Lecture 3

Island Physics

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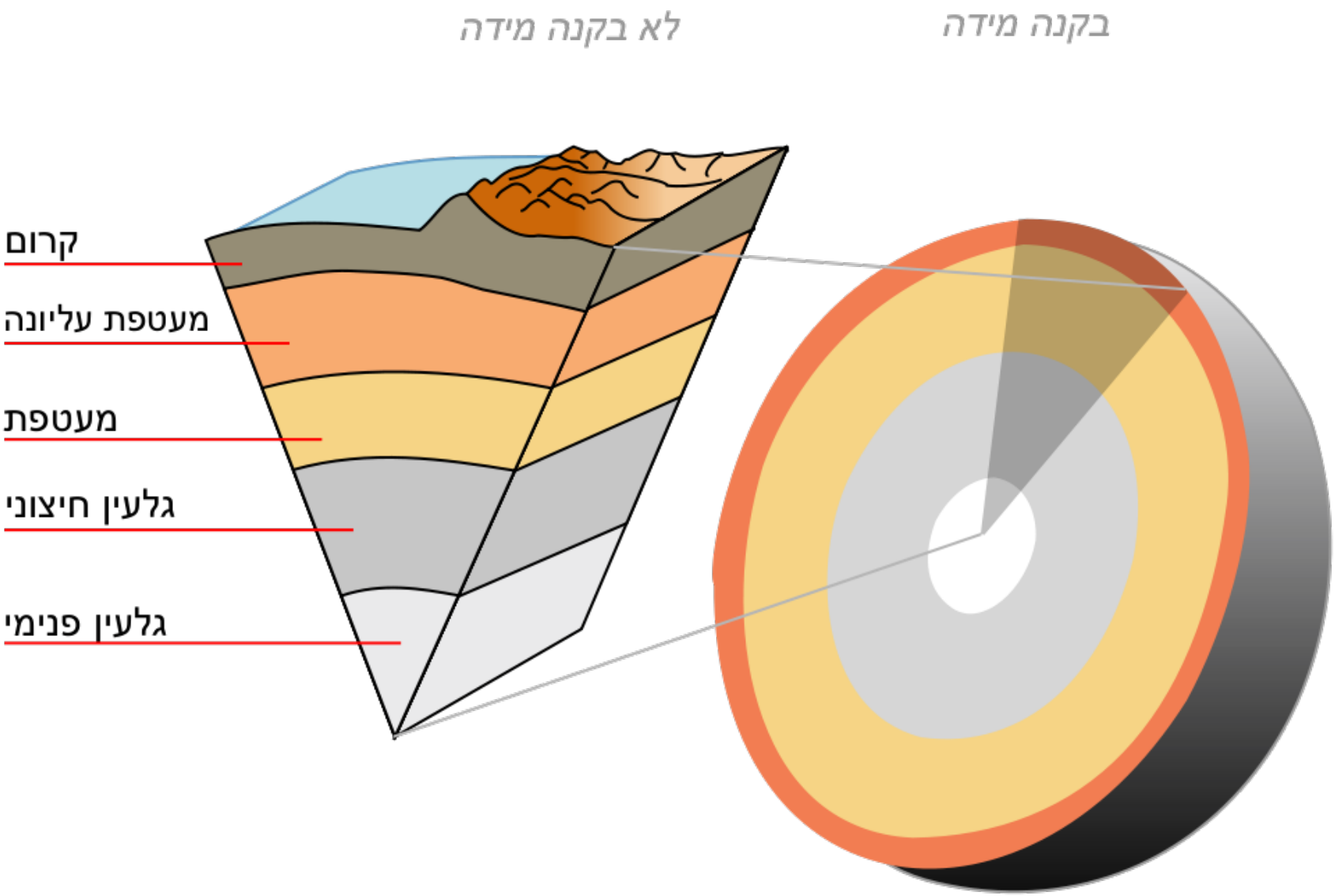
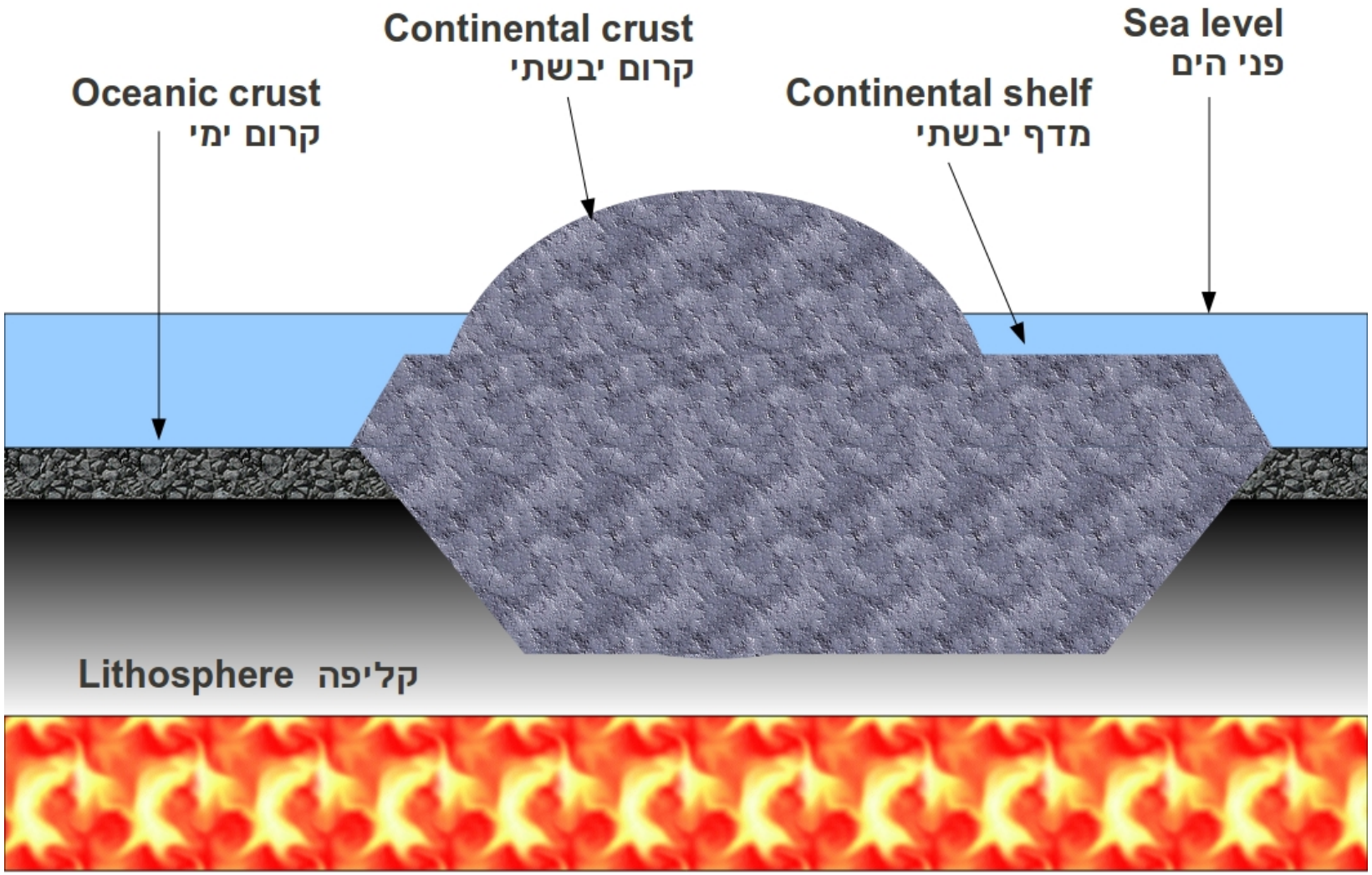
Outline

Oceanic vs. Continental (shelf) Islands



Oceanic vs. Continental (shelf) Islands



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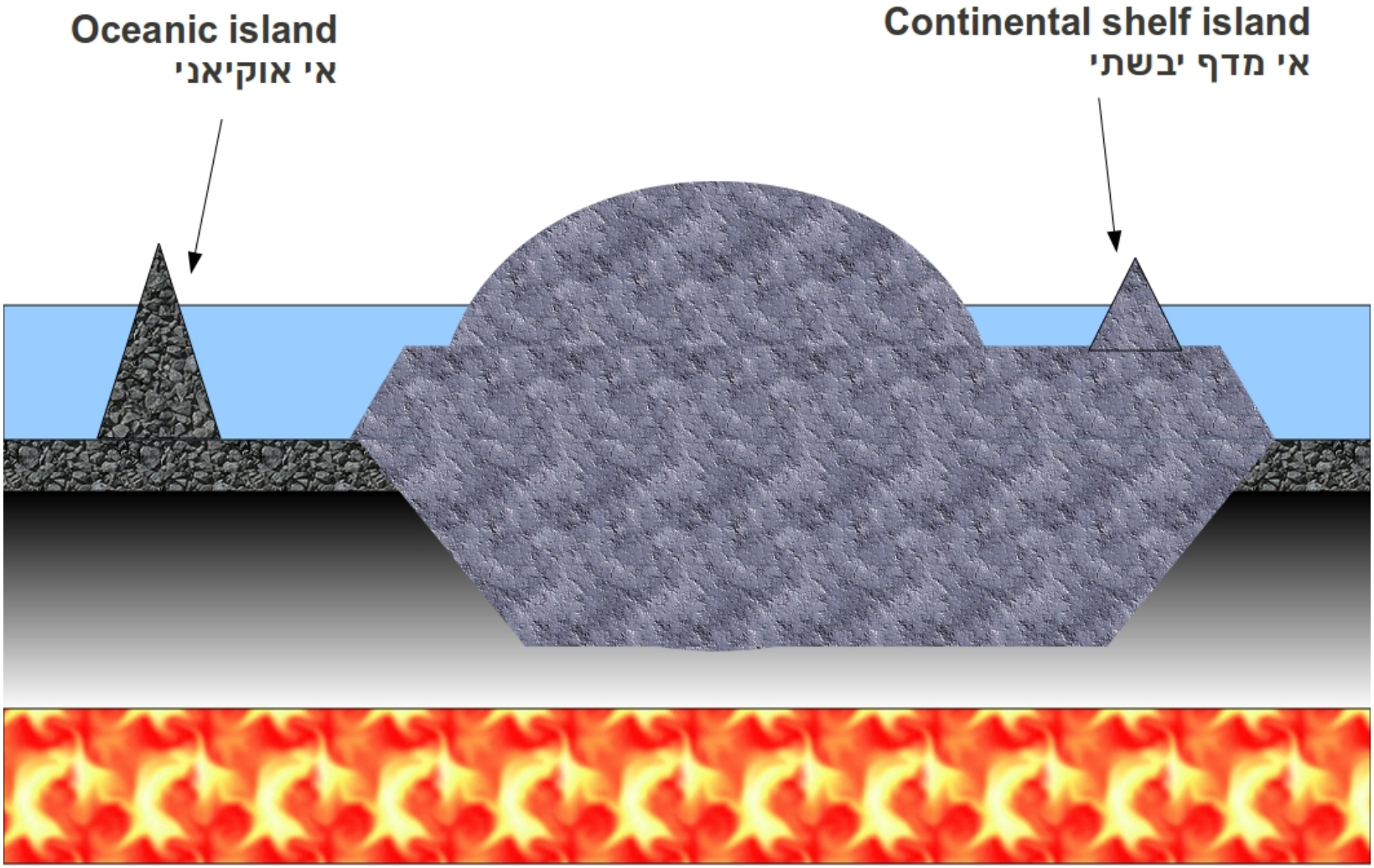

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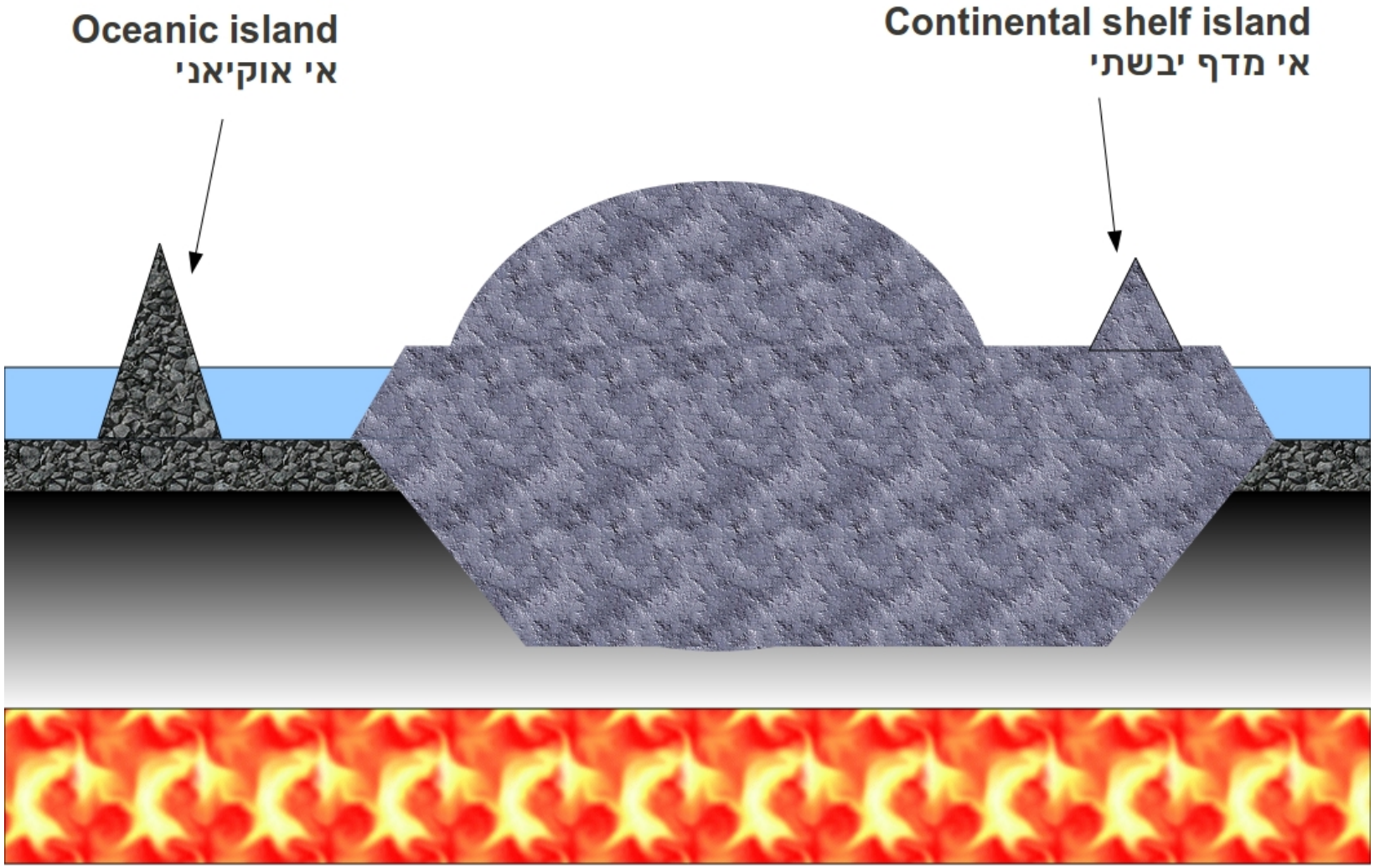


