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EDITORIAL

ALTERNATIVE SCIENCE?

By a curious coincidence, the titles of all papers in this issue of RB end with question-marks. This is not so strange, though. RIAP aims at scientific studies of *anomalous* phenomena, and anomalistics is in fact a big question-mark, erected before the modern scientific picture of the world. Do we need any "alternative science" to convert the potential of this doubt into the energy of knowledge? As experience tells us, pretensions "to go beyond the limits of science" rarely take their authors somewhere. On the contrary, attempts to approach "anomalous problems" in a rigorous scientific way can be fruitful indeed.

True enough, the number of real attempts of this kind is rather limited, to say the least. Nonetheless, they do merit attention. A prominent place among them is occupied by the problem of the Tunguska explosion. Science got its teeth into this problem, believing it could be solved within the limits of the established paradigm of meteoritics. It was known that on June 30, 1908, a fiery body had flown over Central Siberia and fallen not far from the Podkamennaya Tunguska river. On falling it leveled taiga for tens of kilometers around.

All this looked quite like the picture of the fall of a giant meteorite, its crater and debris remained to be found. The expeditions of the 1920-s and 1930-s, organized by the Academy of Sciences of the USSR and led by L.A.Kulik, were aimed just at normal meteoritic studies. Even when (practically immediately after discovering the area of the leveled forest) it was established that at the epicenter of the catastrophe the trees were still standing upright, showing no sign of a meteorite crater, no real significance was attached to this fact. There was just a little shift from the idea of a single meteorite body to that of a meteorite shower (which had to arise from destruction of the initial body due to air resistance at some altitude above the Earth's surface). Respectively, the forest was supposed to be leveled by the ballistic wave of the collapsed body. L.A.Kulik mistook thermokarst holes for meteorite craters, and nobody should throw a stone at him for this mistake: being a really eminent specialist in meteoritics, he looked for a meteorite, not for something else.

The real importance of the "first Tunguska anomaly" — the overground character of the explosion — was grasped rather late. Even in 1951 the most distinguished Soviet astronomers wrote in the popular-science journal "Nauka i Zhizn" ("Science and Life"): "There is no question that immediately after the meteorite fall, a crater-like depression formed where at present the Southern Swamp exists. It is quite possible that the... crater was relatively small and soon it was inundated with water. In subsequent years it was covered by silt and moss, filled with peat hummocks and partly overgrown with bushes. The dead trees standing upright can be seen not at the center of the catastrophe, but on the hillsides which surround the hollow..."[1]

Meanwhile, five years ahead of that paper, the Soviet engineer and science-fiction writer Alexander Kazantsev paid special attention to the overground character of the Tunguska explosion (as well as to a certain similarity between it and nuclear ones), advancing the hypothesis of an extraterrestrial spaceship which had met with disaster due to a malfunction at the final stage of its space travel. But it was not until 1958 that the work of the first post-war Tunguska expedition, organized by the Committee on Meteorites of the USSR Academy of Sciences (KMET) made everyone involved in the

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discussion to agree: the Tunguska Space Body (TSB) had in fact exploded in the air and it would be premature to classify it as a usual crater-forming meteorite. Thereafter the number of anomalies discovered on the site of the Tunguska explosion began to grow steadily. The hypothesis of a thermal explosion, according to which the TSB was a meteorite or the core of a small comet that exploded as a result of the rapid deceleration in the lower atmosphere, met with difficulties trying to assimilate all of them. And as soon as in 1962 KMET got rid of the problem, turning it over to the Commission on Meteorites and Cosmic Dust of the Siberian Branch of the USSR Academy of Sciences (KM SOAN). The TSB problem was, so to speak, exiled to the place of its birth.

In reality it was the Interdisciplinary Independent Tunguska Expedition (its Russian abbreviation being KSE) that became the center of the Tunguska studies. It does not mean, of course, that only KSE and KM SOAN were entitled to study the problem (there have been some research teams outside these bodies, including, in particular, the team of A.V.Zolotov), but the role of KSE in this work can hardly be overestimated.

The Interdisciplinary Independent Tunguska Expedition is a kind of informal scientific research institute aimed at interdisciplinary studies of the Tunguska problem. It was formed in 1958 in the Siberian city of Tomsk, originally under the leadership of G.F.Plekhanov, and consisted at first of a dozen of specialists in various scientific disciplines, mainly physicists and mathematicians. A few years later the "core" of KSE involved about 50 scientists, some 100 specialists per year took a part in expeditions and the field-work on the site, and no less than 1000 researchers working in various institutes all over the country analyzed the collected materials.

KSE performed a really huge amount of the work, and its results have been published in a series of collections of papers. Nonetheless these results remain virtually unknown in the West and not fully assimilated in the CIS. The real extent of anomalousness of the Tunguska phenomenon that was discovered during this research work was hardly perceived outside the narrow circle of specialists in the TSB problem. Besides, there were very few special publications on this topic even in the Russian language, let alone the English one. The paper "The Tunguska Meteorite: A Dead-Lock or the Start of a New Stage of Inquiry?", by N.V.Vasilyev, fills in this gap. Part I of this paper appears in this issue of RB; Part II will appear in the next one. In fact, this is the most comprehensive survey of anomalous aspects of the Tunguska phenomenon ever published, being also the first work describing and discussing these aspects in sufficient detail. The author of the paper, Dr. Nikolay V. Vasilyev, Member of the Russian Academy of Medical Sciences and Deputy Chairman of the KM SOAN, has been the head of the KSE since 1963. One of his main tasks has been interdisciplinary coordination of the Expedition works. Actually, Dr. Vasilyev is in the best possible position to expound the results of the 35-year-long KSE investigations.

