

# Plate Tectonics & the Distribution of Mineral (and other) Resources

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### Important Concepts in Plate Tectonics

Earth's crust is made up of several large plates that fit together like a jigsaw puzzle.

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### Pangaea: The Supercontinent

- At some point in Earth's history, all landmasses were joined in one Supercontinent, then
- It drifted apart....**Plate Tectonics** – process that:
  - underlies earthquakes & volcanoes
  - determines geography of Earth's surface, i.e. – shapes the earth.

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### Plate Tectonic Boundaries

There are 3 major types of plate boundaries:

- 1. Divergent** – plates move away from each other (tension)
- 2. Convergent** – plates move towards each other (compression)
- 3. Transform** – plates grind horizontally against one another (strike-slip motion)

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### Plate Tectonic Boundaries.....contd.

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### Drivers of Plate Movements

Lithospheric plates overlie hotter & weaker semi-plastic **Asthenosphere.**

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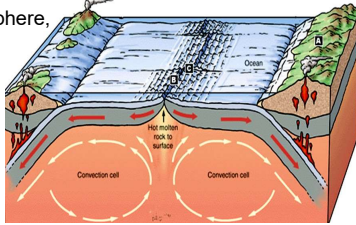
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**Drivers of Plate Movements.....contd.**

As plates move over Asthenosphere, they:

- separate, mostly at **oceanic ridges**
- collide, in areas such as oceanic trenches, where they may be subducted back into mantle.



**A. Volcanic Arc; B. Oceanic Rift; C. Transform Fault**

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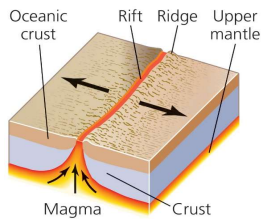
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**1. Divergent (Extensional) Boundaries**

a) Are **spreading ridges**, where:

- Plates are separating; crust is extended, thinned & fractured.
- magma surges upward to surface, divides plates and pushes them apart, creating new crust as it spreads and cools
- Thus, new oceanic lithosphere is formed.



**(a) Divergent plate boundary**  
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**1. Divergent (Extensional) Boundaries.....contd.**

At these boundaries, Magma may;

- originate from **partial melting of mantle**, and thus, it is **basaltic**, or
- originate from **crust**, and thus it is **granitic**
- intrude into vertical fractures to form dikes
- be extruded as lava flows

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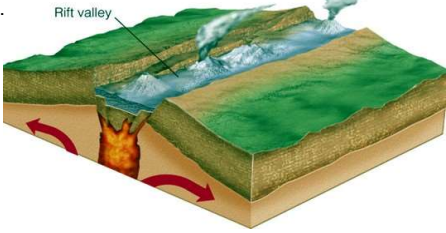
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**1. Divergent (Extensional) Boundaries.....contd.**

b) Result in formation of such features as Rift Valleys, where:

- magma typically intrudes into fractures & flows onto valley floor....



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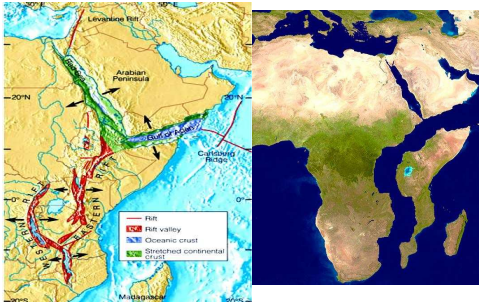
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**1. Divergent (Extensional) Boundaries.....contd.**

An example of a rift valley is the **East African Rift Valley**



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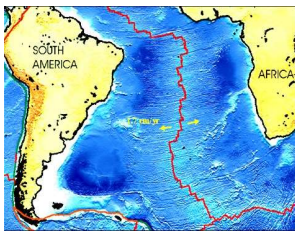
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**1. Divergent (Extensional) Boundaries.....contd.**

The Atlantic Ocean basin is today separating North and South America from Europe and Africa by thousands of kilometers.

∴ Divergent (extensional) tectonics form topographic lows.



