VOYAGE OF THE CONTINENTS

NORTH AMERICA

Script - 52’

10 00 03 00: Commentary (Teaser series)

Since its creation, our planet has been in constant transformation.

10 00 12 00

Phenomenal collisions formed the continents. Colossal forces lifted the ocean’s floors, giving rise to magnificent mountain ranges.

10 00 27 00

These movements on the Earth’s surface can still be seen today, as evidenced by volcanic eruptions, earthquakes, and tsunamis.

10 00 38 00

Tectonics sculpt our landscapes, alter the climate, change the course of oceans and can even influence the living world.

10 00 54 00: Commentary (Teaser episode)

For millions of years, fragments of the Earth’s crust have come together and broken apart resulting in volatile upheavals.

10 01 02 00

Even today, the continent carries scars of its tumultuous past.

10 01 11 00

From smoking craters to craggy mountain tops, specialists track these hidden clues. In their hands, every rock, every fossil becomes a word on the page in the story of North America.

An exceptional testimony to the never-ending… voyage of the continents.

10 01 30 00

Beginning Credits

1/ The beginnings of North America – the oldest rocks on the planet

10 01 49 00: Commentary

At its birth 4.6 billion years ago, the Earth is a gigantic ball of lava.

It then cools and rocky plates aggregate, forming the first fragments of the earth's crust.

10 02 05 00

Thus begins the first chapter of the history of the North American continent.

10 02 14 00

In Montreal located in eastern Canada, it so happens there's a researcher who studies these vestiges of our planet's infancy.

10 02 22 00

Professor Don Francis works in the Department of Earth and Planetary Sciences at the prestigious McGill University.

10 02 32 00

Every day, he rides his bike across Montreal's historic city center to his laboratory.

10 02 42 00

This area is ideal for geologists.

Because 90% of the province of Quebec is covered by what is called "a craton".

…A fragment of the earth's crust which has remained unchanged for billions of years.

10 03 01 00

The rocks that crop out here are not the oldest… But for the scientist, each one will likely reveal an element of North America's story nonetheless.

10 03 12 00

Don Francis

So all these rocks are much younger than the rocks of the craton which are normally 2.7 and our team have discovered an area within the craton where the rocks are as old as 4.3 billion years old. This is a very old age, and the rocks there tell us a lot of interesting things about that time. For example, we know that because there are Pillow lavas there, that there was an ocean. This is a time when the moon was being bombarded by very large meteorites: all the big craters you see on the moon were produced during this time, and in fact, it must have been happening on the Earth as well. So you have a marine environment, where there are hot springs and big meteorites falling out of the sky so there was a very unusual environment.

10 04 05 00: Commentary

Don Francis and his colleagues recently discovered these rocks, dating back 4.3 billion years, in Northern Quebec.

10 04 13 00

The announcement caused a sensation in the scientific community. These rocks are, in effect, the oldest specimens ever discovered.

10 04 27 00

The study of their structure gives an unprecedented view of the environment that reigned on primitive Earth.

10 04 38 00

But the geologists must still confirm the rock's age in a definitive manner. To do this, they look for traces of a particular mineral inside the granite: zircon. This mineral is known to be exceptionally stable, and to contain infinitesimal quantities of uranium which over time transform into lead.

Thus by calculating the proportions of lead and uranium in the zircon crystals, the exact age of the rock can be determined.

10 05 10 00

Cut into very fine slices, the samples reveal their inner structure under the microscope's lens.

10 05 19 00

Don Francis

There's one of these granit, in black… with the filter in, but when you take the filter out they're clear… And that's the way you identify them…

Don Francis

Up until recently, 3.8 was the oldest rocks. The result of that is a lot of people are now going back to 3.8 areas, which are not very many, you can probably count them on two hands, maybe less, but they're been going back into these areas trying to see whether they can find the same anomaly that we've found and to see whether in fact there are more than one occurrence of very old rocks.

