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Krakatoa: The first modern tsunami

By **Simon Winchester**
Expert on the Krakatoa eruption

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It is not the first time that a major seismic event in Indonesia has made front-page news around the world. In the 1880s, close to the epicentre of this Boxing Day's earthquake, huge waves crashed into countries all around the Indian Ocean. It was the eruption of the volcano Krakatoa.

A German, the manager of a quarry, wrote his recollections of being swept away.

He was carried off the top of his three-storey office building at the summit of a 30m high hill.

The tsunami that roared in from the sea that Monday morning in 1883 must have been 40m high, at least.



Like earthquakes, volcanoes form at weak points in the Earth's crust

He recalled being carried along on the wave's green unbroken crest, watching the jungle racing below, paralysed with fear.

Then suddenly to his right, he saw, being swept along beside him, an enormous crocodile.

With incredible presence-of-mind he decided the only way to save himself was to leap aboard the crocodile and try to ride to safety on its back.

How he did it is anyone's guess, but he insists he leapt on, dug his thumbs into the creature's eye-sockets to keep himself stable, and surfed on it for 3km.

He held on until the wave broke on a distant hill, depositing him and a presumably very irritated croc on the jungle floor.

“ The loudest sound ever made since mankind was around to note such things ”

He ran, survived, and wrote about the story.

'First modern catastrophe'

It is an account now formally recorded in the archives as part of the official report of the first catastrophe of the modern age, the eruption of Krakatoa in August, 1883.

The same geological suture line that caused the recent Sumatran earthquake was responsible for Krakatoa, and the

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ANNIVERSARY



Still struggling
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effects, tragic and disastrous, were uncannily similar and world-affecting.

First came an ear-splitting bang.

It was the loudest sound ever made since mankind started noting such things.

The police chief over on Rodriguez Island heard it clearly, like a cannonade of naval gunfire, but he was 4,776km away.



It was like people in London hearing, with perfect clarity, an explosion in Baltimore, or Khartoum.

Then the island exploded with a cataclysmic eruption, hurling a tower of ash, cloud and fire nearly 48km high, and raining down enormous islands of pumice, which were later found floating, laden with skeletons, 6,500km away.

And then there were the waves, four of them.

Immensely tall, immensely fast, felt as far away as France and England.

They smashed into the shores on Java and Sumatra, laying waste to everything, killing nearly 40,000 people.

Aftermath

Wreckage lay uncleared for years.

An iron naval patrol boat was carried nearly three miles inland, and stayed there for more than a century.

I found bits of it, rusted and covered with creepers, back in the 1990s.

Physically, the East Indian islands recovered, as mankind always does.

After all, the biggest volcanoes in human history, Toba and Tambora, exploded nearby, but their only legacy is myth, and their miseries are long forgotten.

But psychologically and

physically the effects of Krakatoa were profound, as the intangible consequences of truly immense tragedies often are.

The defining difference about Krakatoa was that the news of it spread around the world in minutes, because the undersea telegraph cables had just been laid.

It was, if you like, the first event of today's global village.

Looking for answers

But though the world had the information about the event, it still lacked explanation and understanding for what had



disarray a year after the tsunami

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The debris is almost cleared on a beach in Phuket, Thailand

can't lack explanation and understanding for what has happened.

Science would not come with answers as to why earthquakes and volcanoes really happened until the 1960s.

And so the world was frightened and bewildered.

Its people turned to God for answers.

Nowhere more so than in Java itself, where the local Islamic priests insisted that the eruption was a sign of Allah's displeasure, and organised rebellions against the Dutch rulers of the time.

What strikes me as most odd about the aftermath of such events, though, is that not only do people recover, but they invariably go back.

'Magnetically tempting'

The most geologically risky places to live are invariably the most attractive.

Mountain chains, coastlines, peninsulas, islands, set down as they are for some dramatic geological reason, are all too often magnetically tempting to mankind.

People live in their millions near San Francisco, a place of terrible danger.

Elsewhere in America, the Oregon coast is long overdue for a tsunami and Yellowstone will surely soon explode.

Japan is a seismic nightmare.

The Philippine volcanoes erupt and villages are built right over the fertile lava fields, right in the path of the next catastrophe.

And thousands now live along the coasts overlooking the beautiful relics of Krakatoa island, ominously still smoking each day.

Soon, no doubt, villages will spring up once more in Banda

Aceh and south of Trincomalee, in Sri Lanka, and along the coasts of Tamil Nadu.

Man seems to prefer to live on the edge, and to shy away from where it is safe, from places like Nebraska, or the great plains of Siberia.

Man decides where to live, the earth decides whether to allow it.

Or, as the adage has it: Man exists on this earth subject to geological consent, which can be withdrawn at any time.

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Magma lying below Yellowstone Park could erupt at any time

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Krakatoa Volcano: Facts About 1883 Eruption



The eruption of Krakatoa in August 1883 was one of the most deadly volcanic eruptions of modern history. It is estimated that more than 36,000 people died. Many died as a result of thermal injury from the blasts and many more were victims of the tsunamis that followed the collapse of the volcano into the caldera below sea level.

The island of Krakatau (Krakatoa) is in the Sunda Strait between Java and Sumatra. It is part of the Indonesian Island Arc. Volcanic activity is due to subduction of the Indo-Australian tectonic plate as it moves northward towards mainland Asia. The island is about 3 miles wide and 5.5 miles long (9 by 5 kilometers). Before the historic eruption, it had three linked volcanic peaks: Perboewatan, the northernmost and most active; Danan in the middle; and the largest, Rakata, forming the southern end of the island. Krakatau and the two nearby islands, Lang and Verlatan, are remnants of a previous large eruption that left an undersea caldera between them.

In May 1883, the captain of the *Elizabeth*, a German warship, reported seeing clouds of ash above Krakatau. He estimated them to be more than 6 miles (9.6 km) high. For the next two months, commercial vessels and chartered sightseeing boats frequented the strait and reported thundering noises and incandescent clouds. People on nearby islands held festivals celebrating the natural fireworks that lit the night sky. Celebration would come to a tragic halt on Aug. 27.

