REAL Potential Disasters

ROBERT NAEYE

Asteroid impacts, gamma-ray bursts, supervolcanoes, and mega-tsunamis represent threats to humanity's future, but don't lose sleep worrying about them.

AS E. C. KRUPP eloquently explains in his article (page 22), Mayan astronomers were *not* predicting the world to end in 2012. But you might be asked if there are any looming disasters that portend mass death and destruction.

The short answer is "probably not." Scientists are studying several potential cataclysms that could threaten humanity's collective survival, or at least disrupt our civilization on a massive scale. Fortunately, none are likely to occur within the lifetime of anyone reading this article.

Jupiter recently experienced the most obvious threat: the impact of an asteroid or comet (page 34). As scientists have pointed out, the impact of a kilometer-scale object is the sole natural disaster that could annihilate our species. But it's also the only one that we could prevent with near-term technology. A giant asteroid impact 65 million years ago extinguished all dinosaur lineages except birds. But the probability of such a large-scale calamity occurring in the next century is about one in a million. Moreover, astronomers are well on their way toward cataloging almost all of the near-Earth asteroids that are big enough to threaten our collective survival, which will leave even rarer comet impacts as the remaining potential threat.

A much more likely disaster is a smaller impact or airburst, such as the explosion over Siberia on June 30, 1908. These events occur perhaps once every 100 to 1,000 years, on average. Impactors on the order of 100 meters are so difficult to detect that we might have no advance warning. Yet these objects could flatten a city or region, or inundate coastlines if a big chunk splashes into an ocean and spawns a tsunami. The sudden death of millions of people would certainly have a profound effect on civilization. But such a tragedy would not threaten humanity's survival unless it triggered an accidental nuclear war.

Television programs have touted the danger posed by a more distant astronomical phenomenon: gamma-ray bursts. A massive star exploding in our galaxy as a GRB,

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and with a jet aimed precisely at Earth, could seriously damage Earth's atmosphere. Researchers have speculated that a GRB caused the Ordovician mass extinction 450 million years ago, because the pattern of species extinction is consistent with what one might expect from a GRB. But there is no direct evidence that a GRB (or a supernova) has ever affected life on Earth.

A Hubble Space Telescope survey of GRB host galaxies indicates that bursts are exceedingly rare in mature spiral galaxies such as the Milky Way. The chances of our planet being in a nearby GRB's line of fire are much lower than the odds that I'll win the decathlon gold medal at the 2012 Summer Olympics. And there are no supernova progenitors close enough to Earth to substantially harm our biosphere should any of these stars explode in the next several centuries (*S&T:* March 2007, page 26).

The threat posed by wandering stars, pulsars, black holes, and other interstellar exotica is even more minuscule, given their low density in space. But extraterrestrial objects are not the only causes for concern. Geologists have discovered several ticking time bombs lurking *within* our planet.

As dramatized reasonably accurately in the TV movie *Supervolcano,* Yellowstone National Park contains a volcanic caldera roughly 45 miles across, and lurking beneath it is a giant, seething mass of molten rock. The Yellowstone supervolcano last went off 640,000 years ago, pumping 1,000 cubic kilometers of volcanic ash and gases into the atmosphere, covering much of North America.

impacts

INCOMING! Asteroid fragments heading toward Earth could wreak regional havoc.

