FACULTY OF ARTS AND PHILOSOPHY

DEPARTMENT OF PHILOSOPHY AND MORAL SCIENCE
CENTRE FOR LOGIC AND PHILOSOPHY OF SCIENCE

ALFRED WEGENER AND HIS RIVALS: DRIFTING CONTINENTS & SHIFTING INTERPRETATIONS OF (GEOLOGICAL) EVIDENCE

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OVERVIEW

- Topic: episode in the history of the earth sciences (1915-1930).
- The three protagonists and the labels of their theories.
- Data to be explained by these geological theories.
- Different explanations / interpretations of data (+ core ideas of the theories).
- Why is this episode philosophically interesting?
  - ➢ Period of rational disagreement.
  - ➢ Contrasts with the period of revolution in the earth scieces (1965-1975).

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THE PROTAGONISTS

Alfred Wegener: *Continental Drift*

James Dwight Dana: *Permanentism*

Eduard Suess: *Contractionism*

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DATA TO BE EXPLAINED (1)

- Geological data:
  - Mountain ranges with the same rock types, structures & ages on opposite sides of the Atlantic Ocean (Appalachians vs. mountain ranges in Ireland, UK and Norway).
  - Coal basins also seem to continue (Pennsylvania on one side, French-Belgian coal basin on the other side).
  - East coast of South America fits into the West coast of Africa.
  - Presence of kimberlite (igneous rock containing diamonds) in Brazil & South Africa.

- Coral reefs are found in locations where it is much too cold today.

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DATA TO BE EXPLAINED (2)

- Distribution of extinct species:

  Fossils of the same species of extinct plants and animals are found in rocks of the same age on continents that are widely separated.

  Examples:

  - *Mesosaurus:* swimming reptile but could only swim in fresh water.
  - *Cynognathus* and *Lystrosaurus:* land reptiles & unable to swim.

- Distribution of living species: freshwater fish (low salt tolerance!), frogs, parrots, penguins, ….

- Earthworms and ants.

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CONTRACTIONIST EXPLANATIONS

- Core of the theory:
  - As the earth lost its heat, a rigid crust formed.
  - The earth continued to cool and shrink, this crust wrinkled and collapsed.
  - These collapses occur sporadically, creating new oceans and new continents. When the crust collapses in a certain region, the water flows to the new lowest point; continents thus can become oceans and oceans land.
  - Because the collapses occur sporadically the history of the earth is divided into periods of rapid change + periods of stability.

- Specific implementations:
  - The paleocontinent *Gondwana*: the central part of sunk in the Indian Ocean. What remained is now Australia, India + Africa.
  - A land ridge between South America and Africa.

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PERMANENTIST EXPLANATIONS

- Core of the theory:
  - Continents formed in remote geological times as the earth gradually cooled down and contracted.
  - Since then, they had been permanent features of the earth's surface.
  - Continents do not move laterally and do not disappear.
  - There have been small elevations (producing mountains) and small subsidences (producing shallow inland seas).

- Permanentists cannot explain the geological or (paleo)biogeographical data. They *interpret them as* 'chance phenomena'.

- They can explain the formation of mountains.

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WEGENERS EXPLANATIONS (1)

- Core of the theory.
  - Continents consist of blocks of *sial* (silica + alumina) which (like icebergs in the sea) partially float on and extend into blocks of *sima* (silica + magnesia).
  - Oceans are situated between the blocks of sial, and ocean floor is made of sima.
  - Continents were once united in the super-continent Pangaea, which broke apart in the Cretaceous, Since then, the continents
  - They are propelled by one or more forces through the ocean floor.
  - Sometimes they move apart (Africa and South America). Sometimes they collide, resulting in mountains (e.g. collision of India & Asia creating the Himalayas).

WEGENERS EXPLANATIONS (2)

- Continental drift explains everything that contractionists can explain.

- Wegener claims to have an explanation for some extra phenomena:
  - ‘Puzzle-fit’ (for Contractionists: a chance phenomenon).
  - Fossils of coral reefs at biologically impossible places (for Contactionists: a miracle).

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RATIONAL DISAGREEMENT (1)

- Some of you may have asked:
  - How could one be a Permanentist? It is obviously a very poor theory.
  - Why did hardly anyone adopt Wegeners theory? It is clear that it has the largest explanatory power.

