

Earth Movement and Resultant Landforms



Structure of the Earth

- Lithosphere : earth's crust
- Asthenosphere : upper mantle zone where material is near its melting point & acts almost like liquid (approx. 600 km thick)

Earth Movement and Resultant Landforms



Recall:

You have now seen how the rock-forming processes yield igneous, metamorphic and sedimentary materials of the earth's crust.

Now:

We will now look at how huge slabs of the crust itself are moved by heat energy and motions originating within Earth.



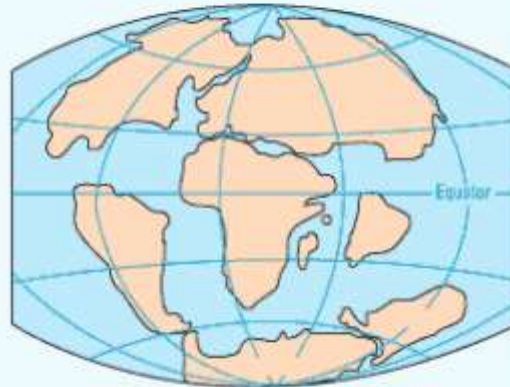
PERMIAN
225 million years ago



TRIASSIC
200 million years ago



JURASSIC
135 million years ago



CRETACEOUS
65 million years ago



PRESENT DAY

Continental Drift

The Continental Drift Theory

Who ?

- Developed by Alfred Wegener from Germany in 1910s

What ?

- proposed that about 200 million years ago, a super continent called Pangaea (“all Earth”) slowly broke up & drifted apart forming 2 landmasses called Laurasia & Gondwanaland
- These 2 landmasses continued to break up & drift apart to their present positions



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Evidences supporting the Continental Drift Theory:

- coastlines of continents such as South America & Africa show that they could fit together like a jig-saw puzzle
- Rare & identical fossils are found in rocks in South America & Africa
- mountain chains of Europe & Africa & the Americas are geologically related, but separated by the Atlantic Ocean
- In the 1950s & later, geophysical evidence from paleomagnetic & ocean floor studies led to the synthesis of ideas in plate tectonics

