VOYAGE OF THE CONTINENTS
AFRICA TODAY
Script - 52'

10 00 03 00 : Narration
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 53 00 : Narration
For 100 million years, Africa has existed in the shape we know today.
But its story is far from over. The continent is slowly moving towards Europe, and the collision has already begun.
To the East, the great Rift Valley moves mountains, and prepares to split Africa in two.

Along the ocean shores and in the depths of the desert, scientists seek clues that may point to Africa's future. Every relief system, every fossil and every earthquake is a new enigma to resolve. As they uncover the secrets enclosed in the rock, they reveal the forces that shape Africa today, in a never-ending… voyage of the continents.

10 01 46 00

Opening titles

10 02 06 00 : Narration
300 million years ago, one vast supercontinent united all the planet's land masses.

10 02 13 00
But Pangaea, as it is called, finally broke in two. Eurasia split off from what would become Africa and the other continents of the southern hemisphere. Between them, an ocean opened up ; the Tethys Sea.

<u>Sequence 1 – Africa moves dangerously close to Eurasia – in the East</u>

10 02 31 00 : Narration
The history of this marine expanse has left traces in the heart of one of the planet's most arid regions, the Arabian peninsula.
Here, the ground abounds with a precious resource : oil.

10 02 46 00
The black gold has brought wealth to the Gulf states, and in particular to the Sultanate of Oman.

10 03 02 00
The Wadi Nakhr canyon in the north of the country is one of the places where indications of how it was formed are the most visible.

10 03 14 00
Louai Machour is a geologist and oil prospector.

10 03 22 00
In his expert view, Oman's situation today, as an oil eldorado, is due to the presence of the age-old Tethys Sea.

10 03 41 00

Louai Machhour

We're in the heart of the Oman mountain range. The Tethys opened up in this region of the Arabian plate. At that time, this whole area was under water : hence the considerable sedimentation.

10 03 56 00 : Narration
About 100 million years ago, Oman was located further south, a long way from the future Europe. Long before the desert and the mountains, the region was partially covered by the waters of the Tethys Sea.

10 04 09 00
As the centuries passed, sediments were laid down over the sea bed.
The Tethys was warm and shallow. An ideal environment for bacteria to prosper, transforming matter into one particular substance : kerogen.

10 04 24 00
20 million years ago, however, the continents drew closer together, and the Tethys Sea closed up. The kerogen sank deeper into the ground.

10 04 32 00
Under the effects of pressure, it transformed into hydrocarbons, and seaped into cracks in the rock…

10 04 56 00
Louai is prospecting throughout the region.

10 05 02 00
He observes the rocks meticulously, looking for the slightest suggestion they could contain oil reserves.

10 05 18 00

Louai Machhour

A reservoir is like a sponge, with little holes, and all these holes are filled with hydrocarbons or gas. We can see that this surface is ridden with cracks all along it, (which were) certainly caused by tectonic movements. If these cracks remain open, they improve the horizontal permeability of the rock and aid the circulation.

10 05 47 00 : Narration
This area seems to be particularly rich in deep-set hydrocarbons…

10 05 54 00
Studying the rock even closer, further indications confirm that the sea once came this far inland.

10 06 03 00

Louai Machhour
This is a fossil, of coral, solitary, and so we can clearly see the structure, which is cellular, and well preserved. So we have marine sedimentation here : sedimentation in a sea that was quite shallow and quite warm.

10 06 26 00 : Narration
By observing the rock around the cracks, Louai confirms his initial analysis.

10 06 35 00
The next step is to drill an exploration well to see if oil really exists deep underground.

10 06 43 00
The Gulf countries of Iran and Irak are today among the world's leading oil exporters. Symbolising the Emirs' great wealth, the black gold is also the most precious of testimonies to the whole region's geological history.

10 06 59 00
But the closure of the Tethys Ocean, 20 million years ago, left other traces too, (that are) rather more surprising…

Sequence 2 – The closure of the Tethys Sea between Africa and Eurasia – in the East

10 07 10 00 : Narration
In Egypt, the majestic pyramids of Giza stand as a millenial legacy of ancient civilisations.