Oceanic vs. Continental (shelf) Islands

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

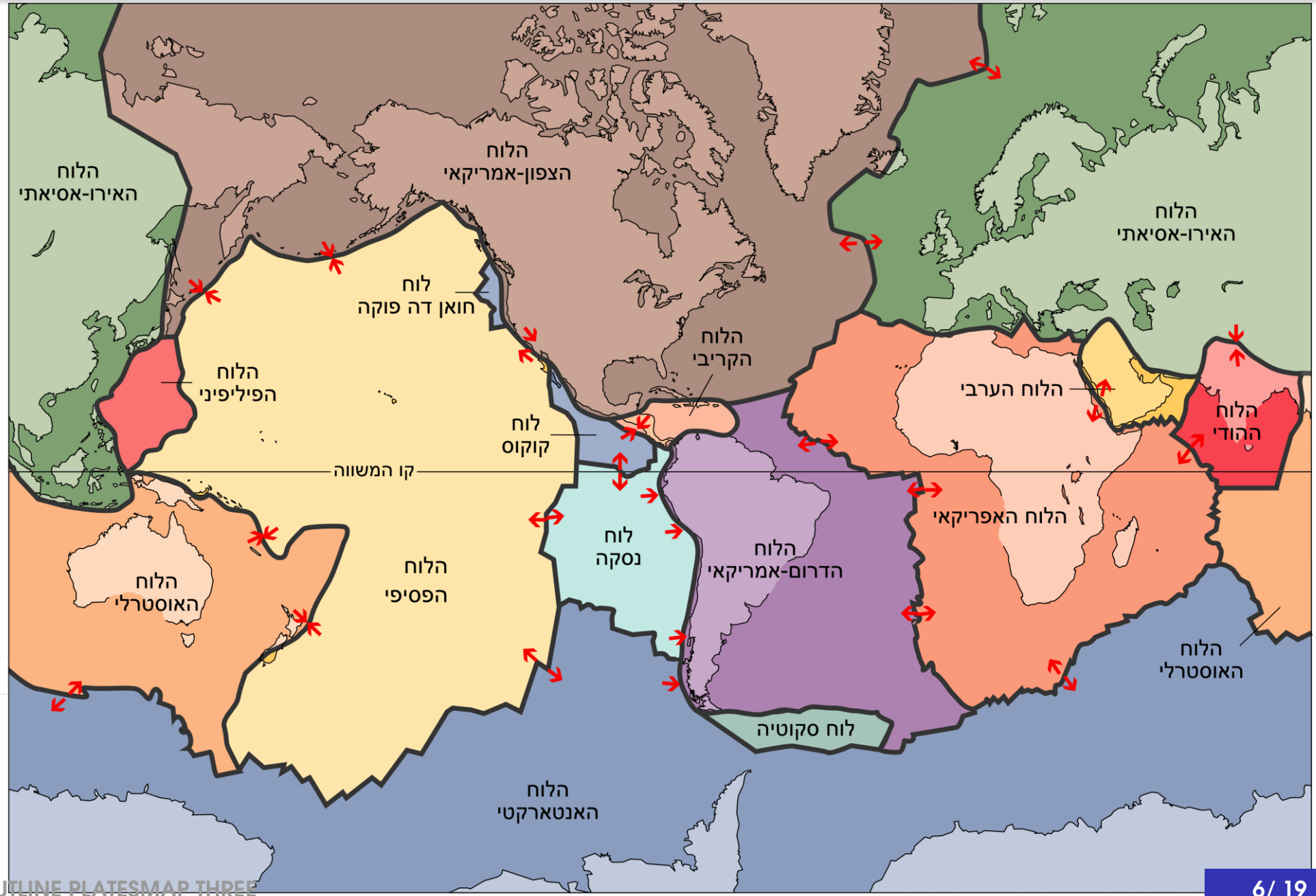


Plate tectonics

In plate margin new crust may be formed.

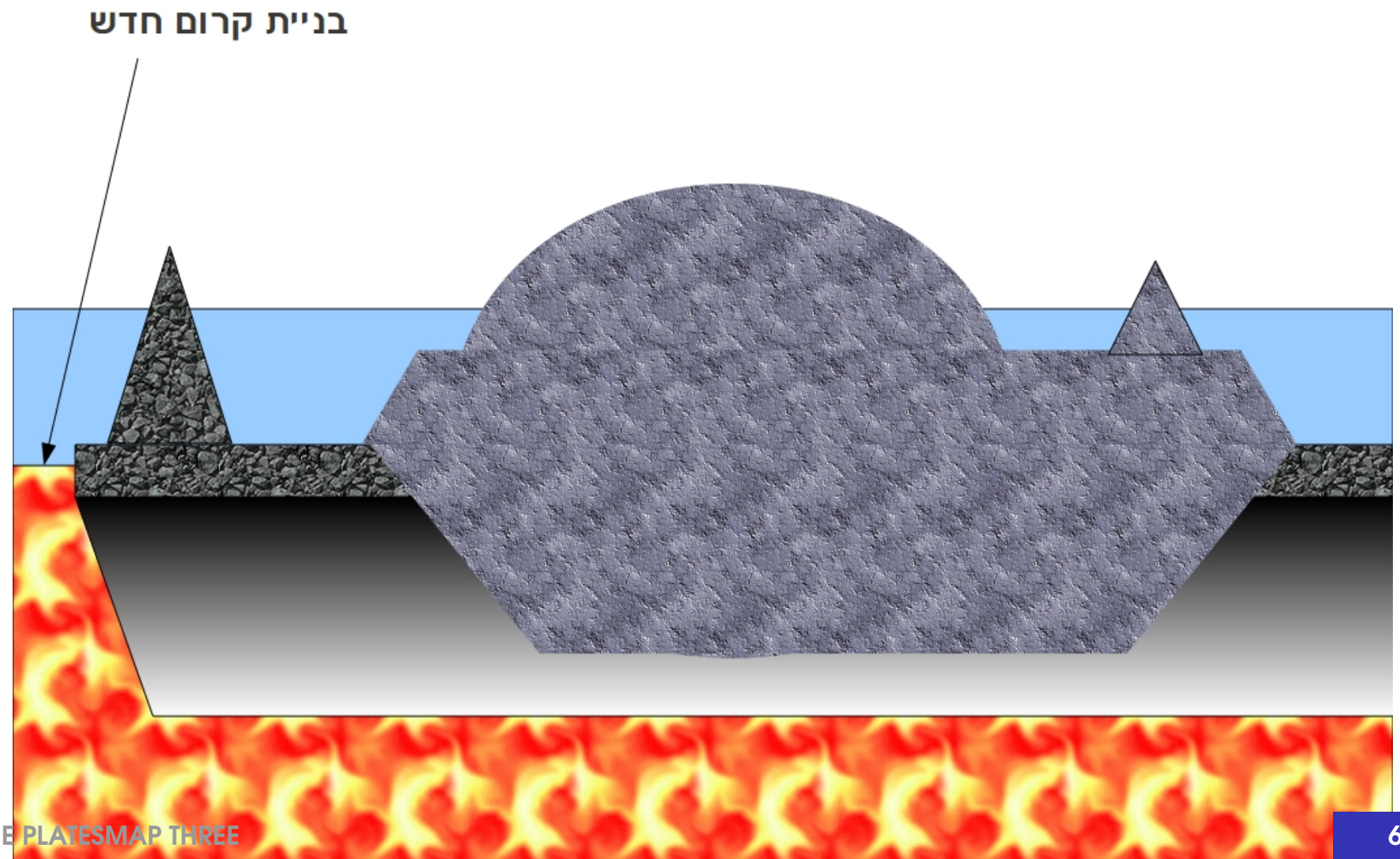


Plate tectonics

Pushing the entire plate and causing it to drift.

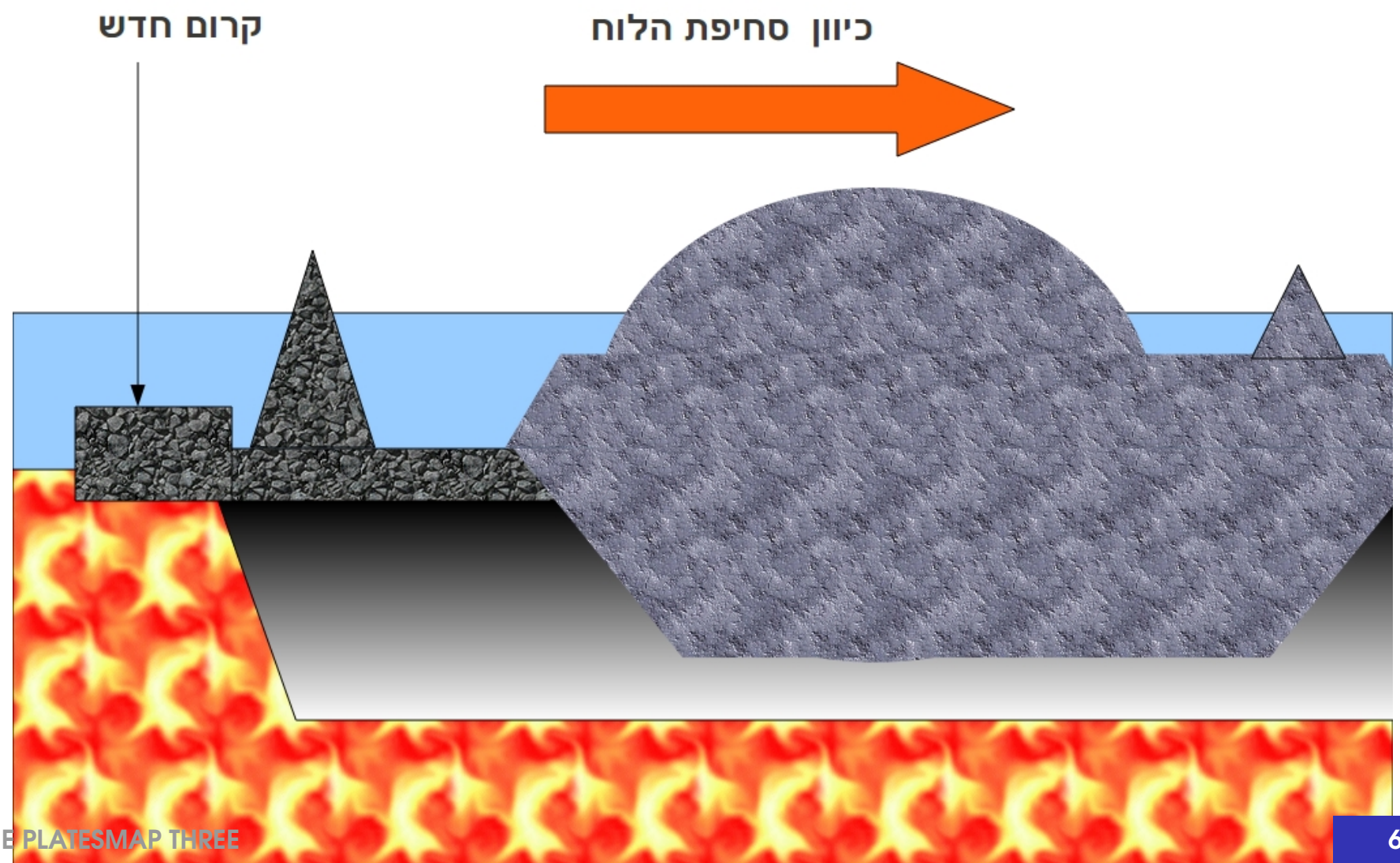


Plate tectonics

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

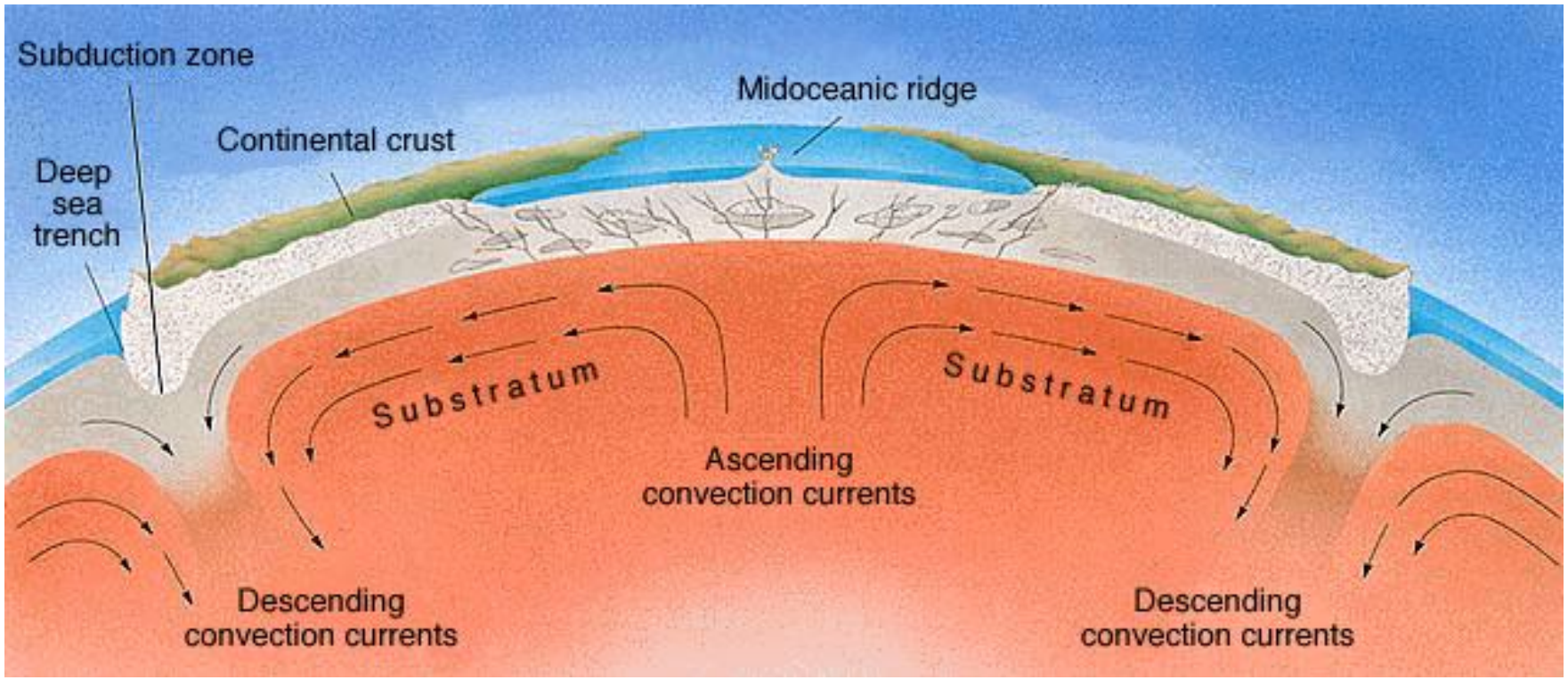
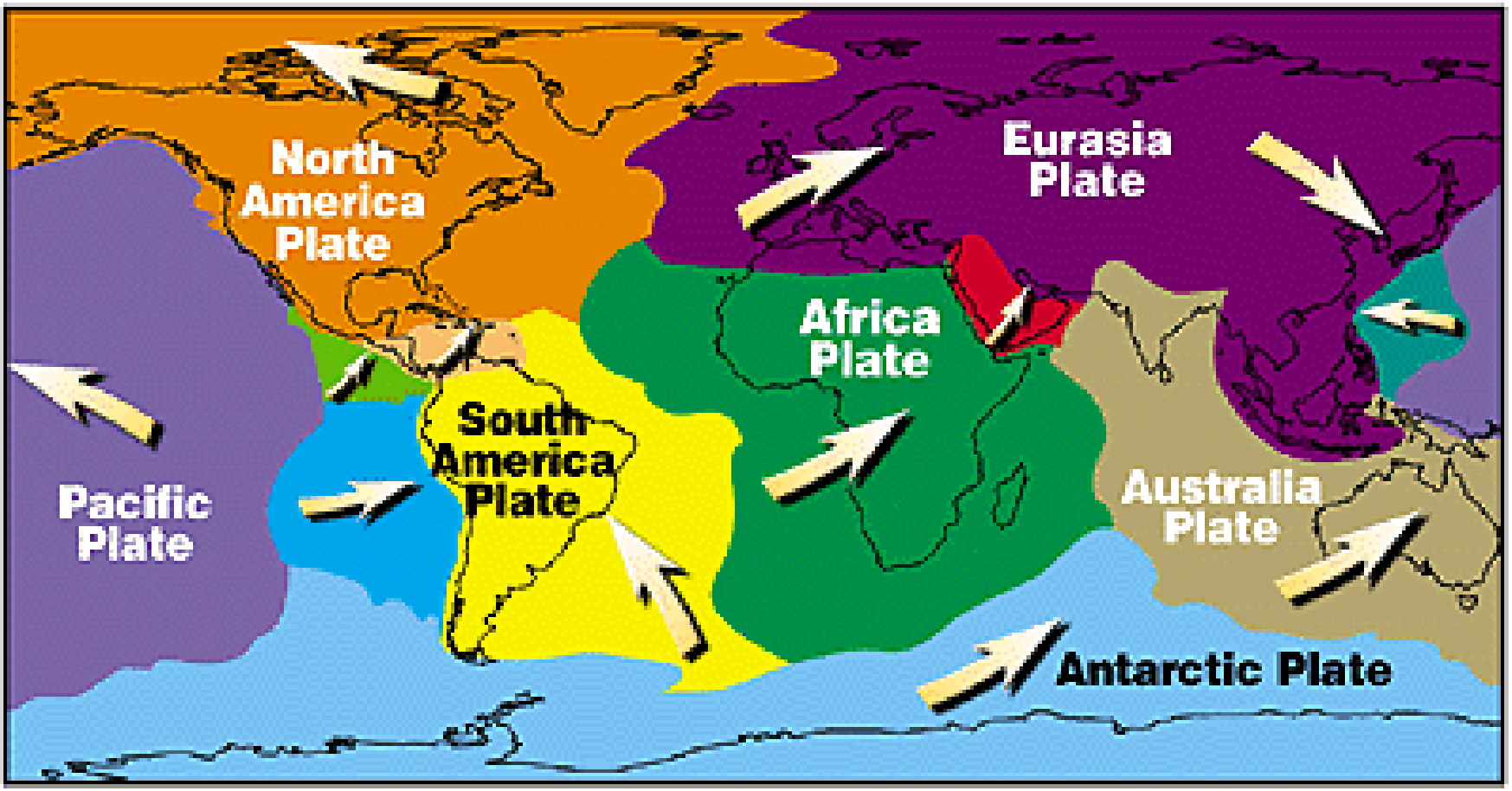