The Theory of Plate Tectonics

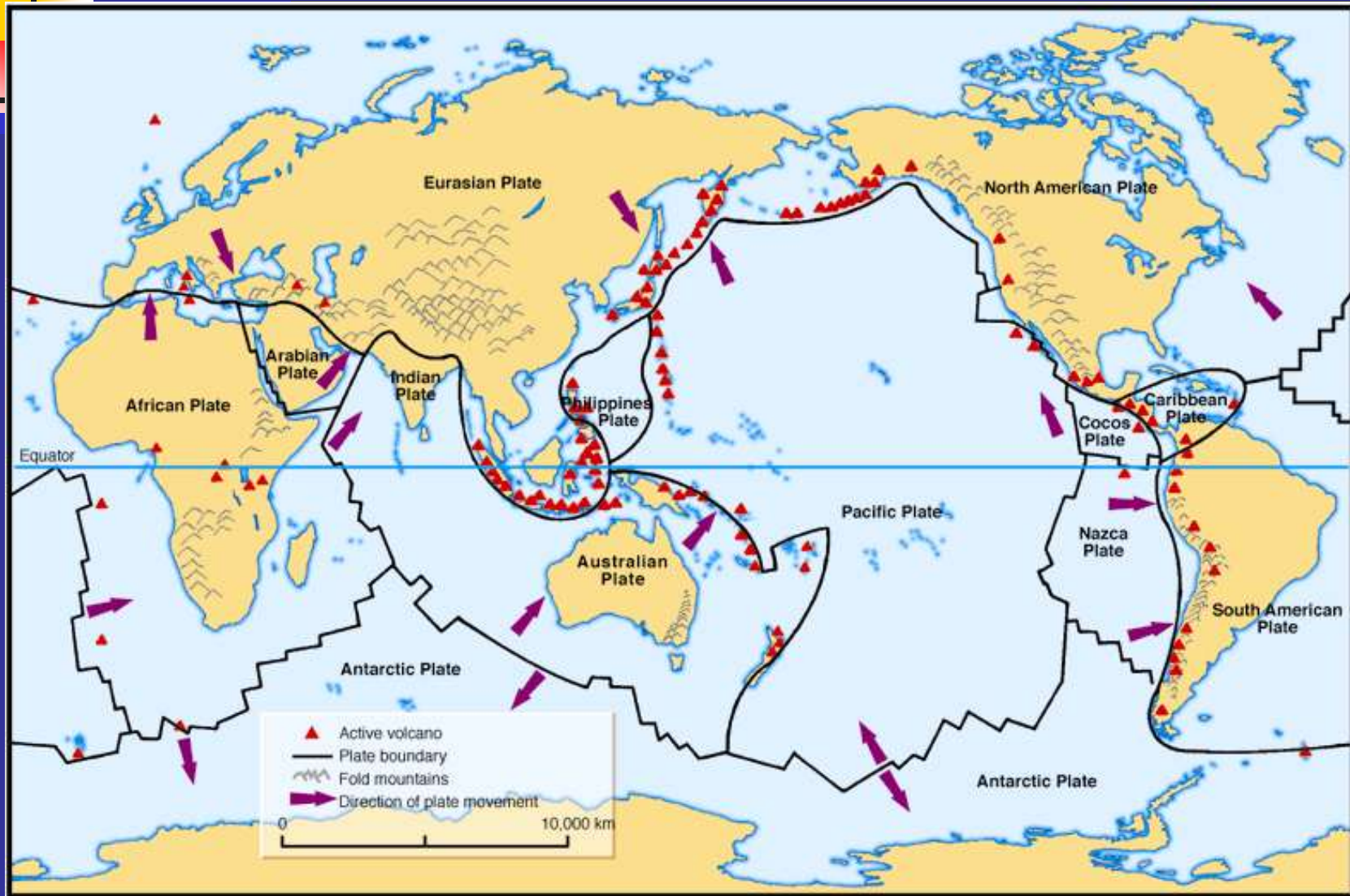
- modifies the old idea of continental drift
- describes the Earth as a restless planet with plates drifting across the surface
- is accepted by most earth scientists today as modern, most satisfactory explanation of :



Earth Movement and Resultant Landforms

1. internal forces shaping Earth's surface
2. crustal movements (folding & faulting) & volcanic activity
3. formation of major landforms
4. occurrence of some major natural hazards like earthquakes & tsunamis

Types of Plate Boundaries





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- believed that the Earth's crust is broken into parts or sections called plates.
- plates consist of sial (forming continents) floating on the denser sima (forming ocean beds).
- Earth movements (ie forces operating inside the Earth's crust) cause these plates to move away from each other or move towards each other
- The lithospheric plates ' float' on asthenosphere & are moved by convectional currents of magma



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- conventional currents are driven by heat energy release by radioactivity (radioactivity decay) in mantle. They drag and move plates above them
- Such movements are not regular & not constant through time
- Plate movements cause changes (called tectonic processes) & instability along plate boundaries , hence they are unstable zones

