VOYAGE OF THE CONTINENTS
CENTRAL AMERICA
Script - 52'

10 00 03 00 : Narration (Teaser)
Since its formation, our planet has undergone constant transformation.

10 00 12 00 :
Stupendous collisions have created continents. Colossal forces have raised up ocean floors, forming dramatic mountain ranges.

10 00 27 00 :
These movements on the Earth's surface can be seen today in (the form of) volcanic eruptions, earthquakes and tsunamis.

10 00 38 00 :
Tectonics sculpt our landscapes, modify the climate, displace oceans, and can even influence the living world.

10 00 54 00 : Narration
Central America and the Caribbean are made up of a slim strip of land and a multitude of islands dispersed across turquoise waters.

10 01 05 00 :
These sumptuous landscapes are the fruit of a turbulent geological history. Caught in a vice between North and South America, the region has forever been subjected to colossal forces.
And today too, this tropical paradise lives under the constant threat of earthquakes and volcanic eruptions.

10 01 26 00 :
From the slopes of volcanoes to the depths of the ocean… from remote jungles to the heart of overcrowded cities, scientists attempt to understand the history of this singular region, subject to Earthly powers, and the ongoing Voyage of the Continents.

10 01 41 00

Opening titles

<u>Sequence 1 –Central America in the Farallon era</u>

10 02 02 00 : Narration
Straddling mountains and oceans, Central America boasts a wide range of exceptional landscapes.

10 02 10 00
To the east, speckled with countless archipelagos, the Caribbean Sea faces the mighty Atlantic Ocean ; to the west, a thin ribbon of land stretches from Mexico to northern Colombia, and the shores of the Pacific.

10 02 27 00
The history of this region is unique in planet Earth's epic journey. Whereas most of the continents are several billion years old, Central America is much younger : emerging from the depths of the sea only 150 million years ago.

10 02 50 00
Understanding every detail and every step in the formation of this territory is the main objective for Thierry Calmus, a scientist from the geology institute at the National Autonomous University of Mexico.

10 03 07 00
His field of study is in the north of Mexico, not far from (the town of) Hermosillo, the capital of the state of Sonora.

10 03 18 00
We're in the heart of the western Sierra Madre, a range of mountains stretching over 1000 kms across the country.
These peaks are the vestiges of the very first moments of the creation of western Mexico.

10 03 34 00
About 200 million years ago, the future North and South Americas began to slowly drift westwards.
They hit an oceanic plate, the ancestor of the Pacific Ocean. Named the 'Farallon Plate', it started to disappear beneath the earth's mantle.

10 04 09 00
Thierry Calmus
This famous Farallon plate gradually sank, between 200 million and 20 million years ago, beneath the north and south American plates. This subduction caused plutonic magma phenomena, which means the intrusion of deep-set magmatic rock, and volcanism, which is magmatic rock reaching the surface. That was the case here in the western Sierra Madre, where we have perfectly typical relief related to that subduction phenomenon.

10 04 46 00
Thierry Calmus is looking for the last vestiges of the Farallon plate, which has today almost totally disappeared.

10 04 59 00
He heads for the La Caridad mine, one of the world's biggest copper mines.

10 05 09 00
The mountain here has been sliced apart over thousands of square metres.

10 05 16 00
For this scientist, the exposed rock becomes an open book on geological history.

10 05 32 00
Thierry Calmus

We're here for one very simple reason. Plates disappear, and most of the Farallon plate, has disappeared due to subduction. Fortunately, we have witnesses like today's volcanoes are witnesses to current subduction processes, we have witnesses to the historic subduction which occured between 200 million and 20 million years ago, and among these witnesses we have these copper mines, which are connected to the magmatism associated with the subduction of the Farallon plate.

10 06 04 00
The copper in the La Caridad mine, in fact, comes directly from the ocean floor that made up the Farallon plate.

10 06 12 00
When the plate sank beneath the north American plate, the precious mineral was swept away by water and magma, then rose through cracks within the continental crust.