At 12:53 p.m. on Sunday the 26th, the initial blast of the eruption sent a cloud of gas and debris an estimated 15 miles (24 km) into the air above Perboewatan. It is thought that debris from the earlier eruptive activity must have plugged the neck of the cone, allowing pressure to build in the magma chamber. On the morning of the 27th, four tremendous explosions, heard as far away as Perth, Australia, some 2,800 miles (4,500 km) distant, plunged both Perboewatan and Danan into the caldera below the sea.

The initial explosion ruptured the magma chamber and allowed sea water to contact the hot lava. The result is known as a phreatomagmatic event. The water flash-boiled, creating a cushion of superheated steam that carried the pyroclastic flows up to 25 miles (40 km) at speeds in excess of 62 mph (100 kph). The eruption has been assigned a rating of 6 on the Volcanic Explosion Index and is estimated to have had the explosive force of 200 megatons of TNT. (For purposes of comparison, the bomb that devastated Hiroshima had a force of 20 kilotons. The [Mount St. Helens](#) explosion of 1980 had a VEI of 5.)

Tephra and hot volcanic gases overcame many of the victims in western Java and

Sumatra, but thousands more were killed by the devastating [tsunami](#). The wall of water, nearly 120 feet tall, was created by the volcanoes' collapse into the sea. It completely overwhelmed small nearby islands. Inhabitants of the coastal towns on Java and Sumatra fled toward higher ground, fighting their neighbors for toeholds on the cliffs. The steamship Berouw was carried nearly a mile inland on Sumatra; all 28 crewmembers were killed. Another ship, the Loudon, had been anchored nearby. The ship's captain Lindemann succeeded in turning its bow to face the wave and the ship was able to ride over the crest. Looking back, the crew and passengers saw that nothing was left of the pretty town where they had been anchored.

The explosions hurled an estimated 11 cubic miles (45 cubic km) of debris into the atmosphere darkening skies up to 275 miles (442 km) from the [volcano](#). In the immediate vicinity, the dawn did not return for three days. Barographs around the globe documented that the shock waves in the atmosphere circled the planet at least seven times. Within 13 days, a layer of sulfur dioxide and other gases began to filter the amount of sunlight able to reach Earth. The atmospheric effects made for spectacular sunsets all over Europe and the United States. Average global temperatures were up to 1.2 degrees cooler for the next five years.

Mount Tambora & the year without a summer

While justifiably rated as one of the most destructive volcanic eruptions of modern times, Krakatoa was not the largest eruption in the recent history of Indonesia. That "honor" belongs to the eruption of Mount Tambora on April 10, 1815.

Tambora is the only eruption in modern history to rate a VEI of 7. Global temperatures were an average of [five degrees cooler](#) because of this eruption; even in the United States, 1816 was known as the "year without a summer." Crops failed worldwide, and in Europe and the United States an unexpected outcome was the invention of the bicycle as horses became too expensive to feed.

The Child of Krakatoa

In 1927, some fishermen were startled as a column of steam and debris began

spewing from the collapsed caldera. Krakatoa had awakened after 44 years of calm. Within weeks, the rim of a new cone appeared above sea level. Within a year, it grew into a small island, which was named Anak Krakatoa, or Child of Krakatoa. Anak Krakatoa has continued to erupt periodically, although mildly.

- [Countdown: Big Blasts — History's 10 Most Destructive Volcanoes](#)

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Describe the 1883 eruption of Krakatau.

Category:

Asia



Krakatau erupted in 1883, in one of the largest eruptions in recent time. Krakatau is an island volcano along the Indonesian arc, between the much larger islands of Sumatra and Java (each of which has many volcanoes also along the arc).

There is a very fine book about the Krakatau eruption by Tom Simkin and Richard Fiske (Simkin, T., and Fiske, R.S., *Krakatau 1883: The volcanic eruption and its effects*: Smithsonian Institution Press: Washington, D.C., 464 p.), so if you really want to know about the eruption you should go to the nearest bookstore or library to find that.

Here are some highlights from their summary of effects:

1. The explosions were heard on Rodriguez Island, 4653 km distant across the Indian Ocean, and over 1/13th of the earth's surface.
2. Ash fell on Singapore 840 km to the north, Cocos (Keeling) Island 1155 km to the SW, and ships as far as 6076 km west-northwest. Darkness covered the Sunda Straits from 11 a.m. on the 27th until dawn the next day.
3. Giant waves reached heights of 40 m above sea level, devastating everything in their path and hurling ashore coral blocks weighing as much as 600 tons.

4. At least 36,417 people were killed, most by the giant sea waves, and 165 coastal villages were destroyed.
5. When the eruption ended only 1/3 of Krakatau, formerly 5×9 km, remained above sea level, and new islands of steaming pumice and ash lay to the north where the sea had been 36 m deep.
6. Every recording barograph in the world documented the passage of the atmospheric pressure wave, some as many as 7 times as the wave bounced back and forth between the eruption site and its antipodes for 5 days after the explosion.
7. Tide gauges also recorded the sea wave's passage far from Krakatau. The wave "reached Aden in 12 hours, a distance of 3800 nautical miles, usually traversed by a good steamer in 12 days".
8. Blue and green suns were observed as fine ash and aerosol, erupted perhaps 50 km into the stratosphere, circled the equator in 13 days.
9. Three months after the eruption these products had spread to higher latitudes causing such vivid red sunset afterglow that fire engines were called out in New York, Poughkeepsie, and New Haven to quench the apparent conflagration. Unusual sunsets continued for 3 years.
10. Rafts of floating pumice-locally thick enough to support men, trees, and no doubt other biological passengers-crossed the Indian Ocean in 10 months. Others reached Melanesia, and were still afloat two years after the eruption.
11. The volcanic dust veil that created such spectacular atmospheric effects also acted as a solar radiation filter, lowering global temperatures as much as 1.2 degree C in the year after the eruption. Temperatures did not return to normal until 1888. The book is full of many more amazing bits of information. Hopefully these small excerpts will be useful to you.

Krakatau is still active. The presently-active vent has formed a small island in the middle of the ocean-filled caldera that developed during the famous big eruption of 1883. The island is called Anak Krakatau, which means child-of-Krakatau. It is pretty much erupting all the time at a low level, but once or twice a year it has slightly larger eruptions that people notice and sometimes report in the news. Of course none of these are anywhere near the size of the famous 1883 eruption.

