GEOROUTE 1

THE GEOLOGICAL TREASURE

ALGORRI

#GEOPARKEA

ALGORRI GEOROUTE

PRACTICAL INFORMATION

SL Gi 5001

DURATION

40 min

DISTANCE

1.52 km

ELEVATION DIFFERENCE

+46 m
-55 m

CIRCULAR

YES

geoparkea.eus

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((112))
SOS DEIAK

ALGORRI GEOROUTE

HOW TO GET THERE?

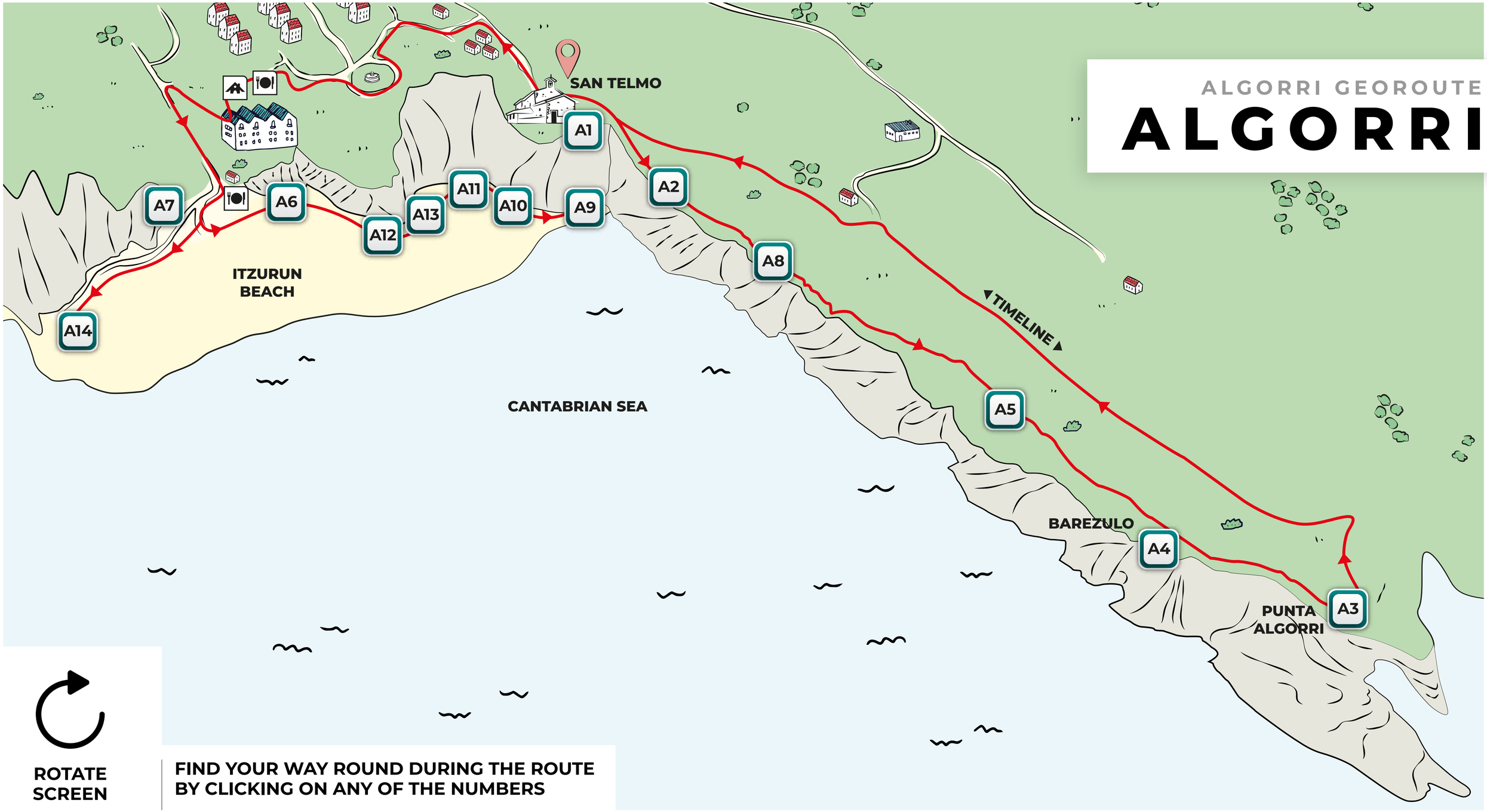
[View in Google Maps]

Starting point: San Telmo Hermitage.

Nearest town: Zumaia.

Coordinates: 43°17’56.2’’N 2°15’40.2’’W

Access: Zumaia is easy to reach by public transport or by car.
Once in the village follow the signs that will take you to the hermitage of San Telmo on foot.


ALGORRI GEOROUTE
ALGORRI
SAN TELMO
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
ITZURUN
BEACH
CANTABRIAN SEA
TIMELINE
BAREZULO
PUNTA
ALGORRI
ROTATE
SCREEN
FIND YOUR WAY ROUND DURING THE ROUTE
BY CLICKING ON ANY OF THE NUMBERS

INTRODUCTION

The Zumaia flysch is one of the great geological sanctuaries in the world. Travel back 60 million years and discover how the Pyrenees were formed, how dinosaurs became extinct or how it was one of the greatest periods of climatic warming in the history of the Earth.

ALGORRI GEOROUTE

This georoute has 14 points of interest identified with plaques on the route itself. Locate them and read the interesting explanations.

A1

HOW WAS THE FLYSCH FORMED?

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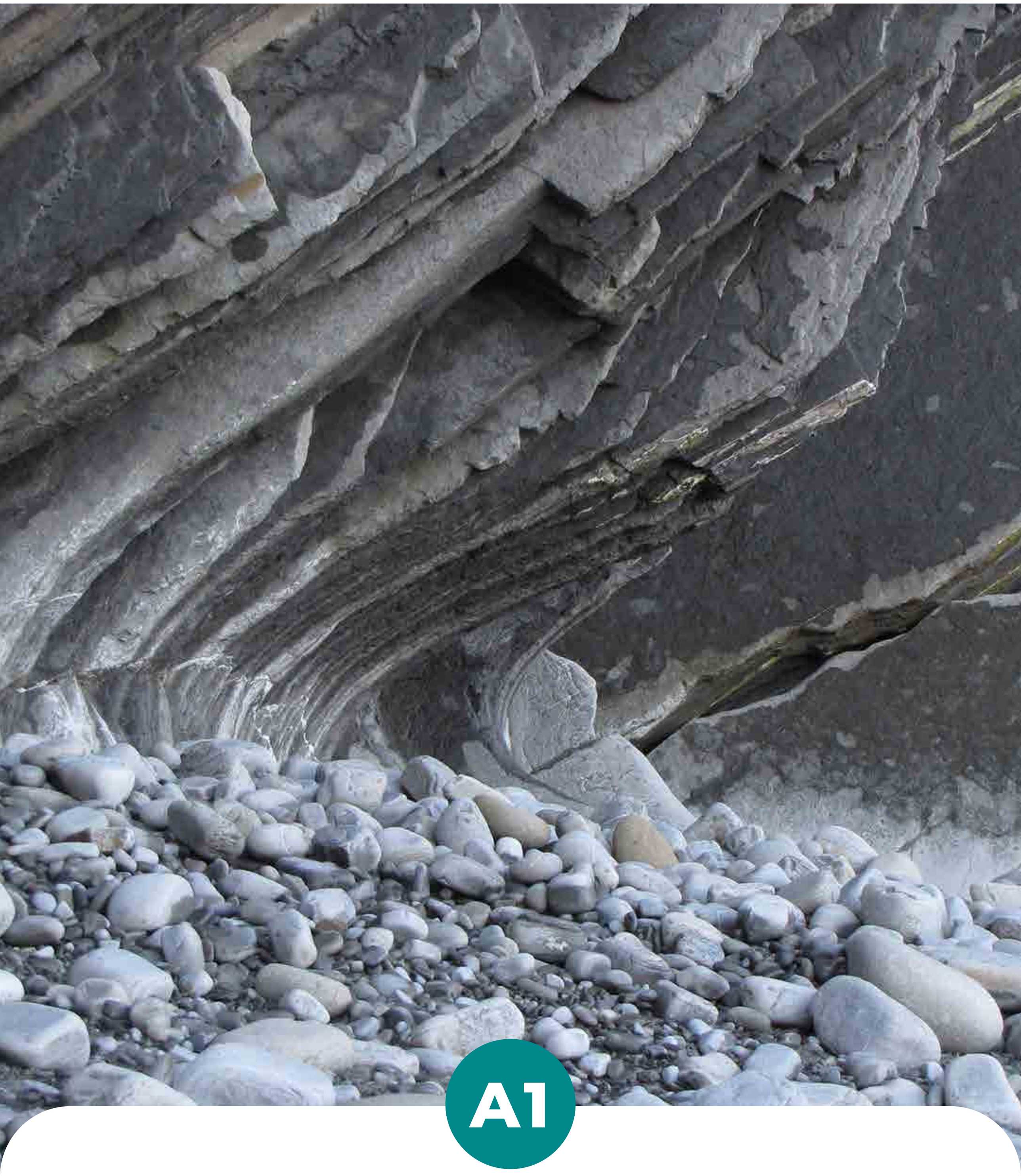
A1 HOW WAS THE FLYSCH FORMED?



The layers of the flysch were formed by the settling of sediments and small shells at the bottom of the sea. They are like **the pages of a great book** where we can read more than 50 million years of the Earth’s history.

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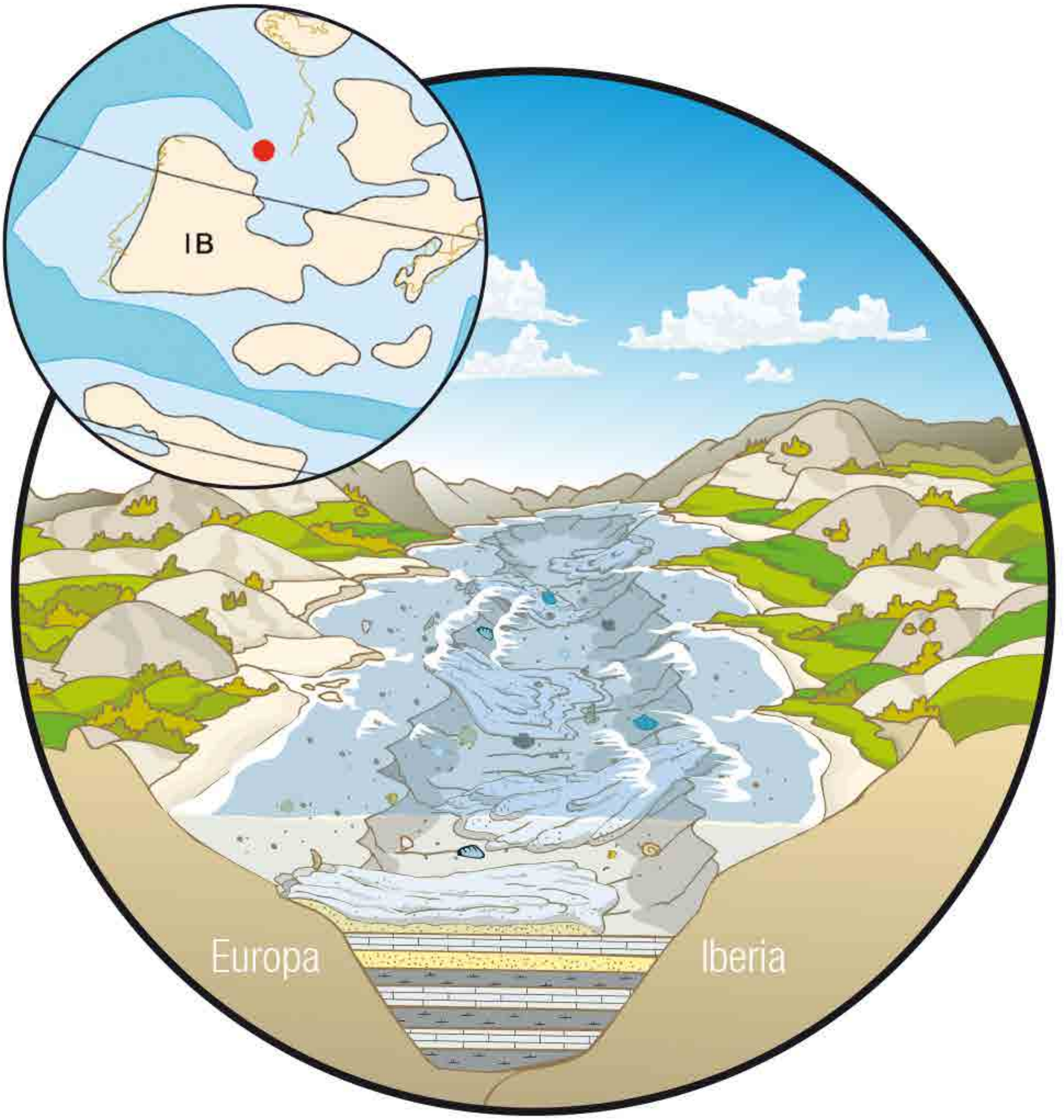
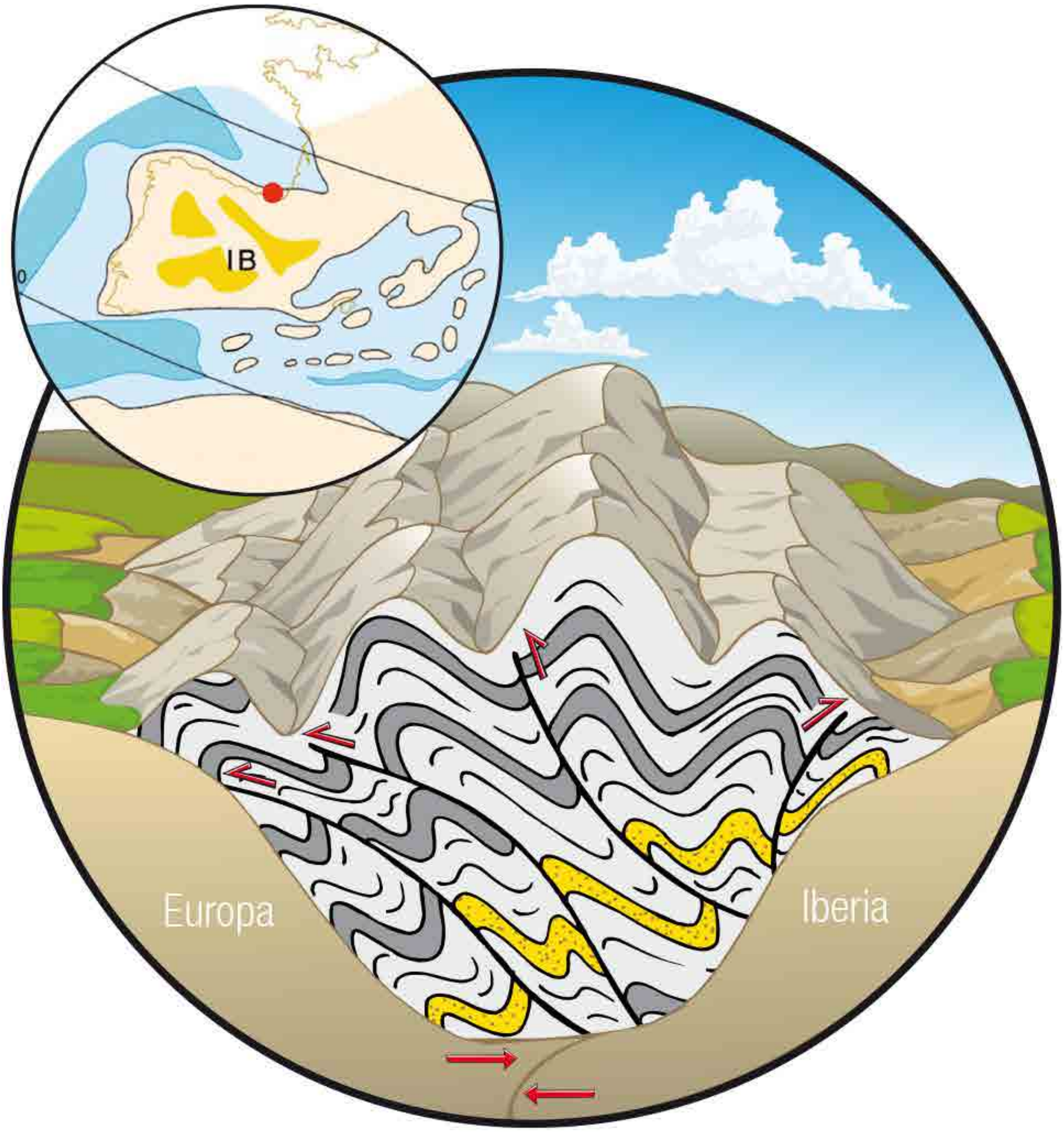
A1 HOW WAS THE FLYSCH FORMED?



