

1

00:00:00,602 --> 00:00:14,363

This series presents information based in part on theory and conjecture.

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00:00:14,363 --> 00:00:21,403

The producer's purpose is to suggest some possible explanations but not necessarily

3

00:00:21,403 --> 00:00:24,883

the only ones to the mysteries we will examine.

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00:00:25,683 --> 00:00:30,883

In the Earth's crust slashes across 700 miles of California.

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00:00:30,883 --> 00:00:32,883

The San Andreas Fault.

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00:00:32,883 --> 00:00:40,884

It borders both San Francisco and Los Angeles and creates one of the world's most dangerous earthquake zones.

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00:00:40,884 --> 00:00:48,884

Scientists are racing to find ways of predicting the next disastrous movement of the fault.

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00:00:48,884 --> 00:00:52,884

When will the great earthquake strike California?

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00:00:59,884 --> 00:01:03,885

California is famous for its warm and sunny climate.

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00:01:03,885 --> 00:01:09,885

Its diverse lifestyles and spectacular vistas are as varied as any other land on Earth.

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00:01:19,885 --> 00:01:24,885

Much of California's rugged beauty derives from violent Earth upheavals.

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00:01:26,885 --> 00:01:30,886

The product of a phenomenon called folding.

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00:01:30,886 --> 00:01:36,886

Deep cracks or faults in the Earth's crust scar the state from one end to the other.

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00:01:36,886 --> 00:01:42,886

A wise, the San Andreas Fault is the longest and most dangerous.

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00:01:43,886 --> 00:01:55,887

At 6 a.m. on February 9, 1971, Californians were jolted into awareness of the powerful forces that molded their state.

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00:02:00,887 --> 00:02:06,887

A sudden earthquake just north of Los Angeles caused massive devastation.

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00:02:06,887 --> 00:02:10,887

50 people were killed in the collapse of two hospitals.

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00:02:11,887 --> 00:02:21,888

Since the quake was of only moderate size, engineers were shocked by the heavy damage to supposedly earthquake resistant buildings and freeways.

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00:02:24,888 --> 00:02:33,888

The Richter magnitude was 6.6, releasing several hundred times less energy than the San Francisco earthquake of 1906.

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00:02:34,888 --> 00:02:40,888

Had the shaking continued for another few seconds, the San Fernando disaster would have been far worse.

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00:02:40,888 --> 00:02:46,889

Two dams holding 7 billion gallons of water threatened 80,000 sleeping people.

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00:02:47,889 --> 00:02:53,889

When the dams began to collapse, only the abnormally low water level prevented catastrophe.

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00:02:57,889 --> 00:03:02,889

Geologists soon pinpointed the quake on a minor branch of the San Andreas Fault.

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00:03:04,889 --> 00:03:08,889

The main spine of the fault hadn't even moved.

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00:03:09,890 --> 00:03:16,890

The San Andreas Fault system is part of a grid of faults, mountain chains and trenches in the ocean floor.

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00:03:16,890 --> 00:03:22,890

These features mark the boundaries between huge moving slabs of the Earth's crust called plates.

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00:03:22,890 --> 00:03:29,890

Carrying continents and oceans with them, the plates float on a hot liquid layer of the planet.

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00:03:30,890 --> 00:03:38,891

Along the fault in California, two plates slip and grind against each other due to movement deep within the Earth.

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00:03:39,891 --> 00:03:44,891

Dr. Tim Hall has studied the San Andreas Fault for 15 years.

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00:03:44,891 --> 00:03:55,891

I visualize the San Andreas Fault as a 700-mile-long vertical curtain of clay that runs the length of California down to a depth of about 10 miles.

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00:03:56,891 --> 00:04:01,892

It separates two moving plates from each other, the American plate and the Pacific plate.

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00:04:01,892 --> 00:04:07,892

In places along that clay boundary, the fault can move along year by year.

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00:04:07,892 --> 00:04:13,892

We call that creep. In other places along the fault, the rocks are stuck together, locked.

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00:04:13,892 --> 00:04:21,892

A large amount of energy gets stored in the surface rocks, which is released periodically by sudden large earthquakes.

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00:04:22,892 --> 00:04:31,893

With its many branches, the San Andreas cuts a broad swath through California from San Francisco, Oakland, San Jose to Los Angeles.

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00:04:31,893 --> 00:04:36,893

All are in fault zones. 15 million people are vulnerable.