In the course of these investigations the problem of the Tunguska explosion has evolved into a multidisciplinary field of research, with its own research community, a set of publications, research methodology, etc. In respect of the "meteoritic establishment" (personified in the KMET), this community turned out to be to some extent alternative, since it was ready to consider every hypothesis of the TSB origin, even the technogeneous one. However, KSE combines its unconventional research strategy with strictly normal, rigorous, scientific research methods. Thus, KSE has been performing a normal scientific investigation of an anomalous phenomenon. This investigation can be considered exemplary in respect of its scientific level, seriousness and unbiasedness. If we associate normal science with these distinctive features (and not with the dullish following paradigmatic models even when the latter are obviously inconsistent with the phenomena under investigation), then we are dealing here with *normal alternative science.*

I would also like to emphasize the importance of the not-so-peaceful coexistence of the "technogeneous" (or "artificial", A–) and "natural" (N–) conceptions of the TSB nature for the development of the Tunguska studies. In fact, their entire history, beginning from 1946 (the year when A.P.Kazantsev published his hypothesis) is a history of the A—N competition. The alternatives "nuclear—thermal" (explosion) and "artificial—natural" (body) have remained the key-note in the whole Tunguska affair, especially in the work of the research team led by A.V.Zolotov (at first in the town of Oktyabrskiy, Bashkir ASSR, and later in Kalinin — now Tver).

Zolotov succeeded in establishing, even on the basis of that empirical material which was collected by the middle of the 1960-s, the following important points: 1) the forest destruction was made by the blast, and not by the ballistic wave; 2) the latter one was rather weak, and hence the velocity of the TSB at the final stage of its flight was low (some 1.2 km s^{-1}); 3) the concentration of the energy of the explosion approaches that of nuclear ones.[2]

The question whether or not the Tunguska explosion was in fact nuclear remained thus far unanswered. One can see from the paper by N.V.Vasilyev that some data do support this assumption. However all attempts to prove or disprove it have not met with success. Nevertheless, it seems that the basic tendency of the results obtained favours the artificial nature of the TSB and at least unconventional character of its explosion. The technogeneous hypothesis is thus coming to the fore in the Tunguska studies. However, the "big science" does not appear to be mature enough to treat it unbiasedly.

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THE TUNGUSKA METEORITE: A DEAD-LOCK OR THE START OF A NEW STAGE OF INQUIRY? — Part I

N.V.Vasilyev

The term "Tunguska meteorite fall" refers to the cosmic phenomenon that was observed on June 30, 1908, about 7 a.m. of the local time in Central Siberia, over Krasnoyarsk Territory, Irkutsk Region and Yakutiya [1]. The most remarkable feature of the event was an explosion of a space object of unknown origin which was moving generally SE to NW and was seen in many settlements of the region.

The flight of the object was attended by sound, seismic and electrophonic effects which covered a vast territory [1–4], and it was equal to the whole set of manifestations of a bolide of $-22^m - -17^m$ of the stellar magnitude. Its brightness was comparable to that of the Sun, but there was no smoky trail characteristic of large iron meteorites. Still, many witnesses noticed a trail of iridescent bands looking like a rainbow [4].

At the moment when the body was flying at the approximate altitude of 5.5 to 8 km over the area with the coordinates 60° 53' N, 101° 54' E (70 km to NW from the little trading station of Vanavara, Krasnoyarsk Territory, not far from the Podkamennaya Tunguska river), there occurred an explosion, or, more precisely, explosion-like energy release.* The TNT equivalent of the effect is estimated as 10–40 megatons, the energy being 4.2×10^{23} to 1.7×10^{24} ergs [5–8]. There is some evidence suggesting that following the explosion-like energy release at least a part of the Tunguska Space Body (TSB) continued to move in the "pre-explosion" direction upwards [9; 10].

The TSB "explosion" gave rise to a seismic wave recorded in Irkutsk, Tashkent, Tbilisi and Jena [1], as well as pressure disturbances which traveled around the globe [3; 11; 12]. In addition, 5.9 + 0.9 min. (or, according to another estimate, 6.6 + 0.2 min) after the "explosion", local magnetic storm began which persisted for more than four hours and was similar to geomagnetic disturbances following nuclear explosions in the atmosphere [13–16].

The shock wave of the Tunguska explosion leveled 2150 + 25 km^2 of taiga [9; 17], and the flash burnt vegetation over an area of about 200 km^2 [18; 19]. The Tunguska explosion resulted in a major forest fire covering an area comparable with that of fallen forest [20; 21].

It is noteworthy that the explosion on the Podkamennaya (Stony) Tunguska was just the most striking event in the set of natural anomalies which occurred in the summer of 1908 and were probably interrelated. It is now known [22] that beginning on June 23, 1908, atmospheric optical anomalies were observed in many places of Western Europe, the European part of Russia and Western Siberia. They gradually increased in intensity till the 29th of June and then jumped to their peak in the early morning of the 1st of July. These anomalies which are described in detail in Refs. [22] and [23] included unprecedentedly active formation of mesospheric (silvery) clouds, bright "volcanic" twilights ("variegated afterglows"), disturbances of the normal travel of the Arago and Babinet neutral points, supposed increase in the emission of the night sky, and unprecedentedly intense and long solar halos. Later, after July 1, these effects exponentially reduced; still some after-effects took place up to late July of 1908.