Marl Limestone Sandstone

1. Settling of sediments at a depth of around 1000 m on the seabed.
100 – 50 million years ago

A1 HOW WAS THE FLYSCH FORMED?



2. Collision between Iberia and Europe and lifting of the layers.
50 – 10 million years ago

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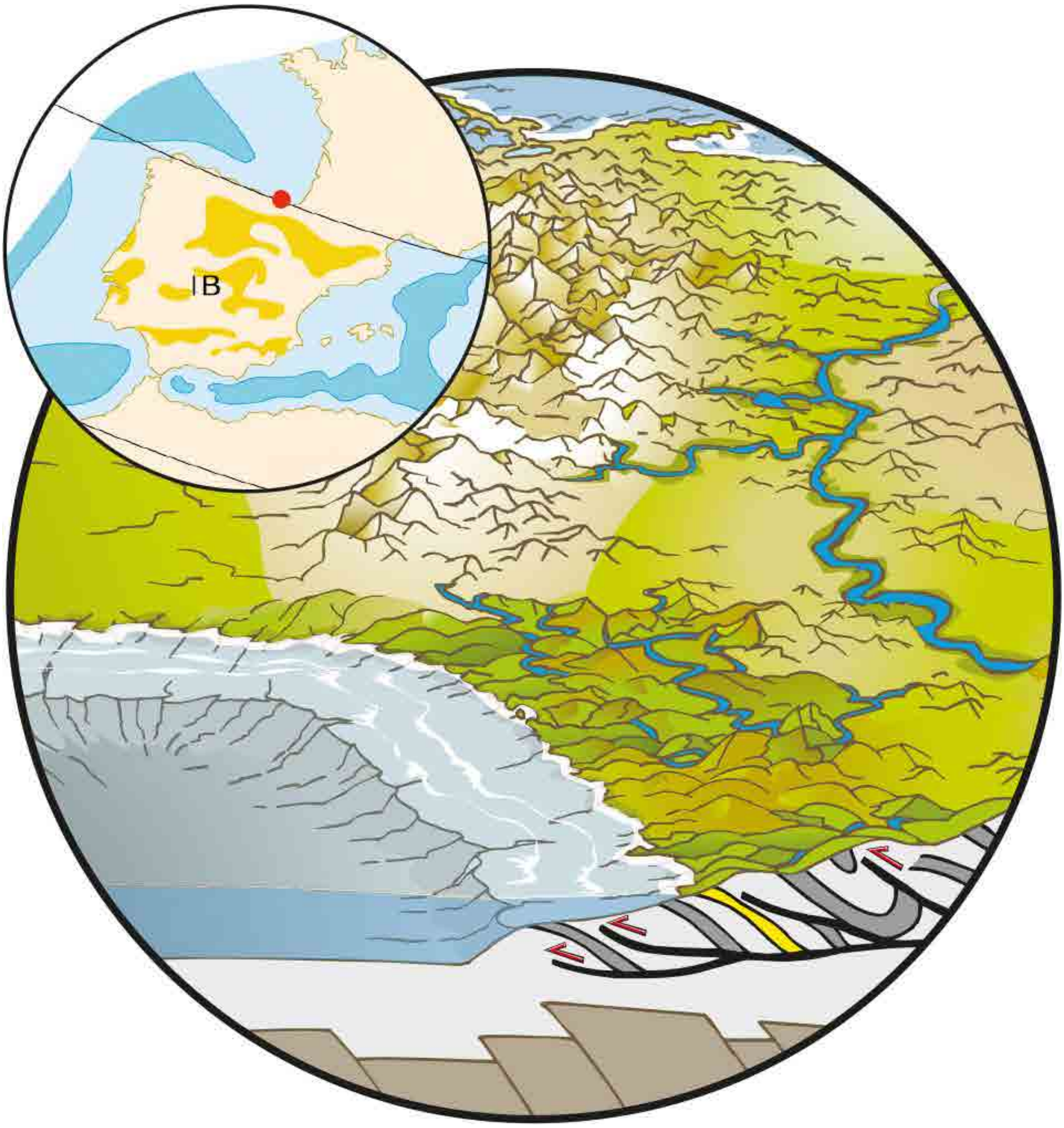
A1 HOW WAS THE FLYSCH FORMED?



3. Erosion and formation of the cliffs.

1-0 million years ago

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A1 HOW WAS THE FLYSCH FORMED?

If you look at the stone slabs of the Hermitage of San Telmo you can see the tracks of the organisms that crawled around on those seabeds.
There are thousands of them.
The flysch is one of the best natural museums for understanding **life in the ocean depths**.

A2

HOW WAS THE FLYSCH RAISED?

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A2 HOW WAS THE FLYSCH RAISED?

A2

The collision between Iberia and Europe lifted up the Pyrenees and produced great forces that were capable of folding the **rocks like plasticine**.

A3

HOW WERE THE CLIFFS FORMED?

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A3 HOW WERE THE CLIFFS FORMED?

A3

When the tide falls we can observe the **wave-cut platform**, a horizontal platform formed by the erosion and retreat of the cliffs.

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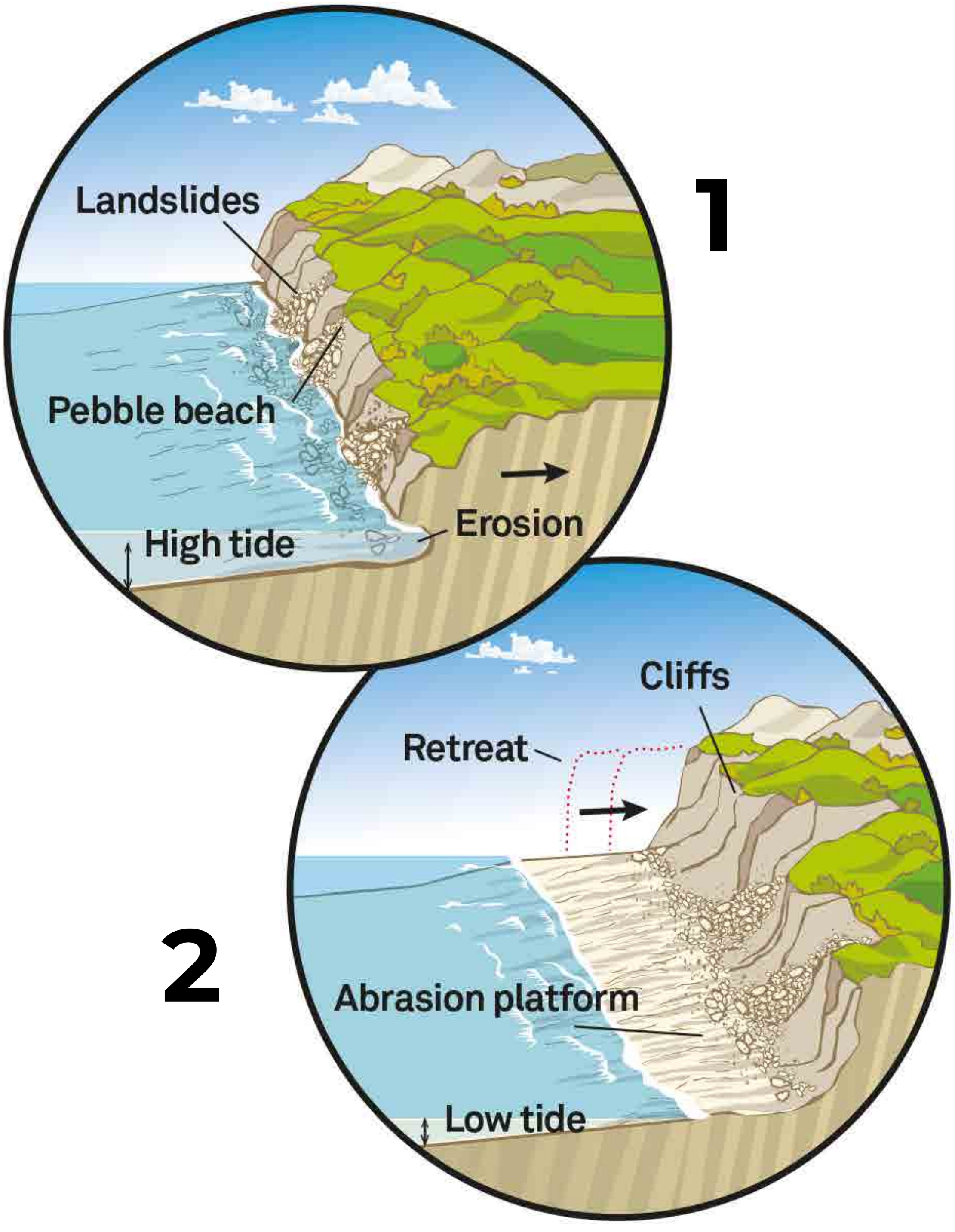
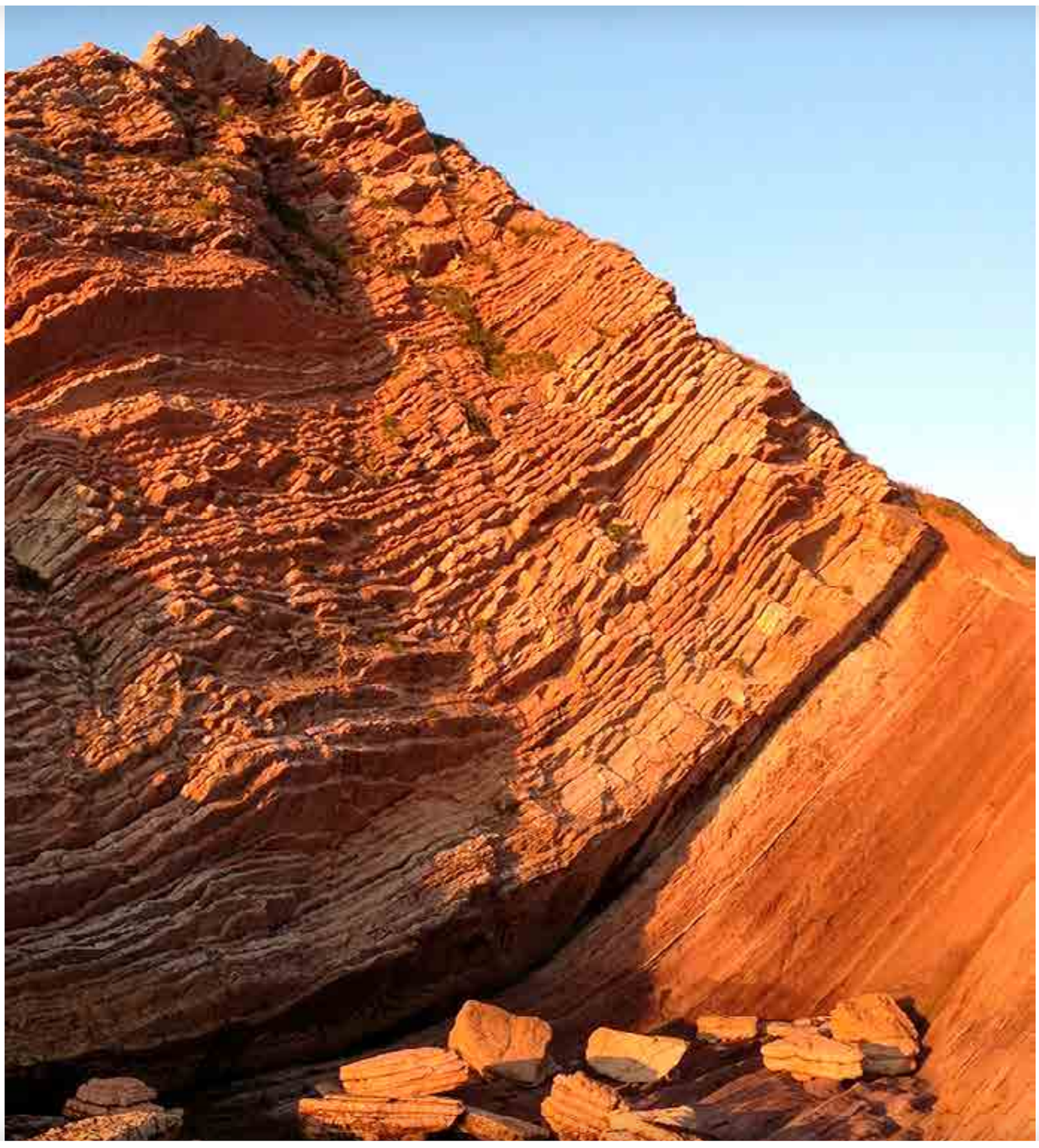
A3 HOW WERE THE CLIFFS FORMED?



1. EROSION
2. RETREAT

A PLATFORM FULL OF LIFE

The wave-cut platform is a protected natural space of enormous ecological value. Here the living conditions change twice a day with the tides.



HOW DID THE DINOSAURS BECOME EXTINCT?

In the cove of Algorri a thin black layer lies hidden. It has an age of 66 million years and in the 1980s it was the key to explaining the extinction of the dinosaurs due to the impact of a meteorite.

This great extinction is known as the **K/Pg boundary** because it marks the end of the Cretaceous Period and the beginning of the Paleogene.

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A3 HOW DID THE DINOSAURS BECOME EXTINCT?

The layer is only 2-3 millimetres thick but it contains some critical clues:

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A3 HOW DID THE DINOSAURS BECOME EXTINCT?

Globotruncana arca

100 microns

1. Extinction. More than 70% of the microfossil shells found in the previous layers suddenly disappear and never appear again.

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A3 HOW DID THE DINOSAURS BECOME EXTINCT?

2. A high concentration of iridium, a very scarce element on Earth but quite common in some meteorites. How could it get here?