3 forms of plate movements & boundaries

1. Divergent plate movement at constructive plate boundary:

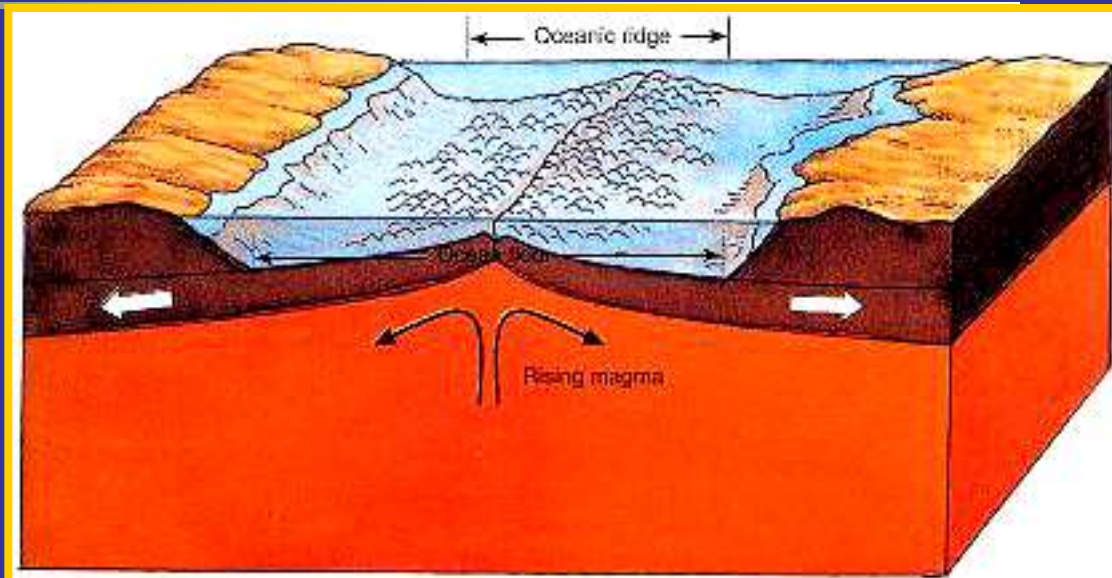
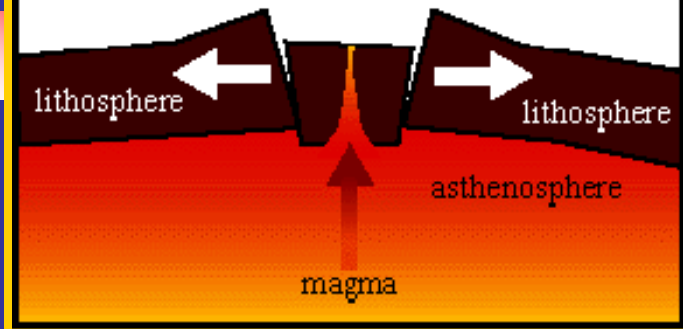
- When plates move apart, hot molten materials wells up from Earth's interior to form a new ocean floor with mid-oceanic ridges.
- Eg : the Mid Atlantic oceanic ridge is formed when the American plates on the west and the Eurasian plate & African plate on the east move apart



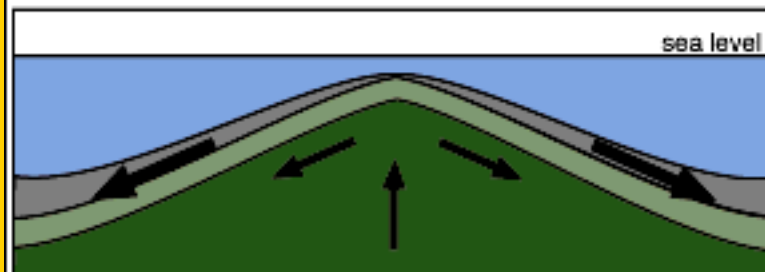
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- new plate or ocean bed will thicken with time as more molten materials wells up while the old plates forming the old ocean floor will spread part further.(sea- floor spreading).
- Volcanic activities are also common

