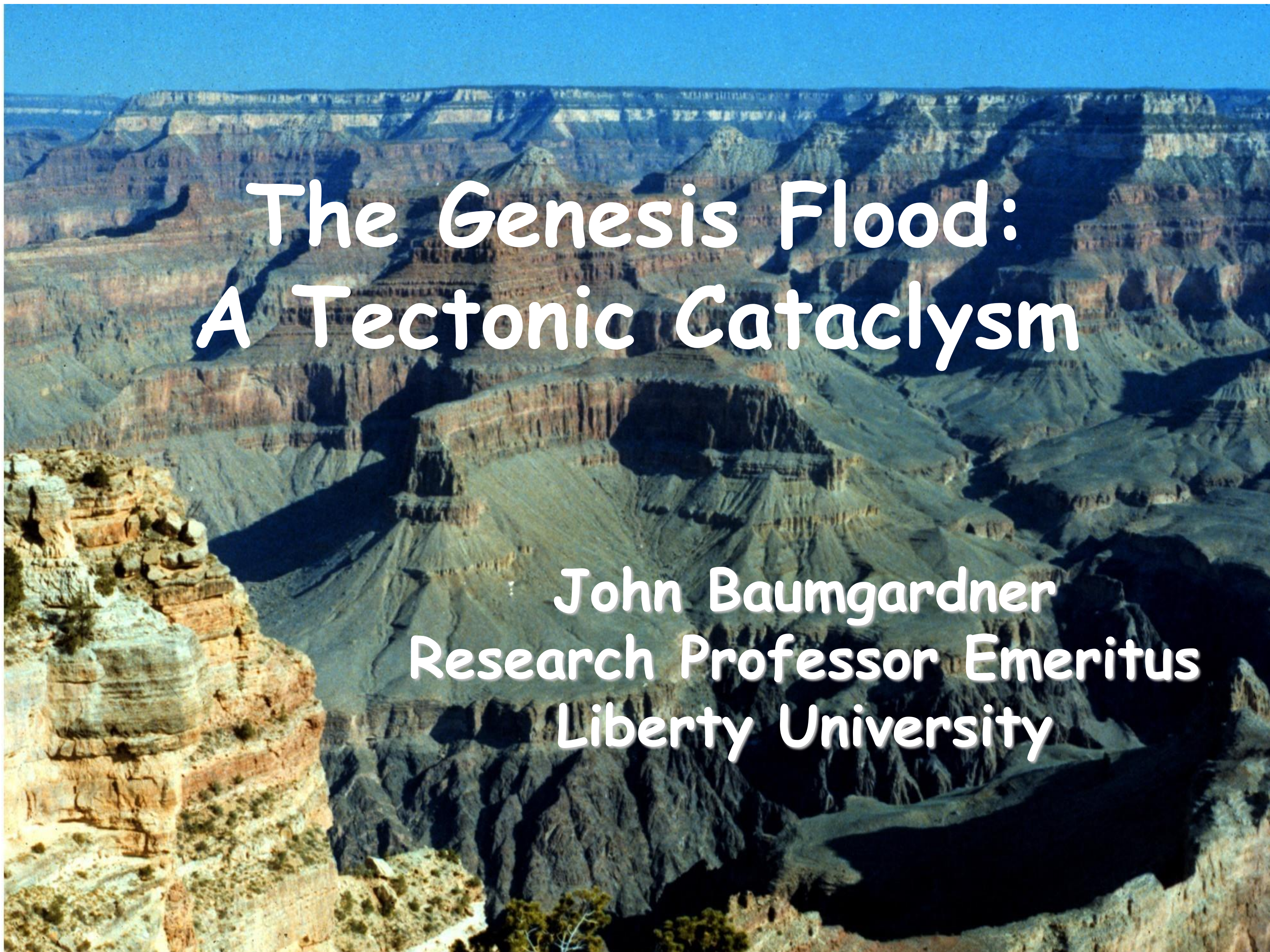
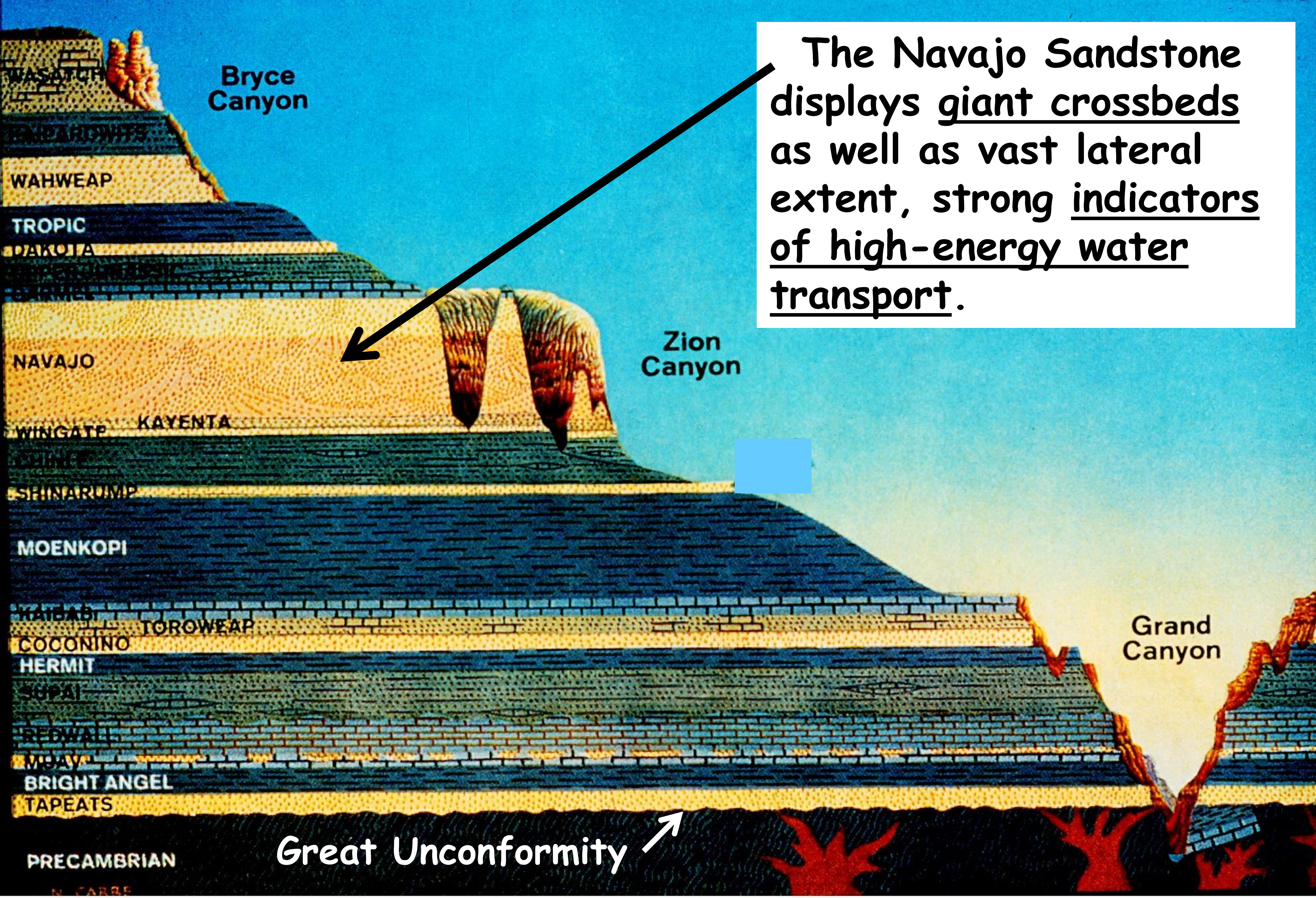
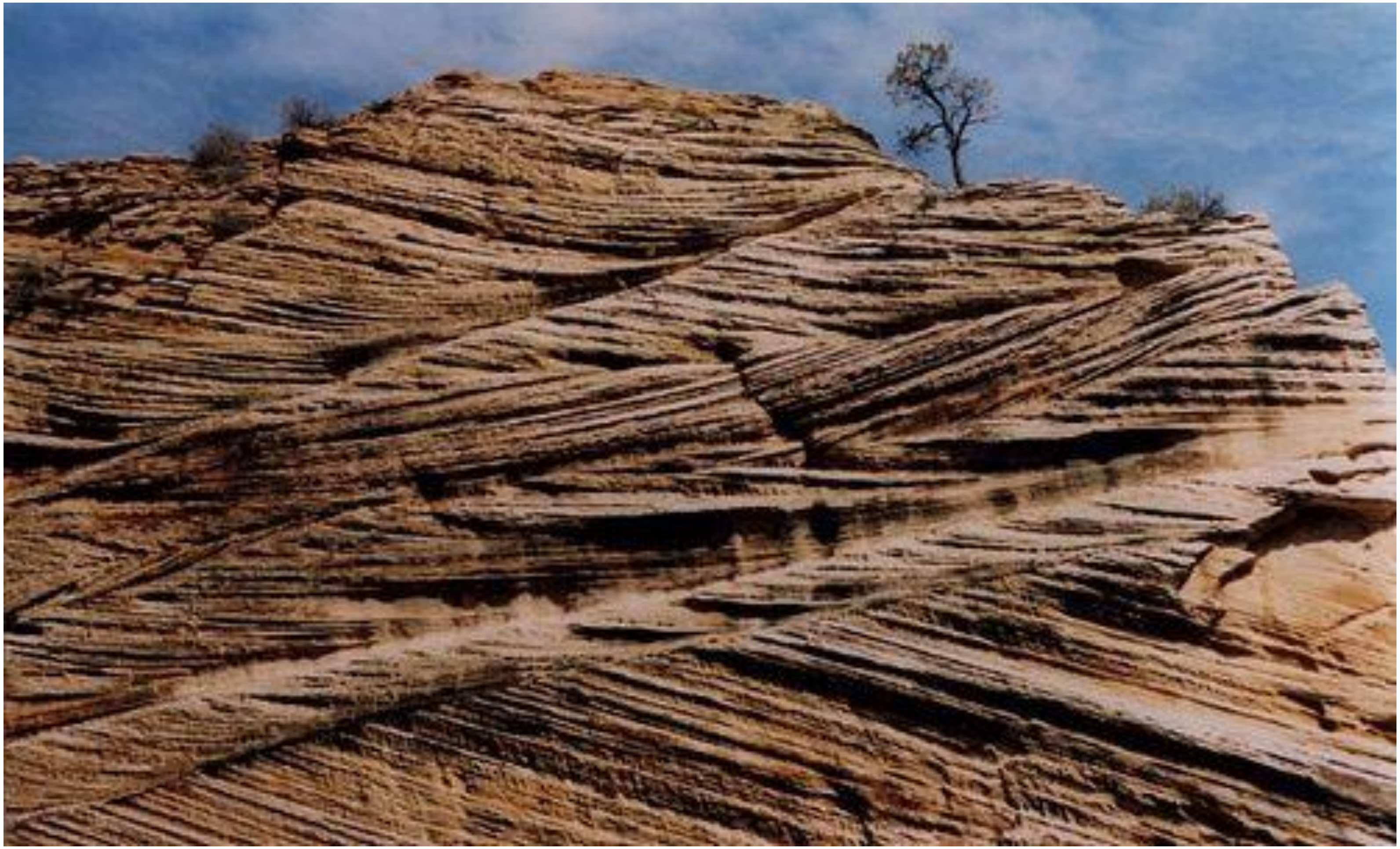

The Genesis Flood:
A Tectonic Cataclysm
John Baumgardner
Research Professor Emeritus
Liberty University



The Navajo Sandstone displays <u>giant crossbeds</u> as well as vast lateral extent, strong <u>indicators of high-energy water transport</u>.

Geological cross-section, north-south, north of Grand Canyon

The 2,300 ft. high cliffs at Zion National Park, shown above, represent the exposed edge of a gigantic sheet of sand, the Navajo Sandstone, that stretched originally from southern California to central Wyoming, and from Idaho to New Mexico. Its volume is sufficient to bury the entire state of Texas to a depth of 285 feet.



Giant crossbeds in Navajo Sandstone, Zion National Park, Utah.

The finer structure corresponds to layers deposited on the back sides of huge underwater sand dunes produced by rapidly flowing water. Bounding surfaces truncate this finer structure.

The global unconformity marking the onset of the Flood is known as the Great Unconformity.

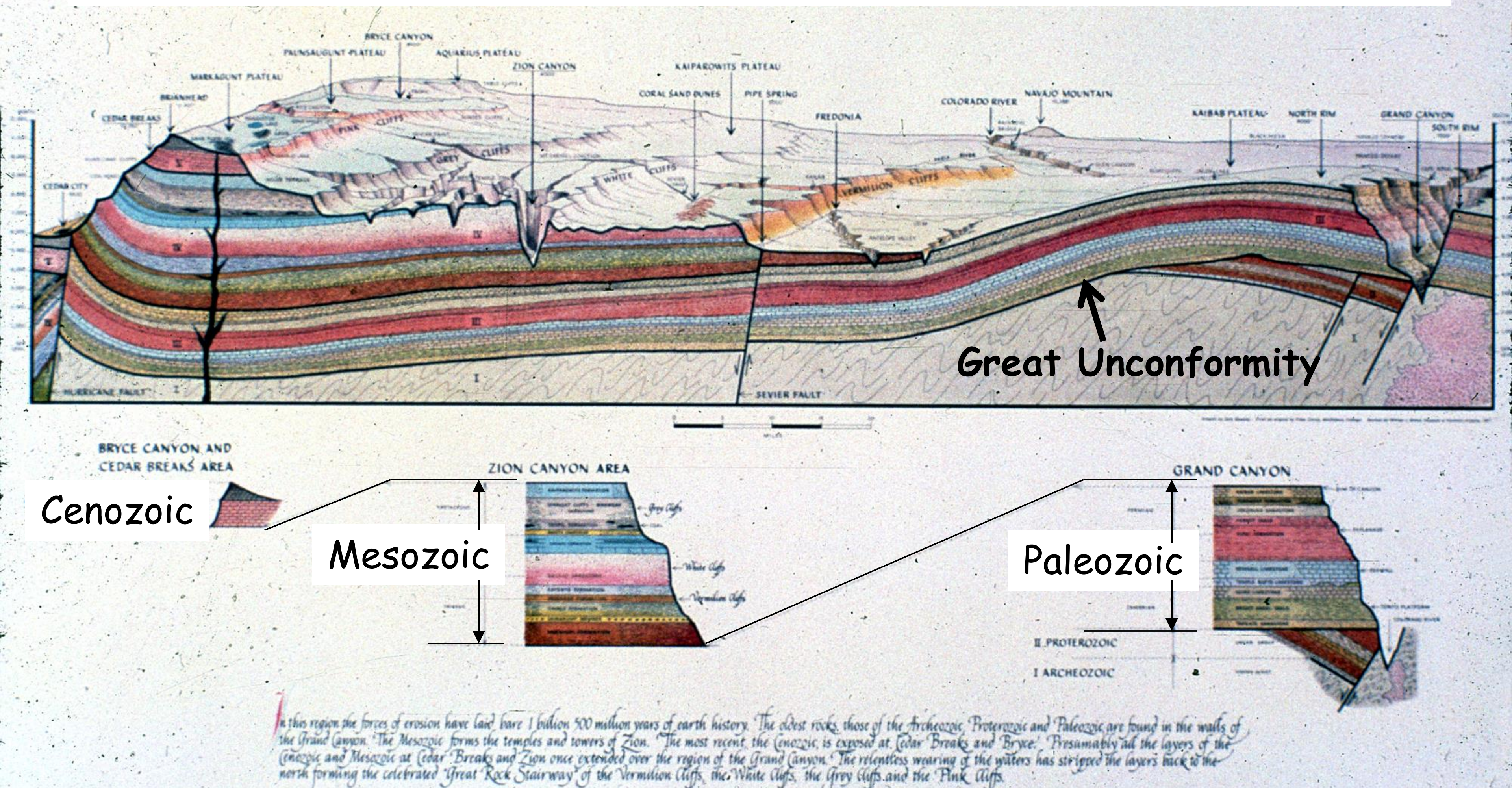
The level of violence displayed at this point in the record is difficult for the human mind to imagine.

Great unconformity in central Wisconsin

Giant Baraboo quarzite boulders atop massive Baraboo Formation

Great unconformity in central Wisconsin

GEOLOGICAL CROSS SECTION FROM THE CEDAR BREAKS AREA IN UTAH (LEFT) SOUTHWARD TO THE GRAND CANYON IN ARIZONA (RIGHT)



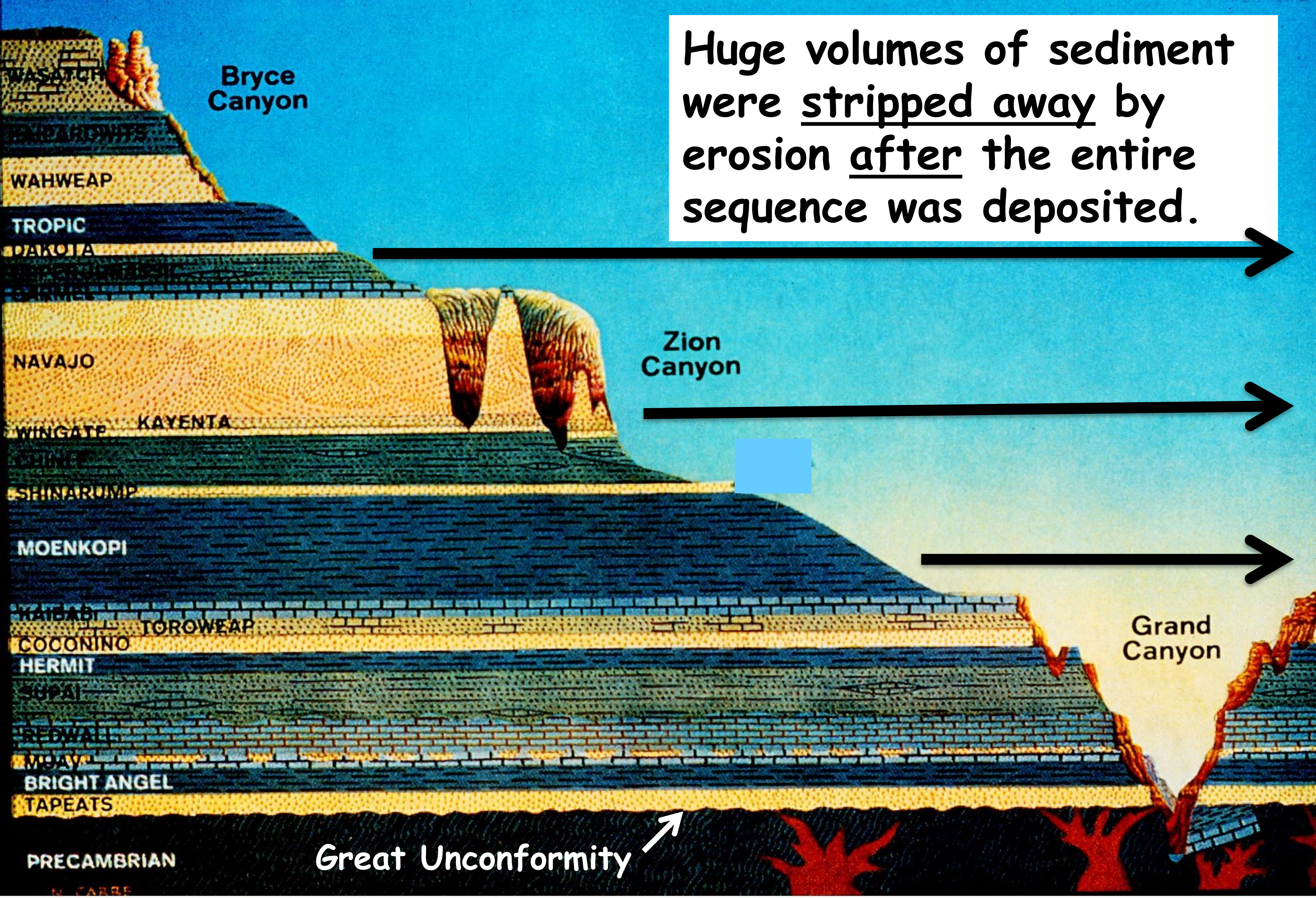
The horizontally extensive layers are continuous in E-W and N-S directions for hundreds of miles, contain fossils, and display internal evidence for high velocity water transport.


The Great Unconformity

What about the end of the cataclysm?

After so vast an amount of sediment had been carried onto the continents and deposited in horizontally extensive layers, a significant fraction of that sediment was stripped away from the continent interiors and carried by runoff water to the continental shelves at the end of the Flood.

Huge volumes of sediment were stripped away by erosion after the entire sequence was deposited.



Geological cross-section, north-south, north of Grand Canyon

Result of rapid Flood runoff in Bryce Canyon, Utah

In summary, a staggering amount of geological change took place during this global cataclysm.

The Bible reveals that it all unfolded within the span of only a single year.

Key issue with regard to the Flood—

Physically how could so much geological change occur in a time span of only a single year?

What conceivably could have been the main causal mechanism?

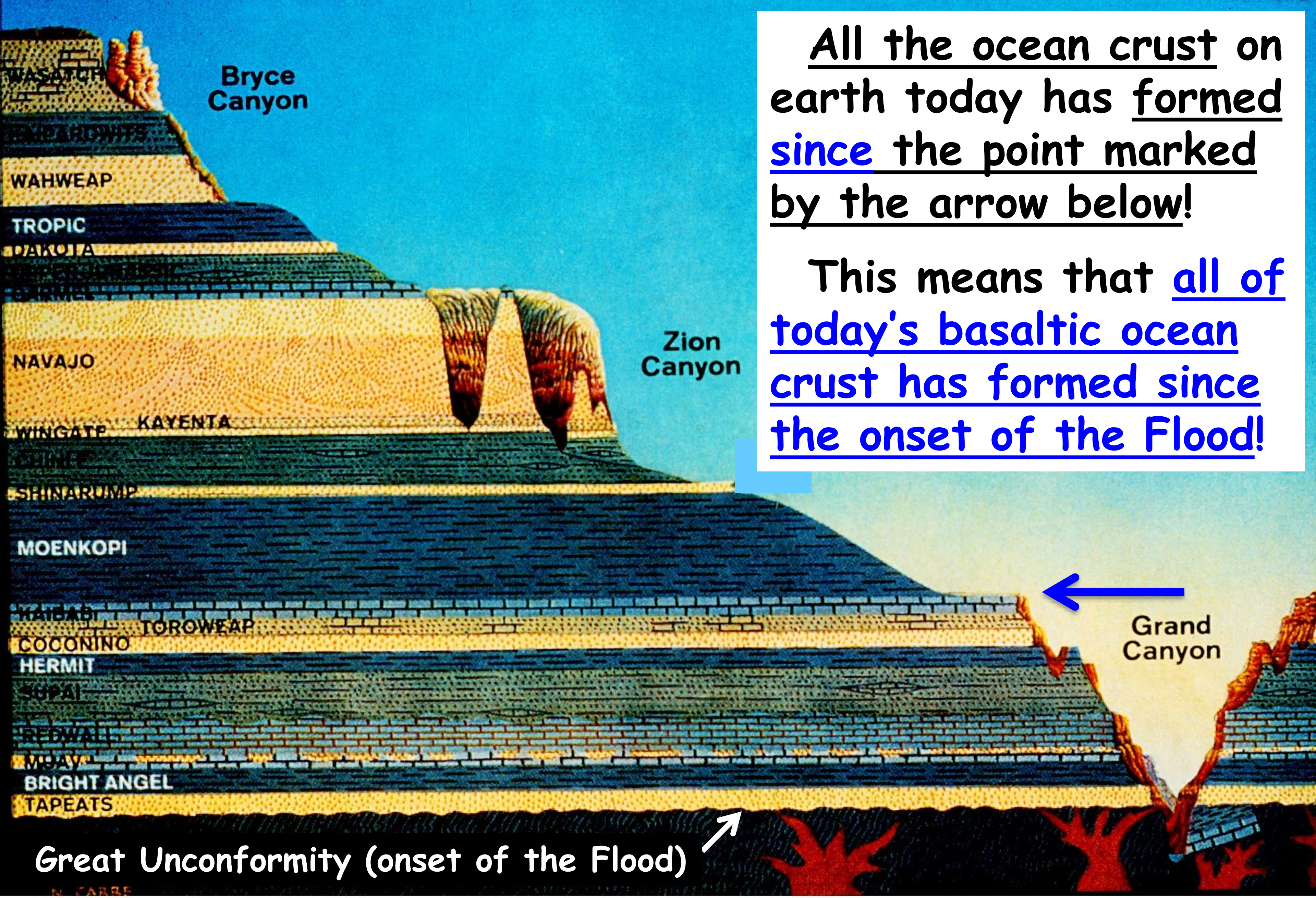
Some major clues to the answer come from the <u>ocean bottom</u>.

Huge discovery of the 1960's:

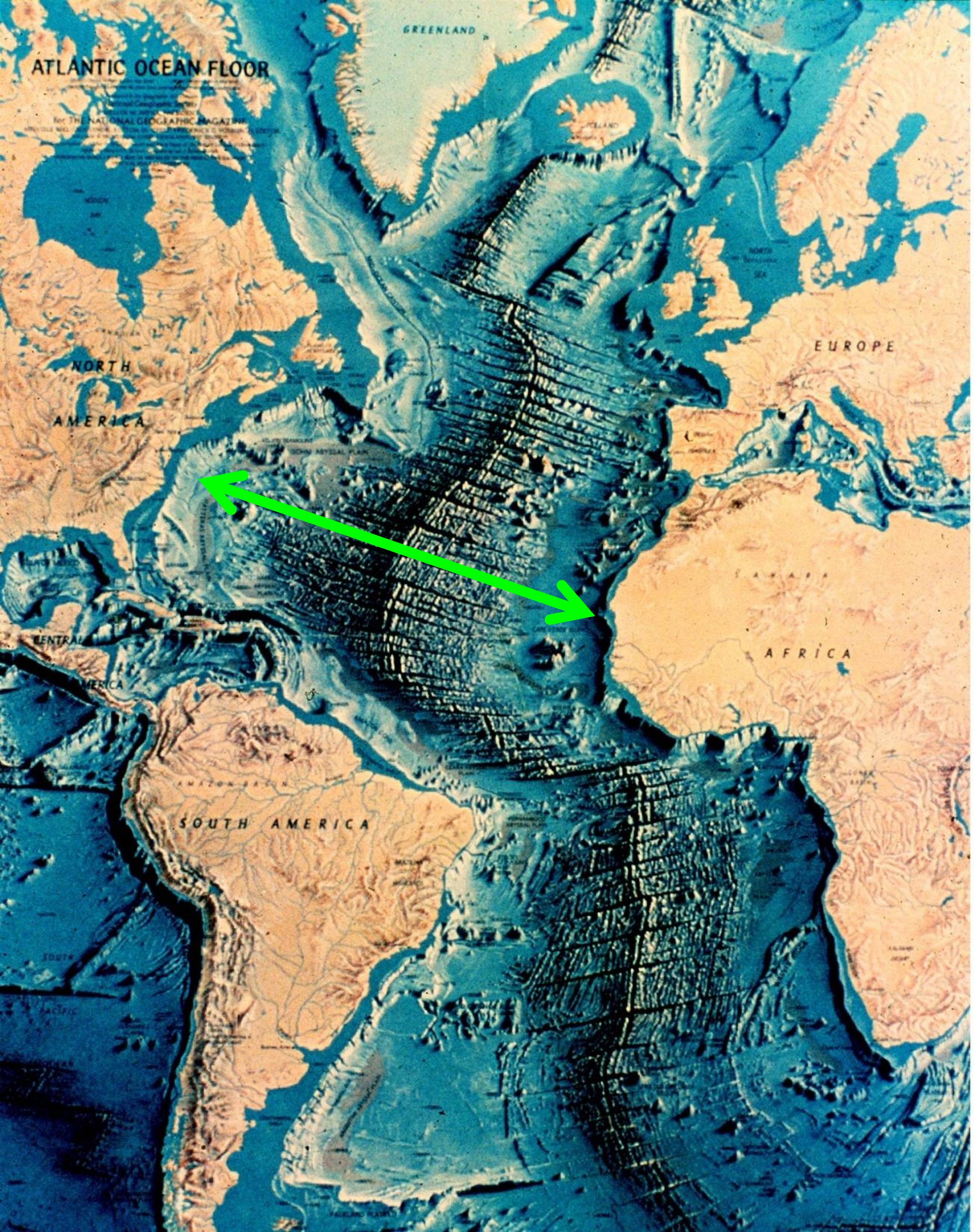
All of today's oceanic crust **is younger** than much of the fossil-bearing sediment record on the continents!