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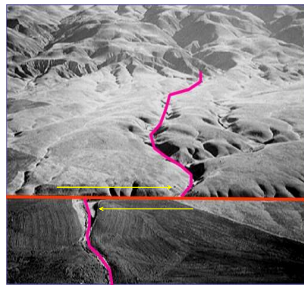
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## 2. Transform Boundaries.....contd.

- where/when plates slide laterally past each other
- roughly parallel to the direction of plate movement
- Movement results in:
  - zone of intensely shattered rock
  - numerous shallow earthquakes.



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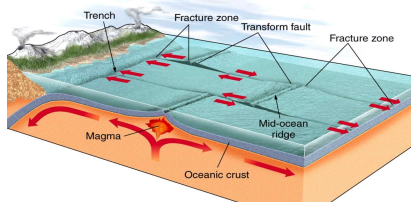
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## 2. Transform Boundaries.....contd.

- The majority of transform faults
  - connect two oceanic ridge segments, and
  - are marked by fracture zones



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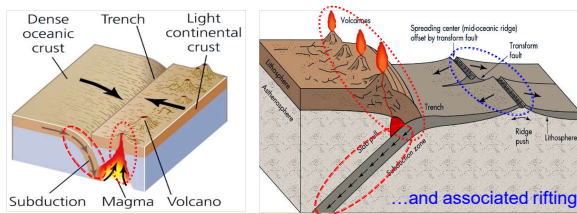
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## 3. Convergent (Compressional) Boundaries

Where:

- plates collide, & **Subduction** occurs – i.e.
  - **one plate of crust slides beneath another.**
- Magma erupts on surface through volcanoes.



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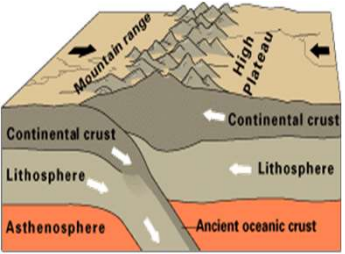
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**3. Convergent (Compressional) Boundaries.....contd.**

- are characterized by:
  - deformation,
  - Volcanism,
  - mountain building,
  - metamorphism,
  - earthquake activity,
  - valuable mineral deposits.



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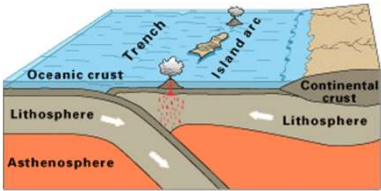
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**3. Convergent (Compressional) Boundaries.....contd.**

- There are three types:
  - a) **oceanic-oceanic – where**  
One plate is subducted beneath another, forming an oceanic trench



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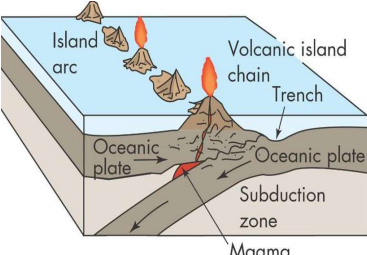
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**3. Convergent (Compressional) Boundaries.....contd.**

As plate subducts into mantle, it is heated and partially melted, generating magma of ~ andesitic composition that rises to surface because it is < dense than surrounding mantle rocks. On surface, magma forms a volcanic island arc.



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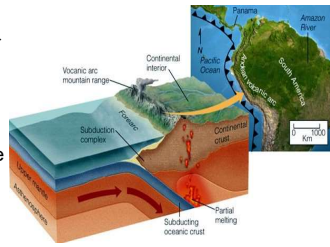
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**3. Convergent (Compressional) Boundaries.....contd.**

**b) oceanic-continental –**

occurs when a denser oceanic plate subducts under less dense continental lithosphere. Magma generated rises into continental crust to form large intrusive igneous bodies or erupts to form a volcanic arc of andesitic volcanoes, e.g. Andes Mountains.