10 06 30 00
These (copper) deposits were therefore the direct result of that age-old collision.

10 06 38 00
By taking extensive samples, Thierry Calmus and his team hope to get a better understanding of the slightest movements that affected the region millions of years ago.

10 06 50 00
Through its very disappearance, the Farallon plate triggered the construction of Central America. It also gave way to another oceanic plate, situated just behind it : the Pacific plate. And 150 million years ago, a major event occured in the middle of this ocean : the birth of the Caribbean plate.

Sequence 2 – Désirade,or the birth of the Caribbean plate

10 07 14 00 : Narration
Traces of this phenomenon can be seen today in the heart of the Antilles archipelago, on the small island of La Désirade.

10 07 26 00
Here, the waves of the Caribbean Sea roll in along a jagged, rocky coastline.

10 07 40 00
The beaches are covered with volcanic rocks and gigantic domes of basalt…

10 07 49 00
This tortuous landscape is an ideal study subject for French geologists Luc Legendre and François Michel.

10 07 55 00
They're looking for clues concerning the formation of the Caribbean plate.

10 08 05 00

Luc Legendre

Here are the volcanic tuff rocks… pillow lava, quite exceptional !

François Michel

Pillow lava is an English term ; in French we would say ‘coussins de lave’, or cushions… and these pillow lava are formed at the bottom of the ocean, 4000 metres down, under the pressure of cold water. We can see the base, and imagine that the lava that emerges is hot, at around 1000 or 1200 degrees, and it forms this bubble, which cools very rapidly. We can clearly see here a sort of cortex around it, a kind of envelope, which cooled more quickly. If we look at the pillow lava below, we can see below the cortex an area of bubbles… and then the heart here, which is basalt, and so on… it accumulated like that. It’s magnificent !

10 08 57 00

For the experts, these lava pillows provide unique testimony to the formation of the Caribbean plate at the bottom of the ocean.

10 09 07 00

They are the result of intense volcanic activity, at what are called ‘hot spots’ : regions of the Earth’s surface where the temperature below the surface is particularly high all the time.

10 09 22 00

Vast quantities of magma rise to the surface from the depths, accumulate beneath the surface, then spread out over the sea bed. The oceanic crust thickens in places, and finally gives rise to a new tectonic plate.

10 09 41 00

Luc Legendre

Here we are with our bathyscaphe, 150 million years ago, looking at the sea bed, with the lava arriving and the pillow lava forming.

François Michel

It would be good if you could tell us the age of these pillow lava.

Luc Legendre

What we’ve been able to date, are the radiolarites. The radiolarites we have here, beneath our feet, contain microfossils that provide us with an age. These are from the end of the Jurassic that would be 145 to 150 million years ago. These microfossils are characteristic of that period. We’re in the presence of the oldest rocks in the region.

François Michel

It’s important to say too that at the end of the Jurassic, 145 to 150 million years ago, the Atlantic Ocean was just beginning to open up, and here, in a way, we’re in the Pacific.

Luc Legendre

Yes, and that's a puzzle. In fact, geologists have been wondering for decades about these rocks and their origins. Thanks to all their studies, we now know that here on the Désirade, we have testimony to the beginning of the formation of the Caribbean, tectonically speaking.

10 11 04 00

For a long time, the date and, above all, the location of the Caribbean plate's formation were a mystery for the specialists.
But these rocky formations on the island of la Désirade provide the proof of its emergence from the heart of the Pacific Ocean, thousands of kilometres to the west of the Americas.

10 11 29 00

Subsequently, the American plates continued to drift slowly to the west. The result was that the Caribbean plate gradually slid between the two giants.

10 11 44 00

Luc Legendre

We have here extremely rare testimony to the formation of the Caribbean plate 150 million years ago in the Pacific. This mass of rock that we're looking at was formed in the Pacific, and it was only gradually that the two Americas moved to the west and the Caribbean plate managed to insert itself, like with forceps, we could say, between the two massive blocks to the north and south.