All the ocean crust on earth today has formed since the point marked by the arrow below!

This means that all of today's basaltic ocean crust has formed since the onset of the Flood!



Geological cross-section, north-south, north of Grand Canyon



This implies that the opening of the entire Atlantic Ocean occurred during the Flood and also that continents migrated by thousands of miles in only a few month's time!

What about the pre-Flood ocean floor?

It is missing from the earth's surface today. Taking cues from today's seafloor, it must have been recycled into the earth's interior.

The firm conclusion that rapid, large-scale tectonic change must have been a fundamental aspect of the Genesis Flood has come to be known as

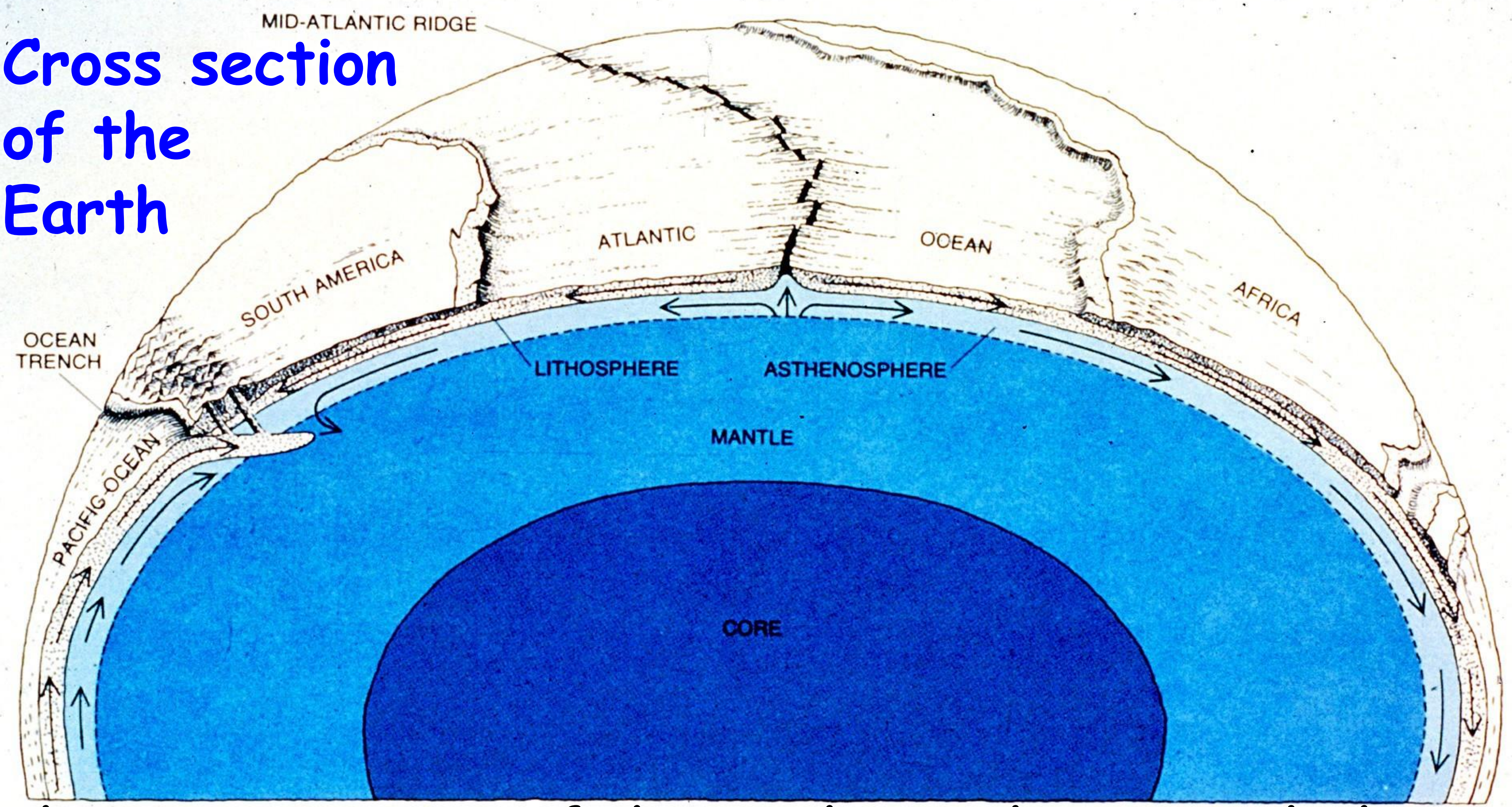
catastrophic plate tectonics

The concept was presented in 1986 at the First International Conference on Creationism in Pittsburgh.

Such large-scale tectonic change at the earth surface implies that the earth's interior was also involved.

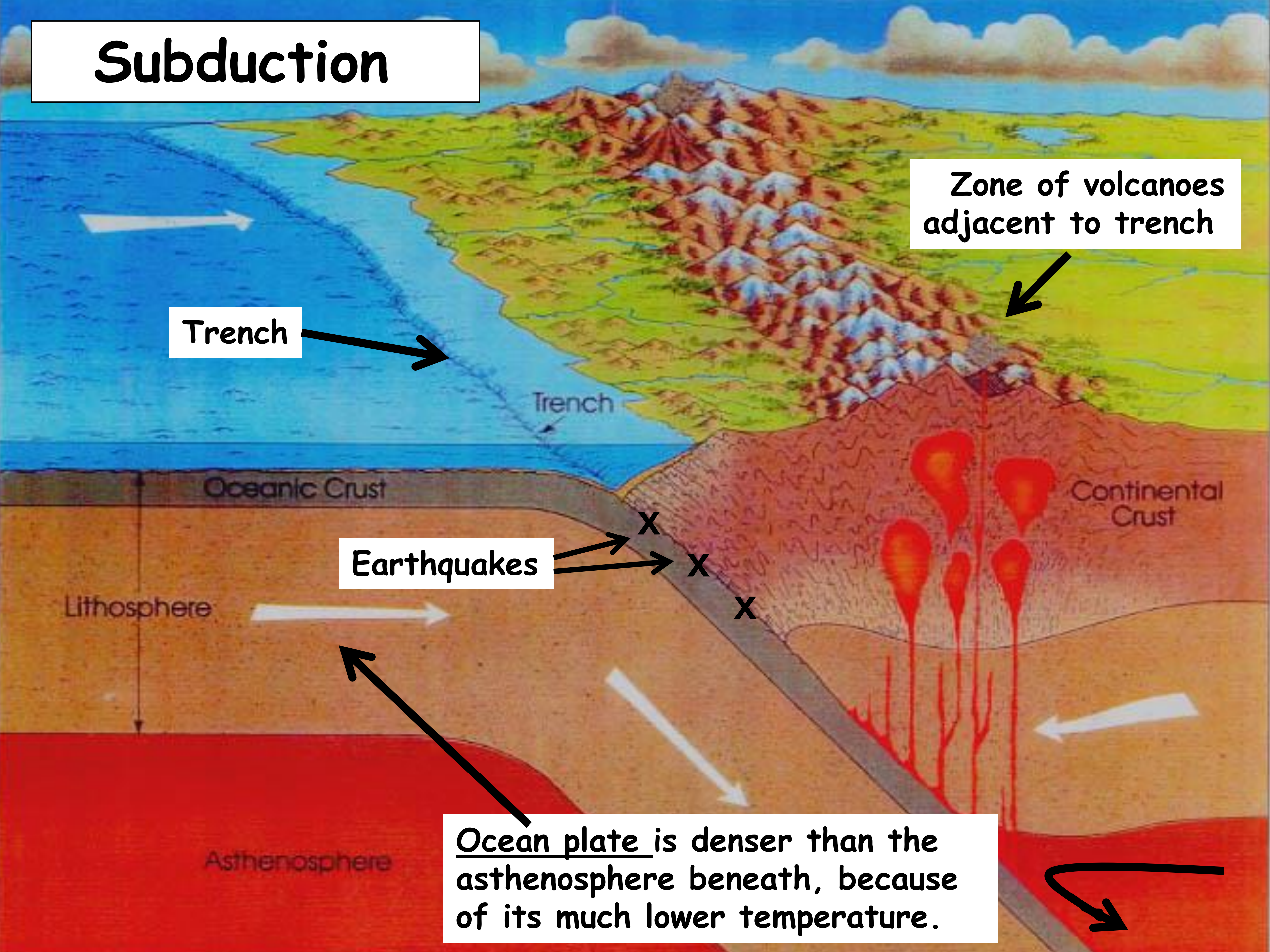
Let us review some basics of the earth's structure.

Cross section of the Earth



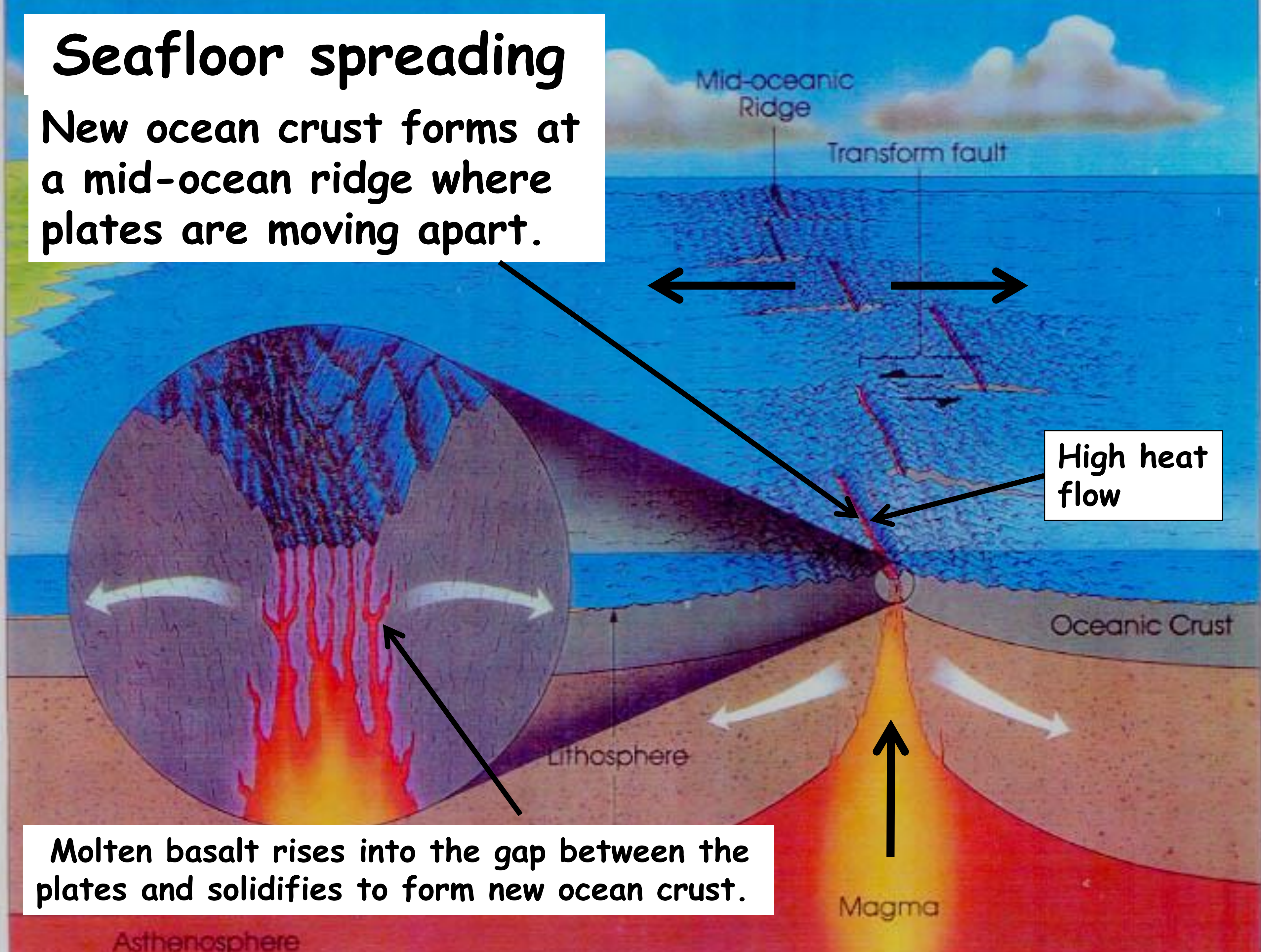
The two main parts of the earth are the core, which is mostly molten iron, and the mantle which is mostly solid silicate rock. The uppermost part of the mantle is the thin, cold, and mechanically rigid lithosphere, which is broken into about a dozen large plates. Just below the lithosphere is the much weaker asthenosphere.

Subduction


Zone of volcanoes adjacent to trench
Trench
Trench
Oceanic Crust
Continental Crust
Earthquakes
X
X
X
Lithosphere
Asthenosphere
Ocean plate is denser than the asthenosphere beneath, because of its much lower temperature.

Seafloor spreading

New ocean crust forms at a mid-ocean ridge where plates are moving apart.



Molten basalt rises into the gap between the plates and solidifies to form new ocean crust.

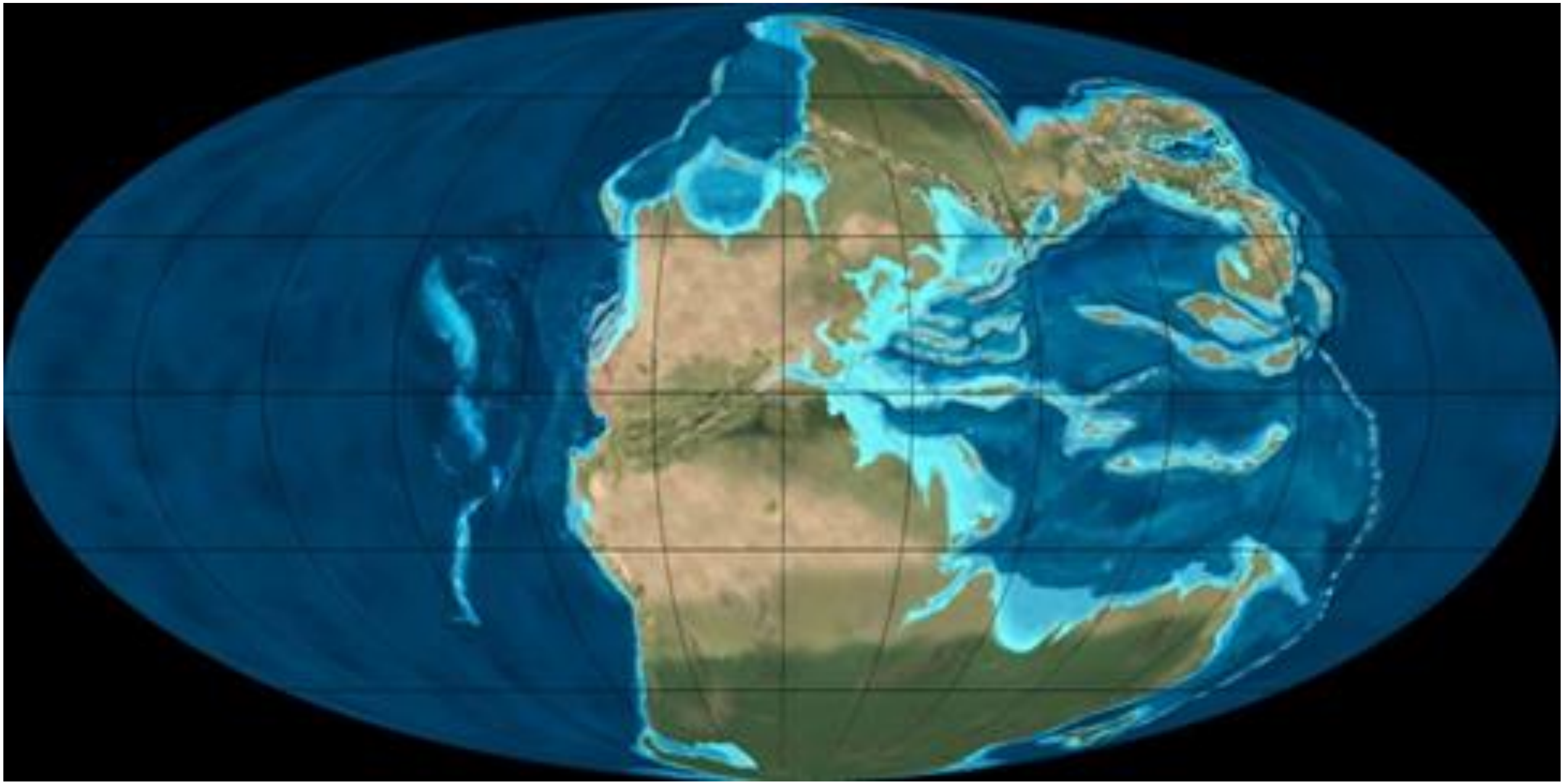
Catastrophic plate tectonics is similar to conventional plate tectonics except that the plate velocities are about billion times higher (~5 mph instead of about ~2 inches/year).

How is this possible? Laboratory experiments show that mantle rock weakens dramatically under stress, at stress levels that can exist inside the earth. This weakening provides the potential for runaway catastrophe.

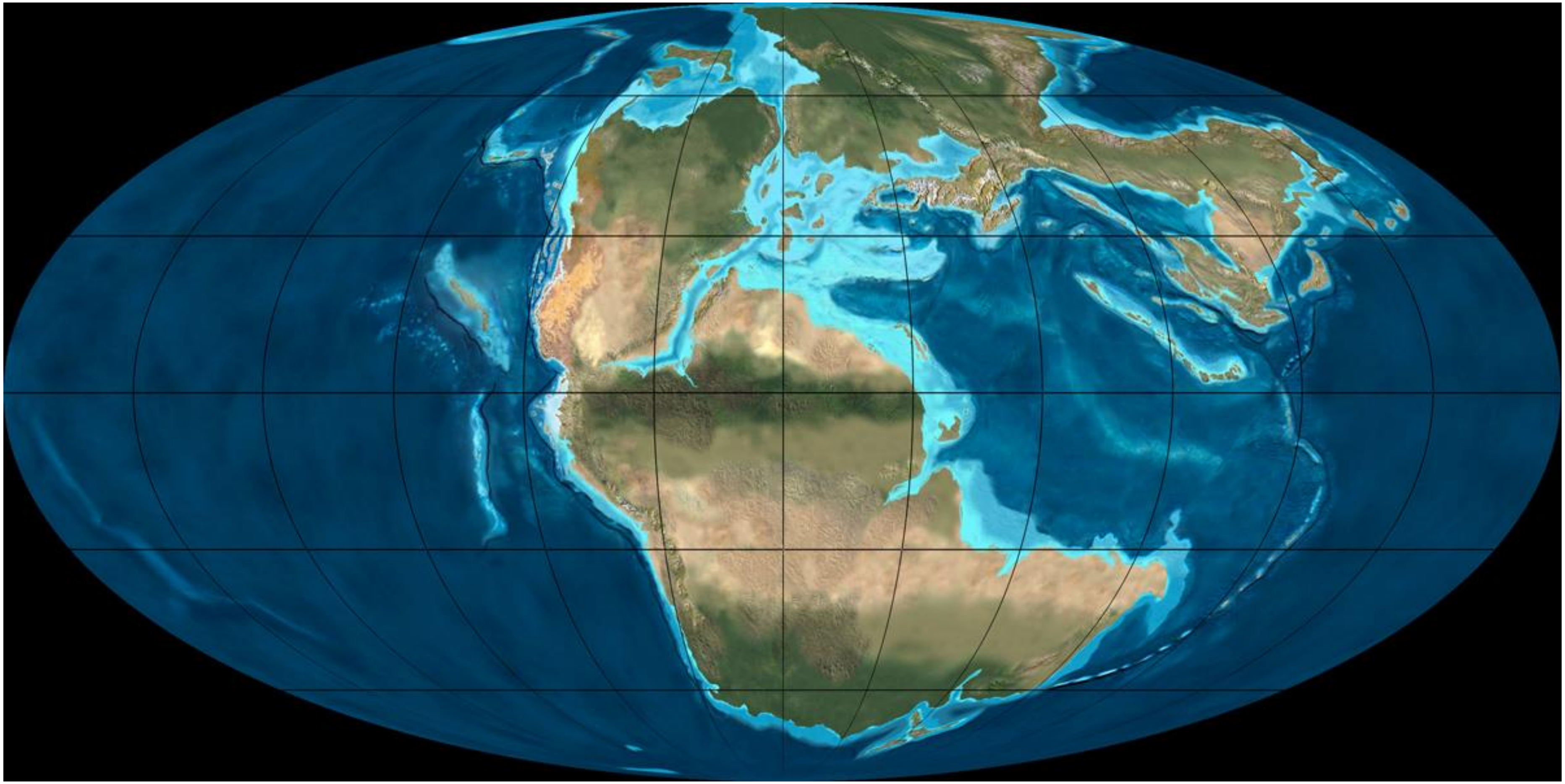
Just <u>how much continental motion</u> occurred during the Flood?

The following images summarize <u>how the continents have moved</u> <u>just since the time when the supercontinent Pangea existed</u>—as reconstructed by the secular earth science community.

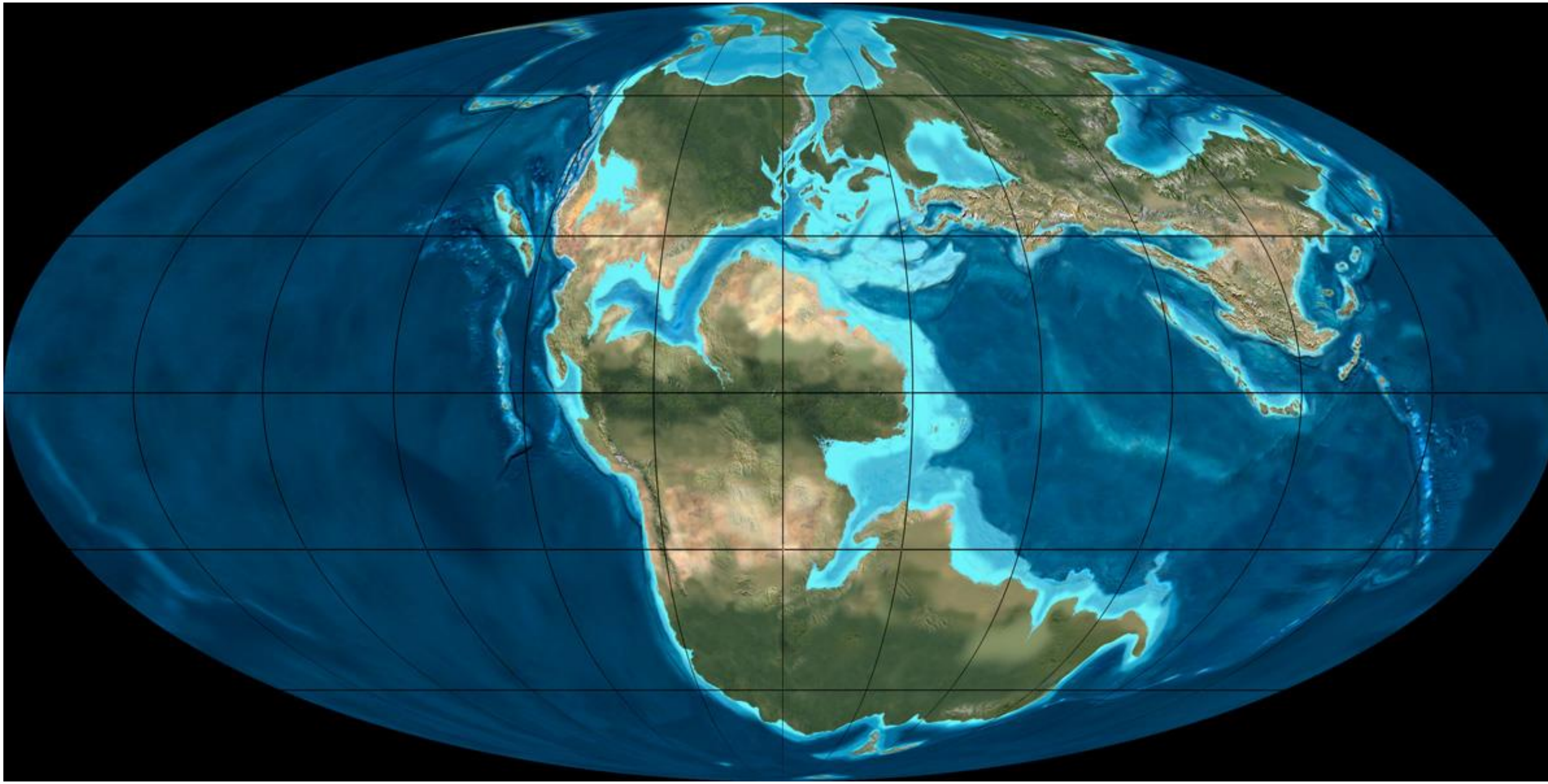
They were produced by Prof. Ron Blakey of Northern Arizona University and are available at <u>http://jan.ucc.nau.edu/~rcb7/mollglobe.html</u>.



