Lecture 2

Course Introduction continued and Island Physics

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Outline

Course outline

- Remote oceanic islands → Continental shelf islands → consequences to ecology and evolution on mainland / continents.
- Island Physics – Geology, Climate, Lifecycle of an island.
- Review of some well-known islands and island chains.
- Arrival on islands – Long-distance dispersal, Land bridges.
- Characteristics of island biotas (flora and fauna).
- Evolution on islands.

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  - Community Assembly.
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- During the course: BBC documentaries on south pacific islands.
- **In lectures**: Examples from islands **worldwide**.
- General patterns and processes (rather than anecdotes).
- Examples also from plants.
- Emphasis on **terrestrial** animals and plants (as opposed to aquatic systems).

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Why study island biology?

- Darwin's work on Galapagos and Wallace's work in Indonesia and New Guinea guided them towards the idea of evolution by natural selection.
- In the 20th century the study of island biotas lead to the development of the theory of island biogeography – a fundamental pillar of modern ecology.
- Still nowadays, island biotas provide the best examples of ecological and evolutionary processes – such as species invasions.
- Islands disproportionally contribute to worldwide biodiversity, to worldwide endangered species, and to extinctions.

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The natural laboratory paradigm

- Small area and discrete.
- "Simple" biotas.
- Numerous and varied – Repetitions of ecological and evolutionary "experiments".
- "Accelerated time" – both geologically and evolutionarily.
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. . . when we have mastered the difficulties presented by the peculiarities of island life we shall find it comparatively easy to deal with the more complex and less clearly defined problems of continental distribution. . .

Alfred Russell Wallace, Island Life, 1902

Species concept: a practical definition

- The unit of biodiversity.

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Darwin, 1859

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Darwin, 1859

. . . I look at the term species, as one arbitrarily given for the sake of convenience to a set of individuals closely resembling each other, and that it does not essentially differ from the term variety, which is given to less distinct and more fluctuating forms.

Darwin, 1859

Species concept: a practical definition

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- **Growth form** (צורת חיים) – especially for plants; herb, shrub, tree etc.

Island biology in a (coco)nutshell

1. Basic physical/geographical characteristics of islands.

   Isolated, Isolation, Remote, Small, Tiny, Specks of land, Far-flung.

2. Island biotas, species number/richness (עושר מינים) and biodiversity (מגוון ביולוגי).

   Unique set of creatures, Found nowhere else on earth, No competition, Fill niche normally taken by mammals, Colonizers, Less than 500 kinds of animals arriving on Hawaii

3. Evolution on islands – Characteristics of animals evolved on islands.

   Unique, Unexpected, Bizarre, Misfit, Opportunity / Freedom to be different, Unusual, Like no other, Oddity, Strangest, Not typical, Extraordinary, Quirky evolution,
   Hawaii fruit flies: 1 colonizer → 1000 species.

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Island Physics

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- Small area
- Young age
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Insular Evolution

