

ERTA ' ALE “Birth of an Ocean”

01:00:07:00

From the Moon, American astronauts could see the biggest geological structure on Earth: the fault system of Africa's Rift Valley, extending over 4,000 kilometers.

The northern part of this fracture marks the start of the definitive separation between Arabia and Africa. It is still at work in the Afar Triangle, in Ethiopia.

It is the only place in the world where you can witness the birth of a future ocean in the middle of a continent.

A scientific team sets off to interpret the landscapes which reveal the Earth's history and to study the mechanisms which tear apart and open up the continent of Africa.

Jean-Louis Cheminée, a volcanologist, has accomplished pioneering research into this region.

Isabelle Manighetti is a tectonics specialist.

Nicolas Villeneuve is a geologist.

Luigi Cantamessa is the organizer of the whole mission.

I, Jacques Durieux, am a volcanologist and am coordinating the expedition.

We also meet the people who live in this hostile region, and then, at the very bottom of the rift, climb the slopes of the volcano Erta'Ale which has a permanent lava lake.

Studying it, is the principal goal of our mission.

01:01:56:00 / TITRE Erta'Ale “Birth of an Ocean”

A film written by Jacques Durieux and Maurice Ribière

Directed by Jacques Durieux

01:02:17:00

Ethiopia's upper plateaus, at the edge of the rift, are formed by an incredible piling-up of lava flows.

01:02:27:00

These deposits are over 2,000 meters thick and cover a surface equivalent to that of France, or Texas, say. The triangular Afar depression cuts a gash in all these lava flows. This is where our whole mission takes place.

01:02:41:00 / Luigi

We set off from the edge of the escarpment at Kombolsha and we are going down towards Afar country. We have already gone down about 500 meters. By tomorrow we will have gone down another 1,500 meters in altitude.

01:02:58:00

From now on, the road to Afar country goes down into the deep rift valley.

01:03:16:00

Moving along the bottom of the rift valley, today we will seek out the fractures which are continually causing it to open up, all signs of the Earth's movement.

01:03:27:00 / Isabelle

We'll try to head for that white spot, past that slope.

Jacques D.

We're just on the edge of this small hill. Where are we on the map? The little hump is just on the left.

Isabelle

Right.

01:03:46:00 / Isabelle

We've just gone past that small hill.

Jacques D.

Yes, this is a fracture, hum...

Isabelle

Try to get that way.

01:03:53:00

On our way, we discover long faults which cut up and push aside big blocks of the Earth's crust. Where certain of these blocks have collapsed, escarpments, formed by the faults, are now visible.

01:04:18:00 / Isabelle

We'll go... Yes, that's it. That little thing there...

We'll go straight ahead. I think that the little bump there...

Luigi

On the right.

Isabelle

That's the little thing we can see there.

Jacques D.

OK.

Isabelle

And in front, there's a flow we can't see.

Jacques D.

Yes.

Isabelle

And the fault we can see is this one.

Jacques D.

So, we have to go that way.

Isabelle

Yes, to the right.

01:04:38:00

We spot these geological features using aerial photos. These stereoscopic glasses show us the relief, enabling us to better interpret the terrain.

In so doing, we discover a volcanic structure which looks interesting, so we are going to try to reach it.

01:05:14:00

Suddenly, we are forced to stop...

01:05:32:00

Not all the region has been pacified yet... And apparently we are not exactly welcome here...

01:05:39:00 / Luigi

It'll work. They can't go against a person like the chief of their own tribe.

01:05:54:00

In the end, they calmed down...The Afars consider their land to be their home: you cannot walk in, uninvited. Now that we've been invited, the same young warriors go with us, showing us the way.

01:06:15:00

We are surprised to discover a crater which looks like it has been punched out of the Earth. There is not the usual volcanic cone around it.

01:06:25:00 / Jean-Louis

I think it's a pit crater. Don't you?

01:06:28:00

This is what the field geologist's work is all about: seeing a landscape, interpreting it, and finding the elements which brought it about.