The area involved in these phenomena included a considerable part of the Northern Hemisphere and was bounded by the Yenisey river in the East, by the Tashkent – Stavropol – Sevastopol – Bordeaux line in the South, and by the Atlantic coast in the West. In August of the year the Western Hemisphere saw a decrease in the air's transparency [24] which was due, as V.G.Fesenkov believed, to atmospheric circulation of the Tunguska explosion products. It has been shown recently that along with the Tunguska aerosol cloud, there was simultaneous circulation of products of destruction of another large bolide which entered the Earth's atmosphere in May of 1908 [25]. Superimposition of these effects makes their separate interpretation more difficult.

It should be also noted that the summer of 1908 was quite rich in bright bolides in Siberia, as well as elsewhere [22; 26] (if one compares that year with the years 1907 and 1909 [27]).

The Tunguska meteorite explosion area was found in the 20-s by surface explorations of L.A.Kulik, as well as through analysis of geophysical data performed by A.V.Voznesensky [28]. The chronology and findings of subsequent studies of this area are described in Refs. [29–32].

The expeditions before World War II that were headed by L.A.Kulik [1; 2; 33], as well as post-war field works (since 1958 till now) found no explosion- or impact-induced astroblemes or large fragments of the TSB [34–37]. Active search for finely-dispersed space material in the area of the catastrophe, over 10,000 km^2, did not result in discovery of a material to be reliably identified with that of the Tunguska meteorite. The meteoritic dust and similar particles which were found on the site [38–41; 44] cannot be now reliably differentiated from fluctuations of the background fall of extraterrestrial matter. However, there have been revealed in the area of the

* Therefore, although we will use in this paper the term *explosion*, it is not fully appropriate for describing the event and should be read rather as "explosion" (that is, *quasi-explosion).*

catastrophe some biogeochemical elemental and isotopic anomalies which may be related to the event under discussion [42–47]. Interpretation of these anomalies is still more complicated since the epicenter of the Tunguska explosion almost ideally coincides with the center of an ancient volcano [48], whose lava flows and thermal ejections undoubtedly affected essentially formation of the biogeochemical situation in the region. The post-war expeditions revealed a complex set of ecological consequences of the Tunguska catastrophe, namely:

1) accelerated growth of young (post-catastrophic) trees and those which survived the event [49–51];

2) population-genetic effects, chiefly at the epicenter and along the TSB trajectory [52; 53].

This is a general outline of the Tunguska phenomenon which, upon thorough study, proves to be principally different from other impact phenomena.

The many hypotheses proposed to explain the Tunguska phenomenon can be subdivided into two groups. One will include those based on the concept of transfer of the *kinetic* energy of the Tunguska body into the shock wave energy. The other group consists of hypotheses emphasizing release of the *internal* energy of the body, chemical or nuclear.

Among the hypotheses of the former group, worthy of detailed consideration are primarily those involving concepts of asteroidal (an iron or stone asteroid, or a gigantic carbonaceous chondrite) or comet TSB nature. These can be classified as hypotheses based on the classical concepts of the minor bodies of the Solar System.

The hypotheses of the latter group assume a special type of the nature of TSB, different from asteroids or comets. These include the hypotheses of the antimatter nature of the TSB [54], of the Tunguska meteorite as a microscopic black hole [55], of a "solar energophore" [56] and even of technogeneous origin of the TSB [57–59].

The very fact of the existence of the so diverse views suggests a situation where the phenomenon in question is difficult to explain in all its aspects. Indeed, profound analysis of the factual data on the phenomenon evidences its structural complexity and seeming contradictoriness which restrict its interpretation in traditional terms. It is thus suitable to dwell upon certain most serious difficulties which are to be coped with in any attempt to construct an integrated concept of the Tunguska phenomenon.

1. On the direction of the TSB flight

The first investigators of the Tunguska meteorite (L.A.Kulik, E.L.Krinov, and I.S.Astapovich [1; 2; 3]) who analyzed comparatively fresh evidences of the flight of the TSB on the Angara river did not doubt that it had moved generally from the south to the north, though there were three versions of its trajectory (the southern one, proposed by L.A.Kulik, the south-eastern by E.L.Krinov and the south-western by I.S.Astapovich). By the early 60-s it was Krinov's trajectory, namely 135° east of the true meridian, that was considered the most realistic.

Later however, as more information was accumulated on the vector structure of the fallen forest field [9; 17; 59], a "corridor" of axially symmetric deviations of the vectors of the forest falling from the dominating radial pattern was revealed, and this deviation was interpreted as the track of the ballistic wave. The direction of the "corridor" which was initially estimated as 111° E from N (114° east of the true meridian) [17] was later found to be 95° E from N (99° east of the true meridian) [10], which roughly coincides with the axis of symmetry of the radiant burn area [19]. In this period of time, V.G.Konenkin [60] and later other investigators [61–63] questioned old residents of the area who had lived in the upper reaches of the Nizhnyaya (Lower) Tunguska in 1908 (where there was no questioning in the 20-s and 30-s). This resulted in the conclusion that TSB had been observed in the said area as well, the analysis of the data suggesting that the body moved from the ESE to the WNW, i.e. by the path coinciding with the projection of that of the TSB, as found on the basis of analysis of the vector picture of the fallen forest area. This coincidence caused revision of the notion of the TSB path, and since the year 1965 the ESE–WNW (in fact, even E–W) version has been accepted in literature. For some years it was assumed to be finally true.

A grave disadvantage of the calculations of TSB path before the mid-80-s was that there were analyzed only some separate groups of eye-witnesses' accounts obtained by different researchers, in different periods of time, and not the whole body of evidence. Publication of the catalogue of eye-witnesses information [4] enabled analysis of the whole event. This was done in Ref. [56] and corroborated the considerations expressed earlier in Ref. [58] and also by I.S.Astapovich [64]. Two fundamental facts were established in particular:

1. The total combination of evidence given by "eye-witnesses of the Tunguska fall" contains in fact information on at least two (most likely more) large day-time bolides. It is important that the "images" of the "Angara" and the "Nizhnyaya Tunguska" bolides are quite different and everything seems to indicate that they belong to different objects.