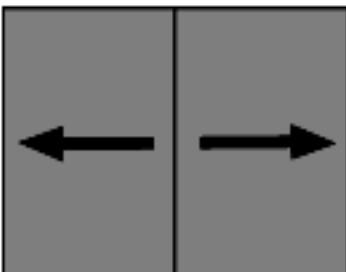
Divergent Plate Boundary



Cross-section



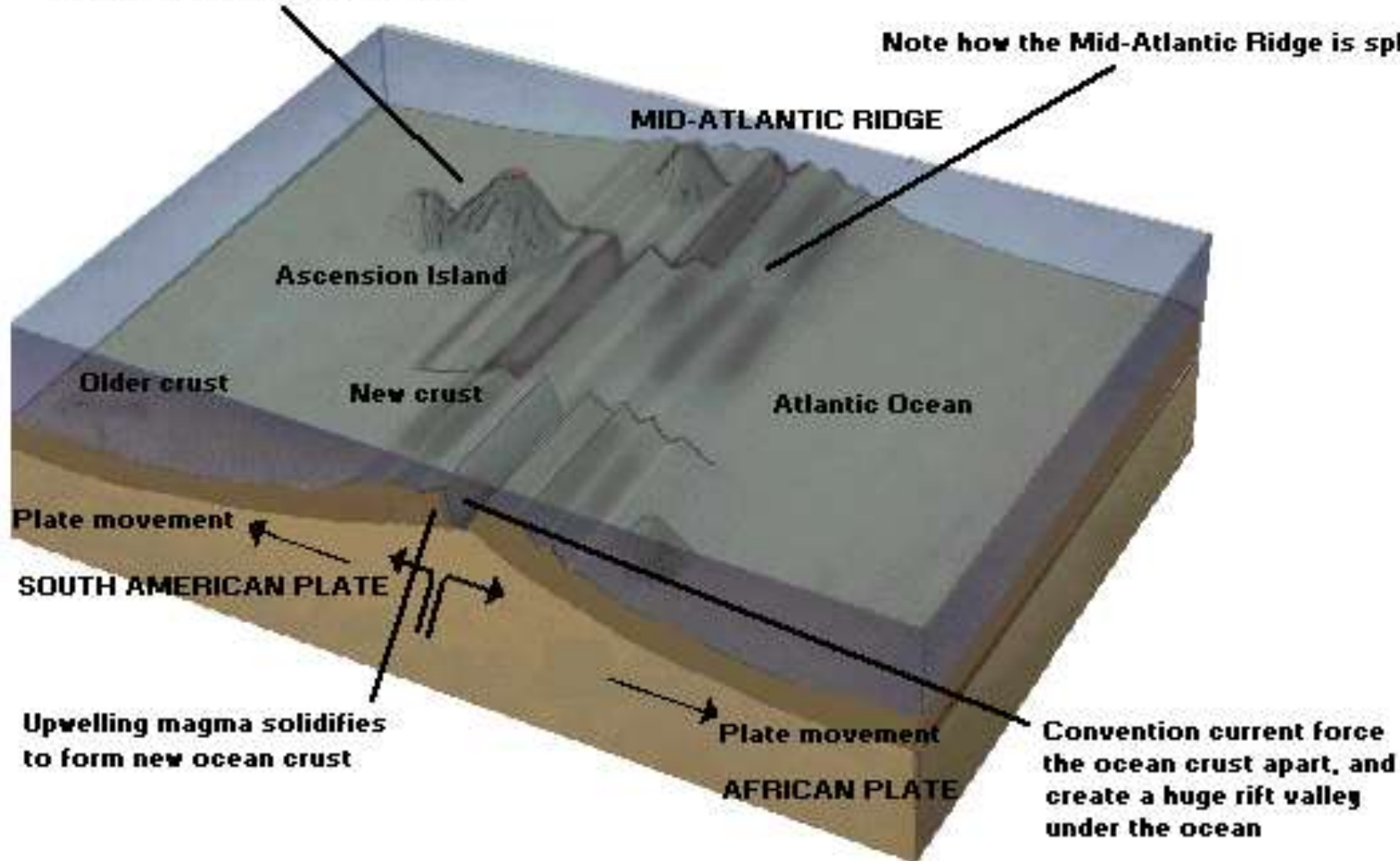
Map view



Divergent plate boundary

Upwelling magma forms submarine volcanoes and volcanic islands

Note how the Mid-Atlantic Ridge is split by faults





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2. Convergent plate movement at destructive plate boundary:

- When plate move towards each other:
 - they may slip past each other & create a tear fault, accompanied by earthquakes but little volcanic activity
 - they may collide and :
 - when **2 oceanic plate edges sink**, plates edges are bent into a deep trench called the subduction zone.



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- Portions of lithosphere are dragged into asthenosphere and melt or become metamorphosed. Eventually, new magma may be pushed through fractures to form volcanic islands
- when ***oceanic plates sinks beneath continental plate***, it is pushed under because it is denser.
 - Lithosphere materials from oceanic crust are subducted in the trench while continental border is fractured, folded & uplifted.