10 07 22 00
But not far away, in the Fayoum desert, the site of Wadi El-Hitan contains other treasures, several million years old.

10 07 40 00
The roads here have given way to trails, marked out in the sand.

10 07 46 00
Improbably-shaped stone giants rise up all around, sculpted by erosion over millions of years.

10 08 03 00
Francis Duranthon is a paleontologist, and curator of the Toulouse museum.

10 08 10 00

For many years, he has travelled the world, looking for fossils that can explain the evolution of species. Wadi El Hitan is of particular interest, as the desert sands here conceal some rather unusual bones.

10 08 26 00

Francis : Hello
Geologist : Hello
Francis : You're digging ?
Geologist : Yes, a small excavation from a whale
Francis : Can I help you dig?
Geologist : Of course. Ya! Ok.
Francis : Do you have a lot of whales here in this area?
Geologist: Ya! Can you imagine that we find like one thousand whales.
Francis : One thousand?!
Geologist : Yes, One thousand.
Francis : Oh!

10 08 56 00 : Narration
Nicknamed the 'valley of whales', the Wadi El Hitan site is a veritable open-air museum.

10 09 04 00
The first bones were discovered here over a century ago by a British archaeologist.

10 09 13 00
Since then, more than a thousand whale skeletons have been found. As time goes by, the wind continues to blow away the sand, revealing even more relics.

10 09 31 00

Francis Duranthon
It's surprising to find whale skeletons like this in the middle of the desert. So why are they here ? Well, in fact, we're where the Tethys Sea used to be, between about 37 and 40 million years ago. The sea was quite shallow here, and it was probably a lagoon area, where these small whales, dorudons, came to reproduce. The dorudons were whales about 5 metres long.
But they were prey to other, much bigger whales, called basilosaurus, which could measure up to 18 metres long. The small dorudon skeletons we've found, and particularly the young, have bite marks on them. Meaning that they were the prey of the big basilosaurus. So these animals came to reproduce in this region, where the sea was about 30 metres deep… and when they died, obviously they sank to the sea bed and fossilised.
Naturally, sediment subsequently accumulated (over them) and when Africa rose up, due to (the) plate tectonics, the sediment was removed and eroded, and so the whale remains were revealed, and uncovered by the desert wind that they call here the Khamasin.

10 10 43 00 : Narration
For the paleontologist, the Egyptian desert is an open book on the region's history.

10 10 50 00
In the middle of the sand, whale skeletons lie alongside sharks' teeth, fossilised mollusks, and even the bones of crocodiles and marine turtles.

All these remains testify to the wealth and diversity of the Tethys Ocean's wildlife, over 30 million years ago.

10 11 09 00

Francis Duranthon

(So) the Tethys Sea was once a vast expanse linking the Atlantic Ocean to the Indian Ocean and the Pacific. Africa was completely isolated from Eurasia, and progressively, because of plate tectonics, the Arabic plate would open up, and pivot, because of the opening up of the Red Sea, and would close off this expanse of sea to form what is today the Mediterranean Sea, a fragment of what the Tethys Sea once was.

10 11 36 00 : Narration

The existence of this ocean, today disappeared, is the proof of the slow rise of the African continent, and its collision with Europe.

10 11 49 00

Today, only the Mediterranean Sea separates the two giants.

10 11 55 00

But the voyage of the continents is not over : slowly but surely, Africa continues to move northwards, at a rate of 2 cms per year.

10 12 04 00

The collision is under way, and it's in the Strait of Gibraltar that it's the most perceptible.

10 12 14 00

At Al Hoceima, in Morocco, the land quakes regularly from the effects of tectonic forces.

<u>Sequence 3 – Africa moves dangerously close to Eurasia – in the west</u>

10 12 22 00 : Narration

On February 24th 2004, a quake measuring 6.3 on the Richter scale hit the city, causing over 600 victims. This formidable phenomenon has occured at regular intervals.