10 12 19 00

Approximately 100 million years ago, the young Caribbean plate reached its current position in the tropics, on the edges of the Atlantic and Pacific plates.

10 12 35 00

To learn more about the region's subsequent history, François Michel continues to explore the coast of La Désirade, seeking out more clues.

10 12 49 00

François Michel

Here we have another outcrop of rock… and we find the same basalt we saw at the last outcrop. These rocks are very old, about 150 million years old. And we find them in the form of pebbles, these dark pebbles, which are very old. And they're a complete contrast to the lighter pebbles, which are much more recent, and part of a whole other story, almost contemporary, from the last few thousands or hundreds of thousands of years, that we can find on the terraces above us.

10 13 32 00

The southern shore of the island is lined with a terrace of varying width, rising up about twenty metres above sea level.

10 13 40 00

As he observes the rock strata above Mahault Bay, the geologist can almost completely reconstitute La Désirade's geological past.

10 13 49 00

François Michel

Here at Mahault Bay, we see a new outcrop, where the base is made up of the same basalt we saw before, the pillow lava, about 150 million years old. And above that, there's a marine terrace which tells us a whole other story. This is 150 million years old, and this is 120,000 years old, as the sea gradually rises. It laid down, as we can clearly see here, an initial layer of rock, mainly composed of pebbles and gravel, and an accumulation of shells. We call that a conglomerate.

And when the level of the sea rose, we can see that something else settled, with a very different aspect, and that's quite simply a coral reef, a barrier reef.

So here, we have both the oldest rocks in the Caribbean, and no doubt the youngest too, in terms of geological history. Between the two a fantastic amount of time passed, (a period) that saw the birth of the Caribbean plate.

10 14 55 00

Over millions of years, therefore, the Caribbean plate underwent numerous dramatic changes. The sea level rose, then fell, until the landscape we know today appeared.

10 15 11 00

But on its eastern side, the Caribbean experienced a very different, much more violent phenomenon : its encounter with the Atlantic Ocean.

10 15 22 00

The two oceanic plates collided, and the denser Atlantic plate slid below the Caribbean plate. At the point of contact, the rock fractured and split.

10 15 35 00

Magma rose up from deep down, and an arc of volcanic islands was formed above the waves.

Sequence 3 – Basse Terre, islands born from volcanos.

10 15 48 00 : Narration

In the heart of the Lesser Antilles, the La Soufrière volcano is the best-known testimony to this collision, which is still going on today.

10 16 01 00

It's located on Guadeloupe, about ten kms from the town of Basse-Terre.

10 16 17 00

On the slopes of the volcano stands Guadeloupe's volcanological observatory. Research workers here have front-row seats to observe the activity of the barely dormant monster.

10 16 29 00

A team of volcanologists is today setting out on a field trip. Their destination is not easy to get to, so Dominique Gibert, from the Global Physics Institute in Paris, has to be lowered down by helicopter, along with his team.

10 16 45 00
They've brought with them a cutting-edge apparatus : a geological scanner, which enables them to see inside the volcano.

10 16 57 00

Dominique Gibert

So here we're unpacking a cosmic ray telescope… it's a prototype, composed of particle detectors, that we can see here, the yellow frames, which measure the quantity of cosmic particles that go through the volcano. By doing this kind of reading, we can determine the density of the dome, as the denser the rock, the more it stops the particles… so we can make X-rays of the volcano with this telescope.

10 17 30 00 : Narration
For hours, the whole surface of the volcano is subjected to the scanner's scutiny.
A spectrum of colours emerges, representing the density of each type of rock. The red zones correspond to the densest and most solid areas… The blue zones to the most fragile…

10 17 53 00

Dominique Gibert

The interest of these experiments, and of these radiographs, is that they provide us with information about the volcano's structure. When it was formed, it was composed of quite new, robust lava, and it had a fairly stable form. Since its formation, the volcano has been infiltrated by extremely acidic fluids which come from the hydrothermal system and which eat away at the interior… so the volcano now is likely to collapse, because it's lost a good deal of its mechanical cohesion. This could involve the collapse of a single sector or the whole thing, and the radiographs that we've done tell us about the size and the number of the zones affected which could collapse in the event of an earthquake.