- "Untypical" creatures
- Adaptive radiation
-

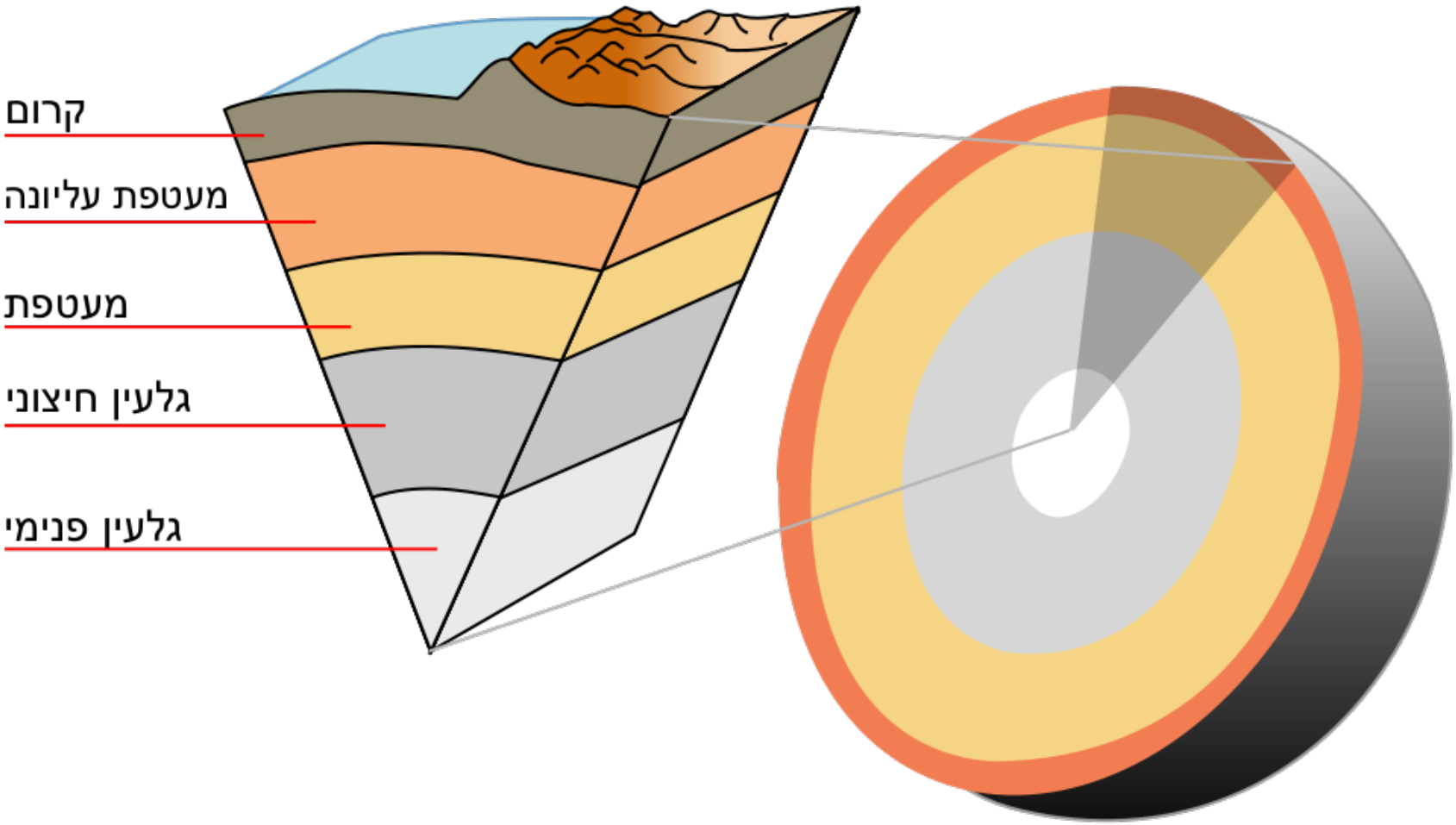
Untypical creatures: examples

Adaptive Radiation: Hawaiian honeycreepers

Adaptive Radiation: *Echium* on Canary Islands

Outline

Oceanic vs. Continental (shelf) Islands



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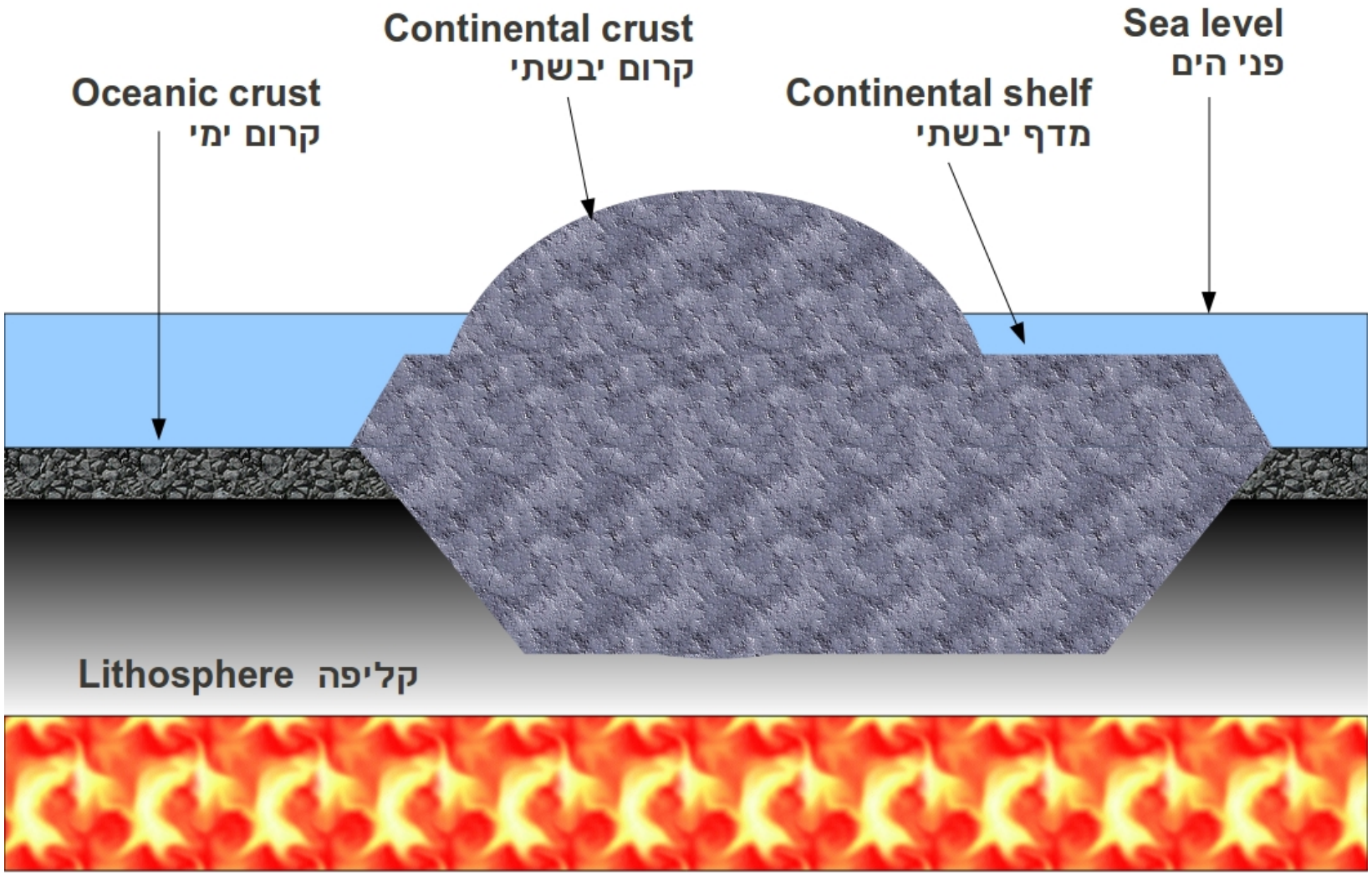

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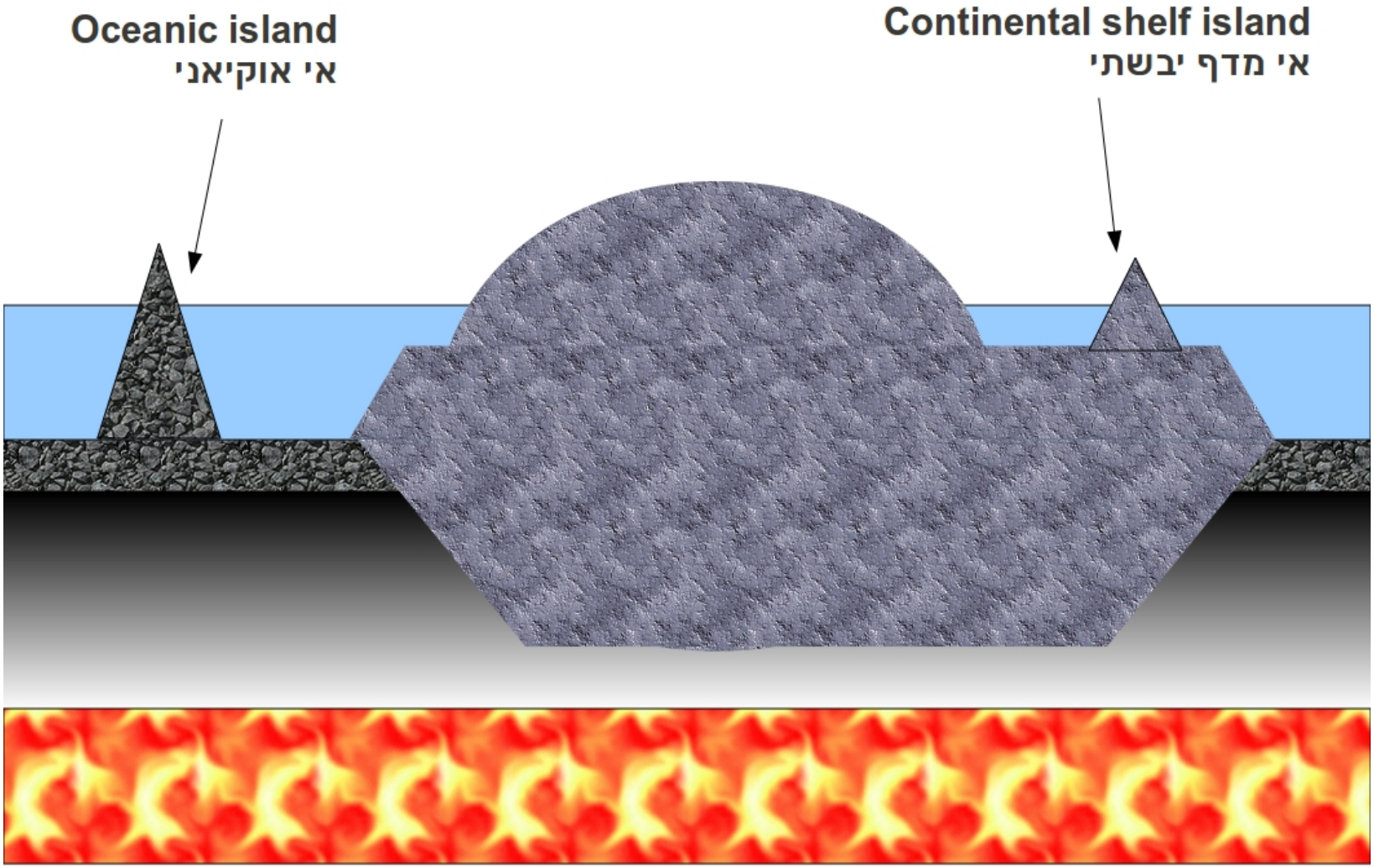

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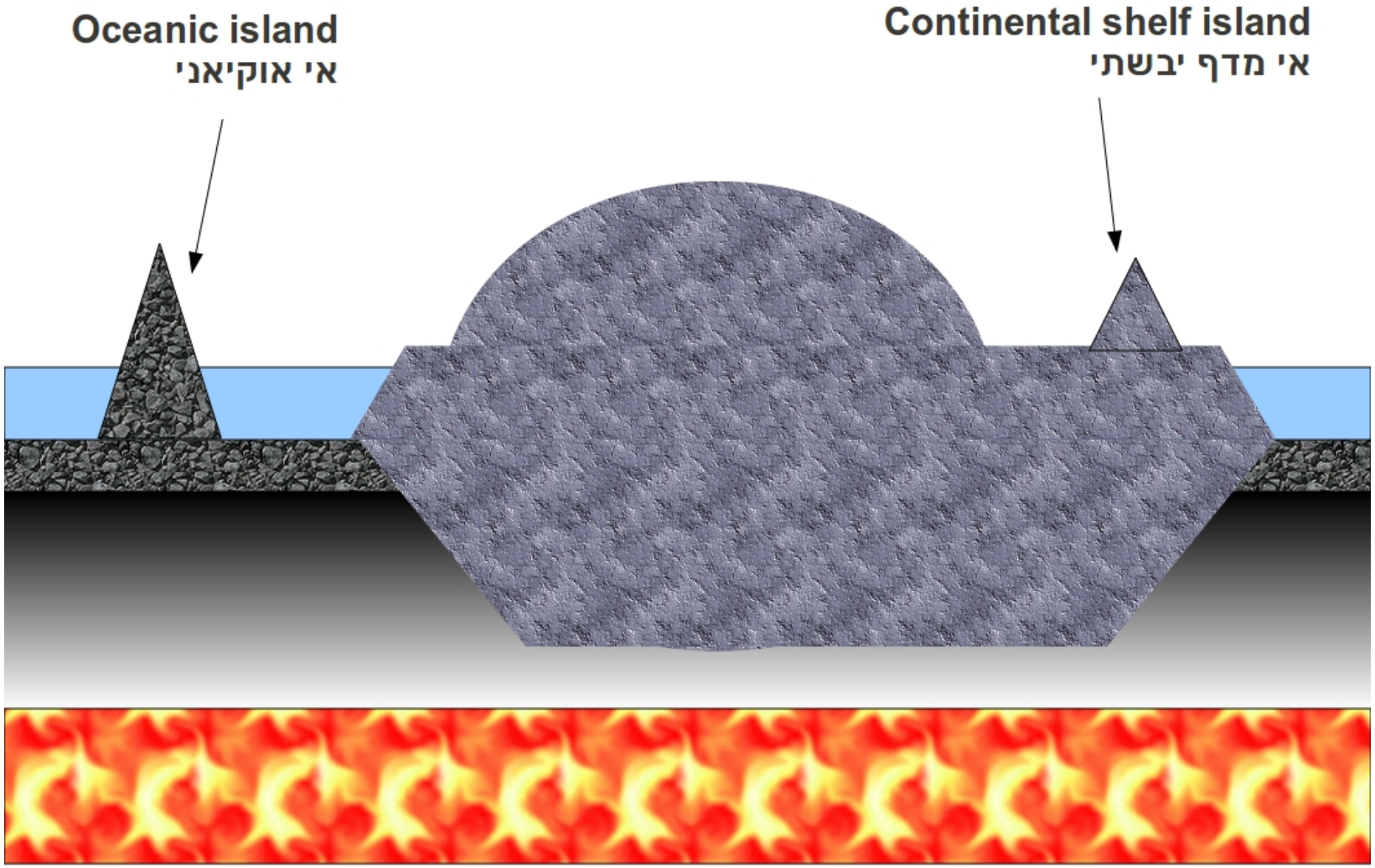


Oceanic vs. Continental (shelf) Islands

Continental (shelf) islands

- Rise from continental crust (continental shelf)
- Mixed origin and rock types.
- May have been connected to mainland.
- Britain, Ireland, Indonesian islands of the Sunda shelf, Sri Lanka, Malta.

