# What was the Chelyabinsk Meteoroid really?

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**Abstract**

It is shown that a concept of representing the events more than a year ago, 15 February 2013, in the skies south of Chelyabinsk as the air blast of chondrite meteorite, size of which was of the order of 15 – 20 m, mass was 10 – 15 kt and explosion energy 0.3 – 0.5 Mt in TNT, is not consistent with the phenomena observed in the atmosphere and on the underlying surface. This thesis is proved by visual comparing of effects from it and from thermonuclear explosion of such energy on a comparable distance of about 50 km. As well as comparing maximal path lengths of infrasonic waves from Chelyabinsk explosion and the explosion of the most powerful man-made thermonuclear device – the so-called Tsar Bomba with the energy of 58 Mt and explosion of high-altitude bolide with the energy of about of 1 Mt.

All observations around Chelyabinsk match the destruction in the stratosphere of snow-ice fragment of comet, which was contaminated by chondrites. The size of this celestial body was 180 – 185 m, mass – of about 1.8 Mt, and its explosion energy was close to 57 Mt of TNT. Surface of it was covered with a crust of chondrites, pieces of which were found after explosion on the ground as meteorites.

*Keywords*: Chelyabinsk meteorite, Tsar Bomba, meteoroid, nuclear explosion, height, energy, epicenter, infrasound, shock wave, pressure, distance

## I. Introduction

As it's known, explosion of very large meteoroid in the skies to the south-southwest of Chelyabinsk February 15, 2013 in the first hours after the event has led to numerous speculations both professional astronomers and amateurs. It was quite a natural reaction to the event, however, is not a natural fact that these first hasty conclusions until now, after more than year, are dominating in minds not allowing to evaluate accurately and objectively this incident. As the result, more or less general consensus of scientific community was the adoption of these first parameters of Chelyabinsk meteoroid that were announced in a big hurry – as though was exploded the chondrite meteorite with density of 3300 kg/m$^3$, the size of which was of the order of 15 – 20 m, mass was 10 – 15 kt and explosion energy 0.3 – 0.5 Mt of TNT.

The author during March 2013 has constructed a mathematical model relating the parameters of motion of celestial bodies in the sphere of activity of the Sun, and in the sphere of activity and atmosphere of the Earth, with mass-energy characteristics of these bodies and parameters of explosions caused by their destruction. These characteristics in turn are linked to the observed phenomena [1 – 3]. The model showed that all the observations corresponds to stratospheric destruction of snow-ice fragment of comet, which was contaminated by chondrites, mean density of which was about 570 kg/m$^3$, size was 180 – 185 m, mass – of about 1.8 Mt, and its explosion energy was 57 Mt of TNT.

In paper [4] on the basis of various calculations and evaluations was conducted a comparison of this two concepts of such an extraordinary phenomenon and mathematically rigorous and physically soundly was shown complete failure of a popular concept of chondrite meteorite. From the entire set of evidence here were selected two of them, which are the most obvious and understandable on a purely visceral level even without any calculations.

## II. Comparison of the actions of shock waves from two explosions, energies of which supposedly were close

Let's get start. Unlike all previously completed works of the author on this topic here will not be used calculations more complicated than the Pythagorean Theorem, and will be simple, direct and visually comparing of the available experimental data. Thermal explosion of Chelyabinsk meteoroid was somewhat extended in time compared to nuclear explosions, so its nominal height on different models depending on the characteristics considered (flash, shock wave et cetera) may slightly vary between 27 – 30 km [5, 6].

The central part of Chelyabinsk, including located there South Ural State University (ЮУрГУ), lies about 35.5 km from the epicenter. Then according to the height of the explosion the distance from its center was about 45 km. Another remarkable point on the map of Chelyabinsk is the region near Chelyabinsk zinc plant, where it was destroyed part of the roof and walls of zinc concentrate warehouse. From the epicenter of explosion to zinc plant the distance was about 39.5 km, so that from the center of the explosion – almost 50 km. In addition, notable damages received Ice Palace «Urals Lightning», located somewhat closer to the center of the explosion (45 km) and pretty close to the zinc plant.

According to statements made by opponents the explosion energy of Chelyabinsk «meteorite» allegedly was 0.3 – 0.5 Mt of TNT [5, 6]. Unfortunately for them and for all of humanity, hundreds of nuclear and thermonuclear explosions with energies ranging from a few hundredths of kiloton up to 58 megatons have conducted in the Earth's atmosphere for almost two decades until 1963. Furthermore, it was still a relatively small number of atmospheric explosions of nuclear powers of the second level, which did not immediately acceded to the treaty of prohibition of all nuclear explosions, except underground. They continued this activity until the last «secret» nuclear explosion in the atmosphere in 1981 [7]. The energy range of these explosions differed by more than a million times. And, apparently, due to the huge scale of this activity, despite the secrecy that surrounded it, persons, who even quite not implicated in it, can quite easily get almost any information about these events.