2. The trajectory calculated on the basis of evidences of witnesses of the "Angara" phenomenon and corresponding most likely to its version proposed by E.L.Krinov [1] deviates considerably from that determined by analyzing of the vector structure of the forest fall area and the radiant burn area [9; 19]. Indeed, evidences of the Angara eye-witnesses, including the report of a district police officer, strongly suggest that the bolide flew "high in the sky", which is hardly consistent with the path 99° E of the true meridian. On the contrary, the data ob-

tained on the Nizhnyaya Tunguska river, though agreeing with the configuration of the destruction area, are in contrast with the Angara observations.

An extra complication is that Nizhnyaya Tunguska data suggest virtually unambiguously that bolide's flight took place in the afternoon, unlike those of the Angara which refer to the early morning.

Attempts to resolve the conflict between the data face with considerable problems. If the Angara and Nizhnyaya Tunguska observations are due to different bolides, which is most probably so, — then with which of them the destruction area originally explored by L.A.Kulik is associated? Judging by the destruction area configuration, the most probable candidate is the eastern (Nizhnyaya Tunguska) bolide. However none of TSB investigators doubts that the explosion at the distance of 70 km from Vanavara occurred in the early hours of the day, not past midday [56]. Moreover, there is no direct proof that the Nizhnyaya Tunguska bolide was observed in the year 1908, inasmuch as this event was not recorded in any official documents, unlike the Angara bolide.

Besides, even assuming the area of the leveled forest, discovered by L.A.Kulik, to be due to the Nizhnyaya Tunguska bolide, it remains unclear where the Angara bolide fell, then. Throughout the Tunguska "meteorite" study there was no doubt the latter had in fact exploded in the Vanavara region...

But if the forest leveling was caused by the Angara bolide, how does it fit the direction of the "corridor" impressed in the area of the fallen forest by the TSB ballistic wave?

In the search of way out of this maze, more than one approach has been tried. Some researchers, preferring direct physical evidence, practically ignored eye-witnesses' testimonies as an unreliable subjective material. This approach could be agreed with to some extent, if it were a matter of a few inconsistent testimonies, not many hundreds of independent reports. Besides — what is very important — the testimonies of the year 1908 include official documents of the time, whose authors were responsible to the authorities for their trustworthiness. For this reason, the eye-witnesses' reports should be regarded as a material equal to other data sets or at any rate not to be ignored, even if they do not conform to some speculative arguments.

Other investigators tried their best to combine the Angara evidence, the Nizhnyaya Tunguska data and the geometry of the destruction area [65]. The results were rather dubious, strained, and quite different in this from the sufficiently unambiguous and clear picture which is provided when the two groups of eye-witnesses' reports are analyzed separately.

Then, F.Yu.Zigel [58] introduced the concept of a "manoeuvre" made by the TSB, assuming it to have moved initially in a path close to that calculated by E.L.Krinov [1] and then, describing an arc, entered the space over the interfluve of the Nizhnyaya and Podkamennaya Tunguskas and took an eastern path which led it to the "explosion".

These contradictions have not been reconciled. It seems probable that the eastern group of eye-witnesses' evidence is not directly related to the Tunguska bolide and that the latter moved in a trajectory close to that calculated by E.L.Krinov [1]. The cause of the incompatibility of the bolide path projection with the data of the Angara eye-witnesses' group remains unclear. Yet it should be borne in mind that the identity of the axis of symmetry of the observed forest destruction pattern with the projection of the bolide path that appears almost self-evident to the Tunguska meteorite investigators is only an assumption of high probability, rather than an established truth. The axially symmetric "corridor" is the trace of the ballistic wave *where it touched the earth surface*; it remains essentially an open question what its initial space position was and whether it could change for some reason or other.

However, the problems associated with the TSB path parameters are not only these. Most of the authors who studied this question conclude that the slope of the TSB path was relatively small (some 15°) [1; 66; 67]. Still, modeling experiments [68; 69], as well as results of mathematical simulation of the Tunguska explosion parameters [70; 71] evidence that the slope of the final path section was most probably 40°. The transition of the TSB from the comparatively flat path to the steep one ("the peck") seems to have taken place as the bolide approached the spot of the explosion; it might be due, as is held in Refs. [72; 73], to avalanche breaking of the "meteorite", enlargement of its frontal surface and increasing resistance of the air.

Especially embarrassing is the fact that the "corridor", this impression of the ballistic wave on the forest, is observed, as has been recently shown, even beyond the epicenter of the explosion, as if roughly continuing the direction of the TSB flight [74]. The most reasonable explanation is assumption of a ricochet of the TSB part which survived the explosion and continued its flight, maintaining, to some degree, the same trajectory. The question however arises if this assumption satisfies the requirements of the theory of the strength of materials.

As was mentioned above, the TNT equivalent of the Tunguska explosion is estimated as 10–40 megatons, the temperature of the center of the fire ball measuring at least tens of thousands of degrees Kelvin [75]. What must have been the characteristics of the TSB substance to withstand this "fiery font" and retain compactness and ability to ricochet? And how does it go with the above concept of the TSB consisting of comet ice or a silicate material, suggested by the first group of hypotheses to account for the Tunguska phenomenon?

Thus, analysis of materials characterizing the

TSB path suggests its rather complex nature. It is not improbable that the Tunguska object moved in a non-ballistic trajectory.