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00:04:36,893 --> 00:04:44,893

We shall travel along the fault, seeing places where the danger is great and observing sites where crucial research is underway.

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00:04:45,893 --> 00:04:51,894

The trip begins at Southern California's Salton Sea.

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00:04:51,894 --> 00:04:57,894

Repeated fault movement has lifted and exposed the reddish band of rock.

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00:04:57,894 --> 00:05:02,894

The twisted cliffs were gouged by the fault's immense power.

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00:05:02,894 --> 00:05:08,894

Nearby, the San Andreas has made pockets of groundwater.

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00:05:08,894 --> 00:05:14,894

Lines of palm trees and brush mark the fault's passage beneath the bleak sands.

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00:05:19,895 --> 00:05:25,895

Outside Palm Springs, two-mile-high mountains were thrust up by millions of years of fault movement.

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00:05:28,895 --> 00:05:31,895

The fault skirts the Los Angeles Basin.

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00:05:32,895 --> 00:05:38,895

Its numerous sub-branches, including the one which shook San Fernando, threaten more than 10 million people.

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00:05:41,896 --> 00:05:45,896

North of Los Angeles County, the fault carves a broad valley.

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00:05:47,896 --> 00:05:55,896

Near Palmdale, Dr. Kerry Seed dug into the San Andreas and found a treasure trove of prehistoric earthquakes.

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00:05:56,896 --> 00:06:02,896

Using carbon dating, each event is identified.

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00:06:02,896 --> 00:06:09,897

The fault goes down through many distorted layers, which mark earthquakes going back to the time of Christ.

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00:06:09,897 --> 00:06:16,897

The intervals between major quakes range from a maximum of 300 years to only half a century.

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00:06:17,897 --> 00:06:24,897

The earthquake of 1857, largest ever recorded in Southern California, shows up as a sandblow,

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00:06:24,897 --> 00:06:29,897

where sand and water spouted from the earth in an eerie fountain.

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00:06:33,898 --> 00:06:41,898

Trees along the fault had their roots sheared during the quake, causing growth to slow abruptly at the 1857 ring.

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00:06:42,898 --> 00:06:51,898

In 1975, researchers found that a broad area of desert along the fault had risen about one foot during the last 15 years.

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00:06:54,898 --> 00:06:59,899

They began a massive survey program to monitor this Palmdale bulge.

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00:07:01,899 --> 00:07:06,899

Survey teams worked their way tediously up from Los Angeles, measuring the land level.

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00:07:11,899 --> 00:07:15,899

Ammonously, part of the bulge recently subsided.

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00:07:17,899 --> 00:07:24,900

This pattern of uplift and collapse also happened before the devastating Alaskan and Chilean earthquakes.

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00:07:27,900 --> 00:07:32,900

In Southern California, the pattern occurred once before without an earthquake.

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00:07:33,900 --> 00:07:41,900

Does the Palmdale bulge reflect the harmless cycle or worn of a major jolt on the San Andreas Fault?

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00:07:50,901 --> 00:07:57,901

North of Palmdale, geologists drilled deep into the fault zone to measure the stress on underground rock.

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00:08:02,901 --> 00:08:09,901

In hope of finding a new way to forecast earthquakes, the researchers pumped water into the drill hole.

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00:08:14,902 --> 00:08:17,902

They increased the pressure until the rock breaks.

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00:08:20,902 --> 00:08:27,902

Knowing the natural strength of rock, they measure what added stress it is under from the earthquake fault.

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00:08:28,902 --> 00:08:35,902

They have found that rock in the fault zone is cracked, water saturated, and close to the breaking point.

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00:08:39,903 --> 00:08:43,903

Further north, the San Andreas cuts through hilly desert country.

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00:08:47,903 --> 00:08:53,903

In the stark and desolate Carrizo Plain, fault features are clearer than anywhere else.

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00:08:57,903 --> 00:09:03,904

Most ground movement here occurs during large earthquakes in jumps of several yards parallel to the fault.

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00:09:04,904 --> 00:09:07,904

The last of these took place in 1857.

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00:09:10,904 --> 00:09:15,904

The quakes also cause the ground to move vertically, forming ridges along the fault.

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00:09:18,904 --> 00:09:22,904

Repeated slippage has diverted streams along the fault.

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00:09:23,904 --> 00:09:30,905

According to carbon dating, this streambed moved 125 meters in the last 3400 years.

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00:09:33,905 --> 00:09:36,905

The Pacific Plate slides northwest averaging 2 inches a year.