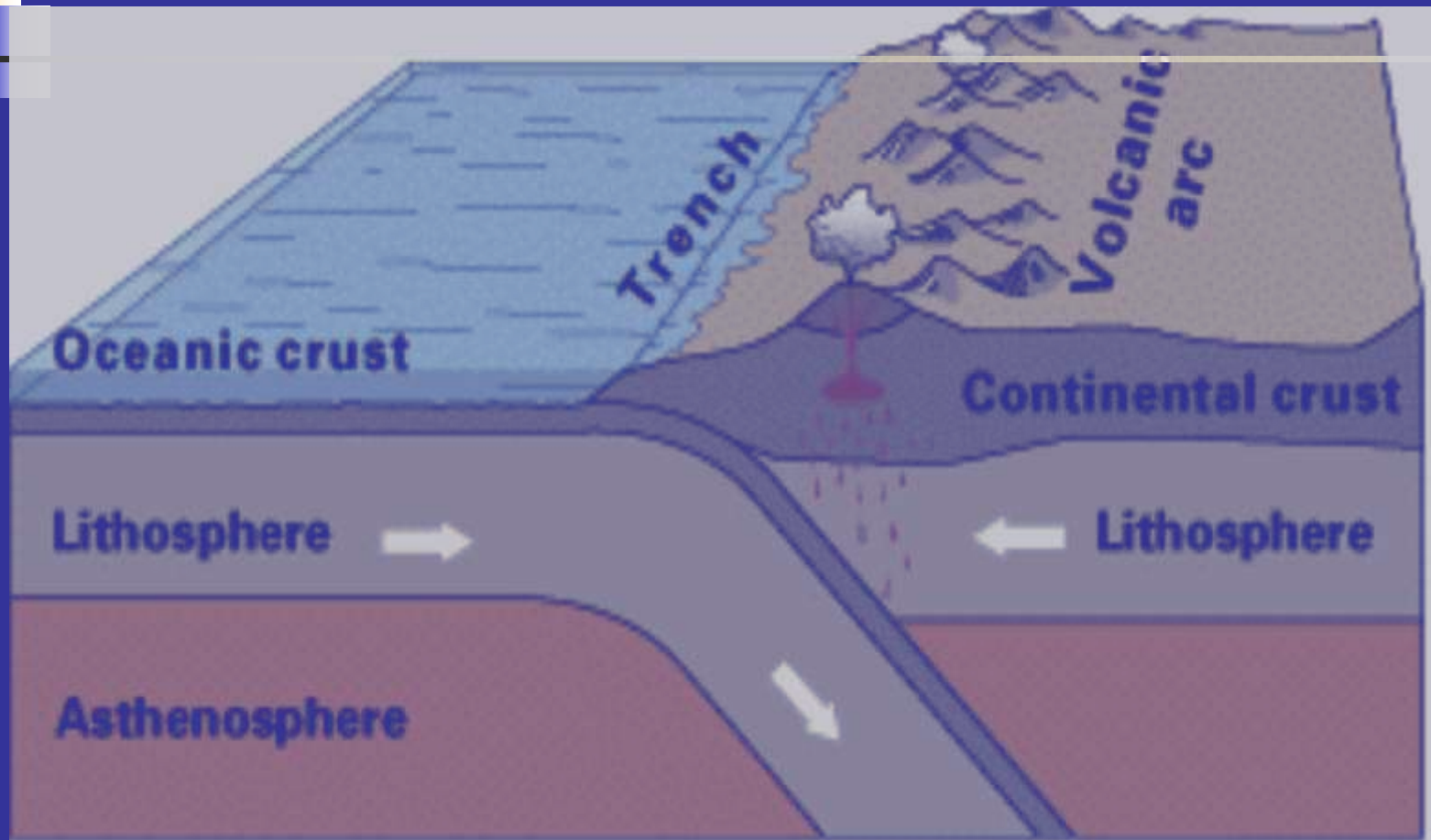
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- Magma rises from the subduction zone through fractures. Thus, a mountain system accompanied by volcanic activity can be found on the continental edge parallel to the ocean trench.
- Other processes include faulting & earthquakes
- Resultant major landforms include oceanic trenches like the Chile-Peru Trench, fold mountains like the Andes, volcanoes like Mt St Helens (USA) & volcanic island arcs like the Japan islands