Krakatau is following a pattern that is pretty common for volcanoes. This pattern involves hundreds to thousands of years of small eruptions to build up the volcano followed by 1 or more huge eruptions that causes the volcano to collapse into a caldera, and then the cycle starts over again.

The chances of a huge 1883-style eruption are very small for the time being. However, it is certainly dangerous to go onto Anak Krakatau, especially if it is one of its more agitated moods. It is probably not even very smart to spend too much time on the small islands that form the remnants of what was once the main Krakatau island. This is because even a small collapse of Anak Krakatau could generate a small [*tsunami*](#) that could sweep towards these islands. Since they are so close to Anak Krakatau there wouldn't be very much time for a warning.

Anak Krakatau photograph courtesy of and copyrighted by Robert Decker.

1883 eruption of Krakatoa

The **1883 eruption of Krakatoa** in the [Dutch East Indies](#) (now in [Indonesia](#)) began on August 26, 1883 (with origins as early as May of that year) and culminated with several destructive eruptions of the remaining [caldera](#). On August 27, ²/₃ of [Krakatoa](#) collapsed in a chain of titanic explosions, destroying most of the island and its surrounding archipelago. Additional alleged [seismic](#) activity continued to be reported until February 1884, though reports of those after October 1883 were later dismissed by [Rogier Verbeek](#)'s investigation. It was one of the deadliest and most destructive volcanic events in recorded history, with at least 36,417 deaths being attributed to the eruption itself and the [tsunamis](#) it created. Significant additional effects were also felt around the world.

Early phase

In the years before the 1883 eruption, seismic activity around the volcanoes was intense, with [earthquakes](#) felt as far away as Australia. Beginning 20 May 1883, steam venting began to occur regularly from [Perboewatan](#), the northernmost of the island's three cones. Eruptions of ash reached an estimated altitude of 6 km (20,000 ft) and explosions could be heard in New Batavia ([Jakarta](#)) 160 km (99 mi) away. Activity died down by the end of May, and there was no further recorded activity for several weeks. ^{[*[citation needed](#)*]}

Eruptions started again around 16 June, featuring loud explosions and covering the islands with a thick black cloud for five days. On 24 June, a prevailing east wind cleared the cloud, and two ash columns were seen issuing from Krakatoa. The seat of the eruption is believed to have been a new vent or vents which formed between Perboewatan and [Danan](#). The violence of the ongoing eruptions caused tides in the vicinity to be unusually high, and ships at anchor had to be moored with chains as a result. Earthquake shocks began to be felt at [Anyer](#), [West Java](#), and ships began to report large [pumice](#) masses appearing in the [Indian Ocean](#) to the west. ^{[*[citation needed](#)*]}

On 11 August, a Dutch topographical engineer, Captain H. J. G. Ferzenaar,

investigated the islands.^[1] He noted three major ash columns (the newer from Danan), which obscured the western part of the island, and steam plumes from at least eleven other vents, mostly between Danan and [Rakata](#). When he landed, he noted an ash layer about 0.5 m (1 ft 8 in) thick, and the destruction of all vegetation, leaving only tree stumps. He advised against any further landings. The next day, a ship passing to the north reported a new vent "only a few meters above sea level." (This may be the most northerly spot indicated on Ferzenaar's map.) Activity continued through mid-August.^[*citation needed*]

Climactic phase

By 25 August, eruptions further intensified. At about 13:00 (local time) on 26 August, the volcano went into its [paroxysmal](#) phase. By 14:00 observers could see a black cloud of ash 27 km (17 mi) high. At this point, the eruption was virtually continuous and explosions could be heard every ten minutes or so. Ships within 20 km (12 mi) of the volcano reported heavy ash fall, with pieces of hot pumice up to 10 cm (3.9 in) in diameter landing on their decks. A small [tsunami](#) hit the shores of [Java](#) and [Sumatra](#), some 40 km (25 mi) away, between the time of 18:00 and 19:00 hours.

On 27 August four enormous explosions took place at 05:30, 06:44, 10:02, and 10:41 local time. At 5:30 A.M, the first explosion was at [Perboewatan](#) volcano, triggering a tsunami heading straight to [Telock Botong](#). At 6:44 A.M, Krakatoa exploded again on [Danan](#) volcano, with the resulting tsunami stretching eastward and westward. The largest explosion, at 10:02 A.M, was so violent that it was heard 3,110 km (1,930 mi) away in [Perth](#), [Western Australia](#), and the [Indian Ocean](#) island of [Rodrigues](#) near [Mauritius](#) (4,800 km (3,000 mi) away), where they were thought to be cannon fire from a nearby ship.^{[2][3]:22} Each explosion was accompanied by large [tsunamis](#), which are believed to have been over 30 meters (100 ft) high in places. A large area of the [Sunda Strait](#) and a number of places on the Sumatran coast were affected by [pyroclastic flows](#) from the volcano. The energy released from the explosion has been estimated to be equal to about 200 megatons of TNT,^[4] roughly four times as powerful as the [Tsar Bomba](#) (the most powerful thermonuclear weapon ever

detonated). At 10:41 A.M, a landslide tore off half of [Rakata](#) volcano causing the final explosion.

Final explosive eruption

The pressure wave generated by the colossal fourth and final explosion radiated out from Krakatoa at 1,086 km/h (675 mph).^[5] It was so powerful that it ruptured the eardrums of sailors on ships in the [Sunda Strait](#),^[6] and caused a spike of more than 2½ [inches of mercury](#) (ca 85 hPa) in pressure gauges attached to [gasometers](#) in the Batavia gasworks, sending them off the scale.^[7] The pressure wave radiated across the globe and was recorded on [barographs](#) all over the world, which continued to register it up to 5 days after the explosion. Barographic recordings show that the shock-wave from the final explosion reverberated around the globe 7 times in total.^[3] Ash was propelled to an estimated height of 80 km (50 mi).

The eruptions diminished rapidly after that point, and by the morning of 28 August, Krakatoa was silent. Small eruptions, mostly of mud, continued into October 1883.

"The Burning Ashes of Ketimbang"

Around noon on 27 August 1883, a rain of hot ash fell around Ketimbang (now Katibung in [Lampung](#) Province) in Sumatra. Approximately 1,000 people were killed, the only large number of victims killed by Krakatoa itself, and not by the waves or after-effects.^[8] Verbeek, and later writers, believe this unique event was a [lateral blast](#), or [pyroclastic surge](#) (similar to the catastrophic [1980 eruption of Mount St. Helens](#)), which crossed the water. The region of the ash fall ended to the northwest of Ketimbang, where the bulk of [Sebesi](#) Island offered protection from any horizontal surges.

