

## OUT OF OLD BOOKS

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### THE TUNGUSKA METEORIC EVENT

A recent paper by the Soviet astronomer V. G. Fesenkov on the Tunguska meteorite increases the interest in that remarkable object. Fesenkov's paper, "On the Cometary Nature of the Tunguska Meteorite", appeared in the *Astronomical Journal*, U.S.S.R., July–August 1961, vol. 38, p. 577, with a translation in *Soviet Astronomy AJ*, January–February, 1962, vol. 5, p. 441. The purpose of the paper is to set forth the reasons why Fesenkov and some other astronomers consider that this was not the fall of an ordinary meteorite, but actually the collision of the earth with a small comet.

This great event occurred in the basin of the Podkamennaya Tunguska river in Central Siberia on June 30, 1908. Though it has been extensively investigated, much of the information has been published in Russian, and even the translations published in English are not easily available to many of our readers. One of the best early review articles is by W. H. Christie in the *Griffith Observer*, April 1942, from which the diagram is taken. The book by E. L. Krinov, *Principles of Meteoritics*, recently translated into English by Irene Vidziunas, Pergamon Press, 1960, contains an excellent summary of the circumstances of this fall.

A number of prominent Soviet astronomers, including L. Kulik, E. L. Krinov, and I. S. Astapovich have spent many years gathering and correlating information about this event. First to start a real investigation was Kulik, who went to Central Siberia in 1921–22, but because of the isolation of the place, it was not until 1927 that he reached the actual region of the fall. Subsequently he returned on a number of expeditions, on one of which he wintered in this inclement place, whose winter temperatures are frequently  $-60^{\circ}$  F.

Because the event occurred in such a remote and sparsely inhabited region, it took many years to piece together the story. The meteorite fell at 7:17 a.m. local time, near the trading post of Vanovara, at latitude  $60^{\circ} 55' N.$ , long.  $101^{\circ} 57' E.$  Witnesses early that morning saw flying across the sky a bolide so blindingly bright that the day sky appeared dark by comparison. It went from SE to NW or from SSW to NNE, according to different investigators. The fall could be seen in a cloudless sky in Central Siberia over an area about 1,500 km. in diameter. A thick

