

SATURN

SCIENCE FICTION AND FANTASY

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**CALIFORNIA
IS DOOMED!**



ROBERT A. HEINLEIN - FRANK BELKNAP LONG - ALAN BARCLAY

SATURN

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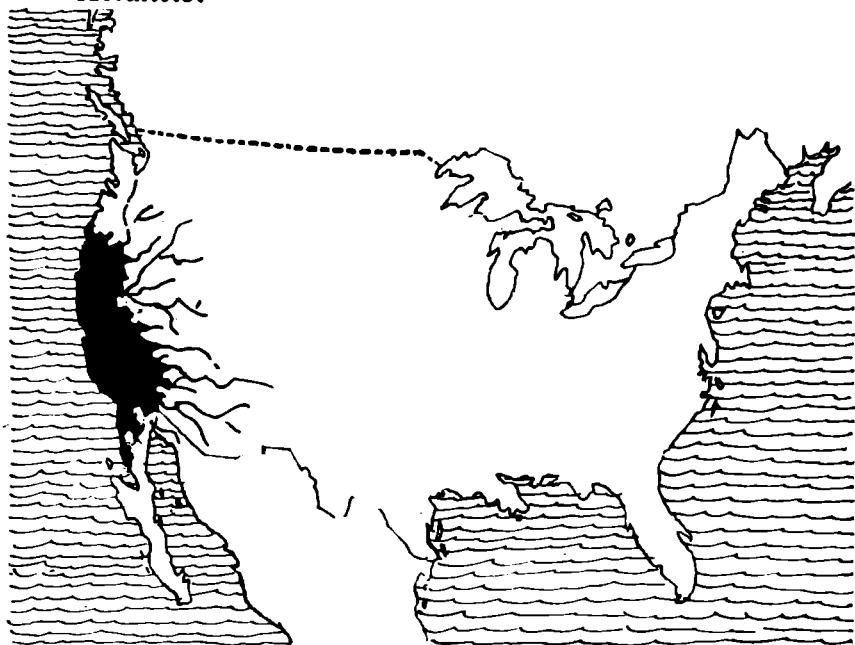
<i>Editor and Publisher</i>	ROBERT C. SPROUL
<i>Art Director</i>	DAN KOERNER
<i>Editorial Consultant</i>	DONALD A. WOLLHEIM
<i>Editorial Assistant</i>	HARRIET MICHELSON

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CALIFORNIA WILL FALL INTO THE SEA

by WILLIAM F. DRUMMOND, Ph. D.

Is America destined to be the scene of a second Atlantis?



AS ANYBODY who has studied geology knows—certainly those who have mapped out the future movements of the North American continent—a few thousand years more will see that section of the Pacific Coast west of the Rockies vanish from the map. It is taken for granted that

California will join those other more ancient parts of the world's surface which have been swallowed up by the sea. This has always been regarded as inevitable, though for a long time no one saw any reason to suppose that this change would be in our time. But now there have been developments in the

very recent past and in the present that indicate a drastic change—for the worst.

It is now not only possible, but quite probable, that the sinking of California into the sea has been immensely advanced, that the first signs of it are beginning today, and that it may culminate in full disaster not thousands of years from now, but in the immediate future, next year, this year, even tomorrow. There are good sound reasons for this belief.

The recent series of earthquakes which have disturbed the rock base which underlies the state of California have aroused very little concern anywhere in the world—not even in California. The residents of the western coastal area of the United States have become so used to the frequent tremors that rattle the dishes in their cupboards and make hairline cracks in the stucco walls of their buildings that even a real, heaving roll of the supposedly solid earth beneath them gets only slight notice.

Californians have gotten their sealegs on dry land, and, unless there is vast destruction and great loss of life, an earthquake in that part of the country deserves no more than passing mention. The ears of the

natives have long since become deaf to the constantly recurring cry of "Wolf!"

Historically speaking, this mental attitude is not in the least unusual. A little less than nineteen hundred years ago, in the popular Roman resort town of Pompeii, the local citizens felt the same way. There were occasional tremors and shakings of the earth, but what of that? Nothing really serious had ever come of the rumbling threats. Pompeii had stood on the fertile slopes of Mount Vesuvius for more than four hundred years; there was no reason to suppose that it would not stand for four hundred more.

Pompeii, Herculanium, and other nearby towns had plenty of warning. In A.D. 63, after a series of minor seismic vibrations, a major earthquake struck, destroying most of the public buildings, and so badly damaging the remaining structures that they had to be rebuilt. And rebuild they did. Ignoring the warning, the people of Pompeii were still working on the reconstruction of the town when, sixteen years later, in A.D. 79, Mount Vesuvius shook and exploded, burying Pompeii and Herculanium under tons of volcanic

ash and asphyxiating the citizens with noxious, suffocating volcanic fumes.

