

# TUNGUSKA

## OVERVIEW

30 June 1908 0714 local

Central Siberia near the Podkamennaya [Stony] Tunguska River 101°53'40" E 60°53'09" N

Crater Diameter = 0; that is, *there is no crater*

15 Mt atmospheric explosion at 7 km [5-10 km] [from seismic, barographs, and tree blowdown]

Eyewitnesses: Fireball from 110° 15° atmospheric entry - steepened to 40° may have veered  
indigenous Evenki were nomadic reindeer herders, hunters and trappers

## PRE-IMPACT GEOLOGY

Triassic traps of Siberia - mostly basalts and fine-grained gabbros; south of glaciated terrain

Geology not really important; surface conditions more relevant:

taiga, or boreal forest, of larch, pine, and birch w/ abundant lichens, incl reindeer moss

discontinuous permafrost zone, but appears continuous at hypocenter, p-frost table about 30 cm

## IMPACTOR

Hypothesized: Iron meteorite, cometary nucleus, carbonaceous chondrite, stony asteroid

comet exploded	850 m	0.002 g/cm <sup>3</sup>	at 40 km/s	30°	Turco ao	1982
asteroid disintegrated -	30 m	3.5 g/cm <sup>3</sup>	at 15 km/s	45°	Chyba ao	1993
asteroid disintegrated -	58 m	ablates by EMR after fragmentation			Svetsov	1996
asteroid disintegrated -	80 m	deceleration and explosion			Hills and Goda	1993
ricocheted out of atmosphere -					Plekhanov and Plekhanova	1998

Vasilyev – probably a small asteroid, density about 3, about 10<sup>5</sup> tonnes, 15 kps

Also suggested: antimatter, micro black hole, permafrost gas hydrate eruption, nuclear-powered spaceship accident

## IMPACT EFFECTS

Tremendous explosion - heard hundreds of kilometers away

Pressure wave registered on microbarographs around the world

Seismic records from stations around Russia, as far as Germany

Geomagnetic disturbance recorded at Irkutsk – similar to nuclear blast

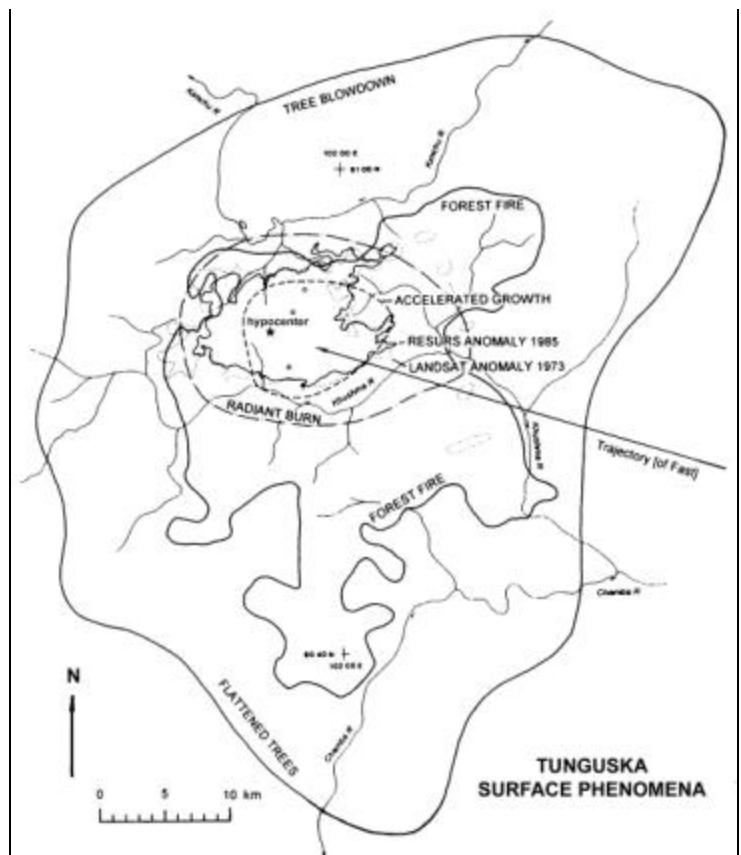
Light night and noctilucent clouds [mesospheric ice from cosmic dust] seen throughout Europe