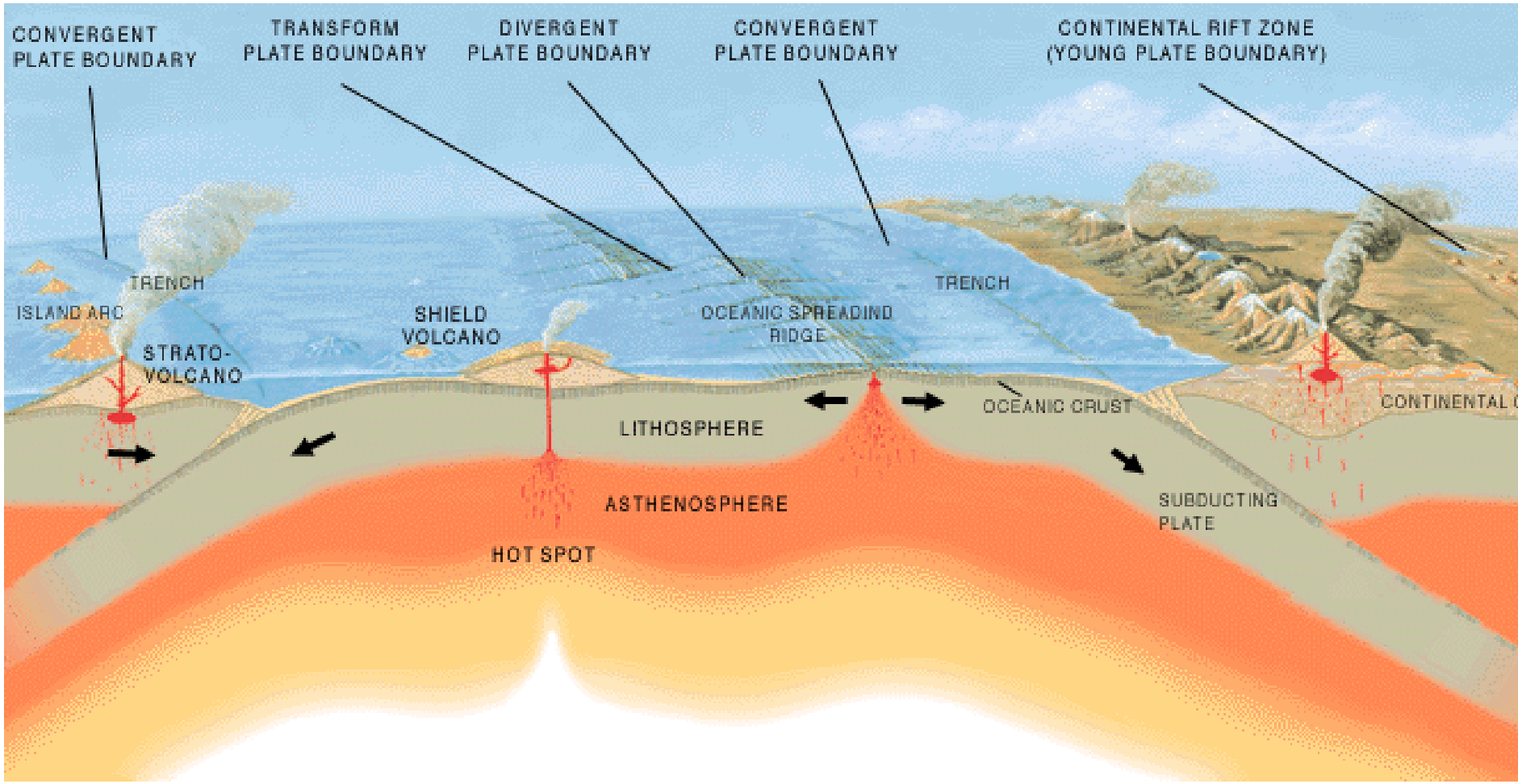
Plate tectonics

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



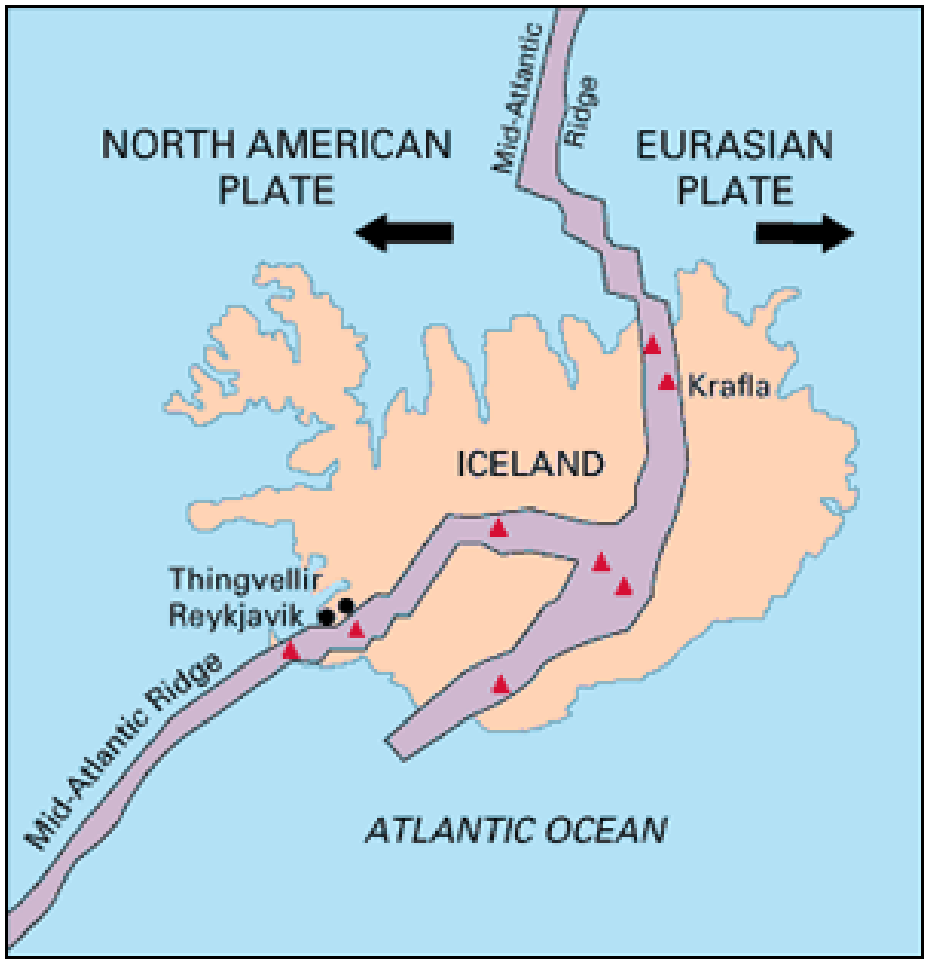
Three ways to form volcanic islands

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



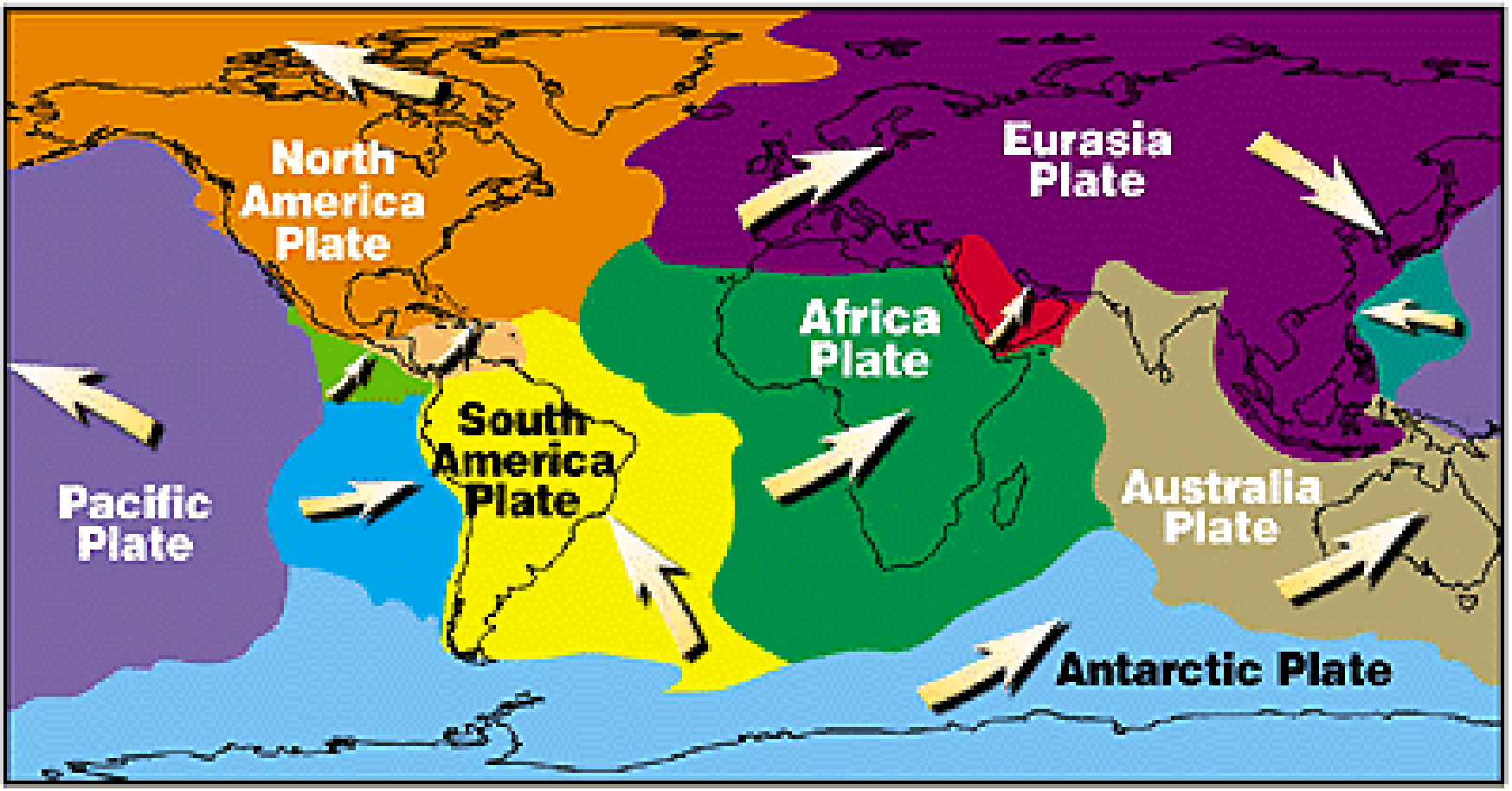
Three ways to form volcanic islands

Mid-oceanic ridges



Three ways to form volcanic islands

Triple junctions



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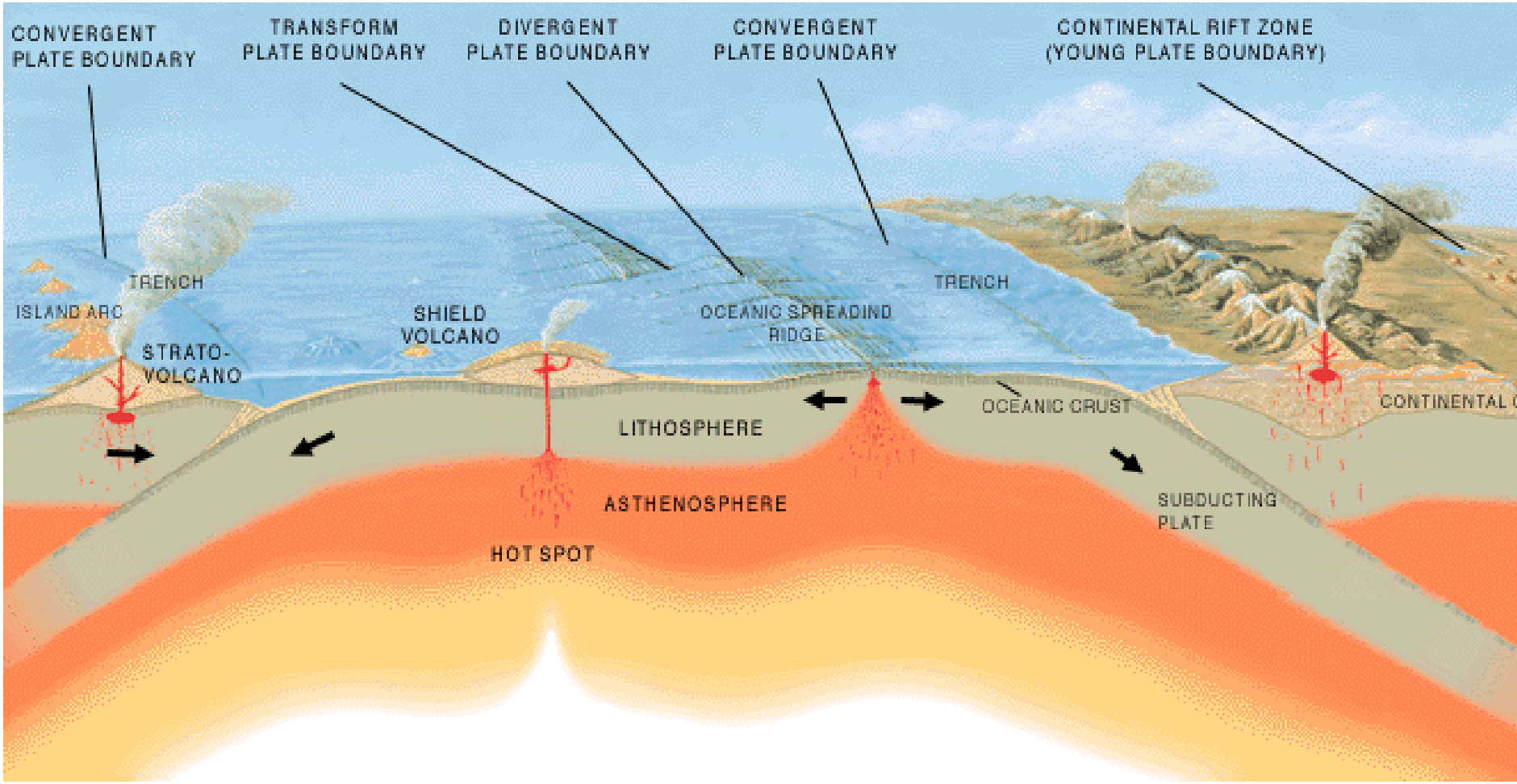
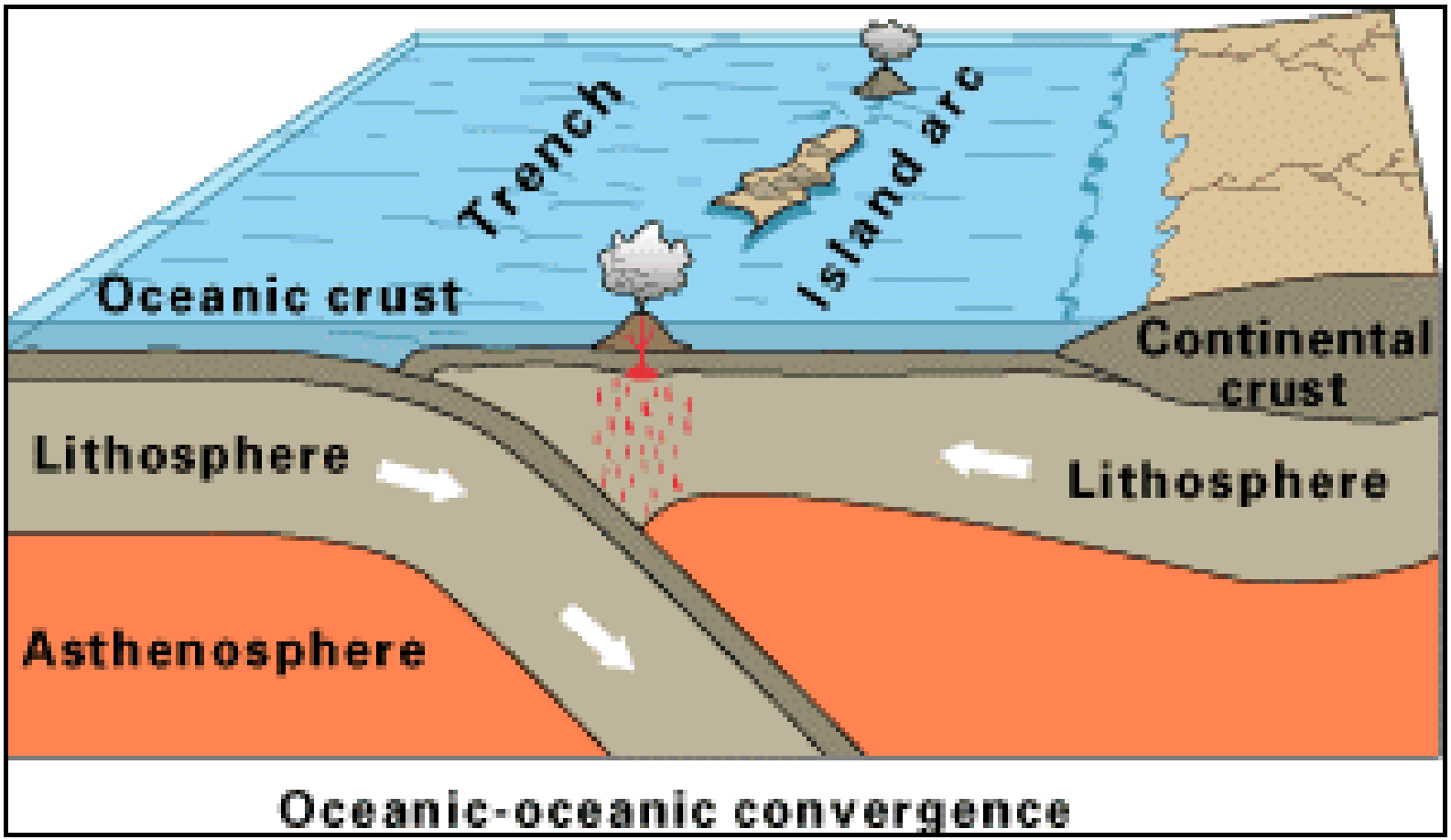


Three ways to form volcanic islands

