

## Tunguska: The explosion of a stony asteroid

On the morning of June 30, 1908, an enormous fireball streaked across the sky over the Siberian wilderness. The tremendous atmospheric explosion that followed released enough energy to flatten and char trees over an area 60 kilometers wide near the Tunguska River. But the blast left no crater.

Explanations of this cataclysm have ranged from an encounter with a lump of antimatter or a miniature black hole to the entry into Earth's atmosphere of a "puffball" comet or an asteroid. Now Christopher F. Chyba of NASA's Ames Research Center in Mountain View, Calif., and his collaborators suggest a stony asteroid as the likely perpetrator.

To explain the peculiar pattern in which energy was deposited at the Tunguska site, many investigators have favored the explosion of a comet with such a low density that it would rapidly decelerate and come to a stop in the atmosphere. In a computer simulation, however, Chyba and his colleagues show that the nuclei of comets explode too high in the atmosphere to account for the Tunguska phenomena.

The researchers calculate that taking aerodynamic forces into account, an asteroid would fracture when mounting air pressure exceeds the object's strength. Thus, a stony asteroid about 30 meters in diameter and moving at 15 kilometers per second would disintegrate at roughly the same height at which the Tunguska object apparently exploded, whereas an iron-rich asteroid would explode too low—if at all—and a carbonaceous asteroid would explode too high.

The researchers report their results in the Jan. 7 NATURE.

"Given that the Tunguska object was kind of typical, it was probably a stony asteroid," Chyba concludes. But the simulation doesn't entirely rule out an unusually fast, iron-rich asteroid or a very strong carbonaceous asteroid.

Nonetheless, comments H. Jay Melosh of the University of Arizona in Tucson, "instead of an implausibly low-density comet, the Tunguska projectile [is] more likely a representative of the most common class of meteorites."

To improve estimates of the probability of atmospheric explosions or direct impacts caused by cosmic projectiles striking Earth, Chyba and his colleagues intend to use their computer model to check systematically the fates of different types of objects over a wide range of sizes as they enter the atmosphere. Chyba has already found that of about eight small objects known to pass close to Earth, half would cause Tunguska-like explosions if they hit the atmosphere.

"A lot of these objects wind up being bad news," Chyba says.

Heightened interest in the likelihood of

devastating explosions and impacts caused by such objects has also prompted researchers to take a closer look at Earth-approaching asteroids. Last month, astronomers at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., used a large radar antenna to obtain the sharpest images yet of one of these asteroids — Toutatis — when it passed within 2.2 million kilometers of Earth.

The radar images reveal that Toutatis consists of two irregularly shaped, cratered chunks, about 4 and 2.5 kilometers in diameter, which may be held in contact by gravity. "Three years ago, we were startled by the initial evidence for con-



Asteroid Toutatis consists of two pieces apparently in contact.

tact-binary asteroids," says JPL's Steven Ostro. "Now it seems that double bodies might be very common in the Earth-approaching asteroid population."

— I. Peterson

## Dietary fat predicts breast cancer's course

Many women who undergo surgery to remove a malignant breast tumor live in fear that cancer will return. Now, a study by a team of Swedish investigators suggests that a low-fat diet may help women avoid a recurrence of this disease, which will kill more than 46,000 women in the United States this year.

Epidemiologists have long pondered whether a low-fat diet can prevent breast cancer from appearing in the first place. Rather than focus on the cause of breast cancer, however, epidemiologist Lars-Erik Holm, then at the Karolinska Hospital in Stockholm, and his colleagues wondered if fat intake could change the course of the disease.

Holm, now at the National Institute of Public Health in Stockholm, and his co-workers studied 220 women who had surgery to remove a malignant breast tumor. At the time of surgery, doctors analyzed a snippet of each patient's tumor to learn whether it had protein receptors that bind with the sex hormone estrogen. After their surgery, women in the study received adjuvant therapy, such as radiation, chemotherapy, or hormonal treatment with the drug tamoxifen. Such adjuvant therapy helps reduce the risk of cancer recurrence in the breast and in other parts of the body.

Next, the researchers sent a nutritionist to each woman's home. The nutritionist asked about diet and food preparation habits (such as the use of cooking oil) during the year prior to the patient's diagnosis.

The team then monitored the subjects for at least four years and noted all reappearances of cancer. A statistical analysis revealed that fat intake did influence the outcome of breast cancer treatment, but only in women who had tumors with lots of estrogen receptors.

In the Jan. 6 JOURNAL OF THE NATIONAL CANCER INSTITUTE, the team reports that women with estrogen-rich tumors who had eaten fatty foods before surgery (and

presumably afterward) were more likely to suffer a return of the disease than women with estrogen-rich tumors who had a less fatty diet.

The team then homed in on saturated fat, the type found in foods of animal origin, such as butter. Women in the group who ate the most saturated fat ran a 20 percent higher risk of recurring cancer than those whose diets contained the least saturated fat.

The mechanism underlying fat's link to breast cancer recurrence remains a mystery, Holm says. However, high-fat diets may boost concentrations of estrogen in the blood. Estrogen fuels the growth of breast tumors, especially those that contain many estrogen receptors. Indeed, the researchers could find no association between fat intake and the risk of cancer recurrence in women whose tumors had very few or no estrogen receptors.

The study doesn't resolve the controversy regarding fat's role in the development of cancer, comments Norman F. Boyd of the Ontario Cancer Institute in Toronto. Last year, a U.S. team found no link between fat intake and the appearance of breast cancer (SN: 10/24/92, p.276). However, Boyd and others still believe that dietary fat may help cause breast cancer.

At the same time, the new findings provide convincing evidence that dietary fat affects the growth of an existing breast tumor, adds Boyd, who wrote an editorial in the same issue of the journal. The Swedish team hopes that a low-fat diet may prove beneficial, even for women who switch to less fatty foods after surgery.

A low-fat diet, as well as adjuvant therapies, may increase the odds that women can avoid a second bout with cancer, Holm says. A low-fat diet causes no ill side effects and can help prevent cardiovascular disease, diabetes, and other debilitating health conditions, he adds.

— K.A. Fackelmann