10 12 40 00

Philippe Vernant and Jean-François Ritz, geologists at the University of Montpellier, are currently working in Al Hoceima.

10 12 48 00

Jean-François Ritz : 1,70

Jean-François Ritz :

Is the radio on ?

Jean-François Ritz :

Right, we're off… north on the surface…you head west, and go as far as T1, then you take T3 and come back.

10 13 16 00: Narration

The scientists want to make precise models of the tectonic movements the African plate undergoes in contact with Europe. Armed with their GPS, they explore the area, taking extremely precise topographical readings.

10 13 29 00

Jean-François Ritz
The idea is to mark out an itinerary that will enable us to accurately measure the topography of the different areas we see here, and the whole profile, which forms a basic rectangle, and allows us to see the difference in height of the various areas. Notably here, for example, at (the point) T3, which is an old river bed that has risen up. There's the river today.. We can get a very precise measurement of the height difference between the old and new beds.

Jean-François Ritz
We've crossed east to west, and we have the cape point here. You went to T3, and here's the north-south profile where we'll take samples of the pebbles.

Jean-François Ritz
There is an active river bed, but what we can see in the landscape is that the river used to flow here. That's the initial level. In fact, the river sank (into the ground). It sank because the earth's crust rose at this point. And where they are, up there, there are also pebbles, which shows that there was an uplift here of about 40 meters. What we want to quantify is the rate of that uplift. To do that, we have to do two things. We have to measure the exact height (difference) between the two river beds, the current one and the old one, and then we have to date the pebble deposits up there. So if we have those twopieces of information, we divide the height by the age and we get the rate of uplift.

10 15 37 00 : Narration
Throughout the region, the ground sinks and rises and fractures…
The collision between Africa and Europe causes the rock to fold, and numerous fault ruptures appear.

10 15 50 00
An analysis of the GPS data will soon enable the scientists to understand the scale of the movements.

10 16 10 00
A few days later, Philippe Vernant and JF Ritz are back at work.

10 16 21 00
This time, they've traded their GPS equipment for ropes and harnesses.
They're focusing on a rocky cliff a few dozen metres high. The aim is to reconstitute the chronology of the earthquakes that led to the appearance of this fault.

10 16 34 00

Jean-François Ritz
Ok Phil, pull it up !

Philippe Vernant
It's ok, I've got it !

10 16 43 00 : Narration
In order to date previous quakes, the scientists use a rather particular technique : dating by cosmic rays.

10 16 50 00
Jean-François Ritz
Right, it's taut!

10 16 56 00 : Narration
The Earth is constantly being struck by particles from space. When they hit the ground, they're absorbed by the surface rocks, whose composition is slightly altered.

10 17 09 00
With each seismic event, the ground fractures, and new rocks are exposed. By analysing the surfaces, the scientists can determine how long each strata was exposed to the cosmic rays, and therefore date the successive quakes. The height of each uplift also provides precise indications of the magnitude (of the event).

10 17 43 00
On the ground, the geologists take rock samples from along the top of the cliff.

10 17 53 00
Philippe Vernant
If we take samples from all along this surface, we should (be able to) see that it's older up above. So that means that we're seeing a quake, and then we can see a different period below, with another quake, more recent, and so on, moving to the bottom. So we can see the history of the different seismic events which led to the formation of this fault plane, and so that tells us something of the region's seismic destiny. Every so many years, in fact, there was an earthquake, which led to this, and depending on the movement, we can get an idea of the magnitude of the events.

10 18 30 00 : Narration
Characterising the various quakes that shook the region over thousands of years will enable the scientists to gain a better understanding of the movements that affect the African continent.

10 18 42 00
Philippe Vernant
6 and a half, seven here… we can take 6, 6 and a half probably…

10 18 51 00 : Narration
This study will ultimately contribute to making more precise predictions of quakes in the Al Hoceima region. For the land continues to tremble here, inexorably. The movement of Africa towards Europe is a fundamental action that nothing can stop.