So the author of this work without any difficulty could find a photograph in which in the moment of explosion of a thermonuclear charge with almost the same energy (0.67 Mt), that opponents have arrogated to Chelyabinsk blast, were depicted participants of this test [8], which were at the same distance – about 50 km from explosion center [9]. It was American air explosion of Questa nuclear charge 2 May 1962 at the height of 1.6 km after reset from bomber over the Pacific Ocean south of Christmas Island (Kiritimati now).

In the photograph (see Fig. 1) the participants in this experiment are shown in their camp at airfield on the northern coast of the island at the time of the explosion. However, their condition is quite consistent with the overpressure level on the shock wave around 1.4 – 1.5 kilopascals (kPa) received with various calculations methods – slightly more than one-hundredth of atmospheric [4]. All of them are fairly relaxed sit or even stand on your feet and don’t feel anything any problem watching the explosion. Their tents are also in order.

Fig. 1

In Chelyabinsk was stratospheric explosion that in itself significantly reduces the impact of the shock wave and the levels of overpressure for the same distances from the center of the explosion. And here, in this explosion and even supposedly at energy of 1.5 – 2 times lower and almost the same distance – 45 km in the corridors of South Ural State University (ЮУрГУ) we can see a very different picture, as opposed to what was happening on a tropical island: people were knocked down by the shock wave (see Fig. 2). But this shock wave did not pass along the

smooth surface of the ocean, but literally has forced one's way through many kilometers of multi-storey urban areas, shattering hundreds thousands of square meters of glass and damaging the buildings [4], wherein, there was the dissipation energy and weakening of the wave. And, nevertheless, the result is obvious – just compare these photos.


Fig. 2

When the wave has not suffered significant losses, passing through fields, forests, Shershnyovsky reservoir (long blue stain in the center of Fig. 3) and through one-story buildings of rural and suburban regions, the result can be seen below.

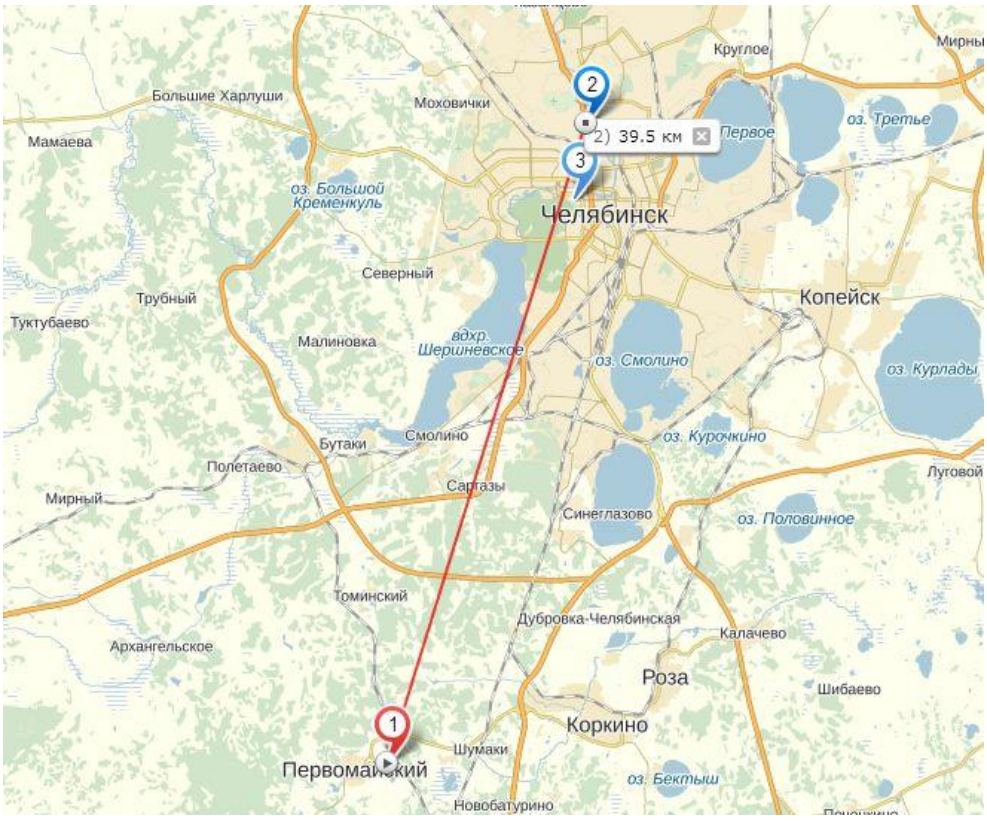


Fig. 3

Location on the map of Chelyabinsk and its environs of explosion's epicenter (label 1) and warehouse of concentrate of zinc plant (label 2), where there was destruction of walls and roof is shown in Fig. 3. The distance between them, as reported earlier, was 39.5 km. It should be noted that the Ice Palace «Urals Lightning» (label 3), in which in the morning February 15, 2013 supporting beam was collapsed (see Fig. 4 [10]) and were curved several beams, as well as the cladding was destroyed (see Fig. 5 [11]) was at a distance of about 45 km from the center of the explosion, and almost on the same line, which connects the epicenter of the explosion with a warehouse of zinc concentrate, see Fig. 3.