01:06:44:00 / Isabelle

The caldera is 103 meters... diagonally... it's not accurate.

01:06:54:00

It is clear to us that this pit crater is the result of an eruption caused by the opening of large faults in the rift system. These fractures cut gashes into the Earth's crust all over the place, forming these gigantic steps, the lowest point being the bottom of the rift.

01:07:20:00

All these fissures combine to spread a part the two continental blocks of Arabia and Africa. Between them is a collapsed area known as the rift. It is the result of a process which began 30 million years ago.

01:07:43:00

The hot spots are huge plumes of hot, light matter. They are formed in the Earth's mantle. Each of these plumes is composed of a head, followed by a tubular conduit which rises rather like a hot-air balloon. When the head of the plume hits a lithospheric plate, it changes the shape of the plate and fractures it. The magma of the plume then erupts on the surface. 30 million years ago, a plume hit the Arabia/Africa plate which was then still intact. Three fractures appeared: the East African rift, the Aden rift, and the Red Sea rift. They help to separate Africa from Arabia. This process is still going on in the present day in the Afar depression. Several million years from now, a new ocean will appear. It will grow and continue to push apart the African and Arabian plates.

01:08:10:00 / Subtitles

01:08:16:00	– 30 million years
01:08:23:00	– 20 million years
01:08:27:00	– 10 million years
01:08:32:12	The present day
01:08:36:00	+ 5 million years
01:08:43:00	+ 10 million years

01:09:07:00

Everything here in the landscape reveals the forces at work on the Earth's crust. With each fracture, the rift is moving further apart and getting deeper, and in so doing, opening up the

continent of Africa.

01:09:26:00

The more we go on, the more intense the heat becomes. In the last two days, it has been over 40 degrees Centigrade in the shade... but there is no shade here!

01:09:42:00

At times, the vehicles suffer as much as the humans.

01:10:21:00

The rift opening is such that it keeps collapsing. A large part of its base is below sea level. Since ancient times, this basin has been covered by the sea on several occasions. In more recent times, freshwater lakes have occasionally appeared.

01:11:02:00

It took four days of traveling to reach the north of the depression.

01:11:18:00

The Afar desert is not a lifeless place. No matter how remote the geological sites we visit, we encounter Afar nomads.

01:11:27:00

The aim here is to display the greatest valor and endurance.

01:12:28:00

The last great caravans of this part of Africa leave from here.

They carry the salt that the men collect at Asale, at about 120 meters below sea level. The area has been flooded on several occasions. Each time, the sea has evaporated, leaving a thick layer of salt. It is almost 2,000 meters thick and spread over 4,000 square kilometers, in other words, about half the size of Hawaii.

01:13:14:00

For almost 3,000 years, the Afars have used this salt. Bricks of salt exactly the same size as those cut today were found in the Pharaohs' tombs. Every day, the men mine several dozen tons... And there seems to be an endless supply.

01:14:47:00

The long caravans of donkeys and camels travel to the upper plateaus of Ethiopia. The blocks of salt will do the rounds of the markets, supplying all of East Africa, from Somalia to Chad.

01:15:49:00

Beyond the salt mine, we come across loose sediment deposits, left by the various phases of flooding. They are making our progress more and more difficult.

01:16:00:00 / Luigi (in English)

Johannes, I want to give you the position, from the GPS.

01:16:05:00

We wanted to reach Dallol, a very unusual site right in the north... but the track is becoming far too difficult... and we have to leave enough time to make our detailed study of the

volcano that awaits us. In the end, we decide to use a helicopter.

01:17:11:00

Here, under the salt are active volcanoes. When they erupt, some very different things are brought to the surface. This phenomenon is unique to this part of the world.

01:17:23:00

First, a dome of potash emerged, then the steam from the hot springs brought various kinds of salt which form these multicolored concretions.

01:17:33:00 / Jean Louis

We have had recent volcanic eruptions through all that. There are some there and some further south, over there. That means that the magma is not very far below, and all the water seeping through is coming up to the surface and bringing potash, salt, etc... and is depositing all these concretions.