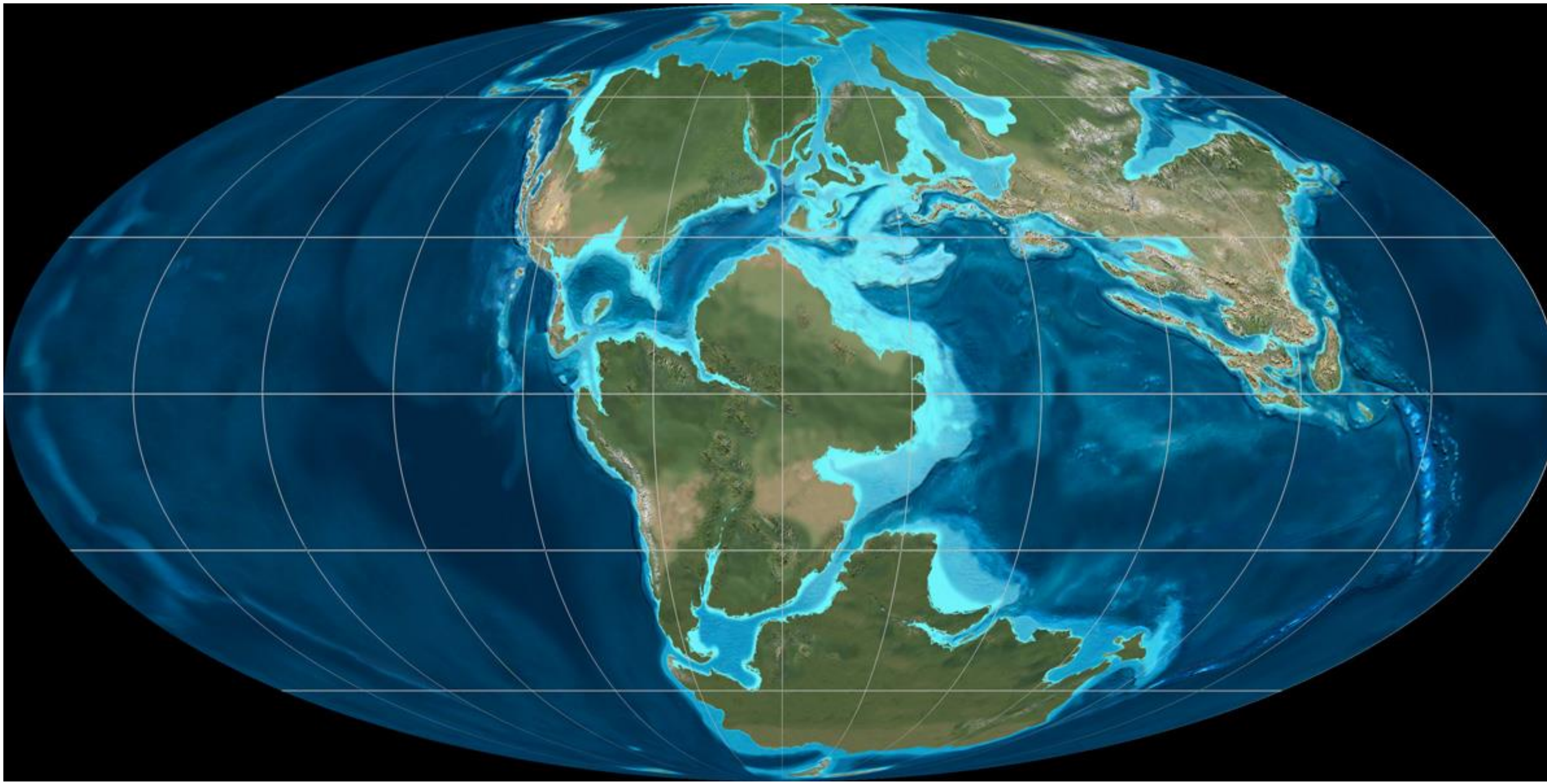
<u>Pangea</u> Early Triassic



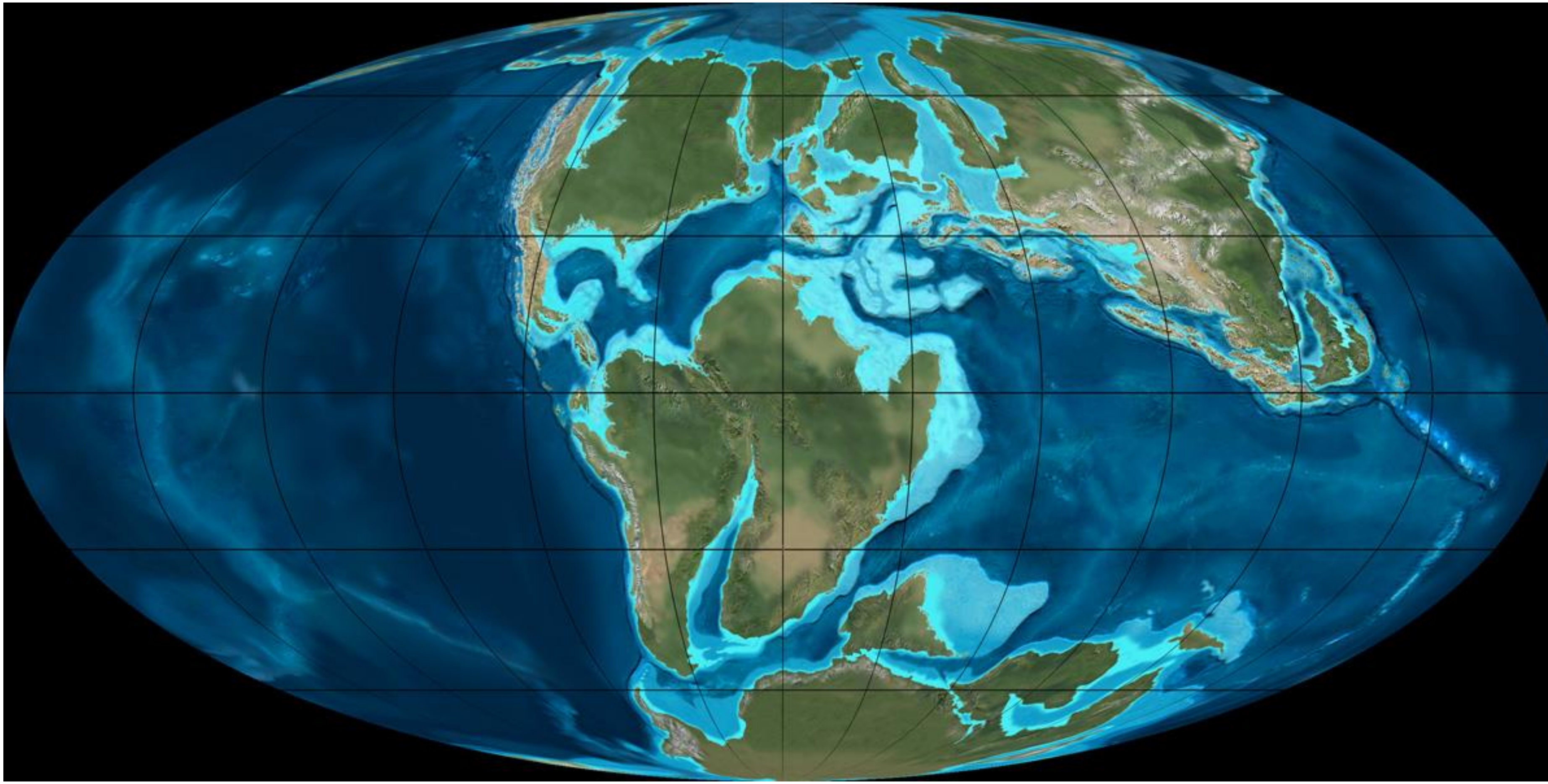
Early Jurassic



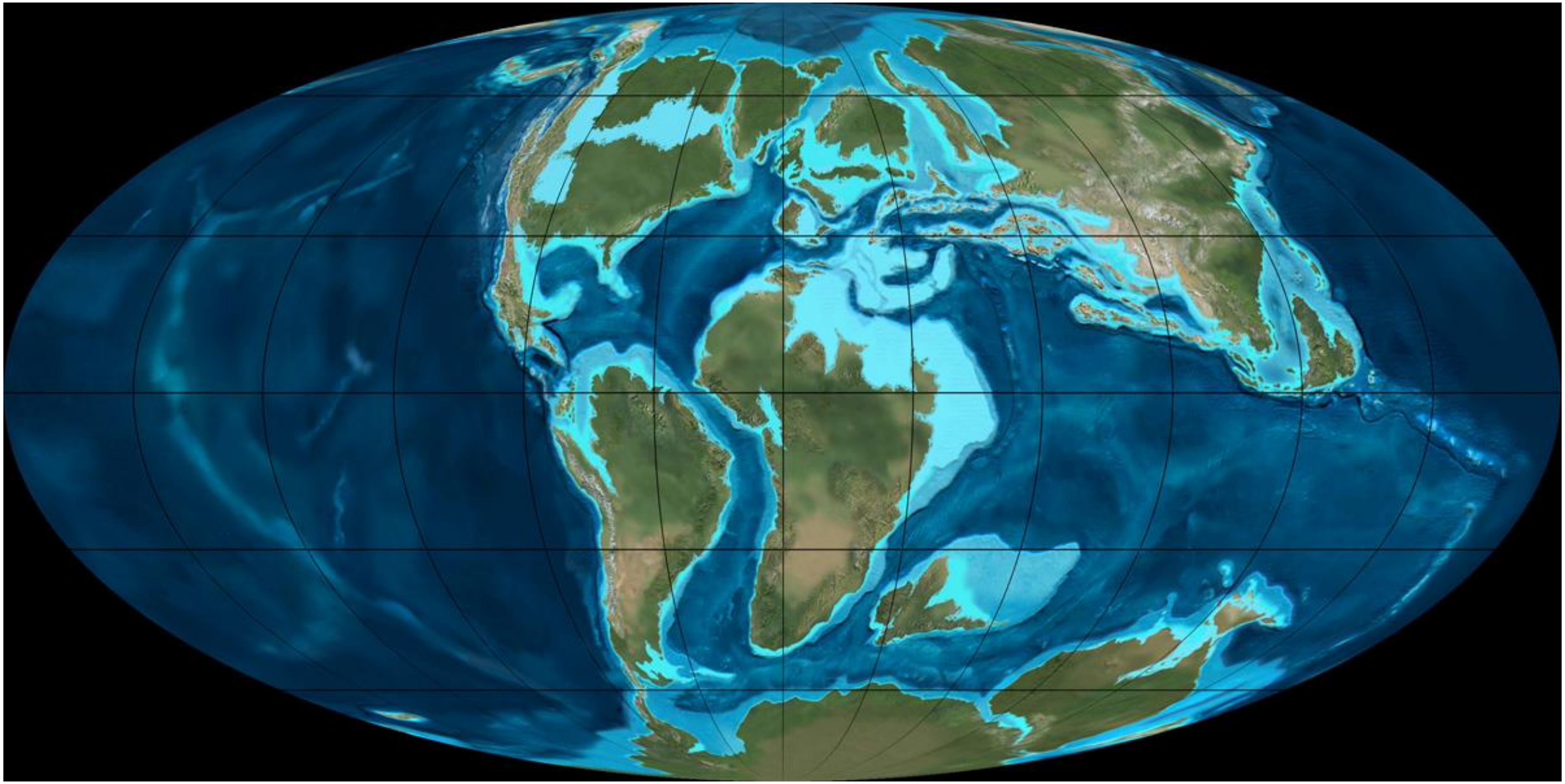
Mid-Jurassic



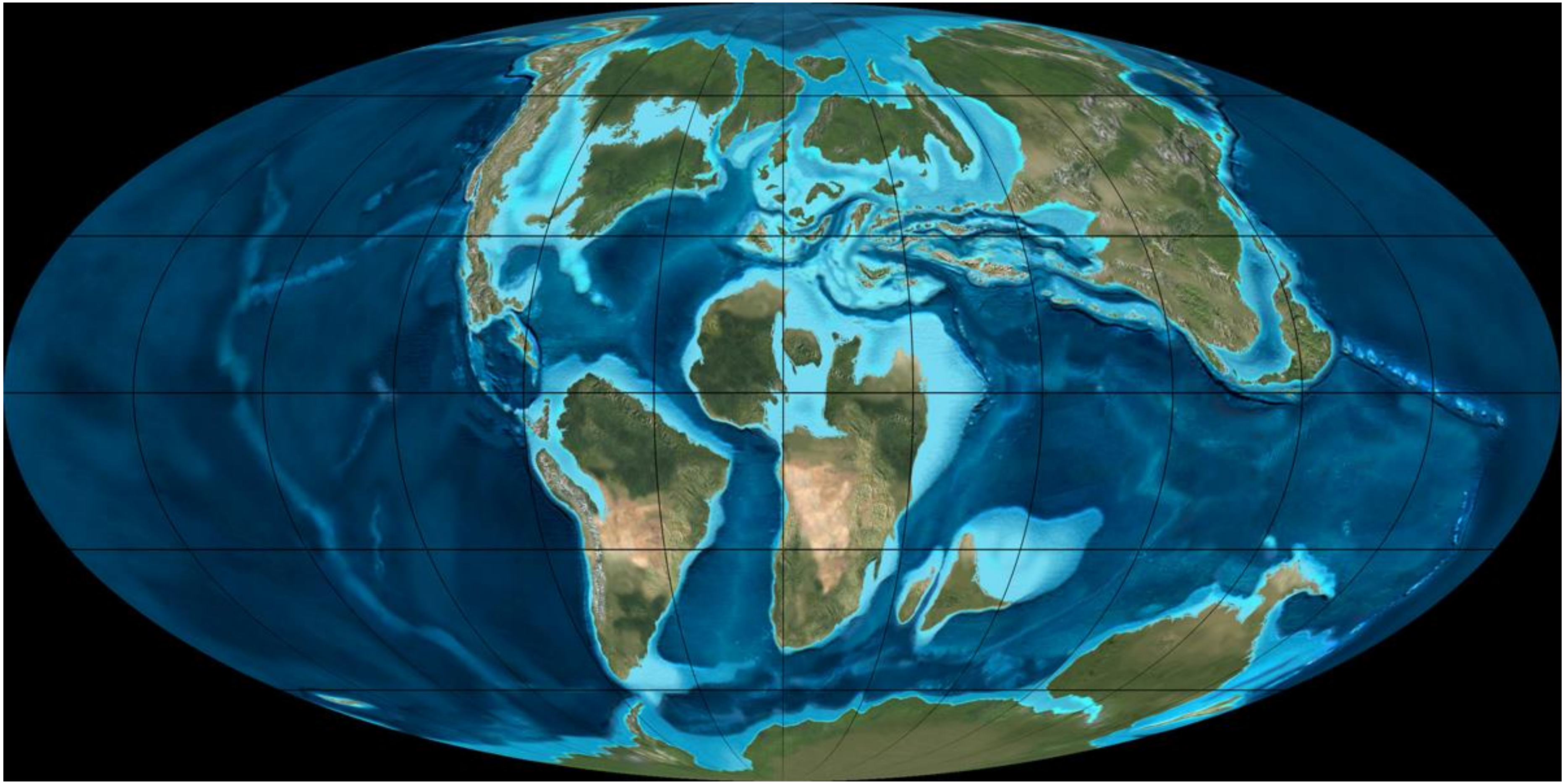
Late Jurassic



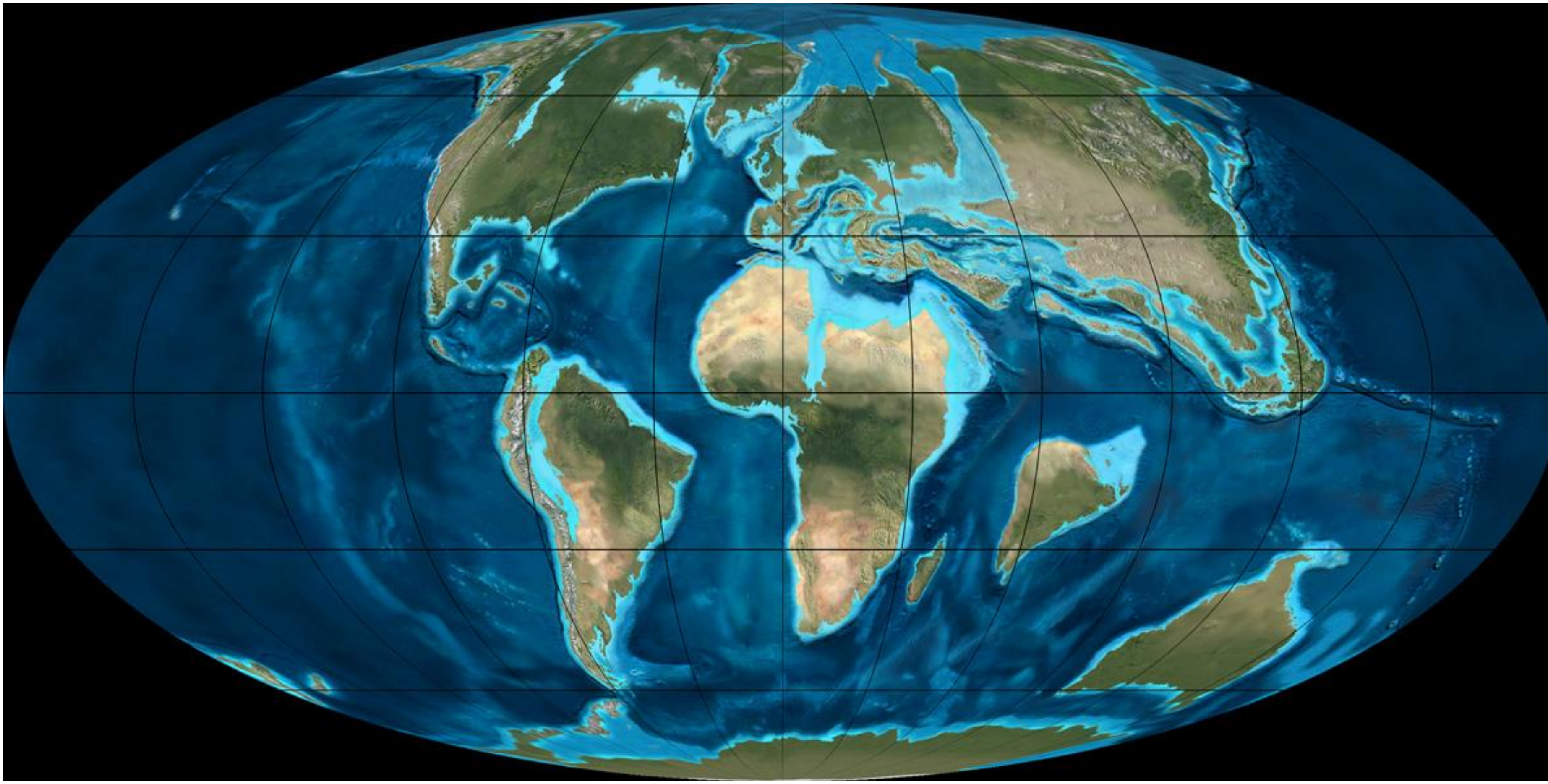
Early Cretaceous



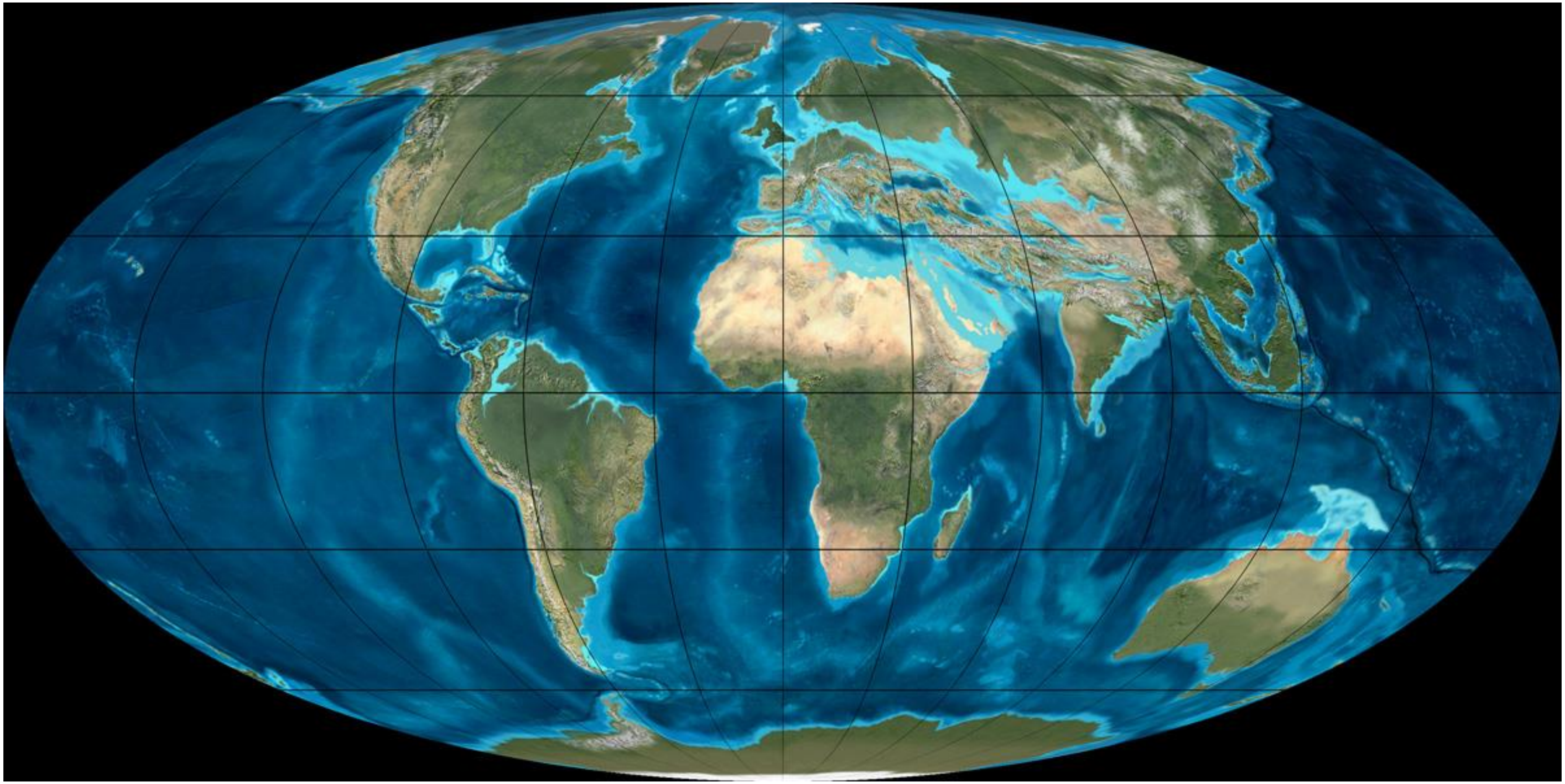
Mid-Cretaceous



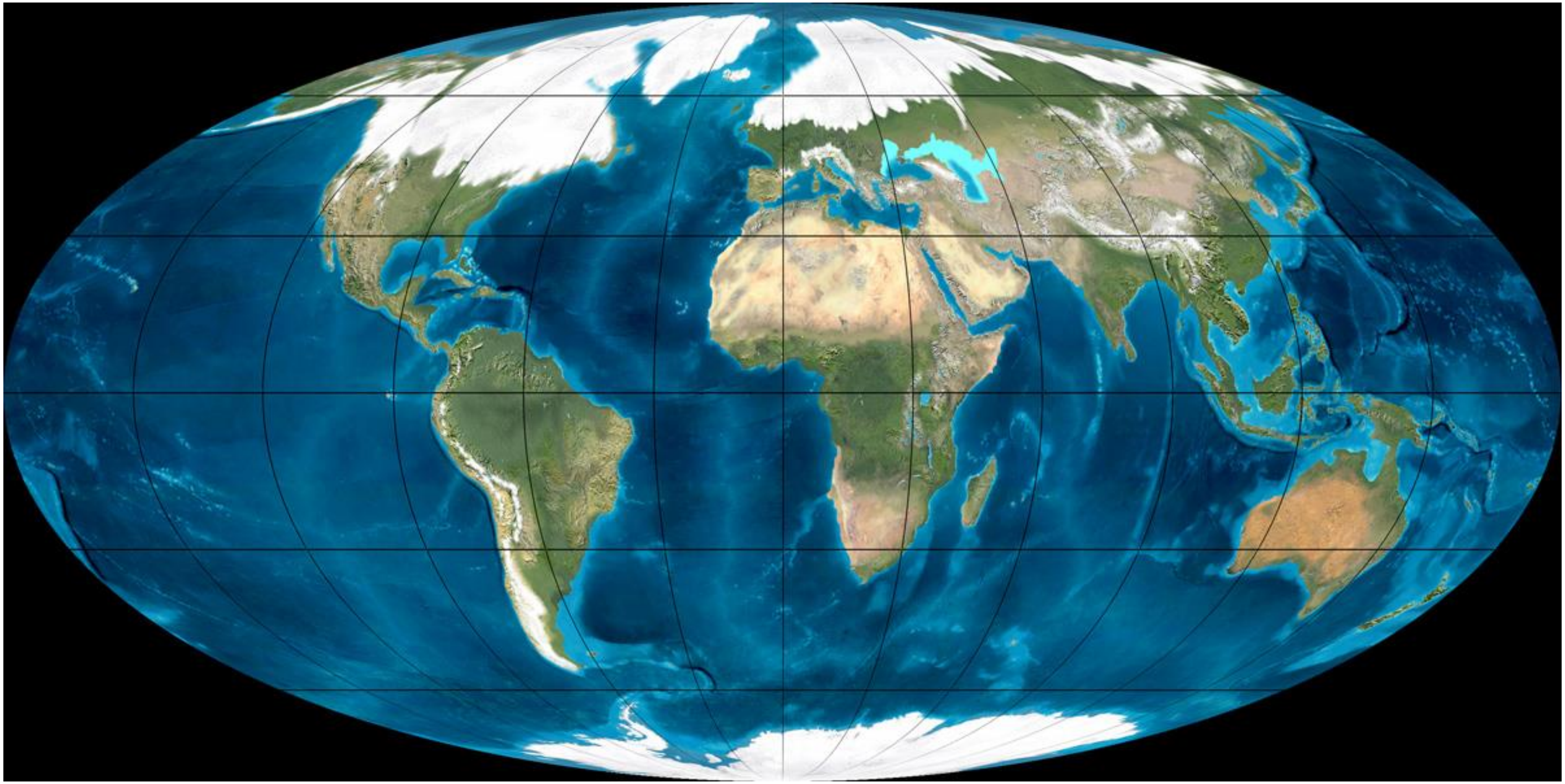
Late Cretaceous



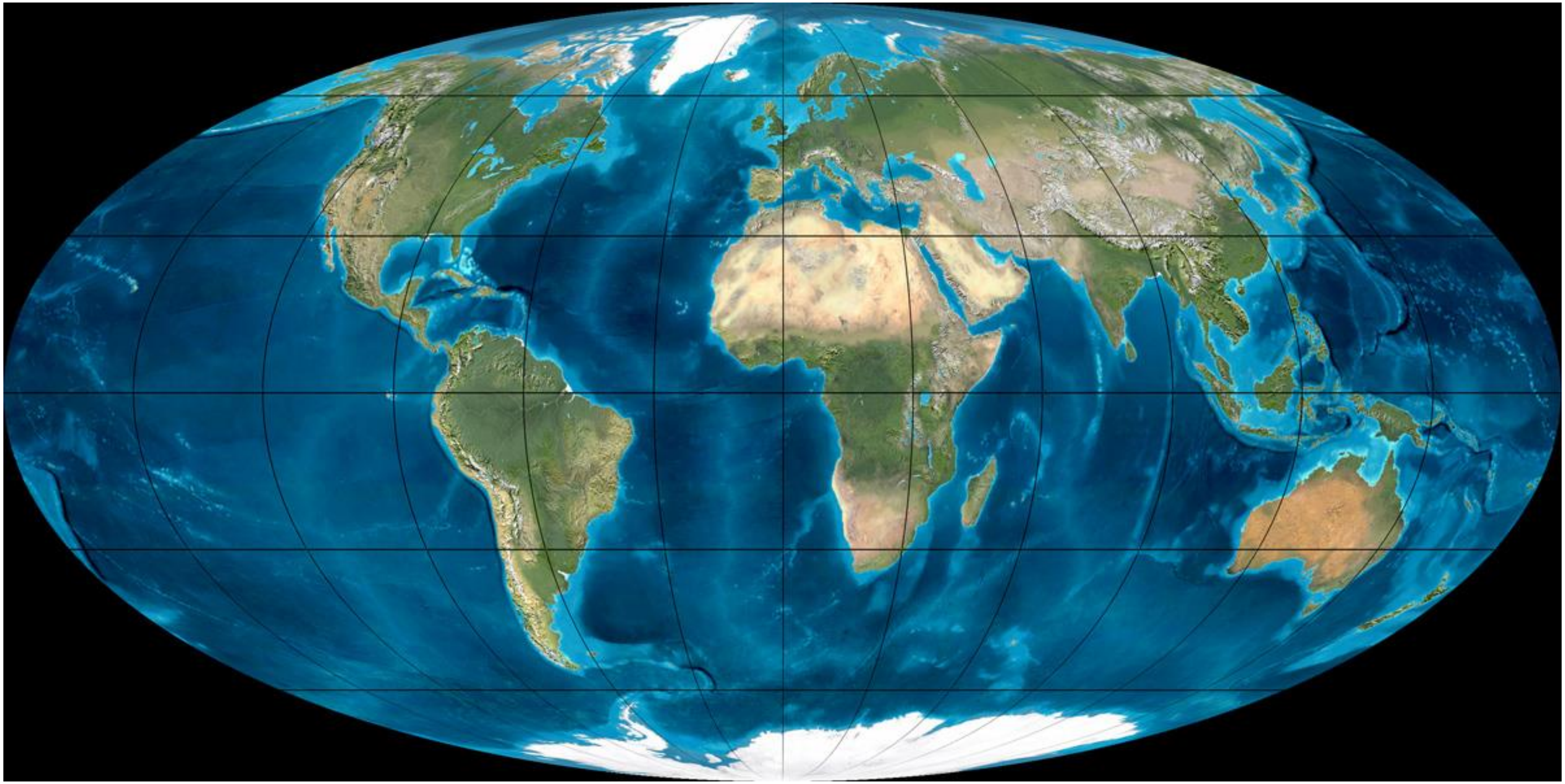
K/T boundary



Oligocene



Ice Age (following the Flood)