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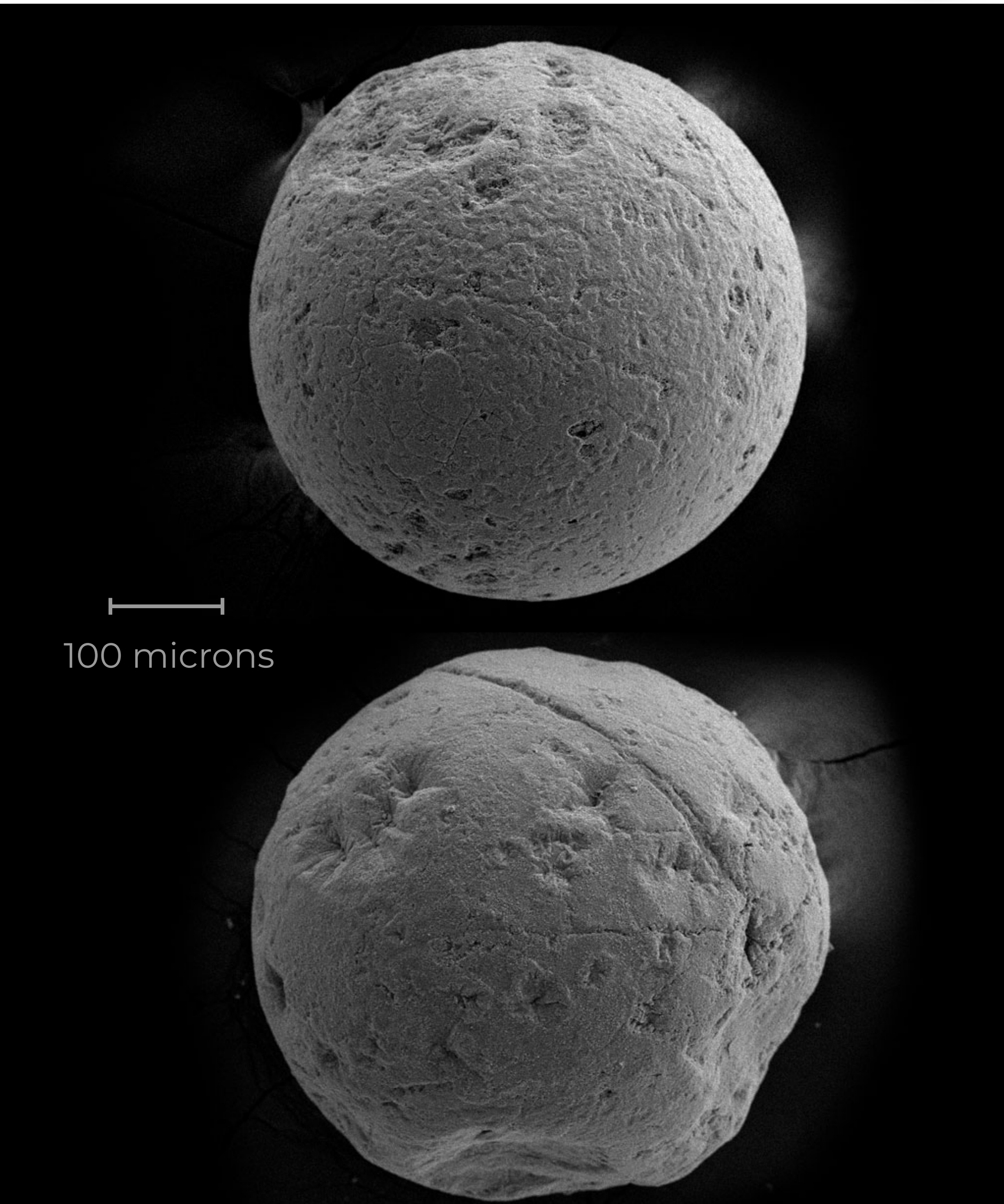
A3 HOW DID THE DINOSAURS BECOME EXTINCT?



3. Nickel-rich microspherules. These were formed by the rapid crystallisation of molten material from the impact zone.

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A3 HOW DID THE DINOSAURS BECOME EXTINCT?

4. **Soot** from great fires.

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A3 HOW DID THE DINOSAURS BECOME EXTINCT?

WHERE IS THE CRATER?

The **Chicxulub** impact crater is buried in the Yucatan Peninsula. It is 170 km in diameter and 66 million years old.

The meteorite was 10 km in diameter.

A4

IS THERE AN ORDER TO THE LAYERS OF THE FLYSCH?

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A4 IS THERE AN ORDER TO THE LAYERS OF THE FLYSCH?

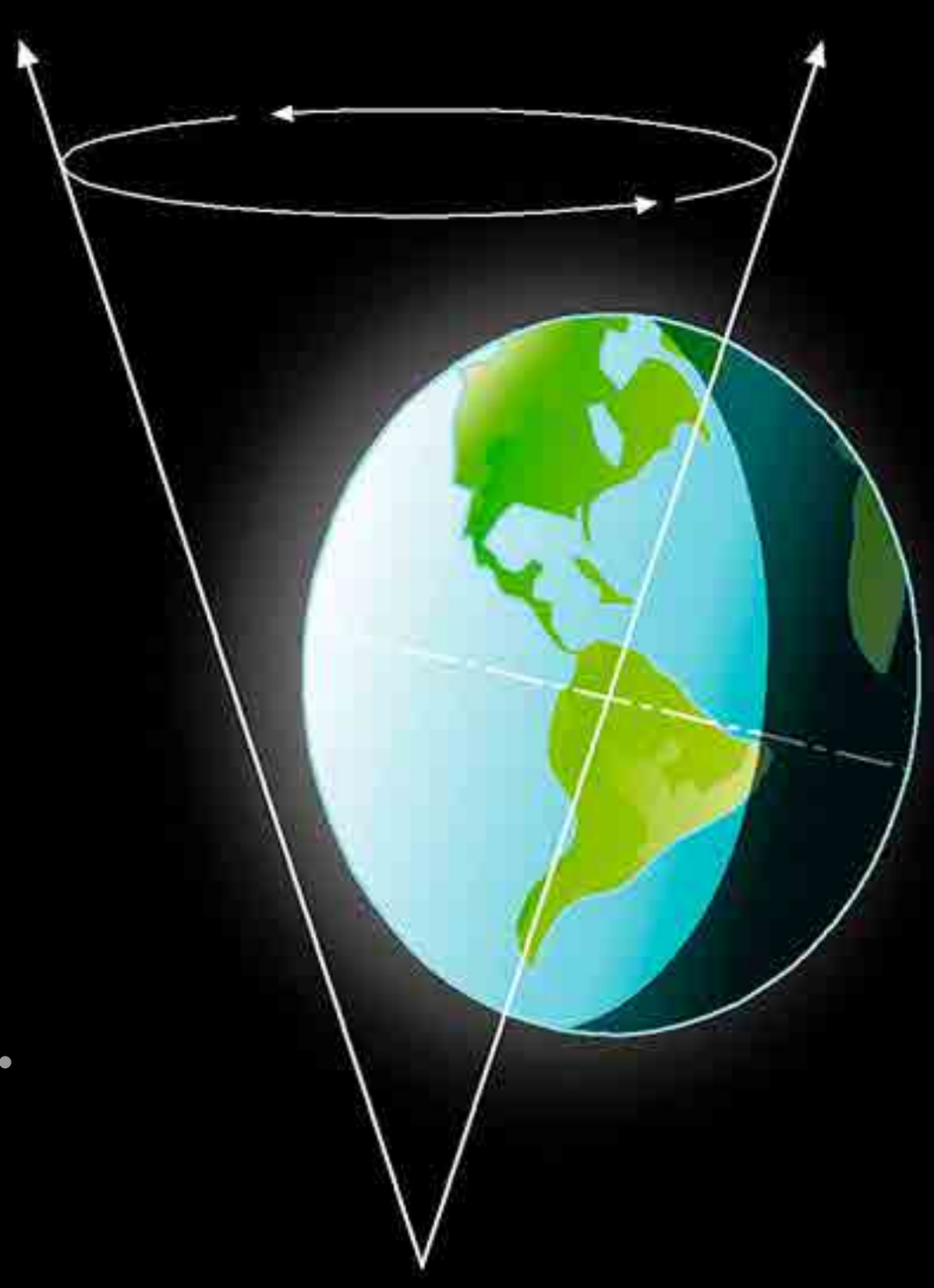
A4

Look at the base of the cliff. The layers of the flysch are arranged in pairs of **limestone** (harder) – **marl** (softer) and also in groups of 5 pairs.

Milankovitch astronomical cycles

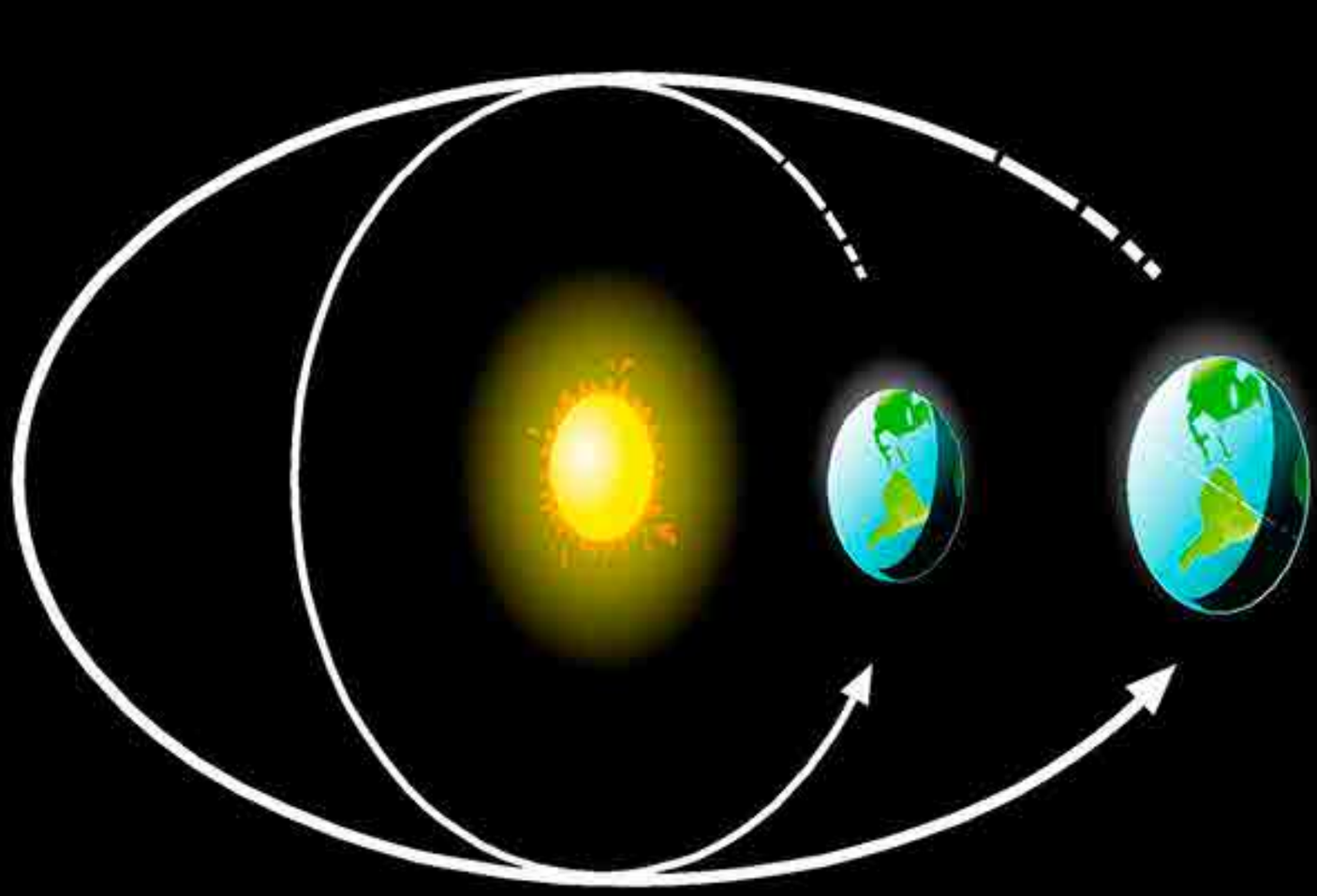
Precession ~20,000 years

A precession cycle gives rise to a limestone/marl pair.



Eccentricity ~100,000 years

An eccentricity cycle is made of five pairs.



This cyclical pattern is defined by the Milankovitch astronomical cycles which **condition the Earth's climate**.

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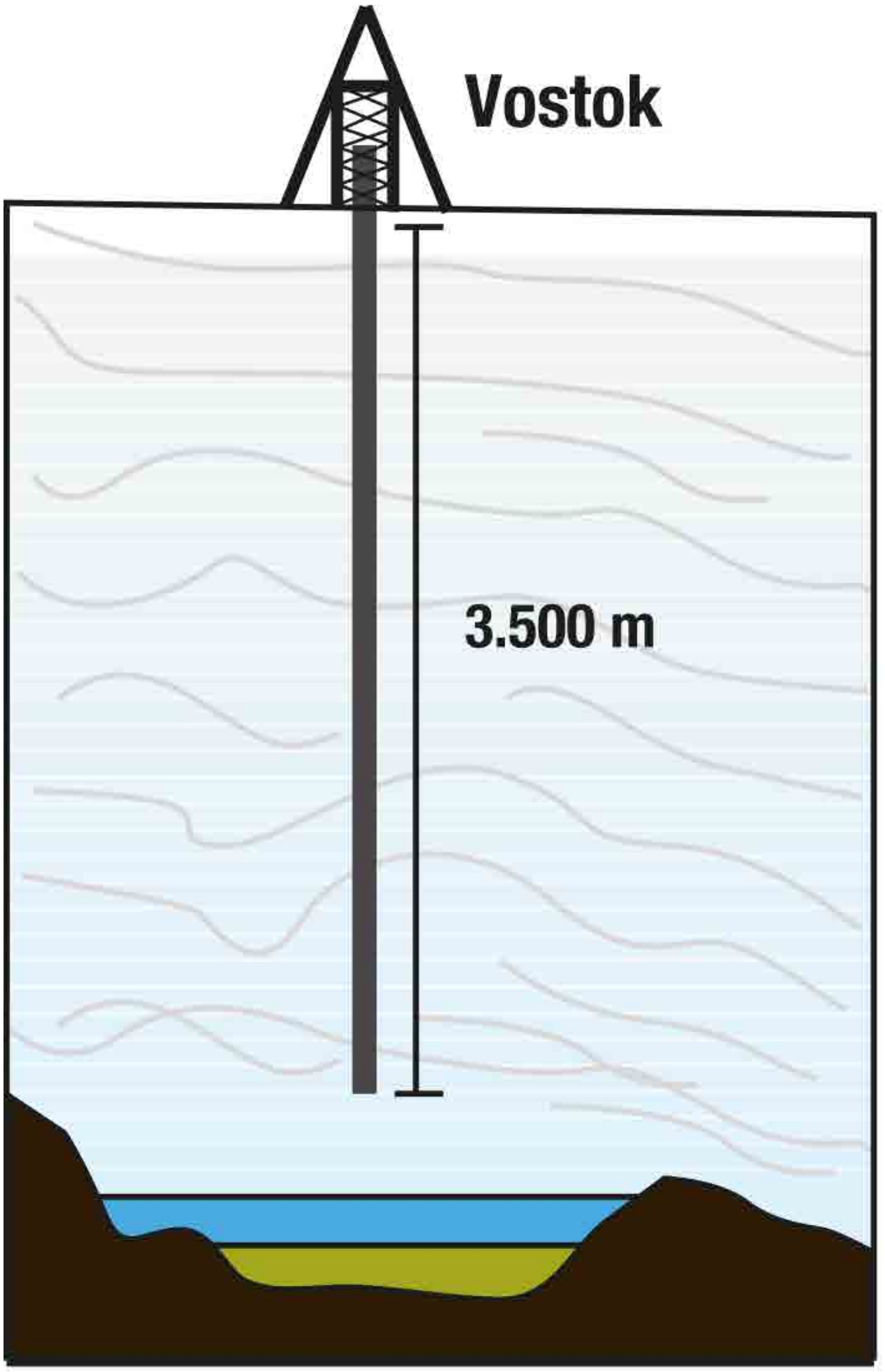
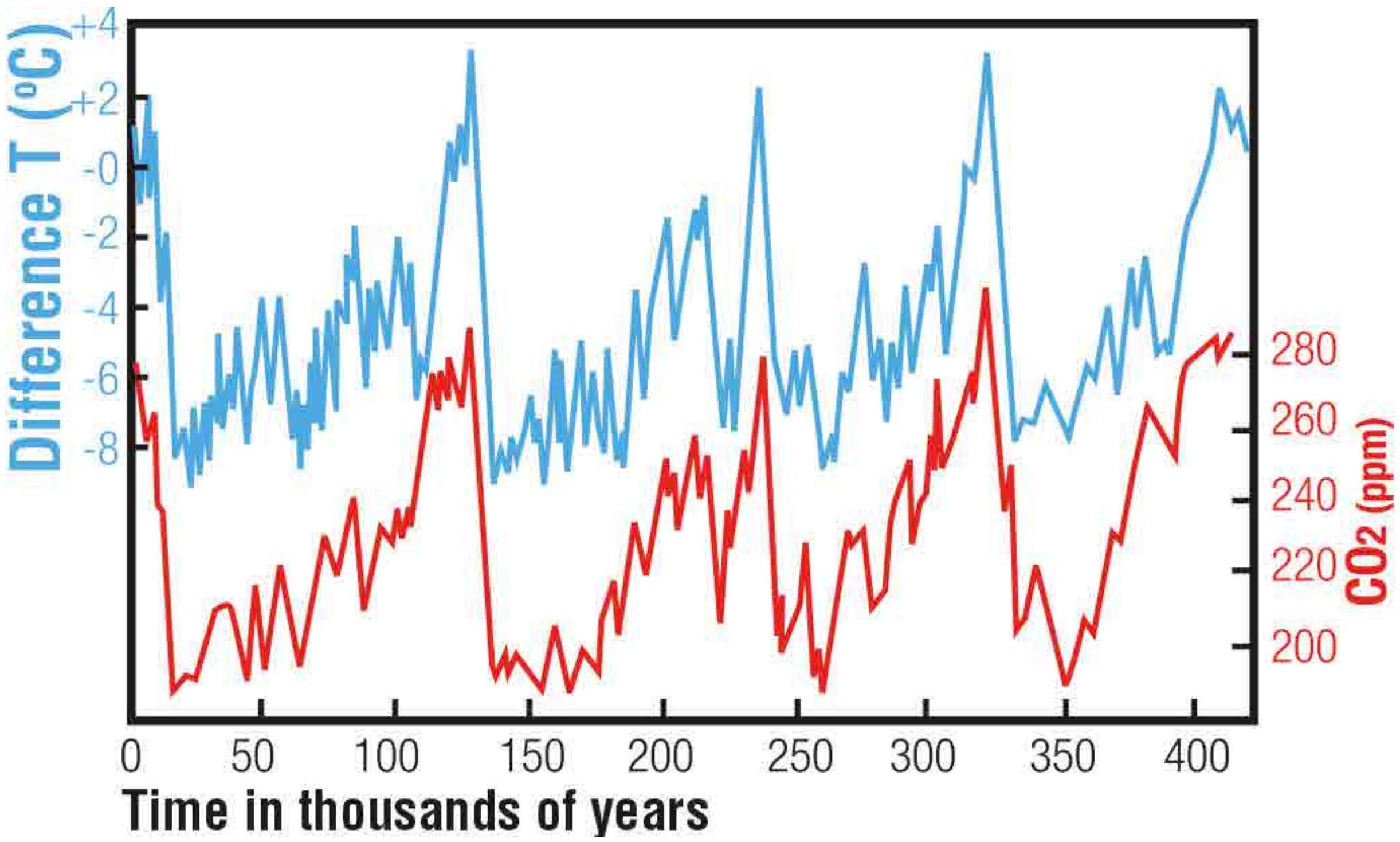
A4 IS THERE AN ORDER TO THE LAYERS OF THE FLYSCH?



