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| Tunguska Revision, and a Possible NEA Impact on Mars |  |

Article Posted: December 21, 2007

A proposed downsizing of the energy of the 1908 Tunguska airburst implies an increase in the expected frequency of such impacts. In addition, a possible Mars-impactor has been discovered by the Spaceguard Survey.

**(1) TUNGUSKA IMPACTOR SIZE REVISION**

The 1908 Tunguska airburst from a small asteroid has generally been estimated to have had an energy of 10-15 megatons. The corresponding size for a rocky impactor is roughly 60 meters in diameter. Mark Boslough of Sandia Laboratory, however, has generated new supercomputer simulations that suggest a smaller Tunguska explosion. In part his models require less energy in the explosion because he includes the substantial downward momentum of the rocky impactor, rather then modeling it as a stationary explosion. If this revision (down to an estimated energy of 3-5 megatons, and a corresponding diameter perhaps as low as 40 m) is correct, the expected frequency of such impacts changes, from once in a couple of millennia to once in a few hundred years. If smaller impactors can do the damage previously associated with larger ones, of course, the total hazard from such impacts is increased. Below is a press release from Sandia and a newspaper article discussing this new work.

David Morrison

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**(1a) SANDIA PRESS RELEASE: NEW ESTIMATE OF TUNGUSKA IMPACTOR SIZE**

December 17, 2007

ALBUQUERQUE, N.M. The stunning amount of forest devastation at Tunguska a century ago in Siberia may have been caused by an asteroid only a fraction as large as previously published estimates, Sandia National Laboratories supercomputer simulations suggest.

"The asteroid that caused the extensive damage was much smaller than we had thought," says Sandia principal investigator Mark Boslough of the impact that occurred June 30, 1908. "That such a small object can do this kind of destruction suggests that smaller asteroids are something to consider. Their smaller size indicates such collisions are not as improbable as we had believed." Because smaller asteroids approach Earth statistically more frequently than larger ones, he says, "We should be making more efforts at detecting the smaller ones than we have till now."

The new simulation - which more closely matches the widely known facts of destruction than earlier models - shows that the center of mass of an asteroid exploding above the ground is transported downward at speeds faster than sound. It takes the form of a high-temperature jet of expanding gas called a fireball. This causes stronger blast waves and thermal radiation pulses at the surface than would be predicted by an explosion limited to the height at which the blast was initiated.

"Our understanding was oversimplified," says Boslough, "We no longer have to make the same simplifying assumptions, because present-day supercomputers allow us to do things with high resolution in 3-D. Everything gets clearer as you look at things with more refined tools."

The new interpretation also accounts for the fact that winds were amplified above ridgelines where trees tended to be blown down, and that the forest at the time of the explosion, according to foresters, was not healthy. Thus previous scientific estimates had overstated the devastation caused by the asteroid, since topographic and ecologic factors contributing to the result had not been taken into account.

"There's actually less devastation than previously thought," says Boslough, but it was caused by a far smaller asteroid. Unfortunately, its not a complete wash in terms of the potential hazard, because there are more smaller asteroids than larger ones.

Boslough and colleagues achieved fame more than a decade ago by accurately predicting that that the fireball caused by the intersection of the comet Shoemaker-Levy 9 with Jupiter would be observable from Earth.

Simulations show that the material of an incoming asteroid is compressed by the increasing resistance of Earths atmosphere. As it penetrates deeper, the more and more resistant atmospheric wall causes it to explode as an airburst that precipitates the downward flow of heated gas.

Because of the additional energy transported toward the surface by the fireball, what scientists had thought to be an explosion between 10 and 20 megatons was more likely only three to five megatons. The physical size of the asteroid, says Boslough, depends upon its speed and whether it is porous or nonporous, icy or waterless, and other material characteristics.

"Any strategy for defense or deflection should take into consideration this revised understanding of the mechanism of explosion," says Boslough.

One of most prominent papers in estimating frequency of impact was published five years ago in Nature by Sandia researcher Dick Spalding and his colleagues, from satellite data on explosions in atmosphere. "They can count those events and estimate frequencies of arrival through probabilistic arguments," says Boslough.

The work was presented at the American Geophysical Union meeting in San Francisco on Dec. 11. A paper on the phenomenon, co-authored by Sandia researcher Dave Crawford and entitled "Lowaltitude airbursts and the impact threat" has been accepted for publication in the International Journal of Impact Engineering.

The research was paid for by Sandia's Laboratory-Directed Research and Development office.

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**(1b) SMALL ASTEROIDS POSE BIG NEW THREAT**

By Charles Q. Choi, SPACE.com  
19 December 2007

The infamous Tunguska explosion, which mysteriously leveled an area of Siberian forest nearly the size of Tokyo a century ago, might have been caused by an impacting asteroid far smaller than previously thought.

The fact that a relatively small asteroid could still cause such a massive explosion suggests "we should be making more efforts at detecting the smaller ones than we have till now," said researcher Mark Boslough, a physicist at Sandia National Laboratory in Albuquerque, N.M.