Present

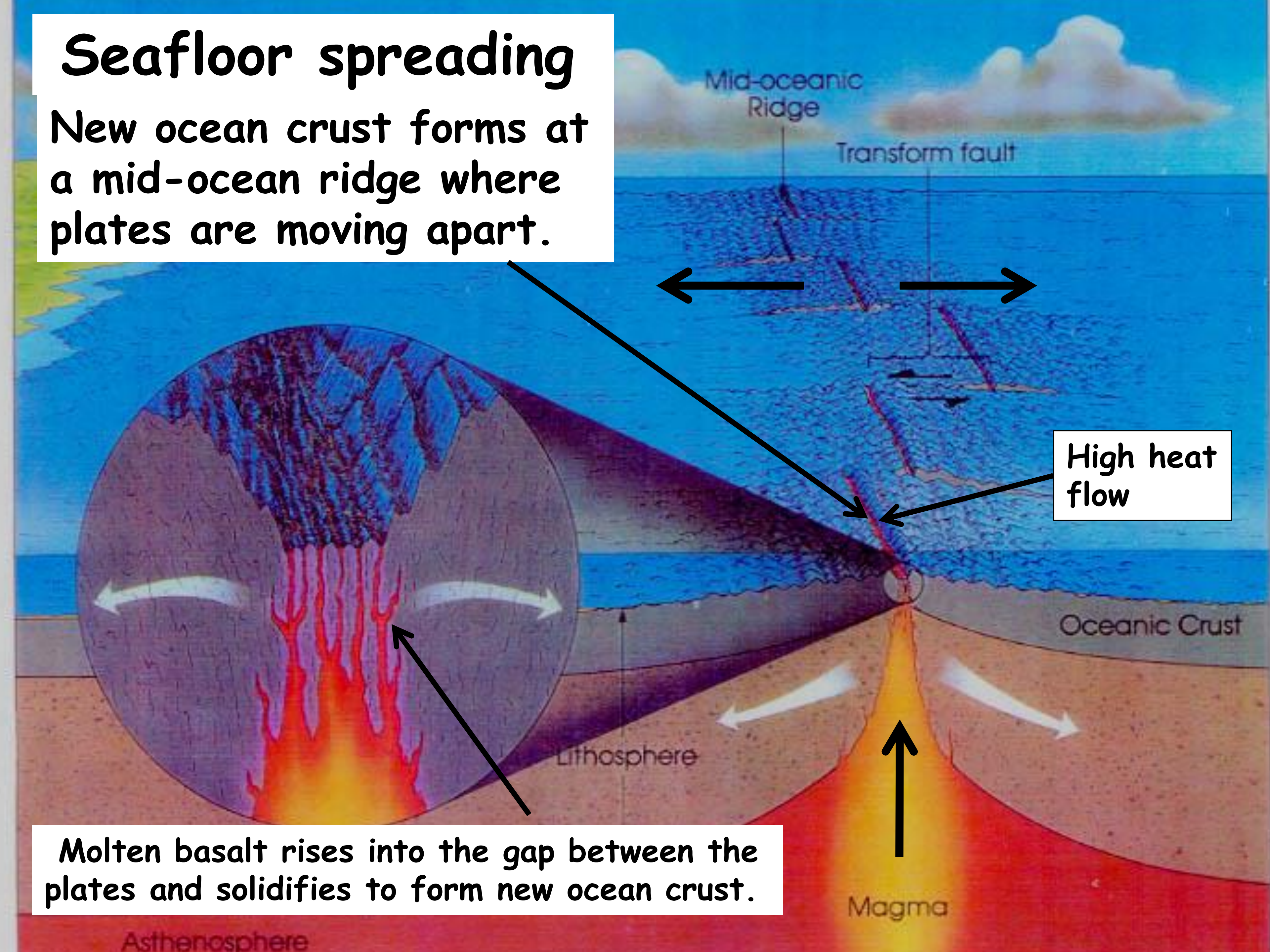
Because fossils are indicative of the geological record associated with the Flood, all the plate motion shown in the preceding sequence must logically have accompanied the Flood and unfolded in the span of a few month's time.

Catastrophic plate tectonics, like conventional plate tectonics, accounts for many of the earth's physical features including:

- the mid-ocean ridges
- deep ocean trenches
- global distribution of earthquakes
- volcanism adjacent to trenches

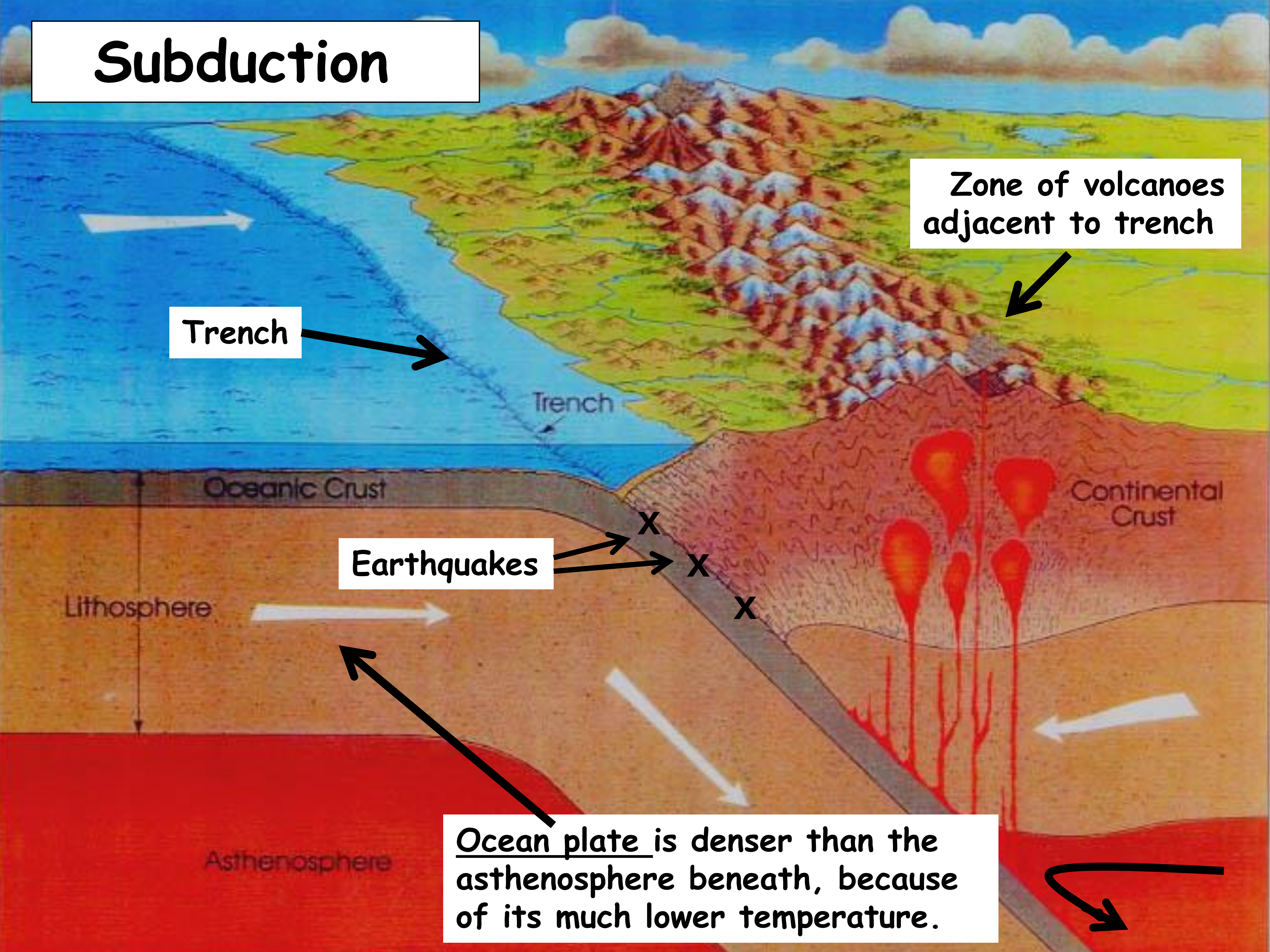
Seafloor spreading

New ocean crust forms at a mid-ocean ridge where plates are moving apart.

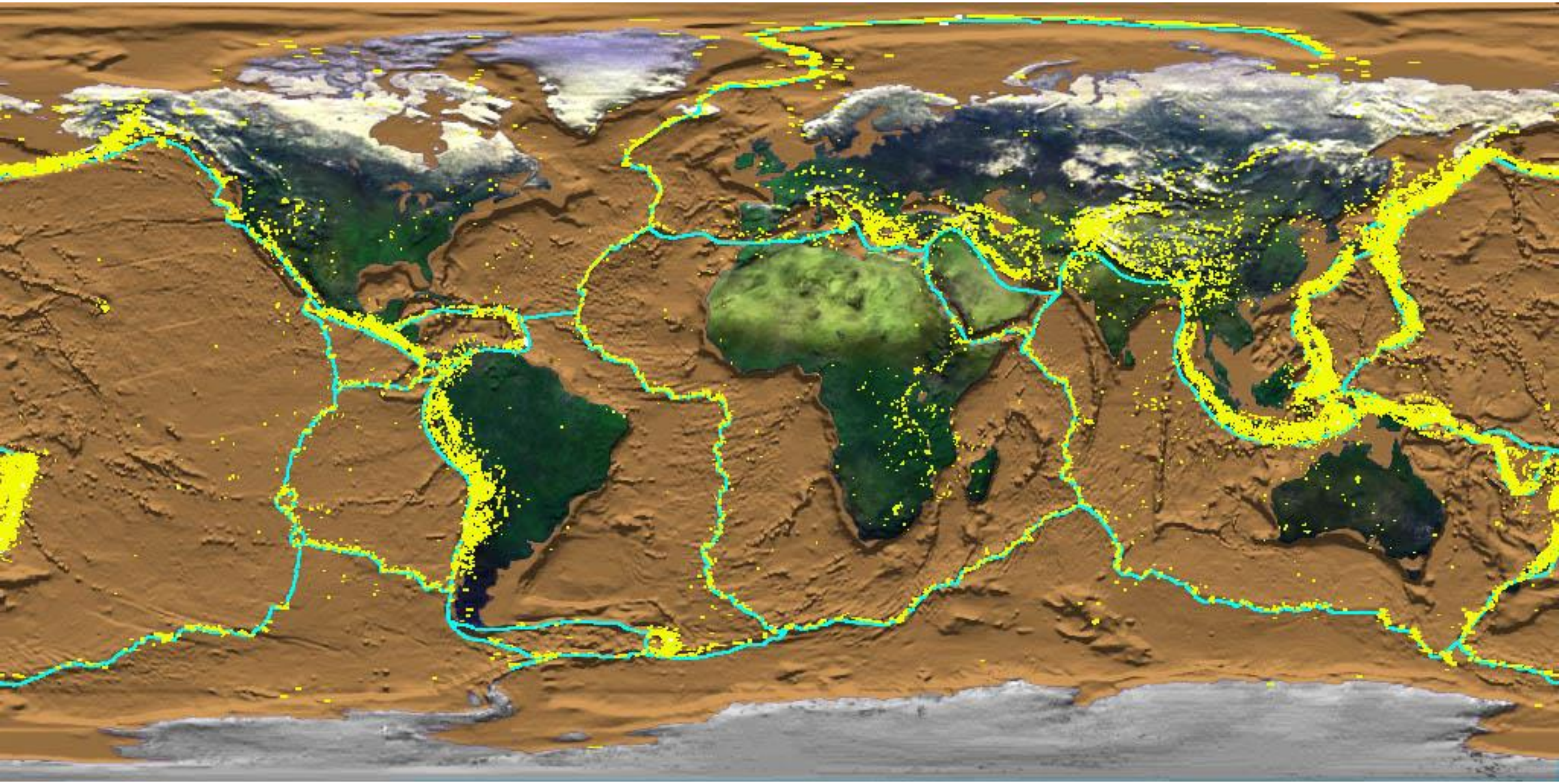


Molten basalt rises into the gap between the plates and solidifies to form new ocean crust.

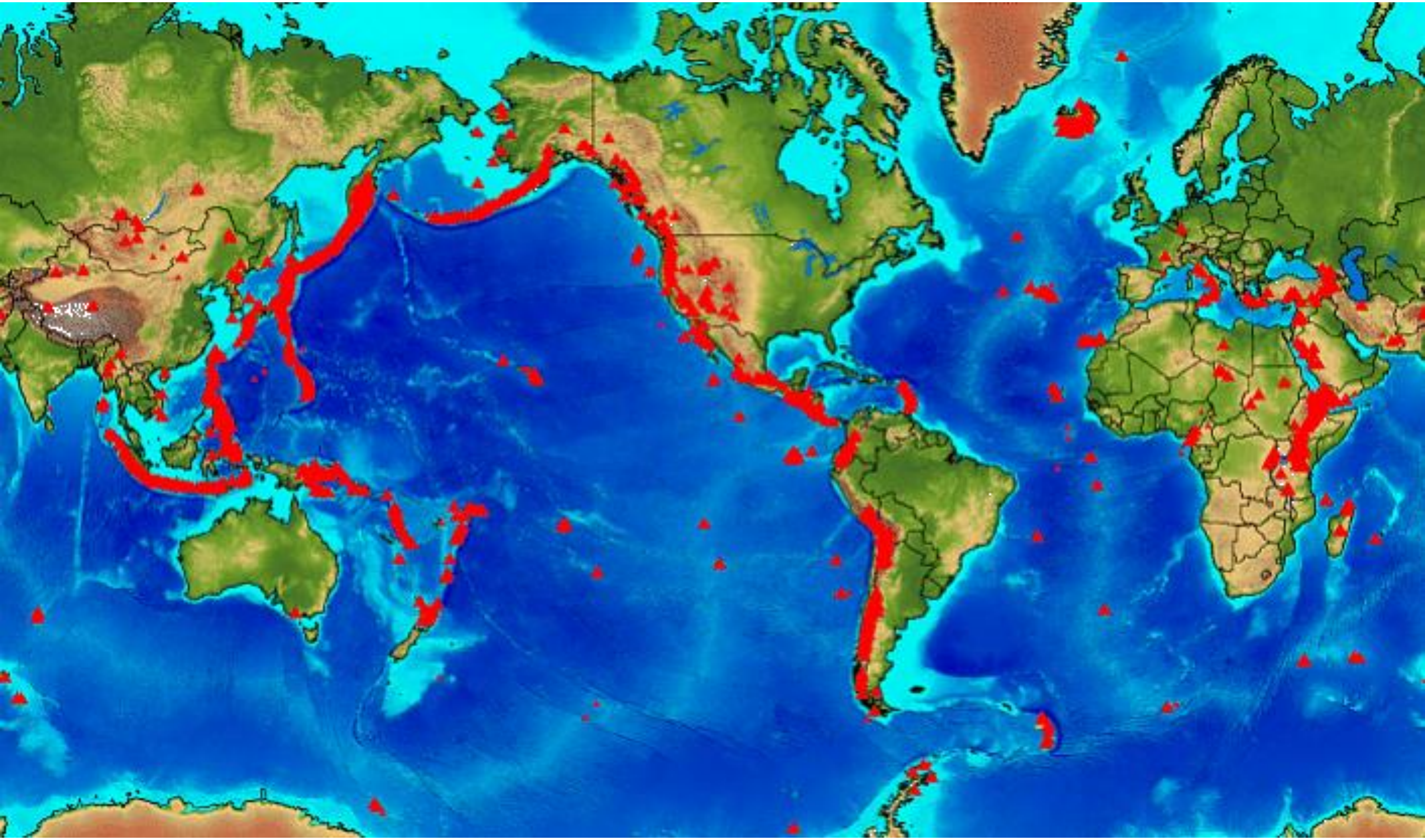
Subduction



Ocean plate is denser than the asthenosphere beneath, because of its much lower temperature.



Location of earthquakes (yellow dots) with magnitudes greater than 4.5 that occurred between 1980 and 1995. Note that the earthquakes are concentrated along plate boundaries (blue-green lines). Source: NASA/GSFC

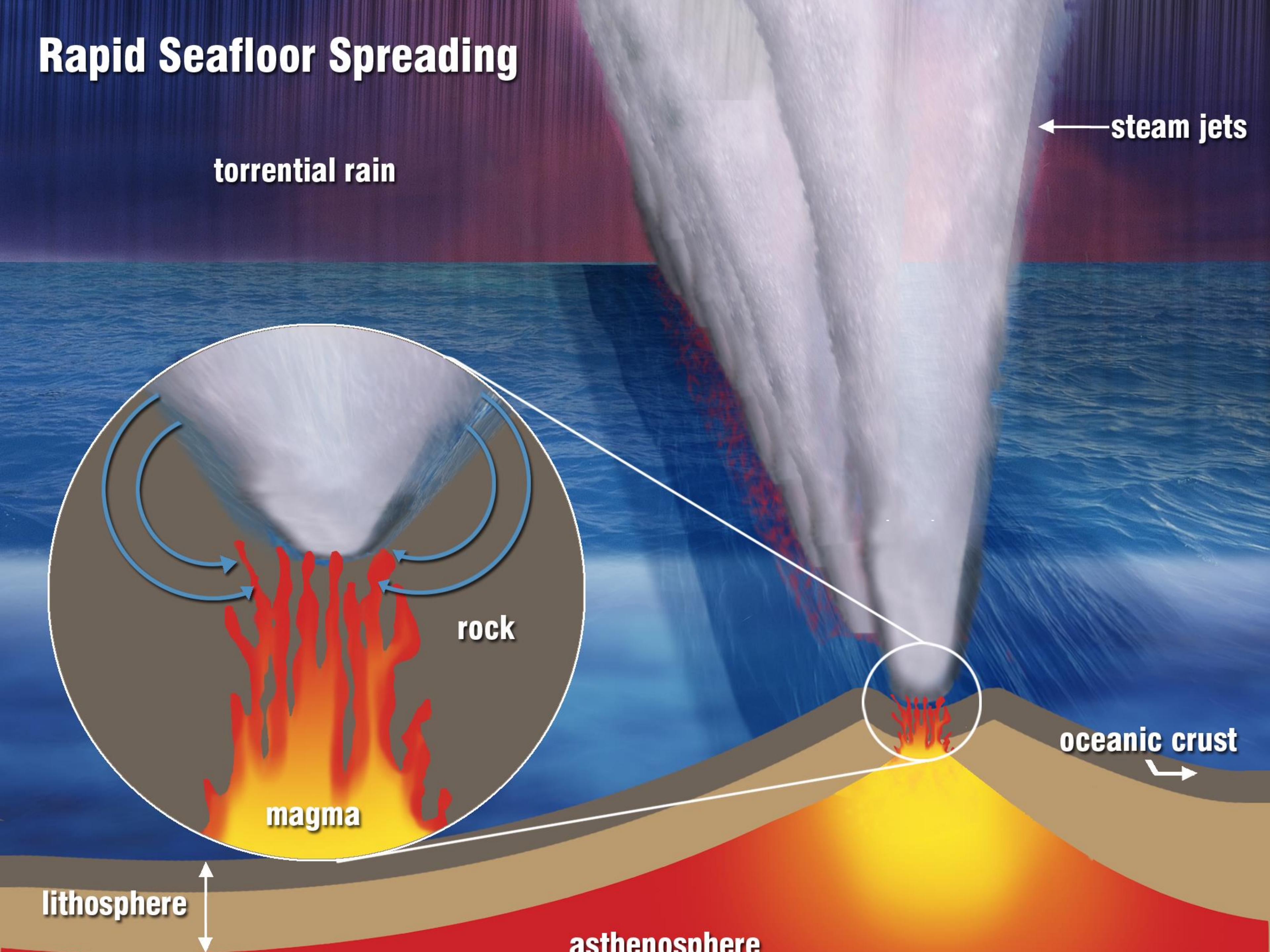


Locations of the world's active volcanoes (red triangles).

Some geological processes <u>distinctive</u> to <u>catastrophic</u> plate tectonics

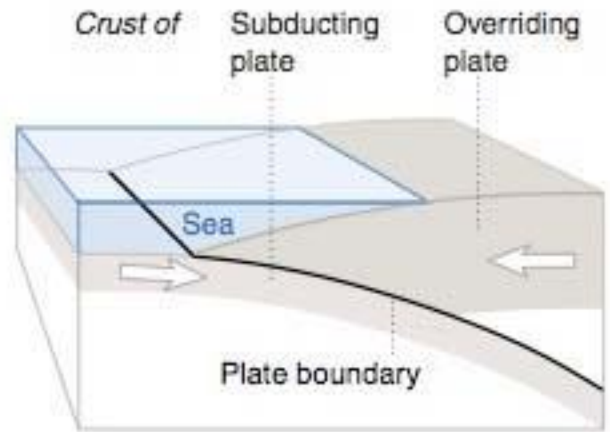
- Supersonic steam jets, emerging from the seafloor along 60,000 km of rapidly spreading mid-ocean rift zones

- Intense global rain from entrained ocean water lofted above the earth by the steam jets

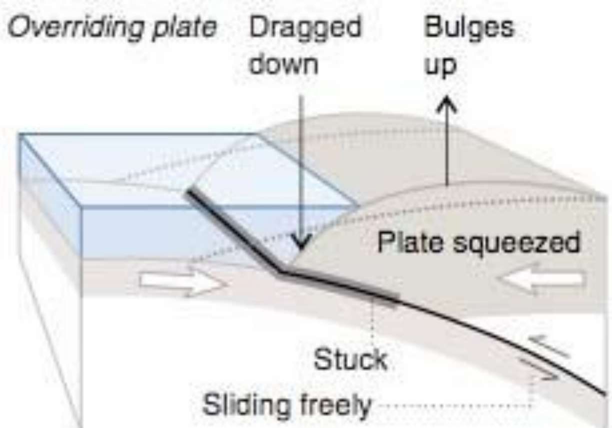

Rapid Seafloor Spreading
steam jets
torrential rain
rock
magma
oceanic crust
lithosphere
asthenosphere

- Giant tsunamis as rapidly subducting ocean plates temporarily stick and then release via large earthquakes
- Significant up and down motions of earth's surface because of rapid flow of rock inside the earth
- Dramatic uplift of today's mountain belts at the end of the cataclysm.
- An Ice Age following the Flood

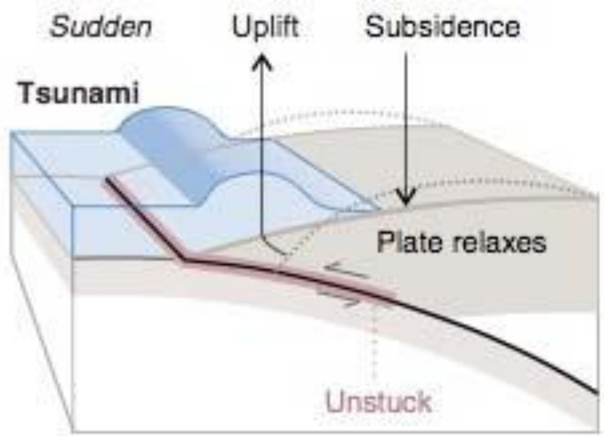
Making a Tsunami



OVERALL, a tectonic plate descends, or "subducts," beneath an adjoining plate. But it does so in a stick-slip fashion.