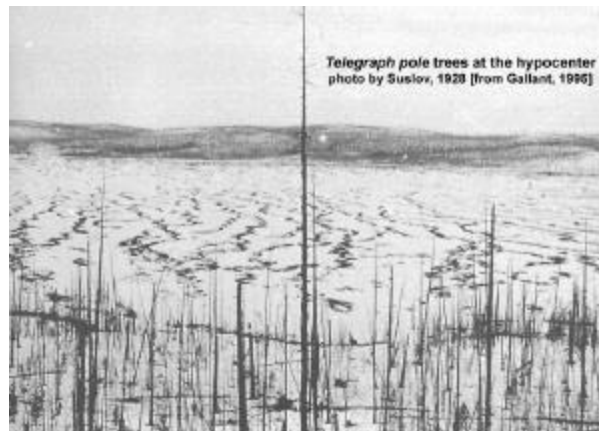
30% kinetic energy as EMR caused radiant burn and flash ignition of green forest over 200 km<sup>2</sup> area

Radial tree blowdown over 2150 km<sup>2</sup> in butterfly pattern; hypocentral trees [3 km] are 'telegraph poles' from vertically directed pressure wave

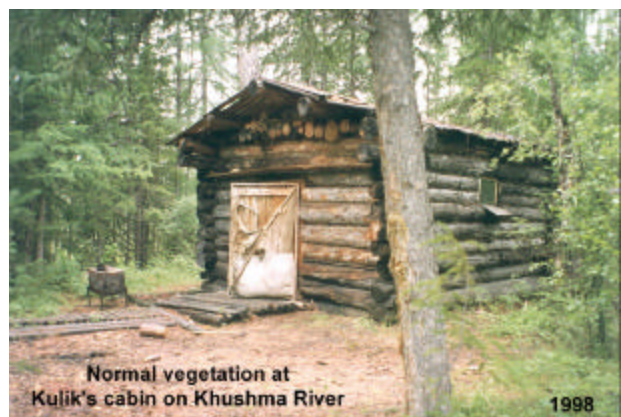
Physically modeled with primacord - inclined string at 30° with larger charge at end

Temperature of explosion - estimated to be 10 000 K - 30 000 K

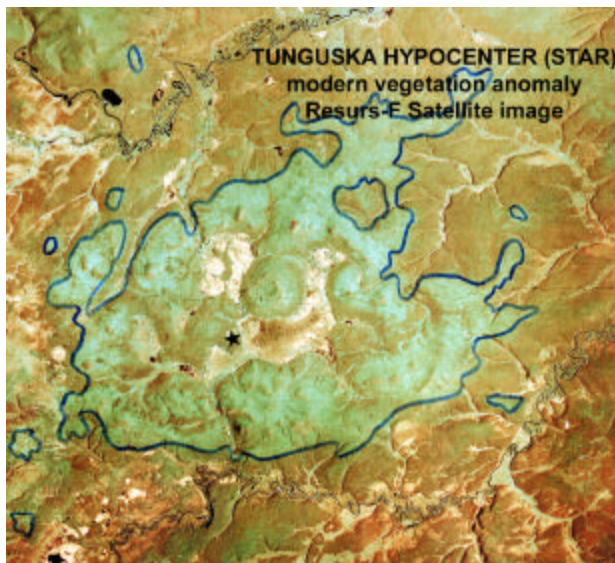




**Physical Evidence** Almost None



The taiga has healed itself. In 1998, very few felled trees remained, and only a few stumps of 'telegraph pole' trees. Scientists flying in to the site by helicopter saw no evidence whatsoever from low altitude. If one weren't aware of the co-ordinates, there would be no way of knowing that anything at all unusual had happened at this site.



**Environmental**      accelerated plant growth few years afterward     $[N_2 \rightarrow N + O \rightarrow NO_3]$   
sharp increase in plant mutations

**Geochemical**      elemental enrichment of 1908 peat layer *suggests* carbonaceous chondrite

**Ir**      [20 ppt ave crustal rock] anomaly 240-540 ppt in ashed *Sphagnum fescue* core [neutron activation analysis, but only found in one peat core of four cores taken, and anomaly only about 2x upper peat layers [Hou ao 1998];  
Kolesnikov ao [1995] show anomaly below 1908 layer, but values are only 5-20 ppt

## HISTORY OF INVESTIGATIONS

**I. 1908 - WWII**      Scientists were unable to find source of explosion because shamanistic Evenki considered the site taboo and diverted attempts to penetrate the taiga.