10 18 45 00
The weather is unpredicatble in the tropics, and the work on the ground is long and fastidious. The scientists have to move the telescope regularly in order to examine the volcano from different angles.

10 19 00 00

Dominique Gibert

We now have a good deal of data and can combine it all to try and do what we do in medicine, which is to create a 3D image, like with a scanner, combining the various angles that we've examined with the telescope. It's been here for about 3 months. It was previously in the south, then to the east of the dome, so we have 3 different viewpoints which should allow us to make a 3D reconstruction of the internal structure.

10 19 36 00

The first results obtained using the revolutionary telescope reveal the fragility of La Soufrière. Eaten away inside, the base of the volcano could collapse at the slightest tremor. Such a catastrophe would have potentially apalling consequences for the 12,000 inhabitants of Basse-Terre.

10 19 58 00
La Soufrière and many other volcanos in the Antilles archipelago embody the violent encounter between the Caribbean plate and the Atlantic Ocean.

10 20 07 00
4000 kms away, an identical phenomenon is under way. On the western side, the Caribbean plate and the southernmost point of the North American continent are being shaken by another ocean, the Pacific.

10 20 23 00
The Pacific plate is gradually been drawn downwards, and once again, the contact between the plates leads to the emergence of new volcanoes.

10 20 35 00
The latest rose from the land less than a century ago ; barely yesterday, on a geological time-scale.

<u>Sequence 4 – From Mexico to Panama – Volcano country</u>

10 20 45 00
It's February 20th 1943. Dioniso Pulido, a Mexican farmer, is inspecting his fields after a long day's work. He discovers a thick layer of ash, that is still hot.
All around, fumaroles emerge from the bowels of the earth…

10 21 02 00
After four days of constant rumbling, a 60-metre high volcano appears. It grows very quickly, throwing out astronomical quantities of lava and ash which destroy the neighbouring villages.

10 21 16 00
Named Paricutin, it is one of the rare volcanoes on the planet to have emerged as man looked on.
A further addition to the long volcanic belt that stretches all along the west coast of Mexico.

10 21 34 00
Not far away, the Nevado de Toluca appeared several million years ago. At 4690 metres high, it's the 4th highest peak in the country.

10 21 46 00
The volcano is today extinct, and its summit cradles two vast craters filled with crystal-clear lakes.

10 21 56 00

This grandiose setting is one of the hunting-grounds of geologist José Luis Arce, from Mexico's National Autonomous University.

10 22 08 00
His aim is to gain a fuller understanding of the geological history of a region home to the greatest concentration of volcanos in the Americas.

10 22 28 00

Jose Luis Arce

We're in the central part of Mexico, where volcanism is due to the subduction of part of the Pacific plate under the North American plate. This subduction produces volcanism. At Nevado de Toluca, we can clearly see this big crater, which is two kms wide and 1.5 kms long. This volcano is part of the Pacific's Ring of Fire.

10 23 02 00
The ring of fire José Luis Arce refers to is the gigantic horseshoe-shaped volcanic arc around the Pacific Ocean, from Indonesia to Canada, and from North America to the south of Chile.

10 23 17 00

Jose Luis Arce

The Pacific Ring of Fire is an area along the edges of the plates, it coincides with a great number of active volcanos all around the Pacific. This generally corresponds to subduction zones. There are active volcanos and significant seismic activity. This is due to the interaction between the plates.

10 23 41 00
But along the west coast of Mexico, the subduction of the oceanic plate does not occur in a perfectly linear manner. The degree of inclination varies, and so the volcanos appear inland at differing distances from the sea.