Earth Movements and Resultant Landforms

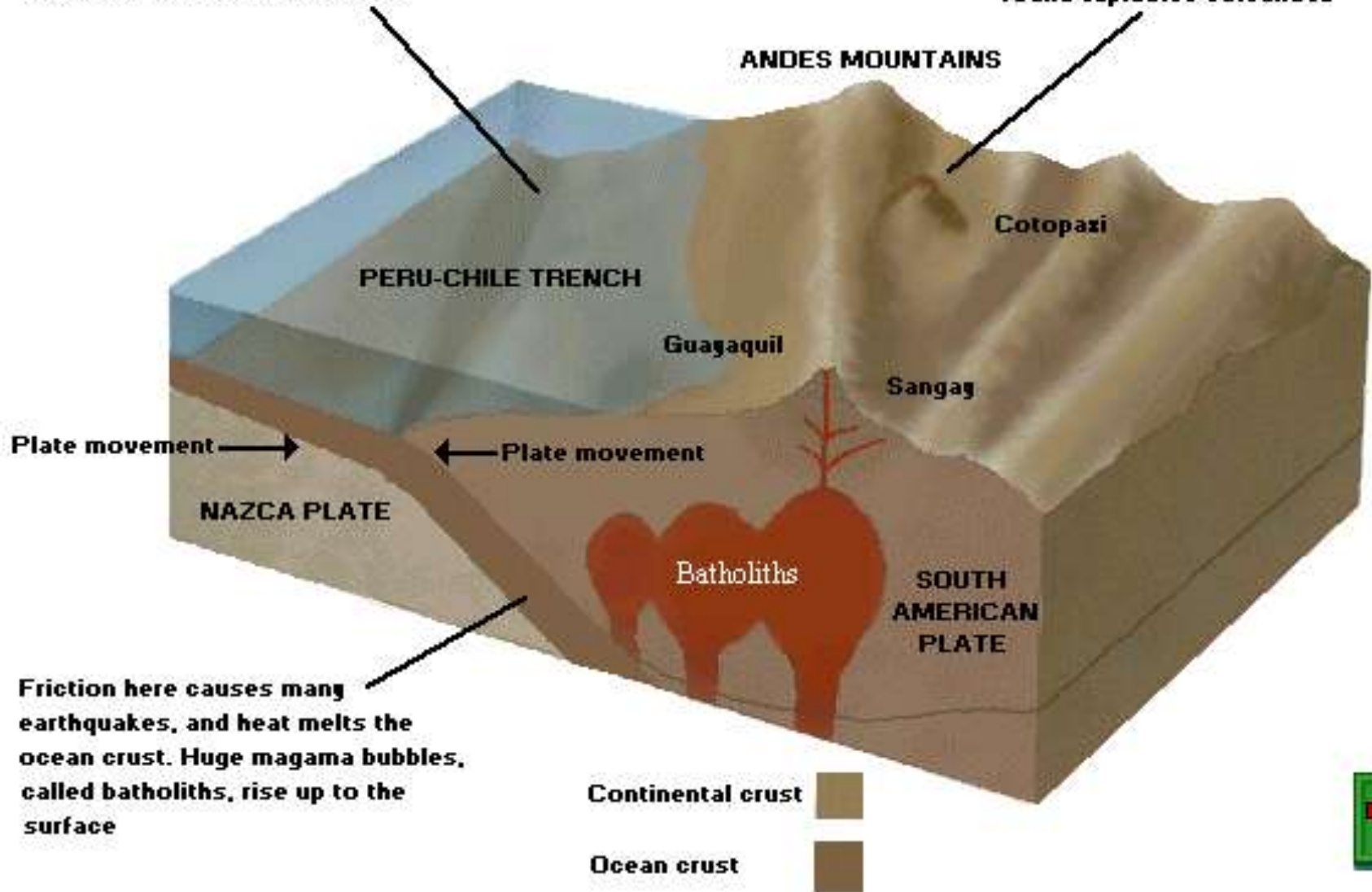
- when ***both continental plates collide***, neither tends to sink because their densities are similar.
 - Instead, continental lithosphere buckles & is uplifted.
 - Fold mountain ranges are formed
 - eg : the Himalayas are formed when Indian plate collided with Eurasian plate & Alps was formed when African plate drifted towards Eurasian plate
 - Little volcanic activity occur because rocks from the lithosphere do not sink deep into the asthenosphere.
 - Earthquakes, faulting & folding are common.