Plate convergence and subduction → Trench → Island arc



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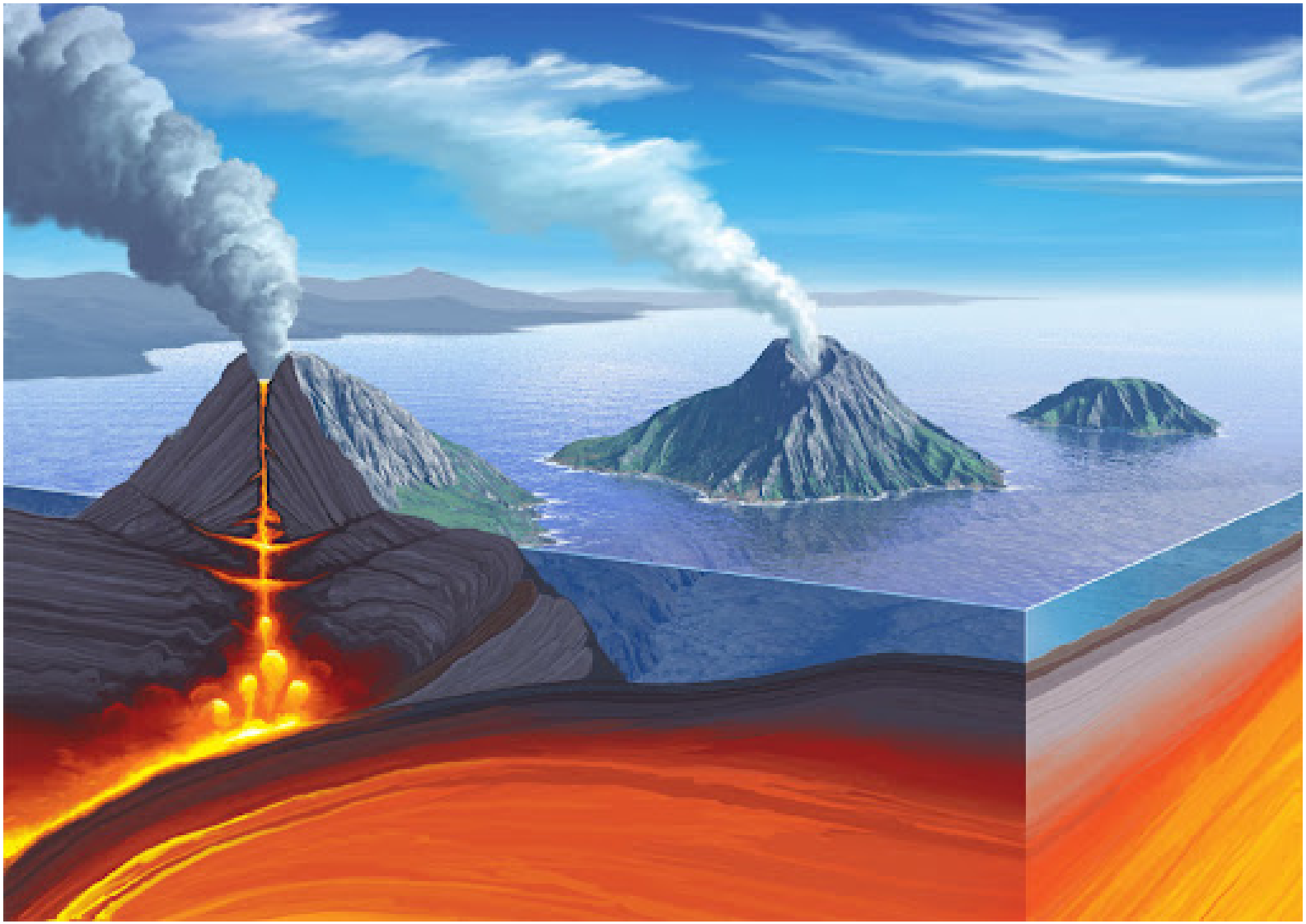
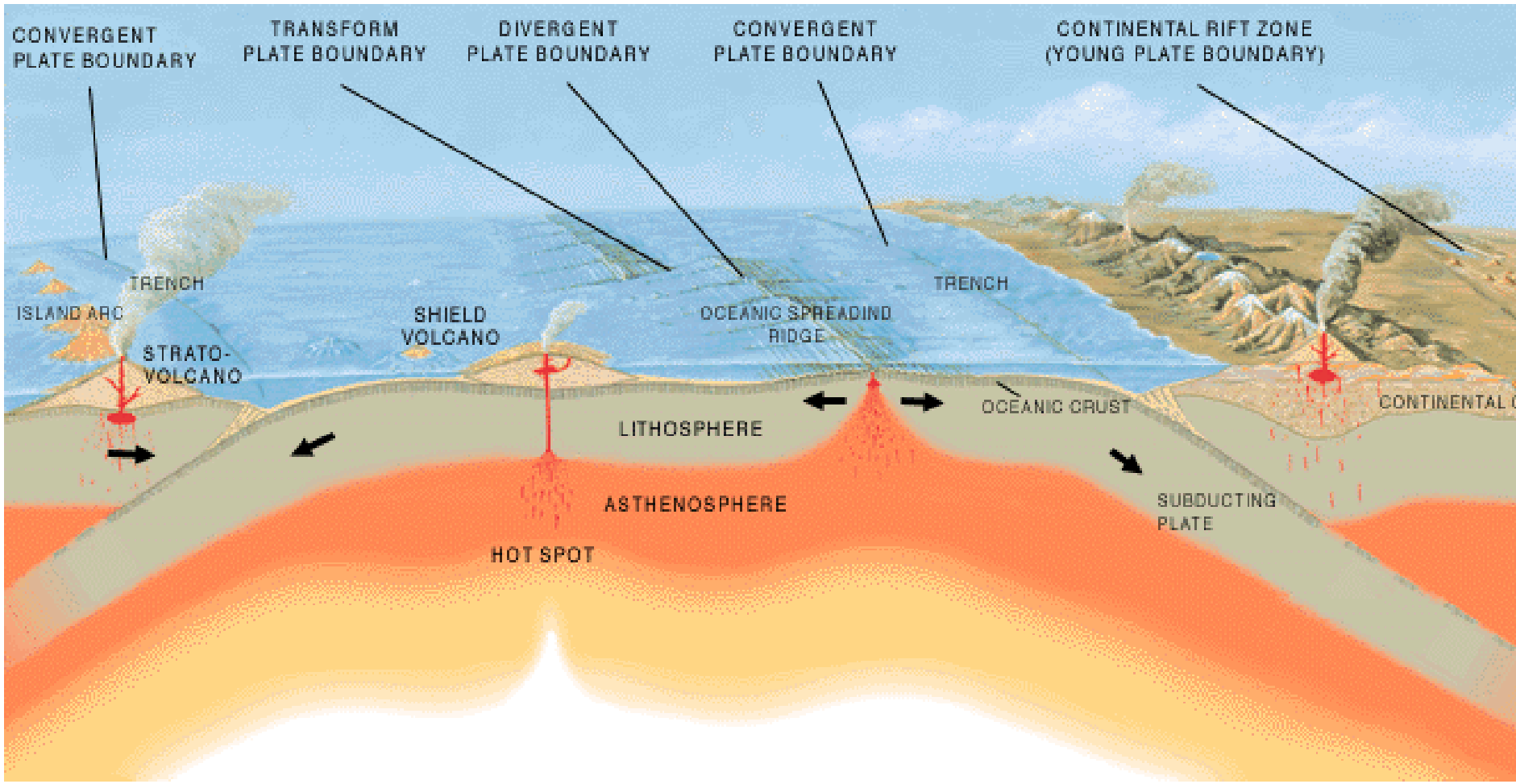


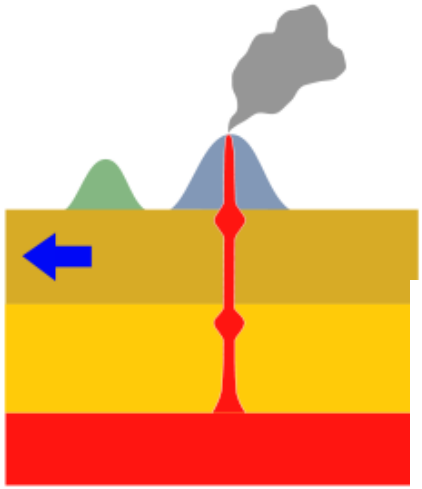
Three ways to form volcanic islands

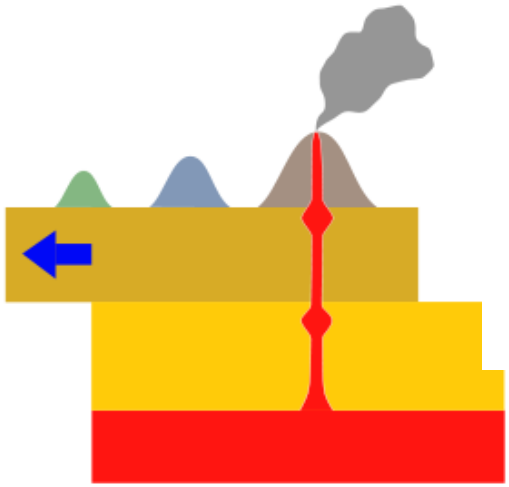
Intra-plate hotspot

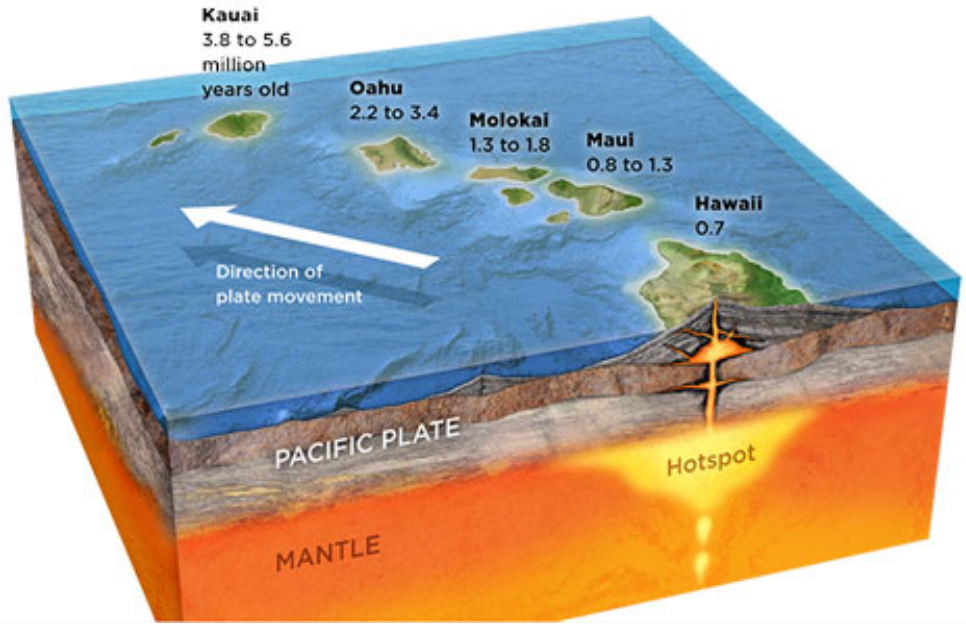


Three ways to form volcanic islands

Hotspot + plate movement → Linear island chains



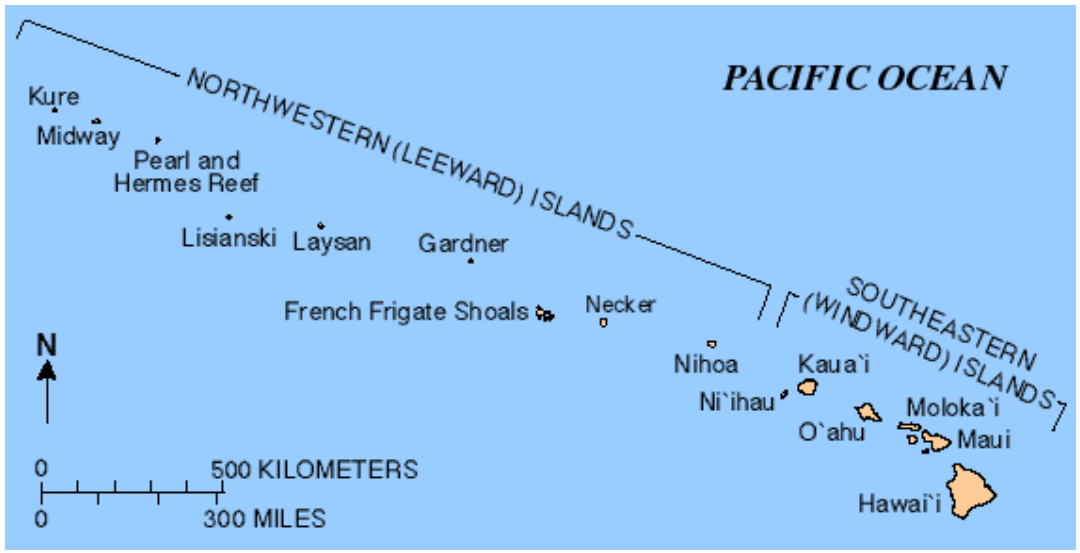




Three ways to form volcanic islands

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.