- Theoretical arguments (consistency with physics) vs. empirical arguments (good explanations of the data).

- Contractionism is incompatible with the presence of radioactive materials in the earth's crust. Radioactive material was widely distributed in the earth's crust and produced heat when decaying.

RATIONAL DISAGREEMENT (2)

- Problem for Wegener:

"The earth did behave like a fluid in some respects, but no one was proposing that the ocean floors were in fact liquid: they were composed of dense, basaltic rocks. How could the continents move laterally through such floors without crumbling to bits? What enormous force not only moved the continents but had crumpled them up to form the Alps, Rockies, Andes and Himalayas? The forces which Wegener invoked did exist but they were far too weak. A force nearly 1000000 times stronger was needed, and if it did exist it would surely have been noticed by physicists." (Le Grand, 1988, pp. 55–56).

- Preference depends on how you value the different (types of) problems.

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REVOLUTION IN 1965-1975 (1)

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REVOLUTION IN 1965-1975 (2)

- Introductory textbooks (new and revised) in the US:

Period	Drift-based	Mostly Pro Drift	Neutral	More Anti Drift	No Mention	Total
1958-62	0	4	10	2	6	22
1963-67	0	6	6	3	2	17
1968-71	3	7	3	0	1	14
1972-75	11	8	2	0	0	21
Total	14	25	21	5	9	74

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PLATE TECTONICS (1)

