Professor probes secrets of Russian meteor's shock wave

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Sometimes opportunity just falls out of the sky – especially if you're Physics and Astronomy professor Peter Brown.

Soon after a meteor exploded over the Russian city of Chelyabinsk on Feb, 15, the Canada Research Chair in Meteor Science was part of a worldwide team to provide an immediate analysis of the fireball. The first few months were frantic for the Western researcher, who is now settling down into more detailed analysis.

"We have put out, based on a lot of initial analysis, some information. Of course people are very interested in this, but we're trying to do more detailed information, looking at refining the orbit and trajectory," said Brown.

A Distinguished Research Professorship releases Brown from his teaching duties for one year so he can pursue these new avenues of inquiry. And he has been using every minute of it.

The air-burst from the blast above the city, located just to the east of the Ural Mountains, injured 1,491 people and damaged 7,200 buildings, fortunately claiming no lives.

In a recent Time magazine story, Meteor Strike: Investigating a Cosmic Crime Scene, Brown spoke about his investigation into records from bomb blast sensors on the day of the meteor strike. There, he found the infrasound given off not only radiated across Russia, but around the world several times. "The Earth was really ringing," he told the magazine.

Actually, the size of the meteorite – captured on numerous videos – was worked out quite early on. The Time article explained it best:

That gave some sense of the mass of the rock (big) and the force of the blast (bigger), but not much more. The next step required a detailed analysis of those more-serendipitous videos. The video that showed the asteroid earliest in its plunge actually captured it at the moment it began to *glow. That would have been at an altitude of about 43 mi. (70 km), since above that point the air is not thick enough to produce rock-burning friction. The angle of flight was about 20 degrees, and by triangulating from the various perspectives from which the scene was recorded, the scientists could determine that the meteor broke up no higher than 18 mi. (30 km) above ground. It took about 10 seconds from entry to breakup, which crude arithmetic means a speed of 40,000 mph (64,000 k/h). And when you know the physics of speed, angle and atmospheric heating—which the folks who study asteroids do—you can calculate the mass of the meteor. In this case it was about 7,000 metric tons, or 15 million lbs. (7 million kg).*

That's the mass equivalent of the Eiffel Tower plunging toward Chelyabinsk.

"Our much more detailed analysis has basically borne out those initial estimates. It was about 20 metres across and had the equivalent energy of about half a ton of TNT," Brown said.

The analysis did reveal at least one surprise. From Brown's perspective, the most unusual aspect was the shock wave, which damaged thousands of windows in the city. He is spending more than 50 per cent of his time trying to understand the damage assessment from that air blast.

"Our models suggest that stony objects, like those at Chelyabinsk, really start producing damage on the ground once they get into the 40-, 50-, 60-meter size. How big do you need to be before you worry about things on the ground?" Brown asked.

The Chelyabinsk event gives researchers like Brown a much-needed opportunity to fill in some gaps in their data.

"This is a huge windfall for us to understand all of these things in a natural laboratory. Something like this object hits the earth maybe once every 80 years, an object of this size or bigger hits near an urban area like Chelyabinsk once in every 4,000 years," Brown said. "For it to happen so close to a city is really unusual. It gives us a great opportunity to dig, in detail, on how these things happen at sizes much larger than we have seen before. This is a totally unique event."

Over the next year, Brown will meet with other researchers trying to understand the damage mechanisms of meteors. He estimates within the next few decades, objects smaller than Chelyabinsk will actually be detected before they impact.

"The question will be, 'What do you do?'" Brown said. "If we had known about Chelyabinsk beforehand, with the information we have at hand now, we probably could argue it may have been worthwhile to evacuate there, because you couldn't be absolutely certain what the shock wave would do, and that probably would have reduced the number of injuries.

"We want to be more informed and this information will come back to play in a practical way in the next few decades as our asteroid survey starts to pick up."

Provided by University of Western Ontario