10 19 16 00
Little by little, the Strait of Gibraltar will close up. And in about 50 million years time, the Mediterranean Sea will have almost disappeared.

10 19 32 00

But as Europe and Africa face off at Gibraltar, another plate steps into the dance in the East… Arabia.

Sequence 4 – The Dead Sea Transform

10 19 44 00: Narration
Arabia is gradually separating from the Sinai region, and moving northwards.
The rate of this movement is greater than in East Africa. The result is that the two plates slide against one another, and in the middle, a gigantic fault has appeared. Known as the Dead Sea Transform, or Dead Sea Rift, it splits the Near East from the Red Sea to Turkey.

10 20 07 00
Between Jordan, Israel and Palestine, this sliding movement (of the plates) has led to the collapse of a whole region… in the middle of which, is the Dead Sea.

10 20 23 00
High up on a rocky spur, the fortress of Massada in Israel benefits from a unique viewpoint over the whole region.

10 20 34 00
This is where Yann Klinger is heading. A geologist from the Institut de Physique du Globe (Global Physics Institute) in Paris, he has been travelling the region for many years.

10 20 47 00
His objective is to understand the movements that have affected the Dead Sea Rift over previous millenia.

10 20 57 00
Above the sheer cliff, the majestic fortress dominates a lunar landscape framing the Dead Sea and the Judaean desert.

10 21 10 00

Yann Klinger

Here we're on the Massada plateau. We're above the Dead Sea, which is 400 metres below sea level. So, 400 metres beneath our feet, more or less. The plateau here is part of the Sinai plate. We're standing over this vast depression filled by the Dead Sea, which is associated with the activity of the Dead Sea Transform. The fault is about 1200 kms long, and it enables the Arabian plate to move northward compared to the Sinai plate, here to the west.

10 21 52 00 : Narration
The sliding movement of the tectonic plates has for a long time produced powerful seismic events in the region.

10 22 08 00
But their magnitude and,above all, their frequency, are still little known.

10 22 16 00
To improve predictions of future earthquakes, Yann is attempting to compose a complete picture of previous events.

10 22 28 00

And so he explores the Dead Sea basin, accompanied by geologist Shmulik Marco, from the University of Tel Aviv.

10 22 33 00

H : So the fault is running here…

Yann Klinger : Each time they move, they create an earthquake

H : Right

10 22 41 00

The rocks here store records of the alternating dry and rainy seasons, and (above all) of each time the earth shook.

10 22 49 00 : Narration

By studying the overlying strata, the scientists can literally go back in time, and retrace the tectonic history of the Dead Sea rift.

10 22 57 00

H : We see 2 different layers: one dark and one white. The white ones were deposit in the summer and the dark ones are the winter deposits. Flash floods came into the lake, deposited fine material and actually each pair is one year…

Yann Klinger : So we can count years?

H : Yes. it is one year

Yann Klinger : And you have huge deformations here. What is it this thing?

H : Yes, here we have, we see folded layers. We see it. We can follow this, and up and down. In this quiet environment the only thing that can set a layer to slump like this is an earthquake.

Yann Klinger : So all these layers for example just get folded like this when it was flat before, right?

H: Yes

Yann Klinger : And this is the signature of an earthquake. And you have a series of things like this here that gives you a chronology of past earthquakes in the Dead Sea fault here.

H: Exactly. We don't have seismograph at this time and we have about 50000 years of record and we have about 30 strong earthquakes that happened in this period.

Yann Klinger : So, you're making a catalog here.

H: Yes it's an archive of earthquakes.

10 24 22 00 : Narration
Nature conserves traces of the seismic events that shape it… but sometimes our own history has a story to tell too.

10 24 34 00
Working in a region with such a rich, 2000-year-old history is a godsend for geologists.

10 24 39 00
In the north of Israel, the ruins of the Vadum Jacob Templar castle also tell the tale of the Dead Sea Rift.