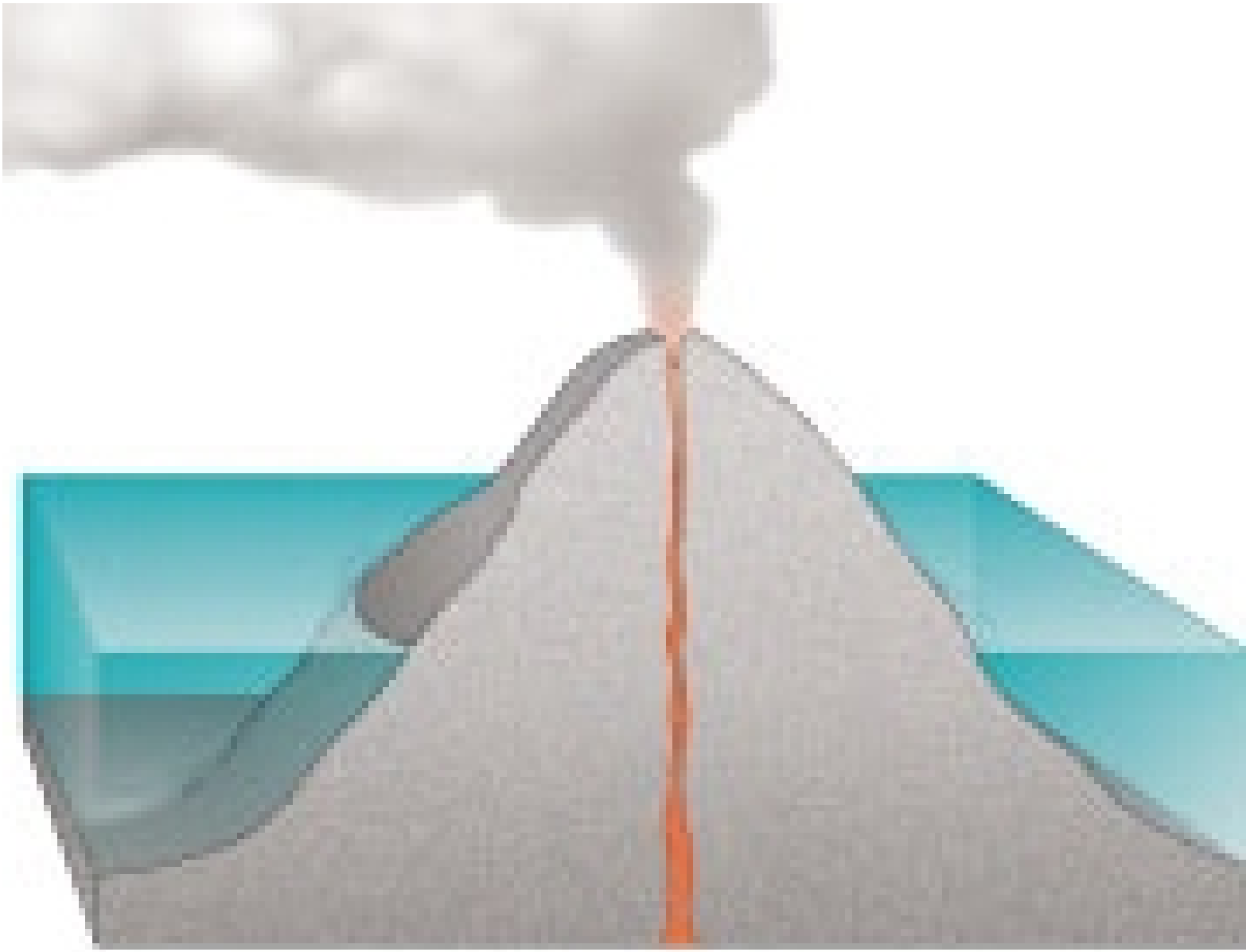
  Solomons, Aleutian, Sandwich islands,

  Antilles, South Aegean arc, Japan.

- Hotspot – linear or clustered island groups.

  Hawaii, Galapagos, Canary islands, Cape Verde.

From high to low island: geology meets biology



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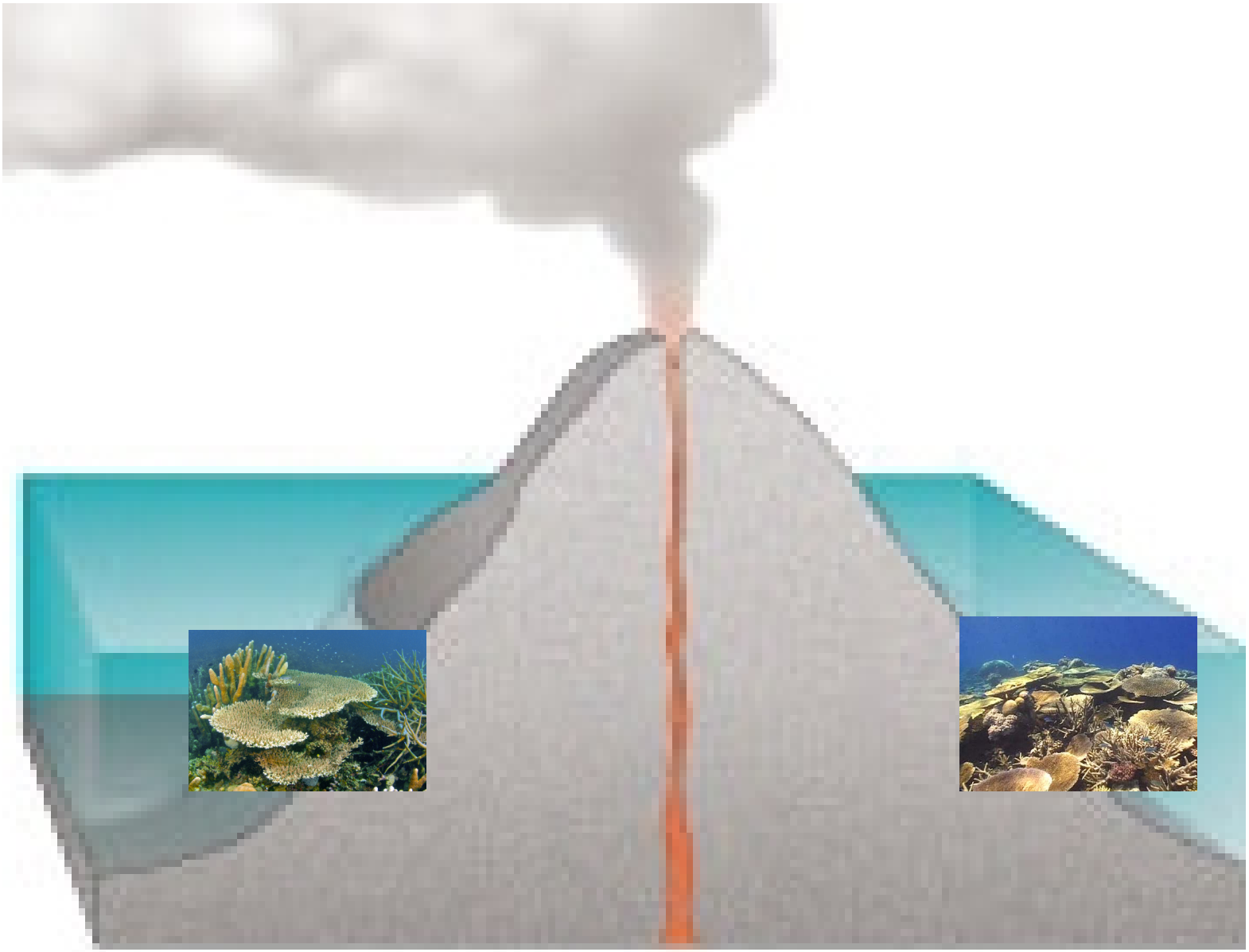
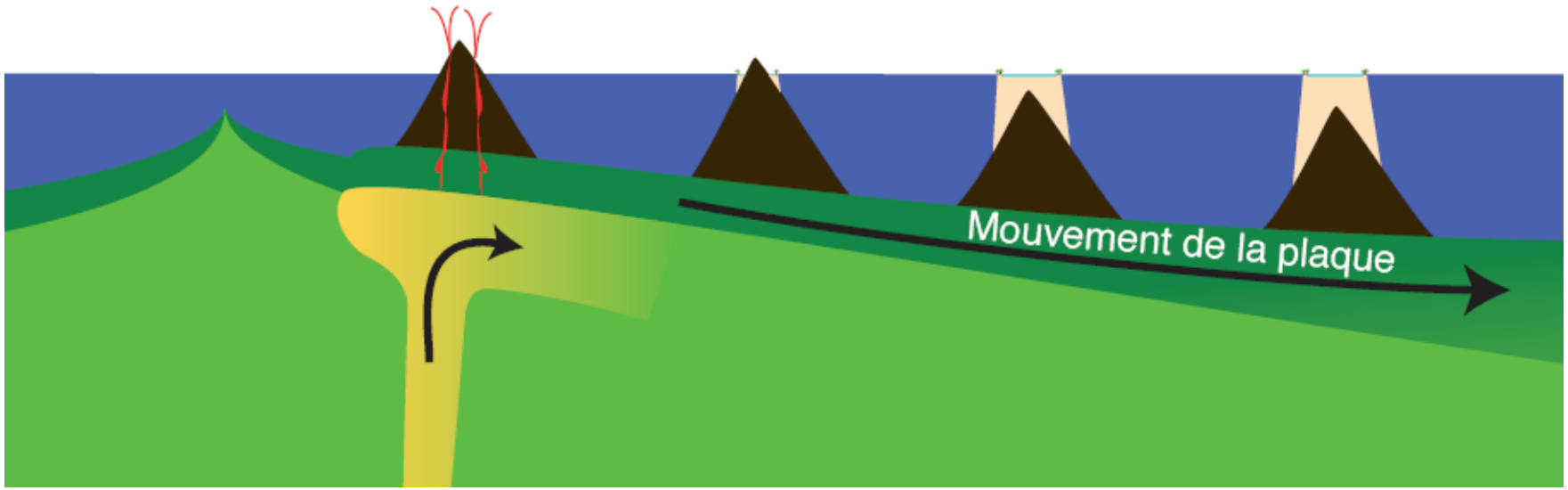


From high to low island: geology meets biology

Fringing reef:

From high to low island: geology meets biology

As volcano drifts away from point of origin (e.g., hotspot), through plate movement, it sinks together with the oceanic crust.



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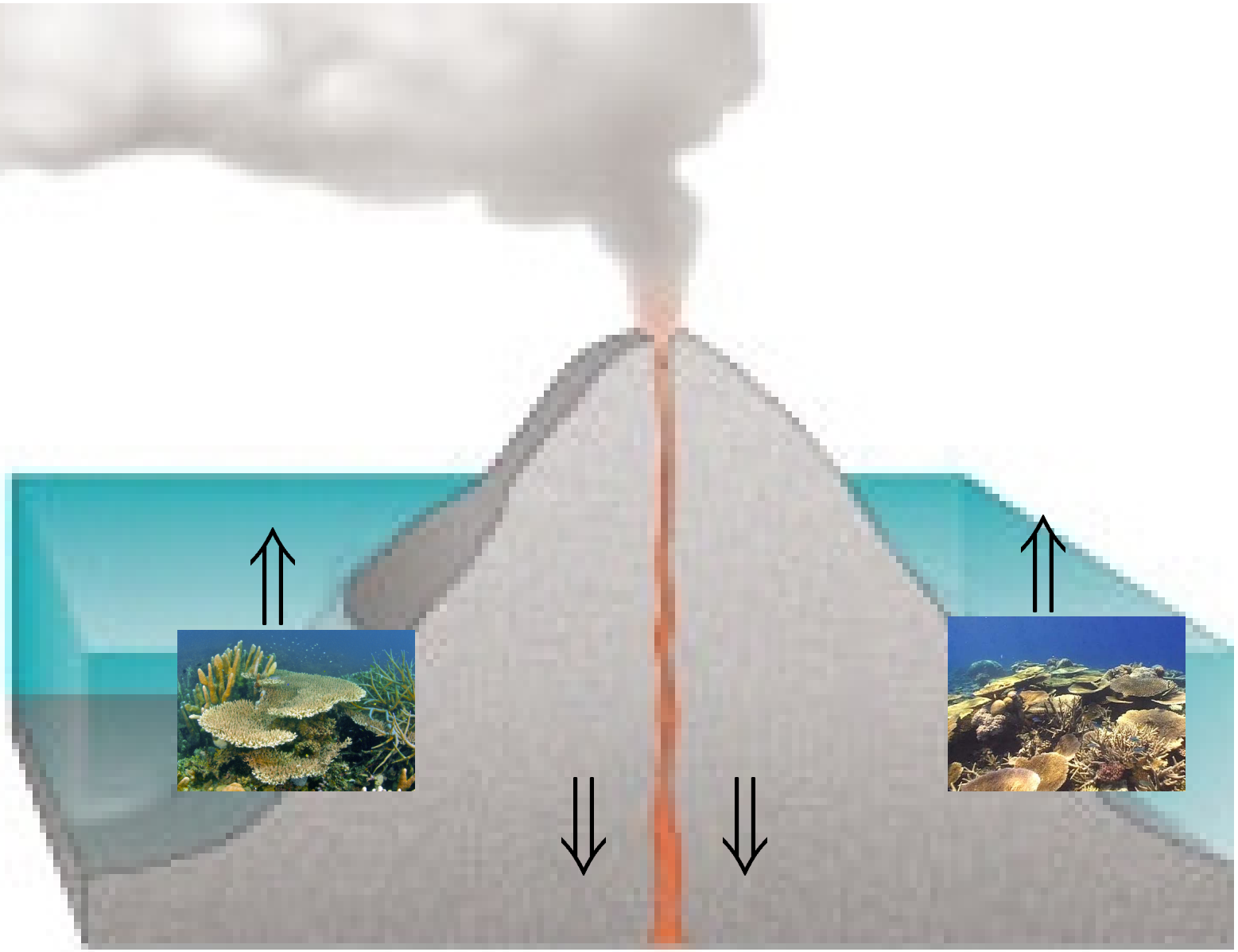
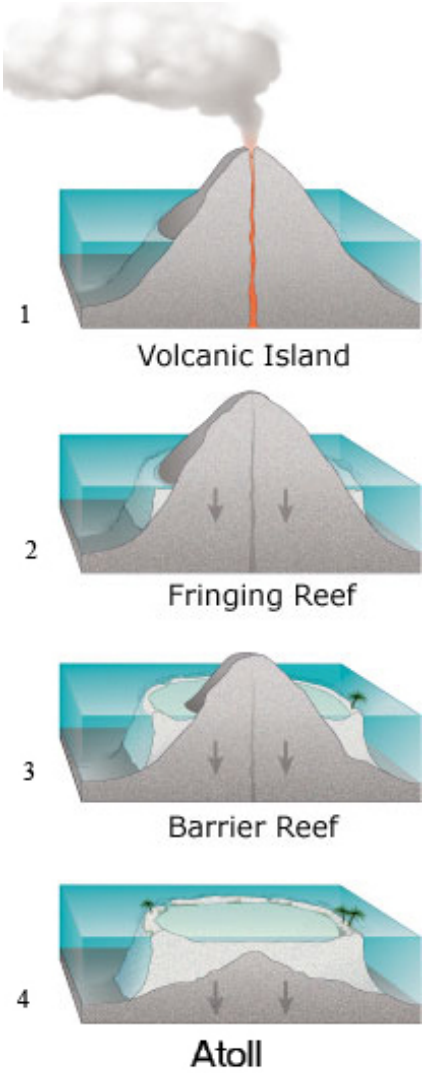