Oceanic islands

- Rise from oceanic crust.
- Invariably volcanic in origin (basaltic).
- Have never been connected to mainland.
- Hawaii, Galapagos, Canary islands, Azores, Mauritius, Easter island.

Oceanic islands: High vs. Low islands

Oceanic islands: High vs. Low islands

Low Island

High Island

Outline

Plate tectonics

Earth lithosphere is broken into tectonic plates.

Plate tectonics

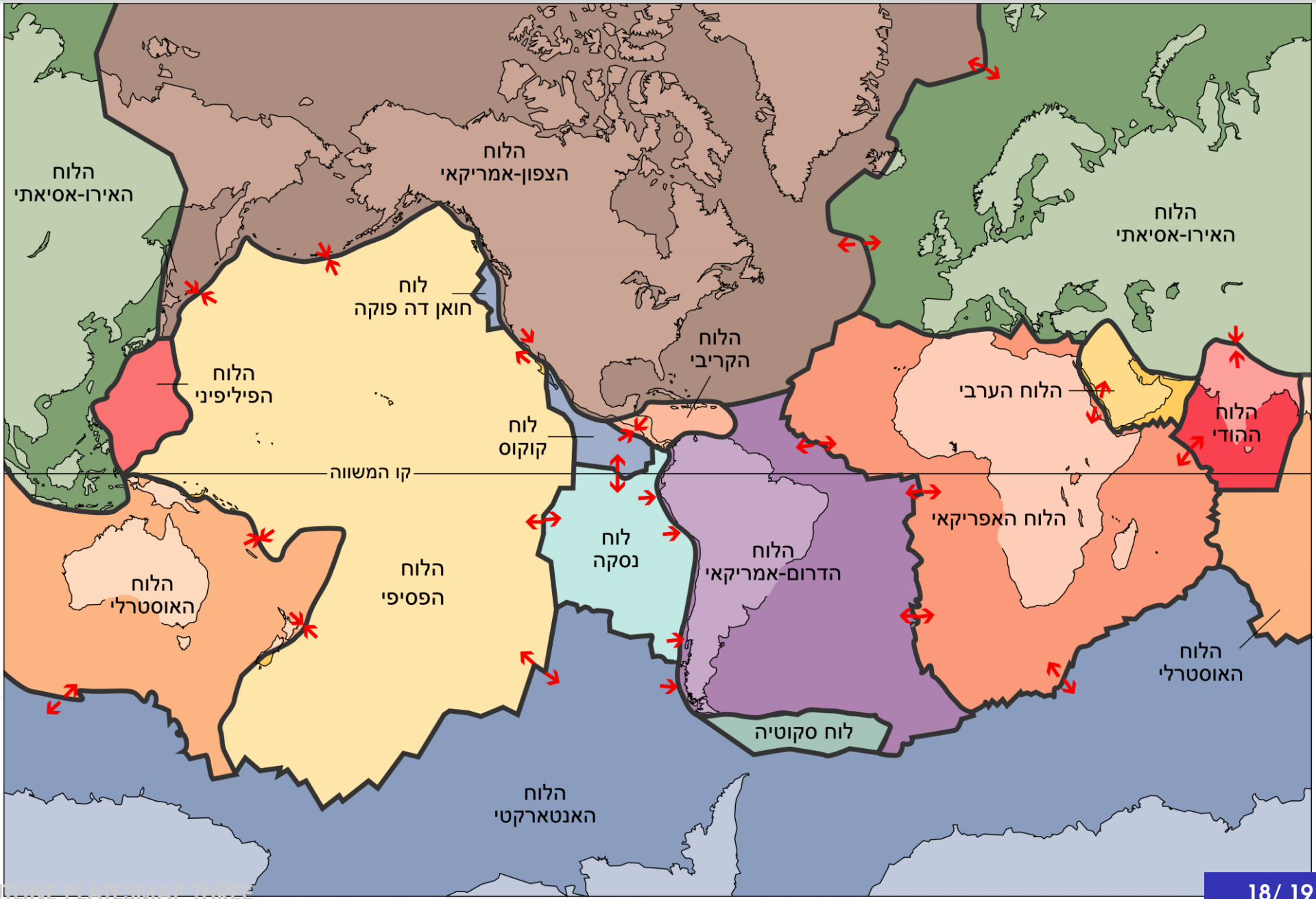


Plate tectonics

In plate margin new crust may be formed.

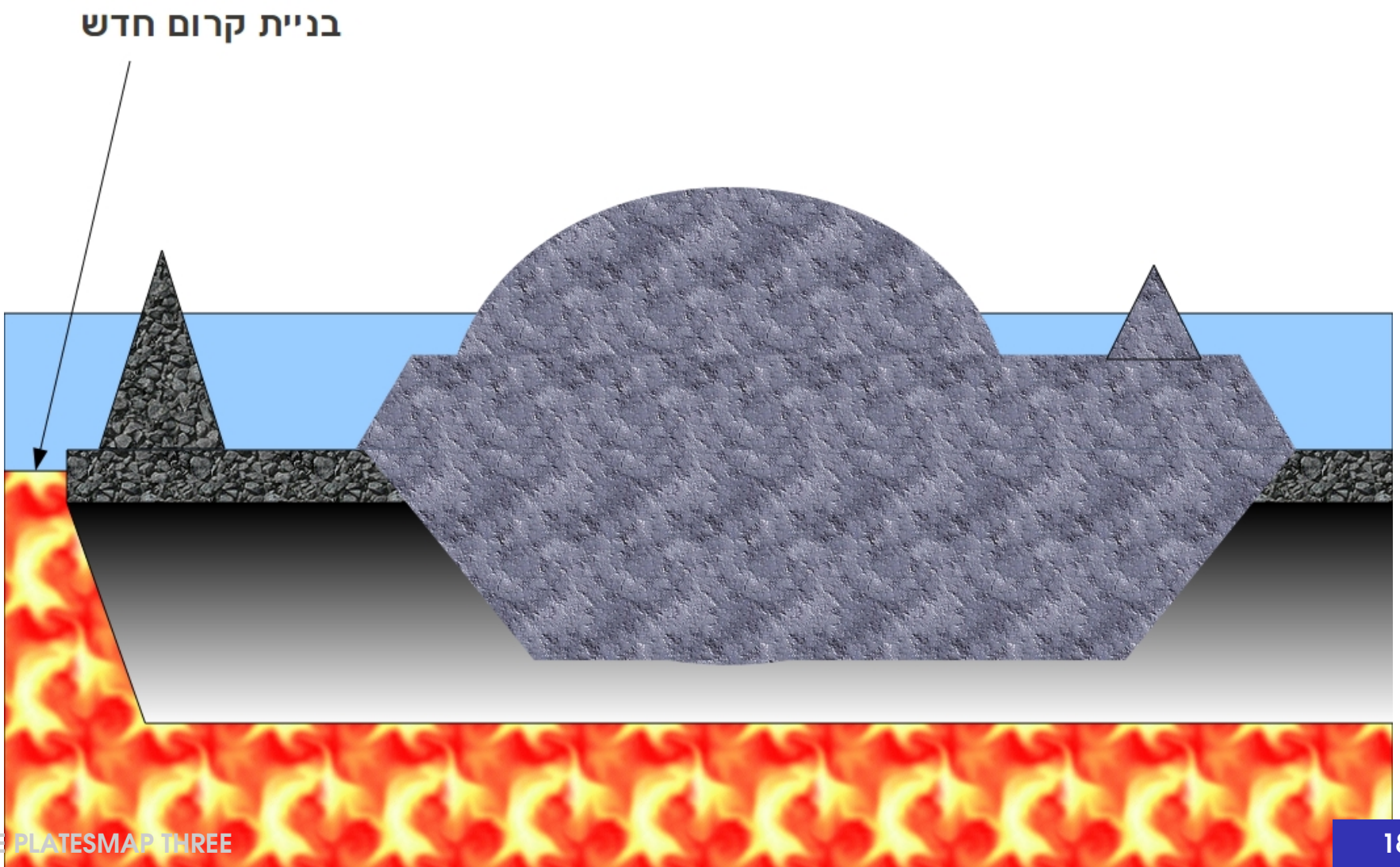


Plate tectonics

Pushing the entire plate and causing it to drift.