10 24 51 00
In 1178, Christian armies built this fortress to prevent the Muslims from reconquering Jerusalem. The Christians would finally lose that war, and Vadum Jacob was partially razed by the enemy. But the site was doomed anyway. The crusaders, in fact, had built on the fault line itself, along the course of the River Jordan.

10 25 18 00
Yann Klinger
Here in this castle, for example, we can see that this wall has shifted. This part of the wall has moved towards me, whereas that part has moved to the north. This is the limit between the Arabian plate, on this side, and the Sinai plate on this side. So we can reconstruct the history of earthquakes here through the archaeological remains, and from the geological records we can find in the area too.
(Far) away from the fault (line), the movement is continual, and imperceptible to man, of around 5mm per year, but here at the fault, we can see that there's no movement. Forces build up, and at some point, those forces exceed the resistance of the (earth's) crust, and there's a tremor, and so all along this fault there are regular seismic events in response to the accumulating forces here, resisting the 5mm per year movements which are continual.

10 26 15 00 : Narration
Thanks to historical writings, and archaeological digs, the date of the first earthquake to hit the castle has been determined.

10 26 24 00
It took place on May 20th 1202, and moved the walls by 1 metre 60 in just a few seconds.

10 26 39 00
Yann Klinger
So here we're on the other side of the castle, and (of course) the fault crosses these walls too. As we go along the wall, there's a gap of over two metres.
So naturally, this fault is an integral part of (the) Eastern Mediterranean regional geodynamics, and when the Arabian plate moves northward, it needs space.
It creates space by building mountains along its front, and by pushing the Turkish plate to the west, to continue on its way forward.
These faults are the translation of plate tectonics, and plate tectonics are in action on our planet, it will never stop. It creates topography, it causes movements, which are locally violent, in the form of earthquakes. And it's something that totally goes beyond human time-scales and which will continue.

10 27 35 00 : Narration

Arabia today continues to move inexorably to the north, millimetre by millimetre.

10 27 43 00
In the future, no doubt other earthquakes will strike the region, and further deepen the Dead Sea Rift.

10 27 56 00
A liitle further south, the separation of Africa and Arabia occurs rather differently…

10 28 04 00
Over the past 20 million years, the two plates have been progressively moving apart, at an average of 15 mm per year. And in the middle, a new ocean is being born…

10 28 20 00
For the moment, it is merely a sound, a maximum of 300 kms wide. It is called the Red Sea, prolonged in the east by the Gulf of Aden.

Sequence 5 – Africa splits apart – the opening of the Red Sea and the Gulf of Aden

10 28 37 00 : Narration
Off the Sultanate of Oman, the small island of Al Hallaniyah is an ideal study site for understanding the impact of the opening of the sea.

10 28 58 00
The ground is often shaken here, as the plates move apart.

10 29 07 00
Félicie Korastelev and Jordane Corbeau work at Jussieu Univeristy in Paris.
Their research subject is the movement affecting the coast along the Gulf of Aden, due to tectonic forces.

10 29 25 00
They're going to Al Hallaniyah to collect a seismograph installed here several months ago.

10 29 43 00
The island is an exceptional site for seismic analysis. It has very few inhabitants, no significant buildings, and only a single, little-used road.

10 29 56 00
There are no vibrations caused by man which could pollute the data recorded.

10 30 10 00

Jordane Corbeau
We've set up about twenty stations in the south of Oman, in the Dhofar region. This is the last station we're collecting. All the others have already been collected. Once we've got it, we'll send it to France to analyse the data.
We obtain recordings of ground movements, of movements due to earthquakes in particular. And so we can therefore study the internal structure of the ground beneath the region.

10 30 41 00 : Narration
The network of seismographs makes continual recordings of even the slightest earthquakes. Each quake reflects an event of greater amplitude that occurs a few kilometres offshore, in the depths of the Gulf of Aden.

10 31 00 00 : Narration
At the point where Africa and Arabia are moving apart, a vast depression has been created, and the sea has moved in between the two continents.