Oceanic-continental convergence

The ocean crust bends and slips down below the continental crust to form a deep ocean trench, which can be up to 8000 metres deep

The edge of the continent buckles up into a huge fold mountain chain up to 60000 metres high in which are found explosive volcanoes



PERU-CHILE TRENCH

ANDES MOUNTAINS

Cotopaxi

Guayaquil

Sangay

Plate movement →

← Plate movement

NAZCA PLATE

Batholiths

SOUTH AMERICAN PLATE

Continental crust

Ocean crust

Friction here causes many earthquakes, and heat melts the ocean crust. Huge magma bubbles, called batholiths, rise up to the surface





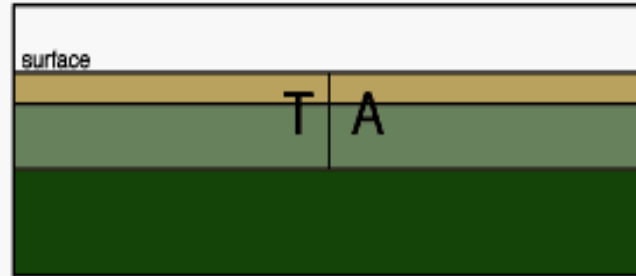
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3. Plates sliding past one another at conservative plate boundary:

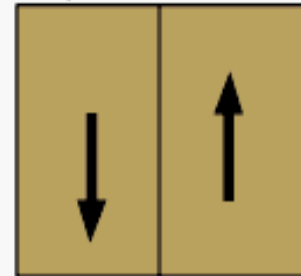
- They occur when 2 plates slip past each other.
- Tear faults form, accompanied by earthquakes because of great amount of stress built up in these areas, but there is little volcanic activity & little crustal material is destroyed
- Eg : the San Andreas Fault in California & Arabian plates sliding past African plate along a transform fault where several gulfs and inland seas have been formed like the Jordan Sea



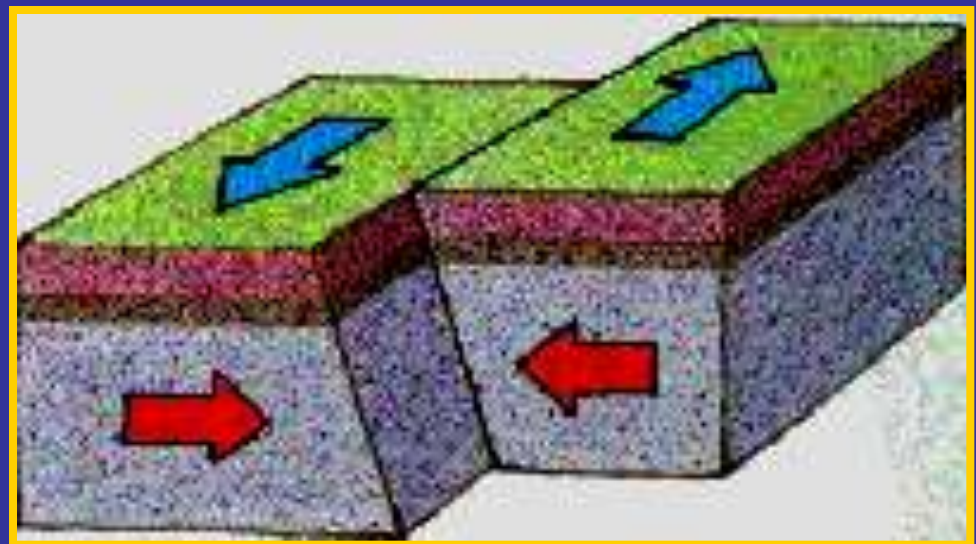
Cross-section



Map view



Transform plate boundary. T = towards and A = away.