Effects

The combination of [pyroclastic flows](#), volcanic ash, and tsunamis had disastrous results in the region. There were no survivors from the 3,000 people located on the

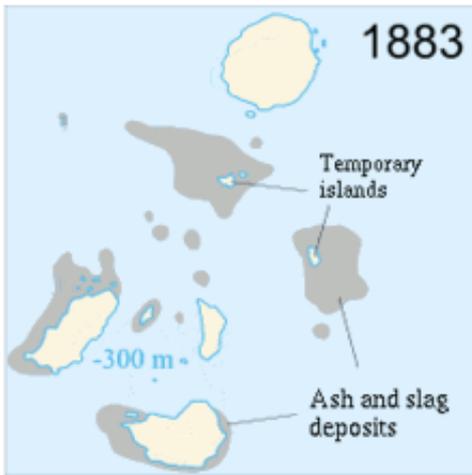
island of [Sebesi](#), about 13 km (8.1 mi) from Krakatoa. Pyroclastic flows killed around 1,000 people at Ketimbang on the coast of Sumatra some 40 km (25 mi) north from Krakatoa. The official death toll recorded by the Dutch authorities was 36,417, although some sources put the estimate at 120,000 or more. Many settlements were destroyed, including [Teluk Betung](#) and Ketimbang in Sumatra; as well as [Sirik](#) and [Serang](#) in [Java](#). The areas of [Banten](#) on Java and the Lampung on Sumatra were devastated. There are numerous documented reports of groups of human [skeletons](#) floating across the [Indian Ocean](#) on rafts of volcanic pumice and washing up on the east coast of [Africa](#), up to a year after the eruption. Some land on Java was never repopulated; it reverted to [jungle](#), and is now the [Ujung Kulon National Park](#).

Tsunamis and distant effects

Ships as far away as [South Africa](#) rocked as tsunamis hit them, and the bodies of victims were found floating in the ocean for months after the event. The tsunamis which accompanied the eruption are believed to have been caused by gigantic pyroclastic flows entering the sea; each of the four great explosions was accompanied by massive pyroclastic flows resulting from the gravitational collapse of the eruption columns. This caused several cubic kilometers of material to enter the sea, displacing an equally huge volume of seawater. The town of [Merak](#) was destroyed by a tsunami 46 m (151 ft) high. Some of the pyroclastic flows reached the Sumatran coast as much as 40 km (25 mi) away, having apparently moved across the water on a cushion of superheated steam.^[9] There are also indications of submarine pyroclastic flows reaching 15 km (9.3 mi) from the volcano.

Smaller waves were recorded on tidal gauges as far away as the [English Channel](#).^[10] These occurred too soon to be remnants of the initial tsunamis, and may have been caused by concussive air waves from the eruption. These air waves circled the globe several times and were still detectable on barographs five days later.^[11]

Geographic effects



In the aftermath of the eruption, it was found that the island of Krakatoa had almost entirely disappeared, except for the southern third. The Rakata cone was cut-off along a vertical cliff, leaving behind a 250-metre (820 ft) deep caldera. Of the northern two-thirds of the island, only a rocky islet named Boatsmansrots ('[Bosun](#)'s Rock'), a fragment of Danan, was left; [Poolsche Hoed](#) had totally disappeared.

As a result of the huge amount of material deposited by the volcano, the surrounding ocean floor was drastically altered. It is estimated that as much as 18–21 km³ (4.3–5.0 cu mi) of [ignimbrite](#) was deposited over an area of 1,100,000 km² (420,000 sq mi), largely filling the 30–40 m (98–130 ft) deep basin around the mountain. The land masses of [Verlaten](#) and [Lang](#) islands were increased, as was the western part of the remnant of Rakata. Much of this gained material quickly eroded away, but volcanic ash continues to be a significant part of the geological composition of these islands.

Two nearby [sandbanks](#) (called [Steers](#) and [Calmeyer](#) after the two naval officers who investigated them) were built up into islands by ashfall, but the sea later washed them away. Seawater on hot volcanic deposits on Steers and Calmeyer had caused steam to rise, which some mistook for a continued eruption.

Global climate

In the year following the eruption, average global temperatures fell by as much as 1.2 °C (2.2 °F).^{[\[citation needed\]](#)} Weather patterns continued to be chaotic for years, and

temperatures did not return to normal until 1888.^[*citation needed*] The eruption injected an unusually large amount of [sulfur dioxide](#) (SO₂) gas high into the [stratosphere](#), which was subsequently transported by high-level winds all over the planet. This led to a global increase in [sulfuric acid](#) (H₂SO₄) concentration in high-level [cirrus clouds](#). The resulting increase in cloud [reflectivity](#) (or [albedo](#)) would reflect more incoming light from the sun than usual, and cool the entire planet until the suspended [sulfur](#) fell to the ground as [acid precipitation](#).^[12]^[*citation needed*]

Global optical effects

The eruption darkened the sky worldwide for years afterward, and produced spectacular sunsets throughout the world for many months. British artist [William Ashcroft](#) made thousands of colour sketches of the red sunsets half-way around the world from Krakatoa in the years after the eruption. The ash caused "such vivid red sunsets that fire engines were called out in New York, Poughkeepsie, and New Haven to quench the apparent conflagration."^[13] This eruption also produced a [Bishop's Ring](#) around the sun by day, and a volcanic purple light at twilight.

In 2004, an astronomer proposed the idea that the blood-red sky shown in [Edvard Munch](#)'s famous 1893 painting *The Scream* is also an accurate depiction of the sky over [Norway](#) after the eruption.^[14]

Weather watchers of the time tracked and mapped the effects on the sky. They labeled the phenomenon the "equatorial smoke stream".^[15] This was the first identification of what is known today as the [jet stream](#).^[16]

For several years following the eruption it was reported that the moon appeared to be blue and sometimes green. [Blue moons](#) resulted because some of the ash-clouds were filled with particles about 1 micron wide—the right size to strongly scatter red light, while allowing other colors to pass. White moonbeams shining through the clouds emerged blue, and sometimes green. People also saw lavender suns and, for the first time, [noctilucent clouds](#).^[13]

Possible causes

The fate of northern Krakatoa itself has been the subject of some dispute among geologists. It was originally proposed that the island had been blown apart by the force of the eruption. However, most of the material deposited by the volcano is clearly magmatic in origin and the caldera formed by the eruption is not extensively filled with deposits from the 1883 eruption. This indicates that the island subsided into an empty [magma chamber](#) at the end of the eruption sequence, rather than having been destroyed during the eruptions.