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00:09:37,905 --> 00:09:45,905

At this rate, in 5 million years, it will carry Los Angeles past the Carrizo Plain on its way to San Francisco.

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00:09:46,905 --> 00:09:54,906

Midway between Los Angeles and San Francisco on the Pacific Coast is the Diablo Canyon Nuclear Plant.

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00:09:55,906 --> 00:10:03,906

The facility was originally designed to withstand an earthquake on the San Andreas Fault of Richter Magnitude 8.5.

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00:10:04,906 --> 00:10:11,906

During construction, however, geologists discovered a nearby fault offshore, the Haasgrie Fault.

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00:10:12,906 --> 00:10:16,906

Ralph Rana is a county environmental worker who lives near the site.

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00:10:17,907 --> 00:10:25,907

I'm opposed to the nuclear power plant at the Diablo Canyon because there's an earthquake fault running 2.5 miles from the plant itself.

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00:10:26,907 --> 00:10:31,907

And that fault happens to be 250 miles long and it's a major earthquake fault in California.

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00:10:32,907 --> 00:10:38,907

A very large earthquake in 1927. Magnitude 7.5 occurred on that fault.

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00:10:38,907 --> 00:10:43,908

A magnitude 8 earthquake is also possible on the Haasgrie Fault.

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00:10:44,908 --> 00:10:48,908

Richard Davin represents the plant's owner, Pacific Gas and Electric.

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00:10:49,908 --> 00:10:55,908

There are earthquake faults around the Ablo Canyon, of course. There's a San Andreas Fault 48 miles away, but there's a Haasgrie Fault which is closer.

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00:10:56,908 --> 00:10:58,908

And that's the one that has been of the major concern in the last several years.

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00:10:59,908 --> 00:11:04,908

And as a result, it's been the most thoroughly investigated fault probably in California outside of the San Andreas.

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00:11:04,908 --> 00:11:09,909

And we have designed that plant to withstand the maximum earthquake that could ever be expected to occur on that fault.

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00:11:10,909 --> 00:11:18,909

Those of us who live close to the plant or 7 miles away myself are wondering whether we are up to be guinea pigs in this experiment or not.

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00:11:19,909 --> 00:11:24,909

People talk about earthquakes even bigger and bigger and bigger to kind of earthquake that would split this containment structure in half.

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00:11:25,909 --> 00:11:31,909

I think when we got that kind of an earthquake, we've reached the end of the world because before that would happen, California would be in the ocean.

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00:11:31,909 --> 00:11:41,910

After the Haasgrie Fault was found, PG&E strengthened the plant. The adequacy of their precautions is controversial.

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00:11:42,910 --> 00:11:45,910

We're only beginning to understand the dynamics of earthquakes.

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00:11:46,910 --> 00:11:53,910

Whether any possible ground shock could cause hazardous release of nuclear radiation remains unknown.

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00:11:53,910 --> 00:12:00,911

Further north, the fault continues to pass through major population centers.

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00:12:01,911 --> 00:12:07,911

A great earthquake would cause incalculable disaster. Is there a way to predict it?

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00:12:08,911 --> 00:12:16,911

The little town of Hollister lies 80 miles south of San Francisco on the San Andreas Fault's Calaveras branch.

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00:12:16,911 --> 00:12:24,912

August 6th, 1979. The strongest earthquake since 1911.

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00:12:25,912 --> 00:12:30,912

San Pintello was outside landscaping when it struck.

99

00:12:31,912 --> 00:12:36,912

I stood here and you could look out over the hills. You could see the hills rolling into each other.

100

00:12:37,912 --> 00:12:43,912

They're just sort of bending. The ground was moving, the house was moving.

101

00:12:43,912 --> 00:12:48,912

Everything seems to be tilting, especially the hills tilting toward each other.

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00:12:49,913 --> 00:12:53,913

And of course I could see the trees shimmering over here. I didn't know it was just eerie.

103

00:12:55,913 --> 00:13:01,913

The fault at Hollister isn't blocked. Slow creep and small shakes tear the land beneath the center of town.

104

00:13:02,913 --> 00:13:07,913

Houses are twisted out of shape.

105

00:13:07,913 --> 00:13:13,913

Streets and curbs are cracked and broken.

106

00:13:14,914 --> 00:13:21,914

In this region of unusual activity, instruments monitor fault movement.