Pompeii was dead and entombed; its very existence was forgotten and remained so for seventeen centuries. By that time, Italian towns had again been built on the sides of the still potentially destructive volcano.

DOES A SIMILAR situation exist in California? There are sound geological reasons for believing that such destruction could occur there—on an even vaster scale!

In order to understand how this potential danger could exist, we must first understand something of the construction of our planet. Let us imagine what the Earth would look like if we were to remove the oceans—completely drain them and dry them, so that the entire surface of our planet would be dry land. What would Earth look like?

We would find that most of the surface—the former ocean beds—is much lower than the relatively small areas of the continents. The continents themselves would seem to be high, mountainous plateaus. Standing on the ocean floor, we would be able to look up

at the high, clifflike escarpments that would cut us off from the tablelands above. Only in a few places would it be possible to walk from the sea bottom to the top of the continent; in most places we would be faced with a steep slope that could only be climbed with difficulty. The height of these precipices would vary from half a mile to nearly ten miles!

The west coast of the United States, from Baja California to Alaska, forms the edge of one of these steep precipices. Due to the slope of the land, the actual edge is below the surface of the Pacific; a few miles out from the shoreline, the bottom drops off abruptly, from a depth of about seven hundred feet to a depth of nearly two miles!

It should be obvious that the edge of such a gigantic palisades would be subject to cracking and crumbling, especially as the sea itself is constantly eroding the underlying support. Such cracking does occur in California, and it is the basic cause of the 'quakes.

But what has this to do with any comparison between a volcano in Italy and earthquakes in California? Many people express surprise on

learning that there is any relationship between the two. Once, when I was giving an address to a small group of students in an Eastern college, one young woman said, "But, Dr. Drummond! There aren't any volcanoes in California!"

She was misinformed, of course; there are a great many volcanoes along the West Coast. Vulcanism and earthquake phenomena are very closely linked. Let us see why.

Beneath the solid surface of the earth, the interior of the planet is very hot. At a depth of only a few miles, the internal temperature is great enough to melt most rocks and metals. It is doubtful that the *magma*, as this hot mixture of minerals is called, is actually in a liquid state. The tremendous pressure to which it is subjected probably keeps it in a semi-rigid state. But if the pressure is removed from above, the magma is squeezed out by the pressure from below, and it reaches the surface in a hot, liquid form. This is exactly what happens during a volcanic eruption.

And it is for this reason that the volcanic regions of the Earth are located along "fault lines", or cracks in the crust;

it is here that the pressure of the depths is released and the magma breaks forth to the surface in the form of lava.

IN CALIFORNIA, we find two places where major fault lines occur. The largest of these is some two hundred miles inland—the Sierra Nevada Range. It is nothing more nor less than a single great fault, formed when the edge of the continental shelf tilted toward the sea. A cross section of the area, taken in an east-west direction, would show that the eastern side of the Sierra Nevadas is steep and clifflike, while the western side slopes gently toward the Pacific.

As the slope approaches the shoreline, another series of faults appears, showing further cracking of the continental shelf. These are known as the Coastal Ranges, a series of mountain chains cut through with many fault lines, places where the basic granite supporting structure of the continent has become cracked and broken.

It is along these faults that the volcanoes appear. In the latter half of the last century, there was an enormous eruption at Tres Virgines, in

Southern California. Lassen's Peak became active only a few years ago. Farther north, we find such active craters as those of Mount Hood and Mount Ranier. A century ago, Mount St. Helena and Mount Baker erupted, pouring forth lava flows and volcanic ash. These are only a few of the active peaks in the Coastal Ranges, and the list does not include the many "inactive" volcanoes that may be found the full length of the Pacific Coast, from Alaska to Baja California.

Many people assume that, just because a volcano is inactive at a given time, it is "dead"; they assume that, like the dinosaurs, it has passed away, never to return. It is worth remembering that, until its disastrous activity during the first century of the Christian Era, Mount Vesuvius had been considered a "dead" volcano throughout all of recorded human history!

Not all major fault lines recede. Those near the edge of the continental shelf tend to be merely cracks in the cooler upper crust, but even so they are a potential threat. The most active of the faults along the California coast is the one known as the San Andreas

Rift. The northern end of this great fissure is south of Eureka, California, near Cape Mendocino. From there, it runs offshore for a distance of some seventy-five miles to a spot a few miles north of Cape Arena. Thence, southward, the rift remains on the landward side of the shore, running through the San Francisco peninsula and curving off to the southeast toward the deserts of Southern California. The total length of the cleavage is nearly six hundred miles.