The established theories - based on the findings of contemporary investigators - assume that part of the island subsided before the first explosions on the morning of 27 August. This forced the volcano's vents below sea level causing:

- massive flooding which created a series of [phreatic explosions](#) (interaction of ground water and magma).
- seawater to cool the [magma](#) enough for it to crust over and produce a "pressure cooker" effect relieved only when explosive pressures were reached.

However there is geological evidence which does not support the assumption that only subsidence before the explosion was the cause. For instance, the pumice and ignimbrite deposits are not of a kind consistent with a magma-seawater interaction. These findings have led to other hypotheses:

- a massive underwater land slump or partial subsidence suddenly exposed the high-pressurized magma chamber to seawater.
- the final explosions may have been caused by [magma mixing](#) caused by a sudden infusion of hot basaltic magma into the cooler and lighter magma in the chamber below the volcano. This would have resulted in a rapid and unsustainable increase in pressure, leading to a cataclysmic explosion. Evidence for this theory is the existence of pumice consisting of light and dark material, the dark material being of much hotter origin. However, such material reportedly is less than 5% of the content of the Krakatoa [ignimbrite](#) and some investigators have rejected this as a prime cause of the 27 August explosions.

Verbeek investigation

Although the violent engulfment phase of the eruption was over by late afternoon of 27 August, after light returned by the 29th, reports continued for months that Krakatoa was still in eruption. One of the earliest duties of Verbeek's committee was to determine if this was true and also verify reports of other volcanoes erupting on Java and Sumatra. In general, these were found to be false, and Verbeek discounted any claims of Krakatoa still erupting after mid-October as due to steaming of hot material, landslides due to heavy monsoon rains that season, and "hallucinations due to electrical activity" seen from a distance.^[*citation needed*]

No signs of further activity were seen until 1913, when an eruption was reported. Investigation could find no evidence the volcano was awakening, and it was determined that what had been mistaken for renewed activity had actually been a major landslide (possibly the one which formed the second arc to Rakata's cliff).

Examinations after 1930 of [bathymetric](#) charts made in 1919 show evidence of a bulge indicative of [magma](#) near the surface at the site that became [Anak Krakatau](#).

In culture

The novel *Blown to Bits, or, The Lonely Man of Rakata: A Tale of the Malay Archipelago* (London: James Nisbet, 1889), by [R. M. Ballantyne](#), is a juvenile adventure novel about the eruption. The publisher's description reads: "The story of the violent nature of the volcanic eruption in Krakatoa in 1883. One of a series of excellent stories of adventure for the young with which this prolific Scottish author's name is popularly associated. Beautifully illustrated."

Czech writer [Karel Čapek](#) was inspired by the name and intensity of the eruption when writing his 1922 novel [Kraťatit](#) about an abuse of power in a form of powerful explosive of the same name.^{[19][20]} It was adapted into film in 1949, directed by [Otakar Vávra](#) and starring [Karel Höger](#).^[21]

[The Twenty-One Balloons](#) (Viking Press, 1947), a [Newbery Medal](#)-winning children's

novel by [William Pène du Bois](#), recounts the incredible adventures of Professor William Waterman Sherman who in 1883 sets off in a balloon across the Pacific, survives the volcanic eruption of Krakatoa, and is eventually picked up in the Atlantic. [22]

Krakatoa, East of Java was a film directed by [Bernard L. Kowalski](#) and starred [Maximilian Schell](#); the [novelization](#) of the same title (New American Library, 1969, ISBN 0-451-03797-9), was written by [Michael Avallone](#).^[23]

Dark of the Sun: A Novel of Saint-Germain (Tor Books, 2004; ISBN 0-765-31103-8), by [Chelsea Quinn Yarbro](#), sees [the vampire Count Saint-Germain](#) flee the eruption and undertake an arduous travel back to his homeland in [Transylvania](#).

In the 1998 Scrooge McDuck comic story "[The Cowboy Captain of the Cutty Sark](#)" by [Don Rosa](#), the events take place in Indonesia at the time of Krakatoa's eruption, which together with its aftermath appear among many memorable scenes.

See also

- [Krakatoa documentary and historical materials](#)
- [List of natural disasters by death toll](#)
- [List of volcanoes in Indonesia](#)
- [Phreatic eruption](#)
- [Volcanic Explosivity Index](#) (includes list of large eruptions)

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- ↑ "How- Krakatoa Made the Biggest Bang"; *The Independent*, 3 May 2006. The third explosion has been reported as the loudest sound heard in historic times.
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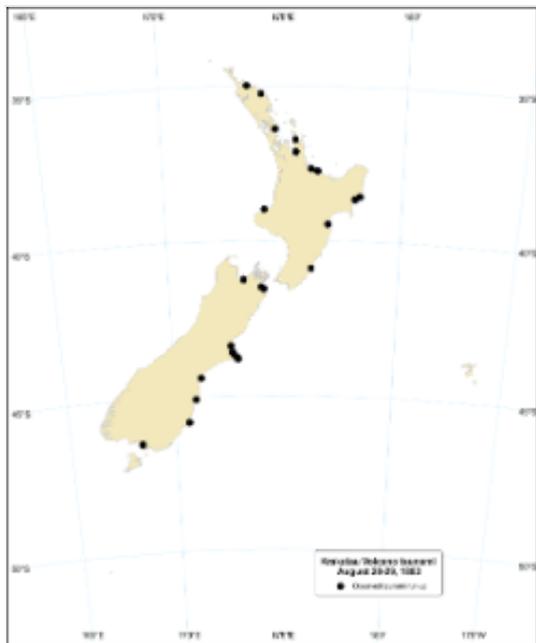
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External links

- [1883 Eruption of Krakatau](#) from the [United States Geological Survey's](#) Cascades Volcano Observatory.
- [Krakatau, Indonesia \(1883\)](#) information from [San Diego State University](#) about the 1883 eruption.
- [Krakatoa Volcano: The Son Also Rises](#)—Companion website to the NPR programme.
- [On-line images of some of Ashcroft's sunset sketches.](#)

Krakatau Volcano tsunami, 28 to 29 August 1883

This tsunami is the only known example of a New Zealand tsunami generated by a volcano.