10 05 57 00: Commentary

Every day, Don teaches his students the history of the Canadian craton. Other tests are still necessary to assure that the oldest of the rocks are indeed 4.3 billion years of age.

But if the results are confirmed, a new chapter will be added to the class syllabus…

That of the birth of the North American continent's very first landmass.

10 06 27 00

Later, fragments of the earth's crust spread across the surface of the globe migrating and combining with one another. When they collided, mountains were created … When they broke apart, seas and oceans were hollowed out.

10 06 48 00

Then water and rain eroded their surface over millions of years.

10 06 56 00

Traces of these ancient events are still visible today, notably on the Colorado Plateau, in the heart of Monument Valley.

10 07 09 00

Here, successive layers of strata testify to the never-ending evolution of the relief over millions of years.

10 07 20 00

But the tectonic plates are always in motion.

And 500 million years ago, the continental landmasses of the northern hemisphere began to draw closer…

10 07 31 00

Little by little they began to collide with Africa.

10 07 36 00

And about 100 million years later, a vast supercontinent was formed: the Pangea

2/ North America becomes independent – the opening of the Atlantic

10 07 43 00

Today, the landscapes tell the story of Pangea's birth, a major event in the history of North America.

10 07 56 00

Southeastern Canada- in the province of Nova Scotia. The city of Passboro is located near the Appalachians.

A vast mountain range, born when America and Africa collided.

10 08 23 00

Paul Olsen, a geologist and biologist at Columbia University in New York, knows the area by heart.

He's roamed these coasts for many years, in search of new clues to Pangea's history.

10 08 44 00

Paul Olsen

This is Nova Scotia in eastern Canada. 300 million years ago, at this spot, North America and Africa collided, producing Pangaea, the last of the great supercontinents. This is really the centre of the action. Let me show you with a drawing. Here's N. America, and it's heading this way. And here comes Africa, and it's being shoved below N. America. And when they finally collide, they produce an enormous mountain range, the Appalachians.

10 09 27 00: Commentary

Sprung from the earth 270 million years ago, today the Appalachians spread over more than 3000 kilometers.

10 09 36 00

A veritable open air geological archive, it's the proof that long ago America and Africa formed one and the same territory.

10 09 46 00

Paul Olsen

When the N. American and African plates collided, they did so with tremendous force. So much so, that they shoved the rocks up from their original flat-line position to these twisted and contorted forms that you can see here; barely recognisable from the way they were when they were formed. And you can find exactly the same kind of rocks in Africa today. But what actually happened, at about 50 million years later, the N. American and African plates began to collapse, and as they collapsed, Africa began to pull away from NA and the crust began to stretch and sink, forming a giant rift basin. And finally the Atlantic Ocean formed, about 200 million years ago.

10 10 40 00: Commentary

The opening of the Atlantic Ocean marks the end of Pangea… But this fracturing makes for a bumpy ride… As the continents break apart, the Earth itself fissures in all quarters.

10 10 53 00

In the interstices, astronomical quantities of magma rise from the depths of the mantle.

10 11 04 00

Massive successive volcanic eruptions continue for more than 600 000 years.

10 11 15 00

Paul Olsen

Now that rock is really interesting. On this side, you see red sediments, deposited by streams and rivers. On this side, you have a completely different kind of rock, it's called basalt, it's basically hardened lava. It's 201.6 million years old. And it's vivid evidence of the formation of the Atlantic Ocean, right here.

If you look carefully, you can see little white dots. Those are minerals that filled in holes that were originally filled with gases. And those gases caused a mass extinction at exactly the time of the eruptions of these lavas. One that shaped the future of life on Earth, and in fact, allowed our ancestors, very long ago, to survive and fill the void.