10 23 56 00

Jose Luis Arce

For Mexico, it's rather particular, as the subduction is not parallel to the Mexican volcanic belt ; there are various angles of subduction. In the western part of Mexico, the subduction is quite inclined, whereas in central Mexico, it's flatter, and this is why the volcanoes are further away from the subduction zone.

10 24 36 00
In the Mexico City valley, another volcano, Xitle, left a fatal and indelible mark on the country's history.

10 24 50 00
It erupted almost 1300 years ago, totally destroying the town of Cuicuilco, at the time one of South America's most prosperous cities.

10 25 04 00
José Luis Arce meets Maria Saudoval Gonzales, the archaeologist in charge of the site.

10 25 11 00
Together, they explore the archaeological remains, looking for traces of the ancient lava flows.

Jose Luis Arce
We have lava here, volcanic rock. The bubbles indicate that they contained gases, mostly CO2 and water vapour. These gases separate from the lava as it advances. And the bubbles deform as they're crushed.

D. Maria Saudoval Gonzales
This lava covered the city of Cuicuilco. It was buried in around 750 AD, by the volcano Xitle, which is to the south of Mexico City.

Jose Luis Arce
We can see various structures here, these are lava flows. These structures are like wrinkles which form when the lava moves forward. It advances and leaves these lines.

D. Maria Saudoval Gonzales
Because it gets colder ?

Jose Luis Arce
Yes, it advances and gets colder at the same time, and leaves these marks, which give us an idea of the direction of the flow.

10 26 43 00
Like an American Pompeii, the city of Cuicuilco is today a major archaeological site. Valuable testimony, recalling that geological history can be inexorably intertwined with that of mankind.

Sequence 5 – Guadeloupe : face to face with the Atlantic

10 27 03 00
In Central America, however, volcanic eruptions are not the only threat to the inhabitants. Wherever plates meet, tectonic movements regularly cause tremendous underwater earthquakes. These can then lead to the formation of colossal waves, and even tsunamis.

10 27 23 00
According to the experts, the northern Caribbean is particularly at risk. Over the past 500 years, more than 50 tsunamis have already been recorded.

10 27 40 00
Along the eastern rim, the Lesser Antilles' region is being closely monitored.

10 27 56 00
The advance look-out station is in Guadeloupe, at the volcanology and seismology observatory.

10 28 07 00
Its director, Daniel Amorese, is today accompanying Sebastien Deroussi on a trip to gather the data recorded by a whole network of sensors.

10 28 24 00

Sébastien Deroussi
Well, the building's in good condition, it hasn't moved recently…

Daniel Amorese
One of the roles of the volcanology and seismology observatory in Guadeloupe is to take part in the tsunami watch. The main cause is seismic activity, which we can observe at the interface between the Caribbean and the North American plates, in the subduction zone, about 100 kms from here.

10 28 57 00

Daniel Amorese
Did you checked the supply recently?
Sébastien Deroussi
Yes, it's picking up, the satellites, everything looks good.

10 29 04 00
To evaluate the risk of tsunamis in real time, tide gauges are deployed throughout the region.
These instruments constantly record the slightest change in the sea level.

10 29 17 00

Sébastien Deroussi
If a tsunami is triggered in the region, then everyone around the basin will be affected. The instruments that we use here, like this tide gauge, are able to detect a wave that's already passed, so in a way, it would already be too late. But it will be useful for the people in surrounding countries, further away. In return, our colleagues around the Caribbean basin have other instruments which are useful for us. So we really have to regard this system as being of global value. We can't simply have a tsunami alert system all alone, in isolation. It wouldn't work, because tsunamis cross whole oceans, and it takes time for them to cross oceans and seas, and it's that time that enables us to warn people.

10 30 04 00
An earthquake in the northern part of the Caribbean (plate) could generate waves of more than 12 metres and endanger the lives of some 35 million people.

Sequence 6 – Grande Terre – islands created by subduction

10 30 16 00
The tectonic forces in action in the northern Caribbean have always shaped and modeled the region. Millions of years ago, volcanic islands emerged from the waves, and tomorrow, they will perhaps be swallowed up by a tsunami.