Run-up for Krakatau Volcano tsunami.

- **Date:** 28/29 August 1883
- **Source:** Distant
- **Cause:** Volcanic

The 27 August 1883 explosion of Krakatau Volcano in Indonesia is one example of an eruption-caused tsunami. The eruption generated a 30m tsunami in the Sunda Strait which killed about 36,000 people, as it washed away 165 coastal villages on Java and Sumatra. It also caused atmospheric pressure disturbances, which seem to have excited water waves by transferring energy into the ocean, resulting in sea level disturbances being recorded on tide gauges at locations more than 7,000 km from the source.

In New Zealand, the tsunami was observed at many locations around the country, and was first noticed late in the evening of 28 August (at Mangonui, Lyttelton and Port Chalmers) about 29-30 hours after the eruption took place. Many locations, however,

did not notice any surges until the next morning, when the surges probably reached their maximum at most places. Several places reported continuance of oscillations for more than 24 hours. The places that were most affected by surges were mainly the eastern seaboard from Mangonui (in Northland) to Port Chalmers (in the South Island). The height of the waves above sea level at the time was mostly less than 1.2m. The locations where the waves were (reliably) more than 1m are Mangonui, Warkworth (i.e. Mahurangi estuary), the upper reaches of Waitemata harbour, eastern side of the Coromandel Peninsula, Whangara (north of Gisborne), locations on Banks Peninsula, and Oamaru. These are some of the largest effects recorded worldwide outside the zone not affected by the tsunami directly generated by the eruption/explosion.

Krakatoa Volcano Eruption in 1883 Was a Worldwide Weather and Media Event

The eruption of the volcano at Krakatoa in the Pacific Ocean in August 1883 was a major disaster by any measure. The entire island of Krakatoa was simply blown apart, and the resulting tsunami killed tens of thousands of people on other islands in the vicinity.

The volcanic dust thrown into the atmosphere affected the weather around the world, and people as far away as Britain and the United States saw bizarre red sunsets caused by particles in the atmosphere.

The events at Krakatoa were also significant because it was one of the first times that detailed descriptions of a colossal news event traveled around the world quickly, carried by [undersea telegraph wires](#). Readers of daily newspapers in Europe and North America were able to follow current reports of the disaster and its enormous implications.

The Volcano at Krakatoa

The great volcano on the island of Krakatoa (sometimes spelled as Krakatau or Krakatowa) loomed over the Sunda Strait, between the islands of Java and Sumatra in present day Indonesia.

Before the 1883 eruption, the volcanic mountain reached a height of approximately 2,600 feet above sea level. The slopes of the mountain were covered with green vegetation, and it was a notable landmark to sailors passing through the straits.

In the years preceding the massive eruption several earthquakes occurred in the area. And in June 1883 small volcanic eruptions began to rumble across the island. Throughout the summer the volcanic activity increased, and tides at islands in the area began to be affected.

The activity kept accelerating, and finally, on August 27, 1883, four massive eruptions

came from the volcano. The final colossal explosion destroyed two-thirds of the island of Krakatoa, essentially blasting it into dust. Powerful tsunamis were triggered by the force.

The scale of the volcanic eruption was enormous. Not only was the island of Krakatoa shattered, other small islands were created. And the map of the Sunda Strait was changed forever.

Local Effects of the Krakatoa Eruption

Sailors on ships in nearby sea lanes reported astounding events associated with the volcanic eruption. The sound was loud enough to break the eardrums of some crewmen on ships many miles away. And pumice, or chunks of solidified lava, rained from the sky, pelting the ocean and the decks of ships.

The tsunamis set off by the volcanic eruption rose as high as 120 feet, and slammed into the coastlines of the inhabited islands of Java and Sumatra. Entire settlements were wiped away, and it is estimated that 36,000 people died.

Distant Effects of the Krakatoa Eruption

The sound of the massive volcanic eruption traveled enormous distances across the ocean. At the British outpost on Diego Garcia, an island in the Indian Ocean more than 2,000 miles from Krakatoa, the sound was clearly heard. People in Australia also reported hearing the explosion. It is possible that Krakatoa created one of the loudest sounds ever generated on earth, rivaled only by the volcanic eruption of [Mount Tambora](#) in 1815.

Pieces of pumice were light enough to float, and weeks after the eruption large pieces began drifting in with the tides along the coast of Madagascar, an island off the east coast of Africa. Some of the large pieces of volcanic rock had animal and human skeletons embedded in them. They were grisly relics of Krakatoa.

The Krakatoa Eruption Became a Worldwide Media Event

Something that made Krakatoa different from other major events in the 19th century was the introduction of the transoceanic telegraph cables.

The [news of Lincoln's assassination](#) less than 20 years earlier had taken nearly two weeks to reach Europe, as it had to be carried by ship. But when Krakatoa erupted, a telegraph station at Batavia (present day Jakarta, Indonesia) was able to send the news to Singapore. Dispatches were relayed quickly, and literally within hours newspaper readers in London, Paris, Boston, and New York were being informed of the colossal events in the distant Sunda Straits.

The New York Times ran a small item in the edition of August 27, 1883, only hours after the first reports were tapped out on the telegraph key in Batavia:

“Terrific detonations were heard yesterday evening from the volcanic island of Krakatoa. They were audible at Soerkrata, on the island of Java. The ashes from the volcano fell as far as Cheribon, and the flashes proceeding from it were visible in Batavia.”

The initial New York Times item also noted that stones were falling from the sky, and that communication with the town of Anjier “is stopped and it is feared there has been a calamity there.” (Two days later the New York Times would report that the European settlement of Anjiers had been “swept away” by a tidal wave.)

The public became fascinated with the news reports about the volcanic eruption. Part of that was due to the novelty of being able to receive such distant news so quickly. But it was also because the event was so enormous and so rare.

