in terms of heat flux; in the structure of potential fields; in the structure of the Moho surface and the crystalline basement; in the power of the layers of the earth's crust; in the modern geodynamic mode, in the macroseismic field, degassing and ionization of the atmosphere (up to the ionosphere). The structure of tectonic nodes has a

fractal-like (tree-like) structure, similar to the structure of advective uplifts and diapirs of mantle asthenoliths. In the area of tectonic nodes, there is a correspondence of the structure of the deep layers of the earth's crust in the basement, sedimentary cover and modern relief, as well as in the structure and properties of the vegetation cover. These processes are explained by geodynamic processes, deep degassing and the occurrence of induced magneto-telluric currents in the earth's crust. IntergEOSpheric interaction in the areas of tectonic nodes is reflected in the structure of the atmosphere and, partially, the ionosphere. As a result of measurements of atmospheric pressure over tectonic nodes, the fact of a constant «deficit» of atmospheric pressure was established. We recorded an increased density of thunderstorms in the areas of tectonic nodes, as well as distortion of GPS signals. This scientific direction has a prognostic value in geoecological research. The results obtained are important to take into account when developing and analyzing geoecological studies of various scales and monitoring modern geoecological risks."

One more interesting aspect considers a relation between aurora and coastlines. Here is an abstract from [Frank and Sigwarth, 1999]:

"A camera on board the Polar spacecraft has provided an unique opportunity to search for coastline effects on the spatial distributions of auroral emissions. This study is motivated by a ground-based report of such shoreline effects on auroral emissions during the Russian Polar Expedition of almost a century ago. This Polar camera, the Low-Resolution Visible Camera of the Visible Imaging System, is capable of obtaining auroral images of the Northern Hemisphere with high spatial and temporal resolutions for extended continuous periods of time, i.e., tens of km, one to several minutes, and many hours, respectively. The entire set of 8588 auroral images at OI 557.7 nm which were gathered during January 1997 were examined for three types of coastal effects, (1) diversion of the auroral arc at the shore, (2) increase of intensity as the arc is followed from sea to land, and (3) decrease of intensity from sea to land. A null test of the results of this auroral survey was conducted by a search of the entire set of images for random coincidences of auroral features in rotated maps of the coastlines. This null test provides support for the occasional transient existence of coastline effects during the onset and early expansion phases of auroral substorms and some auroral intensifications."

More info can be read in <https://space.physics.uiowa.edu/aurora/coast.html> .

In [Popov et al., 1989; 2010] a connection is shown of auroras and geological structures in Siberia.

In the opinion of the Author, both endogenic/tectonic and atmospheric processes play a role in formation of the earthquake lights. In particular, a favorable factor is the proximity of cloud cover in space or time (that is, near the cloud boundary and/or before a sharp change). In 1990s the Author also attempted to find a possible connection with cosmic factors, such as sunspot number and the relationship with sidereal time. Interesting results were obtained, but due to insufficient statistics, they cannot be considered reliable. More research is needed.

Unfortunately, the author can say little about the physical mechanisms of the phenomena under consideration. In some cases, there are signs of powerful electromagnetic manifestations (the lithosphere-atmosphere-ionosphere coupling?). In other cases, this has not been observed. Perhaps, in addition to the electromagnetic processes of the forms we know, there are also other, unknown phenomena taking place? Who knows...

Anyway, many peculiar things are associated with earthquakes. For example, here is from [Richter, 1958] regarding so called the visible waves:

"A similar overestimation must be involved in the following observation, which almost amounts to positive proof that some part of the waves seen is illusory.

... On the occasion of the San Jacinto earthquake ... on April 21, 1918, Dr. J. A. Anderson of the staff of the physical laboratory of the Mount Wilson Observatory was in the laboratory in Pasadena. When the earthquake motion became strong he decided to leave the building, a one-story structure with a cement-concrete floor ... As he moved toward the door this floor appeared to him to be thrown into waves with vertical amplitudes (trough to crest) of not less than four to six inches and wavelengths of six to ten feet . . . Immediately after the cessation of the shock he returned and inspected the floor which showed no new cracks of even minute dimensions. [The search for cracks was made with the aid of a hand lens.] Moreover, many relatively unstable objects on the tables and shelves in the laboratory remained in position, apparently undisturbed."

Richter proposed an explanation:

"Illusion certainly exists. Some of it may be psychological. The most obvious type could hardly apply to Dr. Anderson's observation, as anyone acquainted with him would be sure; but it is well known that many reasonable and sane persons, when exposed to a sudden and terrifying event, seem to see and experience things which bear little relation to fact, and they report them later with perfect honesty and conviction."

The Author is a bit cautious regarding the explanation, especially as Richter in his book gives another remarkable account:

"Dr. R. H. Jahns relates that, at the time of the Long Beach earthquake in 1933, he seemed to see large waves along the top of the wall of a dry swimming pool, although no effect was apparent on the floor of the pool, and Venetian blinds on a far wall were only slightly disturbed."

Moreover other similar accounts exist. Here is from Haroun Tazieff, who explored the aftermath of the Great Chilean earthquake of 1960 [Tazieff, 1964]:

"Thus, in the course of this long inquiry, which lasted for six weeks, and which we began that evening in Puerto Montt, I received precise testimonies in which, however, it was impossible to believe: one grave, level-headed man asserted that during the height of the shock the thick wooden pillars supporting the roof of a verandah rippled like hanging ropes; now not only was the thing materially impossible because of the great thickness of these posts, which were less than twelve feet high, but the most scrupulous inspection could not discover the least crack on their surface which might perhaps have proved that what the man thought he had seen was something other than an illusion. At Lota, to the south of Concepción, a young engineer, surely an objective witness, described to me the waves that had run up and down the tall factory-chimney of the coal-mine. Although this brick erection had finished by breaking half-way up, I was unable to believe in the vision of a serpent-chimney, for here again, in spite of its great height, no trace of the movement that was supposed to have been seen was detectable. In the foothills of the Cordillera the manager of a saw-mill, a steady, intelligent man, as trustworthy as the others, spoke of the road "upon which there ran waves like the waves at the sea-side"; but there was not a single unseated paving-stone, nor any other sign that had lasted to bear witness to so extraordinary a phenomenon. And yet . . . Every very violent earthquake produces accounts of this kind, whether it is in Japan, America, India or China."

If the cause is indeed some psychological or physiological factor, then it must be identified.

Returning to mini-Tunguskas: for now, the discussion is primarily at the phenomenological level. In general terms, it can probably be said that this is the result of some kind of self-organization of the natural environment. By the way, living beings (including humans) are also the result of self-organization of the natural environment...

Some miniature versions of the Tunguska event have been discussed above.

One might wonder: could super-Tunguskas exist? The Author does not rule out the possibility that some events in our planet's past were associated with such super-Tunguskas. However, more data is needed for more or less reliable conclusion.

Currently, in the Author's opinion, the most pressing task is collecting factual material, systematizing it, generalizing it, and attempting to find connections with other natural phenomena.

4. Conclusion

When the earthquake lights are presented as moving fireballs, they are sometimes confused with meteoroidal meteors/bolides. If this misconception is not quickly corrected, it may become a part of history and continue to mislead new generations of scientists.

The general conclusion is that such events are very complex phenomena. Research of these events requires the participation of experts in various fields. In the opinion of the Author, researching these events will allow us to better understand the life of such a complex system as our planet.

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