2. On some peculiarities of the evidence of eye-witnesses who were close to the Tunguska explosion epicenter

The TSB (or some part of it) exploded over a sparsely populated area, and for this reason only few eye-witnesses of the event found themselves close enough to the scene of the disaster. (The number of the victims of the Tunguska catastrophe was also very limited.) Besides Russian eye-witnesses who lived at the Vanavara trading station (70 km SE of the epicenter), whose reports were collected by L.A.Kulik (see: [1]), there were within 40 km around the epicenter detached nomad camps of the Evenks (Tungus) on the Nizhnyaya Dilyushma, the Avarkitta (or possibly the Makikta, a right tributary of the Chamba river) and near the mouth of the Yakukta river (40 km to the south of the epicenter, close to where the so-called Kulik's path intersects the Chamba river). The testimonies of the witnesses from the Nizhnyaya Dilyushma river were published as early as in the 1920-s [76] and contain memories of the fire in the forest and fallen trees. These are well known and have been commented on by specialists more than once. As regards the testimonies of the Evenks who had been on the Avarkitta and the Yakukta, those were published much later and contain some strange details that seem to deserve special attention. These details are definitely queer, and the reader finds himself before the alternative: either deny them as obviously absurd, or — be they believed if to a certain degree — assume that our ideas of the physics of the Tunguska explosion are wrong.

The first of these reports was communicated by the well-known ethnographer and public figure I.M.Suslov who spent many years working in Evenkiya (the territory of the Evenks or Tungus). In 1925, during the "suglan" (kin council), he questioned those people who had seen the Tunguska event [76]. Much later, in the 60-s, being a pensioner, I.M.Suslov informed the Siberian Commission on Meteorites and Cosmic Dust that he had some unknown materials on the problem which he was ready to make public in a collection of papers on the topic of the Tunguska meteorite. Shortly after that he gave them a large manuscript, which was edited and abridged by V.E.Shnitke and then published in the collection *The Problem of the Tunguska Meteorite* in 1967 [77]. It remains unclear why Suslov had not had it published before. Equally unknown have remained the initial records on which the paper was based. No original notes on the topic were discovered in Suslov's papers after the man's death. The impression is that the paper was written by himself on the basis of either his personal memories or some notes now missing.

I.M.Suslov's paper is a detailed presentation of a report of the Evenks of the Shenyagir kin who were at the moment of the Tunguska explosion in the middle part of the Avarkitta river. The scope of the present paper is not sufficient to completely present this report, but its essence can be summarized as follows.

There were five explosions, the second seeming to have been the most powerful. Light flashes followed at an interval of a few seconds and were seen at different spots of the sky. The last, fifth explosion took place far in the north, somewhere near the Taymura river. Trees began to fall and the fire began after the first explosion, while the Evenks were in their "chums" (tents of skin or bark), the latter being thrown down. There were traumatized people.

The data communicated by I.M.Suslov are quite detailed and enable the whole phenomenon to be estimated as lasting no less than 20–25 seconds.

Another report was conveyed to the TSB investigators by V.G.Konenkin, a local inhabitant and school teacher of physics in Vanavara, who had questioned old residents of settlements of the upper reaches of the Nizhnyaya Tunguska and the Tunguska–Chunya Region of Evenkiya for several years. Among those questioned was an Ivan Ivanovich Aksenov, an elderly Evenk man, who was said to have been a shaman hiding for many years in taiga from the authorities. The entire record of I.I.Aksenov's account is presented in Ref. [4]. At the moment of the catastrophe the eye-witness was on the Chamba river, hunting near the mouth of a tributary of the Chamba, that is some 40 km to the south from the catastrophe epicenter. A particular feature of Aksenov's account (agreeing otherwise with the early evidence of Vanavara residents that Kulik had heard as far back as the 20-s), is the assertion of the eye-witness that after the explosion he had seen an object flying down the Chamba, i.e. generally north to south. He called the object a "devil". "As I came to myself, he told Konenkin, I saw it was all falling around me, burning. You don't think, Viktor Grigoryevich [V.G.Konenkin], that was god flying, it was really devil flying. I lift up my head — and see — devil's flying. The devil itself was like a billet, light color, two eyes in front, fire behind. I was frightened, covered myself with some duds, prayed (not to the heathen god, I prayed to Jesus Christ and Virgin Mary). After some time of prayer I recovered: everything was clear. I went back to the mouth of the Yakukta where the nomad camp was. It was in the afternoon that I came there..."

Afterwards I.I.Aksenov repeated his account in the presence of V.G.Konenkin and V.M.Kuvshinnikov, an active participant of the Tunguska expeditions. In this case, however, he said that he had seen the "flying devil" not during hunting but in the afternoon, when already in the camp near the mouth of the Yakukta, also a tributary of the Chamba. The devil was going flying southward along the Chamba.