The Eruption at Krakatoa Became a Worldwide Event

Following the eruption of the volcano, the area near Krakatoa was enveloped in a strange darkness, as dust and particles blasted into the atmosphere blocked sunlight. And as winds in the upper atmosphere carried the dust great distances, people on the other side of the world began to notice the effect.

According to a report in the Atlantic Monthly magazine published in 1884, some sea

captains had reported seeing sunrises that were green, with the sun remaining green throughout the day. And sunsets around the world turned a vivid red in the months following the Krakatoa eruption. The vividness of the sunsets continued for nearly three years.

American newspaper articles in late 1883 and early 1884 speculated on the cause of the widespread phenomenon of "blood red" sunsets. But scientists today know that dust from Krakatoa blown into the high atmosphere was the cause.

The Krakatoa eruption, massive as it was, was actually not the largest volcanic eruption of the 19th century. That distinction would belong to the [eruption of Mount Tambora](#) in April 1815.

The Mount Tambora eruption, as it happened before the invention of the telegraph, was not as widely known. But it actually had a more devastating impact as it contributed to bizarre and deadly weather the following year, which became known as [The Year Without a Summer](#).

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Disasters: [Eruption of Mount Tambora](#) | [Year Without a Summer](#) | [Cholera Epidemic](#) | [Wreck of SS Arctic](#) | [Johnstown Flood](#) | [Chicago Fire](#) | [New York Hurricane](#)

The eruption of Krakatoa, August 27, 1883

Krakatoa was dormant until May 20, 1883, when it erupted catastrophically. By August 11, three vents were regularly erupting on the volcano. During this time tides were unusually high, and phenomena such as windows suddenly shattering were commonplace. Ships at anchor were sometimes tied down with chains as a result.

The August 26 eruptions occurred at 5:30 am, 6:42 am, 8:20 am and 10:02 am local time. The last of these eruptions opened fissures in the walls of the volcano, allowing sea water to pour into the magma chamber. The resulting explosion of superheated steam destroyed most of the island. The sound of the explosion was heard as far away as Australia 3500 km away, and the island of Rodrigues near Mauritius 4800 km away. It is the loudest-ever sound in recorded history. (A possibly louder sound is believed to have been generated during the 1815 eruption of Mount Tambora, also in the Indonesian archipelago).

Although no one is known to have been killed as a result of the initial explosion, the tsunamis it generated had disastrous results, killing some 36,000 people and wiping out a number of settlements, including Telok Batong in Sumatra, and Sirik and Semarang in Java. An additional 1,000 or so people died from superheated volcanic ash which literally rushed across the surface of the ocean. Ships as far away as South Africa rocked as tsunamis hit them, and the bodies of victims were found floating in the ocean for weeks after the event. There are even numerous documented reports of groups of human skeletons floating across the Indian Ocean on rafts of volcanic pumice and washing up on the east coast of Africa up to a year after the eruption.

The 1883 eruption was amongst the most severe volcanic explosions in modern times (VEI of 6, equivalent to 200 megatons of TNT - by way of comparison, the biggest bomb ever made by man, Tsar Bomba, is around 50 megatons). Concussive air waves from the explosions travelled seven times around the world, and the sky was darkened for days afterwards. The island of Rakata itself largely ceased to exist as over two thirds of its exposed land area was blown to dust, and its surrounding ocean floor was drastically altered. Two nearby islands, Verlaten and Lang, had their land

masses increased. Volcanic ash continues to be a significant part of the geological composition of these islands.

The eruption produced spectacular sunsets throughout the world for many months afterwards, as a result of sunlight reflected from suspended dust particles ejected by the volcano high into Earth's atmosphere. Interestingly, researchers in 2004 proposed the idea that the blood-red sky shown in Edvard Munch's famous 1893 painting *The Scream* is an accurate depiction of the sky over Norway after the 1883 eruption of Krakatoa.

It has been suggested that an eruption of Krakatoa may have been responsible for the global climate changes of 535-536. Additionally, in recent times, it has been argued that it was this eruption which created the islands of Verlaten and Lang (remnants of the original) and the beginnings of Rakata - all indicators of that early Krakatoa's caldera size, and not the long-believed eruption of c. 416, for which conclusive evidence does not exist.

Since the 1883 eruption, a new island volcano, called Anak Krakatau ("Child of Krakatoa"), has formed in the caldera. Of considerable interest to volcanologists, this has been the subject of extensive study since 1960. Additionally, it has also been studied as a case study of island biogeography and founder populations in an ecosystem being built from the ground up, virtually sterilized, certainly with no macroscopic life surviving the explosion. However, the island is still active, growing at the rate of 13 cm per week.

Witness Account

Severe Weather and Natural Disasters

Volcanoes

Witness Account

The Volcano That Shook the World: Krakatoa 1883
Sunday, August 26, 1883

It was an especially lovely afternoon in Anjer, a small seaside town on the island of Java. Children played on sparkling white beaches. Palm trees whispered in the breeze. Families rested or strolled along the streets. It was not the kind of day anyone would expect disaster to strike.

Then, at about 1:00 p.m., the sudden, sharp crack of an explosion shattered the quiet. All eyes turned west, toward Krakatoa (kra-kuh-TOW-uh), a volcanic island about six miles long and two miles wide.

Krakatoa jutted up 2,625 feet out of the sea. It lay in the Sunda Strait, a stretch of water separating the islands of Java and Sumatra, in the Indian Ocean, in Southeast Asia. Today, both islands are part of Indonesia. In 1883, the islands were Dutch colonies, controlled by the government of the European country the Netherlands.

The volcano of Krakatoa had been quiet, or "dormant", for 200 years. Then, in May, it had suddenly awakened, with cracklings, explosions, and smoke.

Most sensed that the noises and smoke of this afternoon seemed different from the rumblings of the past few months. But nobody could imagine the catastrophe that was



The gray line on this map is the outline of Krakatoa Island before the 1883 eruption. Today, smaller islands have grown up where Krakatoa used to be.
Credit: Jim McMahon

about to overwhelm their beautiful land.

WHAT IS A VOLCANO?

A volcano is a hole in the crust of Earth or other planets. It forms when molten rock, or magma, erupts to the surface, where it is called lava. In a way, you could say that volcanoes are vents. They are the way that planets cool off.