Fig. 4

Fig. 5

Destruction of warehouse of Chelyabinsk zinc plant, which was at the distance of 50 km from the center of the explosion, can be estimated from the photograph shown in Fig. 6 [12]. Pressure on the shock wave in this area according with paper [5] was about 7.5 kPa, which is approximately 5 – 5.5 times higher than in camp of Questa explosion participants. From well-established dependencies of shock waves propagation on such distances increasing pressure requires an increase in the energy of the explosion in the third degree with respect to pressure growth [13]. This means that the energy of Chelyabinsk explosion must be 2 orders of magnitude more than energy of Questa blast. That is the explosion over Chelyabinsk is not less than a few tens of megatons of TNT. More accurate calculations give a value of 57 Mt [2, 3].

Fig. 6

Thus, opponents as if on behalf of «science» claim: stratospheric explosion is capable to damage the supporting beams of ice palace and to destroy the roof and walls of the large industrial facility at the same distance at which low-altitude explosion with the energy in 1.5 – 2 times greater couldn't compel even to bend down the people watching it. It is obviously that it is contrary to all experience, which was received by humanity so dearly, and also is simply contrary to common sense of anyone who bothered to study the physics of explosion.

**III. Comparison of the maximal path lengths of infrasonic waves from three explosions of different scales**

At large distances from the point of explosion the shock wave weakens and degenerates into a sound wave. Its frequency in explosions of megaton class is very low and lies deep in infrasound. For example, the frequency of infrasound wave created by Chelyabinsk explosion was so low – 0.03 Hz, that has put stumped modern specialists in this field, and their software to handle this signal proved to be completely inadequate [14]. Apparently, over the past half-century after the explosion of Tsar Bomba these specialists have forgotten that there are such frequencies and such explosions, if they ever knew about it at all.

To register infrasonic waves from powerful atmospheric explosions at due time was created a global network of infrasound stations. This network should primarily to monitor nuclear explosions, but in recent decades mainly were recorded the explosions of celestial bodies entering the Earth's atmosphere or volcanic eruptions. Earlier this network was consisted of 60 stations, and by 2011, there remained 41 of such stations [15, 16]. Their location on the map of the world then can be seen in Fig. 7.