Paul Olsen

Animals and plant were quite different in different places. And there was tremendous amount of diversity on the land. There were crocodile relatives that were dominated the landscape over all Pangaea. When NA and Africa began to split apart, and the lava erupted in an enormous area, the gases that were produced by that eruption caused climate changes that killed off almost all of the crocodile relatives, leaving ecological space open for the dinosaurs to occupy, and after that, the dinosaurs actually took over the Earth and we begin the real part of the age of dinosaurs.

10 13 15 00: Commentary

200 million years ago, the tectonic plates resulted in a massive extinction of species.

10 13 21 00

Paul Oslen

These are interesting

10 13 24 00: Commentary

In total, half of the Earth's biological diversity disappeared, giving the dinosaurs free reign. Thus begins their unrivaled dynasty on the planet.

Along the banks of Nova Scotia, a few of these reptile's fossil prints are still visible – the last remnants of their former domination.

10 13 50 00

But much further inland to the west, these cretaceous giants left other evidence of their passage.

3/ The birth of the Great Plains

10 14 09 00 : Commentary

In the Canadian province of Alberta, the city of Drumheller houses the Royal Tyrrell Museum, the largest in the world dedicated to dinosaurs.

10 14 23 00

Gathered here are the skeletons of hundreds of specimens representing more than 35 different species.

10 14 31 00

François Therrien is a paleontologist and geologist. His specialty: the study of the environment and behavior of dinosaurs during the cretaceous period.

10 14 42 00

FrançoisTherrien

So we're here in the storage room. It's here that plaster jackets containing the fossils are stored until they can be prepared. As you can see, there are a great many fossils. The oldest date back to 1962 and we'll probably never be able to prepare of them all, there are so many specimens.

There's always a priority; we always prepare the nicest specimens before the others.

10 15 25 00

François Therrien and Collègue

F : - Hi Dana ! How are you ?

Collègue : - Hello. I'm good. How are you ?

F : - Good, good. What are you working on ?

C : - I'm working on a gar block. A 3D gar. Very rare. So far I've found about 20 of them in here.

F : - Well I was coming to ask you : "Do you wanna go to the field, to the dig site ?

C : - Sure !

F : - Cool. OK, well I have a few things to do, and then I'll just meet you at the site then.

- Cool.

H : - Cool. See you then.

F et C : - See you then.

10 16 00 00: Commentary

The Alberta region is François Therrien's main excavation zone. The great majority of fossils exhibited in the museum come from an area called… the «Badlands".

This valley with its almost lunar scenery draws a long scar across the Canadian west. It formed a hundred million years ago.

10 16 25 00

At that time, the face of North America was vastly different from these spectacular landscapes.

10 16 35 00

FrançoisTherrien

About 180 million years ago at the end of the Jurassic period, a subduction zone developed on the west coast of the North American continent.

Because the crust fragments rose and pressed down on the North America, the continent starts to sag, forming a huge depression in the middle of North America.

Over millions of years, the marine level fluctuated in such a way that the ocean invaded the center of the North American continent, developing a great inside sea that connected the Arctic Ocean to the Gulf of Mexico. Great coastal plains rose up around this inside sea. These coastal zones were inhabited by the dinosaurs.

10 17 28 00: Commentary

Buried under the sediment, the skeletons of reptiles have traversed time and reappear today in a perfectly preserved state.

10 17 42 00

FrançoisTherrien

François : Hi guys ! How is it going ?

Collegue : Good good ?

François : Anything new ? A skull or something ?

10 17 55 00

FrançoisTherrien

Since dinosaurs only lived between 230 and 66 million years, we have to find the rocks that were deposited here during that period. So, south of Alberta is the best place on earth because it meets these criteria. There are rocky outcroppings that formed around 80, 66 million years ago, deposited in the rivers and lakes and we also have the advantage of a very arid climate, which limits plant growth. There are no big forests to cover the outcroppings, so there are a lot of rocky outcroppings which means we can walk about the typical Badlands landscapes and discover other dinosaurs.

10 18 40 00: Commentary

Francois and his colleagues delicately probe the soil, looking for the tiniest fragments of fossilized bone. And like every year, the prospects look good.