Scientists estimate that there are about 1,500 volcanoes that have erupted in the last 10,000 years. Today, scientists keep a careful watch on "active" volcanoes, and can predict when they will erupt. In 1883, however, little was known about volcanoes. And most of the scientists who did study volcanoes lived in Europe and America, across the earth from the remote land of Krakatoa.

ASHES RAINING DOWN

By mid-afternoon, the town of Anjer was enveloped in an eerie darkness. Clouds of smoke had spewed into the air, covering the sun. People could hardly see their hands in front of their faces. Hot ashes rained down. From time to time, a red, fiery glare could be spotted over the volcano.

The seas began to behave strangely. Waves crashed wildly against the shore. In the harbor, churning water tore boats loose from their moorings and dashed them to pieces. The town's telegraph operator tapped out reports to the city of Batavia (today it is Jakarta, Indonesia's capital), 100 miles to the east. But at 6:00 p.m. the telegraph cable broke, and the line went dead. The telegraph operator hoped to fix it in the morning. That was not to be.

As the evening wore on, the explosions continued. People began to panic, not only in Anjer but in other small villages and towns in western Java and in southern Sumatra.

In the Sumatran town of Ketimbang, the Beyerinck family, including three children, fled to their summer cottage in the hills. Just before they set off, a wave rose so high they had to scramble up coconut trees to keep from being washed away. After the wave fell back, they raced through muddy fields to what they hoped was safety.

Soaking wet, covered with mud, and shivering with fear, they reached the cottage at

midnight. All around, local people huddled together. Throughout that long, terrifying night, everyone wondered: What would the morning bring?

A TERRIBLE EXPLOSION

All night long, trading ships in the area were pounded by hot winds full of flying cinders and ash. One captain wrote that the "night was a fearful one...the blinding fall of sand and stones...the sky one second intensely black, the next a blaze of light." Monday arrived, but dawn never came. Instead, the skies stayed dark. Ash filled the air. Lightning flashed.

As Monday morning wore on, Krakatoa's eruptions grew more intense. Beginning at 5:30 a.m., three terrible explosions shook the air, generating immense, powerful waves.

Then, at exactly 2 minutes past 10:00 a.m., the unthinkable happened. Krakatoa exploded into nothingness.

Think about the loudest sound you've ever heard. Multiply that sound by thousands. Then try, if you can, to imagine the loudest sound in the world — a sound so deafening, an explosion so terrifyingly loud, people more than 2,000 miles away recorded hearing it. Buildings 500 miles away shook.

The violent explosion blew away the volcano and most of the small island it sat upon. Six cubic miles of rock were blasted to smithereens. The eruption sent shock waves speeding around Earth at 700 miles an hour. Clouds of gas, fire, and smoke shot up about 20 miles into the sky.

But this was not the deadliest aspect of the eruption. Underwater, the force of the volcano collapsing gave birth to a giant sea wave, called a tsunami.

Moving out from Krakatoa at 60 miles per hour, the wave bore down on western Java and southern Sumatra. When it reached the villages and towns scattered along the coasts, it broke on shore as a powerful, devastating wall of water more than 100 feet tall.

There are stories of the few people who managed to outrun this giant monster. A Javanese field worker near the town of Merak described what happened: "We...saw a great black thing, a long way off, coming towards us. It was very high and very strong, and we soon saw that it was water. Trees and houses were washed away...Not far off was some steep, sloping ground. We all ran towards it and tried to climb up out of the way of the water. The wave was too quick for most of them, and many were drowned almost at my side."

Most everyone killed that day died because of water. But experts believe some people on Sumatra died from burns caused by the spewing of hot gas and volcanic particles, called a pyroclastic flow.

Huddled in their cottage above the town of Ketimbang, Mrs. Beyerinck and her family were at the edge of this kind of flow. She described what it was like that Monday morning: "Suddenly it became pitch-dark...I felt a heavy pressure, throwing me to the floor...Then it seemed as if all the air was being sucked away and I could not breathe...the hot bite of the pumice [a light, gas-filled lava] pricked like needles."

The Beyerincks survived. But 165 towns and villages were destroyed. A total of 36,417 people died from the eruption, making it one of the deadliest in recorded history. Scientists have given the Krakatoa eruption a Volcanic Explosivity Index (VEI) of 6, or "colossal." Eruptions like this occur only every few hundred years.

AFTER KRAKATOA

Propelled by the enormous force of the explosion, the sea wave fanned out from Krakatoa. On the Thousands Islands, east of the Sunda Strait, residents had to climb trees to save themselves. Hours later and nearly 2,000 miles away, the wave killed a woman in Ceylon (today the Asian country of Sri Lanka), who died after being swept off her feet by water. Twelve hours after the eruption, the wave was recorded at a spot 3,800 nautical miles from Krakatoa, a distance it usually took a steamship 12 days to reach.

The devastating eruption of Krakatoa changed the world's skies, winds, and weather, not just in the days following the disaster, but for months to come. The dust cloud

caused darkness as far as 250 miles away, and close to the volcano, it stayed dark for three days. Volcanic ash and pumice from the eruptions covered parts of the nearby islands, making it difficult for plants to grow for several years. Ash fell on Singapore, 525 miles away.

Ash and other particles from Krakatoa entered Earth's atmosphere and circled the equator in about 13 days. Months later, volcanic dust and ash in the upper atmosphere reached northern latitudes, causing violently red sunsets. In November, three months after the eruption, firefighters in Poughkeepsie, New York, raced to what they thought was a blazing red fire. It turned out to be only "a peculiar light" in the sky — light caused by particles of Krakatoa's eruption in the atmosphere.

The volcano of Krakatoa blasted itself out of existence that day in August. It caused horrific loss of life, and one of the largest explosions on Earth in recorded history. It was also the first catastrophe reported immediately throughout the world, thanks to undersea telegraph cables. For the first time, people on different continents could communicate almost instantly.

KRAKATOA Died that Day, in 1883. Or Did It?

Before the eruption, the island of Krakatoa was 14 miles long. The eruption on August 26 spewed billions and billions of tons of rock into the air and destroyed all but a small part of the island. In 1926, a new volcano appeared from under the water. It is called Anak Krakatoa, which means "child of Krakatoa." Someday, this child may be as dangerous as its parent.

From

Deborah Hopkinson. Storyworks. New York: Jan 2004. Vol. 11, Iss. 4; pg. 8