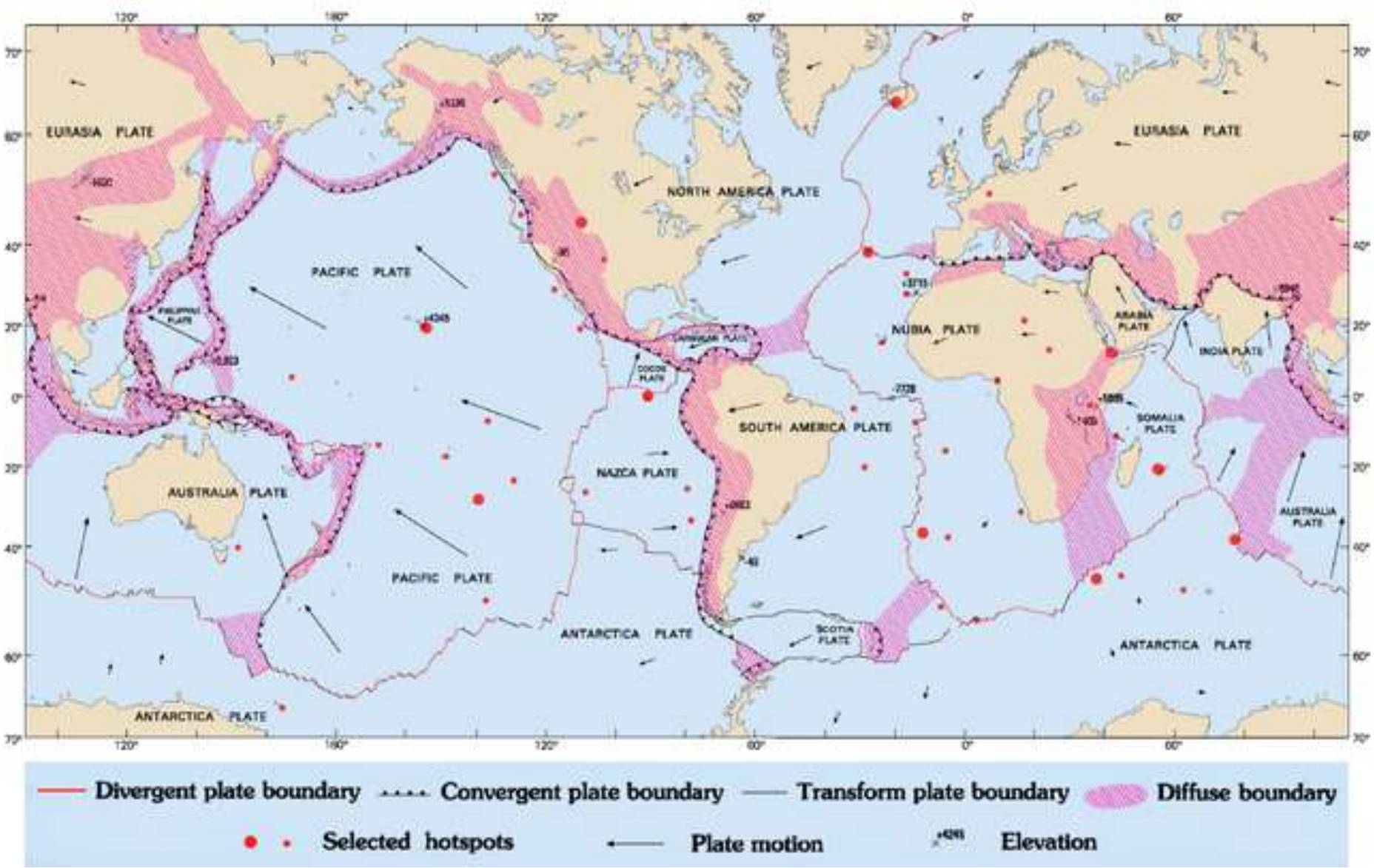

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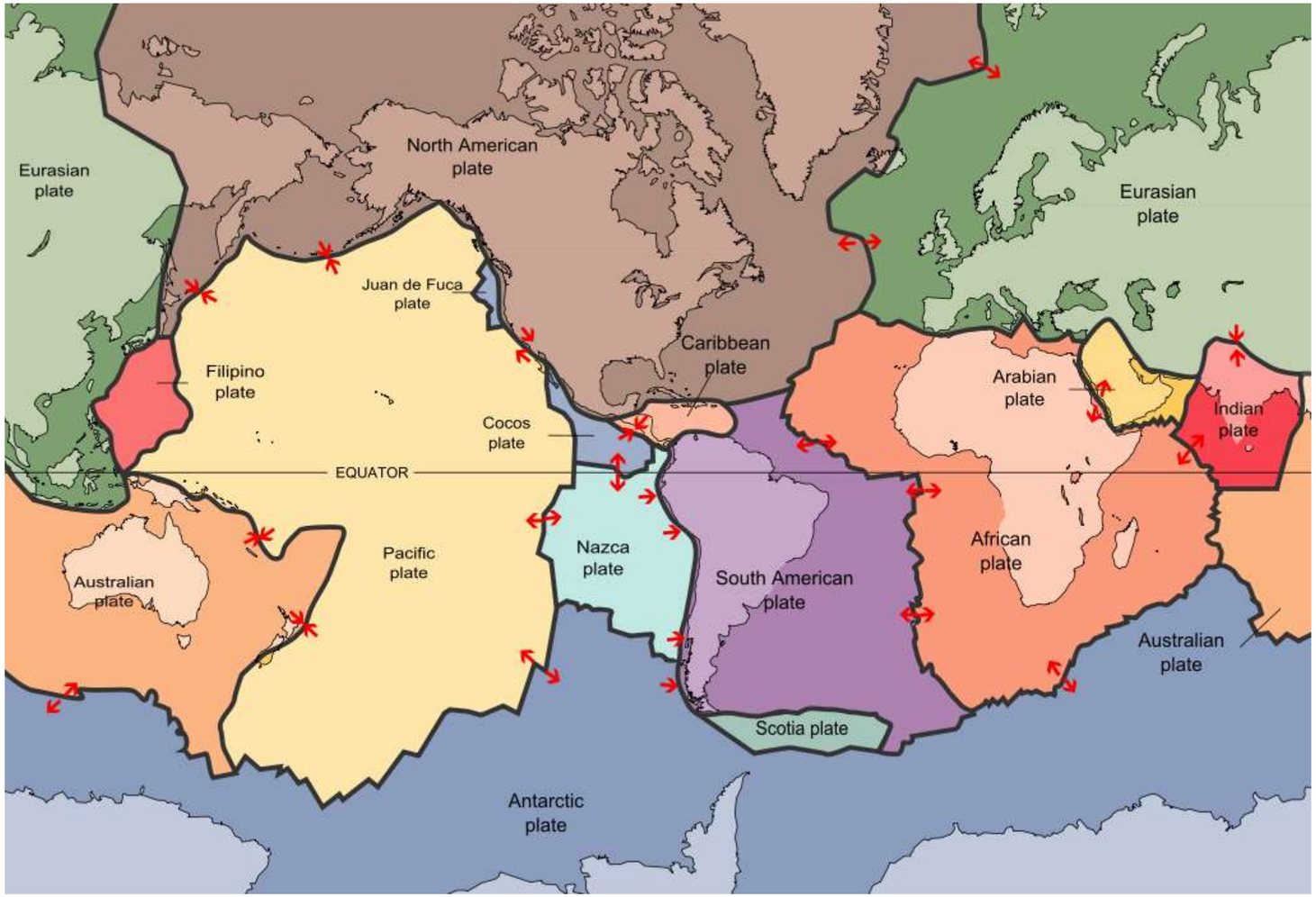
PLATE TECTONICS (2)