10 19 00 00

FrançoisTherrien

We see here… (it's) a bone poking out of the rock. It's the backbone of a horned dinosaur, a ceratopsia.

FrançoisTherrien

So in fact we can say that tectonics aren't only responsible for forming the Great Plains of the North American continent, but tectonics are also responsible for providing ideal conservation conditions for all the dinosaur bones we find here.

As the rocks rose and the earth's crust sagged, there were a lot of rivers running towards this inside sea. These rivers overflowed the plains with alluvium and buried all the animals here. And it's thanks to this tectonic phenomenon that we can admire dinosaur bones in museums all over the world.

10 19 53 00: Commentary

Tirelessly, each year the researchers continue to unearth new bones.

10 20 04 00

These fossils make it possible to deepen our knowledge about dinosaurs, but also of the history of the Great Plains, the swath of terrain born in the heart of North America more than 100 million years ago.

4/ America goes West

10 20 18 00: Commentary

But further west, the age of dinosaurs is marked by another major geological phenomenon…

10 20 25 00

The continent drifts slowly, colliding with fragments of the continental crust dispersed across the ocean's surface.

These tiny islets of land successively graft themselves to the North American plate, which grows little by little.

This is how the 4 most westerly states on the continent - Nevada, Oregon, California and Washington - were formed.

10 20 56 00

Alan Glazner, geologist at the University of California studies the history of these collisions that gave North America its final shape.

10 21 09 00

He carries out his research in the heart of Yosemite National Park.

10 21 20 00

With its mountains, lakes and waterfalls that hurtle down the slopes, it's one of the most beautiful parks in all of the United States.

10 21 30 00

The result of the encounter between North America and the future western states.

10 21 38 00

The collisions caused a folding of the rock, and provoked violent volcanic eruptions.

10 21 53 00

Magma rose from the depths and as it cooled formed these gigantic granite domes.

10 22 11 00

Alan Glazner

If you looked to western north america from space before Pangaea broke up, It would have been quite different, much of today's nevada, oregon washington california would have been under water, but as subduction started, as NA moved westward, then suddenly the continent started to grow because it started adding things like the granite that we're standing on, and if you look at it carefully, you can see lots of detail in it that shows how different pockets of magma came up and cooled and crystallized to form this body here, and one of the most obvious examples of that are these late dykes (?) that came in. As the magma cools, as it gets almost 100% crystallised, it cracks and the very last liquid gets sucked into those cracks to form these beautiful dykes that show up so well here (…) on this surface.

10 23 11 00: Commentary

These veins of rock, which scientists call dykes, are proof of intensive volcanic activity in the past.

10 23 23 00

Alan Glazner

So on the map, we've mapped out all the different pulses. some of them have dark color, some have very light color stripes and they allow us to work out a sequence of injection of magma into this area.

10 23 40 00: Commentary

Magma from the earth's depths has thus infiltrated fissures in the rock to reach the surface.

10 23 53 00

There was a time in history when Yosemite National Park, like the rest of the American West, was in fact located off the coast… in the middle of the Pacific Ocean.

10 24 05 00

But when pieces of the earth's crust collided, they finished by melding into a single continent.

10 24 13 00

Around these collisions the earth gave rise to California's highest mountain range, the Sierra Nevadas, which stretch more than 700 kilometers from North to South.

10 24 30 00

In the field, Alan Glazner constantly analyzes clues to these past events to recover the details of the region's geological history.

10 24 58 00

Today, he is joined by one of his students at the foot of the park's most famous monolith: El Capitan. Here, the granite cliff rises more than a kilometer high.

10 25 07 00

Glazner et Putman

A : - Roger ! How is it going ?

R : - Well

R : - Check this out, Alan… here's a piece of that…

R : - What's the black? Biotite?

A : - Yeah, all I can identify is biotite.

A : - That's a pretty rock. We should definitely get a sample of it analysed, if it isn't in your database already.