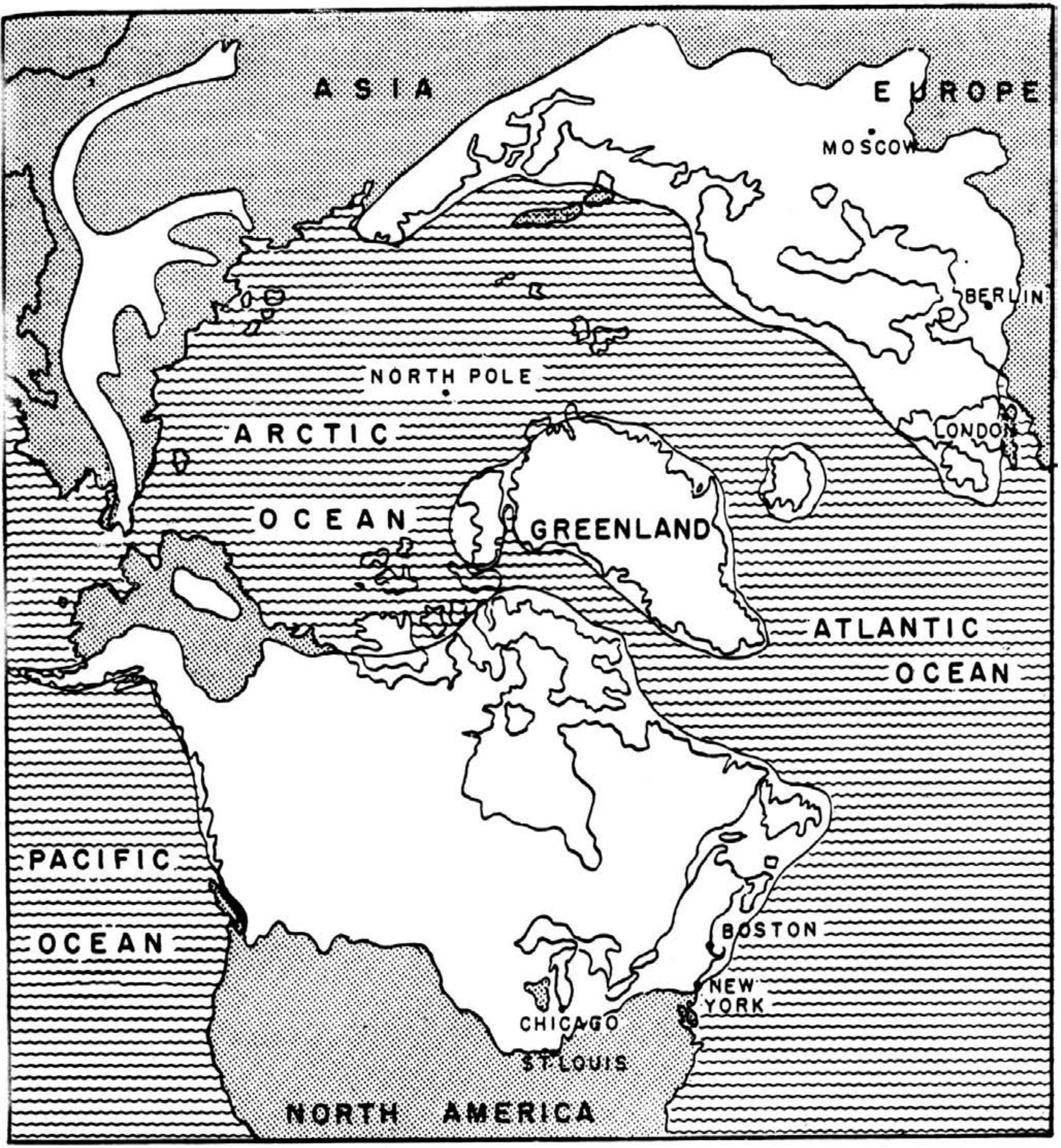
BETWEEN EARTHQUAKES the plates slide freely at great depth, where hot and ductile. But at shallow depth, where cool and brittle, they stick together. Slowly squeezed, the overriding plate thickens.



DURING AN EARTHQUAKE the leading edge of the overriding plate breaks free, springing seaward and upward. Behind, the plate stretches; its surface falls. The vertical displacements set off a tsunami.

Chilean Andes

Photo by Robert Morrow, Wikipedia,

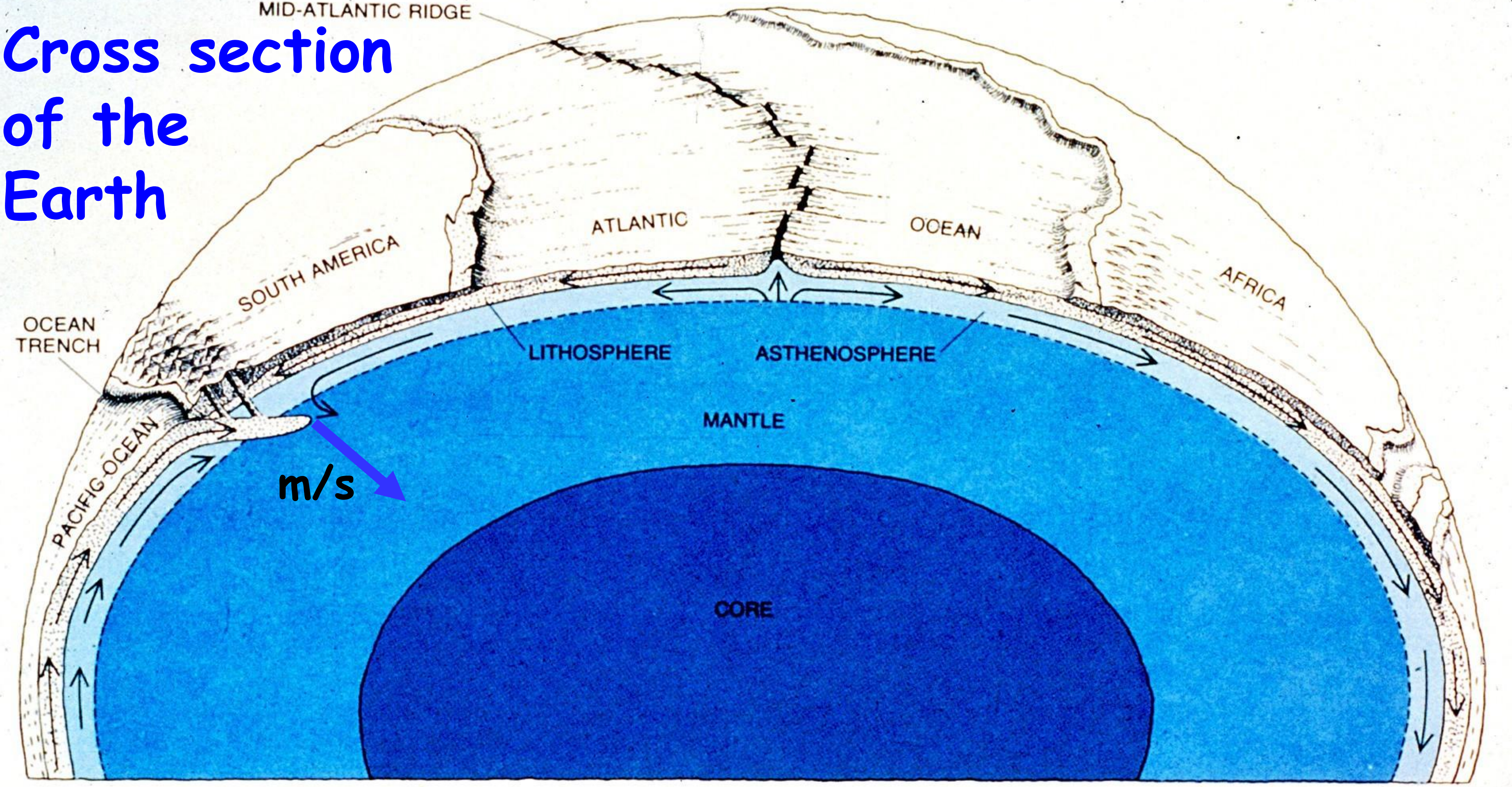


The warming of the oceans during the Flood led to high rates of evaporation, precipitation, and rapid buildup of polar ice sheets and mountain glaciers in the following centuries.

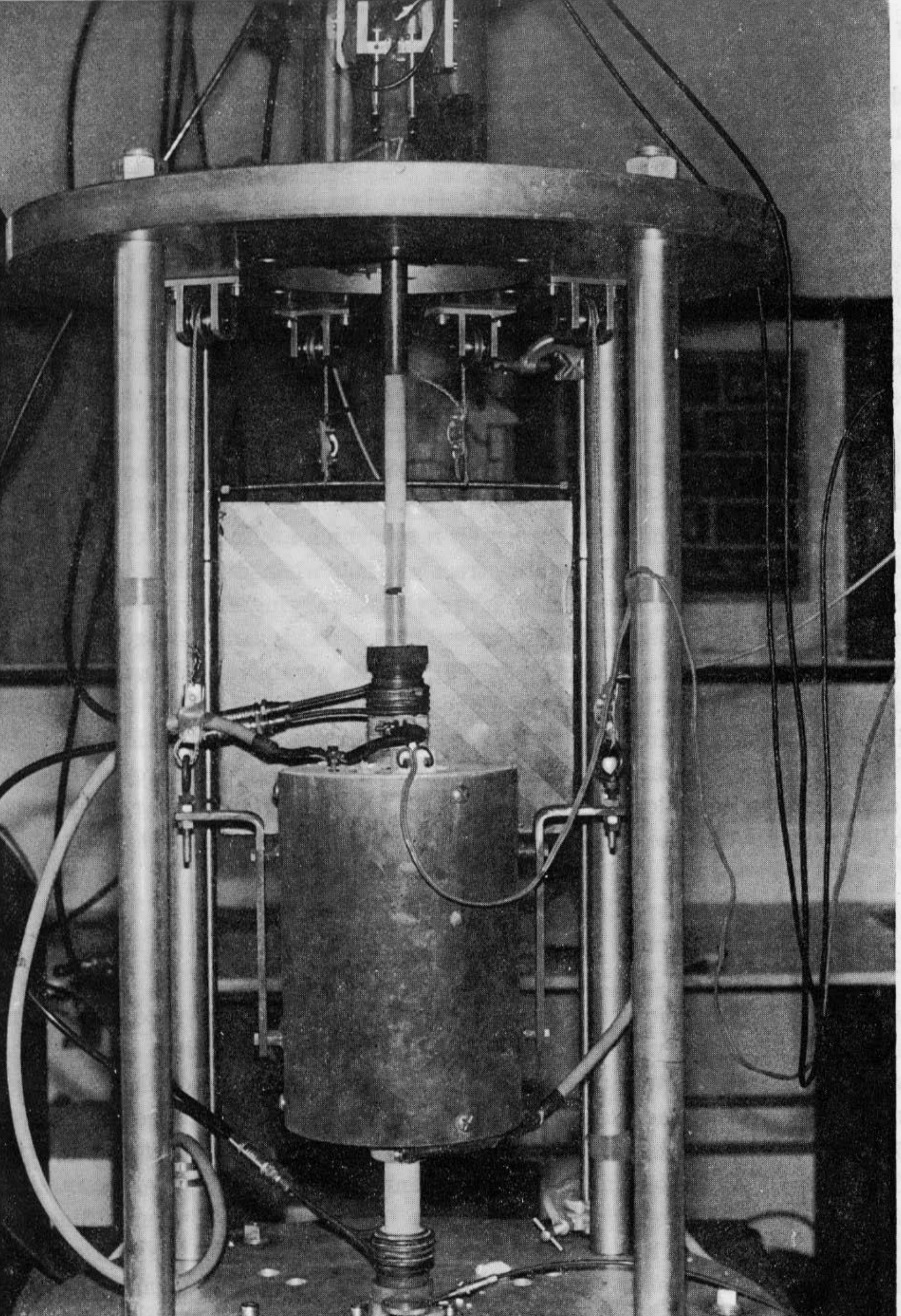
A crucial issue

Can ocean plate actually sink vertically through 2900 km of mantle rock in a few weeks' time?

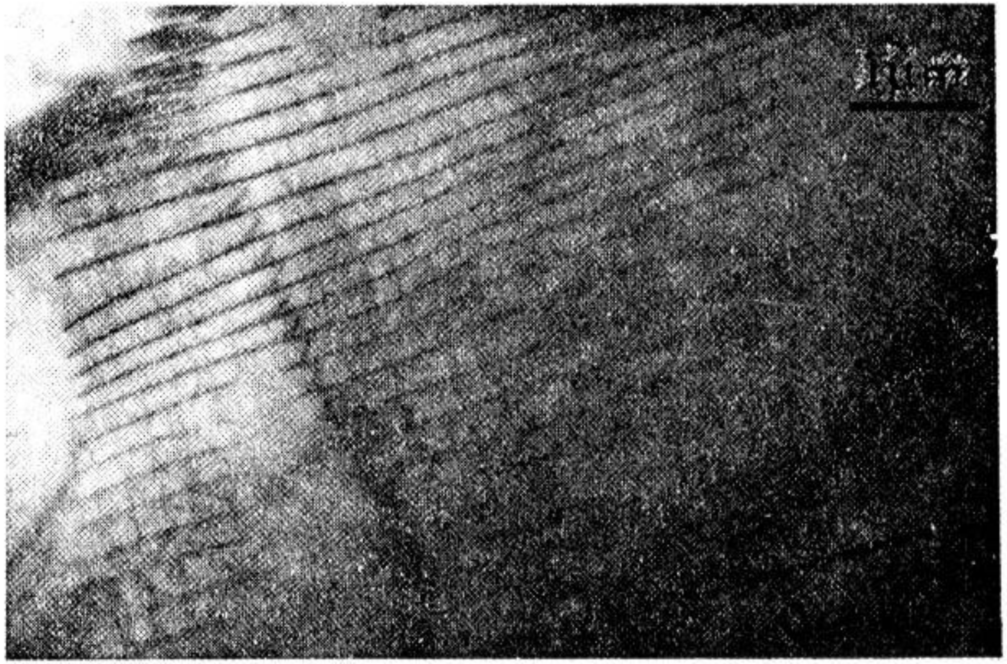
Cross section of the Earth

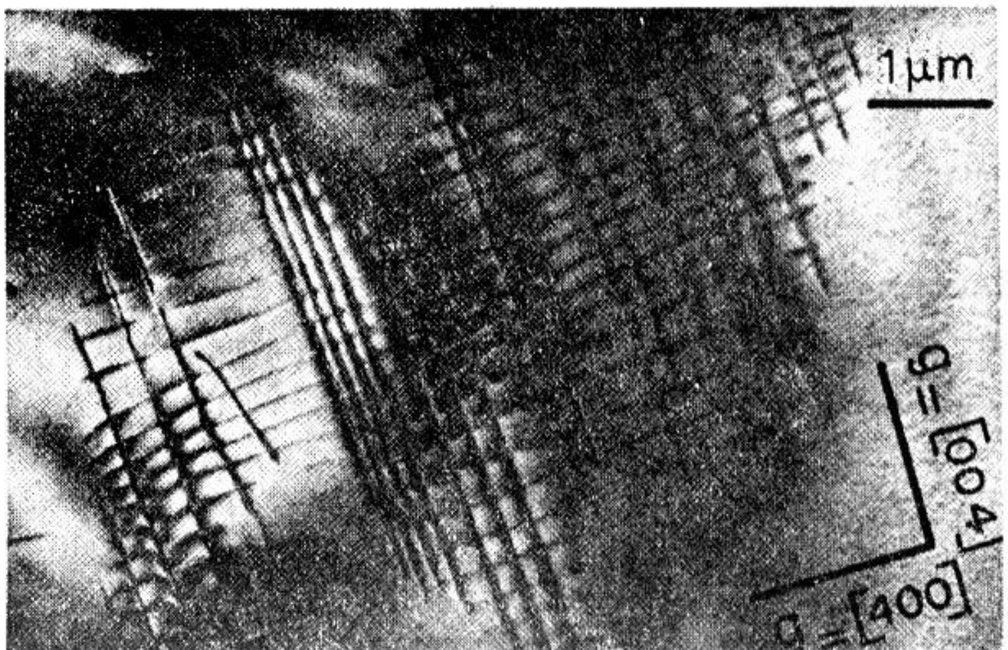


Catastrophic plate tectonics: Ocean plates can slide into the mantle and sink because they are cooler and denser than the mantle rock beneath. <u>Rapid</u> plate motion can occur because <u>mantle rock weakens under stress.</u>



Apparatus
for measuring
deformational
properties of
mantle minerals.





Electron microscope images of deformed olivine crystals.

When the crystal is subjected to shear stress, deformation occurs as planes of atoms, like cards in a deck of cards, slide past one another.

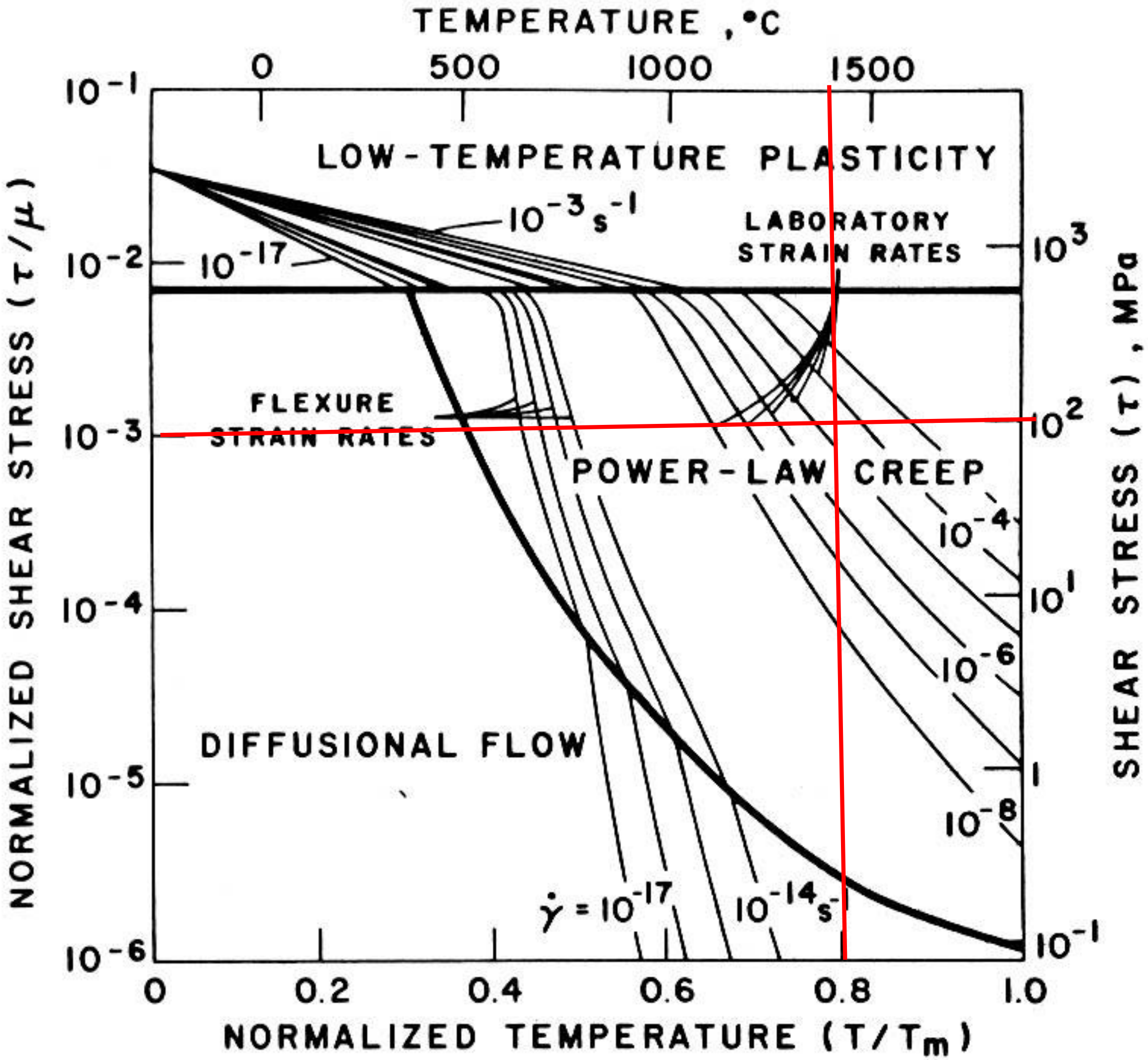
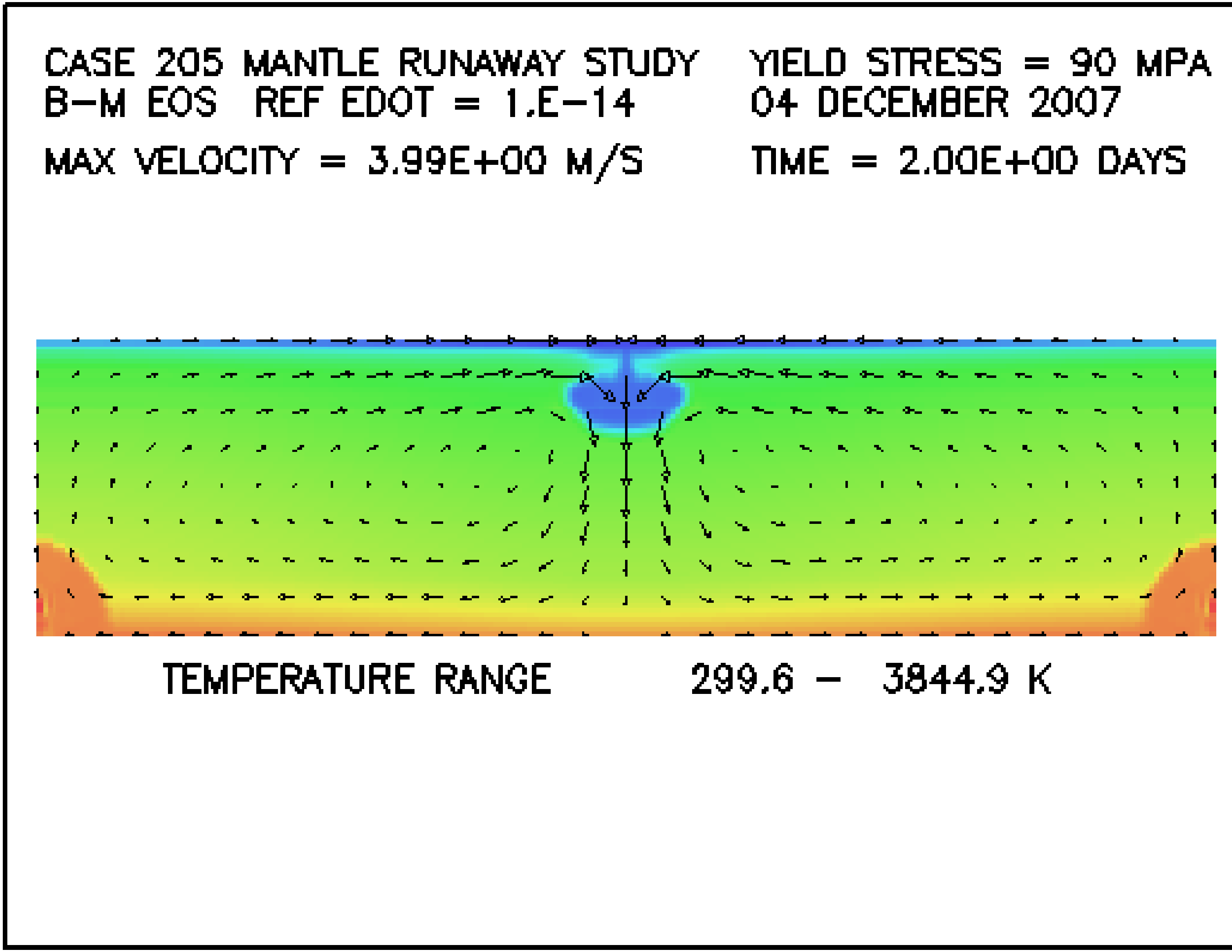


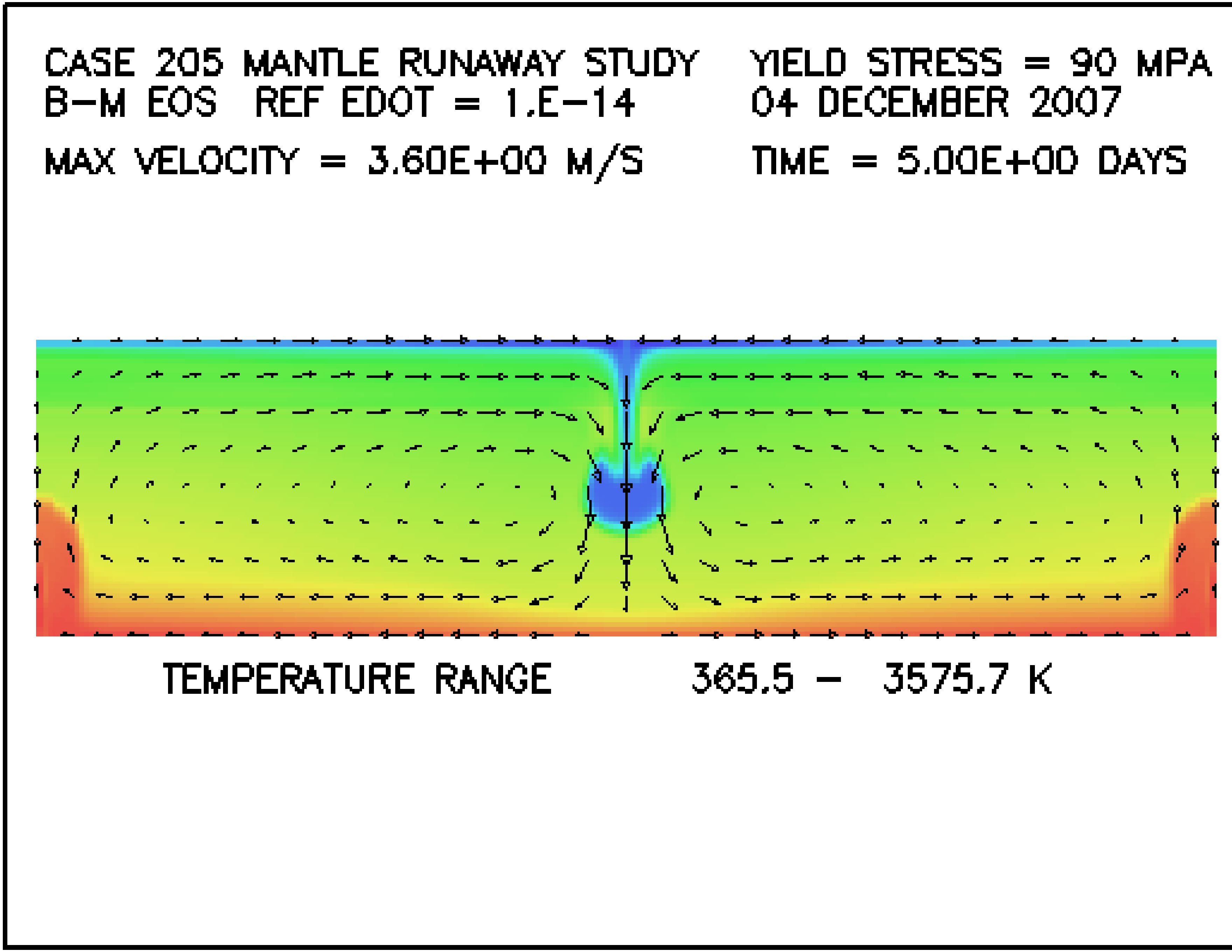
Fig. 1. Deformation mechanism map for olivine with a 1 mm grain size. Shear strain rates $\dot{\gamma}$ (in s^{-1}) are contoured over shear stress τ normalized by shear modulus μ and absolute temperature T normalized by temperature of melting T_m.