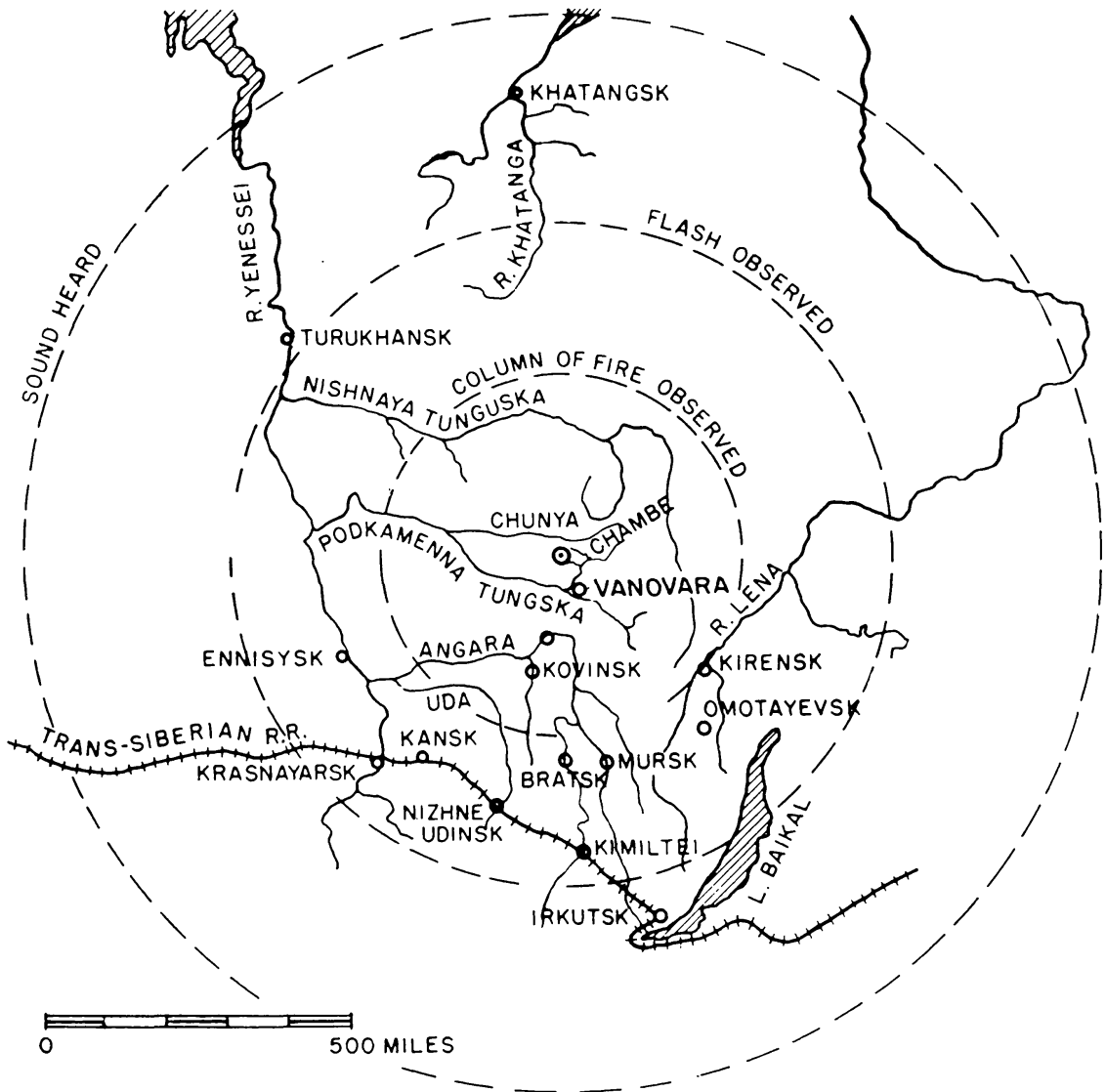


FIG. 1—Region of the Podkamennaya Tunguska meteoric event in Central Siberia. (Courtesy of *The Griffith Observer*.)

dust trail remained along the path, and over the place of fall, fire and a cloud of smoke were seen. Strong detonations, thunder, crackling and rumbling were heard after the fireball itself had disappeared. The sound phenomena were heard up to 1,000 km. from the place of fall.

Over the area where light phenomena were seen, ground tremors were felt, buildings shook, and windowpanes broke. A tent of Evenkians on the taiga about 40 km. from the fall was lifted into the air, along with people inside. The forest was charred and flattened over an area of 250 square kilometres. The central uprooted region had a radius of 12–15 km. From the size of the area over which sound was heard, and the force necessary to uproot the forest, Astapovich calculated the energy of the Tunguska meteorite to be  $10^{21}$  ergs/sec.

It was some years before it was realized that certain effects observed in other parts of the world were connected with this fall. These effects include the bright night sky glow of June 30 that year, the seismic waves registered at various places, the aerial shock registered on the microbarographs of six English meteorological stations, such as South Kensington, Westminster, and Cambridge, and finally the diminution in transparency of the earth's atmosphere from studies of C. G. Abbot in California in the summer of 1908. Fesenkov believes that the observed atmospheric turbidity was caused by an immense quantity—millions of tons—of dust hurled into the atmosphere over Vanovara by the break-up of the body.

Reference is frequently made to the early accounts of the Siberian peasants who witnessed the great explosion. We reprint now excerpts from these accounts taken from *Popular Astronomy*, vol. 43, 1935, pp. 596–599, a translation by Lincoln LaPaz and Gerhardt Wien of the article by L. Kulik in the *Journal of the Russian Academy of Sciences*, 1927A, pp. 399–402.

ON THE FALL OF THE PODKAMENNAYA TUNGUSKA METEORITE IN 1908.—In the month of February, 1927, an expedition, with the author as leader, was equipped by the Academy of Sciences of the U.S.S.R. for the investigation of the place of fall of the meteorite of June 30, 1908, in the basin of the upper part of the Podkamennaya Tunguska river.

In the latter part of March, 1927, I began my investigations to the north of the Podkamennaya Tunguska, having my base at the factory [trading post] Vanovara, lying near this stream in approximately the 72° of longitude east of Pulkovo. After repeated attempts to penetrate the marshy forests north of this river, advancing to the northwest on small rivers by means of a raft, I reached the central part of the area of the fall in the month of June and made a hurried survey of the place and its neighbourhood. . . .