10 30 31 00
But the collision between the Caribbean plate and the Atlantic Ocean also causes slow vertical movements in the sea bed. This phenomenon lies behind the emergence or the submersion of certain fragments of the earth's crust.

10 30 46 00
In Guadeloupe, the island of Grande Terre is the direct result of these constant movements.

10 30 56 00
The rock strata here bear witness to a turbulent past. The island has undergone a succession of both marine and terrestrial events over several million years.

10 31 16 00
Jean Frédéric Lebrun and Jean-Len Léticée are geologists at the Antilles University. For several years now, they have been trying to reconstruct Grande Terre's complex geological history.

10 31 29 00
Today, they're in the town of Sainte Anne, exploring a quarry.

10 31 34 00
Jean-Frédéric Lebrun
That's what we call white limestone… it's dazzling…

10 31 42 00
In the heart of the limestone massif, the scientists look for very particular clues : fossilised coral, which show that the area was once covered by the sea.

10 31 56 00
Jean-Frédéric Lebrun
Look, there's one there too : an agaricia. In fact, we can find all the corals we usually see in quite deep reefs. In calm zones, which enable the limestone mud to settle and to construct this whole formation. So this quarry is quite exceptional, because there are two reefs, one on top of the other. At the bottom, there's the agaric limestone, which is about 40 metres thick, all the same, and then there's an eroded surface, which goes down, and which undulates, because there are channels which have been dug out, and it continues down there. The eroded surface has recorded a lowering in the sea level. The sea went down, and erosion carved out the cliff.

10 32 49 00
The sea level therefore went down. Subsequently, the level varied further, and the sea rose slowly, bringing sand with it. This sand was deposited on the coral reef, until it was completely covered.

10 33 05 00
Jean-Frédéric Lebrun

So we can see that it's getting higher, the sea level rises, and the beaches advance, and move on, and they reach (as far as) up there. On the top, we can see a second reef, an acropora reef, which looks quite granular from here. So that's the second reef, that settled on the top. And that represents the stabilisation of the higher sea level.

10 33 29 00
After this second floodng, Grande Terre experienced a final dramatic change due to the effects of subduction. Around 400,000 years ago, it surfaced once more, becoming the island we know today.

10 33 42 00
As time goes by, Jean-Frédéric Lebrun and his collegues learn ever more about the history of the Antilles. But the tectonic phenomenon at play here are complex… In their laboratory, a map of the region reveals a disparate tangle of faults on the edge of the plates…

10 34 01 00
Jean-Frédéric Lebrun
This is a bathymetrical and topographical map. It shows the region's relief, and so Guadeloupe and la Soufrière are here. And this is the arc of volcanic islands. With Dominica here, the Saintes islands, and Basse-Terre. What's interesting on this map is that we can clearly see all the structures, all the faults.
The faults are connected to an opening towards the north… the front part of the arc is drawn to the north because of the subduction, which occurs obliquely in this region, and so it's cut all these faults. We can see here, for example, the Morne-Piton fault, which we can clearly see on Marie Galante, it's like a step, and it goes from here to there. So it's almost 60 kms long… this part has gone down, and this part has risen.

10 34 52 00
A few kms south of Grande-Terre, the island of Marie Galante is cut in two by a gigantic fault, which has widened gradually over the centuries. Several dozen faults split the land all around Guadeloupe.

Sequence 7 – Hispaniola : an island created from earthquakes

10 35 21 00
A little further north, the Greater Antilles archipelago is subjected to the same tectonic stress. And here, the confrontation of the Caribbean and North American plates has even more spectacular consequences.

10 35 35 00
Instead of one going under the other, according to the subduction phenomenon, the two plates slip against one another, and in the middle, another gigantic fault has appeared.

10 35 59 00
Haiti, and its capital, Port au Prince, are smack in the middle of this displacement zone.

10 36 14 00
On January 12th 2010, an earthquake of a magnitude of 7 devastated the country, causing more than 230,000 victims.
Even today, Haiti is still attempting to heal its wounds.