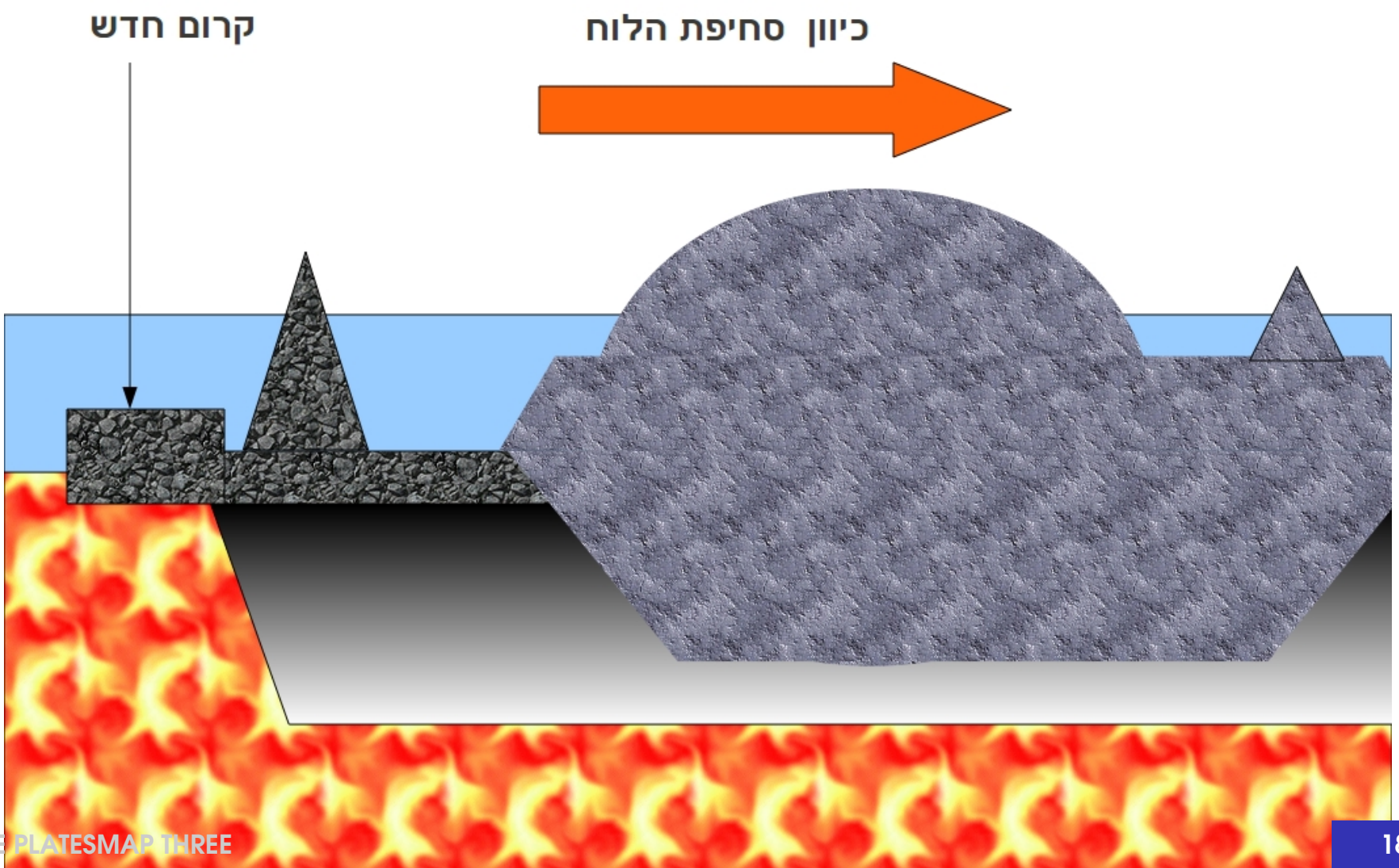


Plate tectonics

Plate drift also caused by currents in liquid mantle and by plate subduction on the opposite side of the plate

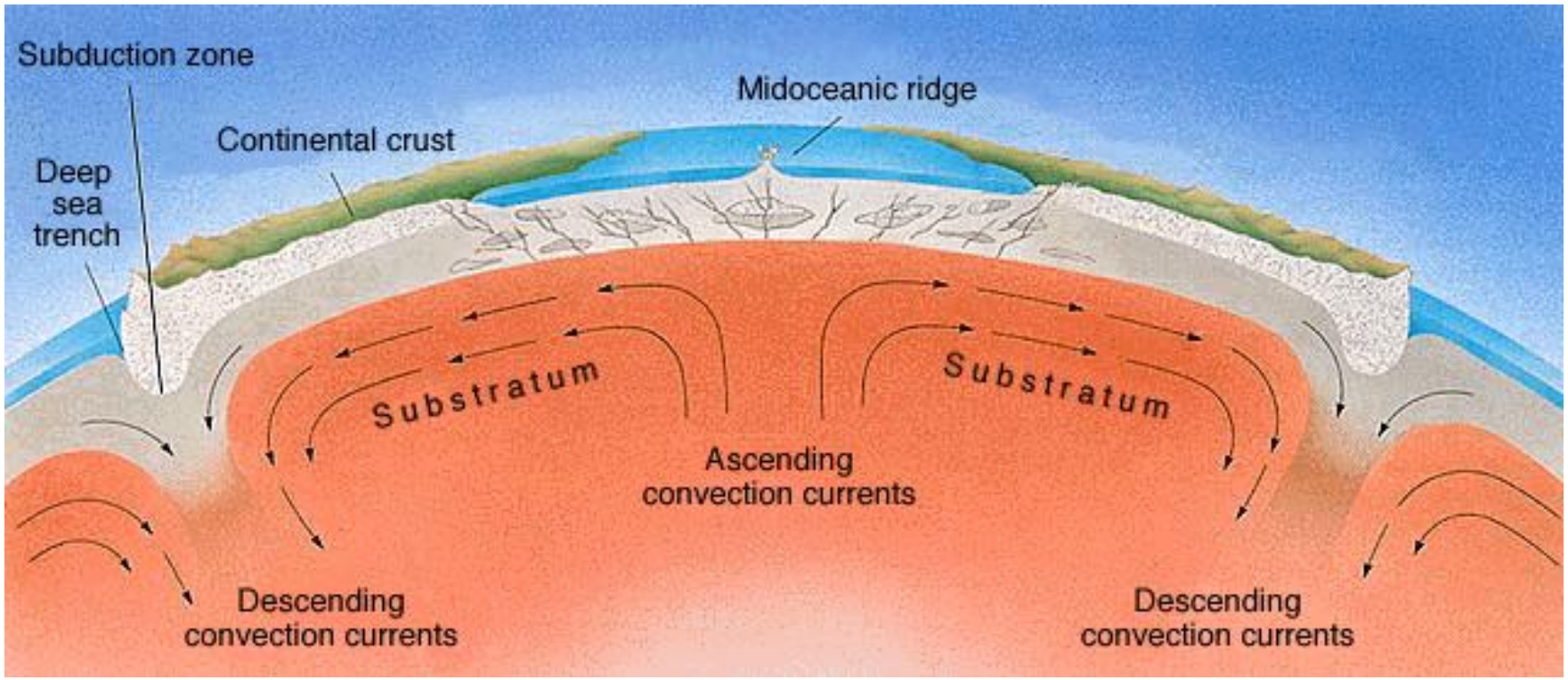
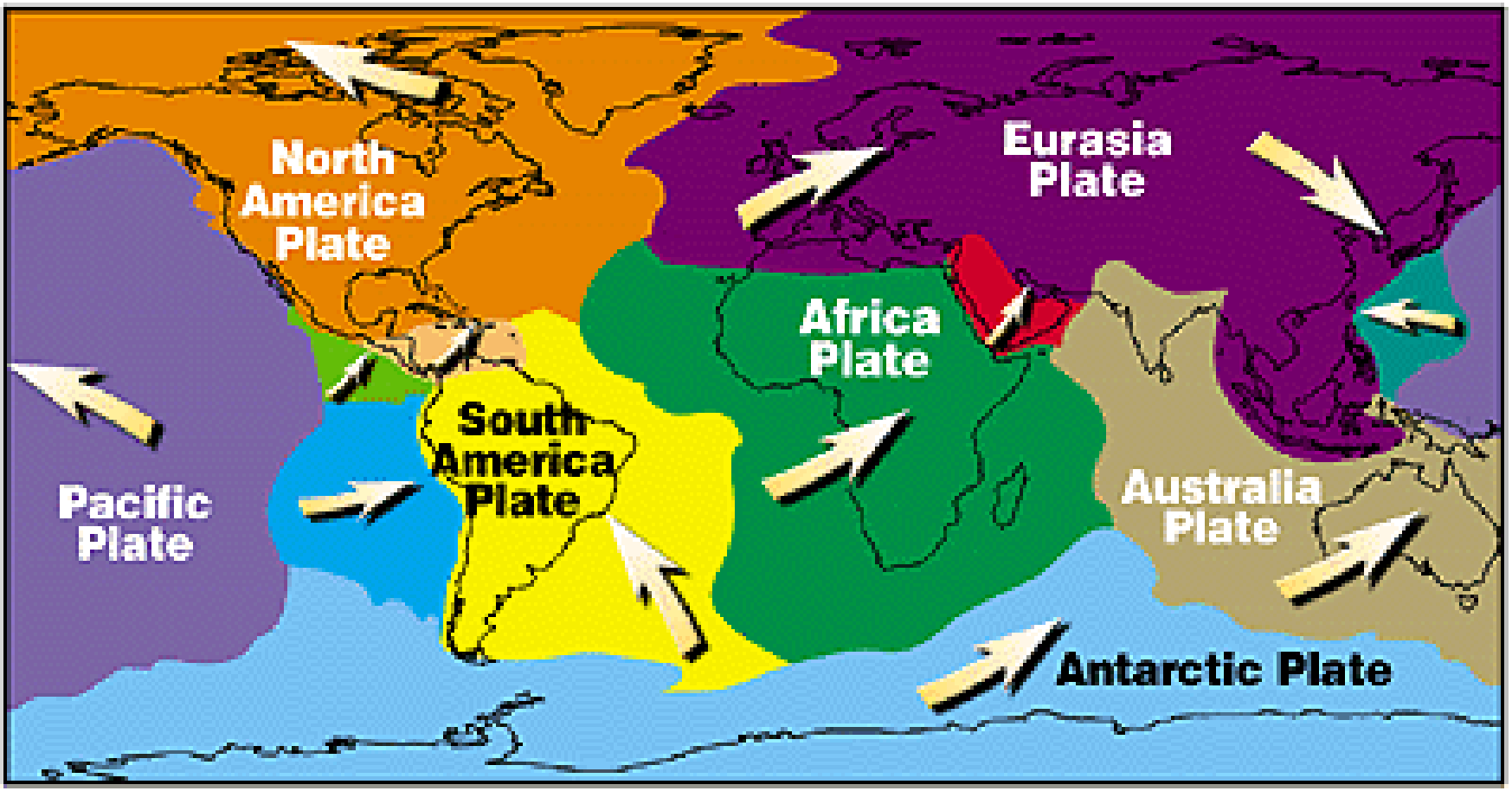