The explosion near the Podkamennaya Tunguska River on June 30, 1908, flattened some 500,000 acres (2,000 square kilometers) of Siberian forest. Scientists calculated the Tunguska explosion could have been roughly as strong as 10 to 20 megatons of TNT 1,000 times more powerful than the atom bomb dropped on Hiroshima.

Wild theories have been bandied about for a century regarding what caused the Tunguska explosion, including a UFO crash, antimatter, a black hole and famed inventor Nikola Tesla's "death ray." In the last decade, researchers have conjectured the event was triggered by an asteroid exploding in Earth's atmosphere that was roughly 100 feet wide (30 meters) and 560,000 metric tons in mass more than 10 times that of the Titanic.

The space rock is thought to have blown up above the surface, only fragments possibly striking the ground.

Now new supercomputer simulations suggest "the asteroid that caused the extensive damage was much smaller than we had thought," Boslough said. Specifically, he and his colleagues say it would have been a factor of three or four smaller in mass and perhaps 65 feet (20 meters) in diameter.

The simulations run on Sandia's Red Storm supercomputer the third fastest in the world detail how an asteroid that explodes as it runs into Earth's atmosphere will generate a supersonic jet of expanding superheated gas. This fireball would have caused blast waves that were stronger at the surface than previously thought.

At the same time, previous estimates seem to have overstated the devastation the event caused. The forest back then was not healthy, according to foresters, "and it doesn't take as much energy to blow down a diseased tree than a healthy tree," Boslough said. In addition, the winds from the explosion would naturally get amplified above ridgelines, making the explosion seem more powerful than it actually was. What scientists had thought to be an explosion between 10 and 20 megatons was more likely only three to five megatons, he explained.

All in all, the researchers suggest that smaller asteroids may pose a greater danger than previously believed. Moreover, "there are a lot more objects that size," Boslough told SPACE.com.

NASA Ames Research Center planetary scientist and astrobiologist David Morrison, who did not participate in this study, said, "If he's right, we can expect more Tunguska-sized explosions perhaps every couple of centuries instead of every millennia or two." He added, "It raises the bar in the long term ultimately, we'd like to have a survey system that can detect things this small."

Boslough and his colleagues detailed their findings at the American Geophysical Union meeting in San Francisco on Dec. 11. A paper on the phenomenon has been accepted for publication in the International Journal of Impact Engineering.

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**(2) POSSIBLE "TUNGUSKA-SIZE" IMPACT ON MARS**

The Spaceguard Survey has discovered a small NEA that might hit Mars, not Earth, Orbit calculations from JPL indicate that Asteroid 2007 WD5 is on a trajectory that will bring it close to Mars on January 30, with a chance of hitting (based on the current uncertainty in the orbit) of better than 1%. Only once (3 years ago) has the orbital analysis of a NEA indicated a higher probability of impact, and the target then was Earth. For about two days around Christmas, 2004, the calculated impact probability for NEA Apophis was better than 1%, reaching a maximum of slightly greater than 1 in 50. Of course, additional orbital data then showed that while Apophis would come close in April 2029, it would not hit. The same thing will probably happen with the orbital analysis of 2007 WD5.

The present orbital estimate has considerable uncertainty, and not all computer simulations make exactly the same prediction. An impact is quite unlikely, but those of us in the business of surveying for possible impacts must always consider the possibility of a hit, even if the odds are against it. Should 2007 WD5 actually hit Mars, it would have an impact energy similar to that of the 1908 Tunguska impact on Earth, making a roughly 1-km-diameter crater. This crater, with its freshly exposed ejecta, would be extremely interesting to study from several spacecraft now in orbit around Mars. We can hope that this might happen, providing us a new window into the martian subsurface -- but the most likely ending for this story will be a miss, with 2007 WD5 quickly fading from memory.

Below are the NASA/JPL press release and two newspaper stories that discuss this possible Mars impact.

David Morrison

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**(2a) NASA/JPL NEWS RELEASE: ASTRONOMERS MONITOR ASTEROID TO PASS NEAR MARS**

December 21, 2007

WASHINGTON - Astronomers funded by NASA are monitoring the trajectory of an asteroid estimated to be 50 meters wide that is expected to cross Mars' orbital path early next year. Observations provided by the astronomers and analyzed by NASA's Near-Earth Object Office at the Jet Propulsion Laboratory in Pasadena, Calif., indicate the object may pass within 30,000 miles of Mars at about 6 a.m. EST (3 a.m. PST) on Jan. 30, 2008.

"Right now asteroid 2007 WD5 is about half-way between Earth and Mars and closing the distance at a speed of about 27,900 miles per hour," said Don Yeomans, manager of the Near Earth Object Office at JPL. "Over the next five weeks, we hope to gather more information from observatories so we can further refine the asteroid's trajectory."

NASA detects and tracks asteroids and comets passing close to Earth. The Near Earth Object Observation Program, commonly called "Spaceguard," plots the orbits of these objects to determine if any could be potentially hazardous to our planet.