10 36 30 00
Port au Prince is slowly getting back to normal, but the scars of the catastrophe are still only too visible.

10 36 44 00
This deadly earthquake sounded the alarm among the international community. There is an urgent need to predict future quakes as early as possible. An extensive surveillance programme has therefore been set up.

10 37 00 00
Steve Symithe, from Purdue University in the US, is one of the scientists behind the project.

10 37 13 00
For several months, he has been travelling around Haiti installing GPS equipment.

10 37 22 00
The apparatus enables the slightest ground movements to be observed, month after month. The data then provides precise and detailed maps of the deformation zones, and helps to determine the speed of the plates' movement.

10 37 40 00

Steve Symithe
We set up this apparatus and leave it in place for at least four days ; 3 or 4 days. Then we remove it, and then come back every 3 or 4 months, quite regularly, to take measures, to make sure we have a representative series over time.
Thanks to these measurements we can calculate variations in the strain in the crust, and this enables us to explain the aftershocks we observe after an earthquake. And also, perhaps, to anticipate other earthquakes to come.

10 38 22 00
Initial measures show deformations of around 2 cms per year.

10 38 32 00
The slip and friction between the two plates apply colossal strain to the whole region, and it builds as time goes by. This energy is subsequently released periodically when part of the fault gives way. It is at this point that earthquakes occur.

10 38 52 00

To further improve their knowledge of the movements affecting the zone, another team has been deployed in the field.
Run by Bernard Mercier de Lepinay, from the CNRS in Sofia Antipolis in France, it is entrusted with setting up a series of seismographs at strategic points in the region.

10 39 11 00

Bernard Mercier de Lepinay

We're here next to this antenna because we've set up a seismological station to record the seismic waves, and this antenna is one among 23 that we're equipping throughout the country. We use seismic waves, which are waves like light, and which enable us to create images of the rocky milieu and to see where the main fractures are that cross it.

10 39 43 00

The seismographs measure the amplitude and direction of ground tremors in real time, even the very slightest. By analyzing the data, the scientists can make detailed models of each small fault that splits the region at the junction of the plates.

10 40 00 00

Bernard Mercier de Lepinay

Where we are now, we're practically parallel to the direction of the plates' movement. Not completely parallel. But we're on a line we can qualify as a thrust fault, which means one plate wants to go under another, and that poses a problem of deformation. You can well imagine that when two plates are face to face, and one moves under the other, it creates a lot of deformation on the surface.

10 40 30 00

There is no doubt that further earthquakes will occur here. But scientists now hope to be able to see them coming, and to warn the local population.

Sequence 7 – Paradisiacal islands on Swiss cheese

10 40 41 00

Meanwhile, tectonic forces continue to shape the Haiti landscape. The slipping plates have torn the rock apart deep down, transforming the ground into a hole-filled Swiss cheese. Underground rivers and vast caves have formed everywhere.

10 41 03 00

In the region of Pestel, the Bellony caves are among the best-known.

10 41 18 00

Emmanuel Soielik is the guide in charge of the site.

10 41 25 00

He has been exploring the caves for years, and reveals their secrets to visitors.

10 41 37 00

Flooded on several occasions, the impressively vast caves are decorated with countless stalagmites and stalactites.

10 41 50 00

Emmanuel Soielik

There's friction between the North American plate and the Caribbean plate. Water came in and covered the mountain. The empty space was created below. Then, as it moved out, the water created stalagmites and stalactites. And at the same time, these concretions we can see we're also created by the water.

10 42 30 00

Emmanuel knows the place like the back of his hand. As a child, he loved to get lost in the rocky maze, despite the superstitions that surrounded it.

10 42 44 00

Emmanuel Soielik

When I was little, I used to come here when people had voodoo ceremonies. I lived in Pestel, and I thought the Bellony caves were the devil's hole.