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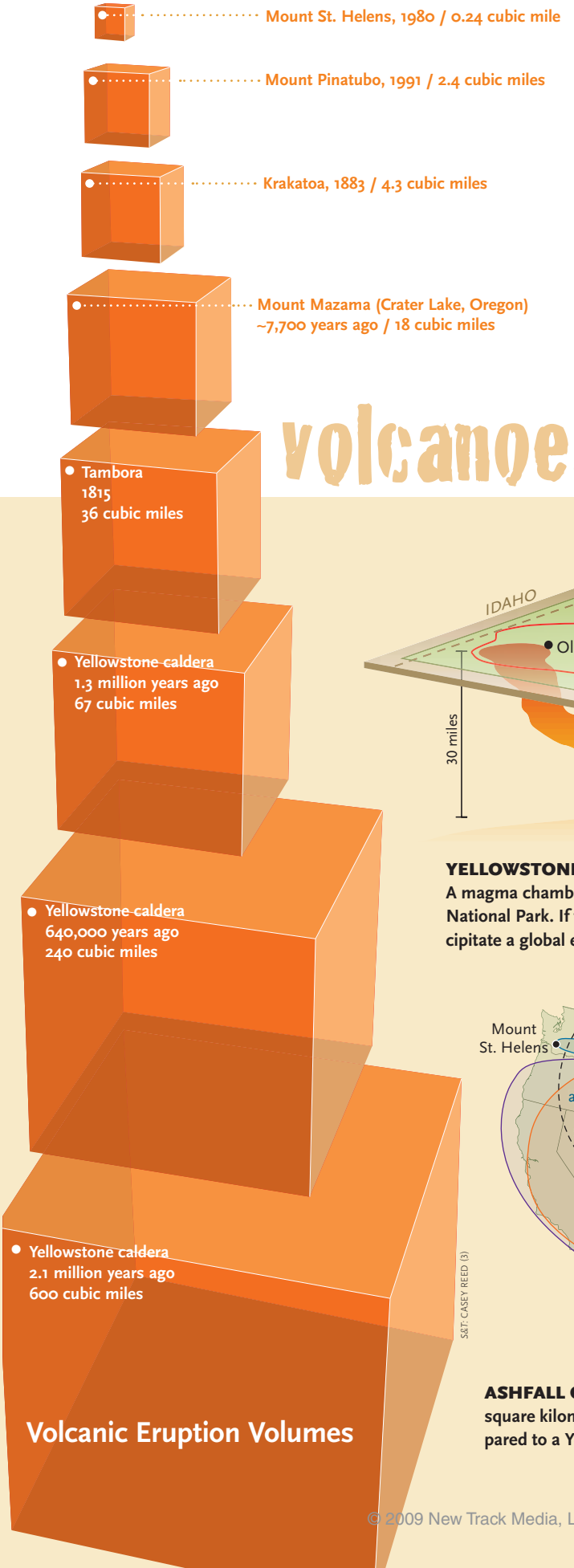
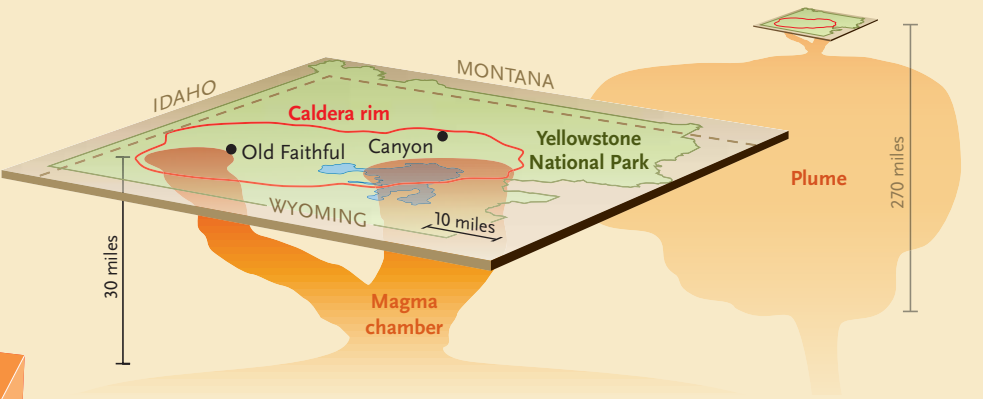
volcanoes



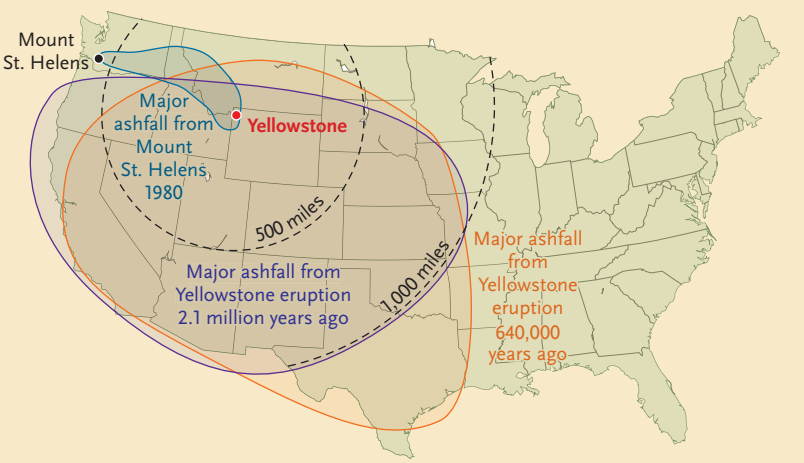
This material blotted out the Sun, cooling the planet for at least several years. If Yellowstone blows its stack next year, at least half of the U.S. will be buried under volcanic ash, and the vast amounts of atmospheric material will snuff out agriculture around much of the world, perhaps culling the human population by tens of percent.