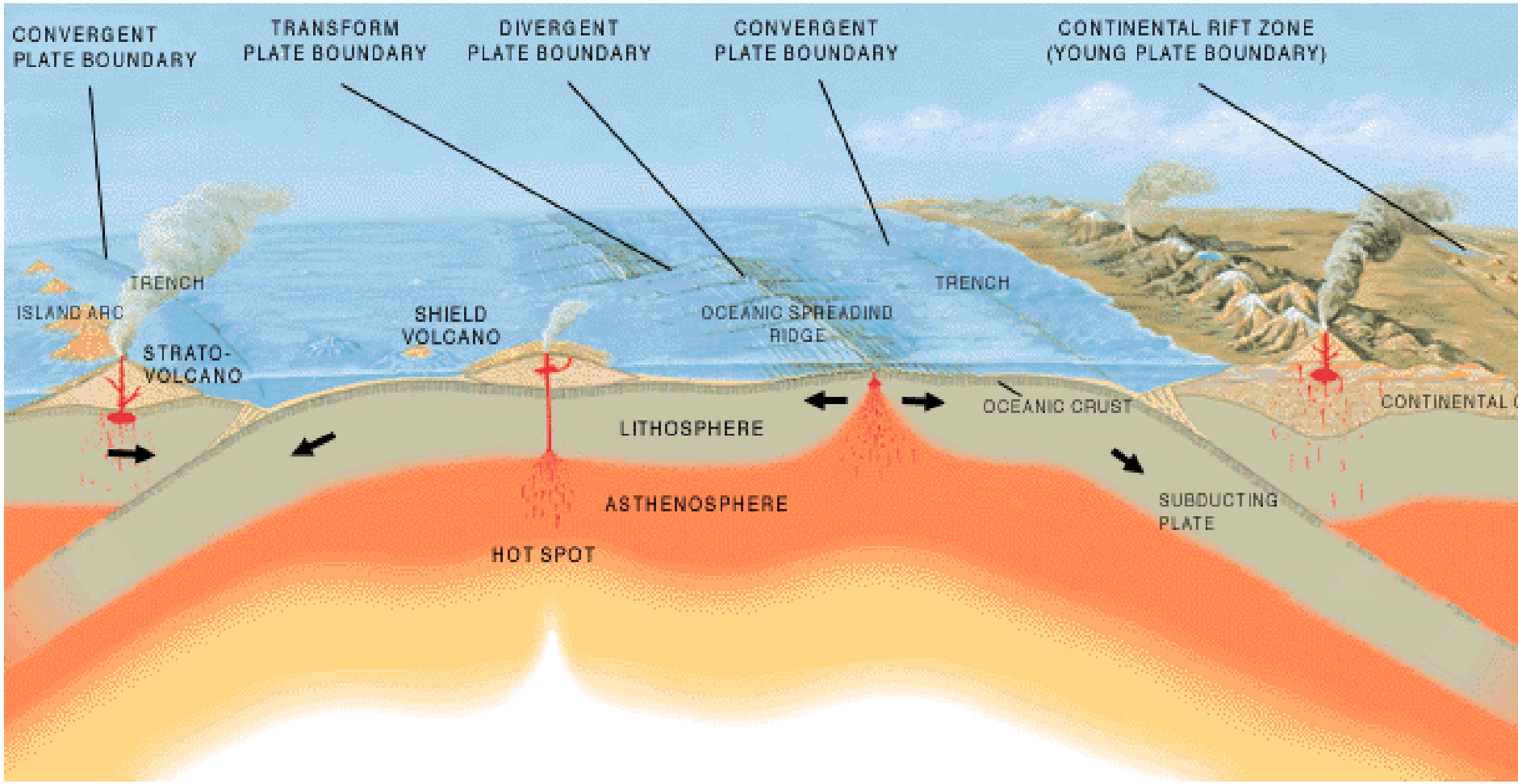
Plate tectonics

. . . causing continents and islands to move like on a conveyor belt.



Three ways to form volcanic islands

Plates divergence → Mid-oceanic ridge → Usually sea mountains (seamounts); Sometimes islands.