R : -I don't have it from specifically here yet, so, yeah, let's get one.

R : - I think one the coolest pieces of geology about the geology of el capitan is that where we are right now, at the base of el cap, was ten kilometers below the air surface, a hundred of four millions years ago, which is the same time of dinosaurs remain on earth, so 10 km about above where we are now, there were dinosaurs walking around, which is the coolest think I have ever think

A : - And there were big volcanos going off at the same time, so those dinosaurs had a lot to worry about.

10 26 46 00: commentary

Today, the Sierra Nevada's highest summit reaches an altitude of 4400 meters.

10 27 01 00

But this height pales in comparison to the colossal mountain that stood here in the past. Because over millions of years, water, wind and ice have worn down the rock.

From the summit of "Half Dome", Alan can contemplate the effects of this slow erosion.

10 27 21 00

The Sierra Nevadas are now composed of a series of valleys, and mountains with rounded peaks.

10 27 31 00

Alan Glazner

When the Sierra Nevada formed, say 90 million years, and we're sitting here, you'd be about 10 kms down in the crust, there'd be a very tall chain of volcanoes above you, and there would be a subduction zone being subducted about the normal angle of, the plate was going down, it's maybe 45 degrees… I'll make a sketch… to illustrate that better. So if we have a normal subduction zone, going down at about a 45 degree angle, like this… for some reason, when the subducted plate gets to a depth of about 100 kms, chemical reactions occur that produce magma, and so this magma rises, being less dense, gets to the surface, it piles up, and erupts, forms volcanoes and lava flows… it erupts volcanic ash, and some of that magma gets trapped in the crust, at depths of, let's say 10 to 20 kms, and when it cools and hardens, it forms granite. And that's what we're standing in here. Erosion has taken off the upper layers of the crust and we're down in this magma factory.

5/ Sierra Nevadas The Rockies Les Rocheuses

10 28 35 00: Commentary

The Sierra Nevadas with its sumptuous landscapes is one of the places that best demonstrates the constant evolution of the continents. It was from here, 100 million years ago, that North America extended westward, to take on its current form.

10 28 53 00

But during the same period, a different phenomenon was taking place a bit farther east. Another mountain range was also rising from the Earth: the Rockies. This massif stretches for more than 4800 kilometers from New Mexico all the way to northern British Colombia.

10 29 14 00

The Rocky Mountains formed during the same period as the Sierra Nevadas. But for a long time, they mystified geologists the world over.

10 29 23 00

Generally, mountain ranges are born at the edges of colliding plates. How then do we explain the presence of these peaks nearly 1000 kilometers inland?

Today, a hypothesis is at last taking shape.

10 29 44 00

About 80 million years ago, a plate slid under the North American continent. But instead of dropping down at a 45 degree angle as is usually the case, it wove its way in much closer to the surface.

10 29 57 00

As a result the rock didn't reach a sufficient depth to be melted by the heat. So the plate continued its journey, and jamming against the earth's crust in its path, gave rise to Rocky Mountains.

10 30 14 00

Today, not every detail of this event has been perfectly elucidated. But in all likelihood, the origin of the Rockies is a geological anomaly…a willful plate that suddenly refused to submerge.

6/ Yellowstone, a super volcano in the heart of America

10 30 37 00: Commentary

Backed up against the Rocky Mountains, another region was victim to the Earth's fitful rage for thousands of years.

10 30 47 00

Yellowstone National Park, located in the state of Wyoming.

10 31 06 00

Henry Heasler is the park's geologist. Every day, he roams this immense natural reserve.

10 31 16 00

His mission: watch over the monster that sleeps just beneath the surface… A supervolcano of unimaginable strength.

10 31 26 00

For years, specialists have tried to understand the origin of this supervolcano.

They finally discovered that Yellowstone Park is situated on what is called a "hot spot".

These are zones, where under the surface, the base temperature is unusually high.