107

00:13:22,914 --> 00:13:27,914

Hill sides are dotted with reflectors for laser beams.

108

00:13:28,914 --> 00:13:34,914

A unique two-color system tracks deep earth movement across the fault.

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00:13:34,914 --> 00:13:39,915

Four months before the August quake, the ground began to creep.

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00:13:40,915 --> 00:13:45,915

Movement lasted for ten weeks, followed by a period of quiet.

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00:13:46,915 --> 00:13:51,915

Then the earthquake struck.

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00:13:52,915 --> 00:13:58,915

It is hoped the laser will eventually provide a reliable way to forecast earthquakes.

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00:13:59,915 --> 00:14:05,916

West of Hollister, the San Andreas Fault gouges a narrow valley.

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00:14:14,916 --> 00:14:18,916

Geologist Tim Hall supervises excavation into the fault.

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00:14:19,916 --> 00:14:24,916

We're looking for a record of earthquakes in California before recorded history.

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00:14:24,916 --> 00:14:30,917

And the way that we do that is look for layers that have been displaced by the San Andreas and attempt to date them.

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00:14:31,917 --> 00:14:36,917

The goal of our study is to predict how often the San Andreas will move in the future.

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00:14:39,917 --> 00:14:44,917

On the northern San Andreas, the earliest known great earthquake occurred in 1838.

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00:14:45,917 --> 00:14:49,917

Only 68 years before the 1906 disaster.

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00:14:49,917 --> 00:14:56,918

If such a small interval is typical, the next major shake may be overdue in the Bay Area.

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00:15:01,918 --> 00:15:08,918

Slashing north along a chain of valleys and long narrow lakes, the San Andreas Fault cuts the San Francisco Peninsula in two.

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00:15:10,918 --> 00:15:17,918

On the shore of San Francisco Bay is Marine World, where studies of the San Francisco Bay are carried out.

123

00:15:17,918 --> 00:15:22,919

This is Marine World, where studies of animal behavior may give warning of earthquakes to come.

124

00:15:25,919 --> 00:15:28,919

Peter Gross is director of Land Animals.

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00:15:29,919 --> 00:15:38,919

What we have here at Marine World is the entire collection of both land and sea animals being viewed on a daily basis by all the keepers and the trainers and the handlers.

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00:15:39,919 --> 00:15:49,920

And what they're looking for is any kind of an unusual sustained behavior that might show flight or fear, which we can then document as happening just before an earthquake.

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00:15:50,920 --> 00:15:59,920

About a half hour before the big earthquake, these animals, which ordinarily mixed together and peacefully coexist amongst themselves, all separated and went into their own species.

128

00:16:00,920 --> 00:16:08,920

The zebras all stayed together, the antelope all went to one area. They just didn't want to mix with each other during this period of unrest and fear.

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00:16:09,920 --> 00:16:15,921

I think that the animals are a lot more in tune to nature's sounds than people are.

130

00:16:17,921 --> 00:16:21,921

Trainer Paul Barkman recalls the morning before another earthquake.

131

00:16:22,921 --> 00:16:29,921

When we finally did get them out of the barn, we watered them down. They all refused to drink and they refused to eat all day long.

132

00:16:30,921 --> 00:16:36,922

We have one lead elephant, Jenny. She's the oldest. And she was thumping the whole day long and she was trumpeting what she very seldom does.

133

00:16:37,922 --> 00:16:47,922

And the other elephants were answering her back and they were just really hard to control the whole day until after 4 o'clock when the quake hit, then they were fine.

134

00:16:48,922 --> 00:16:53,922

Reports of strange animal behavior before earthquakes go back thousands of years.

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00:16:54,922 --> 00:17:04,923

So far, however, it has proven difficult to use such information for reliable prediction. There is still no sure way to warn of an earthquake.

136

00:17:07,923 --> 00:17:12,923

On the western edge of San Francisco Bay, homes are often built on compacted landfill.

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00:17:13,923 --> 00:17:22,923

This kind of land can amplify ground shaking up to 10 times and turn wet, sandy soil nearly to quicksand.

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00:17:24,923 --> 00:17:31,924

Bricks up to 3 feet wide could split foundations and bring thousands of houses crashing down on their owners.

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00:17:34,924 --> 00:17:40,924

On the east side of San Francisco Bay, the Hayward Branch of the Fault cuts through city after city.

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00:17:41,924 --> 00:17:49,924

In 1836 and again in 1868, huge earthquakes here caused little damage because the area was barely inhabited.