The San Andreas Rift itself is difficult to see from the ground, although it is readily visible from the air. It is not an open fissure; it is comparable to the type of crack one gets in a sheet of window glass when the edge is tapped just a trifle too hard. The split will begin at the edge, run partway across the glass, and stop. The fissure is there, but it hasn't opened—yet.

Here, then, is the geological position of the California coast. The edge of the great escarpment is crumbling and cracking, causing the quakes and tremors that shake the seaboard. Occasionally, a major movement of the crust will destroy millions of dollars worth of property and level

whole cities. In 1812, a great 'quake struck in the south, causing widespread destruction throughout Southern California. In 1872 the whole Sierra Nevada fault shifted in a massive subterranean upheaval, causing seismic disturbances as far inland as the middle of Nevada.

San Francisco got its first taste of the Earth's internal violence in 1868, and this was followed by the Great San Francisco 'Quake of 1906. Both were direct results of changes in the San Andreas Rift.

In 1925, Santa Barbara was subjected to a severe shock from subterranean shifts of the crust, and less violent quakes still continue to shake the entire area.

These are all examples of what has already happened in California. What are the possibilities for the future?

IN ORDER to determine the probable outcome of the situation, it will be enlightening to look at several other places on Earth where similar factors exist or have existed in the past.

One of the most violently destructive earthquakes of recent times occurred in 1923,

just off the coast of Honshu, the largest of the islands comprising Japan. The focal point of the shock—the epicenter—was luckily underwater, in the central portion of Sagami Bay, just north of the small island of Oshima. Over seven hundred square miles of the floor of the bay was faulted and shifted by the tremendous shock. One area, a little to the south of the Miura Peninsula, tilted toward the edge of the continental shelf; one end of the broken section was lifted up some fifteen hundred feet, while the seaward end dropped more than twenty-four hundred feet—nearly half a mile! In other places, the bottom of the bay was lowered as much as seven hundred to twelve hundred feet.

If the epicenter of the quake had been some twenty-five miles to the north and an equivalent drop had occurred, the whole city of Yokohama would have plunged beneath the surface of the sea. As it was, nearly eighty percent of Yokohama's buildings were destroyed, and many thousands of its inhabitants were killed. Tokyo, fifty miles north of the epicenter of the Sagami quake, lost sixty-five percent of its buildings, and the loss of

life was tremendous.

A similar decrease in elevation would be terribly disastrous in California. A lowering of only five hundred feet would inundate not only the coastal area, including the cities of San Francisco and Los Angeles, but, entering through the break in the Coastal Range at San Francisco Bay, the sea would flood the entire San Joaquin Valley! The whole section of land between the Coastal Range and the Sierra Nevadas would become a shallow bay. A drop of a full half mile would leave the peaks of the Coastal Ranges as a row of small offshore islands, and the Pacific would reach to the Sierra Nevadas.

Similar floodings of once dry land have taken place in the past; the entire area of the Grand Banks, a shallow portion of the Atlantic Ocean off the coast of New foundland, was once above the surface of the water; at one time there was a wide land bridge spanning what is now the Bering Strait between the western tip of Alaska and the eastern tip of Siberia.

The wide distribution of flood legends; such as that of Noah, in the Book of Genesis, is thought to be caused,

not by a single Great Flood, which covered the entire Earth at once, but many smaller catastrophes which have occurred from time to time throughout the long span of human prehistory. Some geologists are of the opinion that the entire Mediterranean Sea was once dry and that an earthquake broke the chain of land that stretched across the Strait of Gibraltar, from the Iberian Peninsula to Morocco, allowing the Atlantic to pour in and fill the Mediterranean Basin. Many historians feel that the cataclysmic flooding of this area is responsible, not only for the story of Noah, but the legend of Atlantis.

Quite often, earthquakes in or near the sea are followed by what are popularly and erroneously known as "tidal waves." Since such waves have nothing to do with the ordinary tides, geologists, oceanographers, and seismologist refer to them as "seismic sea waves" or as "tsunami," a word borrowed from the Japanese.

These waves radiate from the epicenter of a submarine quake or landslide involving large masses of water, and measuring hundreds of miles from crest to crest. As they ap-

proach a shore, the water at first falls back toward the edge of the shelf. Then, as the crest of the wave comes closer, the sea returns, raising the water to great heights until it sweeps irresistibly over the land, washing away everything in its path.

Any one of these phenomena—earthquake, vulcanism, or tsunami—could cause tremendous damage to our west coast. If conditions were right, the combination of all three would precipitate a disaster unparalleled in modern times.