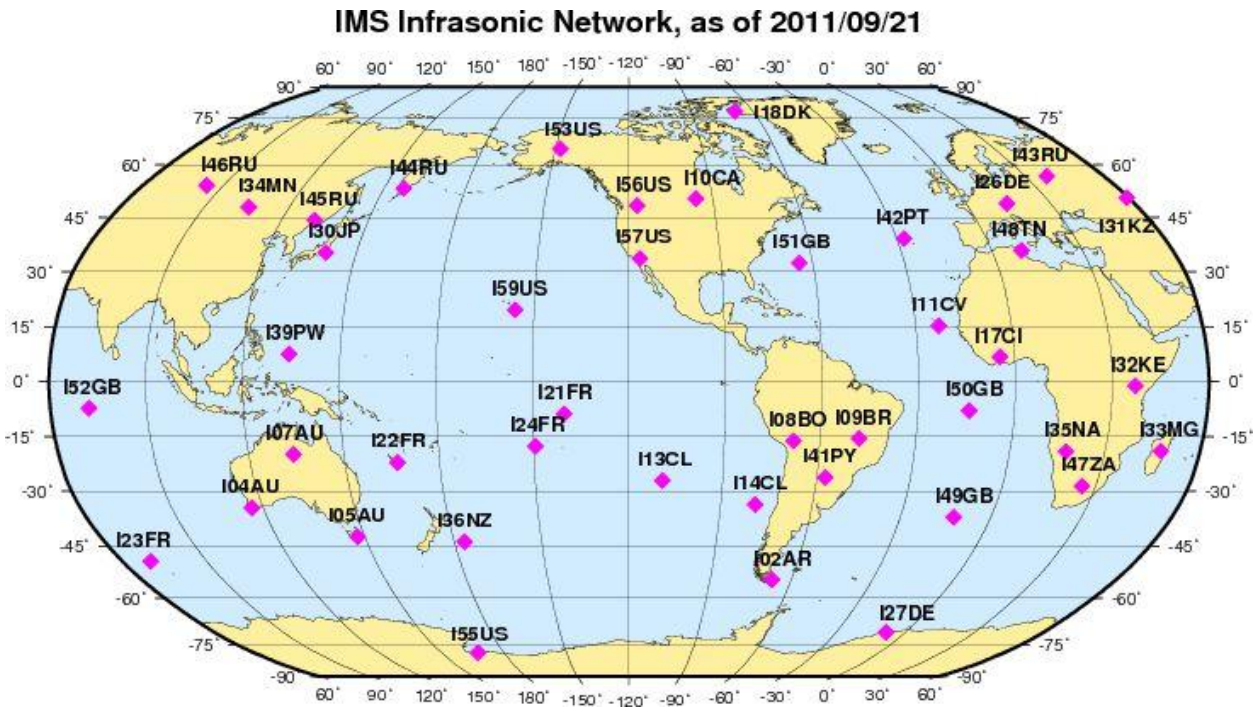


Fig. 7

One from their – Danish I18DK station, located on the northwest coast of Greenland near the American air base Thule, has recorded three signals of infrasound waves from Chelyabinsk explosion [14] with an interval of about 1.5 days. This means that the wave went around the Earth twice and still 5 thousand kilometers separating it from Chelyabinsk. And its pressure level was still greater than the sensitivity threshold of registration systems of this station. Thus, the maximal path length of infrasonic waves from Chelyabinsk stratospheric explosion February 15, 2013 wasn't less than 85 thousand kilometers [17]. Labels 1 and 2 in Fig. 8, respectively, mark the epicenter of the explosion and I18DK station. The double circumference of the Earth and the distance between them constitute together the maximal registered path length of infrasonic wave from Chelyabinsk explosion.

It is known that about the same maximal distance of infrasonic signal was received for explosion of AN602 thermonuclear charge or Tsar Bomba, which was produced October 30, 1961 at Novaya Zemlya [18]. Last third time it was registered near New Zealand at the infrasound station I36NZ (label 4 in Fig. 8) at a distance of 15.8 thousand kilometers from the explosion point (label 3) [19]. The double circumference of the Earth and the distance between them constitute a maximal path length of infrasonic wave from the explosion of this bomb, that is, slightly less than 96 thousand kilometers. Thus, the distance run of waves from these explosions do not differ by more than 13 %, despite the fact that the height of the explosion of Tsar Bomba was 7 times lower than the height of the explosion of Chelyabinsk meteoroid. But we know that the increase in the height of the explosion in the atmosphere due to a drop in air density reduces the shock wave and the intensity of infrasound, into which shock wave is gradually transformed. Thus, this clearly shows that the energies of these two blasts were close.

Eighteen months after the explosion of Tsar Bomba, March 8, 1963, there was recorded stratospheric explosion of celestial body over the southwestern part of the Indian Ocean at the point marked in Fig. 8 with label 5. Its energy was 1.1 Mt, and the most distant infrasound station, which has recorded the wave from this explosion, was at a distance of about 11.5 thousand kilometers. Next the trail of the wave was lost. It was the Portuguese station I42PT, located in the Azores [20] (label 6). It follows that, if the maximal path length of infrasonic wave from stratospheric explosion with the energy of about 1 Mt is about of 10 thousand kilometers, then the wave cannot more than twice fold go around the Earth if it is created owing to a similar explosion with lesser energy of about 0.3 – 0.5 Mt. For this the explosion energy should be close to what was in the explosion of Tsar Bomba, that is, a few tens of megatons. More accurate acoustic calculations with a greater number of experimental points led again to exactly the same value of the energy of the Chelyabinsk explosion – 57 Mt [15], as the calculations of the overpressure on the shock wave at moderate distances from the explosion.


Fig. 8

Consequently, the overpressures on the shock wave at moderate distances from the center of Chelyabinsk explosion, as well as the pressures on the infrasonic wave, which is the descendant of the shock wave, on global distances clearly show that the energy of the explosion could not be less than a few tens of megatons. Any other statements on this occasion did not correspond to reality.

**Conclusions**

1. From the above consideration follows clearly that the energy of Chelyabinsk meteoroid's explosion was close to the energy of the explosion of Tsar Bomba and on two orders of magnitude greater than the values that are currently without adequate grounds deemed accepted.
2. Accurate calculations give a value of the energy of this explosion of 57 Mt of TNT.
3. Therefore near Chelyabinsk was stratospheric destruction of snow-ice fragment of comet, mean density of which was about 570 kg/m$^3$, size was 180 – 185 m and mass – of about 1.8 Mt.

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