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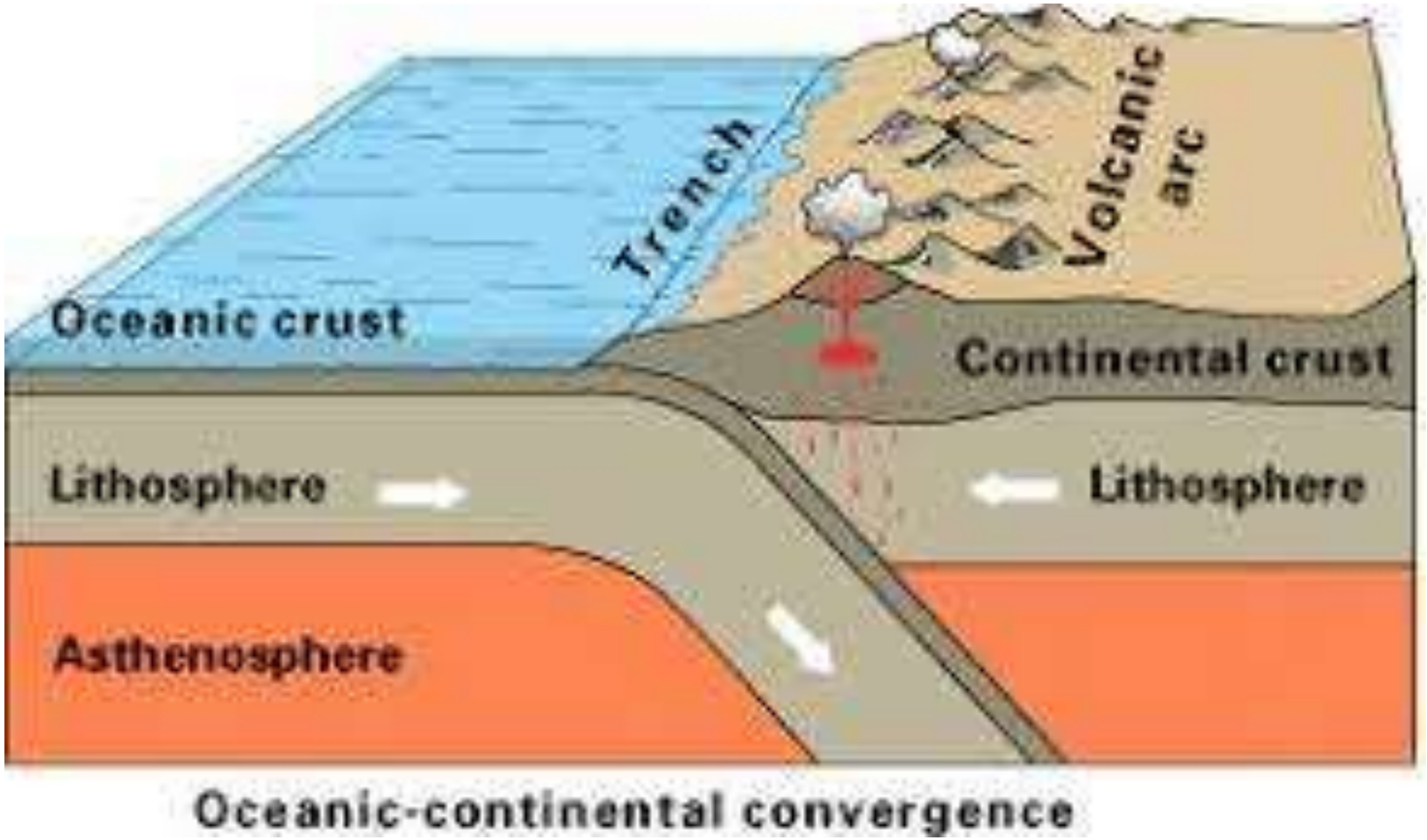
SUBDUCTION