10 31 09 00
Over the centuries, the earth's crust continues to be stretched. Magma spurts up from deep within the mantle and fills the empty space created by the separation of the plates. This then forms what is known as a mid-ocean ridge.

10 31 26 00

Félicie Korastelev
Seismological stations have been set up along the coast of Oman to map Oman's continental margin, and subsequently the opening up of the Gulf of Aden. The continental margin is the transition between the continental crust, characteristic of continents, and the oceanic crust, which is typical of oceans. The Gulf of Aden margin is interesting because it's (currently) being formed, so it's in the opening phase moving from a continental crust to (becoming) an oceanic crust.
So we're here, facing the seafloor-spreading between the Arabian plate and the African plate.

10 32 11 00 : Narration
The two scientists have gathered a massive amount of information during their mission. Analysing it all will take time. But one day, they hope, this study will enable a detailed modeling of the opening-up of a new ocean.

10 32 34 00 : Narration
The Sultanate of Oman is also the scene of another scientific team's field study. Their investigation is taking place not far from the town of Mirbat, on the shores of the Arabian Sea.

10 32 53 00

Man
Along the hills, there are just dykes.
Yeah.

10 32 55 00 : Narration
Sonia Rousse and Melina Macouin are geologists from the Research Institute for Development in Toulouse. Their mission is to determine the date of the opening up of the Gulf of Aden.
To do this, they're studying rather particular rocks, known as « Dykes ».

10 33 11 00

Melina Macouin : I think we're on this one, right ?
Sonia Rousse : We'll have to go and see it…

10 33 17 00: Narration

The dykes were formed 700 million years ago, when the Arabian and African plates were joined.
Within the seams of this magmatic rock are tiny crystals containing iron. It is this metal that is of interest to the scientists. Its presence confers the dykes with a specific magnetism. Analysing this can enable even the slightest movements on the earth's surface to be retraced.

10 33 41 00

Sonia Rousse

These very old dykes can be found on the other side, on the African plate. We have exactly the same dykes, the same age. When we put them together, we can define the rotations of the various geological formations, and see to what extent we can (re)associate them.

10 34 12 00 : Narration
To find out when the Arabian and African dykes began to separate, the scientists take a series of samples along the coast.

10 34 21 00

Sonia Rousse

Concerning the past 30 million years, for the Gulf of Aden for example, we're looking at sea for magnetic anomalies, and we can also look on land for the information we're lacking. And which will perhaps help to determine the period when the gulf opened up and the two plates separated.

10 34 47 00 : Narration
It will take several months more work to know exactly when Arabia began to leave Africa, and understand the movements the two plates underwent.

10 35 02 00
Today, the two continents are almost completely independent.

10 35 15 00
A little further south, a single land bridge still links the two plates. The region is know as the Afar triangle.

10 35 26 00
In a few million years, this corner of Africa, overlapping Ethiopia, Djibouti and Eritrea, will in turn break off, and move away with the Arabian plate.

Sequence 6 – Africa breaks away – the Afar rift

10 35 41 00 : Narration
The land here is fractured and fragmented.The tearing and straining of land massesleads to the ground collapsing, and violent volcanic eruptions.

10 35 55 00
The area is 100 metres below sea level. And exceptionally, the formation of a mid-ocean ridge can be studied on land here.

10 36 15 00
In the easternmost part of Ethiopia, the Erta Ale volcano is one of the region's mythical emblems.

10 36 30 00
All around is a tortuous landscape where sulphur deposits and lava flows stretch as far as the eye can see.

10 36 40 00
This desert, one of the most arid in the world, is home to the Afar people, semi-nomadic herdsmen and renowned warriors.

10 36 56 00
(The volcano) Erta Ale rises up to an altitude of 613 metres.

10 37 03 00
It is one of (only a) few in the world to have a permanent lava lake at its summit.

10 37 03 00
Jacques Durieux : OK

10 37 18 00
Before his death, the eminent vulcanologist Jean-Louis Cheminée was fascinated by this extraordinary smoke-shrouded mountain, which he visited regularly with his team.