The central part of the fall, lying on the plateau which forms the watershed between the basin of the river Chunya and the Podkamennaya Tunguska proper, consists of an area several kilometers in diameter which has the appearance of a huge crater surrounded by an amphitheatre composed of chains of hills and isolated peaks. To the south, along a tangent to this circle of mountains, the river Khushmo, the right hand tributary of the river Chamba, which enters the Podkamennaya Tunguska about 30 km. below Vanovara, flows from west to east. This system of tributaries was for the most part my road from Vanovara to the place of fall and back. In the previously mentioned crater, there are in turn chains of hills and isolated peaks, marshy plains, swamps, lakes, and small streams. Very recently, according to the testimony of local residents, there was here a typical marshy woods. At present the entire marshy woods inside and outside of the crater is practically destroyed, being altogether blown to the ground, where it lies in generally parallel rows of trunks (stripped of branches and bark), the tops of the trunks pointing in the direction away from the center of the fall; this peculiar "fan" of broken-down woods can be especially well seen from the summits of the chains of hills and individual heights which form a peripheral ring about the basin. However, here and there the marshy woods remained in the form of trunks standing on their roots

(usually without bark and branches). Similarly, in spots, unimportant strips and small copses of green trees remained. But these exceptions are a rarity and can be easily explained in every individual case. The whole former vegetation of both the crater and the surrounding hills, as well as the zones for several kilometers around them, carries the characteristic traces of a uniform and continuous burning not resembling the effects of an ordinary [forest] fire; moreover, this burning is shown on the broken-down trees as well as on the standing trees [and] on the remnants of bushes and moss on the summits and the sides of the hills as well as in the marshy plains and on the isolated islands of dry land in the midst of the swamps covered with water. The area with traces of burning is several tens of kilometers in diameter. The central region of this "burned" area, which measures several kilometers in diameter, exhibits in that part of it which is occupied by marshy plains covered with bushes and woods, traces of something like a sidewise pressure which gathered up the soil and vegetation in flat folds with depressions several meters deep, drawn out on the whole perpendicularly to the northeast direction. Moreover, this region is strewn with dozens of freshly formed flat "craterlets" [funnels], which have various diameters, ranging from several meters to tens of meters, with a depth also of several meters; the walls of these "craterlets" are usually steep, although there are also some sloping ones; the bottom of the craters is flat, swampy, and mossy, and carries sometimes the traces of a central eminence. On the northeast end of one of these marshy areas, the moss cover seems to be pushed several tens of meters away from the foot of a hill and replaced by a bog.

To the preceding, it is necessary to add that the collection of testimonies from local eyewitnesses of the fall, made by myself, gave me a number of interesting narratives from which I quote the following.

The peasant S. B. Semenov related to me in a letter:

"It was in 1908 in the month of June about 8 o'clock in the morning; I lived at that time on the Podkamennaya Tunguska at the factory Anovara (Vanovara, L.K.) and was occupied with work around my hut. I sat on the open porch with my face toward the north and at that time there arose, in a moment, a conflagration which gave off such heat that it was impossible to remain sitting—it almost burned the shirt off me. And it was such a flaming wonder that I noticed that it occupied a space of not less than two versts [one verst = 0.663 mile]. But to make up for that, this conflagration endured only a very short time; I had time only to cast my eyes in that direction and see how large it was, when in a moment it vanished. . . . After this vanishing it grew dark, and at the same time there was an explosion which threw me off the open porch about seven feet or more; but I did not remain unconscious for very long; I came to myself and there was such a crashing sound that all the houses shook and seemed to move from their foundations. It broke the window panes and window frames in the houses, and in the center of the square, near the huts, a strip of earth was torn out, and at the same time the so-called shore [bracing strip] of iron on the door of the barn was broken, but the lock remained whole."

Another peasant, P. P. Kossolapov, personally informed me on March 30, 1927, that in June, 1908 at 8 o'clock in the morning, he was getting ready at the same factory to go hay-cutting; he needed a nail; not finding one in the room, he went out into the yard and began pulling a nail out of a window with his pincers. Suddenly something very strongly scorched his ears. Reaching for them and thinking that the roof was burning, he raised his head and asked S. B. Semenov, who sat on the open porch at his house, "Say, did you see anything?" "How could one help seeing it?" answered the other; "It seems to me too as if heat embraced me." P. P. Kossolapov there and then went into his house, but scarcely had he entered the room and got ready to sit down on

the floor to his work when an explosion occurred, the sod fell from the ceiling, the oven door of the Russian stove broke loose and flew on to a bed standing opposite the stove, and one window pane was broken, falling into the room. After this, there was a sound similar to the rolling of thunder, vanishing gradually to the north. When it became somewhat quieter, Kossolapov rushed out into the yard but did not notice anything more.