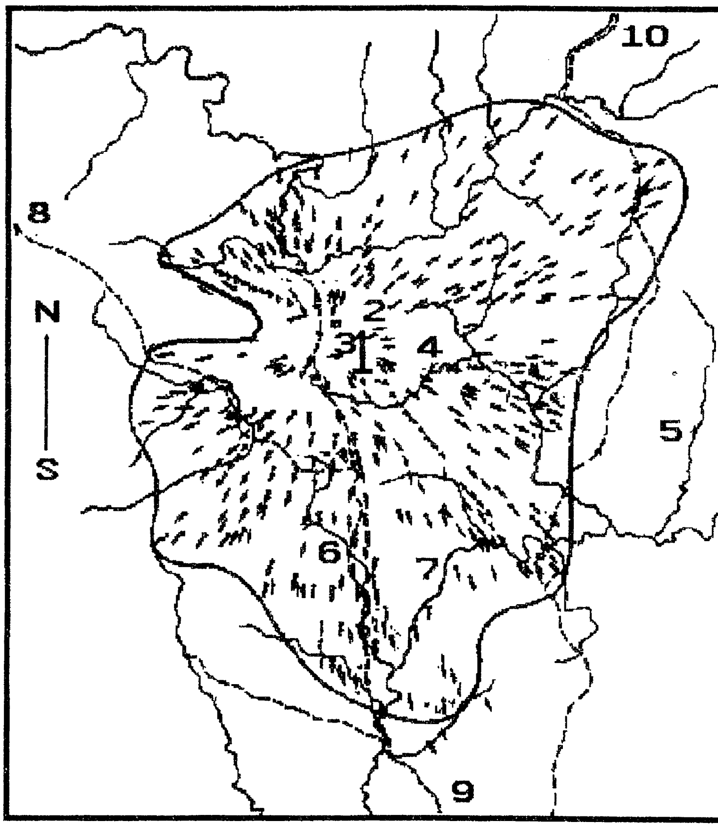

Fig. 1. The area of the Tunguska explosion.

Small arrows indicate average directions of leveled trees in each of 650 test zones. A continuous line bounds the fallen forest area. The numbers designate the locations of:

1 – the Southern Swamp and the epicenter; 2 – the Farrington mountain; 3 – the base of Kulik's expeditions; 4 – the Khushmo river; 5 – the Nizhnyaya Dilyushma river; 6 – the Makikta river; 7 – the Chamba river; 8 – the path to Mutoray; 9 – the path to Vanavara; 10 – the path to Strelka.

This picture is based on the map of the area, compiled by a group of KSE members under the supervision of V.G.Fast, as a part of the expedition works in 1961–1964 (see: Problema Tungusskogo meteorita. Vol. 2. Tomsk: Izdatelstvo Tomskogo Universiteta, 1967, p. 7).

It was going faster than airplanes now do. While flying, the "devil" was saying "troo-troo" (which were not at all loud).

Later, during repeated questioning in Vanavara, he did not insisted on having seen the "devil", repeating nevertheless the other evidence. When evaluating Aksenov's account it should be borne in mind that the eye-witness regarded the expedition people with distrust, considering them representatives of the "authorities", and thus the contact with him was not at all easy. On the contrary, his relations with V.G.Konenkin were fairly confidential, the latter being a local resident and a half-caste. Therefore, in our opinion, the first version appears to be more authentic, because Aksenov does not seem to have had reasons to lie to Konenkin.

What is the true meaning of this queer story and how trustworthy is it — it is now hard to say. Without overrating the significance of individual eye-witnesses' evidence, note nevertheless that at least two reports provided by those (very few) eye-witnesses who were close to the epicenter of the Tunguska explosion are really peculiar.

3. On some specific features of destruction of the forest at the Tunguska explosion epicenter

It has been ascertained that the main cause of forest destruction in the area of the Tunguska catastrophe was powerful energy release that took place at an altitude of 5.5–8.0 km. It must have been thus a huge explosion in the air which gave rise to a spherical shock wave, with the front at the epicenter generally parallel to the earth surface and inclined to it away from the epicenter. Thus, at the latter the vertical component of the shock wave was mainly active, while away from it the horizontal component was ever increasingly dominant, its action most pronounced in the area of interference of the incident and reflected waves [6].

As a first approximation, this is indeed so. Around the catastrophe epicenter there is a vast (about 8 km across) area of what is called "telegraphnik" (that is, looking like a forest of telegraph poles) — the dead forest, scorched and devoid of branches, but trees standing upright. This is the zone of action of the blast wave vertical component. Outside this area forest is put down radially, to distances from 12 to 40 km or more in various directions (see: Fig. 1). This is, in its turn, the area of action of the blast wave horizontal component.

If the above model is fully correct, then, first, at the explosion epicenter there must be no radial forest falling, and second, the destruction pattern should be generally uniform.

The real situation is, however, essentially different. Firstly, even at the epicenter forest was not destroyed completely. Within 5–7 km from the epicenter, many small groups of trees survived [78], mainly of larches. Topography of such groups is not quite definite, though some of them are in shallow valleys between hills or along rivers and brooks. These groups of trees have attracted attention of investigators more than once [1; 4; 79] since as early as the times of Kulik; however attempts to account for them based on the relief features have not yielded unambiguous results. The highest altitude above sea level of the whole area is 593 m, which, in the case of explosion at an altitude no less than 5.5 km, enables treating the whole area as a plane. At the same time, the very fact of existence of these groups and their patchy arrangement seem to suggest high nonuniformity of the action of the kinetic factors responsible for destruction of forest at the catastrophe epicenter.

This assumption is also supported by some other facts. According to calculations [71] and observations in the field [80], the thermal pulse at the epicenter must have been 15 to 55 cal cm^{-2}. This is certainly sufficient to singe cedar branches which are highly sensitive to thermal influences. Meanwhile, there is a group of cedars that survived the Tunguska catastrophe on the bank of the Southern Swamp, no more than 2.5 km from the projection of the center of the light flash of the Tunguska explosion [81], and right in the marsh there grow fir trees which also survived the catastrophe. B.I.Vronski, in the year 1960, found on the surface of the Southern Swamp, practically at the center of the projection of the light flash of the Tunguska explosion, a lively larch, aged over 60 years. The location of the tree made improbable its being screening at the moment of the explosion.

The structure of the forest fall area in the immediate vicinity of the epicenter also proved strange.

Firstly, the assumption of the absence of radial tree falling here is not true. Surface observations [82] evidence that there are some leveled trees in this area as well, and the general radial character of the forest falling is seen up to a "special point", viz. the geometric center of the fallen forest area, as calculated by V.G.Fast [17].