10 37 39 00
With lava samples, gas analyses and rock composition studies, the specialists have examined the volcano in every detail.

10 37 57 00
They have gradually improved their understanding of how a new ocean is formed.
But Erta Ale will continue to fascinate scientists for a long time to come.
The spectacle it proposes here is unique in the world…
A symbol of the link uniting geologists and volcanoes…

10 38 27 00
In Djibouti, the Ghoubbet al-Kharab marks the south-east point of the Afar triangle.
This deep-water bay surrounded by steep cliffs is linked to the sea by a channel with very strong currents.

10 38 50 00
At one end is the Ardoukoba volcano, which last erupted in 1978, that eruption spit out more than 12 million cubic metres of lava, transforming the landscape into a lunar panorama.

10 39 12 00
On the other side of the volcano is Lake Assal. Once filled with freshwater, it is today increasingly salty. As the land spreads and opens up, the sea gradually moves in.

10 39 26 00
For several years now, Bernard Le Gall, from the Univeristy of Brest, has been monitoring the separation of the tectonic plates.

10 39 42 00
He's seeking to understand exactly how the earth's crust is transformed into an ocean floor.

10 39 52 00

Bernard Le Gall

This is an exceptional geological site. We're looking at Lake Assal, which is located 150 metres below the level of the Ghoubbet Gulf. From here, we can clearly see the overall morphology, where the lopsided relief behind is composed of the oldest lava in this sector, about 3 million years old, whereas the lava covering the base of the depression is much more recent, only a few thousand years old.

Here, we're on the surface of one of the very recent lava fields. If we consider the geo-chemical composition of the lava fields in the Assal/Ghoubbet area, we can see that it's very comparable to the oceanic basalt which forms the bed of the current oceans.

10 40 56 00 : Narration
By studying the chemistry of the recent rocks, the scientists have taken a first step in demonstrating that an oceanic crust is in the process of replacing the desert landscape here.

10 41 12 00
It's an exceptional geological spectacle, which normally occurs out of sight, deep down in the depths of the ocean.

10 41 22 00

Bernard La Gall

Geophysical studies have shown that beneath the Assal depression, the crust was very, very thin. The crust is about 4 to 5 kms thick. Which means that, deep down, the crust must be injected with matter from a great depth, and that it's probably already reached the point of rupture. And so this means that here, in front of us, we're witnessing a process of magmatic accretion, with the creation of a new crust of an oceanic type.

10 41 51 00 : Narration
'Magmatic accretion' is the term to describe the rising of magma from the mantle, and the gradual formation of an oceanic ridge.

10 42 16 00

Bernard Le Gall

If we apply the current rate of separation, which is about 2 cms per year, to the future, then it's probable that this zone of accretion at Lake Assal will be about 20 kms wide in 1 million years time, and 200 kms wide in 10 million years.

As the region undergoes accretion, it will also become deeper, and it will progressively be flooded by sea water, which is now at the level of the Ghoubbet gulf.

If we compare mid-ocean ridges with a sort of continental fracture which spreads, then this would be like the top of a zipper which is opening up.

10 42 57 00 : Narration

It's hard to imagine that here, in a few tens of millions of years, we'll be under water, several hundred metres below the surface.

10 43 14 00
But the forces which affect the whole region don't stop there…

Sequence 7 – When tectonics trigger human evolution

10 43 20 00 : Narration
To the south of the Afar triangle, another grand-scale phenomenon is occuring.
A huge scar splits all of the east of Africa. The Great Rift Valley, a fault line extending over 6000 kms, from Ethiopia as far as Mozambique.
Beneath the surface, the continental plates are pulling apart, approximately one centimetre per year.
In about 100 million years, an ocean will split Africa in two. But for the moment, the rift is composed of a vast, deep valley several kms wide.

10 43 59 00 : Narration
In Mozambique, the Gorongosa national park is located at the southernmost point of the rift.