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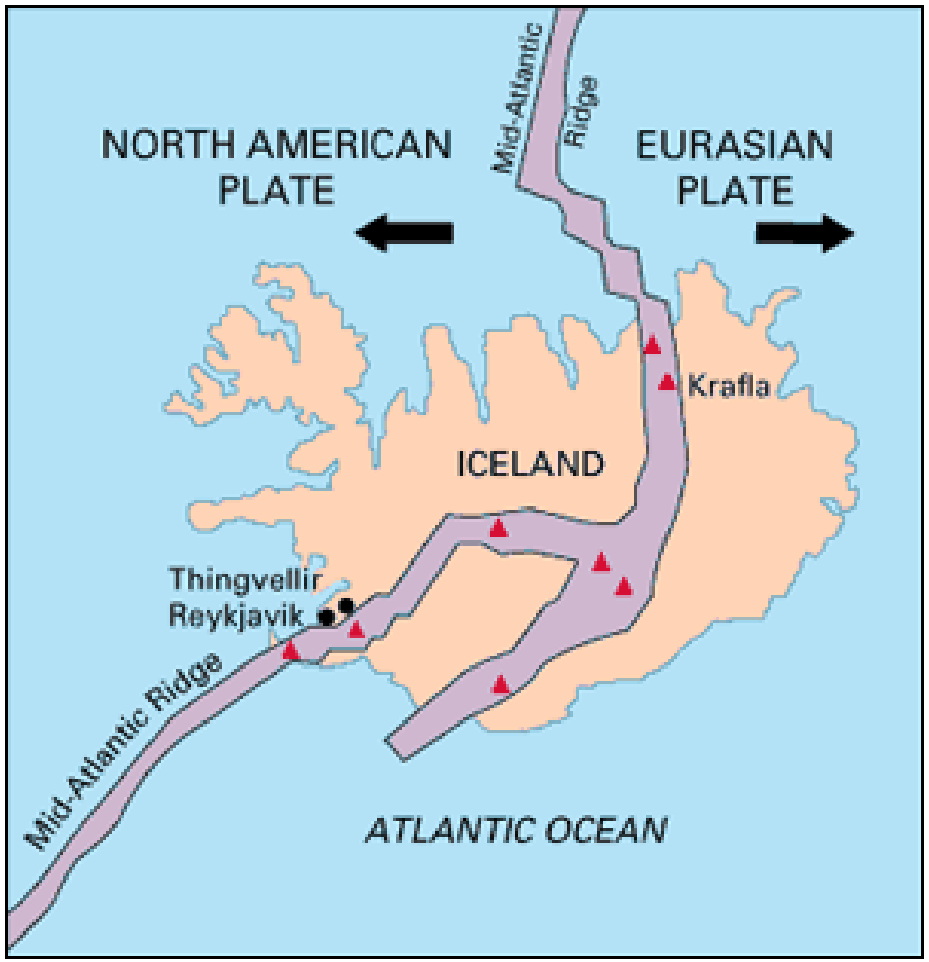
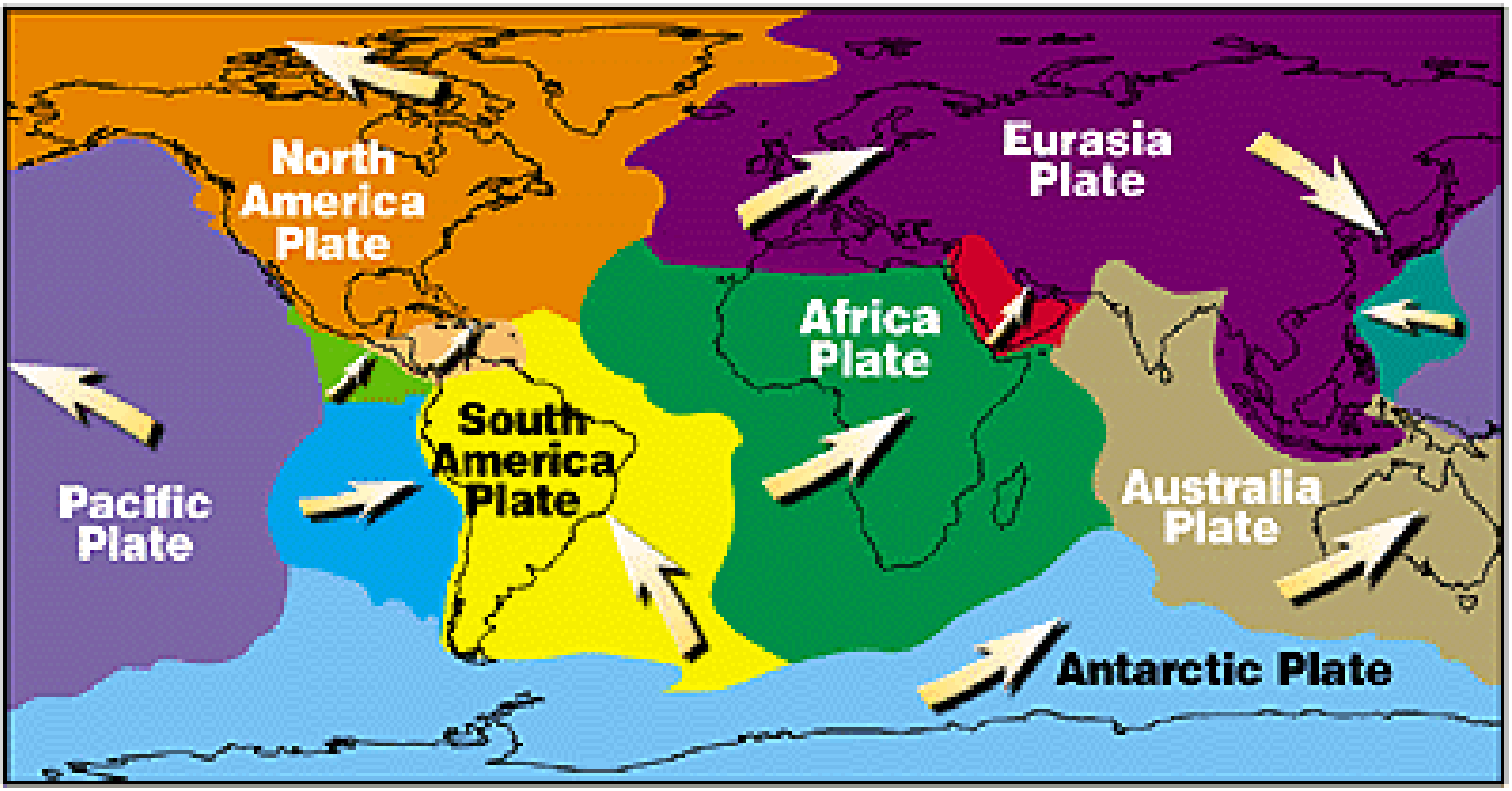
Mid-oceanic ridges



Three ways to form volcanic islands

Triple junctions



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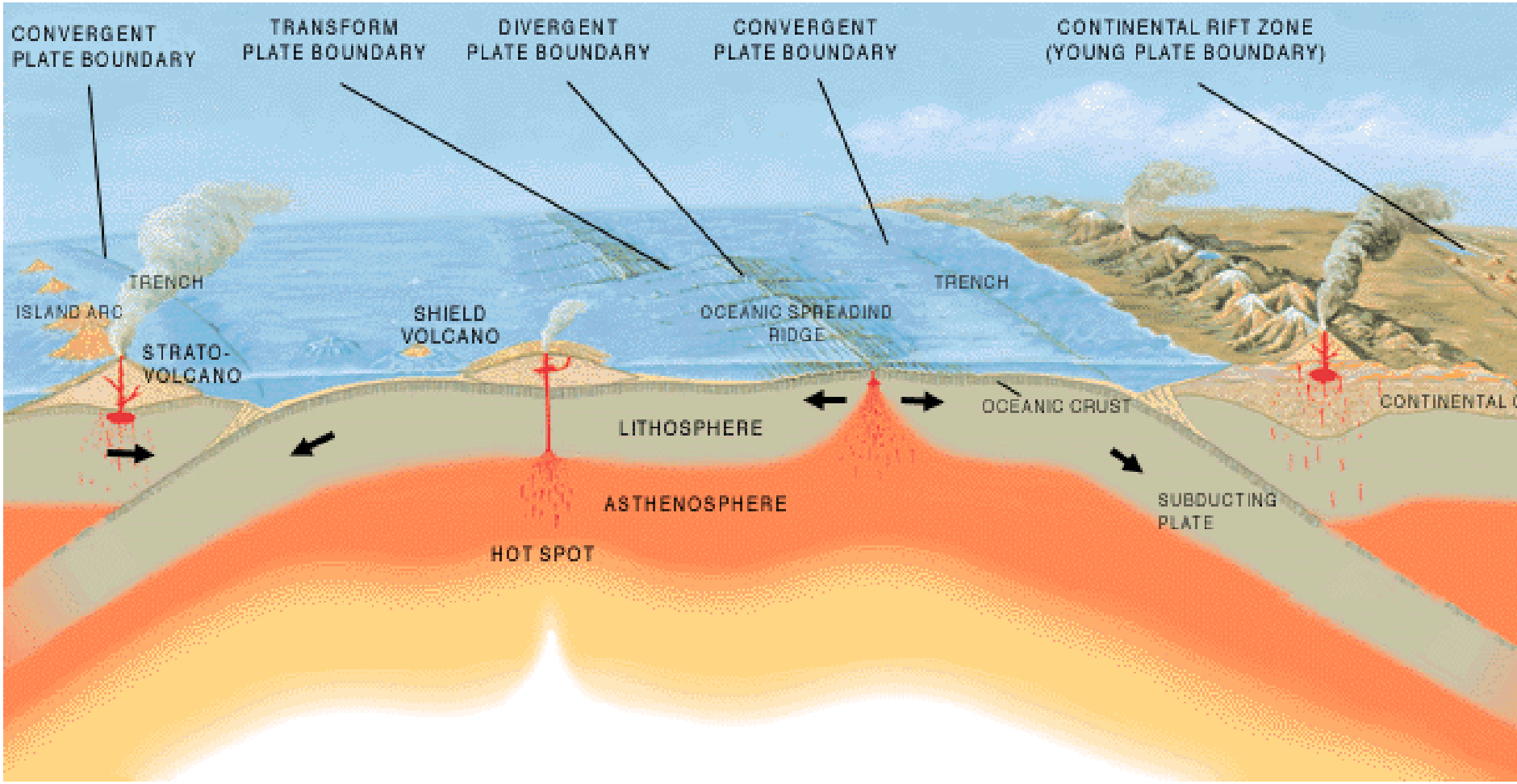
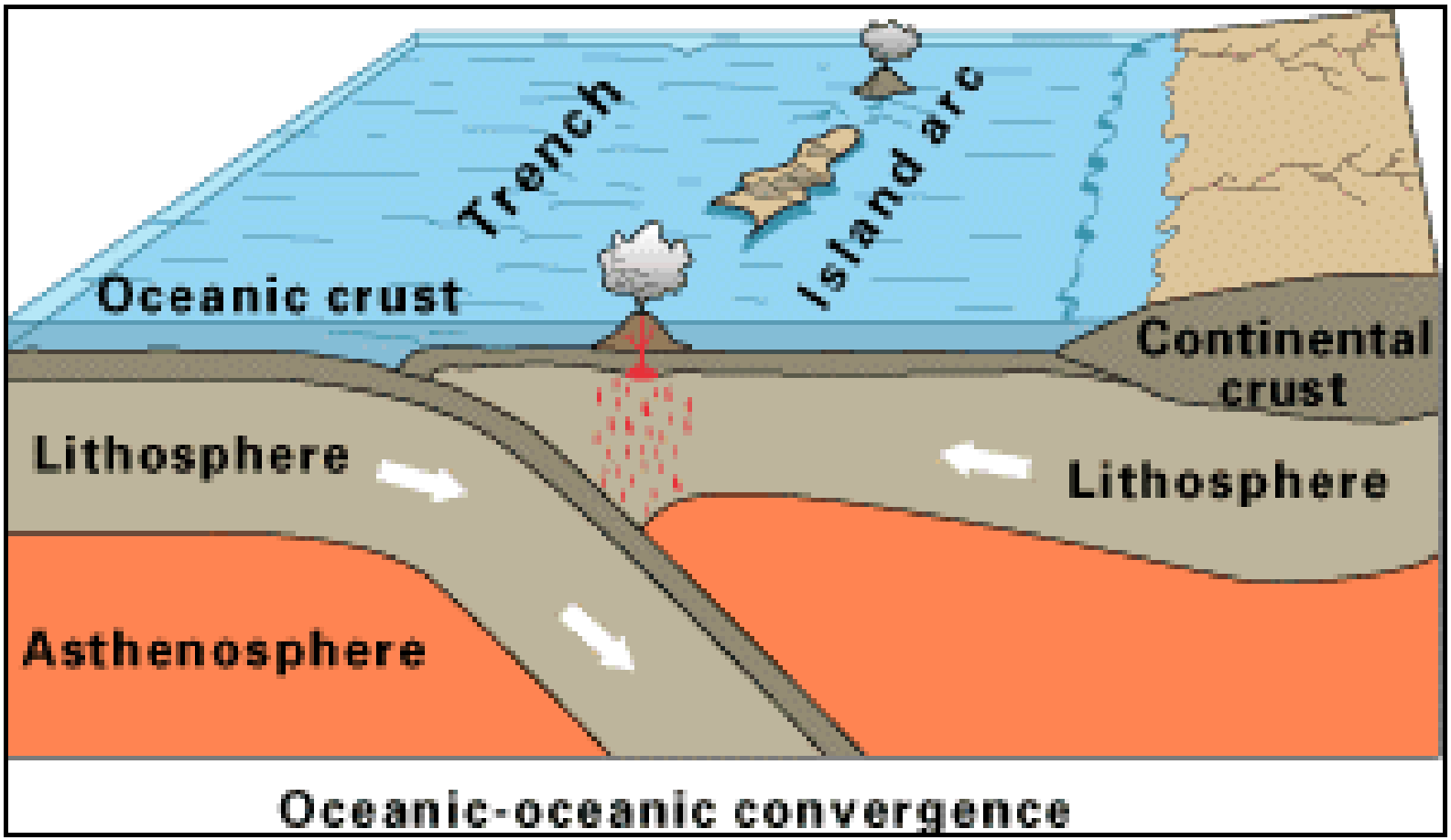


