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/cm³ at 40 km/s 30° Turco ao 1982
- asteroid disintegrated 30 m 3.5 g/cm³ 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, about10⁵ 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 km² area
Radial tree blowdown over 2150 km² 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 fuscue* 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 1st International Expedition

1996 Bologna Conference

1998 90th Anniversary Krasnoyarsk Conference

1999 Italian Expedition Lake Cheko

Conclusion: stony asteroid or comet

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**Fig. 1.** A swarm of debris at a stage of full disintegration of the meteoroid. The coordinates start at the epicenter of the explosion on the ground. The solid circles represent meteoroid particles, the points are particles of the air.

(from Sukhov 1995)
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


Gallant, R.A., 1995, The day the sky split apart – investigating a cosmic mystery: New York, Atheneum Books for Young Readers, 156 p. [this is a great first-read book for any reader]


Vasilyev, N.V., 1998, The Tunguska Meteorite problem today: Planetary and Space Sciences, v.46, no.2/3, p.129-150. [this is the most comprehensive review of Tunguska; unfortunately, Dr. Nicolai Vasilyev, “Mr. Tunguska”, passed away before a later update was completed]