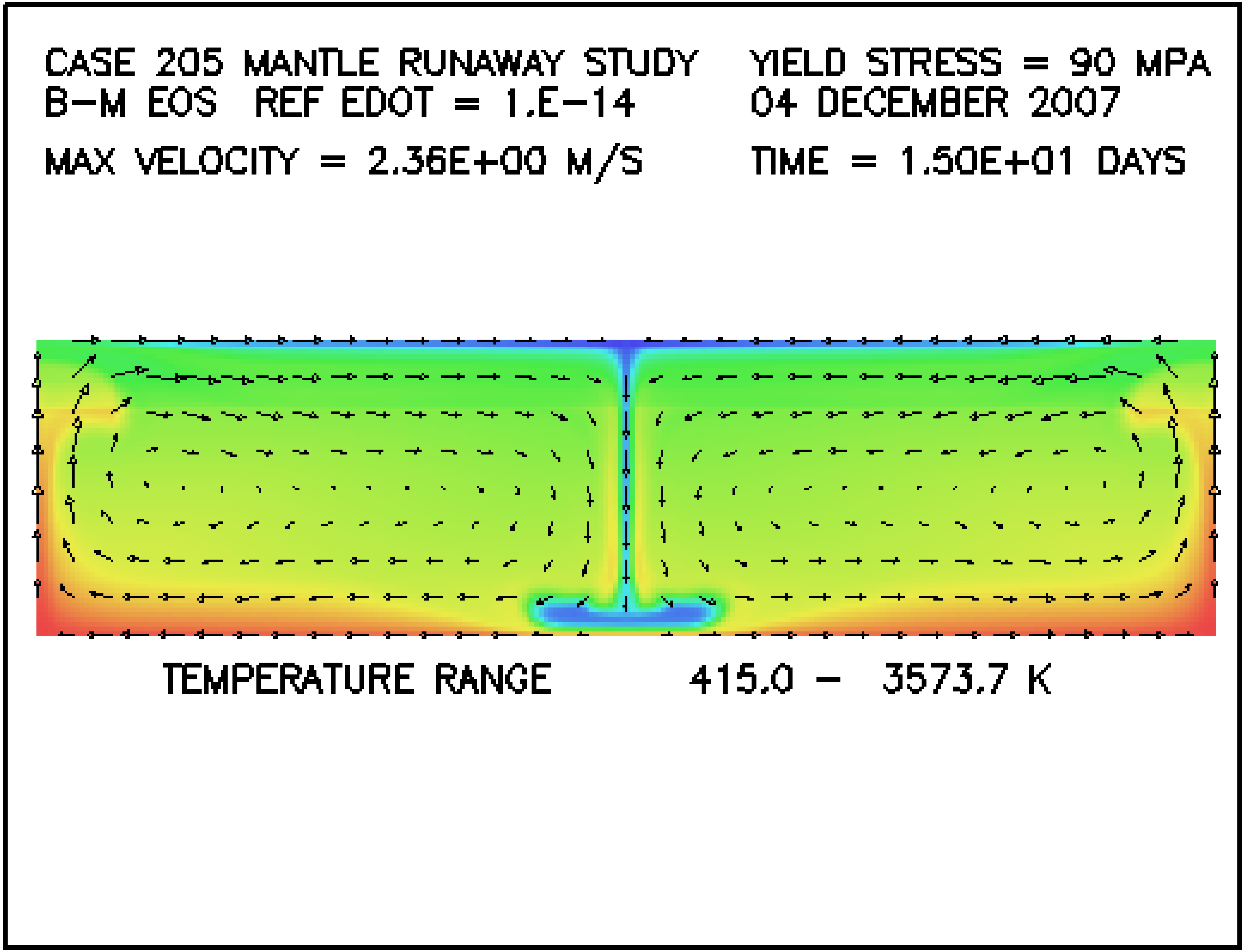
Experimentally measured deformation rates for the mineral olivine as temperature and stress are varied.

2-D computer calculation using experimentally determined rock deformation properties

—shows runaway catastrophe!

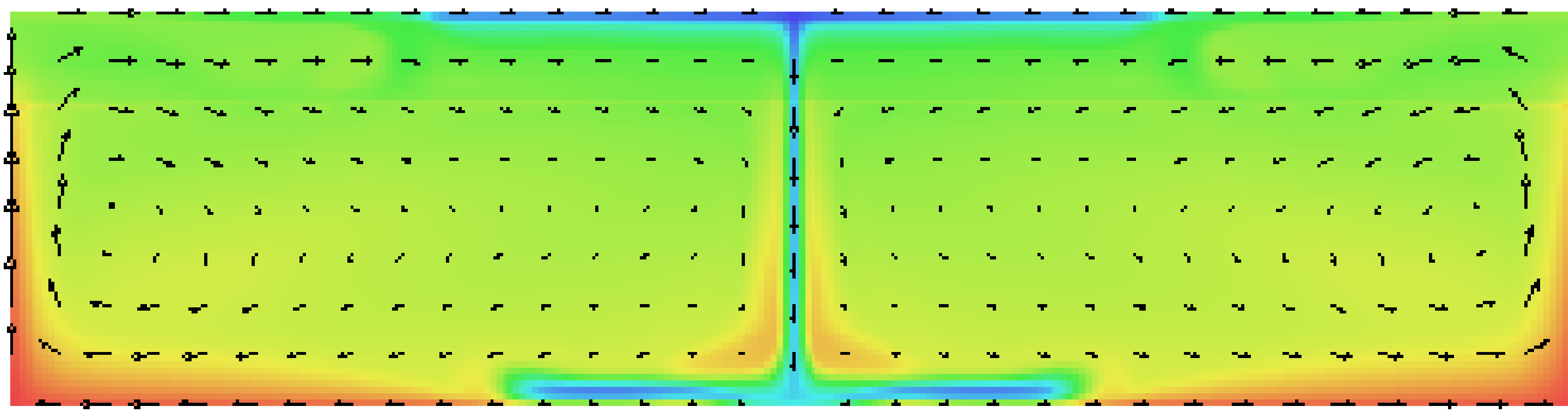

CASE 205 MANTLE RUNAWAY STUDY
YIELD STRESS = 90 MPA
B-M EOS REF EDOT = 1.E-14
04 DECEMBER 2007
MAX VELOCITY = 3.99E+00 M/S
TIME = 2.00E+00 DAYS
TEMPERATURE RANGE 299.6 - 3844.9 K


CASE 205 MANTLE RUNAWAY STUDY
YIELD STRESS = 90 MPA
B-M EOS REF EDOT = 1.E-14
04 DECEMBER 2007
MAX VELOCITY = 3.60E+00 M/S
TIME = 5.00E+00 DAYS
TEMPERATURE RANGE 365.5 - 3575.7 K


CASE 205 MANTLE RUNAWAY STUDY
YIELD STRESS = 90 MPA
B-M EOS REF EDOT = 1.E-14
04 DECEMBER 2007
MAX VELOCITY = 2.36E+00 M/S
TIME = 1.50E+01 DAYS
TEMPERATURE RANGE 415.0 - 3573.7 K

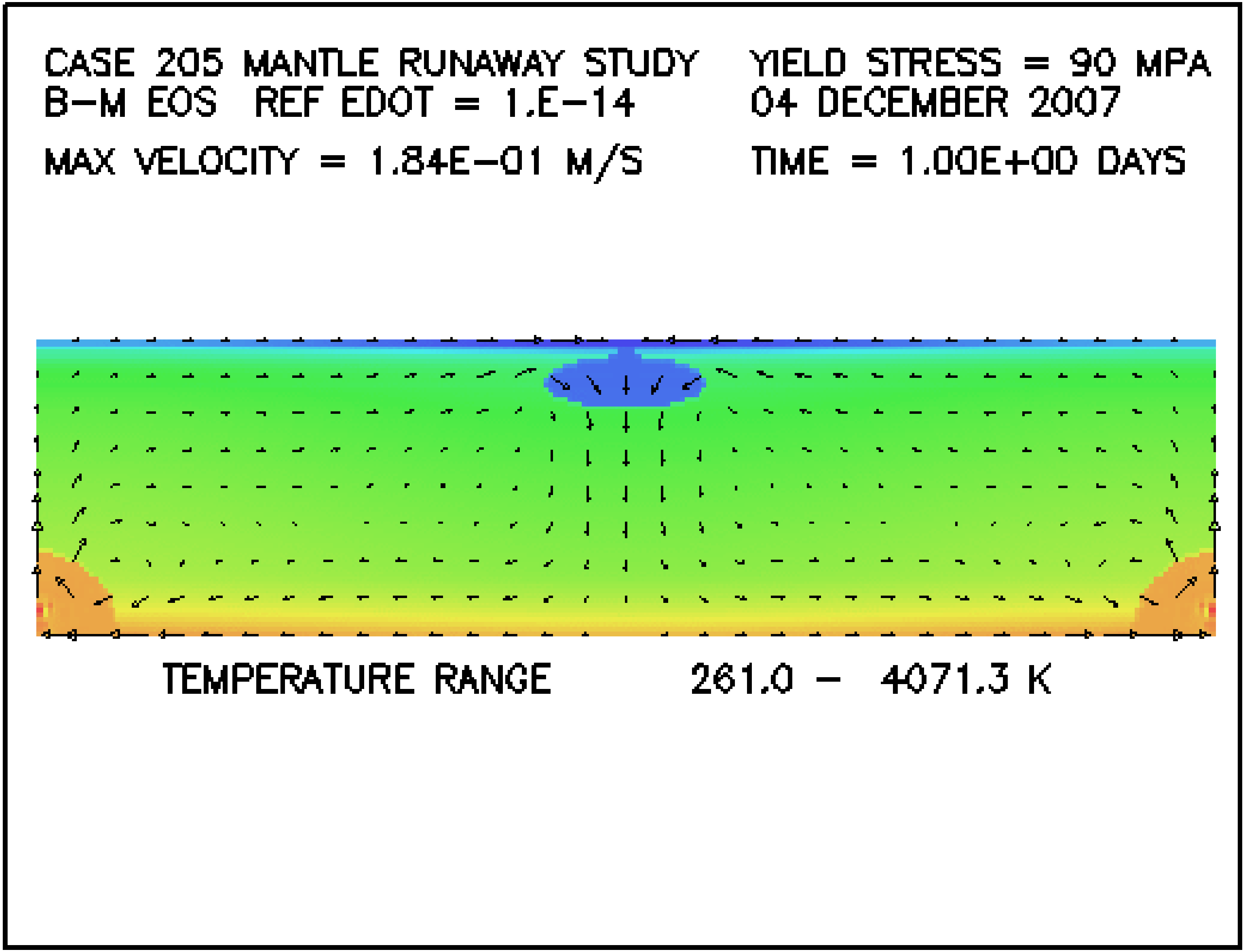
CASE 205 MANTLE RUNAWAY STUDY   YIELD STRESS = 90 MPA
B-M EOS   REF EDOT = 1.E-14   04 DECEMBER 2007

MAX VELOCITY = 1.06E+00 M/S   TIME = 4.00E+01 DAYS



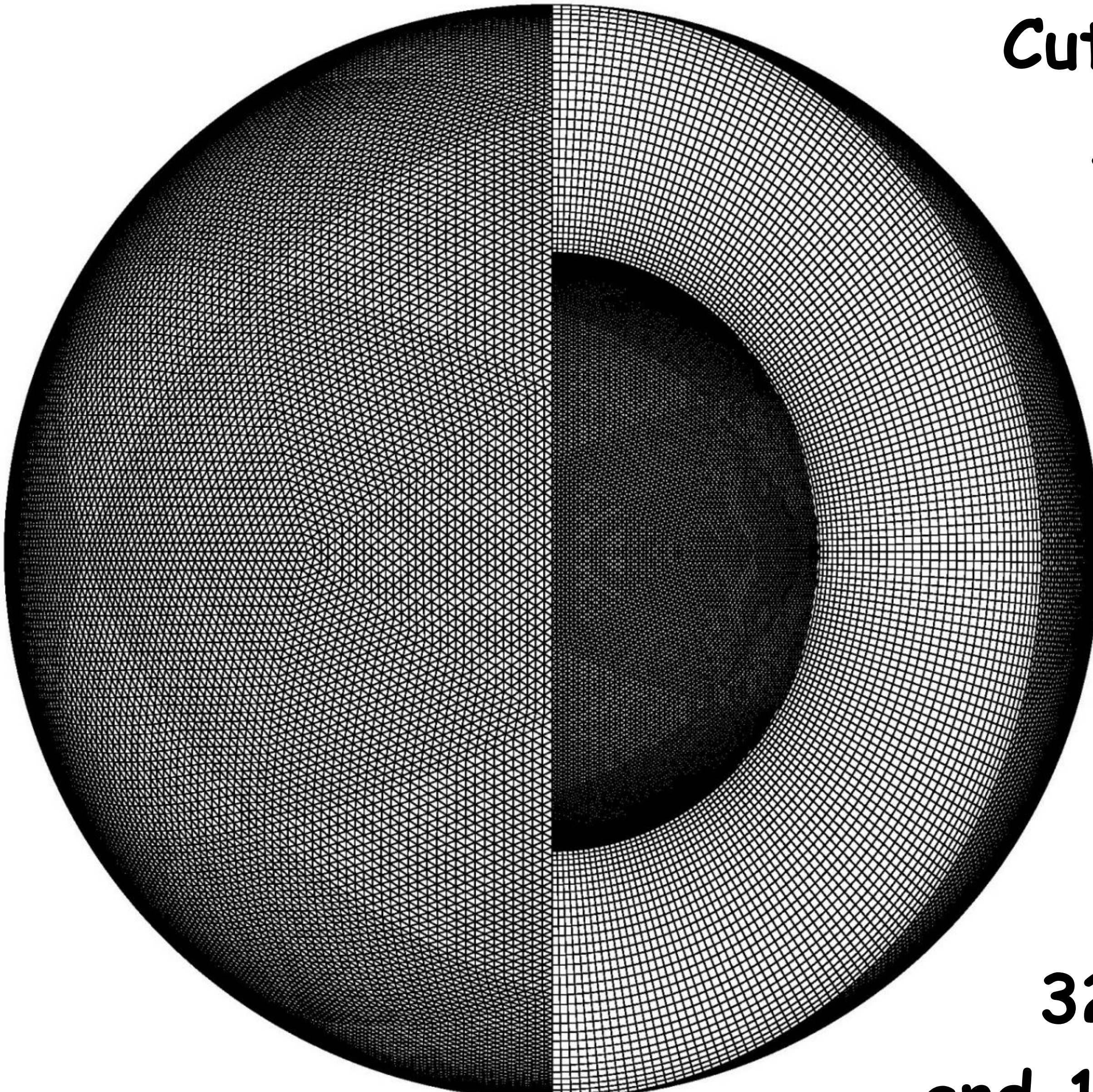
TEMPERATURE RANGE   477.3 - 3544.6 K

Note: The energy driving this process is simply the gravitational potential energy associated with the initial temperature differences.


CASE 205 MANTLE RUNAWAY STUDY
YIELD STRESS = 90 MPA
B-M EOS REF EDOT = 1.E-14
04 DECEMBER 2007
MAX VELOCITY = 1.84E-01 M/S
TIME = 1.00E+00 DAYS
TEMPERATURE RANGE 261.0 - 4071.3 K

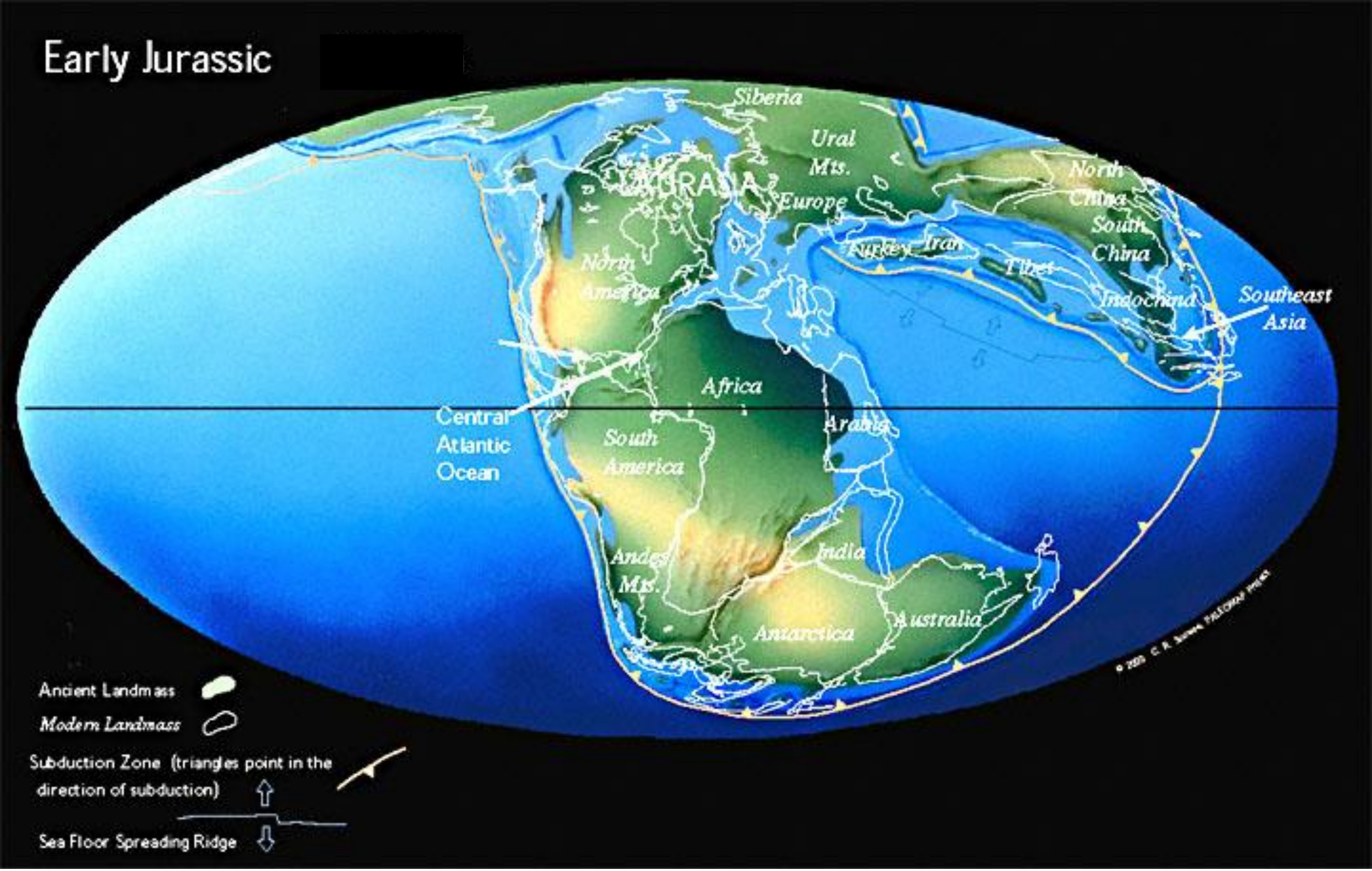
This 2D simulation, although it may not seem that complex or impressive, demonstrates that the physics indeed works, specifically, that stress-weakening in rocks can produce catastrophic consequences in a planet with the gravity field of the earth.

Modeling plate motions in 3D spherical geometry



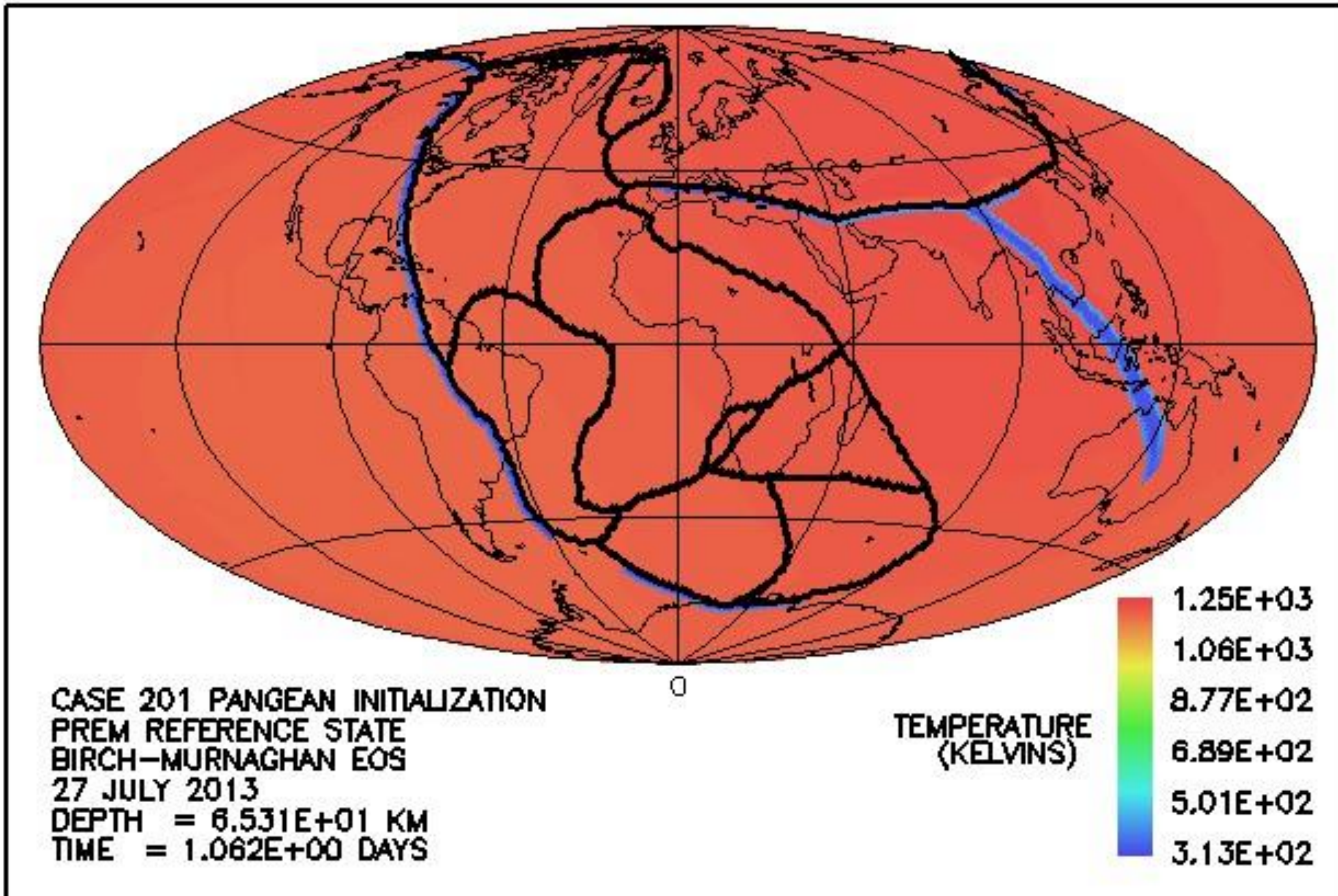
Cutaway view of spherical grid

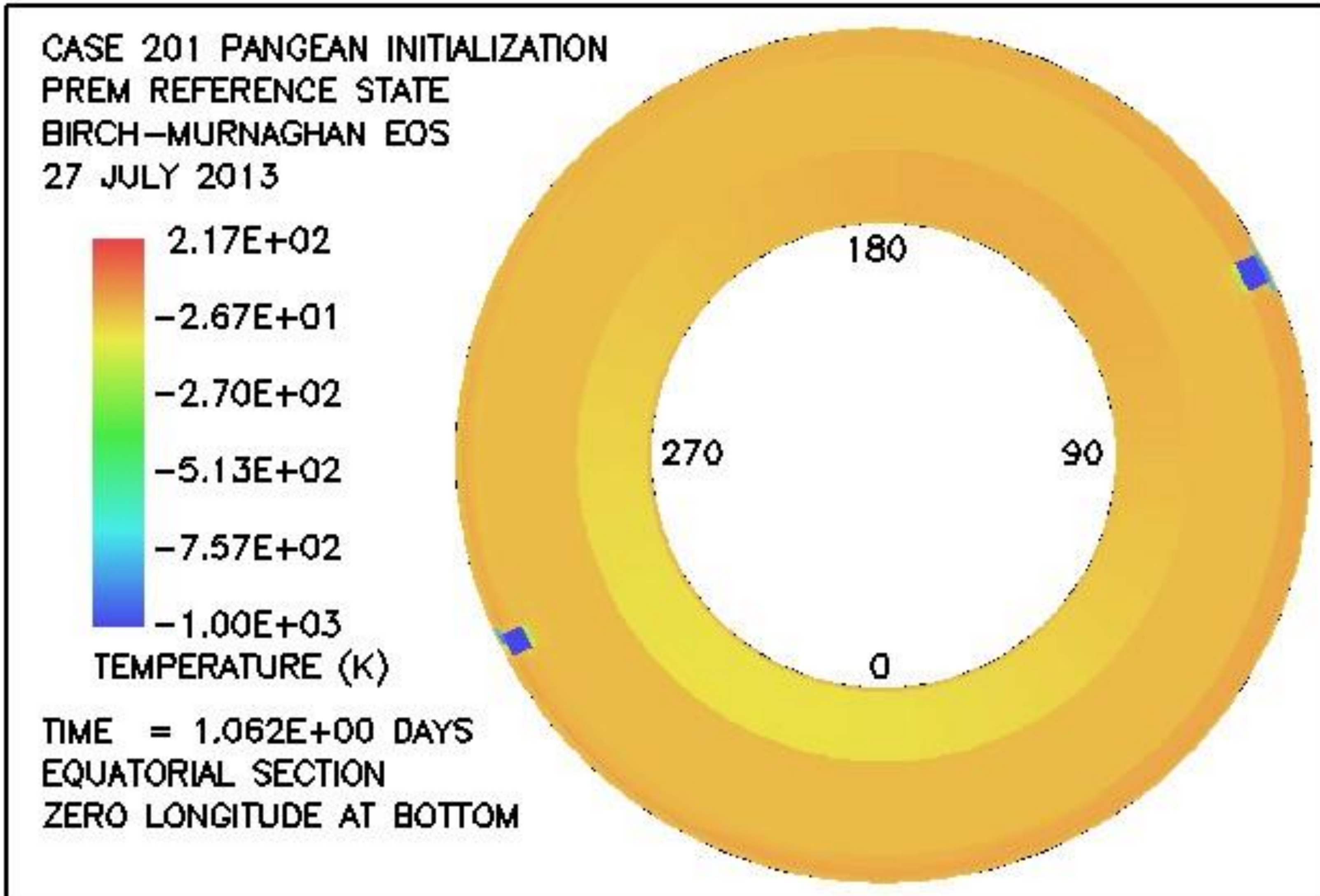
This grid has 32 radial layers and 1,351,746 cells.