This same cyclical pattern can also be seen in the CO_2 and temperature data of the **Antarctic** ice cores.

A4 IS THERE AN ORDER TO THE LAYERS OF THE FLYSCH?

Data from the Vostok survey



There is a clear **relationship** between **temperature** and the concentration of **CO_2** in the last 400,000 years. The climate has been changing every 100,000 and 20,000 years in a natural way.

A5

DID YOU KNOW THAT THE MAGNETIC FIELD OF THE EARTH CHANGES ORIENTATION?

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A5 DID YOU KNOW THAT THE MAGNETIC FIELD OF THE EARTH CHANGES ORIENTATION?

A5

The cylindrical samples are used to establish the **orientation of the Earth's magnetic field** at the time each of the layers was deposited.

A6

HOW IS GEOLOGICAL TIME DIVIDED?

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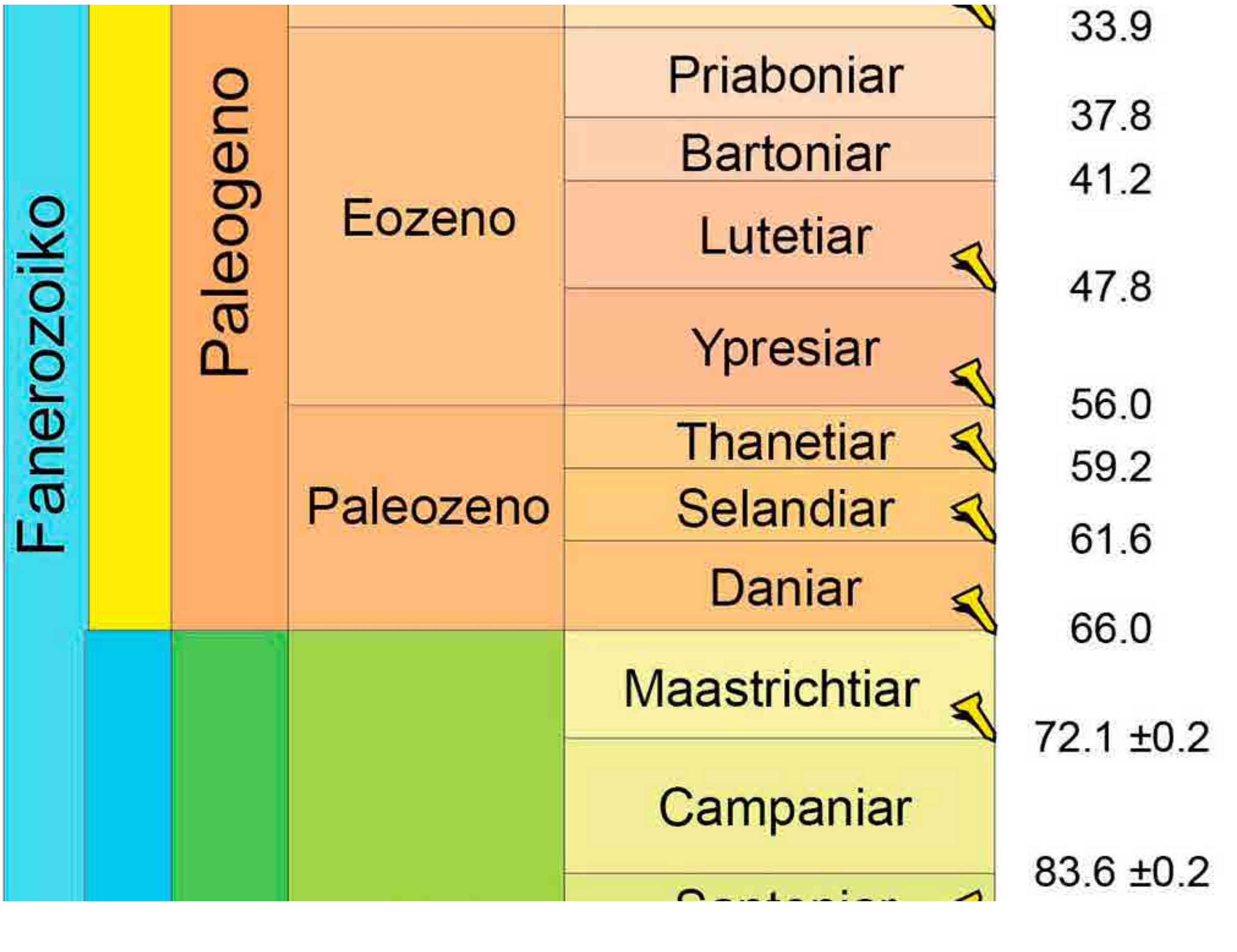
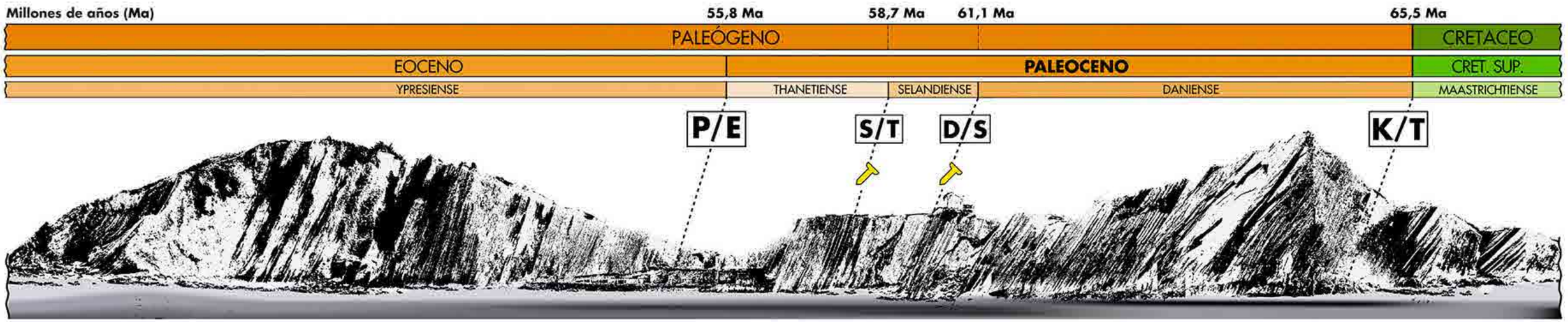
A6 HOW IS GEOLOGICAL TIME DIVIDED?



A6

The Earth has an age of 4,600 million years divided into chapters and sub-chapters. The boundaries between these are defined by events that we can recognise in the rocks.



ROTATE SCREEN

In Zumaia we can see **4 boundaries of geological history** and two of them are global boundary stratotypes. Go up to the panel at the entrance and see if you can find the golden spikes in the rocks.

A7

CLIMATE – COULD WE LEARN FROM THE PAST?

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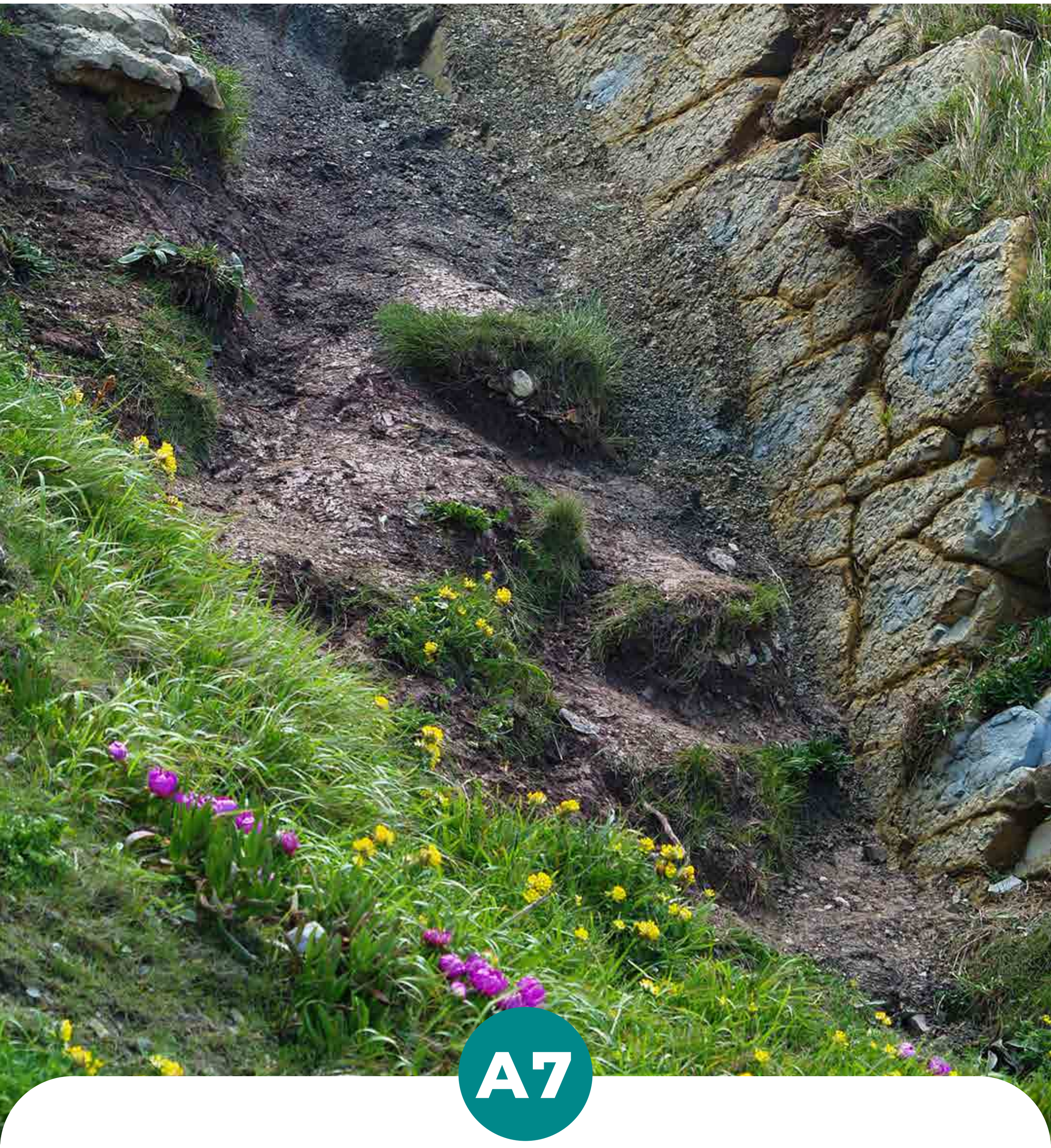
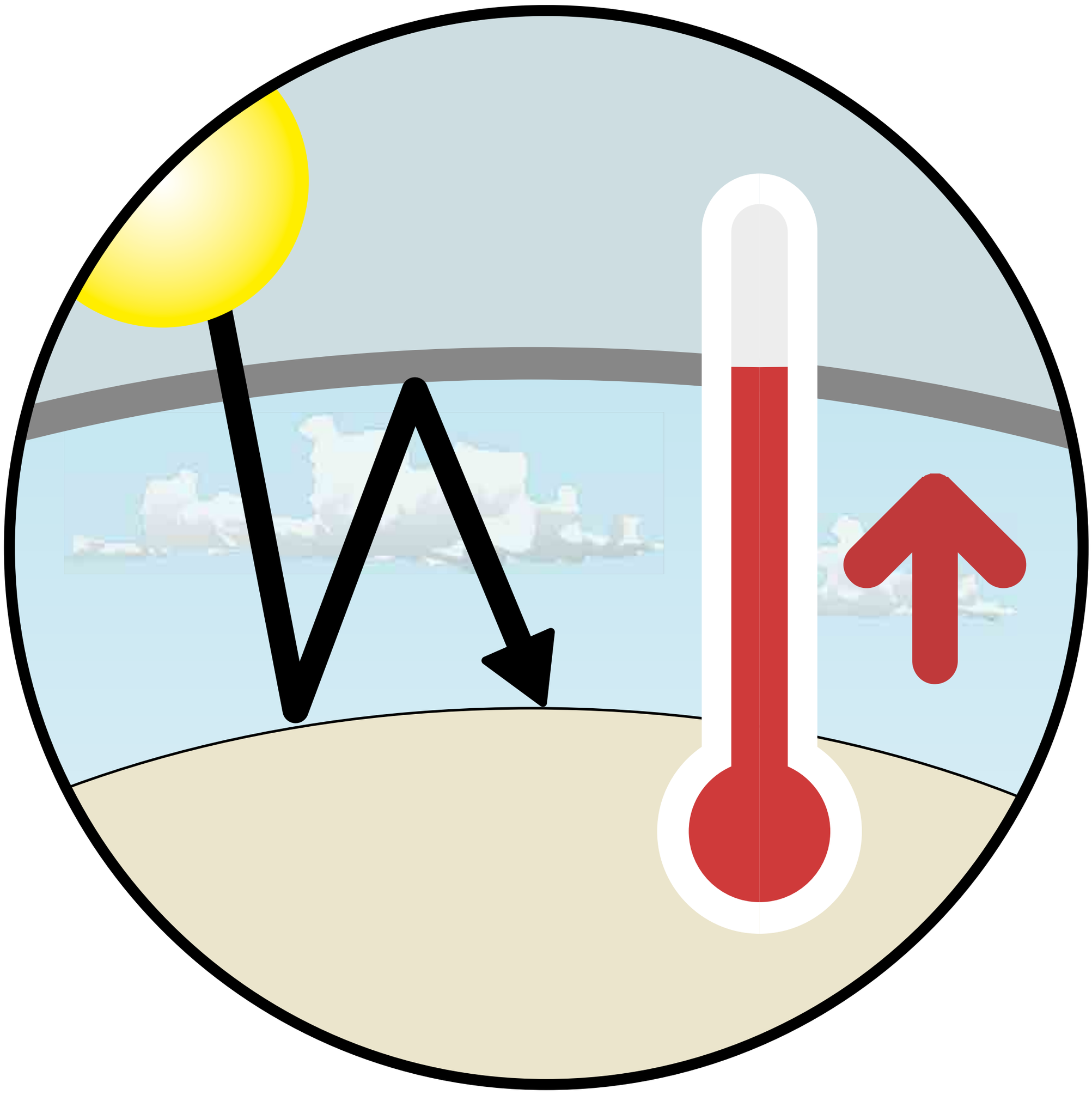
A7 CLIMATE – COULD WE LEARN FROM THE PAST?