10 43 07 00

Be they under ground or under the sea, the numerous cavities in the Caribbean plate are one of many local treasures. For connoisseurs, the sumptuous Blue Hole off Belize, (for example) has become one of the top spots for divers.

Sequence 8 – The Panama isthmus –the strip of land that changed the world

10 43 30 00

For hundreds of thousands of years, Central America has constantly been redrawn by the movements of the terrestrial crust.

10 43 39 00

On its eastern facade, volcanoes and earthquakes are an integral part of the Antilles' history.

10 43 45 00

On the western side, a different type of event has profoundly transformed the whole region. 3 million years ago, North and South America moved closer together, to the point of touching…

10 44 02 00

The two continents were joined together… and a new land was formed… the isthmus of Panama.

10 44 09 00

According to the experts, it would have been formed in several successive stages.

10 44 16 00

It all began about 15 million years ago. As the Pacific plate slid below the Caribbean plate, a string of volcanic islands appeared.

At the same time, tectonic movements pushed parts of the sea bed to the surface. Other fragments of land emerged from the waves.

10 44 34 00
Then sediment built up over the millenia and gradually filled the empty spaces.

10 44 41 00
Finally, the isthmus closed up completely, just 3 million years ago.

10 44 52 00
But at the beginning of the the 20th century, man decided to counter the tectonic forces, digging a gigantic canal to link the Atlantic and Pacific oceans, as they were previously joined.

10 45 05 00
This Herculean task was one of the most difficult projects ever attempted. But its impact on maritime trade is still considerable even today.

10 45 18 00
New work has been under way for several months.

10 45 25 00
The aim is to widen the canal to allow even bigger vessels to pass.

10 45 42 00
The work represents a great opportunity for one team of scientists.

10 45 50 00
Andres Cardenas is a paleontologist at the university of Los Andes, in Colombia.

10 46 00 00
Along with his colleagues, he comes here regularly, to examine the rocks excavated by the huge diggers.

10 46 13 00

Andres Cardenas
The expansion of the Panama Canal has given us a new opportunity to look at the rocks in this location because they are creating artificial exposures and then we could see the fresh rocks and the fresh fossils.

Andres Cardenas
In those environments we can find several mammals like the marsupials, the opossum, the armadillos, they are from South American origins. And if you go to Texas, you have the marsupials, you have the armadillos. In contrast you have here in South America mammals from North American origins, just like the jaguars.
The mammals that we have found here are from North America affinities. It is telling us there was a corridor from the North through South America.

10 47 22 00

When the two Americas came together, (the) wildlife was involved in extensive migration across the new land bridge. After evolving apart for millions of years, species from the north and south met and interbred, colonising whole new territories.

10 47 40 00
This event, known as ‘the great American interchange’ had a considerable impact on the biodiversity of the two continents.

10 47 50 00
For Andres Cardenas, each new fossil that is discovered is a precious clue.

10 48 01 00

Andres Cardenas

In theCulebra formation we could find marine fossils like bivalves, oysters. It’s telling us that this location was at some point under the sea at another point above the sea.

10 48 21 00
The mix of land and marine animal fossils provides valuable information about the formation of the Panama isthmus.

10 48 36 00

Andres Cardenas

That historical event was a very drastic event because it changes not only biological dispersion of the South and North American animals also it changes the global circulation pattern and may be could change also the climatic model of the earth.

Sequence 9 - Conclusion

10 49 01 00
A slender strip of land stretched between two continents, the Central American isthmus has played its part in changing the equilibrium of the whole planet.

10 49 17 00
A remarkable destiny, akin to that of the Caribbean plate.

10 49 26 00
Born in the depths of the oceans, shaped by earthquakes and volcanos, it was formed in barely 100 million years. A mere moment, on the Earth’s geological time-scale… and it has given rise to landscapes of exceptional beauty.

10 49 50 00
Today, the region’s history is far from over. To the east, confrontation with the Atlantic Ocean will form new islands. In a few million years, they could perhaps join together, and even form a new land bridge between the two Americas.

10 50 20 22

Closing titles