Asteroid 2007 WD5 was first discovered on Nov. 20, 2007, by the NASA-funded Catalina Sky Survey and put on a "watch list" because its orbit passes near Earth. Further observations from both the NASA-funded Spacewatch at Kitt Peak, Ariz., and the Magdalena Ridge Observatory in New Mexico gave scientists enough data to determine that the asteroid was not a danger to Earth, but could potentially impact Mars. This makes it a member of an interesting class of small objects that are both near Earth objects and "Mars crossers."

Because of current uncertainties about the asteroid's exact orbit, there is a 1-in-75 chance of 2007 WD5 impacting Mars. If this unlikely event were to occur, it would be somewhere within a broad swath across the planet north of where the Opportunity rover is located.

"We estimate such impacts occur on Mars every thousand years or so," said Steve Chesley, a scientist at JPL. "If 2007 WD5 were to thump Mars on Jan. 30, we calculate it would hit at about 30,000 miles per hour and might create a crater more than half-a-mile wide." The Mars Rover Opportunity is exploring a crater approximately this size right now.

Such a collision could release about three megatons of energy. Scientists believe an event of comparable magnitude occurred here on Earth in 1908 in Tunguska, Siberia, but no crater was created. The object was disintegrated by Earth's thicker atmosphere before it hit the ground, although the air blast devastated a large area of unpopulated forest.

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**(2b) ASTEROID ON TRACK FOR POSSIBLE MARS HIT**

By John Johnson Jr., Los Angeles Times Staff Writer  
December 21, 2007

Talk about your cosmic pileups. An asteroid similar to the one that flattened forests in Siberia in 1908 could plow into Mars next month, scientists said Thursday.

Researchers attached to NASA's Near-Earth Object Program, who sometimes jokingly call themselves the Solar System Defense Team, have been tracking the asteroid since its discovery in late November. The scientists, at the Jet Propulsion Laboratory in La Cañada Flintridge, put the chances that it will hit the Red Planet on Jan. 30 at about 1 in 75.

A 1-in-75 shot is "wildly unusual," said Steve Chesley, an astronomer with the Near-Earth Object office, which routinely tracks about 5,000 objects in Earth's neighborhood. "We're used to dealing with odds like one-in-a-million," Chesley said. "Something with a one-in-a-hundred chance makes us sit up straight in our chairs."

The asteroid, designated 2007 WD5, is about 160 feet across, which puts it in the range of the space rock that exploded over Siberia. That explosion, the largest impact event in recent history, felled 80 million trees over 830 square miles.

The Tunguska object broke up in midair, but the Martian atmosphere is so thin that an asteroid would probably plummet to the surface, digging a crater half a mile wide, Chesley said.

The impact would probably send dust high into the atmosphere, scientists said. Depending on where the asteroid hit, such a plume might be visible through telescopes on Earth, Chesley said. The Mars Reconnaissance Orbiter, which is mapping the planet, would have a front-row seat. And NASA's two JPL-built rovers, Opportunity and Spirit, might be able to take pictures from the ground.

Because scientists have never observed an asteroid impact -- the closest thing being the 1994 collision of comet Shoemaker-Levy with Jupiter -- such a collision on Mars would produce a "scientific bonanza," Chesley said. The asteroid is now behind the moon, he said, so it will be almost two weeks before observers can plot its course more accurately.

The possibility of an impact has the Solar System Defense Team excited. "Normally, we're rooting against the asteroid," when it has Earth in its cross hairs, Chesley said. "This time we're rooting for the asteroid to hit."

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**(2c) ASTEROID MAY HIT MARS IN NEXT MONTH**

By Alicia Chang (MSNBC & AP)

LOS ANGELES (AP) Mars could be in for an asteroid hit. A newly discovered hunk of space rock has a 1 in 75 chance of slamming into the Red Planet on Jan. 30, scientists said Thursday.

"These odds are extremely unusual. We frequently work with really long odds when we track ... threatening asteroids," said Steve Chesley, an astronomer with the Near Earth Object Program at NASA's Jet Propulsion Laboratory.

The asteroid, known as 2007 WD5, was discovered in late November and is similar in size to an object that hit remote central Siberia in 1908, unleashing energy equivalent to a 15-megaton nuclear bomb and wiping out 60 million trees.

Scientists tracking the asteroid, currently halfway between Earth and Mars, initially put the odds of impact at 1 in 350 but increased the chances this week. Scientists expect the odds to diminish again early next month after getting new observations of the asteroid's orbit, Chesley said. "We know that it's going to fly by Mars and most likely going to miss, but there's a possibility of an impact," he said.

If the asteroid does smash into Mars, it will probably hit near the equator close to where the rover Opportunity has been exploring the Martian plains since 2004. The robot is not in danger because it lies outside the impact zone. Speeding at 8 miles a second, a collision would carve a hole the size of the famed Meteor Crater in Arizona.

In 1994, fragments of the comet Shoemaker-Levy 9 smacked into Jupiter, creating a series of overlapping fireballs in space. Astronomers have yet to witness an asteroid impact with another planet. "Unlike an Earth impact, we're not afraid, but we're excited," Chesley said.