A7

56 million years ago the Earth suffered one of the greatest warming events in its history and this was also due to the greenhouse effect. In geology it is known as the **Paleocene-Eocene Thermal Maximum (PETM)** and it can be seen in the red clays of Itzurun.

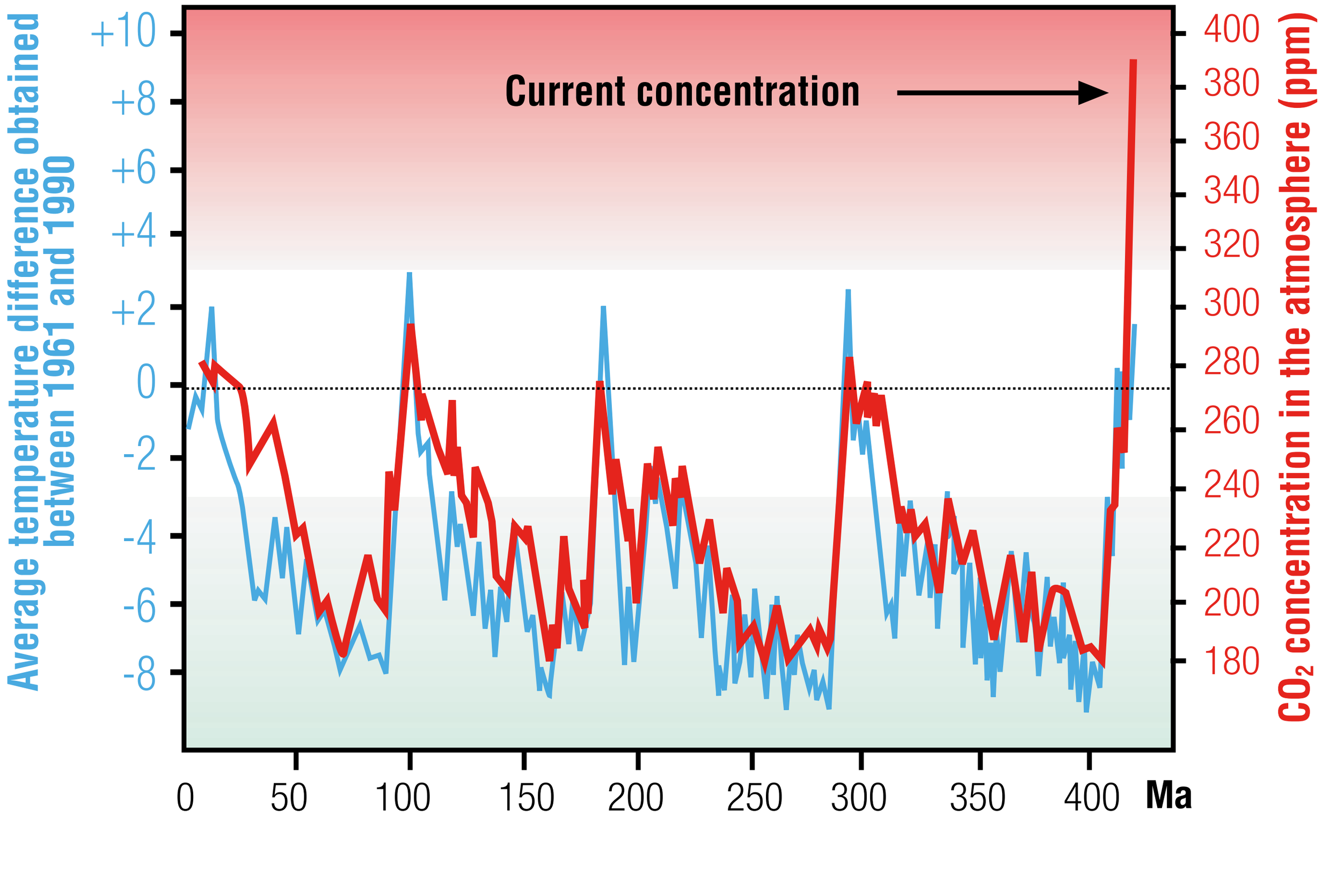


What happened?

1. A significant increase in carbon (CH_4) which produced a powerful greenhouse effect with temperature rises of more than 5°C.

2. Acidification of the oceans.

3. Important changes in the fauna, which had to adapt to the new climatic conditions.



Could it happen again?

The concentration of CO_2 has undergone a very notable increase in the last 100 years, rising to over 400 ppm.

This increase is related to the **burning of fossil fuels**.

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A7 CLIMATE – COULD WE LEARN FROM THE PAST?

If we carry on with the **“business as usual”** model, by the year 2100 the increase in greenhouse gases will be similar to what happened 56 Ma ago. Large amounts of “frozen” methane will be destabilised in polar regions and warming would be beyond our control.

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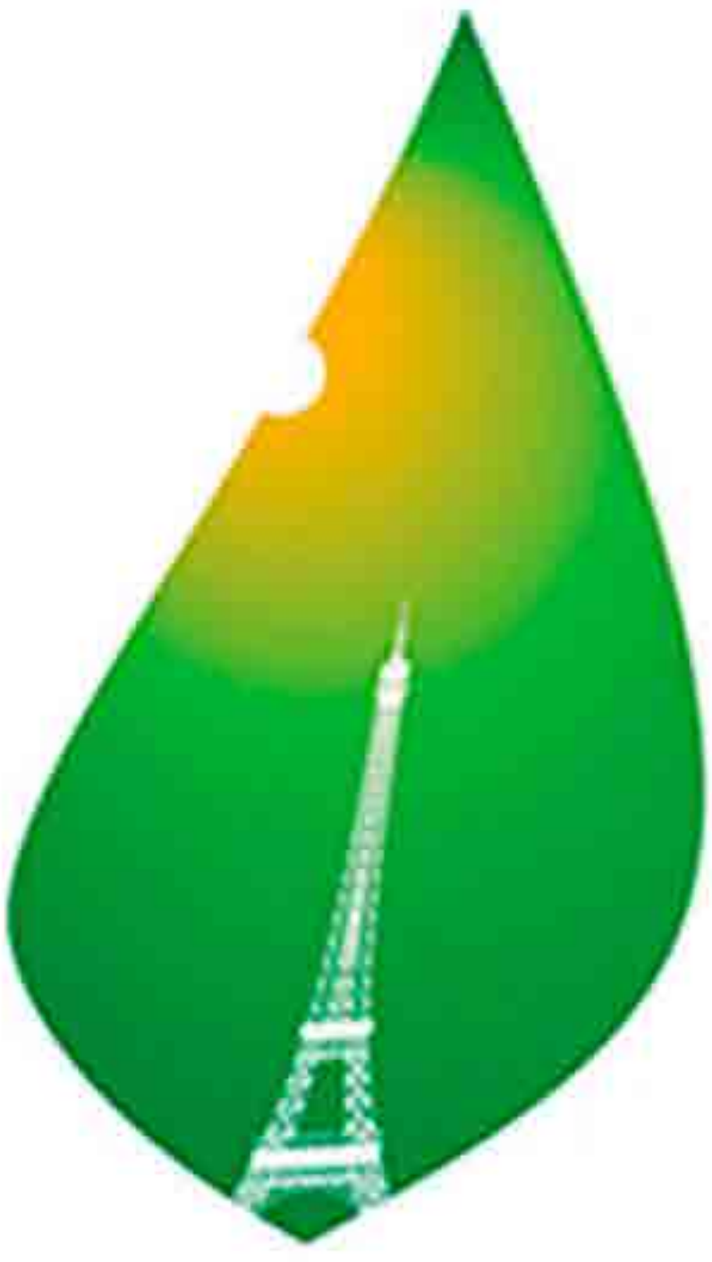
A7 CLIMATE – COULD WE LEARN FROM THE PAST?

One of the most visible effects of warming will be the **rise in sea level**. Millions of people live on small islands and in cities that will be flooded. Some of our beaches will disappear.

A7 CLIMATE – COULD WE LEARN FROM THE PAST?



PARIS2015
Conferencia de la ONU
sobre el Cambio Climático
COP21·CMP11

The Paris agreement (2015), signed by 195 nations, recommends **not increasing the temperature by more than 1.5°C** during this century.

To achieve this, we must change our consumption and travel habits, change the energy policy and invest in research and education.

A8

NATURAL STRUCTURES IN THE FLYSCH

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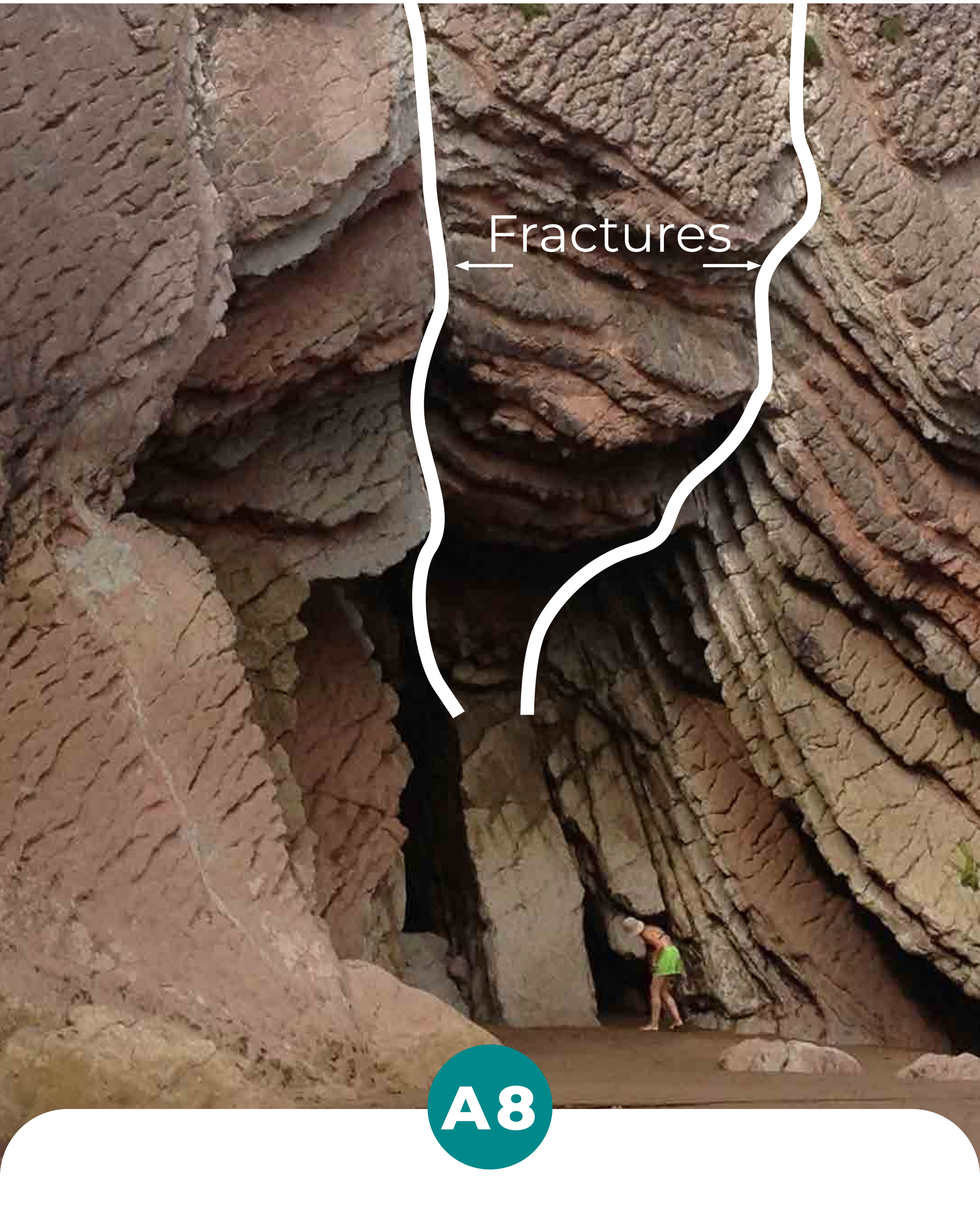
A8 NATURAL STRUCTURES IN THE FLYSCH



A8

The caves on Itzurun beach could not have been formed just anywhere. Look closely. The erosion occurs by taking advantage of **vertical fractures in the rock**.