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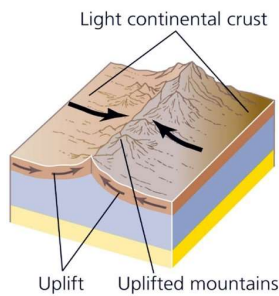
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**3. Convergent (Compressional) Boundaries.....contd.**

**c) continental-continental –**

When 2 continents collide, continental lithosphere cannot subduct because of low density. Thus, they weld together @ **continent-continent plate boundary**, where an interior mountain belt forms.



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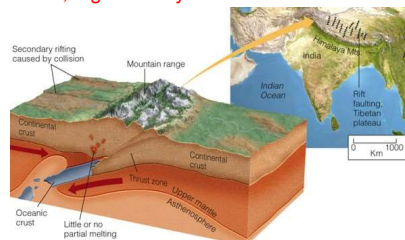
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**3. Convergent (Compressional) Boundaries.....contd.**

➤ Where interior mountain belt forms, it consists of *deformed sedimentary rocks, igneous intrusions, metamorphic rocks, fragments of oceanic crust*, e.g. Himalayas.

➤ Earthquakes also occur @ these margins



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### Recognising old Subduction Zones

- Presence of Andesitic magma, forming island arc volcanoes & continental volcanoes
- Form zones of intensely deformed rocks between trench and area of igneous activity
- Sediments and submarine rocks are folded, faulted and metamorphosed, making a chaotic mixture of rocks termed a **mélange**
- Slices of oceanic lithosphere may be accreted to continent edge to form **ophiolites**.

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### How Plate Tectonics Affect Distribution of Life

Present distribution of plants and animals is largely controlled by

- climate, &
- geographic barriers

Tectonic barriers create **biotic provinces**, with

- each province being characterized by **distinctive** assemblage of **plants & animals**

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### How Plate Tectonics Affects Distribution of Life.....(2)

- Plate movements largely control barriers, i.e., when continents:
  - *break up, new provinces form*
  - *come together, fewer provinces result.*
- As continents move north or south they move across temperature barriers

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### Plate Tectonics & Distribution of Natural Resources

- Plate movements influence formation & distribution of some natural resources, such as:
  - *Petroleum, natural gas, some mineral deposits*
- Metal resources that are related to igneous and associated hydrothermal activity include:
  - *Copper, gold, lead, silver, tin, zinc*

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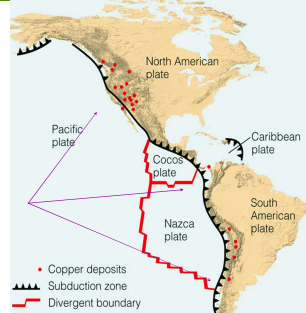
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### Plate Tectonics & Distribution of Natural Resources.....(2)

- Magma generated by subduction can precipitate & concentrate metallic ores, e.g. *copper deposits in western Americas*



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### Plate Tectonics & Distribution of Natural Resources.....(3)

Hydrothermal activity can also generate rich metal deposits at divergent boundaries, e.g.

1. *Island of Cyprus in the Mediterranean, where:*
  - *copper* concentrations formed from pptn. adjacent to *hydrothermal vents* along divergent plate boundary.
2. *Red Sea, where:*
  - *copper, gold, iron, lead, silver*
  - *zinc* deposits have *formed as sulfides* @ a divergent boundary.

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### Examples of Most Common Metal Sulfide minerals

 Chalcopyrite $CuFeS_2$	 Chalcocite, $Cu_2S$	 Bornite $Cu_5FeS_4$
 Pentlandite $(Fe,Ni)_9S_8$	 Sphalerite $ZnS$	 Cobaltite, $CoAsS$
 Galena, $PbS$	 Cinnabar, $HgS$	

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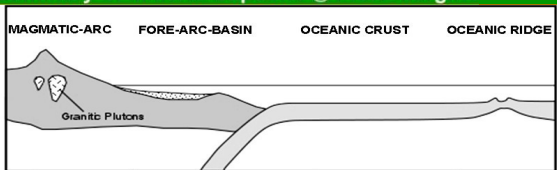
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### Summary of Mineral Deposits @ Plate Margins