01:17:59:00

Each colored area corresponds to a particular composition. All the variations from orange to reddish brown show the different levels of iron oxidation.

In this area, we can see several active centers. These are where the steam comes up and the hot springs spurt out.

Sometimes, these active centers change, following variations deep within the Earth. I have to cross former, now empty basins to reach the site which I think looks the hottest.

01:18:45:00

The beauty of these basins is deceptive. The mixture here is highly acidic, and the ground is just a thin crust of crystals above corrosive springs. So, prudence is called for.

01:19:19:00

Once we have crossed the active area, we reach the great salt plain which occupies the main part of the rift.

01:19:30:00

We are now 120 meters below sea level. The hottest and most inhospitable place in the Afar depression.

01:19:39:00: Jacques D.

We have about 2,000 meters of salt below our feet...

01:19:48:00

For 80,000 years, erosion has cut deeply into the mass of salt deposited by the sea.

01:20:15:00

Exploring these canyons of salt reminds us that we are walking on the bottom of what will, in a few million years, be the new ocean separating Arabia from Africa.

01:20:32:00

We now have to collect our equipment which, in the end, successfully reached the base of the volcano.

01:21:01:00

Dodom is the last inhabited place at the foot of the volcano Erta'Ale.

01:21:09:00

Abdallah is a clan chief in this region. His presence at our side facilitates contact with the villagers. They speak to us of their strange neighbor, known in Afar as Erta'Ale: the Smoking Mountain.

01:21:31:00: Subtitles

01:21:31:00	No one lives there. It's the devil's realm.
01:21:34:00	It's not good to be neighbors with the devil.
01:21:38:00	As we live in the region, it's best not to talk about it.
01:21:42:00	All we know is, he sometimes appears as a human.
01:21:46:00	In human form, he makes people disappear.
01:21:50:00	Those taken at Erta'Ale have never come back, so that others do not try.
01:21:58:00	One of my brothers was among them.
01:22:01:00	We don't know if he's dead or if he was recruited by the devil.
01:22:06:00	All I know is what I was told as a child.

01:22:15:00

Dodom is built directly on Erta'Ale's lava flows. For a few hours, the village will be our base camp. We will set off from here to climb the volcano.

01:22:32:00 / Nicolas

How long will it take to get up there?

Jean Louis

No idea. Some people reckon 8 hours, others 6. You'll see, it'll be magnificent.

01:22:42:00

Abdallah is still keeping us company. He wants to go with us to the volcano. But before we leave, he also wants to tell us what he knows... or rather, what he believes.

01:22:52:00: Subtitles

01:22:52:00	It's the fire that came out of the mountain.
01:22:55:00	We can see it, because a mountain exploded one day.
01:22:58:00	The uneducated people of the Dodom region say it was the devil's fire,
01:23:07:00	that the fire was lit by the devil.

01:23:17:00

For the first time, we will attempt to approach the volcano by land which so far has only ever been reached by helicopter.

01:23:25:00

Taking stock of the terrain on foot is all part of the geologist's job.

01:23:56:00

We leave in the early hours. The distance to cover is not enormous - around 24 kilometers. But we have to make the most of the relative cool of the night. Here, temperatures in the sun can exceed 50 degrees Centigrade. Even the camels suffer in heat like this and refuse to walk during the day.

01:24:51:00

The camels carrying our equipment are having trouble walking on the lava flows.

01:24:57:00

We walk slowly for hour after hour. We have been climbing the very gentle slopes of the sides of the volcano for almost seven hours now at the speed of the caravan... and the summit seems to be continually receding.

01:25:32:00

Suddenly and without warning, the gentle slope is abruptly cut by a vertical cliff. We are on the edge of the caldera that tops the volcano.

01:25:47:00

From the summit, we can truly appreciate, for the first time, the morphology of the whole volcano.