A9

WHEN THE FLYSCH BREAKS

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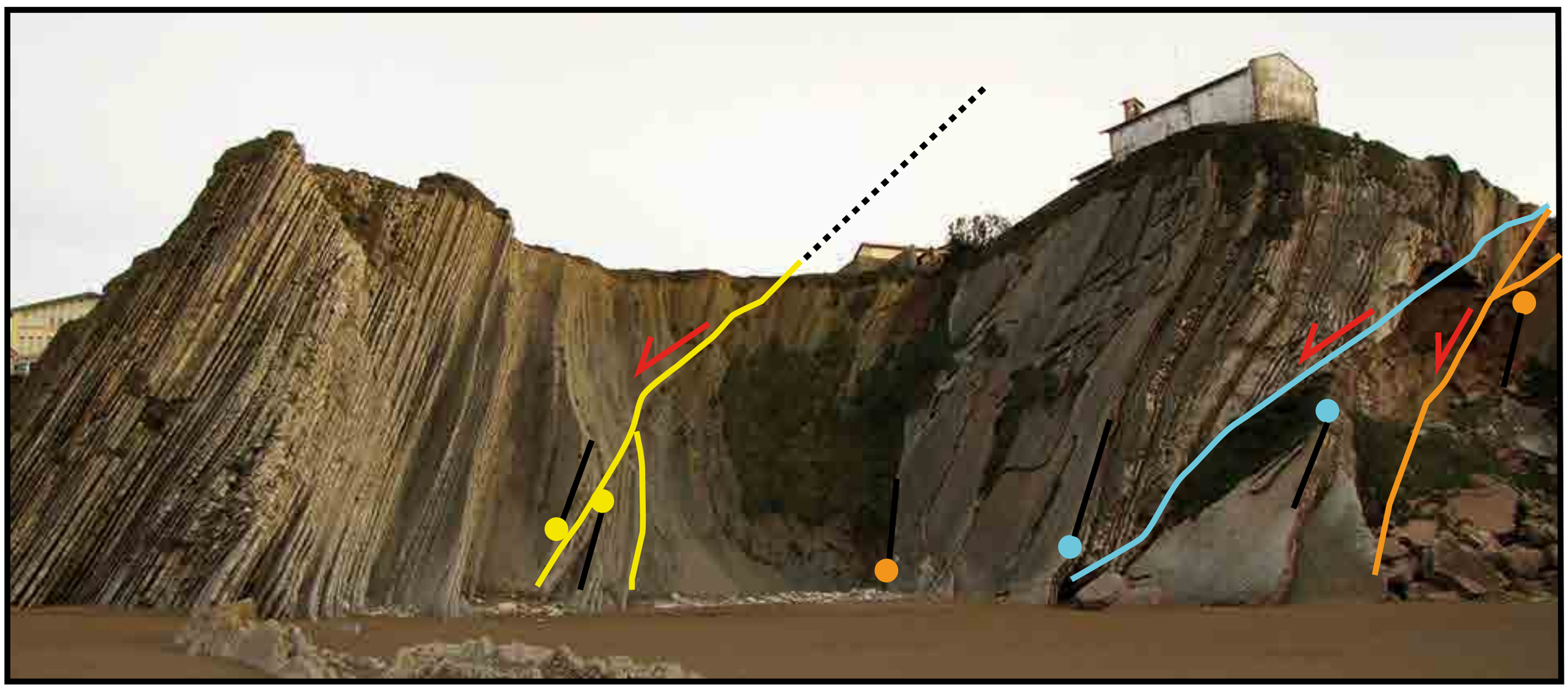
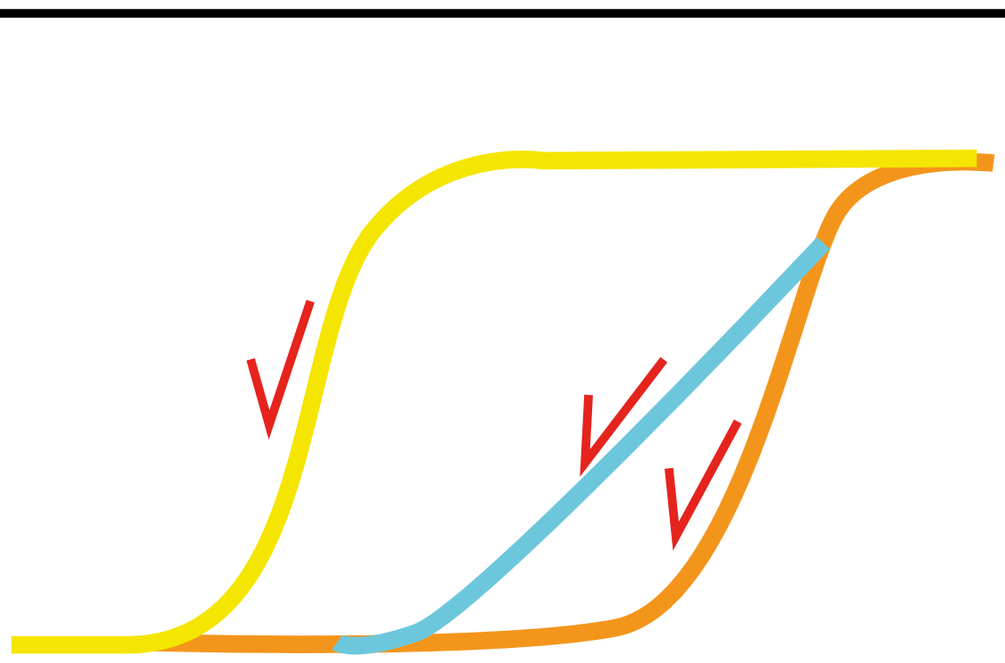
A9 WHEN THE FLYSCH BREAKS

The collision between Iberia and Europe compressed the flysch and caused a number of **faults** (fractures) which moved entire blocks of rock. Sometimes, the flysch repeats itself.

San Telmo duplex





Duplex structure

Diagram of the San Telmo faults. All the fractures are related to each other in a single structure known as a **duplex** in geological language.

WHAT WAS LIFE ON THE SEABED LIKE?

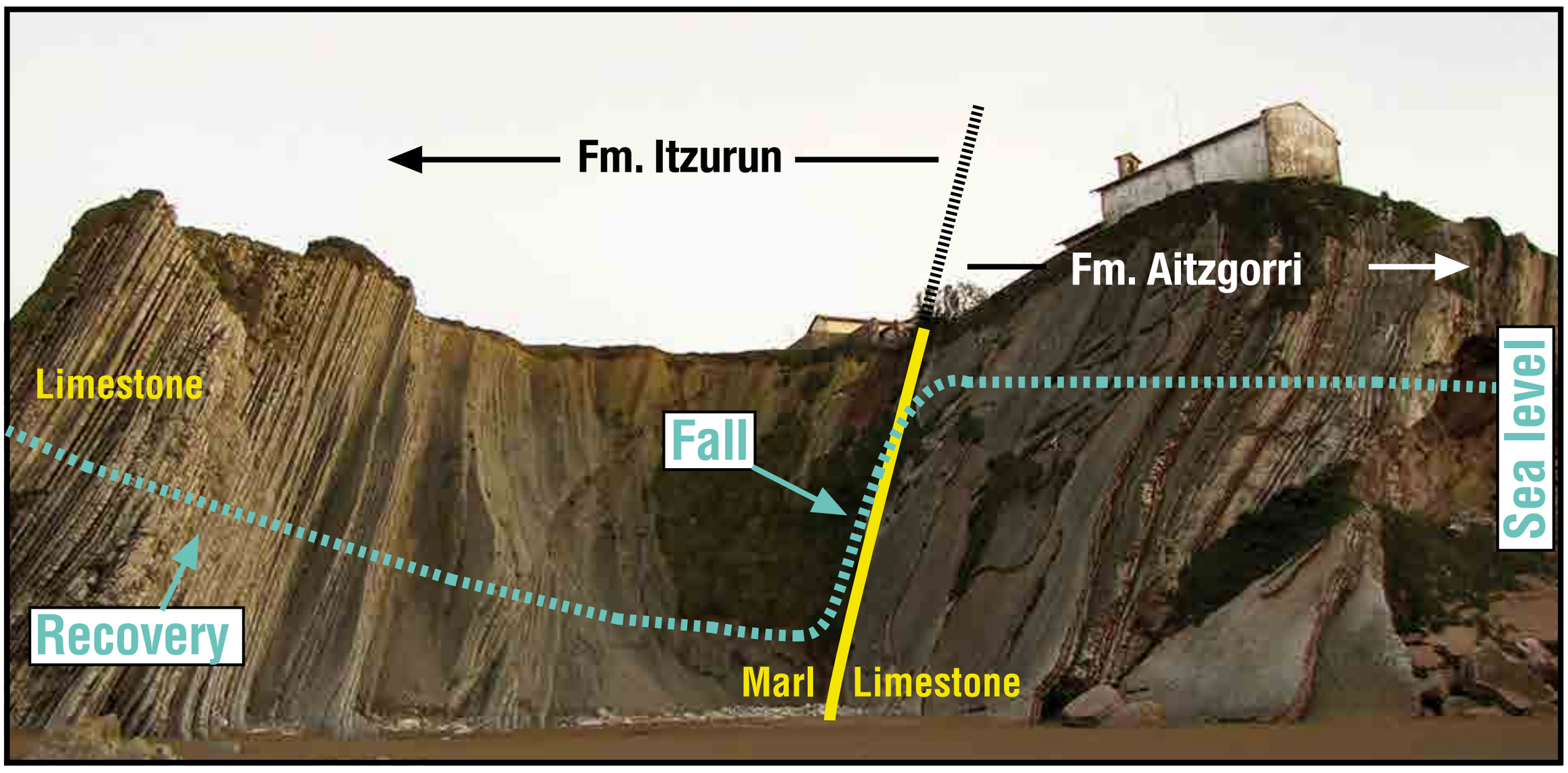
If you look closely at the last reddish strata you can see dozens of galleries that cross from one stratum to another. These are the tunnels dug by the organisms that lived in that clay seabed.

A10

WHY IS THERE SUCH A SUDDEN CHANGE IN THE ROCKS?

A10 WHY IS THERE SUCH A SUDDEN CHANGE IN THE ROCKS?

When the sea fells

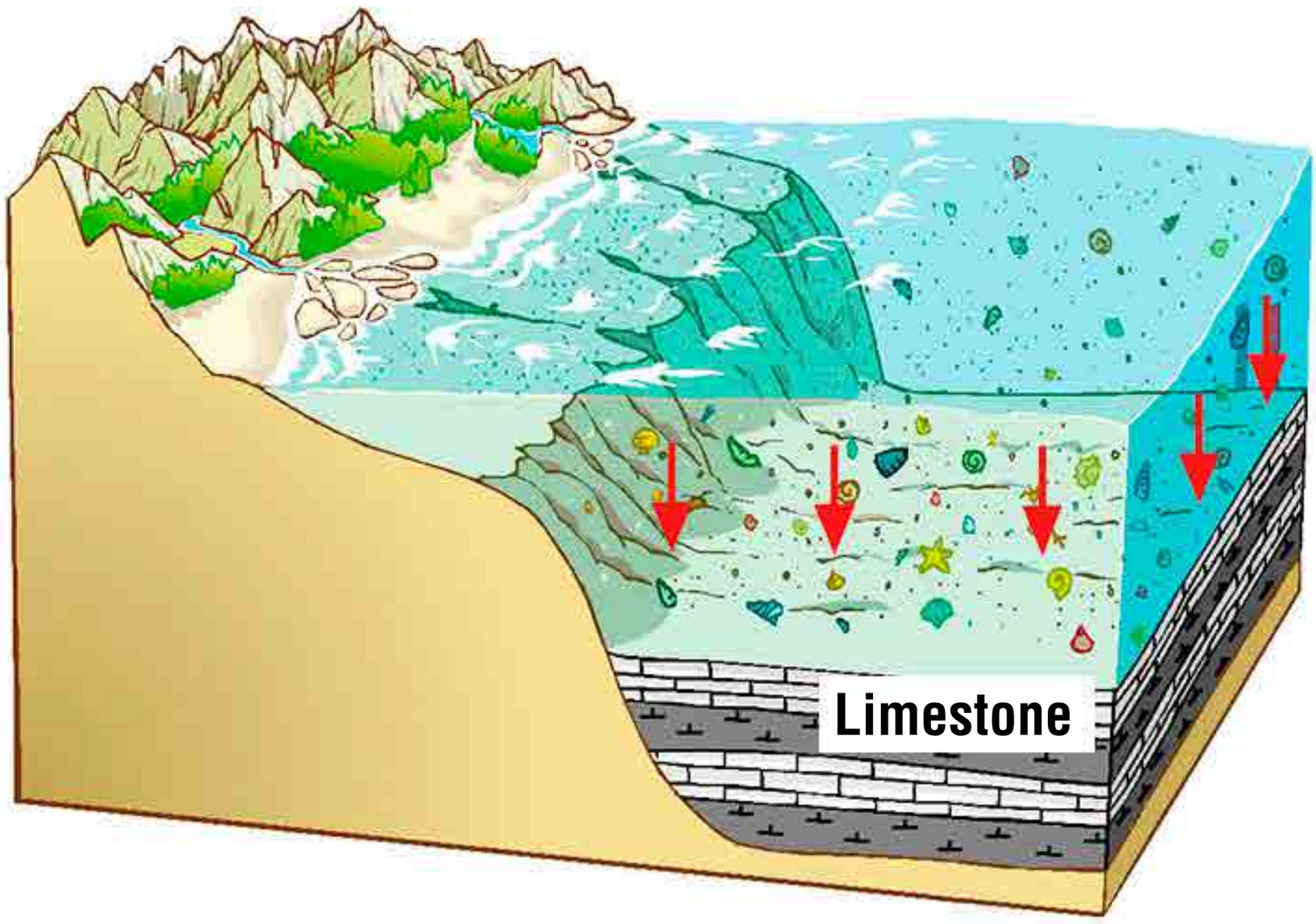


A10

61 million years ago the seabed sank, and **the sea fell by about 80 m**. The shallowest areas were exposed and all the sediments that had accumulated there were carried to the bottom of the basin where the flysch was forming.

A10 WHY IS THERE SUCH A SUDDEN CHANGE IN THE ROCKS?

Normal conditions



Drop in sea level

This addition of sediments makes the flysch clayier and softer.

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A10 WHY IS THERE SUCH A SUDDEN CHANGE IN THE ROCKS?

In 2010 the International Union of Geological Sciences (IUGS) placed a **golden spike** at this point. It is the global boundary stratotype between the Danian (reddish and more calcareous) and the Selandian (grey and clayey) and is dated at 61.6 million years ago.

A11

HOW DO THE FAULTS MOVE?

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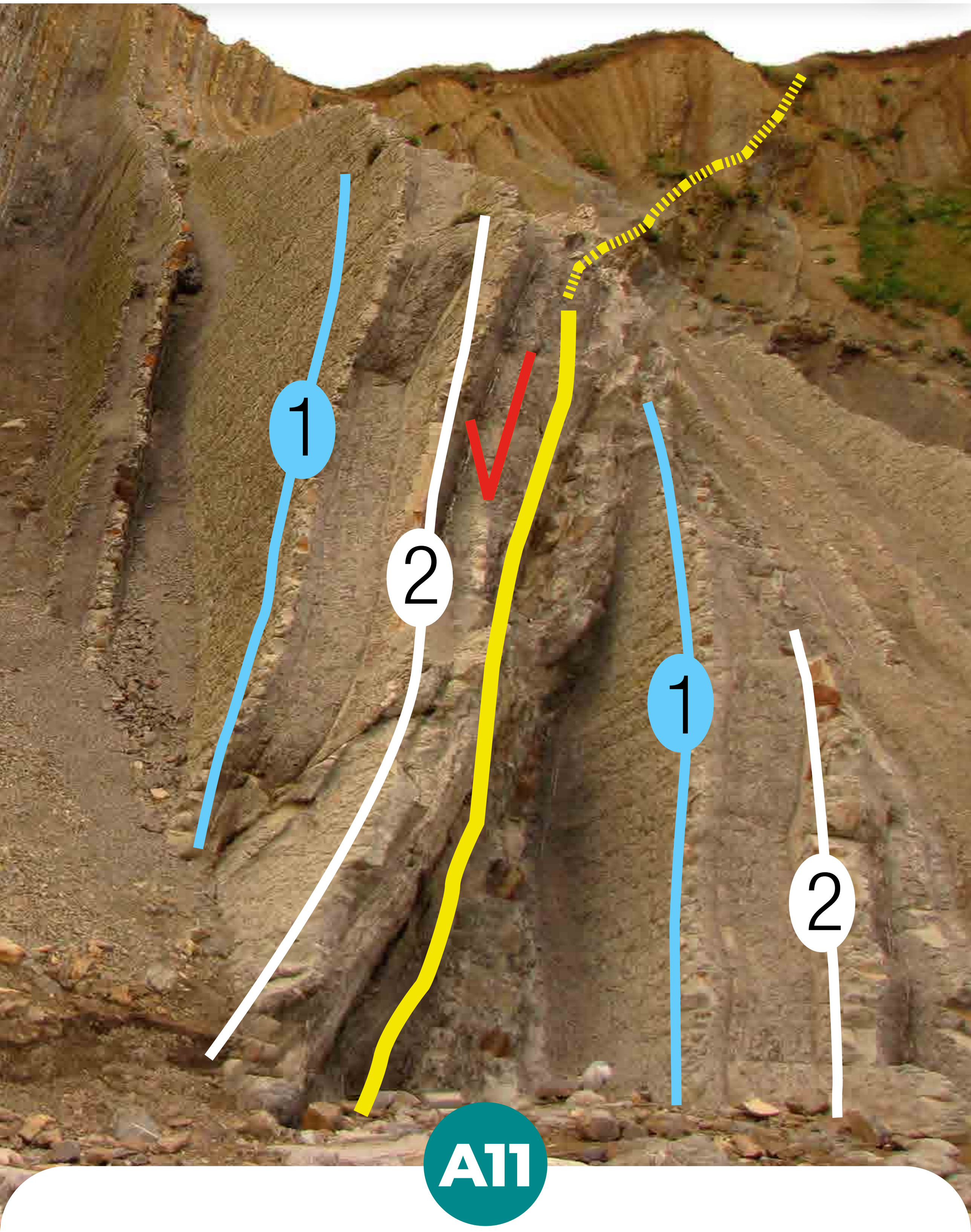
A11 HOW DO THE FAULTS MOVE?