Finally, on the 16th of April, 1927, the Tungus Luchetkan told me that the whole central region of the wind-felled trees was occupied before this event by his relative, the Tungus Vasiliy Ilyich, who used it as a pasture for reindeer. Vasiliy Ilyich was a rich Tungus; he called up to fifteen hundred reindeer his own; he had in this region many sheds in which he kept clothes, utensils, reindeer equipment, etc. With the exception of several dozen tame ones, the reindeer were permitted to roam at will in the hills in the region of the river Khushmo. But down flew the fire and broke down the woods; the reindeer and the sheds were gone. Thereupon the Tunguses went in search of them. Of some reindeer they found the charred carcasses; the others they did not find at all. Of the sheds nothing remained; everything was burned up and melted to pieces—clothes, utensils, reindeer equipment, dishes, and samovars; they found only a few “kettles” [buckets] intact.

Fesenkov cites three reasons for his belief in the comet hypothesis. The first is that, despite extensive searches, no primary meteoritic fragments have ever been found. The numerous craters found are not now considered to be places of fall of parts of the meteorite. It is easier to visualize a “dirty iceberg” exploding to nothing, than huge rocks. There is certainly no doubt that a massive body entered the atmosphere and exploded. Its mass is variously estimated at a million tons or greater. It exploded at a height of 5–6 kilometres above the earth. This height is well established from the measured velocity of the shock wave, both direct and reverse, which travelled around the earth. Since both waves were received at the same place, for example at the Potsdam Geodesic Institute, the speed could be accurately determined entirely independent of any timing at the original source. A few microscopic spherules, partly magnetite and partly silicate, have been found, which may be connected with the Tunguska meteorite since they are found only in the region of its “fall”. They must have been formed by the hardening of the meteorite dust in the atmosphere.

The second reason is that the best interpretation finds that the Tunguska meteorite came in on a retrograde orbit. It was moving from south to north at a time when the earth was moving generally north to south. Now asteroids—the presumed parents of meteorites—are not travelling in retrograde orbit, but are following the normal preferential counterclockwise direction (as seen from the north) of the regular planets. The type of body which is likely to be in a retrograde orbit is a comet. About as many comets pursue retrograde motion as direct.

A third bit of evidence is the curious and unusual night sky glow seen

over Europe. Fesenkov computes that if this glow were caused by the tail of a comet, it would have appeared over western Europe in just the latitudes and longitudes where it was observed. The particles causing this glow were at a height of several hundred kilometres above the earth's surface and did not behave as ordinary meteors in giving a display of shooting stars. The sky glow was not caused by the gigantic break-up of the body near Vanovara. The fragments from that break-up actually went round the world in the northern hemisphere in a period of weeks. The resulting attenuation of sunlight in California was measured by C. G. Abbot, who did not then realise the cause. This dilution of sunlight did not reach its maximum until early August 1908.

One of the vivid accounts of the sky glow over Europe is to be found in the *Observatory*, vol. 31, p. 324, August 1908, an unsigned article.

A PROTRACTED TWILIGHT.—On the night of June 30, and to some extent on the nights succeeding, brilliant sky-glows were observed in various parts of the country, and lasted throughout the night. At 9:30 p.m. at Greenwich, on June 30, the sky along the north-west and north horizon was of a brilliant red, in fact there was what is usually termed a “brilliant sunset”, the only peculiarity being that the brightness stretched more to the north than is usual, and endured, so that at one o'clock in the morning it extended well across the north of the horizon, and the northern sky above was of a brightness approaching that of the southern sky at the time of Full Moon. The light, indeed, was sufficient to take photographs of terrestrial objects. Mr. Evans, of the Royal Observatory, secured excellent photographs of the domes of the Naval College with fifteen minutes' exposure. It has been suggested that this was an appearance of the aurora borealis, but at Greenwich no shooting streamers were seen. It happened that the Sun was in a state of activity at the time, as shown by a large prominence on the south-west limb, and this gave strength to the suggestion that it was an auroral display, but spectroscopic observations fail to give any evidence of this. A long-lasting solar halo was seen in the forenoon and afternoon of June 30, and another on July 1.

The comet theory is by no means a new one. It was first suggested many years ago by Professor Kohl of the Carina Observatory in Denmark to explain the strange night sky glow. Possibly in the years ahead further evidence will be found which will strengthen or weaken the theory. For example, the suggestion has been made that the hunt for the giant meteorite has not been conducted in the region where the pieces might have fallen, but rather in the region which received the greatest shock wave from the explosion. Would further search disclose a rocky mass? Meanwhile we are interested in speculating on this awe-inspiring event, and we are grateful that it occurred in a desolate region of the earth, not in a populous valley or a large city.