Secondly, Kulik's interpretation of the fallen forest area on the basis of the large-scale aerophotography of 1938 not only corroborated the complex vector structure of the epicentral area, but also enabled assumption of the existence there of at least two or three subepicenters [83].

Thirdly, the vector structures of the forest falling on hill-sides facing the epicenter and the opposite ones are essentially different, which is in poor agreement with the assumption of the center of generation of the blast wave located high above the earth.

Thus, the conclusion suggests itself that along with great energy release 5.5–8 km above the earth, there were a number of low-altitude (maybe even right above the surface) explosions that contributed to the total picture of destruction. This seems to be sustained by other data concerning in particular the configuration of the zones of dead trees ("poles") [84] in the central part of the area of the catastrophe and deposition of aerosols immediately after the explosion.

Extraordinary variety of effects is also suggested by analysis of radiant damages of trees [85]. Literally beside trees carrying distinct signs of thermal effects, there are many undamaged trees, the cause being not always clear.

Thus, the features of destructions at the epicenter suggest inhomogeneity of the physical parameters of the Tunguska explosion field and complexity of the physical processes underlying it.

It should be emphasized that though the patchiness of the effects associated with the Tunguska catastrophe has been noted in literature more than once, its origin still as a rule has not been discussed. This seems to be due to serious difficulties of its interpretation in terms of the existing TSB models.

Note that the range of unusual features of local effects caused by the shock wave and the thermal factors of the Tunguska explosion is not restricted to what has been said, as suggested in particular by the difficulties arising in interpretation of fiery damages of trees injured during the explosion-induced forest fire [86; 87].

4. The energy balance of the Tunguska explosion

The TNT equivalent of the Tunguska explosion was 10 to 40 megatons, comparable to the equivalent of the largest thermonuclear explosions. Most energy was consumed by formation of the shock wave, no less however than 10 % released as the flash [88; 89]. It was formerly assumed that the high yield of luminous energy was a typical feature of nuclear explosions and could attest to the nuclear nature of the Tunguska explosion [89]. Later however it was shown that the same effects could attend also other types of explosions, destruction of large meteoric bodies in particular [71]. The energy of the Tunguska meteorite has been independently estimated by analyzing seismo- and barograms [7; 8] and using mathematical modelling. However, as has been suggested by detailed works of V.P.Korobeynikov et al. [70; 90], the models of the Tunguska catastrophe based on the assumption of transition of the kinetic energy into the energy of the explosion do not provide adequate explanation to the observed pattern of destructions and require, for the energy balance, a certain "addition" from the TSB internal energy. This aspect of the TSB problem has not been studied more thoroughly. Thus, the question of the energy source of the Tunguska explosion still remains open.

5. On the geophysical effects of the Tunguska catastrophe

One of the most striking geophysical effects associated with the Tunguska catastrophe is the local geomagnetic disturbance detected, shortly after the explosion, in Irkutsk, though not recorded by any other geophysical observatory of the world existing at that time [13; 14; 15]. This disturbance was similar to some effects following middle- and high-altitude nuclear explosions in the atmosphere [59; 91], but unlike the latter, it exhibited a kind of lag, i.e. it occurred some time after the explosion. It has provided the main argument to account for the geomagnetic effect of the Tunguska "meteorite" as due to entering of the shock wave the ionosphere: the lag was in good accordance with the period of time required for covering by the wave the distance from the explosion site to the lower ionosphere boundary.

Later, however, I.P.Pasechnik [92] has corrected the moment of the Tunguska explosion on the basis of direct experimental measurements of the velocity of the seismic wave between Vanavara and Irkutsk. It has been found that the "lag" was actually longer than 5.9 min. This fact, thoroughly analyzed in Ref. [56], is radically important to the problem, inasmuch as the ensuing velocity of a shock wave in the atmosphere is too low. Hence any mechanism accounting for this effect as a consequence of arrival of the shock wave in the ionosphere appears dubious. The question thus remains open, and again, as in 1960, we are faced with the problem, without explanation.

Neither have been found adequate explanations to the changes of the polarimetric properties of the twilight sky that appeared as deviations from the normal travel of the Arago and Babinet neutral points [22; 93]. This effect was noted on July 1st, 1908 in Arnsberg (Germany) and disappeared by July 20th. Its characteristics differ from the polarimetric disturbances observed after other cases of atmospheric dusting. It is not improbable that such effects are related to global development of mesospheric (silvery) clouds [94]; there has been however no experimental verification of this assumption.

The explanation of the "light nights" of the late June and early July, 1908, with recourse to dispersal of particles of a comet's tail in the upper atmosphere of the Earth [95] is not at all convincing.

Indeed, according to this assumption, particles of the comet's tail were to be decelerated at the altitude of 200 km or more, whereas most light anomalies formed at altitudes of 80 km (the zone of formation of mesospheric clouds), 50–60 km (diffraction effects that caused dawn and afterglow anomalies) and below that (atmospheric halos) [22]. Besides, in this situation the tail of the "Tunguska comet" should have been stretched over Canada [96], but this was not so. Recently, there has been an attempt [97] to ascribe the "light nights" of the summer of 1908 to transport of material from the site of the explosion by stratospheric winds. This assumption however is faced with two contradictions.

Firstly, at least at 10 places of Eurasia there were anomalous light effects on the night of June 29–30, 1908, i.e. practically simultaneously with (and even somewhat before) the Tunguska explosion, which makes it impossible to explain the optical effects of June 30, 1908 as due to mechanical transport of space aerosols from the site of the Tunguska event.