Look closely. There is a large fracture (fault) affecting the entire cliff. Come closer and see how the rocks have broken and moved. **The flysch repeats itself**.

A12

A GOLDEN SPIKE IN THE FLYSCH?

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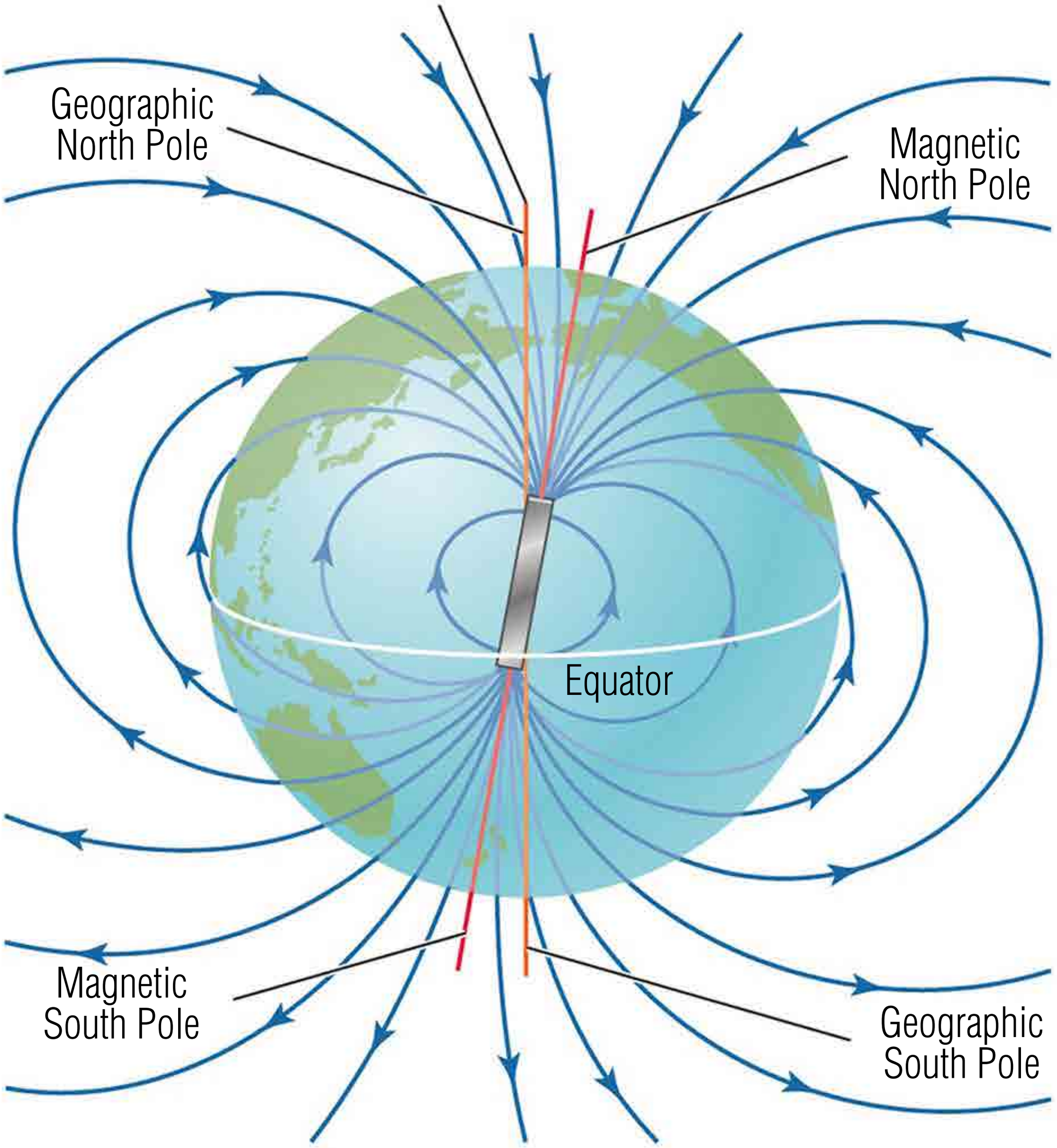
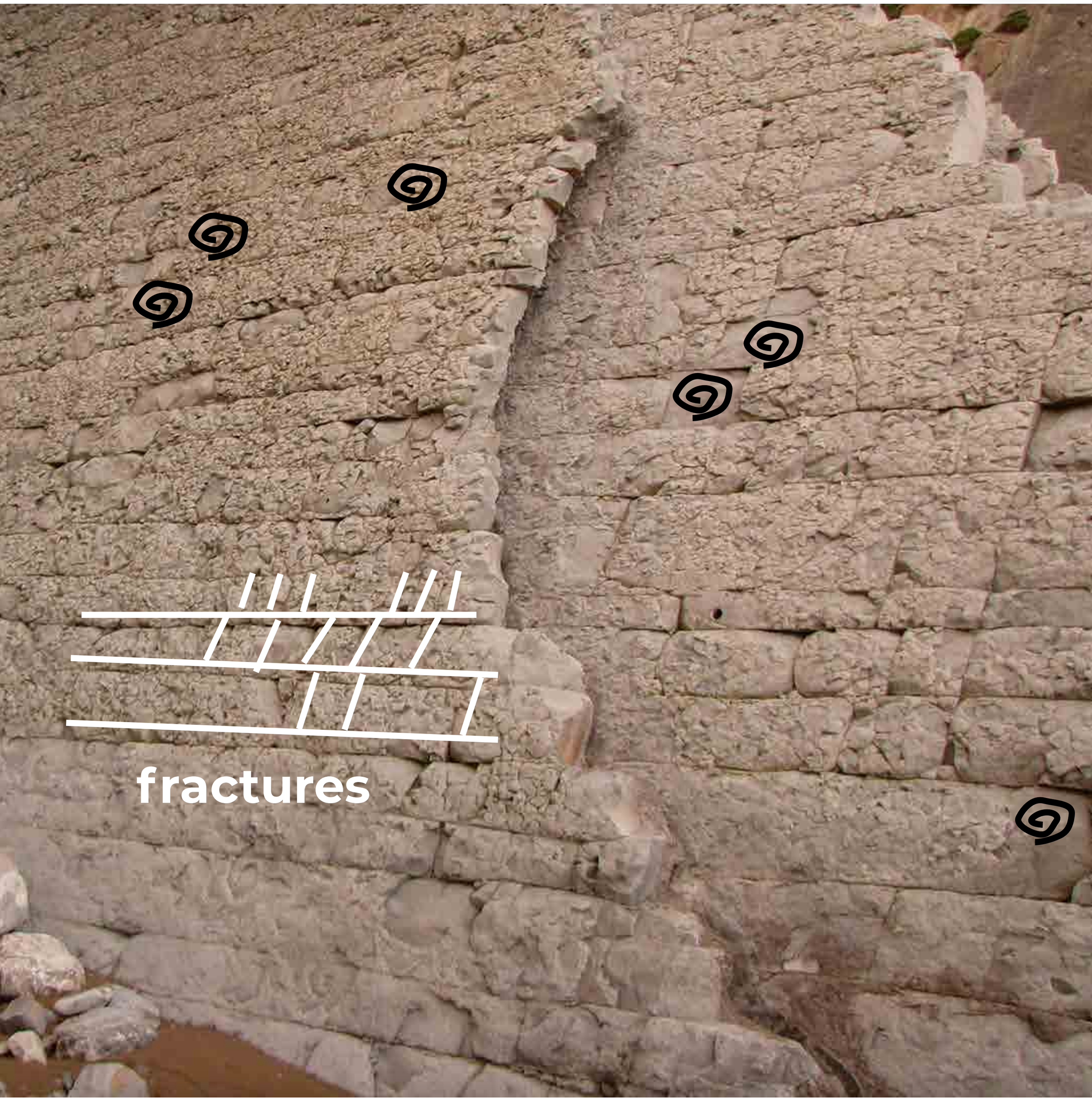
A12 A GOLDEN SPIKE IN THE FLYSCH?

In 2010 the IUGS placed a **golden spike** at this point. It marks the global boundary stratotype between the Selandian and the Thanetian, dated at 59.2 million years ago. Zumaia is the only place in the world where two golden spikes have been placed.



The magnetic south pole became the north pole and vice versa. These changes are very common in the geological record, are not cyclic and are related to the activity of the Earth's core.



ENIGMATIC LIFE ON THE SEABED

Look at the cracked stratum on the right. You can see numerous traces of *Zoophycos*, remnants left by some very small organism that dug in the mud of the seabed creating helical structures.

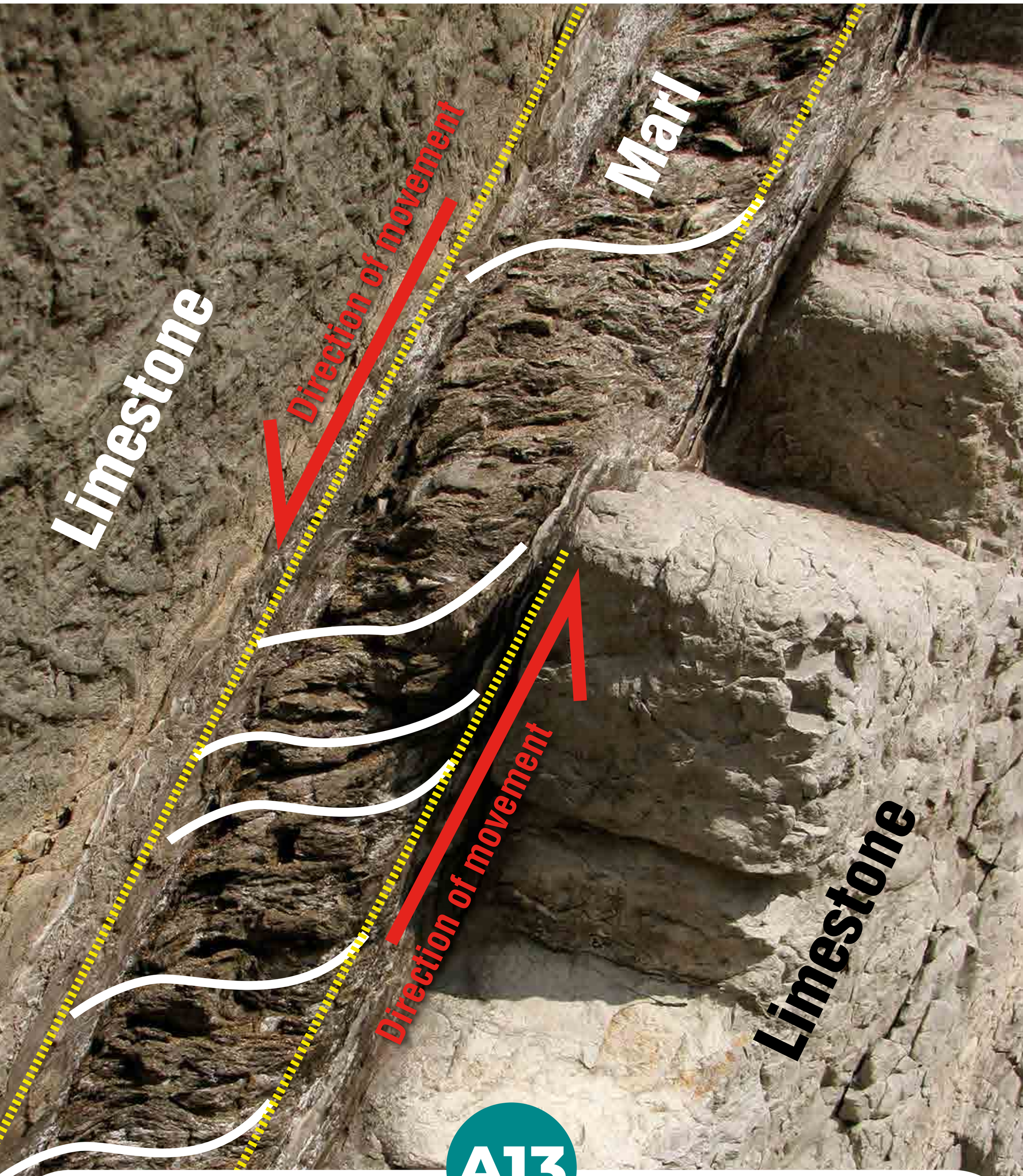
Detail of *Zoophycos*.

A13

THE FLYSCH MOVES

ALGORRI GEOROUTE

A13 THE FLYSCH MOVES



A13

During the lifting process some soft layers behaved **as a lubricant** so that the layers could adopt their new positions. The drawing shows us the movement.