From high to low island: geology meets biology

Fringing reef → Barrier reef → Atoll:



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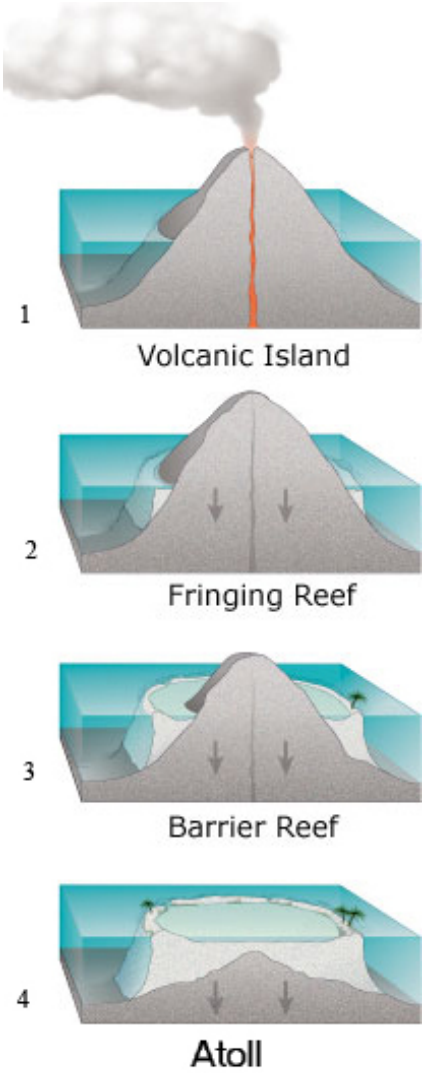

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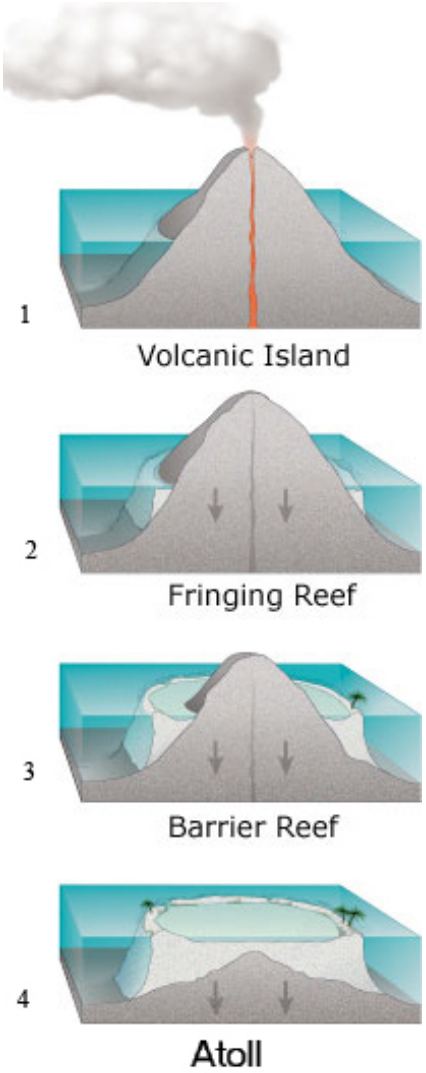
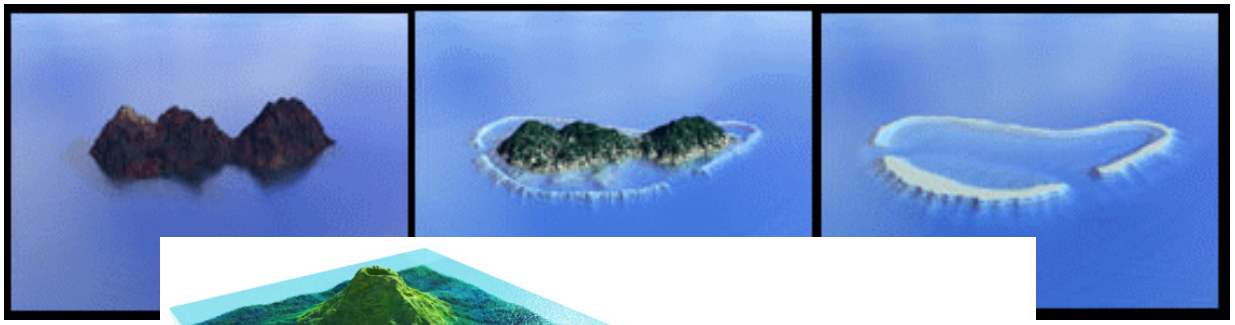
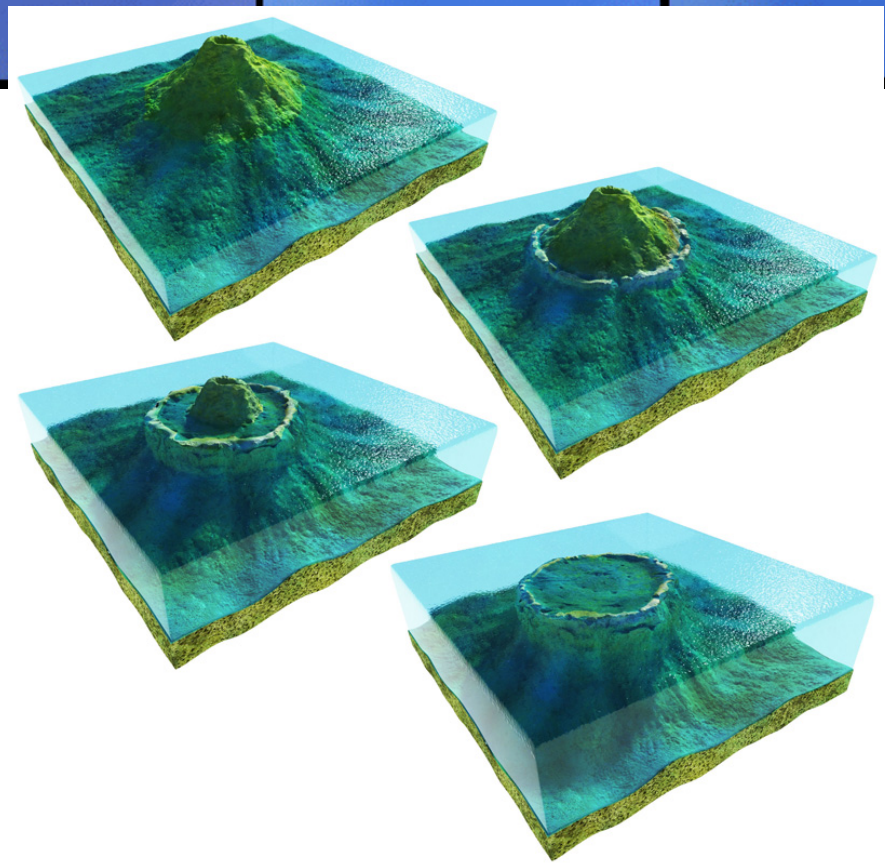




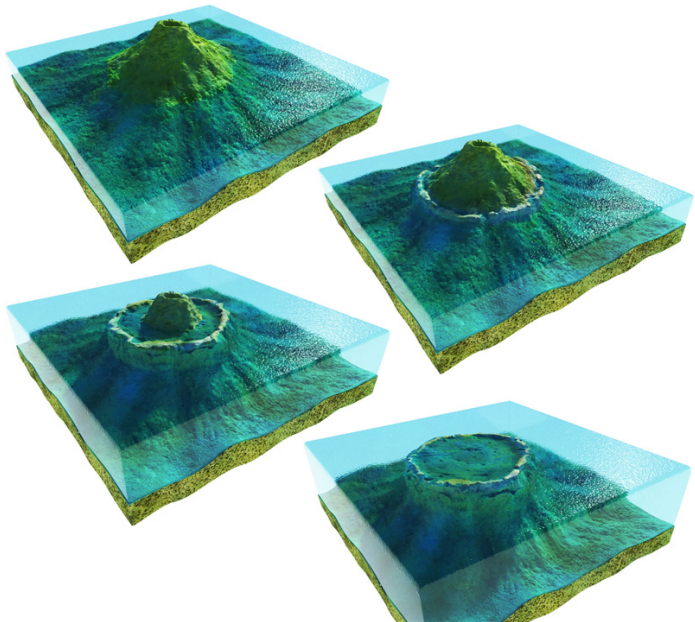


From high to low island: geology meets biology

Outline

Changes in relative sea level

- How much of the island is exposed and how much lies beneath the waves depends on **relative** sea level.
- Changes in relative sea level may occur through:
  1. Tectonic sinking or uplift of oceanic crust,
  2. Change in volume of water in the sea.
- For example, sea level drops when water becomes trapped in polar ice caps during glaciations.



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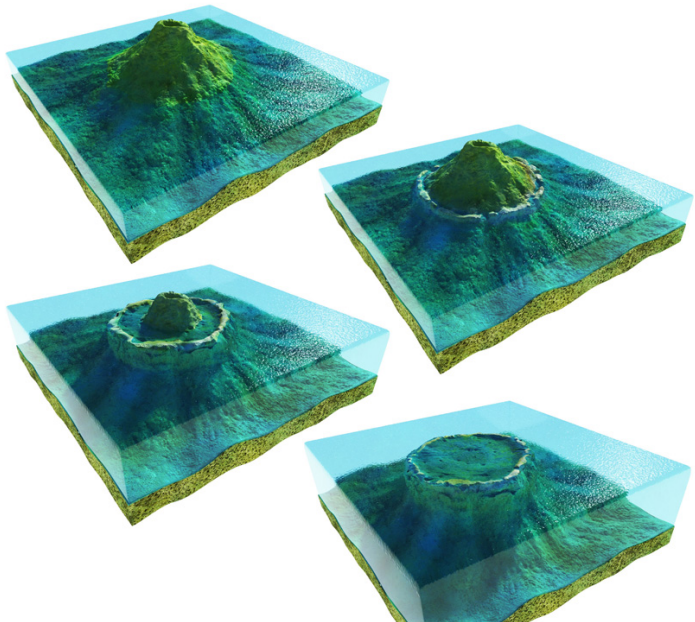

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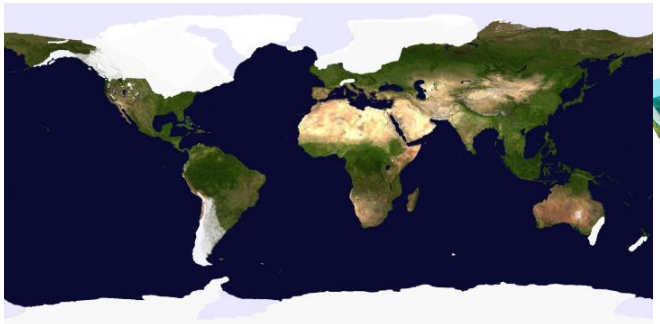