01:26:02:00

The volcano is topped by an elliptical caldera which stretches for 1.6 kilometers. It is pierced by two main craters. Between them is an area of fumaroles. It is in this caldera that we will be spending the next few days.

01:26:40:00

Despite their fears, our camel drivers cannot resist the temptation to go nearer the crater.

10:26:56:00 / Subtitles

01:26:56:00	Look. What's that over there?
01:27:00:00	It looks like it's moving.

01:27:20:00

Last night, Abdallah told us how the volcano is seen in the village. Today, he is standing in front of the reality of the crater.

01:27:32:00 / Subtitles

01:27:32:00	It's that volcano we've heard about.
	Now we can see it.
01:27:38:00	Inside it is fire.
01:27:40:00	It's dangerous, but beautiful.
	It doesn't look evil.

01:27:51:00

The sight of the lava lake reminds Jean-Louis of his first expedition in 1967 when, camped a few kilometers away from the volcano, he saw the top of the mountain glowing red. A few days later, he was the first to go down into the caldera.

01:28:06:00 / Jean-Louis

Once we had discovered the glow above Erta'Ale, the smoking mountain, three of us came by helicopter from Dodom: Marinelli, Borsi and myself. When we arrived, we made a surprising discovery: there wasn't one lava lake, but two.

To get a better view, Giorgio Marinelli lay down on the edge, and Borsi kept hold of his feet. There were two large fissures on each side of them which met just in front of me. Marinelli was busy photographing and observing the lava lake. When they stood up and came back toward me, I showed them the fissures, and it gave them a shock.

01:28:50:00 / Jean-Louis

Things have changed a lot since. The little lake had steep edges with lava right to the top. The second over there was completely full, with little ramparts. And now, we have a single lava lake here - this one.

01:29:16:00

Active lava lakes are extremely rare. Today we only know of the existence of three... and Erta'Ale is the biggest.

Such dynamism is a constant source of wonder but also poses questions for the specialists.

01:29:31:00 / Jacques D.

A big fumaroles, here.

Jean-Louis

There was one there and then, when we were there, there was another here, at the side near the escarpment. But that one, though, is still in the same place.

Jacques D.

Yes. It's more cavernous. it's moving diagonally. The level of the lake suddenly went down by a meter, and you see, it's coming out. It's coming out on the two little round patches. See those two little patches?

Jean-Louis

Yes, indeed.

01:30:01:00 / Jacques D.

The big bubble's still appearing in that rather red area and there's subduction to the right.

01:30:30:00 / Jacques D.

I think it's important that Luigi coordinates the whole thing so he needs to know where the teams are. So, to resume... Nicolas, what are you doing today?

Nicolas

We're going up on the outside of the caldera. We'll go down the slopes a short way to fix a GPS position on the north, a position on the south, and then the east and west.

Jacques D.

Jean-Louis, what about you?

Jean-Louis

I'm going to check out the fumaroles areas.

Luigi

He's going to hide in the gazes.

Jean-Louis

See the possible sites, and so on...

Jacques D.

And you're working with Isabelle on that.

Jean-Louis

Yes.

Jacques D.

So, Jacques and I will continue equipping the pit. We have to be operational to go down into the crater this afternoon.

After that, there's sound recording equipment that needs to be set up with Nicolas. That'll be tomorrow, I suppose.

Nicolas

Tomorrow morning.

Jacques D.

Something we all have to bear in mind is that we have 4 days ahead of us. We have 4 full days in the crater, so we have to make the best possible use of that time.

01:31:27:00

At dawn, Nicolas goes off to set up a GPS network to carry out detailed measurements of the volcano's deformations.

01:31:47:00

This first position, indicated by a nail secured in the rocky ground, will be a fixed point of reference on the volcano, and the beginning of a network of measurements.

01:32:09:00

The GPS's antenna enables it to communicate with a series of satellites. Over the next few days, they will exchange thousands of measurements. This triangulation data lets us localize the points of reference to the nearest centimeter.

01:32:35:00

The same points will be measured again during a future mission. This will reveal the volcano's deformations.