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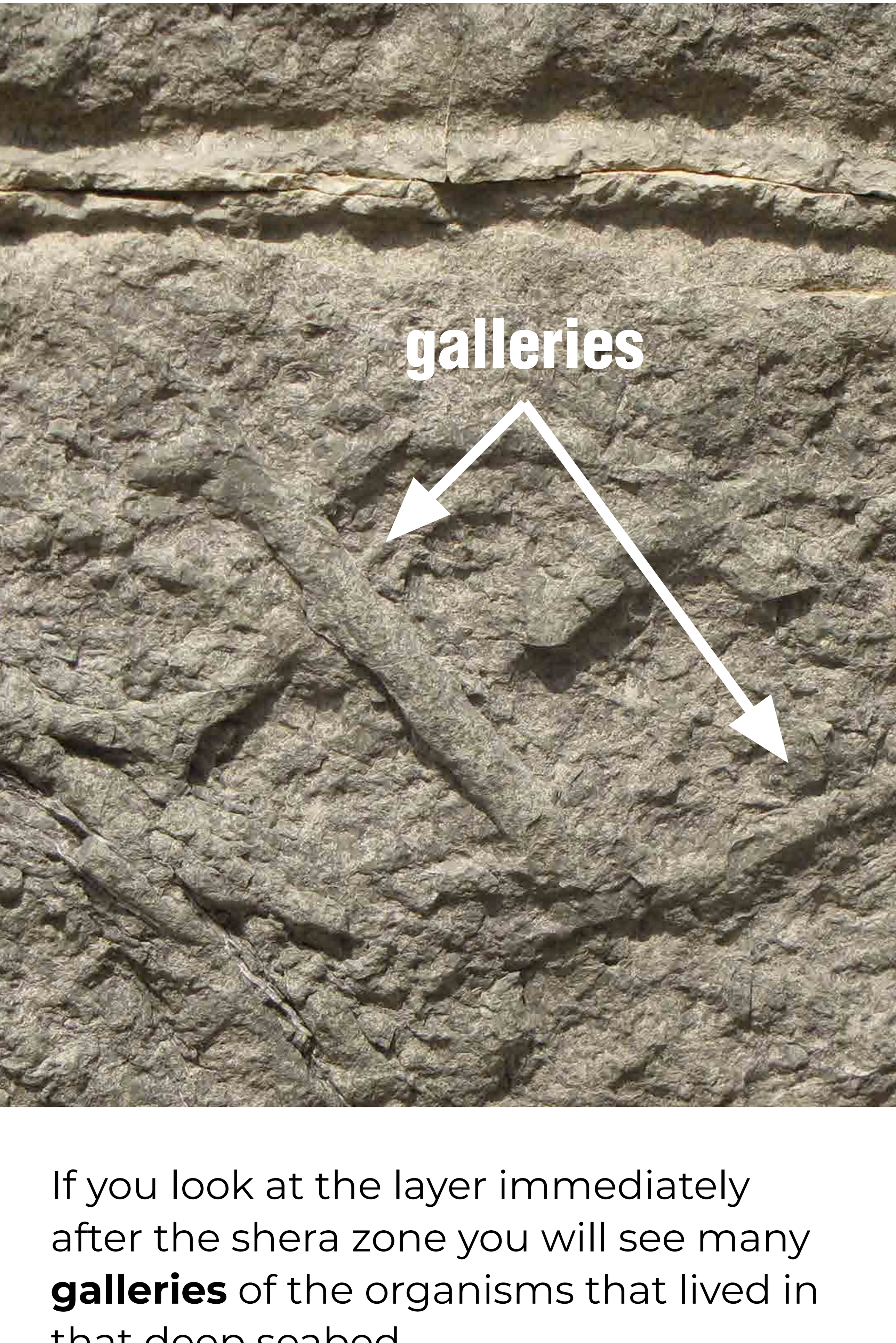
A13 THE FLYSCH MOVES



If you look at the layer immediately after the shera zone you will see many **galleries** of the organisms that lived in that deep seabed.

A14

“AVALANCHES” ON THE DEEP SEA

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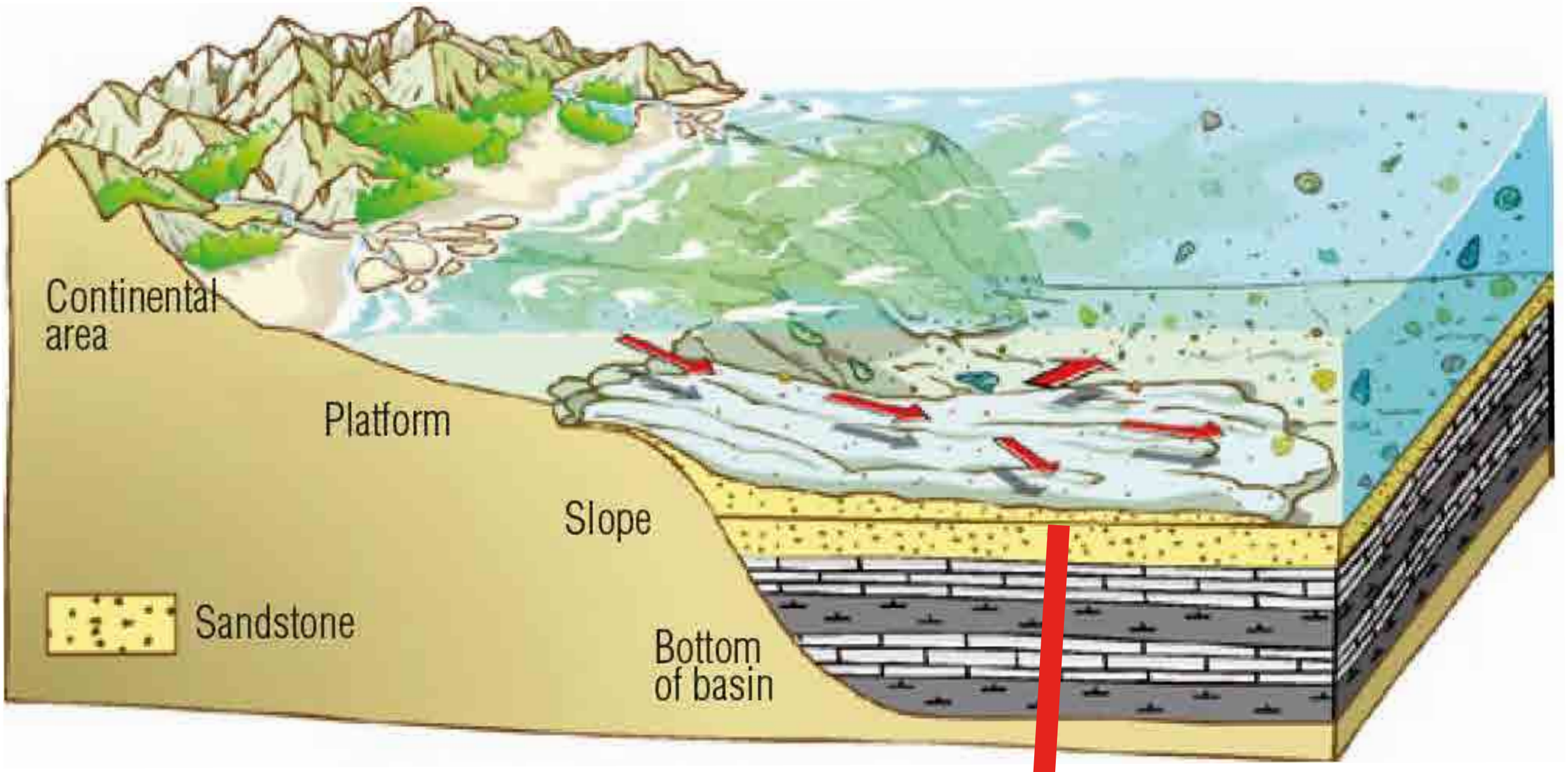
A14 “AVALANCHES” ON THE DEEP SEA

A14

The sandstone layers are called **turbidites** and are the deposits of large “avalanches” of water and sand from the coastal deltas that fell to the ocean floor via **great underwater canyons**.

Formation of a turbidite.



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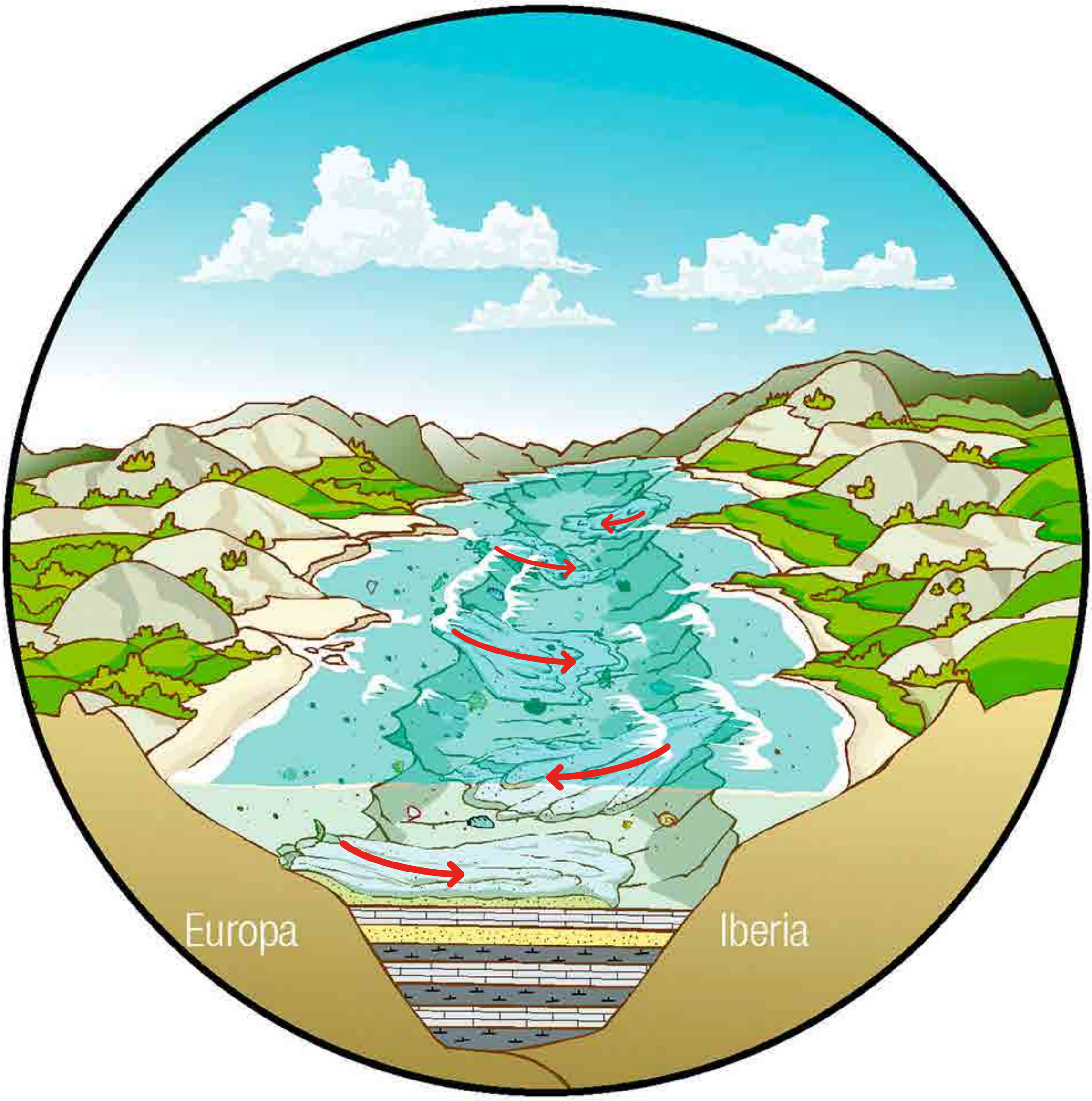
A14 “AVALANCHES” ON THE DEEP SEA



The frequency of turbidites increases when the environment is more unstable, and the movements of the earth produce these “avalanches”. At this time **the Pyrenees had already begun to be raised up** in the east. Everything was very unstable.

THE ADVENTURE CONTINUES

The current cliff line is no more than 10,000 years old. During this time the sea has continued eroding and revealing this great book on the history of the Earth for us.

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A14 THE ADVENTURE CONTINUES

The erosion continues.

Landslide at Marianton point. Year 2019.

ALGORRI GEOROUTE

MORE INFORMATION

BUY COMPLETE GUIDE

SEE OTHER GEOROUTES

PROGRAMME OF GUIDED EXCURSIONS

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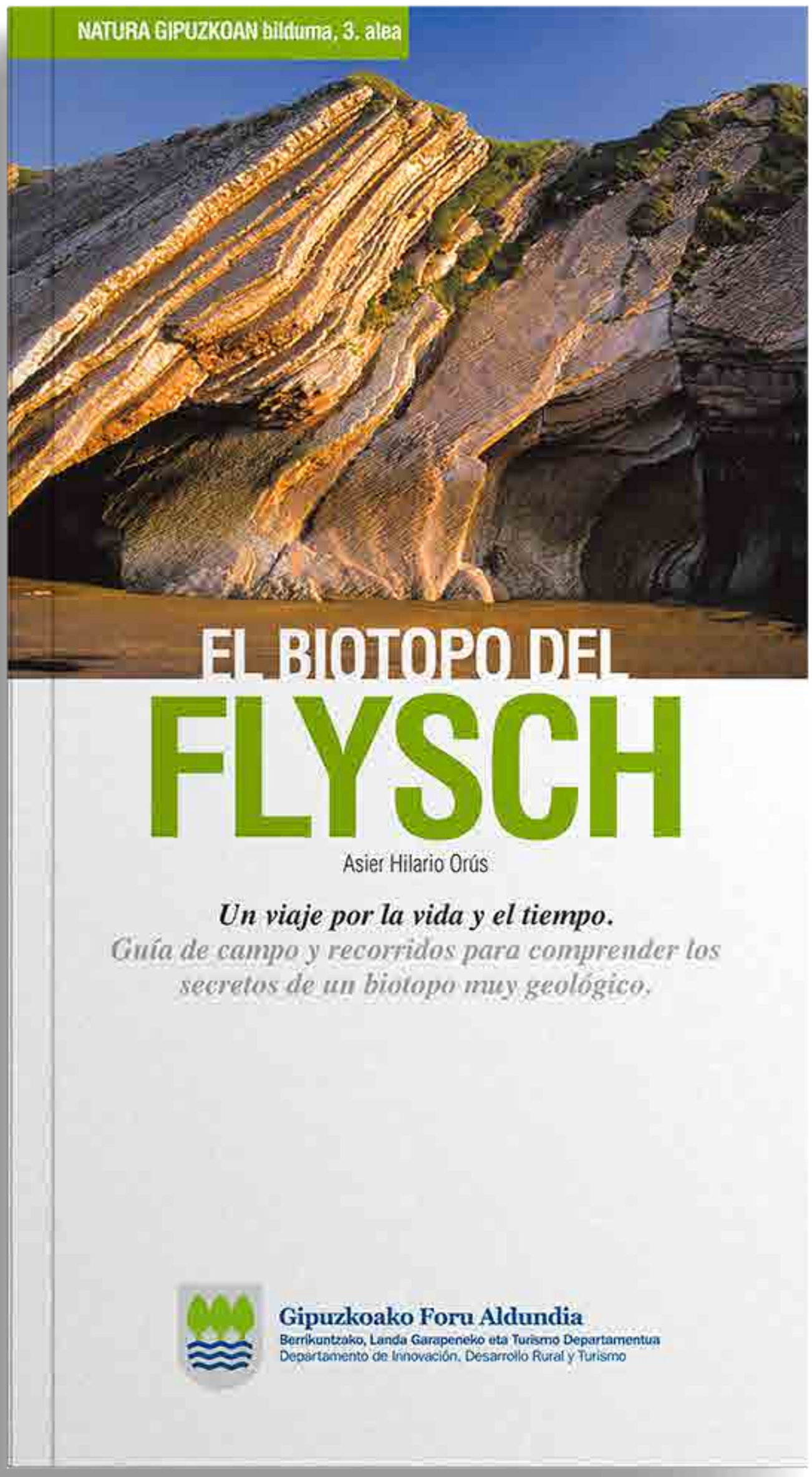

BUY COMPLETE GUIDE

For more complete information about the flysch we have the guide ‘The Flysch Biotope’ which is on sale at the geopark’s tourist offices.

Geoparkea

Euskal Kostaldea - Costa Vasca

Gipuzkoako Foru Aldundia

Diputación Foral de Gipuzkoa

ETORKIZUNA ORAIN

Es futuro

BABESTUTAKO BIOTOPOA
BIOTOPO PROTEGIDO

DEBA ETA ZUMAIA
ITSASERTZEKO BABESTUTAKO BIOTOPOA

EUSKO JAURLARITZA

GOBIERNO VASCO

INGURUMEN, LURRALDE PLANGINTZA ETA ETXEBIZITZA SAILA

DEPARTAMENTO DE MEDIO AMBIENTE, PLANIFICACIÓN TERRITORIAL Y VIVIENDA

EUSKADI

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