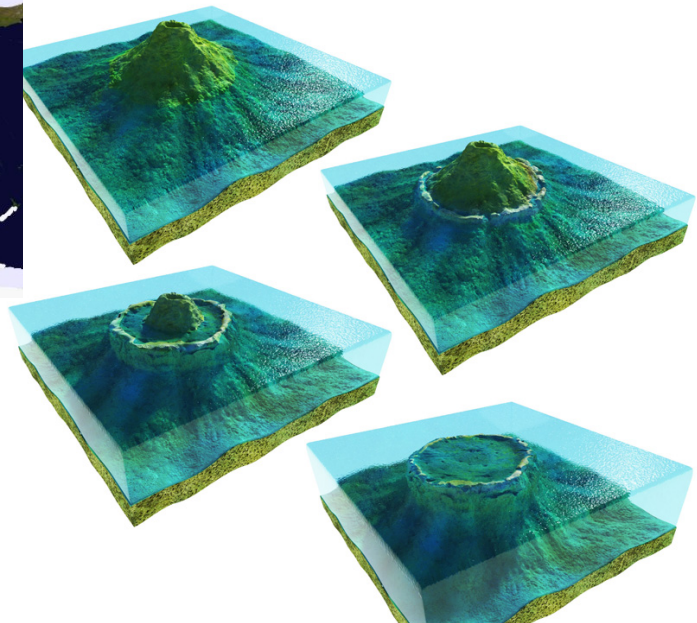

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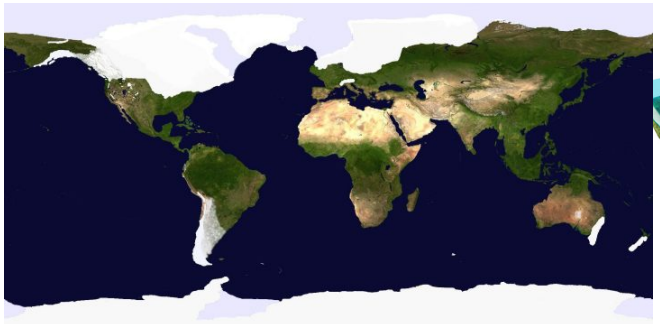
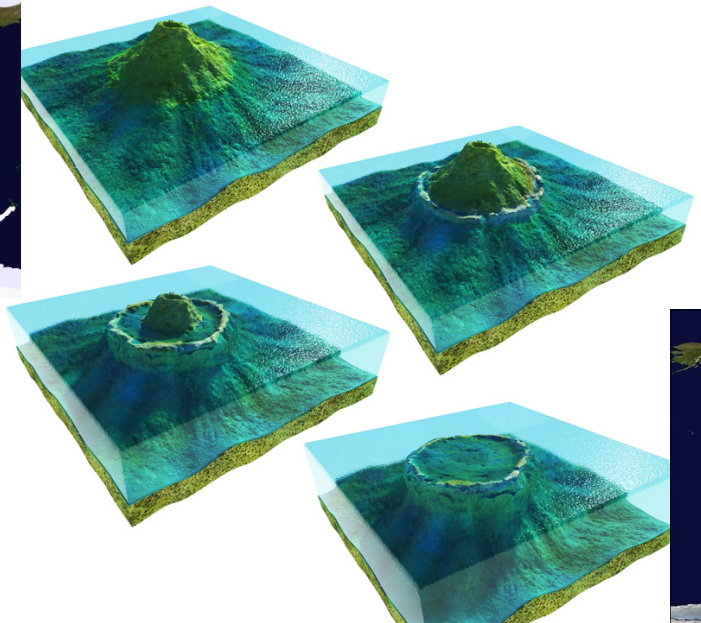
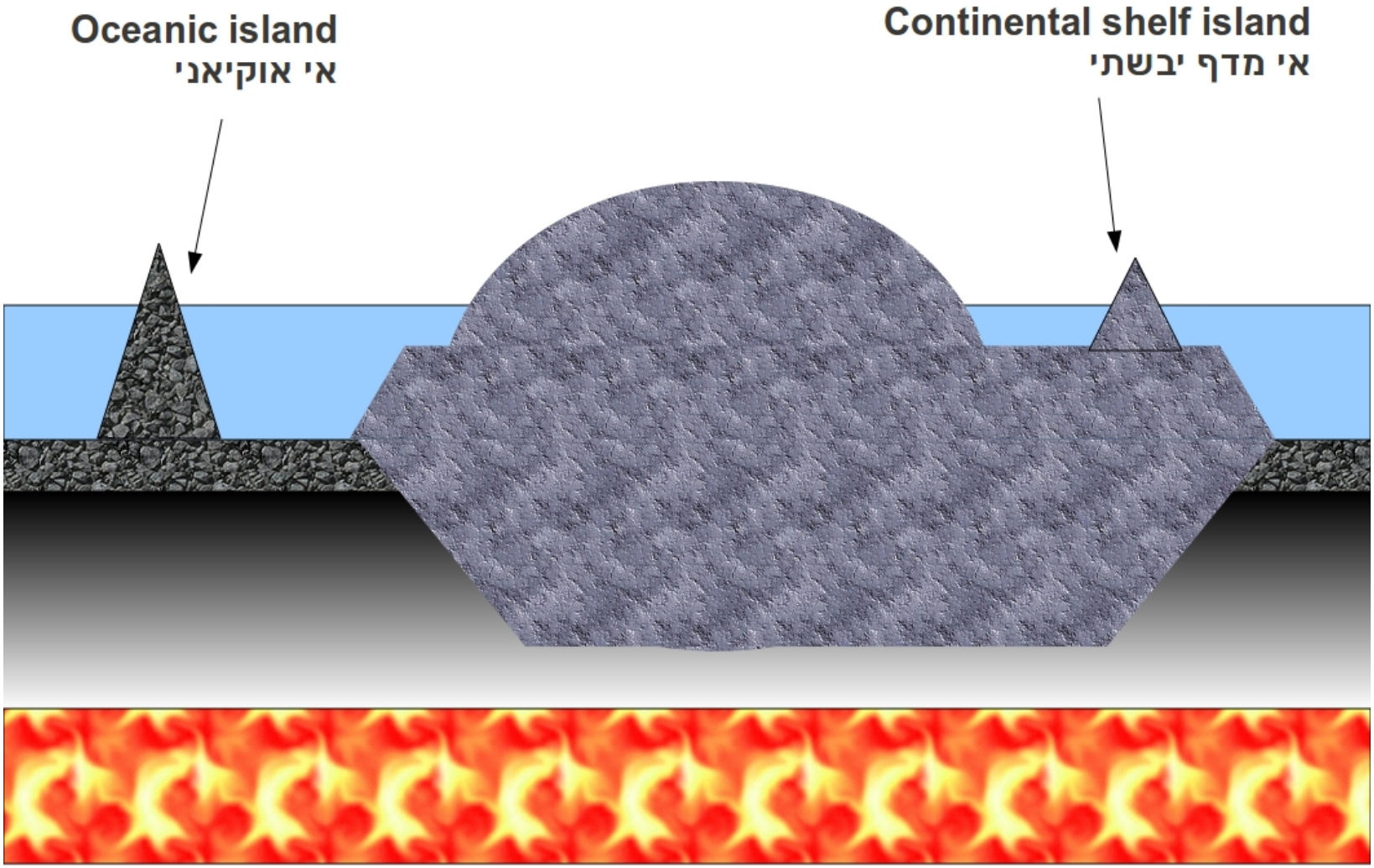




Land bridges to continental islands



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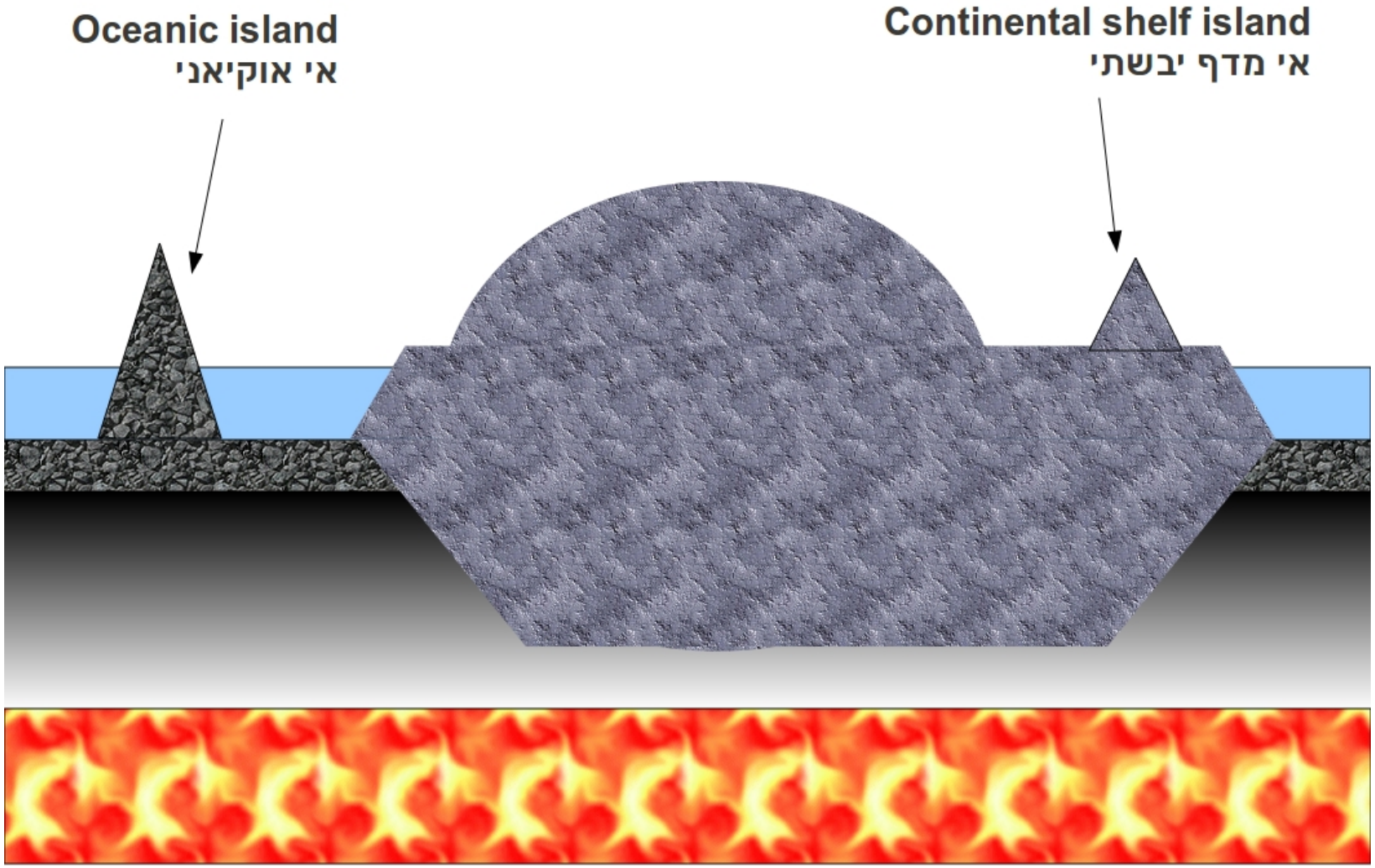
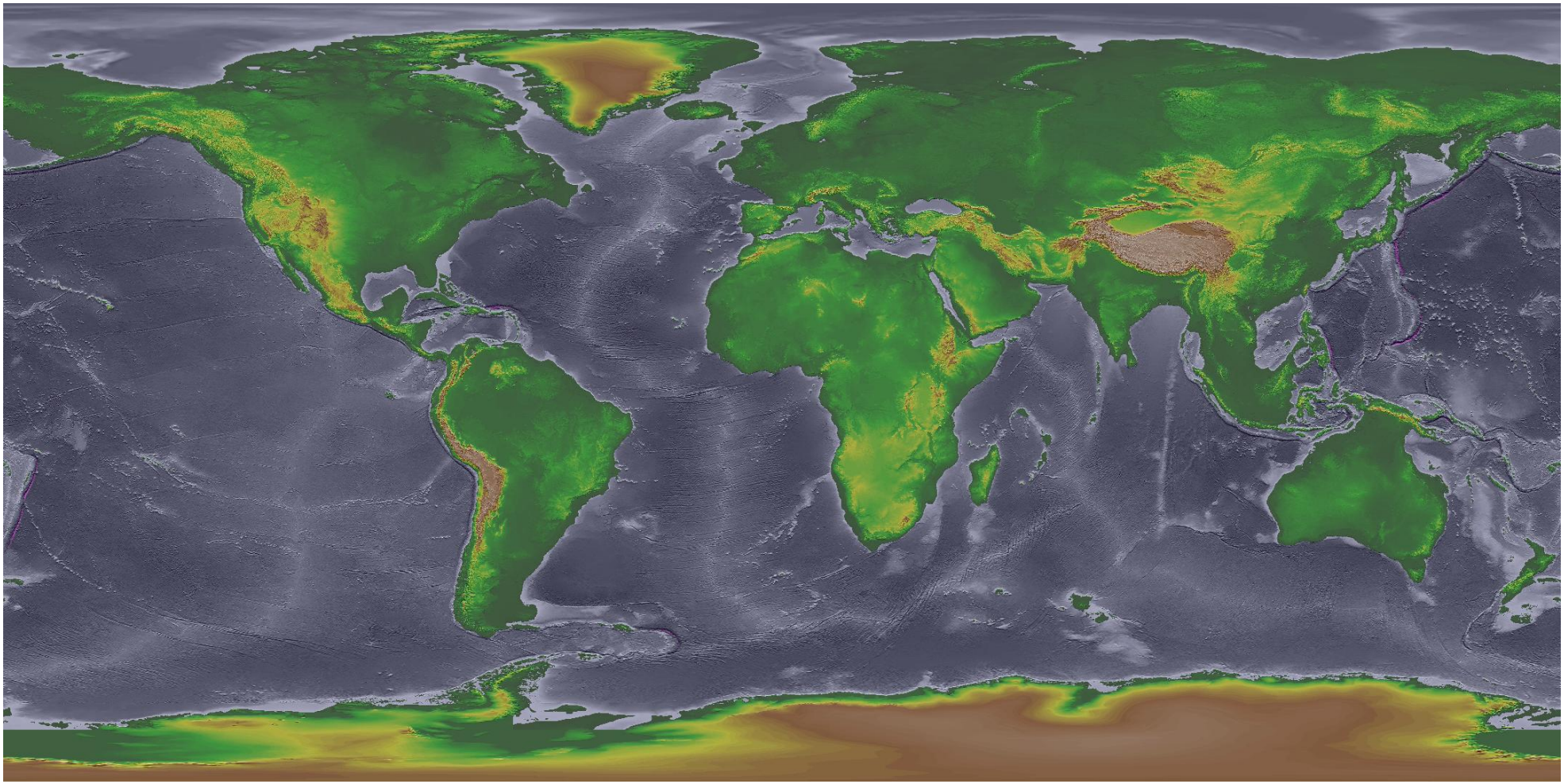
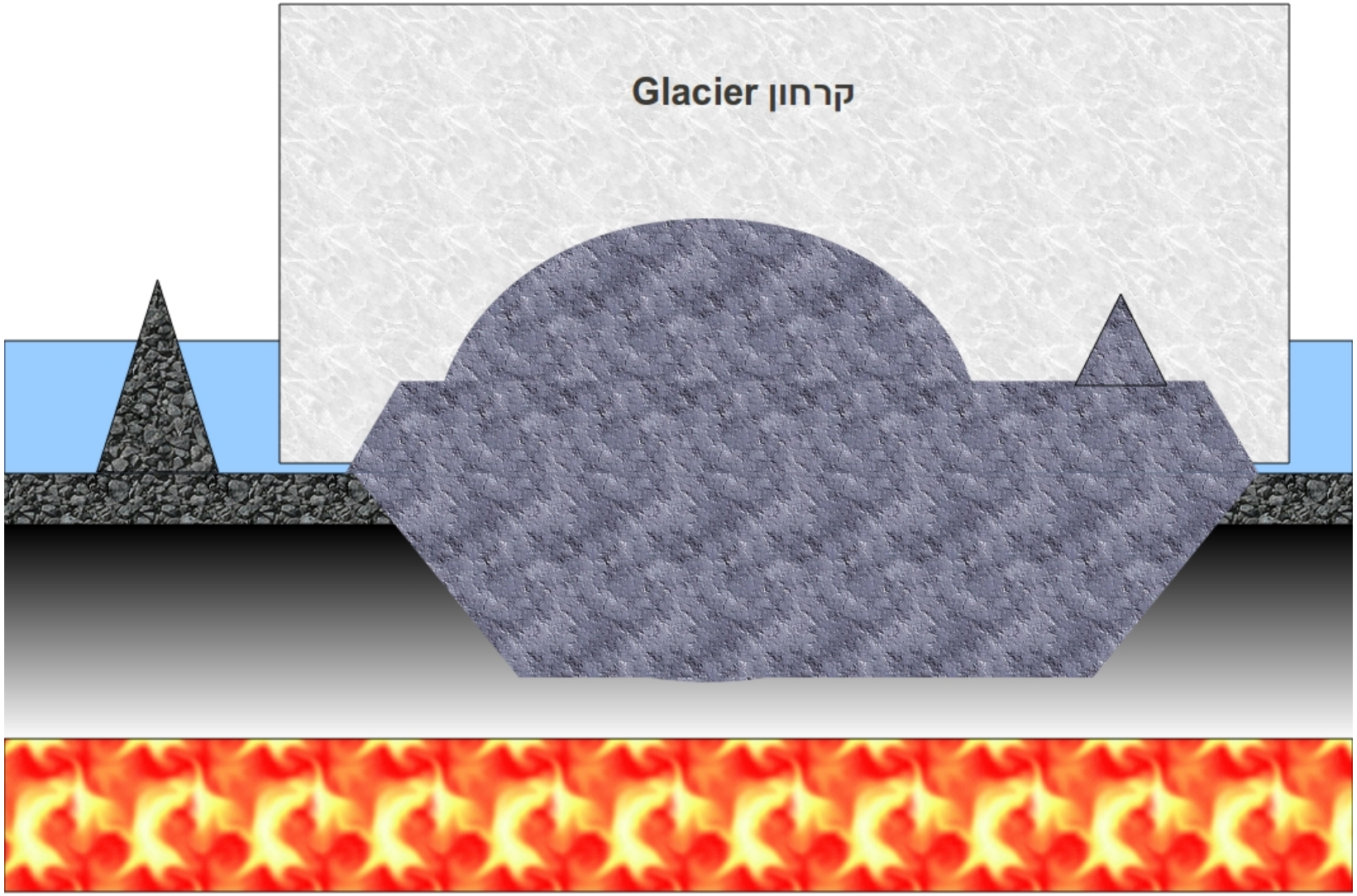


Land bridges to continental islands

World topography during last ice age.