10 31 46 00

Thus enormous quantities of magma rise from the depths and accumulate in a pocket several hundred kilometers under the ground, called a plume.

When the magma is expelled, it pierces the earth's crust…And a volcano appears.

But when the tectonic plate slowly floats above it, the hot spot doesn't move. It thus imprints its mark at regular intervals along the earth's surface.

10 32 17 00

In the last 2 billion years, the Yellowstone region was the site of three major eruptions.

The last one dates back 642 000 years.

Accumulated beneath the earth's crust, the lava burst from its chamber and projected thousands of tons of molten rock, volcanic ash and sulfurous gases into the air.

10 32 41 00

Henry Heasler

When material is forcefully erupted, not as a big blast, but basically vented through all the fissures and cracks that were forming in the earth, it forms a caldera, which is a subsidence feature, and behind me, you can see the evidence for that. Basically, the caldera starts almost exactly where I'm standing and then goes 72 kms directly behind me, where it's covered by more recent lava flows.

10 33 13 00: Commentary

In the heart of the national park, the Yellowstone Caldera forms a gigantic basin 72 kilometers long by 56 kilometers wide. It's all that remains of this colossal explosion, one of the most devastating in the history of the Earth.

10 33 28 00

But today, the supervolcano is far from extinct. The earth here rumbles non-stop… Geysers, gas and vapors as well as other heat sources punctuate the landscape, evidence of the intense activity that reigns beneath the surface.

10 33 46 00

The volcano is simply dozing… And it's potentially one of the most destructive on the planet.

10 33 57 00

Henry Heasler

The super eruptions of Yellowstone were catastrophic for hundreds of kms around what is currently Yellowstone national park, there would be no life left because of the force of the eruptions, the pyroclastic, the hot rock flows, that come out, tens of kms, the resulting ash clouds, the volcanic ash, and volcanic gases, that would be ejected high into the atmosphere and basically circle the entire globe, would cause a volcanic winter to cover the entire world.

10 34 50 00: Commentary

For many years, Yellowstone's supervolcano has been under close observation.

10 34 58 00

The control center is located about 500 kilometers from there, at the University of Utah in Salt Lake City.

10 35 16 00

Jamie Farrel is a geologist. Every day, his task is to analyze the volcano's slightest flutter, thanks to a network of sensors that measures deformations of the ground in real time.

Recently, he also recreated the monster's history and constructed a model of the vast magma chamber that feeds it.

10 35 37 00

Jamie Farrel

So this is a visualization tool that we use to kind of show the data that we record in Yellowstone, so if we turn of the topography, and we put on the earthquakes we've recorded in Yellowstone, these red dots, what you can do here, you can zoom around and look underneath the ground, you can look at the patterns of earthquakes that have occurred from 1973 to the present there's roughly about 46,000 earthquakes here. If you want to look at a little bit of the bigger picture, we can turn on the Yellowstone plume, and that's the orangish-yellowish feature here, this is basically the Yellowstone hot spot, this is the feature that's providing all the heat and energy coming up from the mantle to feed the Yellowstone volcanoes. So you can see here, it comes down, down into the mantle…

Jamie Farrel

So, the Yellowstone hot spot manifested itself on the surface about 16 or 17 million years ago down in this area, in the Nevada-Oregon (area)… so this is kind of the track of the Yellowstone hot spot, as the North American plate has moved over it.

The western US is stretching, we have an area called the Basin and Range, where the crust is being thinned and stretched, and the reason why the Yellowstone hot spot is here is because of that thinning and that may have provided a path for the hot spot to make it to the surface.

10 37 20 00: Commentary

Some 3000 low magnitude tremors shake the Yellowstone region every year.

The earth trembles, the ground is deformed, the composition of the gases evolves…

10 37 34 00

But in the eyes of specialists, there is, for the moment, no proof of an imminent eruption.