Meteoriticist Leonid Kulik eventually found site after 19 years had elapsed, led expeditions 1927, 1928, 1929-30, 1933, 1937, 1938, 1939

Kulik fought in WWII, captured by Germans, died in POW camp

Kulik's Conclusion: originally thought iron meteorite, final thought cometary impact

**II. 1949 - 1992** multidisciplinary research by Soviet scientists    Conclusion: comet or stony asteroid

**III. c1992**    Opened to international scientists

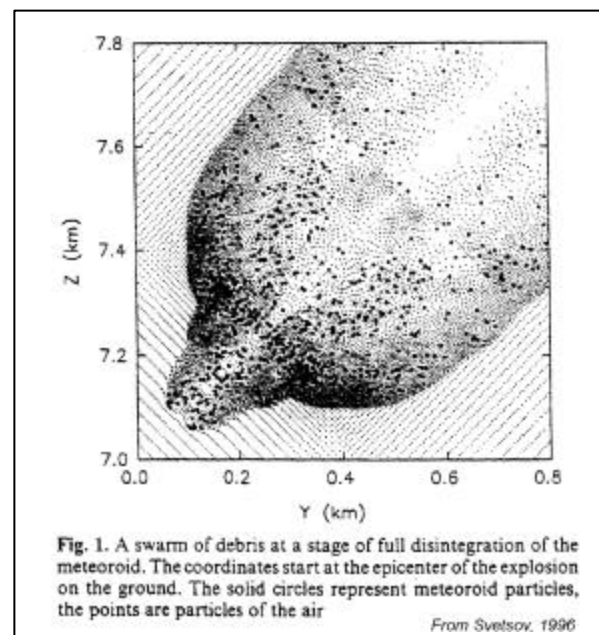
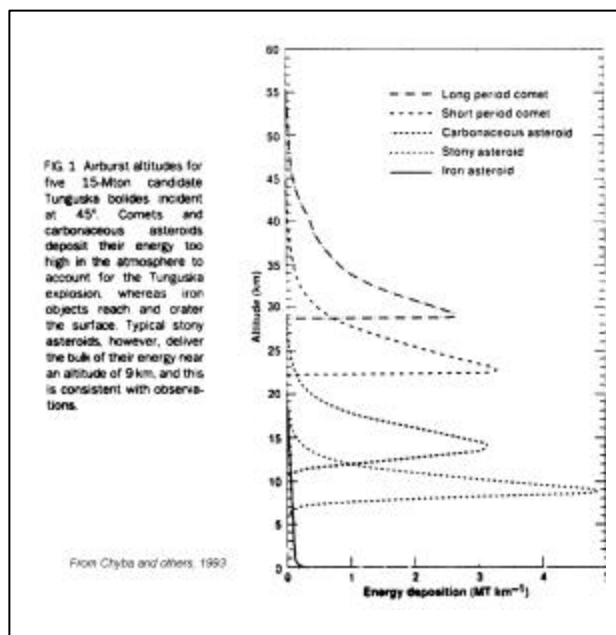
1992 1<sup>st</sup> International Expedition