01:32:48:00

While Nicolas goes off to install the other positions of his GPS network, Isabelle stops being a tectonics specialist and enters the world of volcanology. Jean-Louis teaches her how to find the best places to collect gas samples from the crater's fumaroles.

To collect good samples, you need to find the place where there is a large output of gas at the highest possible temperature. These samples can provide important information on the composition of the magma.

01:33:26:00 / Isabelle

That looks like a good one. What are you looking at?

Jean-Louis

It's the global composition of the gas. If we manage to get condensates, we can try to make isotopic ratio.

Isabelle

What's that's stinging and irritating my eyes?

Jean-Louis

Oh that... Maybe there's some chlorine.

01:33:49:00 / Jean-Louis

That's very concentrated. Well, it's rather diffuse, but...

Isabelle

So, we'll analyze that.

Jean-Louis

Yes. And then, the whitish deposits could well be ammonium chloride. Because ammonium chloride's not uncommon.

There is a fair amount coming from the bottom. If we manage to make a little cavity, put in the tube, then seal it off, there's a good chance it won't be too bad. Because there's a lot coming out. What's more, the advantage is that it's exposed to the wind, so we can work without completely suffocating.

01:34:35:00

With Jacques Barthélemy and Mohammed Abdulkader, I prepare the equipment we need to go down into the active pit crater.

01:34:45:00

Many trips up and down the wall are necessary for the work we have to carry out beside the lava lake.

01:35:06:00 / Barthélemy

Turn it on.

Jacques D.

OK, I'm in line with the pulleys.

Barthélemy

Jacques... slightly unbalanced.

Jacques D.

More slack to the left... I mean, the right.

Barthélemy

I'll shorten it...

01:35:23:00

The pit is about 100 meters deep, and the first 80 meters are vertical. The greatly fractured sides regularly collapse.

01:35:42:00

While Nicolas goes to measure other GPS positions, I get ready to go down into the active pit crater for the first time.

01:35:51:00

The task in hand is to eliminate the most unstable blocks from the rock face.

01:35:55:00 / Barthélemy

Let's test the radio.

01:35:58:00

Then, it has to be secured, in other words, I have to install the equipment we need to go down into the crater.

01:36:06:00 / Jacques D.

Don't speed up, Mohammed.

01:36:13:00 / Barthélémy

Just hang from the rope.

Jacques D.

OK.

01:36:26:00 / Jacques D.

6 meters from now, I'll say, "Stop". I'm nearly at the first pile of loose rock and I'll clean it up a bit.

Barthélémy

Copy.

01:36:34:00 / Jacques D.

I've reached the first block.

01:37:10:00 / Jacques D.

Stop, stop.

01:37:13:00 / Jacques D.

Stop, stop. OK, go on.

01:37:18:00 / Barthélémy

Are you there?

Jacques D.

I'm at the top of the pile of fallen rocks. Give me plenty of slack so I can move away from the side. OK, I'm at the bottom. Well, I'm really pleased to be here, I can tell you. Thanks, everyone. I've been waiting for this moment for 7 years. I think the rock face is more unstable than what we're used to, because there's a great deal of collapsed rock on the side.

01:37:51:00 / Jacques D.

I'm becoming aware of the reflection from the lava lake. I'm beginning to feel the heat. I'm now 12 meters above the lava lake. I think I've already found a perfect spot for collecting samples. But we really, really have to protect ourselves. The heat radiating off it is very intense.

01:38:15:00 / Jacques D.

I'll see how far I can go.

Barthélémy

Night is falling, and I want you to leave enough time to come back up.

Jacques D.

To be honest, I don't really want to go back up. I feel so good down here, I could stay all night.

01:38:38:00

Approaching a lava lake like this and walking freely by the side of it is a pleasure that it is difficult to bring to an end.

01:39:21:00 / Barthélémy

Jacques, come back up. Do you hear me?

01:39:27:00 / Jacques D.
OK.

01:39:51:00 / Jacques D.
Easy, Jacques.
It's OK.