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00:17:51,925 --> 00:17:55,925

Today, however, dozens of schools and hospitals stand in the fault zone.

142

00:17:57,925 --> 00:18:05,925

In the aftermath of the San Fernando Quake, where some buildings that met all earthquake codes collapsed, standards throughout the state were toughened.

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00:18:06,925 --> 00:18:10,925

Schools along the Hayward Fault were reinforced or replaced.

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00:18:12,925 --> 00:18:18,926

A dam, not unlike the ones that began collapsing at San Fernando, is being rebuilt.

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00:18:20,926 --> 00:18:25,926

In Berkeley, the Hayward Fault rims the campus of the University of California.

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00:18:26,926 --> 00:18:30,926

It runs beneath the football stadium, which is slowly being split in half.

147

00:18:31,926 --> 00:18:35,926

Dr. Bruce Bould heads the University's seismographic station.

148

00:18:36,926 --> 00:18:53,927

According to the calculations that I have made based on the work along the San Andreas Fault recently, the chances of a great earthquake affecting either the San Francisco area or the Los

Angeles area in the next 10 years are about 50-50.

149

00:18:54,927 --> 00:19:01,927

If a great earthquake of magnitude 7 or 8 occurred in the Bay Area, undoubtedly there would be considerable loss of life.

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00:19:02,927 --> 00:19:07,928

Most Californians are not well prepared for another great earthquake like that of 1906.

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00:19:08,928 --> 00:19:13,928

North of San Francisco, the San Andreas slices through Marin County.

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00:19:14,928 --> 00:19:16,928

The little town of Olima straddles the fault.

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00:19:17,928 --> 00:19:23,928

On April 18, 1906, a giant tremor broke the earth.

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00:19:24,928 --> 00:19:27,928

It shifted roads and fences at incredible 20 feet.

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00:19:29,928 --> 00:19:37,929

Olima was the epicenter for California's greatest earthquake disaster, known as the San Francisco earthquake.

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00:19:47,929 --> 00:19:53,929

That earthquake claimed 700 lives.

157

00:19:58,930 --> 00:20:04,930

Today, the death toll from a major shock along the San Andreas could reach the tens of thousands.

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00:20:06,930 --> 00:20:11,930

Only a few miles from the fault, San Francisco remains exquisitely vulnerable.

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00:20:12,930 --> 00:20:18,930

Collapse of older buildings, showers of debris and fire would inflict a heavy toll.

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00:20:19,930 --> 00:20:26,931

In Southern California, stress has been building up on the main fissure of the San Andreas for more than 120 years.

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00:20:27,931 --> 00:20:35,931

If the historic pattern is followed, the stress will be relieved by a cataclysm many times larger than the San Fernando earthquake.

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00:20:41,931 --> 00:20:45,931

It is frightening to imagine that disaster multiplied a hundredfold.

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00:20:46,931 --> 00:20:51,932

Thousands dead, families homeless, firestorms raging out of control.

164

00:20:53,932 --> 00:20:57,932

1906 type disaster would cause unimaginable chaos.

165

00:20:58,932 --> 00:21:03,932

But earthquakes recorded in Asia and Alaska were any yet seen in California.

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00:21:04,932 --> 00:21:09,932

Perhaps we have yet to learn the full power of the San Andreas fault.

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00:21:12,933 --> 00:21:16,933

The San Andreas is the most closely watched earthquake fault in the world.

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00:21:18,933 --> 00:21:21,933

Hundreds of instruments monitor its slightest tremble.

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00:21:23,933 --> 00:21:28,933

If it is possible, reliable earthquake forecasting belongs to the future.

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00:21:29,933 --> 00:21:31,933

Earth science is only in its infancy.

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00:21:32,933 --> 00:21:38,934

The forces that mold our planet and cause the ground to shake beneath our feet remain mysterious.

172

00:21:42,934 --> 00:21:47,934

Coming up next in search of continues with an investigation into the Siberian Fireball.

173

00:21:48,934 --> 00:21:53,934

Then on FBI the untold stories, an agent is trapped into a dangerous meeting with drug traffickers.

174

00:21:54,934 --> 00:22:00,934

And later tonight, Fridrich Paulus loses at Stalingrad and defects to the Russians on Hitler's generals.

175

00:22:01,934 --> 00:22:04,935

At 9, here on the History Channel, where the past comes alive.

176

00:22:11,935 --> 00:22:12,935

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