1996 Bologna Conference

1998 90<sup>th</sup> Anniversary Krasnoyarsk Conference

1999 Italian Expedition Lake Cheko

Conclusion: stony asteroid or comet





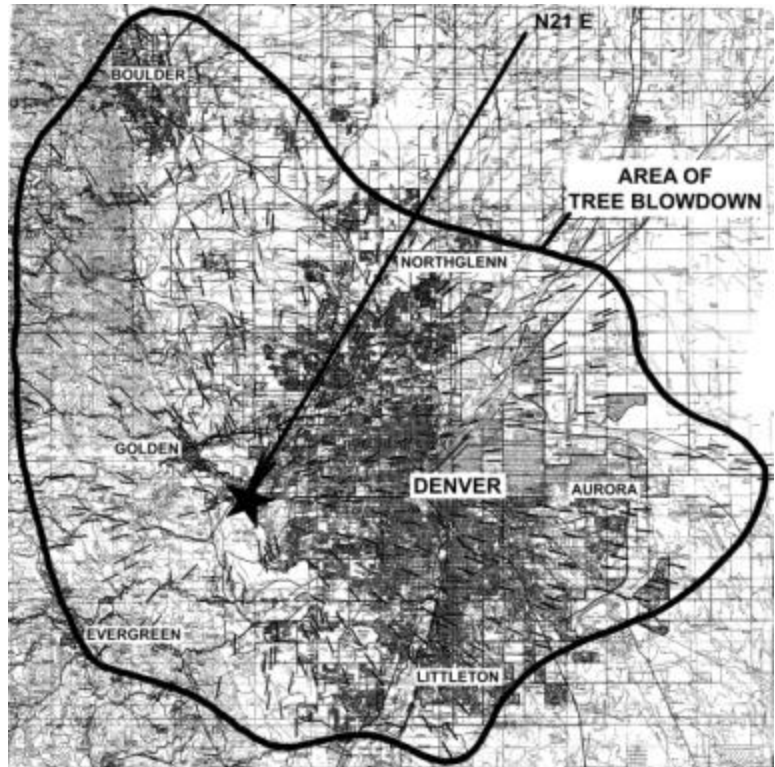
## SIGNIFICANCE

Tunguska represents a category of impactors for which we have no cratering record

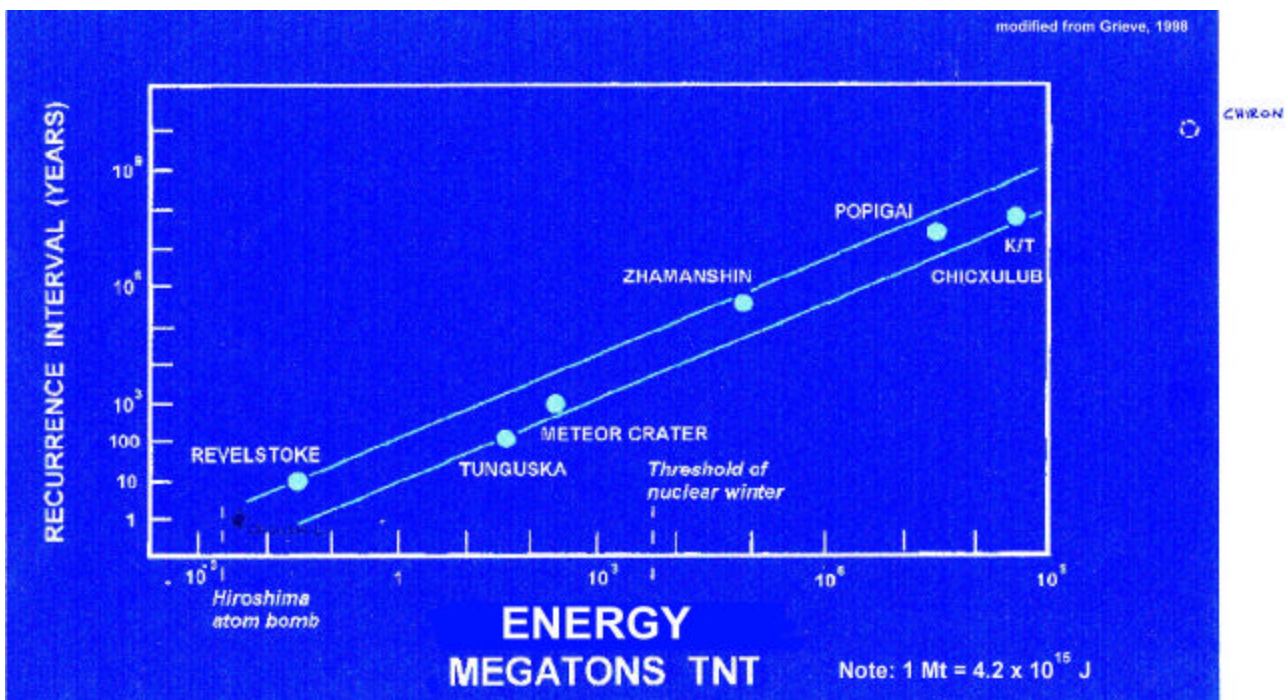
Energy at Tunguska is about the same as Meteor Crater, and may be considerably less than other meteoroids that have lower strength - carbonaceous chondrites [Revelstoke], comets - and therefore explode higher in the atmosphere

If the Tunguska bolide had arrived four hours later, it would have destroyed St. Petersburg.

Overlaying the map of tree blowdown onto a map of the Denver metro area shows destruction in the entire city of Denver, as well as all the outlying municipalities of Boulder, Golden, Evergreen, Littleton, and Aurora.



The recurrence interval for such an event has been estimated to be as frequent as every 100 years.



## Some references

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