SAN ANDREAS FAULT

Where two plates try to slide past each other, the jerky movement causes devastating earthquakes

San Francisco

California

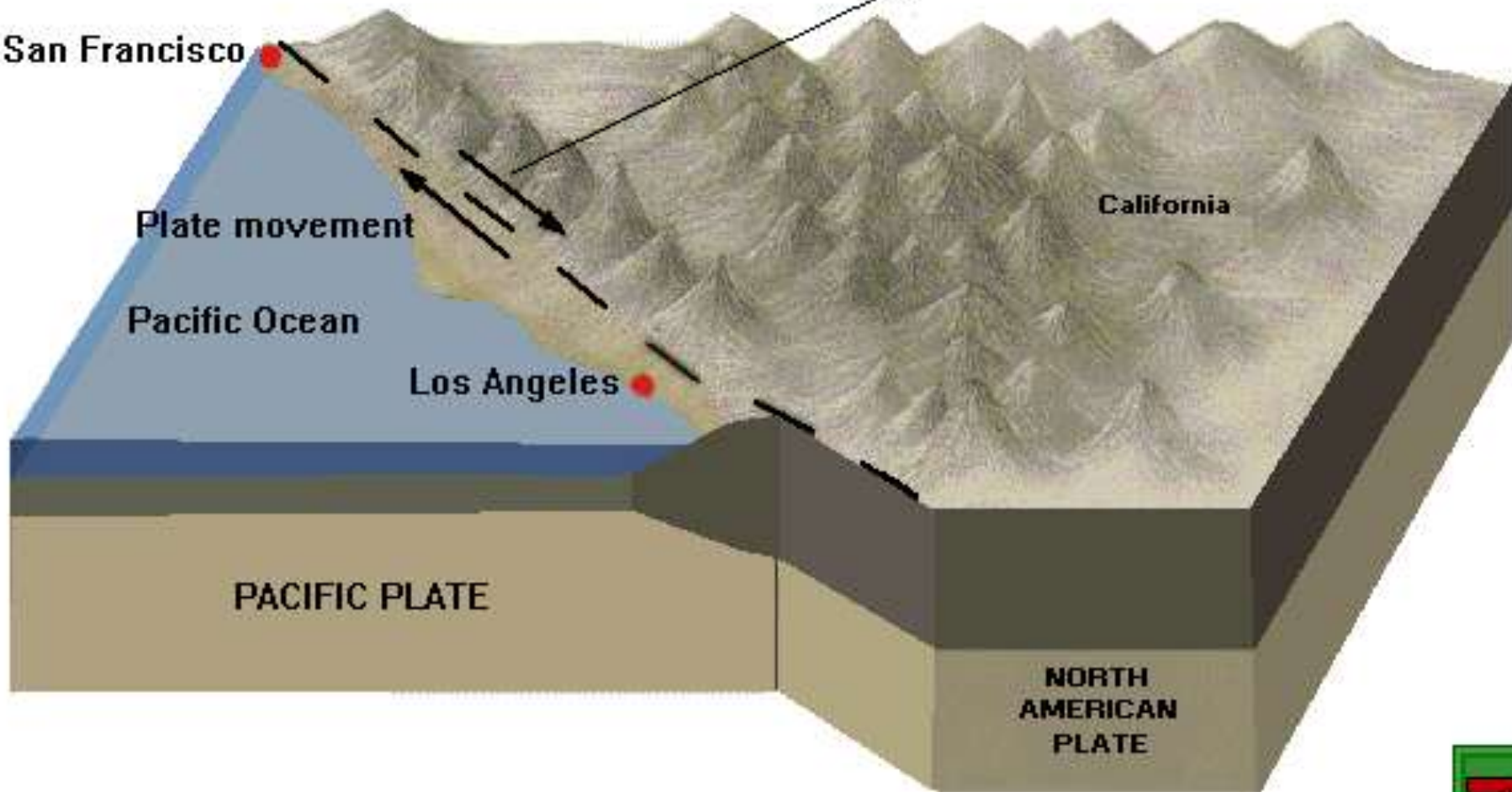
Plate movement

Pacific Ocean

Los Angeles

PACIFIC PLATE

NORTH AMERICAN PLATE





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Note:

Over the Earth as a whole, sea floor spreading and subduction are in steady-state of equilibrium. The total amount of crustal materials at any one time is therefore constant

Different plate boundaries at a glance...