The last three Yellowstone eruptions were spaced roughly 700,000 years apart, which sounds ominous. Fortunately, there is no large-scale ground deformation or greatly increased seismic or geyser activity that signals an impending supereruption. Given the rarity of these cataclysms, we're probably safe for tens of thousands of years.

And that's a good thing. About 74,000 years ago, Lake Toba, a 20-by-60-mile-wide supervolcano on the Indonesian island of Sumatra, exploded and perhaps gave *Homo sapiens* its closest shave with extinction. Genetic studies



YELLOWSTONE TIME BOMB The Yellowstone caldera is about 45 miles across. A magma chamber containing hundreds of cubic miles of molten rock underlies the National Park. If the supervolcano vents this material into the atmosphere, it will precipitate a global ecological crisis that will radically alter the course of civilization.



ASHFALL COMPARED The 1980 Mount St. Helens eruption devastated 600 square kilometers of forest, but its volume of ejected material was puny compared to a Yellowstone supereruption.

NASA / GSFC / MITI / ERSDAC / JARUS / JAPAN ASTER SCIENCE TEAM

LAKE TOBA The most recent supervolcanic eruption occurred in Lake Toba *(far left)*, Sumatra, about 74,000 years ago. The catastrophic 1-gigaton explosion (3,000 times the energy of the 1980 Mount St. Helens eruption) might have cooled global temperatures 3 to 5°C (5 to 9°F) for several years, a volcanic winter that may have brought early modern humans to the brink of extinction.

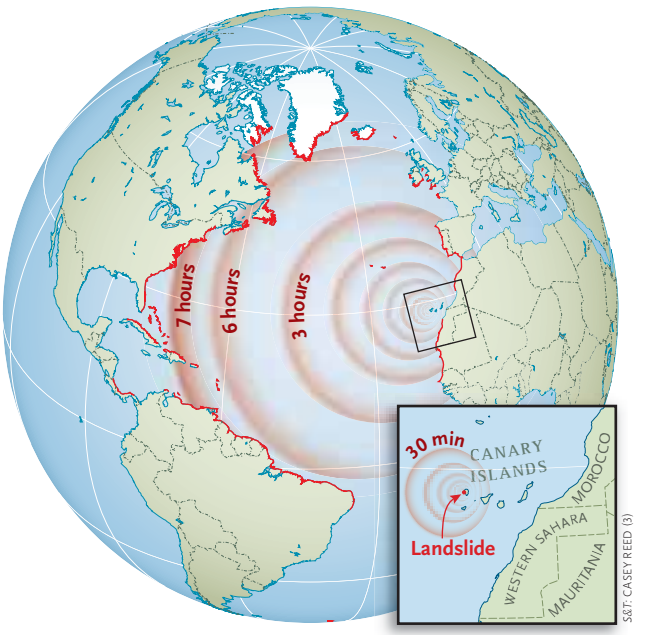
indicate that the human population passed through a bottleneck sometime between 70,000 and 80,000 years ago, when there were perhaps only a few thousand living individuals. Although there is no proven link between the Lake Toba supereruption and the genetic bottleneck, the close association in time may not be coincidental. A recent computer simulation indicates that the eruption produced a decade-long "volcanic winter" that severely affected global ecosystems, posing a formidable challenge to Paleolithic human societies.