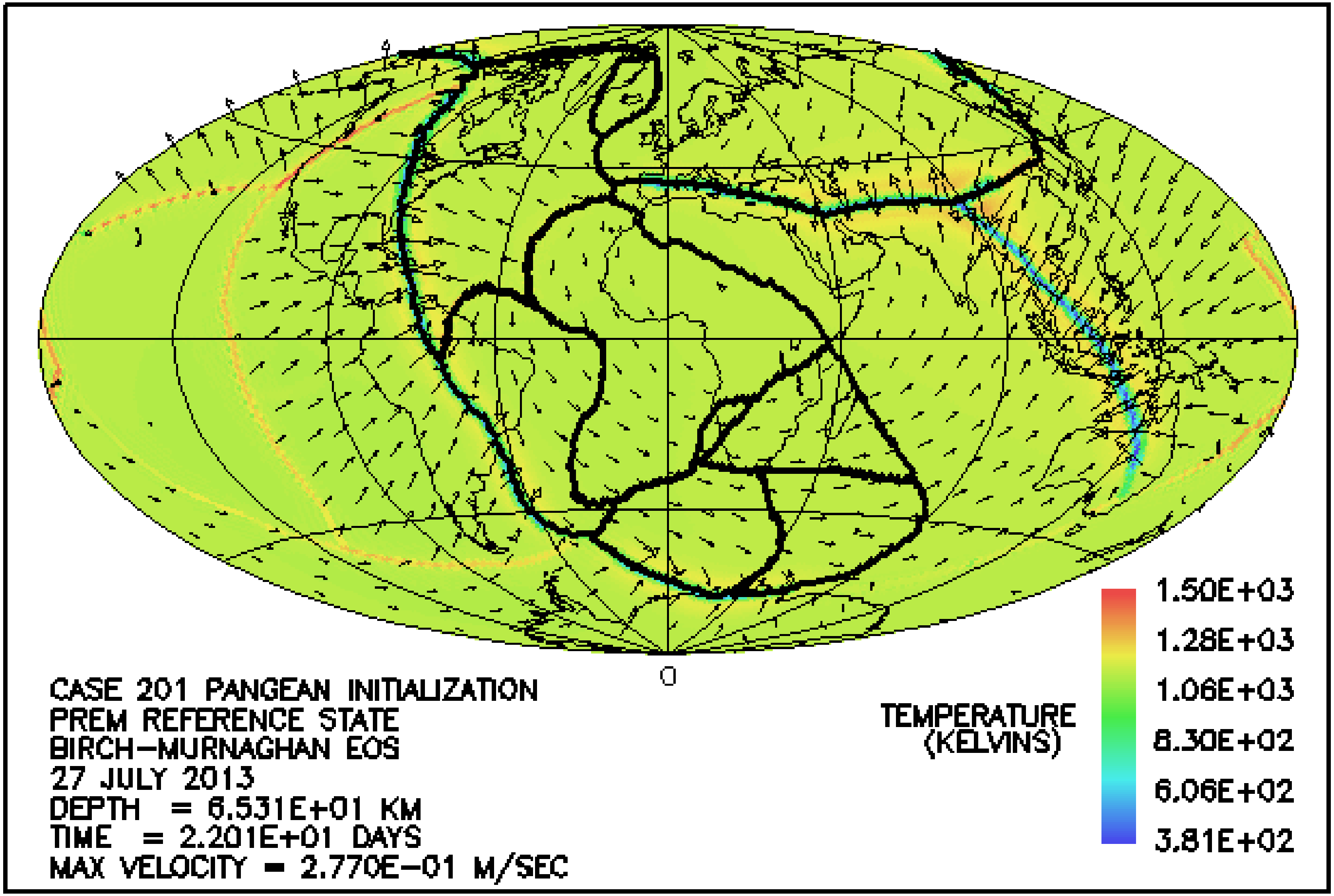
Calculation begins from a continent configuration from roughly the mid-way point in the Flood cataclysm similar to that shown above.

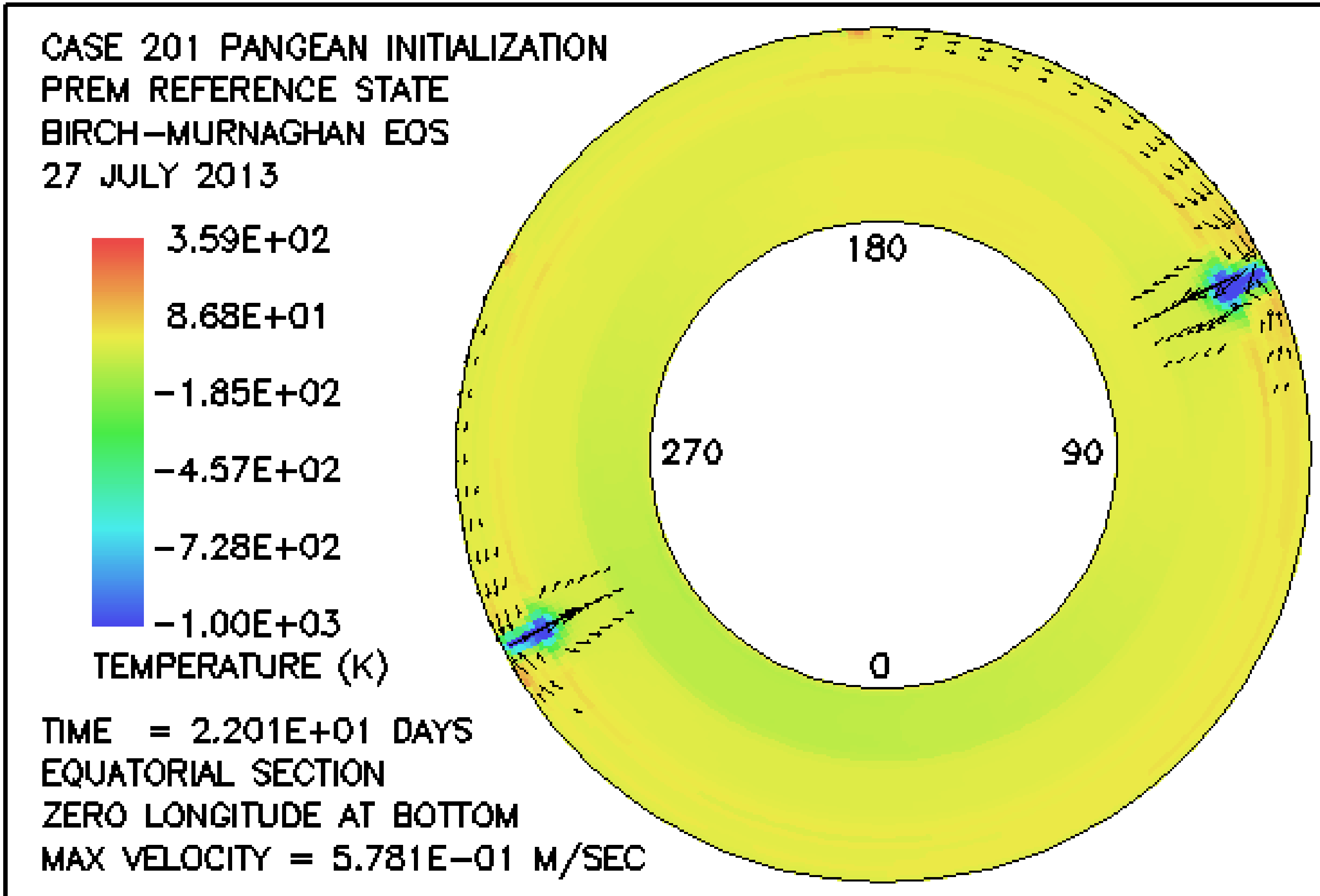
Modeling the portion of the Flood starting with the breakup of Pangea

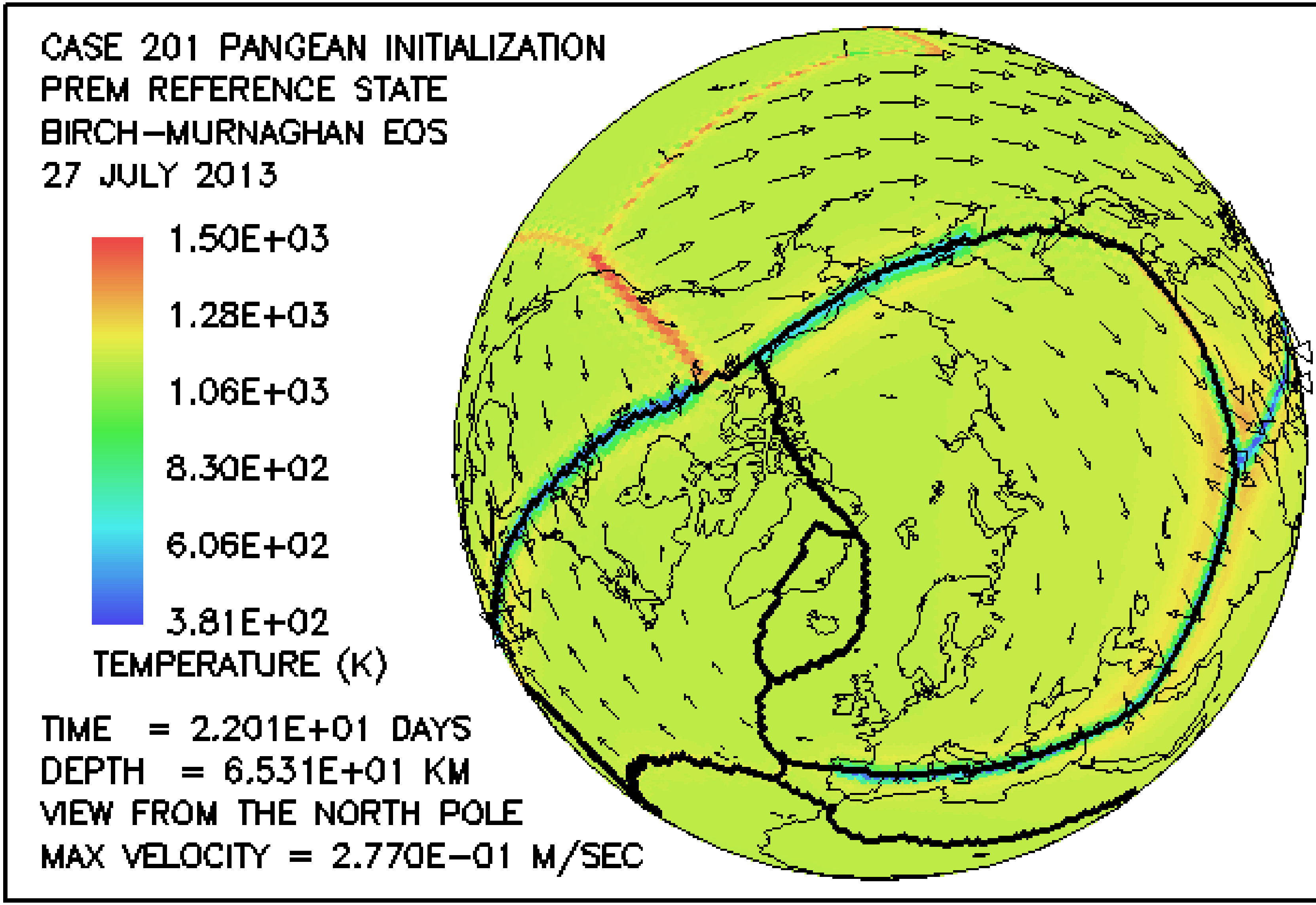


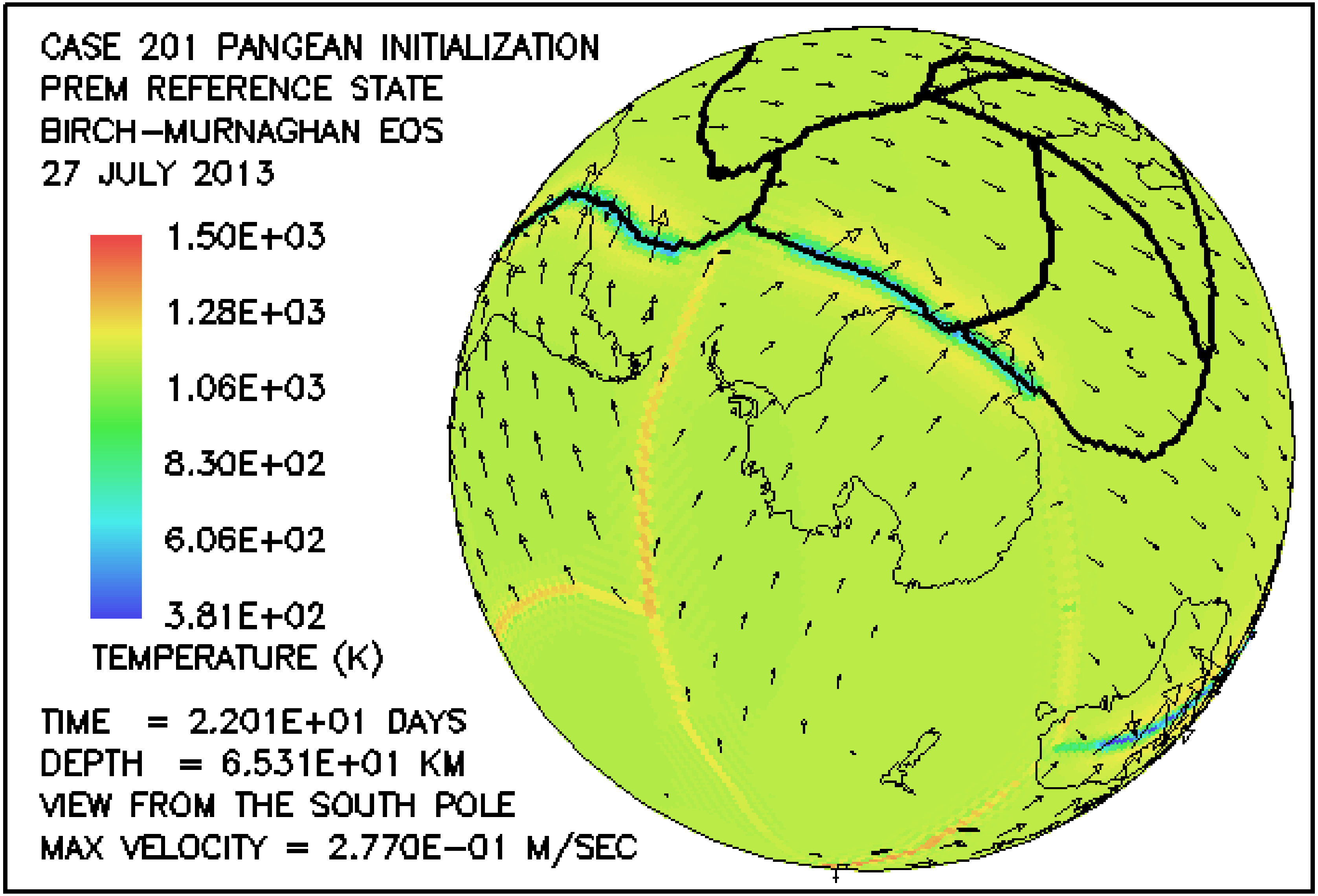

CASE 201 PANGEAN INITIALIZATION
PREM REFERENCE STATE
BIRCH–MURNAGHAN EOS
27 JULY 2013
2.17E+02
-2.67E+01
-2.70E+02
-5.13E+02
-7.57E+02
-1.00E+03
TEMPERATURE (K)
TIME = 1.062E+00 DAYS
EQUATORIAL SECTION
ZERO LONGITUDE AT BOTTOM
180
270
90
0

Modeling the portion of the Flood starting with the breakup of Pangea



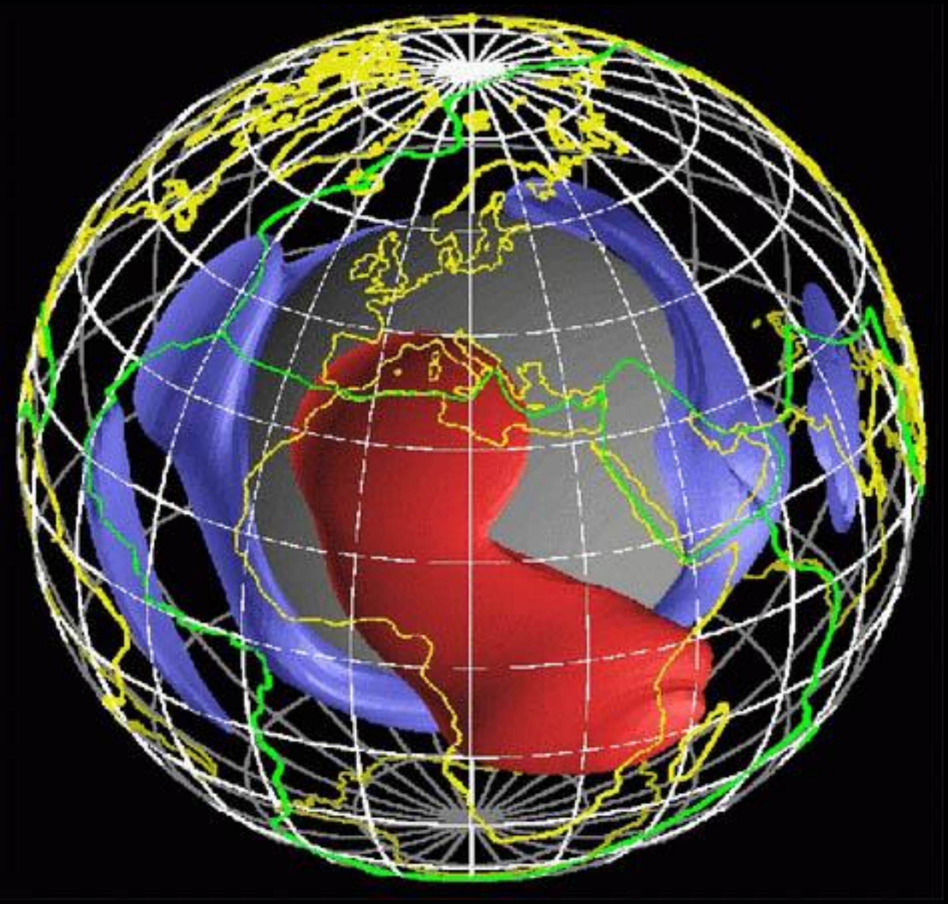

CASE 201 PANGEAN INITIALIZATION
PREM REFERENCE STATE
BIRCH–MURNAGHAN EOS
27 JULY 2013
3.59E+02
8.68E+01
–1.85E+02
–4.57E+02
–7.28E+02
–1.00E+03
TEMPERATURE (K)
TIME = 2.201E+01 DAYS
EQUATORIAL SECTION
ZERO LONGITUDE AT BOTTOM
MAX VELOCITY = 5.781E–01 M/SEC
180
270
90
0


CASE 201 PANGEAN INITIALIZATION
PREM REFERENCE STATE
BIRCH–MURNAGHAN EOS
27 JULY 2013
1.50E+03
1.28E+03
1.06E+03
8.30E+02
6.06E+02
3.81E+02
TEMPERATURE (K)
TIME = 2.201E+01 DAYS
DEPTH = 6.531E+01 KM
VIEW FROM THE NORTH POLE
MAX VELOCITY = 2.770E–01 M/SEC

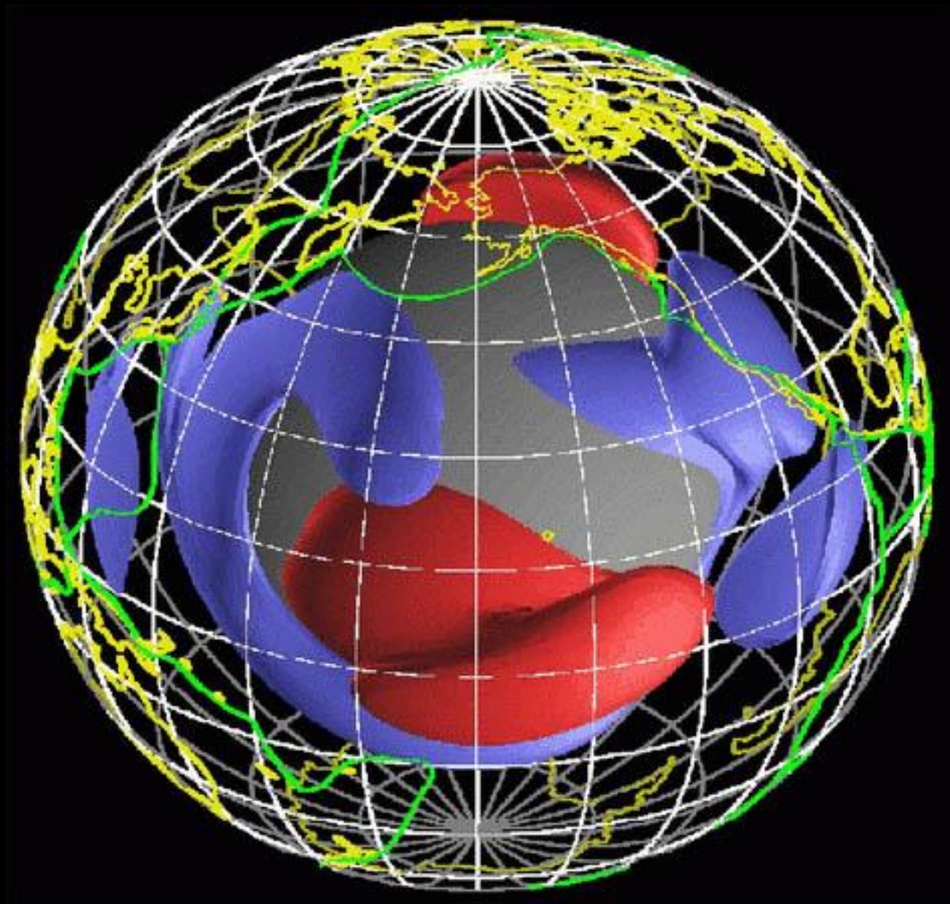

CASE 201 PANGEAN INITIALIZATION
PREM REFERENCE STATE
BIRCH-MURNAGHAN EOS
27 JULY 2013
1.50E+03
1.28E+03
1.06E+03
8.30E+02
6.06E+02
3.81E+02
TEMPERATURE (K)
TIME = 2.201E+01 DAYS
DEPTH = 6.531E+01 KM
VIEW FROM THE SOUTH POLE
MAX VELOCITY = 2.770E-01 M/SEC

Is there evidence supporting a recent episode of catastrophic plate tectonics?

Seismic images of the mantle reveal a ring of <u>unexpectedly cold</u> rock at the bottom of the mantle, beneath the subduction zones that surround the Pacific Ocean.



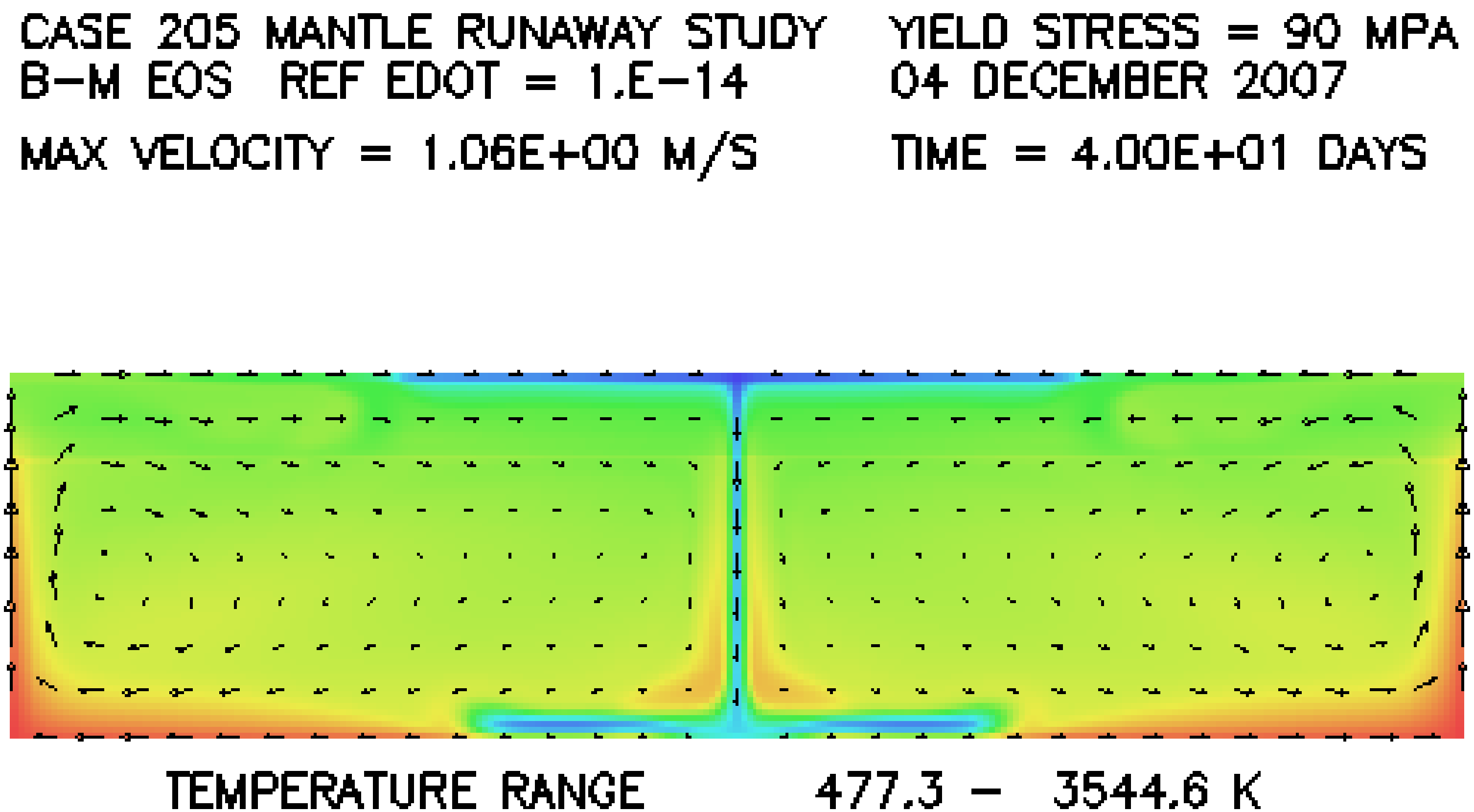
Eastern Hemisphere



Western Hemisphere

Striking temperature features in today's mantle. Blue represents low temperature and red high temperature. Inferred temperature difference is about 3000°C!

The Energy Source



The energy driving this process is simply the <u>gravitational potential energy</u> associated with the <u>initial mantle temperature differences</u>.

Some major remaining issues

How were the continents flooded and by what means was the huge volume of sediment, with its fossils, transported and deposited?

The leading explanation in my opinion is that of giant tsunamis generated by rapid subduction of ocean plates into the mantle. This possibility was discovered through numerical studies undertaken in 2015.

Present-day tsunamis

The March 11, 2011, magnitude 9.1 earthquake off the Pacific coast of Tōhoku, Japan, was the most powerful earthquake ever recorded in Japan, and the fourth most powerful in the world since modern record-keeping began in 1900. It was an undersea megathrust event whose epicenter was about 32 km (20 mi) below the surface and 72 km (45 mi) east of the Japanese coast.

A study published in *Science* in 2011 found that, at the epicenter, there was about 50 m (160 ft) of slip between the overriding plate of which Japan is a part and the underlying Pacific Plate. At the epicenter the sea bottom rose about 7 m (23 ft) as a result of the unlocking of the fault and the relief of stress in the plates.

The earthquake triggered a devastating tsunami that reached heights of up to 40.5 m (133 ft) above sea level and traveled inland as far as 10 km (6 mi).

Tsunami resulting from M9.1 Tohoku earthquake in 2011.

Tsunami moves inland, destroying almost everything in its path.

Damage reached as far as six miles inland from the coast and up to 133 feet above sea level.

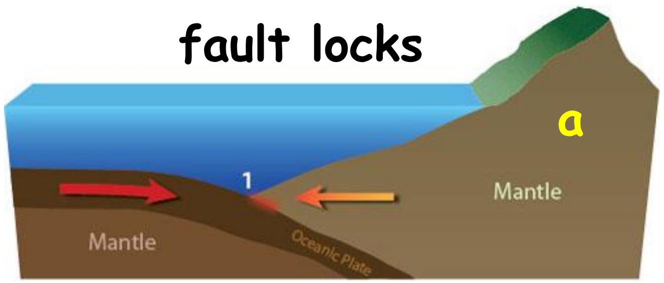
Official reports listed 15,894 confirmed dead, 2,562 missing and presumed dead, and 127,290 buildings totally destroyed.

How are tsunamis produced today?