Secondly, in discord with this explanation is also the sharp exponential decrease in the intensity of the atmospheric anomalies after the 1st of July which well conforms to the assumption of the dominating contribution of photochemical reactions to formation of these. If, alternatively, the main contribution were given by refraction and scattering by aerosol particles, it would be more reasonable to expect gradual decrease in the effects, as in the case of volcano-induced optical anomalies [22].

Thus, explanation of the geophysical effects of the Tunguska "meteorite" has been faced with essential problems, the main being lack of a satisfactory explanation of the geomagnetic effect.

(To be continued in the next issue of RB.)

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LETTER

AN EXTRATERRESTRIAL ARTIFACT?

Sir,

A white bolide of -7^m of the stellar magnitude flew over the Kursk, Belgorod and Kharkov regions from the north to the south at 17 h 45 m U.T. on May 15, 1994 [1–4]. The bolide's trajectory was gently sloping, having about 300 km in extent. This phenomenon was observed by many people including five staff astronomers of the Kharkov University Astronomical Observatory. According to reports of these eye-witnesses, the flight time was some 10 seconds. Hence the bolide velocity was about 30 km s^{-1} what exceeds in three times the maximum possible velocity of artificial satellite on an elliptical circumterrestrial orbit.

The impact site has been discovered by the local resident V.I.Samoylov at 40 km to the SSW from Kharkov, near Okhocheye village. Its location agrees with the reports of bolide observers. Dr. Vladimir A. Zakhozhay (director of the Kharkov University Astronomical Observatory) visited that site with an official expedition of the Observatory on May 27:

"On the edge of the forest we saw a crater 4 m in diameter and 1.5 m in depth, obviously of explosive origin. The energy of the explosion... was estimated to be not less than 60 kg of TNT. We found about 10 kg of metallic substance within a radius of 40–50 m from the explosion center...

"The forest fell to a distance of 10 m: the burnt trees were hit by the debris. Two of the trees which are located northwards from the crater were burnt the most: this is the most probable direction of the body arrival. <...>

"The shape of the debris confirm the artificial origin of that thing, rather than the natural one. However a preliminary chemical analysis of one sample showed its anomalous composition: the iron content is obviously higher than it would have been for a fragment of any usual spacecraft. <...>

"It is necessary to study further the samples and the impact site..." [4]

I saw these debris. The biggest of them appears as a threaded tube 50 cm long and about 2–3 cm thick, crumpled and exploded. When intact, it was probably some 10 cm across, but this estimate is only a very rough approximation. With its chemical composition (Fe – 99 %; Cu – 0.3 %; Ni – 0.04 %; Ti – 0.02 %; Mg and Al have not been found [2;3]) this detail would have been better suited to a heavy tank than to the lightened construction of an artificial satellite. The members of the expedition told me that the explosion was not due to an old weapon of World War II. I personally saw the ablation furrows and the scale (a black crust) on the surface of the debris. Dr. V.A.Zakhozhay has consulted military experts, but the latter could not clear the situation.

This artifact of unknown origin that arrived from a deep space, could probably be a piece of extraterrestrial trash which accidentally reached the Earth [5]. At any rate, this possibility should be taken into account. It would not be wise to miss a chance to study an alien rarity from a distant star civilization.

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— A.V.Arkhipov

(Editorial — continued from page 2)

There certainly may (and probably must) be elaborated different versions of the "artificial" TSB-conception, not only of the "natural" one. The long investigations of the Tunguska explosion area made it possible to realize the complicated and complex character of this phenomenon, which far exceeds the limits of the simplest models still existing in popular-scientific and even scientific literature. In particular, there are some grounds to believe that more than one body was involved in the Tunguska catastrophe.[3] Whether this assumption is correct, remains an open question, but when working in the middle of the 70-s together with A.V.Zolotov and his colleagues, I accepted the so-called "model of the air (or rather aerospace) battle". Of course, to assume that there happened in 1908 over Central Siberia an aerial engagement between two or more extraterrestrial spaceships does not mean to solve the problem. I will not assert that this model is fully adequate, but as a working instrument it was helpful.

In conclusion — a few words about a "less spiritual" matter. Even "normal" (in the "high scientific sense") investigations of anomalous objects frequently remain "alternative" in that they are not (or not sufficiently) funded from the social system of science funding. You will find in the present issue of RB a letter of A.V.Arkhipov containing intriguing information on the fall, not far from Kharkov, of a strange object, different both from usual meteorites and usual spacecraft debris. Frankly speaking, this object is reminiscent of some rusty fragment of a starship from the well-known movie serial "Star Wars". Just too strange a case to remain unnoticed... But one more point of interest has attracted my attention to it. The author of the letter, when quoting the article by the Director of the Kharkov University Astronomical Observatory Dr.V.A.Zakhozhay, removed its last paragraph, probably believing it bore no direct relation to the affair. Meanwhile, it is also worthy of attention. V.A.Zakhozhay admits a curious character of the find, agreeing that it should be examined, but confesses that the Observatory has got no financial means to perform such a work. I think it is safe to say that on this background the discussions about the "principal" normality or anomalousness of the investigations will hardly be of prime importance.

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[3] See: Rubtsov V.V. Dichotomy "natural—artificial" and its role in the problem of extraterrestrial civilizations.—Proc. of 15th Tsiolkovsky Readings, Philos. Section. Moscow: Academy of Sciences of the USSR, 1981, p. 67. See also: this RB issue, p. 4–5.

— Vladimir V. Rubtsov

EDITOR: Vladimir V. Rubtsov
RIAP
P.O.Box 4684
310022 Kharkov-22
UKRAINE

Fax: +7 (057-2) 79-13-13