The media has recently focused a great deal of attention on a more typical volcano, Cumbre Vieja, on La Palma in the Canary Islands. The 6,400-foot-high mountain appears to be unstable, leading to fears of a massive landslide that could trigger a mega-tsunami that would cross the Atlantic in 6 to 7 hours. Large cities such as New York could not be evacuated quickly enough, so giant waves sweeping over Atlantic coastlines would drown millions of people and leave behind incalculable economic destruction. But recent work by geologists at the Delft University of Technology in The Netherlands strongly suggests that Cumbre Vieja will remain stable for the next 10,000 years.

Another inevitable geological threat comes from a magnetic-field reversal. Earth's north and south poles occasionally flip polarity, but without any regular periodicity. The most recent reversal occurred 780,000 years ago, which is longer than the normal timescale between events. Are we overdue? Earth's magnetic-field strength has weakened by about a third in the past 2,000 years, raising legitimate concerns that we might be heading toward a big switcheroo in the next 1,000 to 2,000 years.

Although we don't really know what happens during these reversals, most geologists think the global dipole field shuts down temporarily, and then it turns back on with opposite polarity. During the time when the field is shut down, Earth would lose its magnetic shield. But we'd still have our atmosphere to absorb the blows from the solar wind and cosmic radiation.

There's no evidence that a magnetic reversal has ever

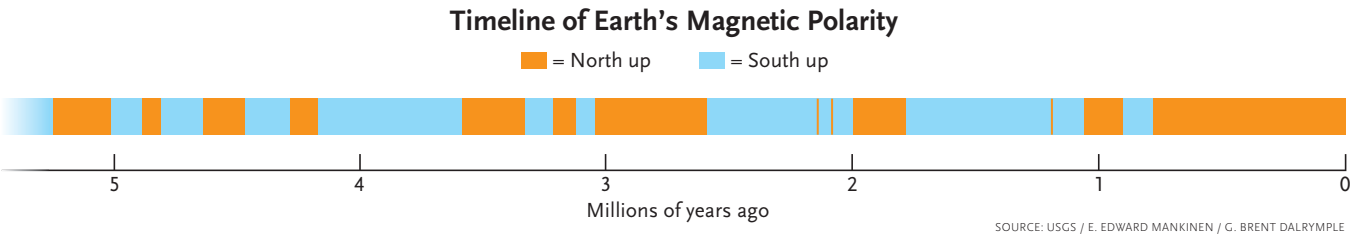


S&T: CASEY REED (3)

tsunamis

NASA / LANDSAT

TSUNAMI IN WAITING? The satellite image on the left shows La Palma, in the Canary Islands. At the southern end lies the volcano Cumbre Vieja, whose western flanks may someday collapse into the Atlantic, triggering a mega-tsunami *(above)* that will inundate coastlines in northern Africa, Europe, and the Americas.



SOURCE: USGS / E. EDWARD MANKINEN / G. BRENT DALRYMPLE

caused a large-scale extinction, and our ancestors, *Homo erectus,* breezed through several reversals without any evidence of a population decline. A reversal won't threaten humanity's existence, but it would disrupt civilization. Without a magnetic shield, powerful solar storms will knock out satellites and power grids. Airliners will be forced to fly at lower altitudes to protect passengers from space radiation. Aurorae will occur all over Earth.

A more near-term possible disaster is a global pandemic, such as the 1918–20 influenza outbreak that killed tens of millions of people (more than from World War I). Many dangerous strains of bacteria are evolving resistance to antibiotics, leading to concerns that a superbug, carried swiftly around the world by airline passengers, could kill millions of people. China, for example, recently quarantined travelers to prevent the spread of swine flu.

MAGENTIC REVERSALS **Earth's magnetic field has flipped polarity about two dozen times over the past 5 million years. There is no obvious pattern, but we seem to be overdue.**

These large natural disasters are so rare that I don't lose sleep. What worries me most are man-made potential disasters, such as environmental degradation, climate change, bioterrorism, and nuclear war, especially as more nations acquire these dreadful weapons. I concur with British astrophysicist Martin Rees, who writes in his book *Our Final Hour,* "Through malign intent, or through misadventure, 21st-century technology could jeopardise life's potential, foreclosing its human or posthuman future." ✦

Anyone who has met S&T *Editor in Chief* ***Robert Naeye*** *knows he has no hope of winning a decathlon gold medal.*