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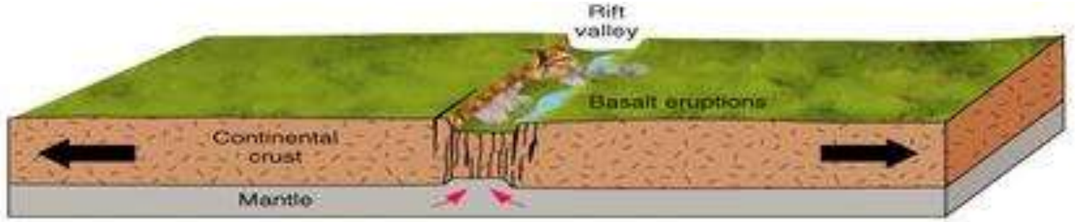
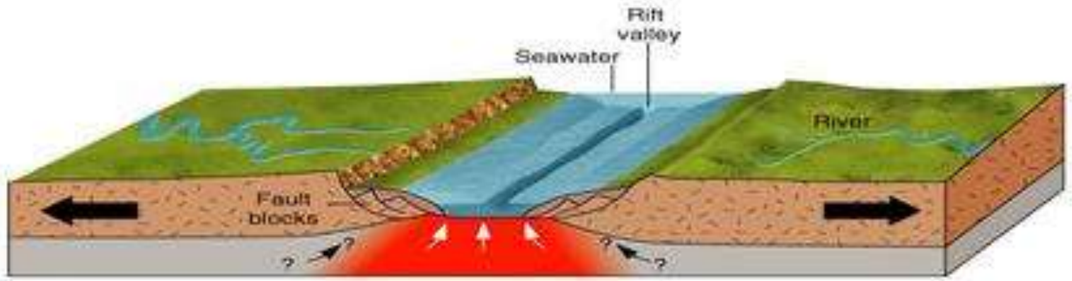
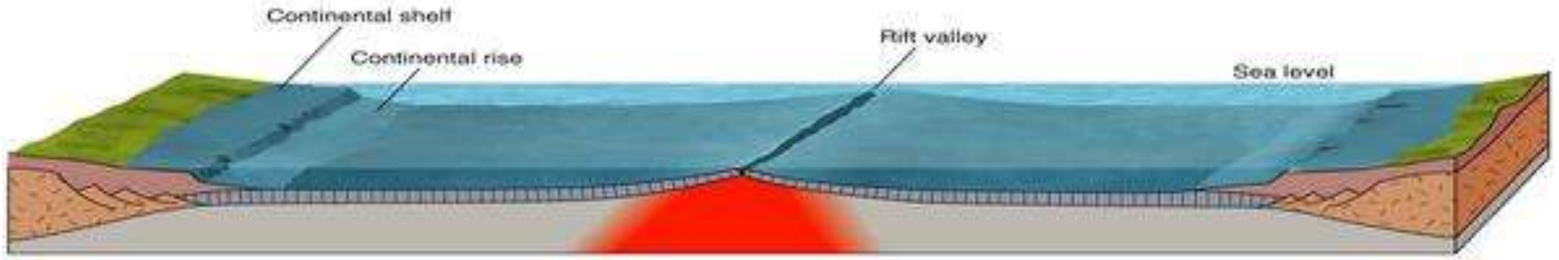
OCEAN RIDGES







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LESSONS

- Example of integrated history & philosophy of science (&HPS).
- Rational disagreement (epistemic values).
- Clear example of a revolution, but without the irrationality that Thomas Kuhn ascribes to them.

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