01:40:00:00 / Barthélémy
We can turn off the motor.
How did it go?

Jacques D.
It went well.

Barthélémy
You're hot, huh?

Jacques D.
Oh, yes. The thing with the Tyrolean traverse is that you're blown all over the place. Even if a stone falls, it'll fall between the person coming up and the rock face.

01:40:18:00
So now, the equipment is in place in the active crater. Tomorrow we can embark on the most important phase of our mission: collecting various samples.

01:41:06:00 / Barthélémy
Here we go. Ready...

01:41:18:00 / Barthélémy
Take your right hand off the rope.

01:41:21:00
Each of the researchers working at the bottom of the active crater has to get past the cliff. The equipment now being used makes this task almost comfortable.

01:41:34:00 / Barthélémy
Let it come... Slowly, now...

01:41:51:00 / Nicolas
Give me some slack.

01:42:03:00
Whatever the researchers' scientific motivations, the sight of the lava lake always holds the same fascination. Each time we go down, we feel inevitably drawn to it.

01:42:26:00
In the lake, the mass of molten lava is whipped up by gas bubbles rising from the depths. When these bubbles reach the surface and burst, they make a distinctive sound, a large proportion of which is inaudible to our ears.

01:42:49:00
Recordings of these sounds at various frequencies, deciphered and analyzed in the laboratory, should tell us more about the dynamics of the lava lake.

01:43:23:00

On the edge of the northern crater, fumaroles emit most of the volcano gases. The analysis of the gas, together with the analysis of the lava, will give us a better understanding of the composition of the magma.

01:43:40:00

To collect good samples, we need to find the place where there is a large output of gas at the highest possible temperature.

01:43:51:00 / Jean Louis

Right, can you hold it?

Isabelle

Yes, OK.

01:44:10:00 / Jean Louis

So, the first thing is to try to get rid of the air... before pushing this in and opening it... You saw that it went in all right. It's condensed inside, no doubt about it.

01:44:58:00 / Jean Louis

I think that's OK. Right, I'll close off the bottom of it.

Isabelle

There we are!

01:45:10:00

This gas sample will remain protected in this collection bottle until it can be analyzed in the laboratory. The variety of samples will provide us with additional information.

01:45:52:00 / Jean-Louis

Right, I'll now try a soda bottle. The soda lets us concentrate everything that does not condense, in other words, the acids stay in the soda, and then things like helium, etc. are concentrated in the empty part of the bottle.

01:45:52:00 / Jean-Louis

Right, we should now have the substances that don't condense. It was bubbling a lot, so it's working well. I think the soda's saturated now.

01:46:50:00

Tirelessly Nicolas continues to build up his network of measuring positions. Some of them are over 4 kilometers away from the edge of the crater. Sometimes he has to collect satellite data until long after nightfall.

01:47:16:00

Today I will try to collect samples from the molten lava lake.

01:47:58:00

The temperature of the lava lake exceeds 1,000 degrees Centigrade. It is essential to wear protective clothing due to the heat reflected. The suit is covered with polished aluminum which reflects the heat, rather like a mirror reflects light. The helmet has a window with a transparent gold-leaf coating.

01:49:09:00

The technique used to collect samples is very simple. A weight is attached to a steel cable, and the hot lava will collect on the weight thrown into the lake. Then, all that remains to be done is to pull up the line.

01:49:33:00

The rapid cooling of the sample prevents it from crystallizing and thereby making the various analyses to be carried out in the laboratory more complete and precise.

01:50:02:00

This magma which is now visible in the lava lake will help to create the plate which will become the bottom of the new ocean between Africa and Arabia.

This will occur in a few millions years, by which time Erta'Ale will be one of the volcanic islands emerging from that ocean.

Nobody knows today if the volcano will still be active. But, in the meantime, an Afar legend relates that in the backwash of the lava lake, you can hear a voice which draws you irresistibly into the crater of the Smoking Mountain.

01:50:57:00

END CREDITS

01:51:47:00

END

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"Birth of an ocean"

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