Three ways to form volcanic islands

Plate convergence and subduction → Trench → Island arc



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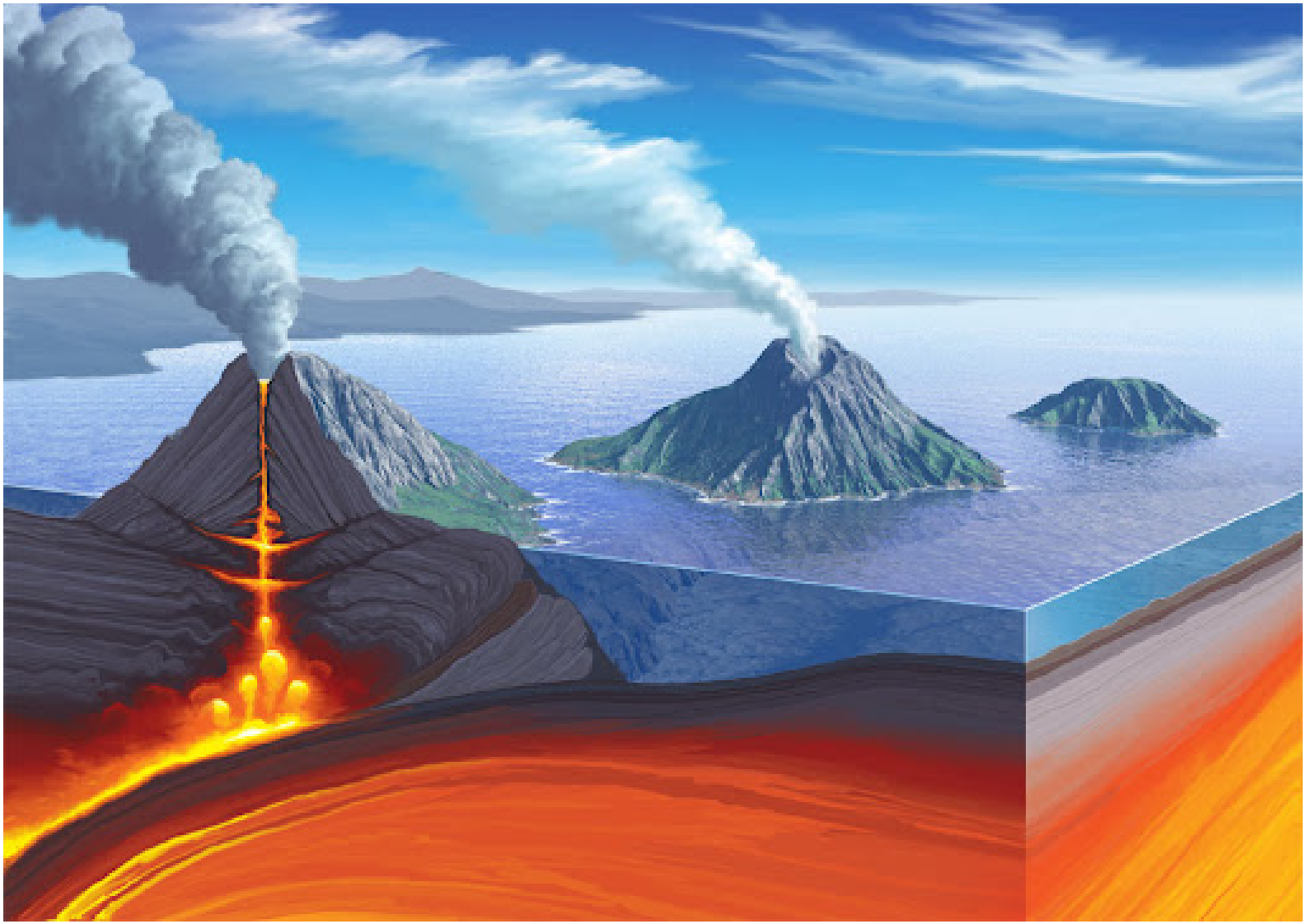
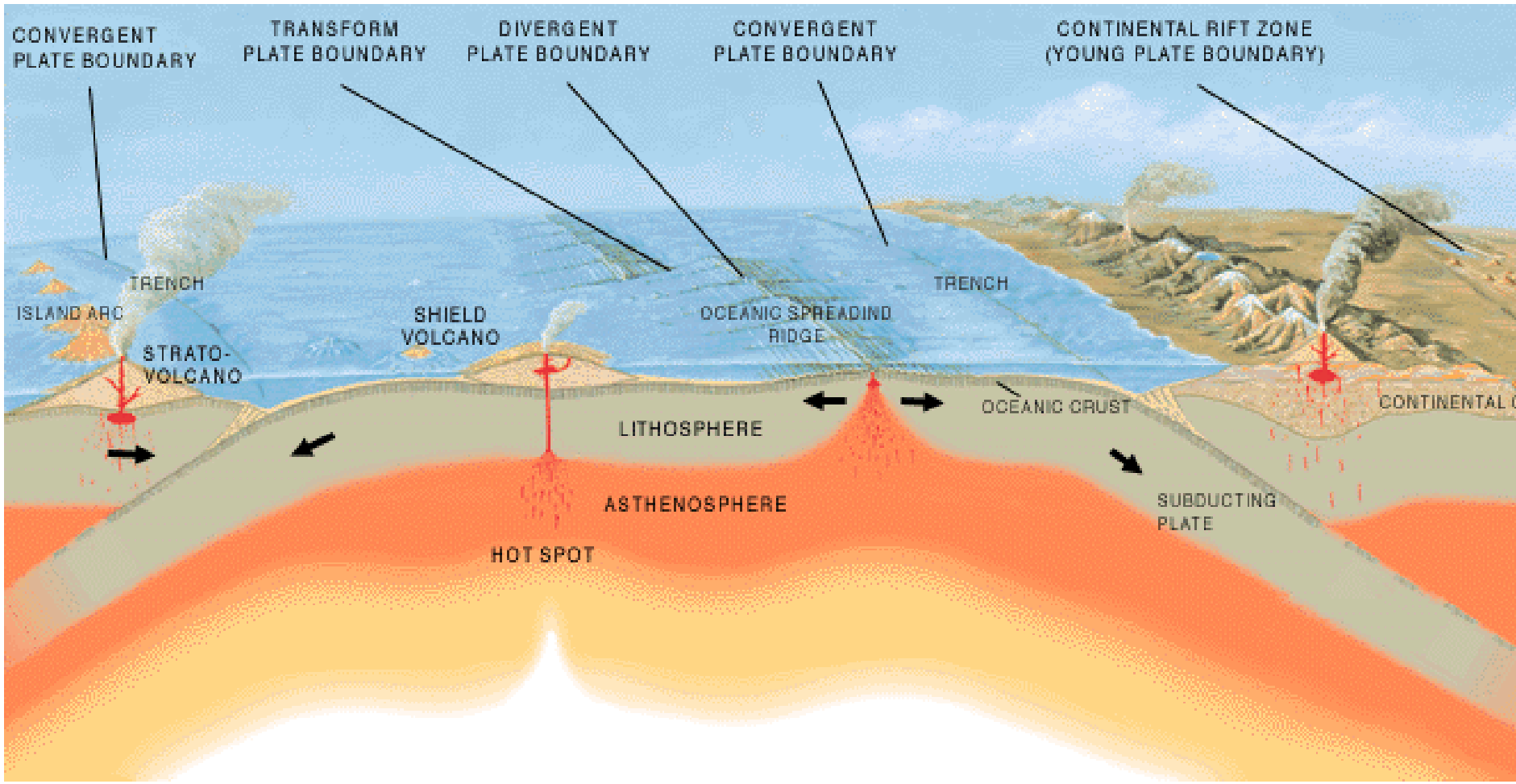