THE NEAREST approach to such a calamity, at least in terms of physical destruction, was probably the explosion of the volcanic island of Krakatoa, in the Sunda Strait of the Netherlands Indies. At some time in the distant past, a huge volcano stood in the center of what is now the Sunda Strait. A vast explosion blew the entire mountain away, leaving only the base as a broken ring of small islands. But the career of the volcano was not ended; as the pressure of the magma beneath the sea floor built up, more small craters were formed within the ring of the great, ancient crater. The largest one, the one we

know as Krakatoa, rose some twenty-six hundred feet above the surface of the sea. There is evidence that the volcano gave warning of its forthcoming activity in 1680; in that year an eruption was reported, and there were great earthquakes in the area. By 1877, earthquakes were common in the Sunda Strait. Then, in May of 1883, the volcano erupted, blowing ash, pumice, and dust into the air and shaking the area with thunderous explosions and earthquakes. This continued all through the summer, with only occasional lulls in the activity.

The climax came on the 26th, 27th, and 28th of August, 1883. Krakatoa quite literally blew its top. The whole northern wall of the cone was blasted away, and the smaller, nearby crater of Rakata lost the northern slope of its cone, revealing a perpendicular cliff which showed an almost perfect cross section of the smaller volcano. Instead of the former island, which had risen nearly fourteen hundred feet above the sea, there was now left only a great hole in the sea bottom, a hole nearly a thousand feet deep. The sound of the explosion was heard all over the world—not once, but

seven times, as the gargantuan energy of the sound wave carried it around the earth, and then around again and again. The debris that was blasted into the air fell all over the area, smothering nearby islands; the finer dust remained in the upper atmosphere for years afterwards, giving the Earth beautiful sunsets and sunrises for over a decade, since it was spread all over the world by air currents. It is estimated that the column of the blast was more than seventeen miles high.

The upthrusting of the ocean floor produced several new islands in the area, and this seismic disturbance, in turn, produced one of the greatest tsunami on record. On the coasts of Sumatra, Java, and Borneo, and the other, smaller islands in the vicinity, the destruction caused by the waves was appalling. The waves lifted boats and ships from their moorings, carried them inland, and left them stranded. The cities and towns near the shores were almost completely obliterated by the pounding and washing of the sea. It is estimated that more than thirty-six thousand died as a result of the tsunami.

The explanation for the

vastness of the explosion itself is rather easily understood. Superheated gases absorbed in the tremendously hot magma beneath the crust forced their way out, blowing open the side of the crater. Immediately, sea water rushed in, pouring over the column of molten lava. The resulting steam caused further explosions, and, at the time, a cool crust was formed over the lava, sealing in the pent-up gases below. When the pressure built up again, another explosion followed. The process was repeated until the cooling of the sea finally formed a crust which could hold back the now lessened pressure beneath.

All this has not, of course, stopped the activity in that region. In the years 1927-29, there were more, although less violent eruptions, and today there is another volcano which has built itself on the spot. It is called, appropriately enough, "Anak Krakatoa" or Child Of Krakatoa.

FROM THIS, it is easy to see what would happen if a seismic shift were to open the San Andreas or some other fault in California. The influx of sea water would produce an explosion of titanic propor-

tions—far greater than the blasts at Krakatoa. If the crumbling edge of the continental shelf were to break off and drop into the Pacific, the resulting tsunami would destroy every coastal city on our side of the Pacific and very likely inundate Hawaii.

I have often been asked if it would be possible for an atomic or a hydrogen bomb to cause such a disaster. My answer is this:

If a thermonuclear explosive weapon is detonated on normal, stable portions of the Earth's crust, there is very little likelihood that any such thing would happen. But—and here is the crux of the answer—California is *not* stable. If a thermonuclear bomb were to be set off at just the right spot, near one of the great faults, the resultant energy might be just enough to upset the balance.

But even a close and direct application of atomic energy is not necessary. For the entire area of the Pacific Ocean, its edges and basin, constitutes the thinnest crust of the Earth—and therefore the most volcanic and unstable.

Early this year the Russians set off a series of atomic ex-

plosions somewhere in Siberia. Within a few hours, a chain of earthquakes and tsunami ran down the Pacific from Alaska to Hawaii to California. No one can say just how these were connected—for the exact location and the exact strength of the Russian explosions is their secret. Yet the timing of the subsequent earthquakes was a grave indication that those man-made hammer-blows on the world's crust set off those shocks, sent tremors vibrating through all the faults and cracks of the Pacific.

Just how many more such hammer shocks will be required to crack the shell is unknown. Later this year other such explosions are being planned by British and American experimenters, again in the Pacific volcanic area. Again atomic hammers will pound on the shaky surface of the world's most unstable crust.

How much more of this can the shaky California coast take? Probably not much more. For the evidence is sufficient for all but the blind to see. Disaster may strike at any time. But it now seems that it will be soon. Quite soon.

THE END