10 37 51 00

Henry Heasler

Change is the normal situation at Yellowstone, with earthquakes, with ground deformation, with the geothermal system, with the gases. So, roughly, the probability of another catastrophic eruption is very poorly understood, because we've only had three in the past two million years, but it's about the same as a large asteroid hitting the earth and destroying it. So if you're concerned about a large asteroid hitting the earth, then maybe you should be concerned about Yellowstone erupting,.

Henry Heasler

The future of this volcano, eventually, is to become very, very cold and inactive. It will probably end with an outpouring of basalts, the ground elevation will go down because it will no longer be very hot, so we'll have a very, very different looking terrain, some time into the future, maybe millions of years into the future, so the more interesting question for me is, will humanity even be around when Yellowstone changes a lot?

10 39 10 00: Commentary

One day, the supervolcano will thus disappear… Until then, the volcanic gases of this hugely powerful monster will continue to dance above the staggering beauty of these lands.

7/ Confronting the Pacific: San Andreas

10 39 26 00: Commentary

But today, another large-scale phenomenon is in progress.

10 39 31 00

An immense scar rips through the western region of North America. Baptized the "San Andreas Fault", it runs for 1300 kilometers through California.

10 39 45 00

In this area, the Pacific Plate climbs northeast, while the North American Plate descends in the opposite direction. The result: these 2 fragments of the earth's crust slide against one another, making the ground tremble at regular intervals.

10 40 05 00

On the banks of the San Francisco Bay, specialists from the University of California keep careful watch over the San Andreas Fault 7 days a week, 24 hours a day.

10 40 15 00

Everyone here is used to the regular tremors produced by the earth's movements. The fault line is part of everyday life for Californians.

10 40 28 00

On the campus, geologist Roland Burgmann teaches about the history of geology, but also of its future.

10 40 37 00

Because inexorably, California is breaking off from the continent at a rate of 5 centimeters a year. In a million years, it will have become… an island.

10 40 49 00

Roland Burgmann

The San Andreas fault was born about 25 million years ago. Before that time, California was a place where subduction occurred, so the San Andreas fault is a strike-slip fault. That means that motions of plaques or plates adjacent to the fault or parallel to the fault are horizontal, in a strike-slip motion (?) rather than one plate moving on top of the other, as we might see in a subduction zone. And if we have the SA fault continue with its motion and there's no reason to believe that it would stop, in another 9 million years, we should be seeing the LA basin offshore here and ruining our views

10 41 38 00: Commentary

A squeaky valve between two plates of the earth's crust, the San Andreas Fault gave birth to a complex system of fissures…

10 41 49 00

Several secondary fault lines have appeared and now run across the entire region. Among them, the Hayward fault which runs to the east, is particularly worrisome to seismologists.

10 42 02 00

Aurélie Guilhem is a post-doctoral candidate from France at the University of California at Berkeley. In the field, she's on the lookout for possible signs of movement along the Hayward Fault.

10 42 13 00

Aurélie Guilhem

So here we are in the city of Hayward, which has the same name as the Hayward Fault. It was here that the 1868 earthquake took place. In addition to powerful earthquakes, of a magnitude of about 7, that occur along this fault, the fault also causes slow slipping. We can observe this slow slipping in the sidewalks, like here, but also by the cracks along the streets. This sidewalk wasn't made like this. It was built straight but since then has been deformed by the fault zone that runs through here. We can clearly see the movement in the relationship between these two blocks. This movement corresponds to the movement of the

Hayward Fault. Which has a right lateral strike-slip, so the block propagates to the south in relation to this block, here, which propagates the north.

10 43 12 00: Commentary

The plates thus slide slowly one against the other… But sometimes, the accumulated energy suddenly cracks the fault… It ruptures, provoking an earthquake.