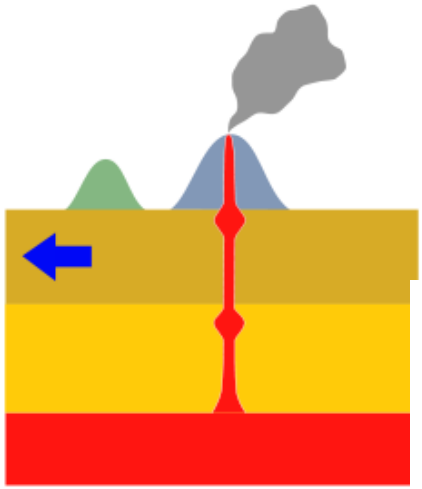
Three ways to form volcanic islands

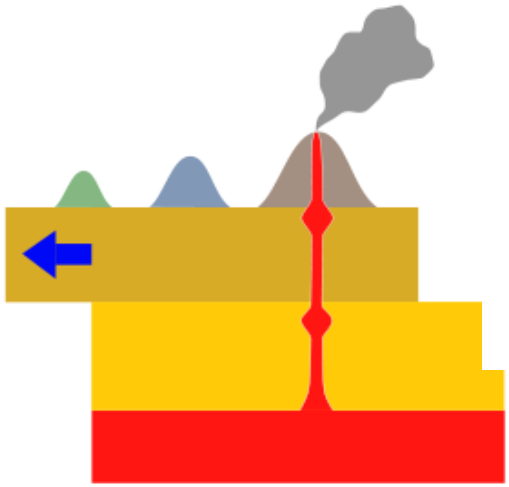
Intra-plate hotspot

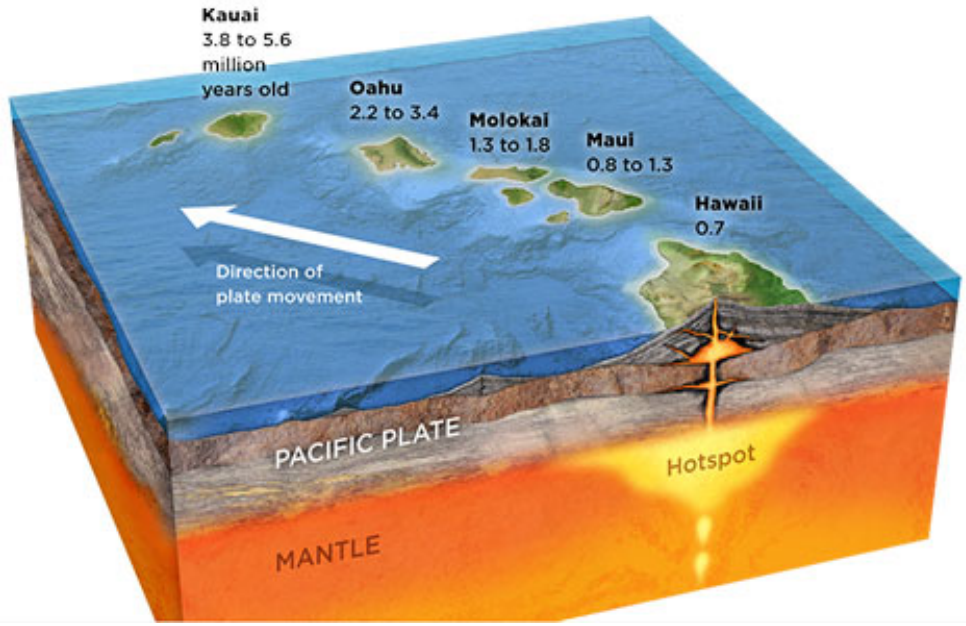


Three ways to form volcanic islands

Hotspot + plate movement → Linear island chains



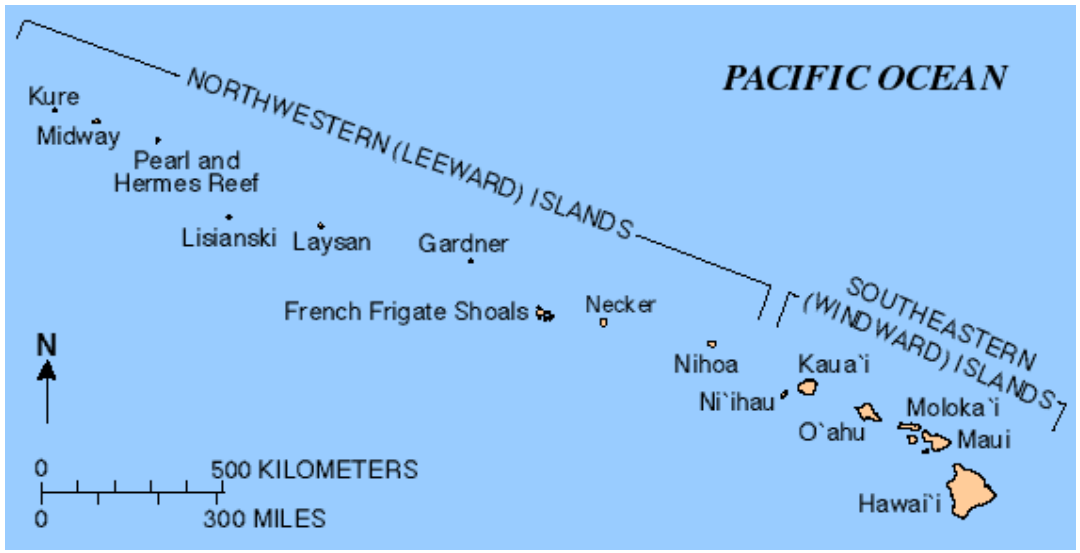




Three ways to form volcanic islands

Hawaiian islands age, area and elevation:

Name	Age (Myr)	Area (km^2)	Elevation (m)
Hawaii	0.38	10,432	4,205
Maui	1	1883	3,055
Ohau	3	1545	1220
Kauai	5.1	1430	1598
Laysan	19.9	4	15



Three ways to form volcanic islands

- Plate divergence – often in triple junctions.

  Iceland, Azores, Rodrigues.

- Plate convergence – Island arcs parallel to trenches.

  Solomons, Aleutian, Sandwich islands,

  Antilles, South Aegean arc, Japan.

- Hotspot – linear or clustered island groups.

  Hawaii, Galapagos, Canary islands, Cape Verde.