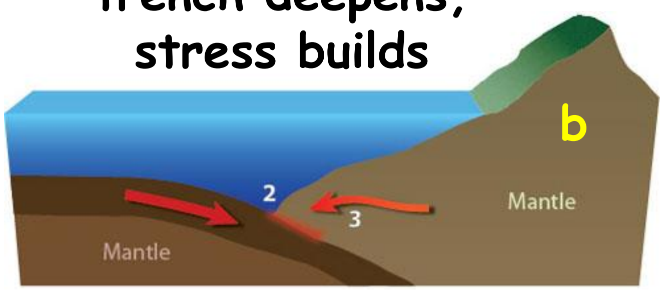
Tsunamis are generated in subduction zones where most of the time the overriding plate is locked against the sinking subducting plate along the fault separating the two plates. When the fault unlocks, the overriding plate springs back to its unstressed shape. The resulting slip between the plates can produce a significant uplift of the sea bottom, which can generate a tsunami.

Making of a tsunami

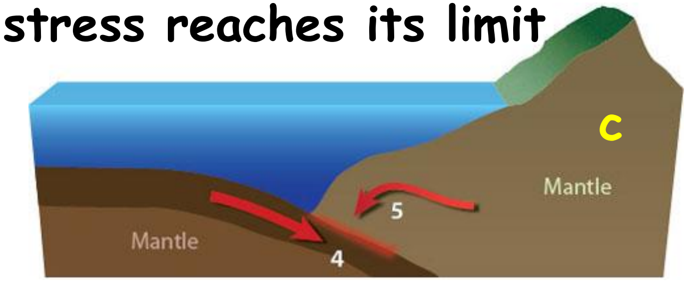
fault locks



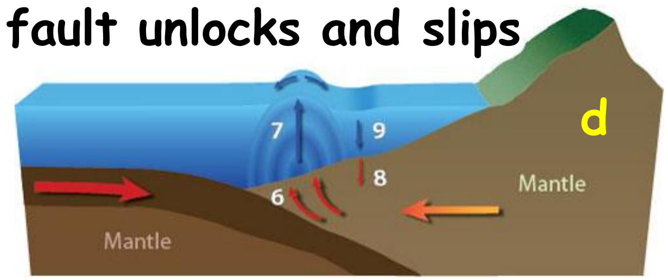
trench deepens,
stress builds



stress reaches its limit



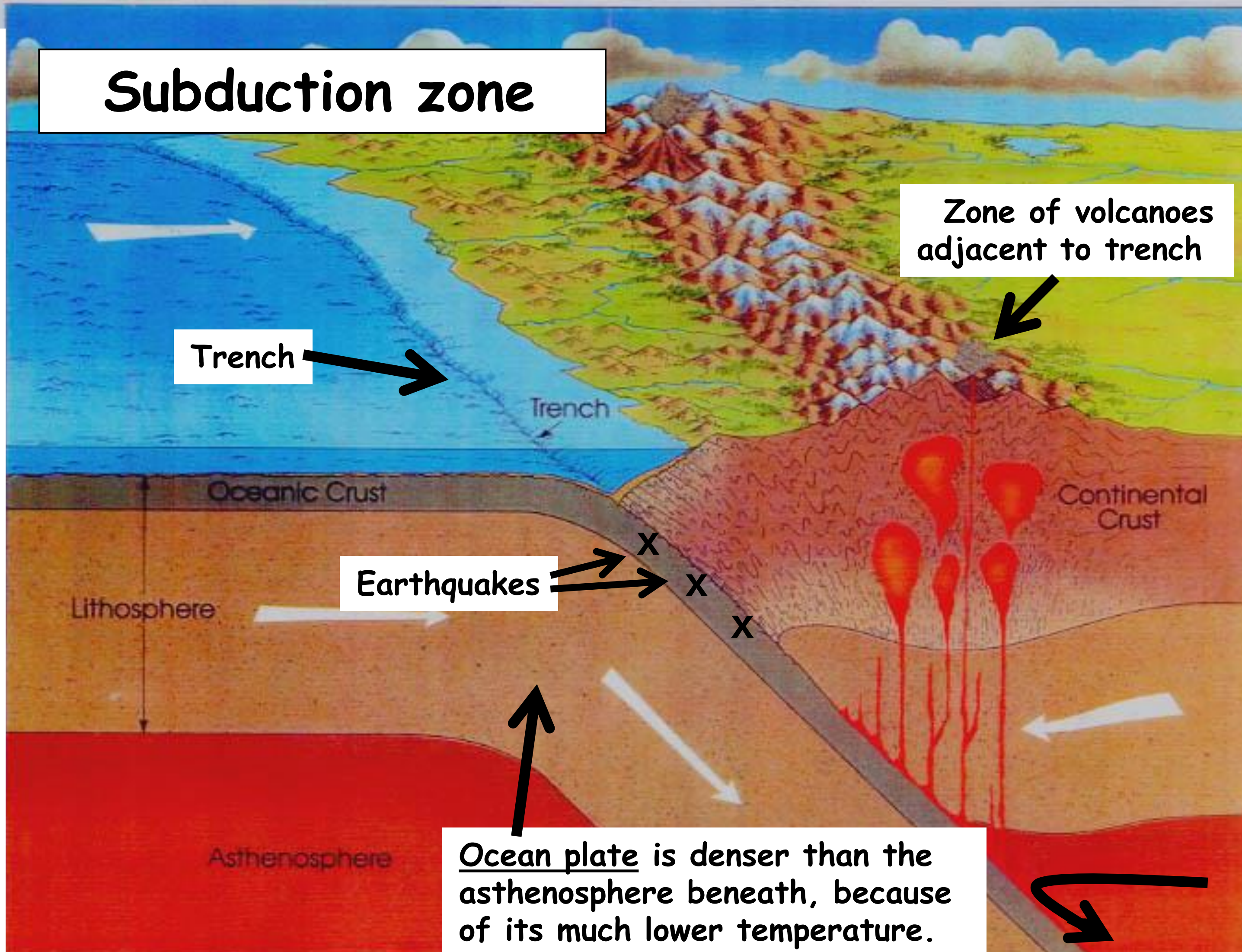
fault unlocks and slips



tsunami is unleashed

Note change in trench depth between frames c and d.

Subduction zone

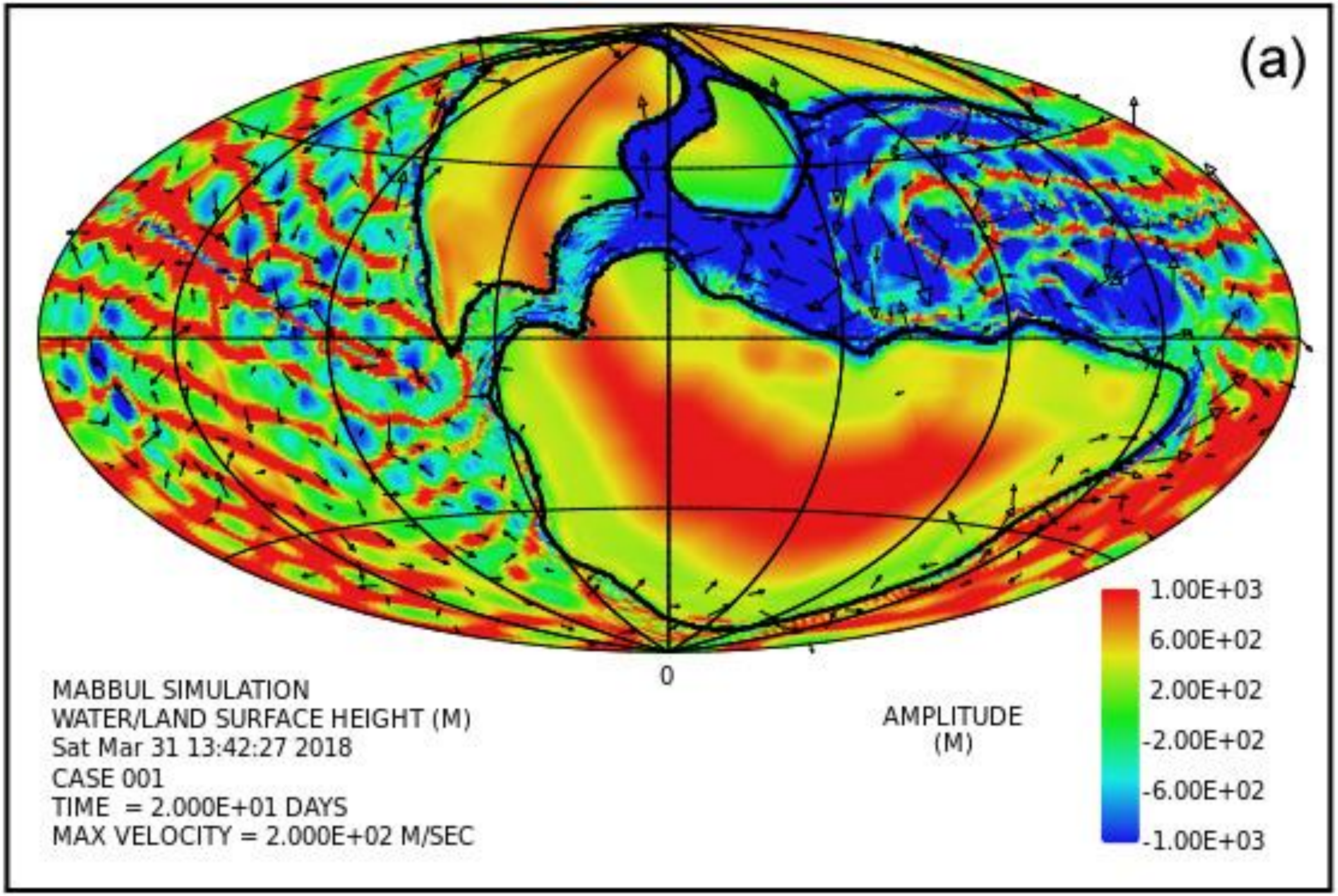


The Tasa Collection: Plate Tectonics

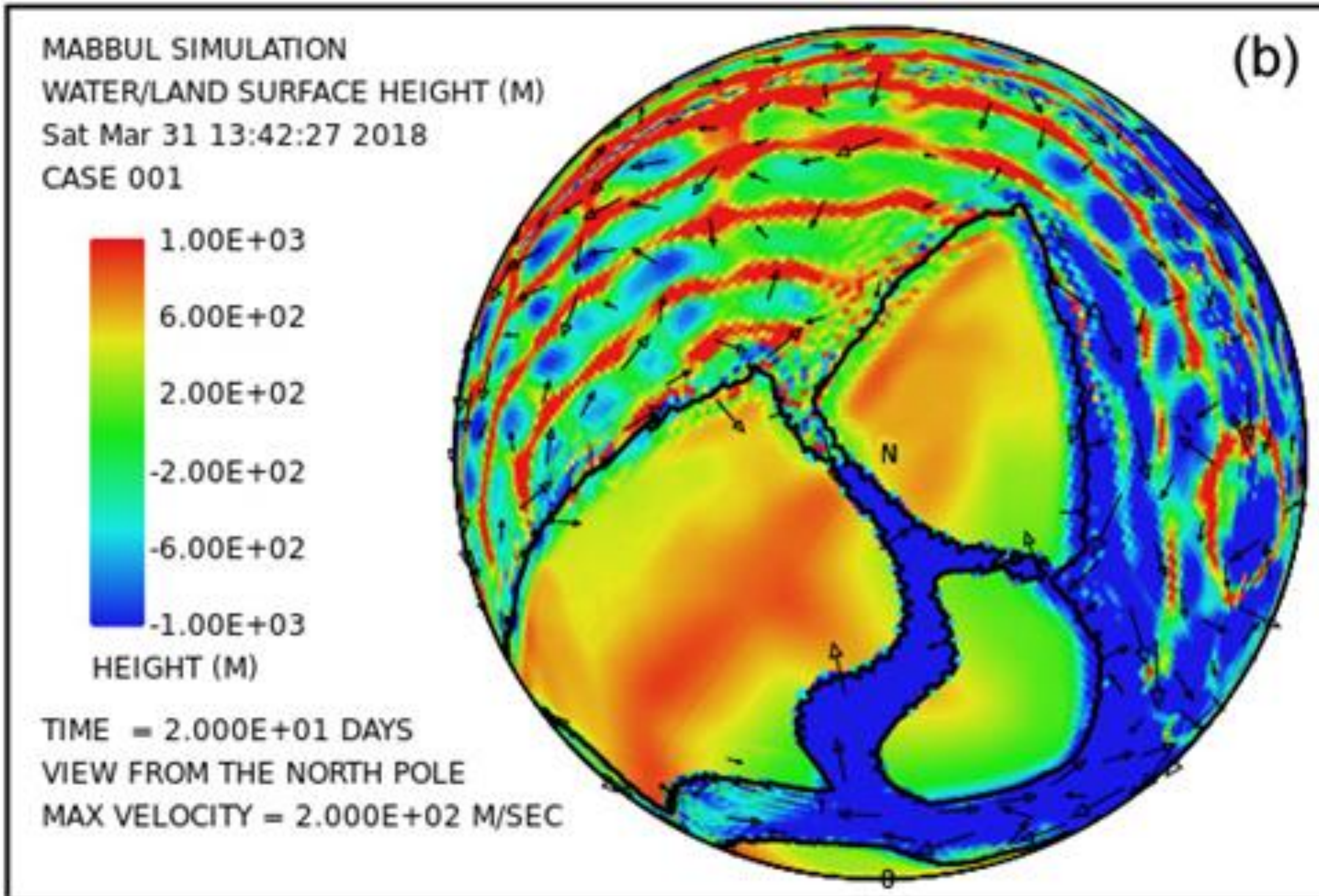
Recent numerical studies reveal that giant tsunamis can account for many of the main features of the Genesis Flood exceedingly well. For example, they can account for the erosion, transport, and deposition of great thicknesses of sediment on the continents today.

They also explain how the continents were flooded, where the water came from, and where the water went afterward.

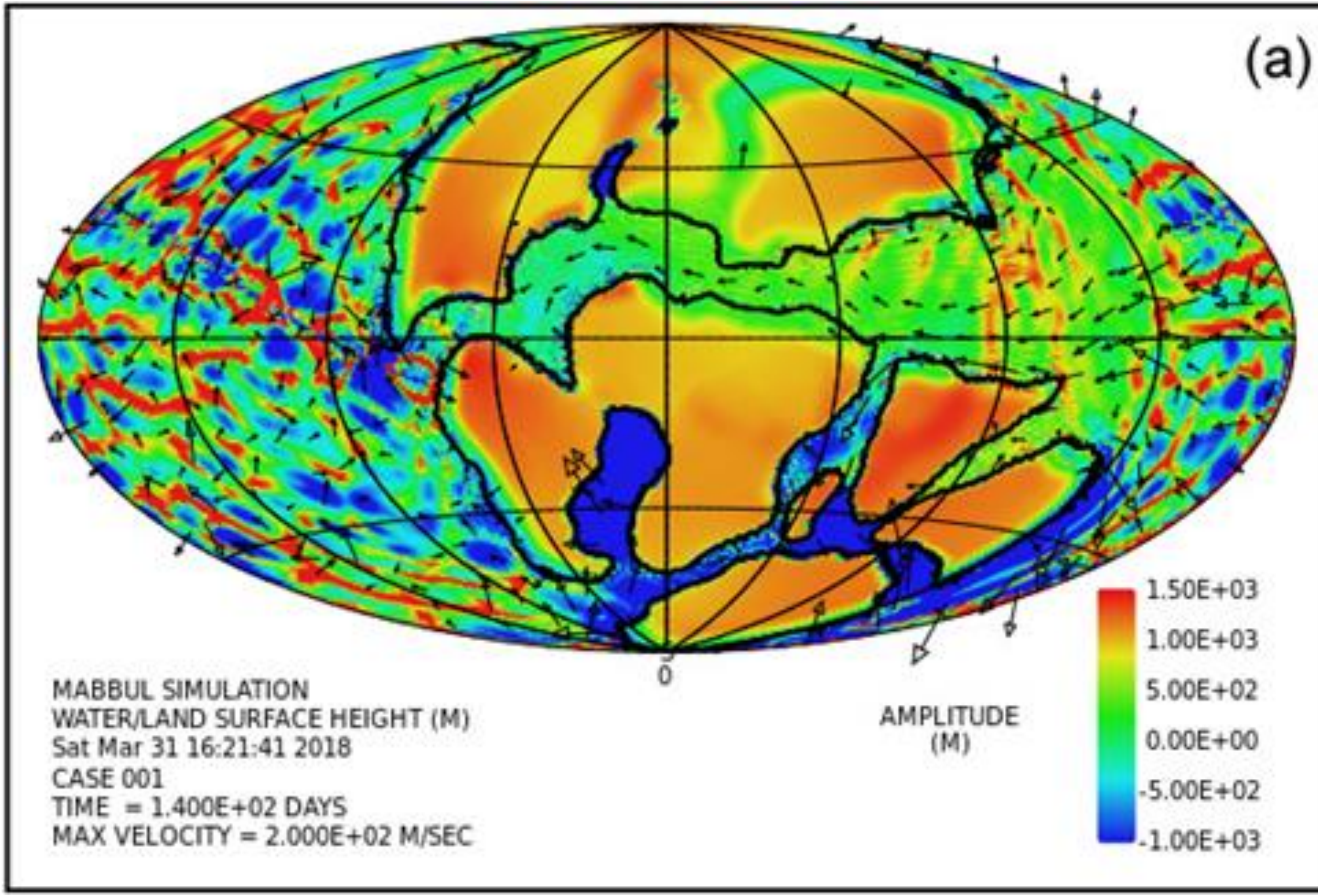
Illustrative Case



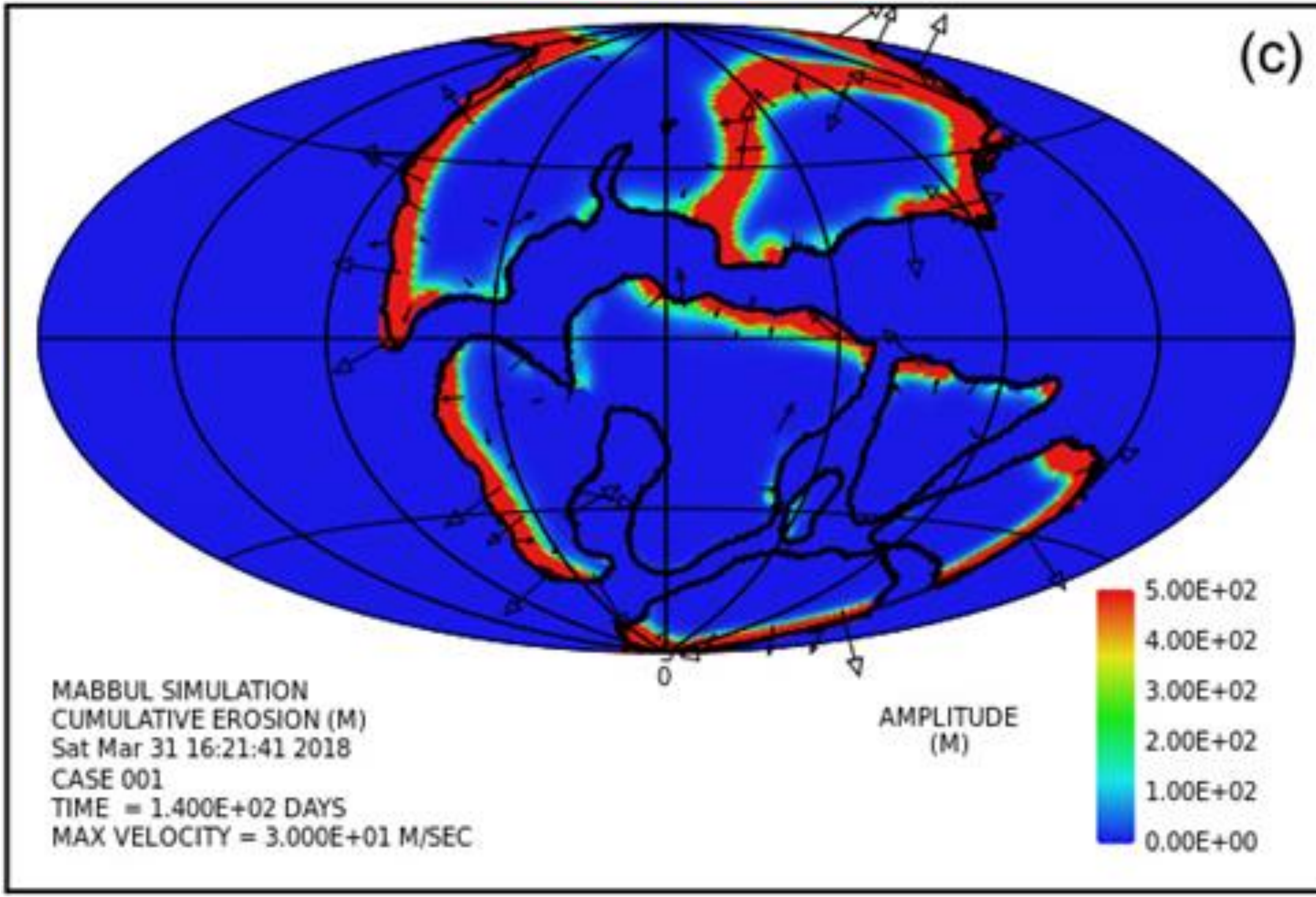
Water/land surface height (m) at 20 days. Equal area view. Arrows denote full water column velocities, clipped to 200 m/s. Note amplitudes of tsunami waves in the open ocean.



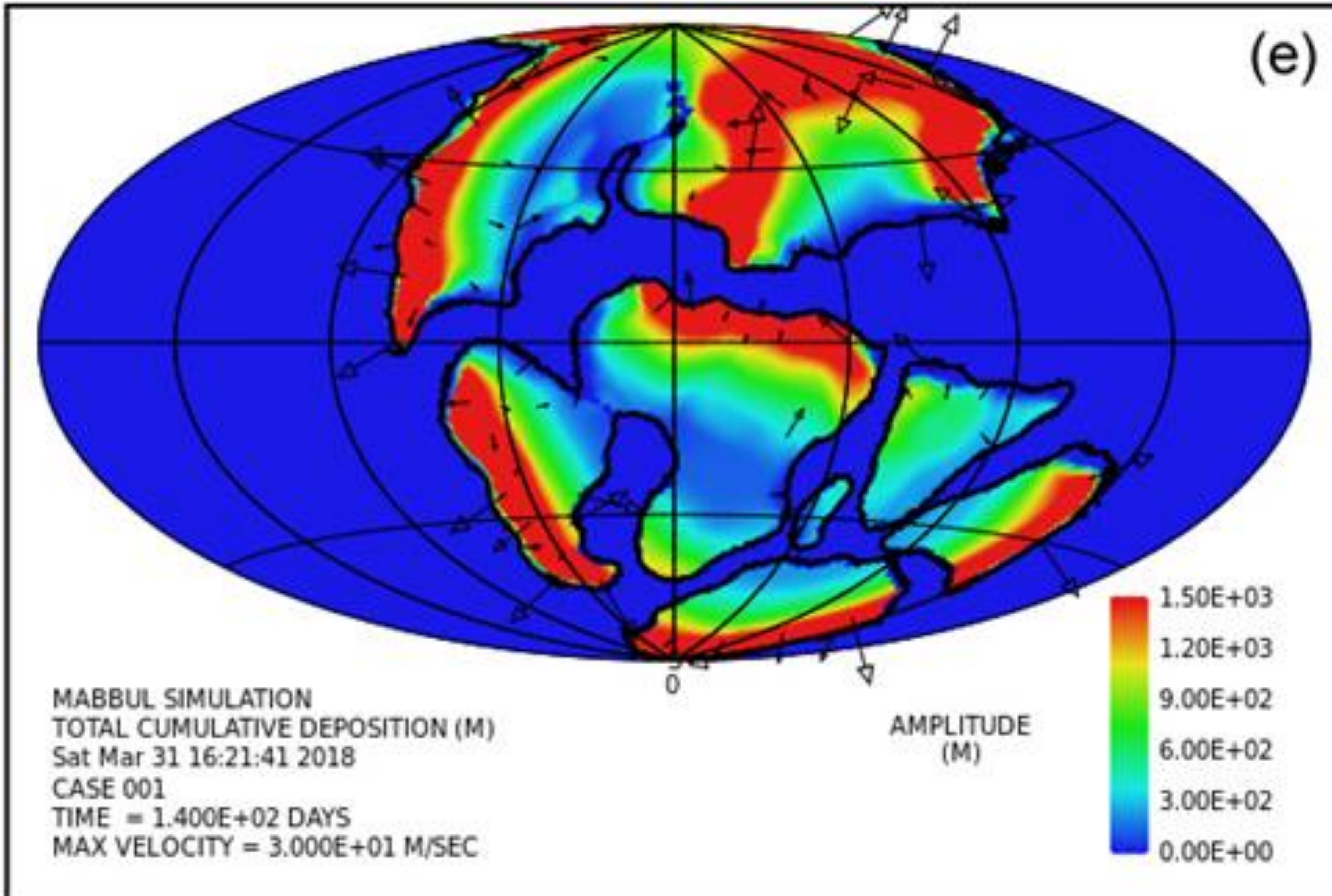
Water/land surface height (m) at 20 days. North polar view.



Water/land surface height (m) at 140 days.



Cumulative bedrock erosion (m) at 140 days.



Net cumulative sediment deposition (m) at 140 days. Average is 1,162 m.

Encouraging New Insights

This numerical investigation sheds important new light on many of these prominent issues. First, regarding a source for the huge volume of Phanerozoic sediment present in the continental rock record, the calculations reveal that tsunami-driven cavitation erosion during the time span of the Flood can generate new sediment at a rate sufficient to account for a sizable fraction of the Phanerozoic sediment inventory. The cavitation, occurring at water speeds of several tens of m/s, rapidly reduces crystalline continental crustal rock to sand-sized and smaller particles.

Encouraging New Insights

As to why so much sediment is emplaced <u>on top of the continents</u> when their surfaces mostly lie above sea level, these calculations provide especially helpful insight. The water speeds and depths are sufficient to sustain the level of turbulence needed to suspend the large volume rate of sediment produced by cavitational erosion, to transport it to distant locations, and to deposit that sediment on the continent surface in thicknesses exceeding more than a kilometer over vast areas.

Encouraging New Insights

The tsunami-driven flow accounts not only for erosion of significant volumes of sediment but also its emplacement above sea level on top of the continents in coherent patterns with large horizontal dimensions and thicknesses. The model thus seems to account in a powerful way for the emplacement of the sediment on top of the continental surface in broad agreement with observations.

For more details, download my 2018 ICC paper, “Understanding How the Flood Sediment Record Was Formed: The Role of Large Tsunamis,” at

https://digitalcommons.cedarville.edu/cgi/viewcontent.cgi?article=1020&context=icc_proceedings

or visit http://www.globalflood.org

Why is the issue of the Flood and a solid defense of its reality so important today?

- The truthfulness of the Bible depends on it.
- The truthfulness and authenticity of Jesus depends on it.
- The relevance of the gospel depends on it.

Jesus was quite clear as to the reality of the Flood.

"For the coming of the Son of Man will be just like the days of Noah. For as in those days before the flood they were eating and drinking, marrying and giving in marriage, until the day that Noah entered the ark, and they did not understand until the flood came and took them all away; so will the coming of the Son of Man be."

Matt. 24:37-39