	MAGMATIC-ARC	FORE-ARC-BASIN	OCEANIC CRUST	OCEANIC RIDGE
Metals	Tin Copper Gold Silver Lead Mercury Molybdenum	Lead Zinc Copper	Manganese Cobalt Nickel Chromium	Copper Zinc
Deposits	Veins Porphyry Copper Pegmatites	Stratabound Evaporites	Magmatic Evaporites	Massive Sulphides



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### SUMMARY

1. Earth's crust is made up of several large tectonic plates that fit together like a jigsaw puzzle.
2. Convection currents in the mantle act as **'engines'** that push plates around with radioactivity providing the heat energy.
3. Tectonic plates are continuously moving at about 2-15 cm/year.
4. **New crust is generated @ spreading centres**, while **old crust is recycled @ subduction zones**.

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**SUMMARY.....contd.**

**Convergent** plate margins are associated with:

- Compression
- Reverse faulting
- Creation of a subduction zone
- Mountain building processes
- Collisions of plates:
  - *Oceanic vs. oceanic*
  - *Oceanic vs. continent.*
  - *Continent vs. continent*

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**SUMMARY.....contd.**

**Divergent** plate boundaries are associated with:

- Tension or extension (pulling apart)
- Normal faulting
- Rifting (as in mid-oceanic rift zone)
- Creation of magma material inside rift zone, i.e., NEW CRUST

**Transform** plate boundaries are associated with:

- Horizontal grinding motion
- Strike-slip faulting
- Lateral offset of rock units

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**SUMMARY.....contd.**

Thus, **Plate tectonics** helps to explain:

- earthquakes
- volcanic eruptions
- formation of mountains
- location of continents
- location of ocean basins

**Tectonic interactions** affect:

- atmospheric & oceanic circulation, and climate.
- evolution & extinction of organisms
- geographic distribution & formation of resources

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**SUMMARY .....contd.**

Plate Boundary	Plates Involved	Dynamics	Results	Example
Divergent	Usually oceanic	Spreading. The two plates move away from one another and molten rock rises up to fill the gap.	Mid-ocean ridge forms and new material is added to each plate.	African and North American plate boundary (Figure 2.6a) Mid-Atlantic Ridge
Convergent	Ocean-continent	Oceanic plate sinks beneath continental plate.	Mountain ranges and a subduction zone are formed with a deep trench. Earthquakes and volcanic activity are found here.	Nazca and South American plate boundary (Figure 2.6a) Andes Mountains Peru-Chile Trench
Convergent	Ocean-ocean	Older, denser, oceanic plate sinks beneath the younger, less dense oceanic plate.	A subduction zone is formed with a deep trench. Earthquakes and volcanic activity are found here.	Fiji plate (Figure 2.6a) Fiji Islands
Convergent	Continent-continent	Neither plate is dense enough to sink into the asthenosphere; compression results.	A large, high mountain chain is formed, and earthquakes are common.	Indo-Australian and Eurasian plate boundary (on land) (Figure 2.6a) Himalaya Mountains
Transform	Ocean-ocean or continent-continent	The plates slide past one another.	Earthquakes common. May result in some topography.	North American and Pacific plate boundary (Figure 2.12) San Andreas fault

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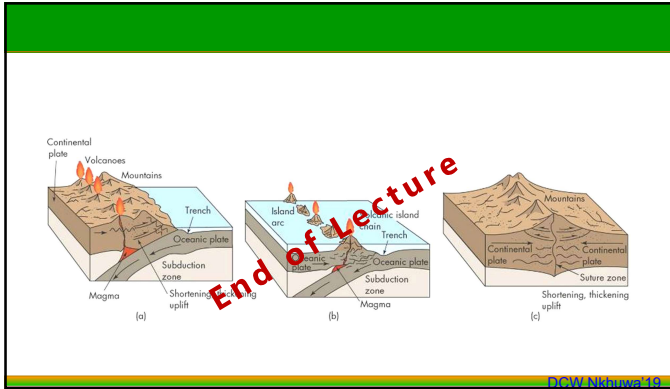
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