10 43 28 00

Aurélie Guilhem

We're at the Memorial Stadium on the Berkeley campus. This stadium was built in 1923 after the 1868 quake hit along the Hayward Fault. It measured 6.8 on the Richter scale. This stadium was built after that and it has some deformation that can be seen on top of the stadium here where in fact the Hayward Fault cuts the stadium in two. So it's been affected over time even since the structure was built. The deformation is about 40 centimeters and it proves that the Hayward Fault slides continuously about .5 centimeters per year. It's a relatively new structure but we can clearly see a large deformation with the naked eye.

10 44 31 00: Commentary

April 18th, 1906, another earthquake registering 8.2 on the Richter scale hit the city of San Francisco.

10 44 42 00

There were 3000 victims and it transformed the city into a vast field of ruins.

10 44 49 00

The same phenomenon took place on the October 17th, 1989. 63 people died, nearly 4000 others were wounded and material damage reached almost 6 billion dollars.

10 45 07 00

Today, what everyone fears is the "Big One". The megathrust earthquake that's supposed to hit California in the next 30 years.

10 45 21 00

For Richard Allen, director of UC Berkeley's Seismological Laboratory, residents must definitely prepare for this disaster scenario.

10 45 31 00

Richard Allen

So here we're on the UC Berkeley campus, and the Heyward fault actually goes across the Berkeley campus, so if we have an earthquake on that fault, we expect fairly significant damage in this area. Most of the buildings on campus here have been retrofit so they

should not collapse during an earthquake, however, many may be seriously damaged and we won't be able to use them following the event.

Richard Allen

So while we can't predict the exact time at which an earthquake is going to occur, we know we're going to have big earthquakes in this region over the next few decades, in fact there's a two in three chance of a major damaging earthquake in the Bay Area in the next 30 years. So that's how we can then get ready for these earthquakes by building buildings, but the other thing that we can do is we can use the very beginnings of an earthquake, the P waves that radiate from a fault to say something about the shaking that's coming and provide a few seconds warning to people before they feel the shaking.

10 46 39 00: Commentary

Will the famous Golden Gate Bridge stand up to the Big One when it hits?

One thing is certain: the population must prepare itself for the next tragedy…

Aurélie Guilhem studied the possible consequences of a megaquake in the San Francisco Bay Area.

And it's from this promontory, overlooking the bay, that the amplitude of potential damage is most visible.

10 47 04 00

Aurélie Guilhem

From here we can get an overview of the Hayward Fault. So, behind the hill is Berkeley with the Memorial Stadium. In front of us is San Francisco and right there is Oakland.

During a future quake, the Hayward Fault will break at this spot here with serious consequences. Below us, there's a big highway network. The Hayward Fault will cut the highway in two. This region is also very populated. And facing us there's a gas factory right next to the fault. We imagine there'll be problems with electricity distribution in the weeks following a future quake. Something else that can't be seen here are water pipelines in that area, running east to west, and thus crossing the fault line.

10 48 15 00: Commentary

During the 1906 earthquake, broken water mains prevented firemen from putting out the dozens of fires that ravaged the city…

10 48 30 00

Aurélie Guilhem

If the water lines here are blocked or shut down as well as the highways, and the electricity is out, we are looking at a pretty big natural disaster in this highly populated region.

10 48 50 00: Commentary

Every day, experts are on the lookout for the slightest tremor, ready to sound the alert in the case of an imminent quake.

10 49 00 00

But until then, San Francisco keeps its cool. As if the all-powerful tectonic forces couldn't mar one of the most beautiful cities in the world.

Conclusion

10 49 18 00: Commentary

North America as we know it today represents only an ephemeral stage in the planet's history.

10 49 27 00

In the future, the Earth's terrible fits will continue to mold its landscape… Earthquakes and volcanic eruptions threaten one day to wreak long- lasting consequences on the entirety of the living world.

10 49 41 00

And in several million years, the continent will be ripped in two. California will detach and drift at length through the Pacific Ocean.

10 49 52 00

The colossal forces of the tectonic plates have not yet finished sculpting the surface of the North American continent.

10 50 02 06

End Credits