10 44 10 00
Martin Pickford is a paleontologist at the natural history museum in Paris.
For an explorer seeking clues to the history of the Earth, the valley is of great interest…

10 44 25 00
Martin Pickford
It's magnificent, no ? We have the rift here, and Lake Orema in the background there.

10 44 34 00 : Narration
The appearance of the rift, millions of years ago, led to the whole valley collapsing.
The sea swept in (to the fault) on several occasions, depositing countless layers of sediment.

10 44 47 00
Within the valley, thousands of bones were fossilised, in ideal conditions, and have survived through the ages, untouched by the ravages of time.

10 45 00 00
Today, erosion has brought a myriad of fossils to the surface.

10 45 11 00
Martin Pickford
Looks like a fragment of a pelvis acetebulum here. The sediments stuck on it here. But it's in a terrible condition. It is difficult to identify but at least it shows that there's fossils, and bones have been fossilised in this area.

10 45 35 00 : Narration
Martin Pickford is particularly interested in the origins of mankind.

10 45 42 00

In the year 2000, it was in the heart of this rift valley that he made an exceptional discovery : the remains of Orrorin, a hominid some 6 million years old.

10 46 05 00

Martin believes the formation of the rift could have contributed to the appearance of our distant ancestors. Tectonic forces would have led to a profound transformation of the landscape. Whereas tropical forest covered western Africa, savana now dominated the eastern part of the rift.

10 46 27 00

The first men could well have settled in this new, more hospitable environment. They would have evolved very differently to their cousins, the great apes, more adapted to a forest milieu…

10 46 44 00

Martin Pickford

So actually the eastern rift is the resulting savanna fauna that we see today giraffes, hyenas, lions. It's actually the result of two movements, one from the South installing some animals and plants, and one from the North installing other animals and plants. That's really the importance of the rift, rifting tectonic changes the climate, changes the vegetation and of course the animals move as the situation changes, as the conditions change.
Homo actually evolved not in the rift itself in east africa, but somewhere else, and then came in. Because when you find it, you find the stone tools and so on almost in every locality. Before that, there was nothing. They came in and then they are homo.

Martin Pickford

Here we have a gallery going into the side of the cliff. And we can see it goes into a cave at the end, and opens up into a ravine at the side. So were early humans living here ? Or maybe one of them might have fallen into the cavity and got fossilized. We need to go and excavate to be sure. But when you think there's hundreds of kms of these gorges in this region. The chances are there are at least several of these caves thatprobably have earlier hominid remains in. And I just have a feeling that it would yield interesting information.

Martin Pickford

Ok. It's just big enough for a human to come inside.
And here we are.
Here is a recent infilling of sand but some of these would have old deposits which are turned to stone and in those we can get, we can find bones and snails, bits of wood and that sort of thing.

10 48 59 00: Narration

The theory that the rift played a major role in the appearance of humans is the subject of widespread debate. But for Martin Pickford, our planet would no doubt be very different if the earth had not shifted and opened up in east Africa…

10 49 18 00

Martin Pickford

So, it's strange to think, if it hadn't been for plate tectonics and its global activity, climate change and so on, humans would not be here today. In fact, I wouldn't be

here looking at the rift valley. In a manner of speaking, it would still be the planet of the apes. Strange... But probably true.

10 49 47 00 : Narration
In Africa, like everywhere else, evolution is intimately linked to the history of the land.

10 49 58 00
Man today has conquered the whole planet, and extended his dominion over every natural milieu.
But will he still be here tomorrow to witness the transformation of the African continent ?

Séquence 8 – Conclusion

10 50 17 00 : Narration
In a few million years, Africa and Europe will form a single continent.

10 50 24 00
As for the Red Sea and the Gulf of Aden, they will become vast oceans…
And for the first time in its history, the heart of Africa will be split in two.

10 50 38 00
The eastern part will begin a long journey across the Indian Ocean, drifting according to the movement of the (tectonic) plates, and possible collisions…

10 50 48 00
The all-powerful tectonic forces have not yet drawn up the definitive contours of the African continent.

10 51 06 11 :

Closing titles