Post-glacial rebound



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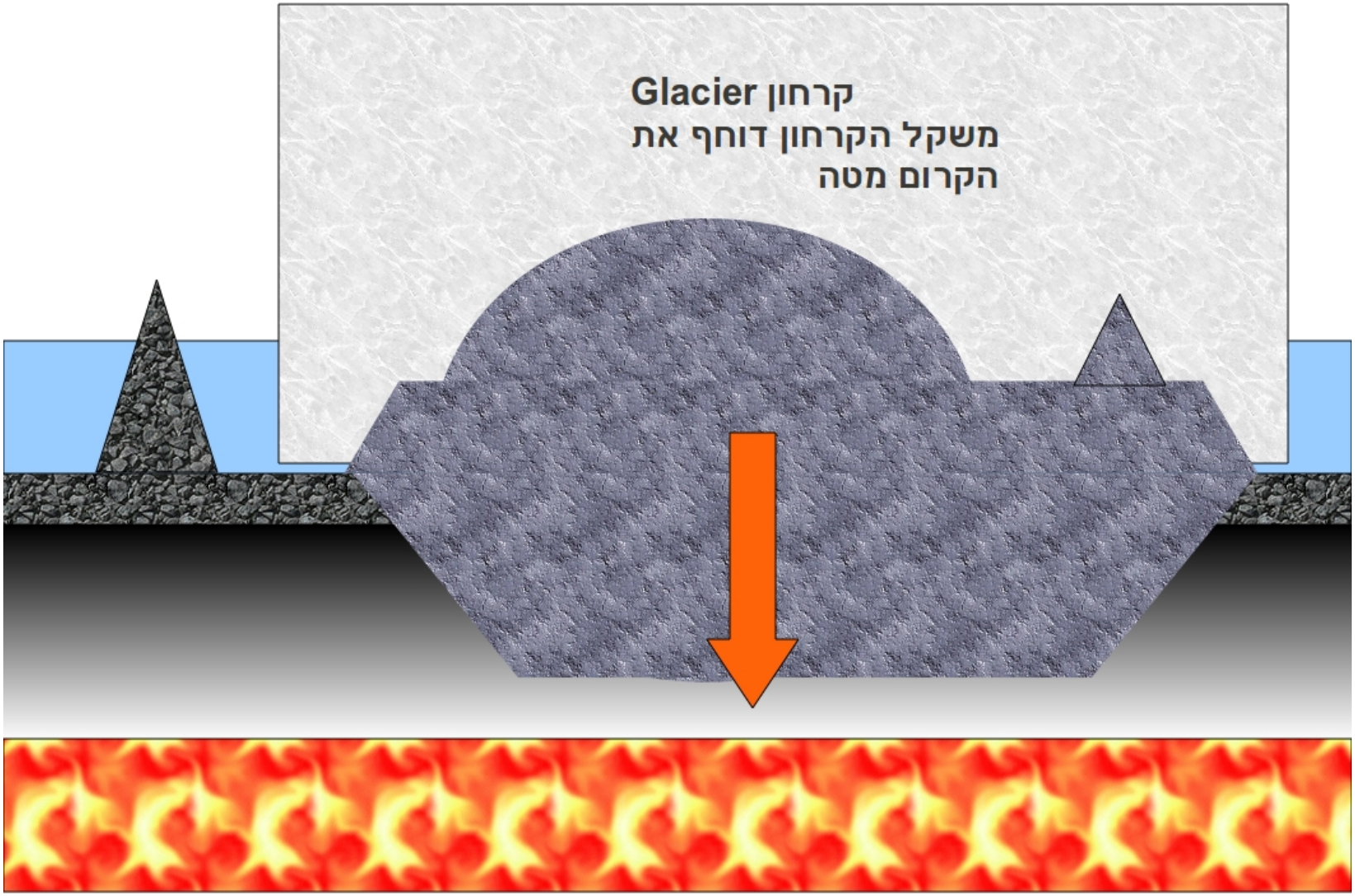

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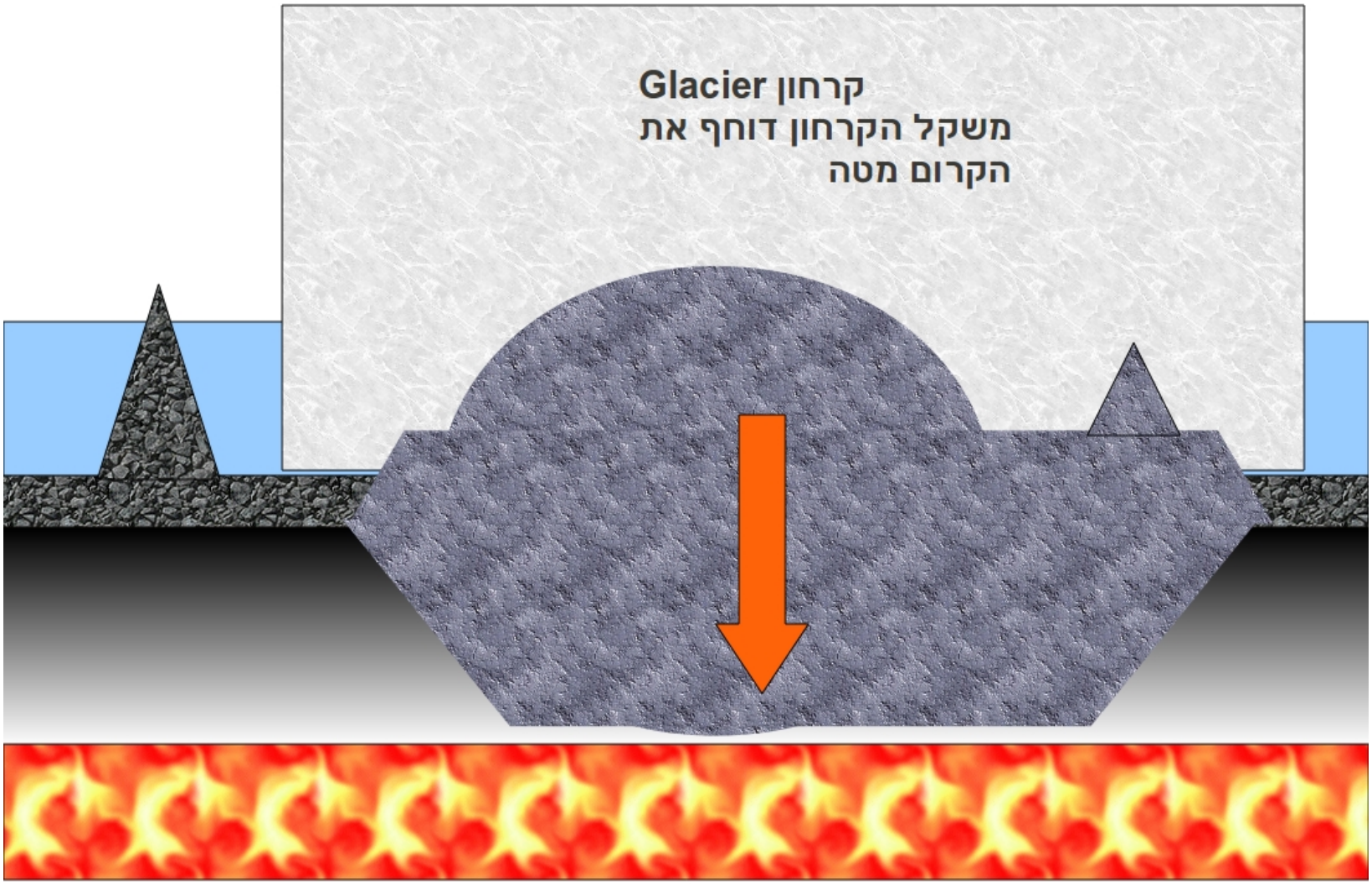
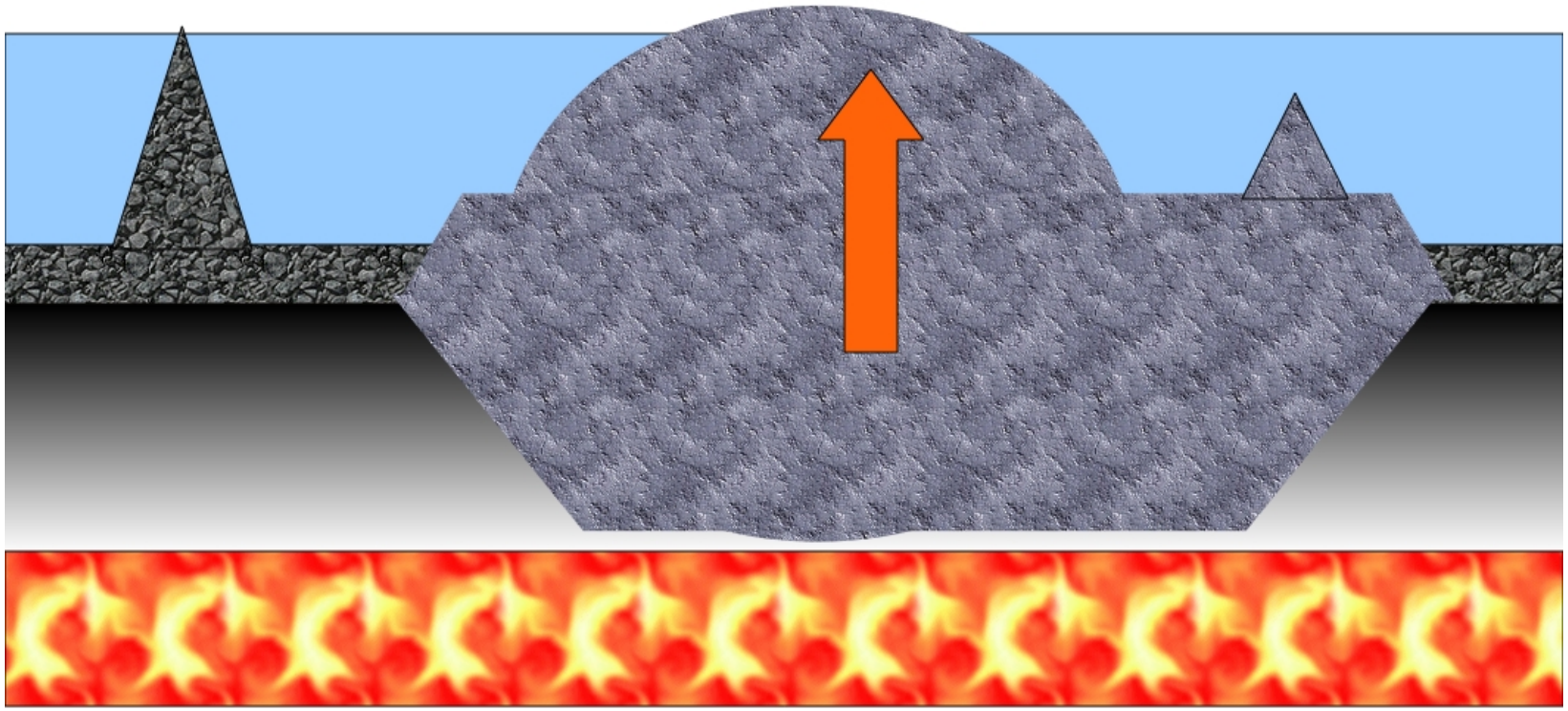


Post-glacial rebound

לאחר הפשרת הקרחון הקרום שואף
לחזור למצבו המקורי, נדחף מעלה



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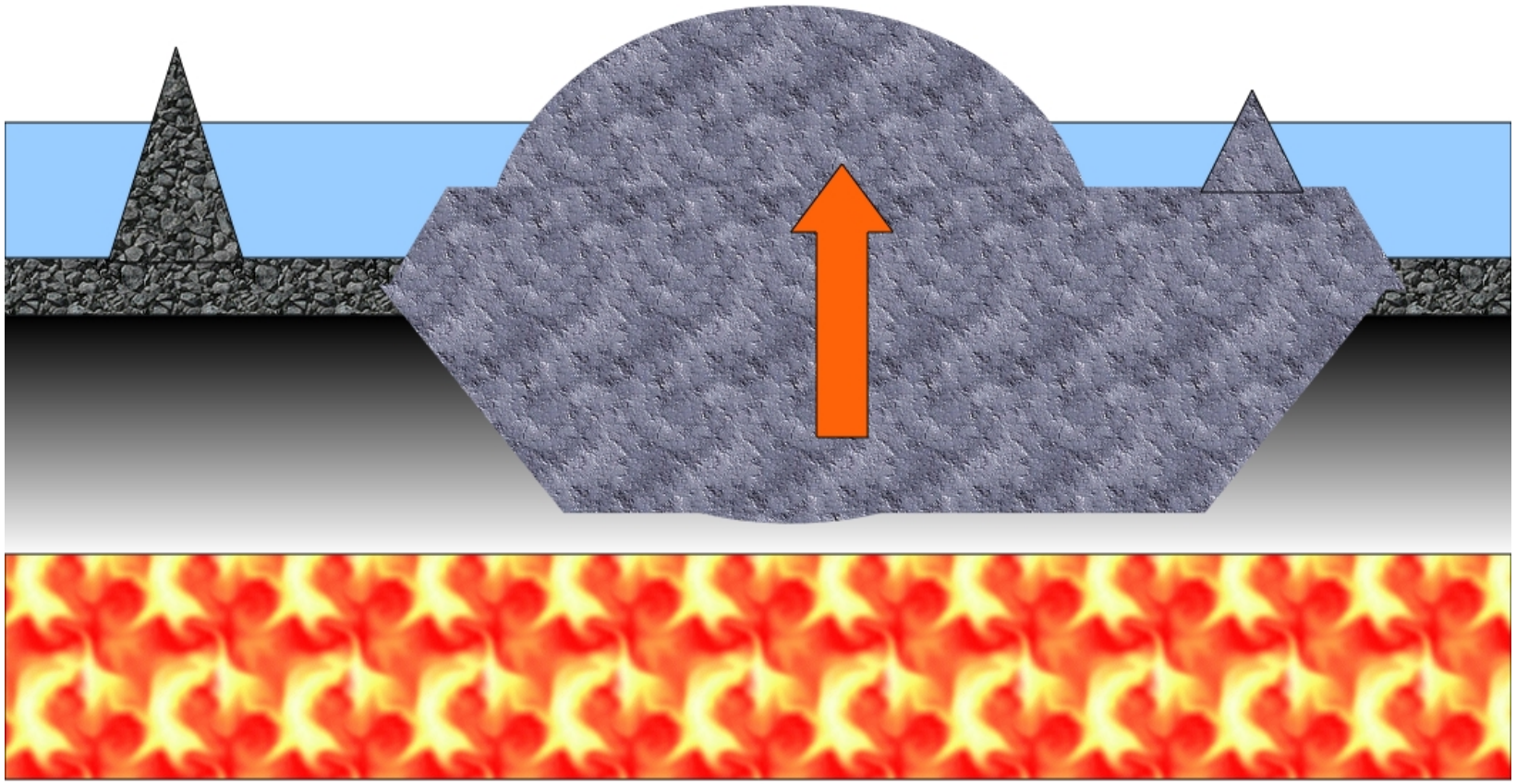
איים נחשפים מעל פני הים



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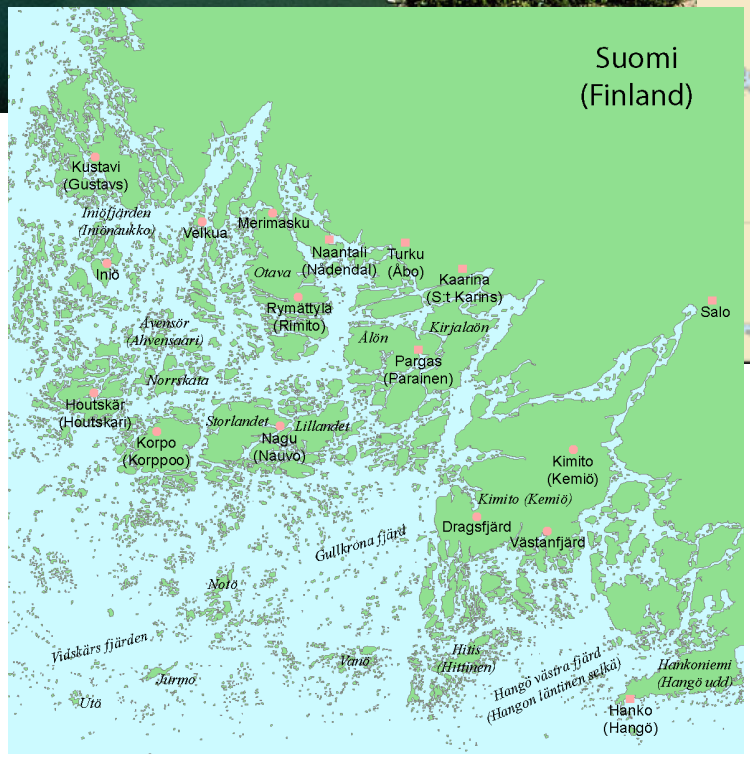
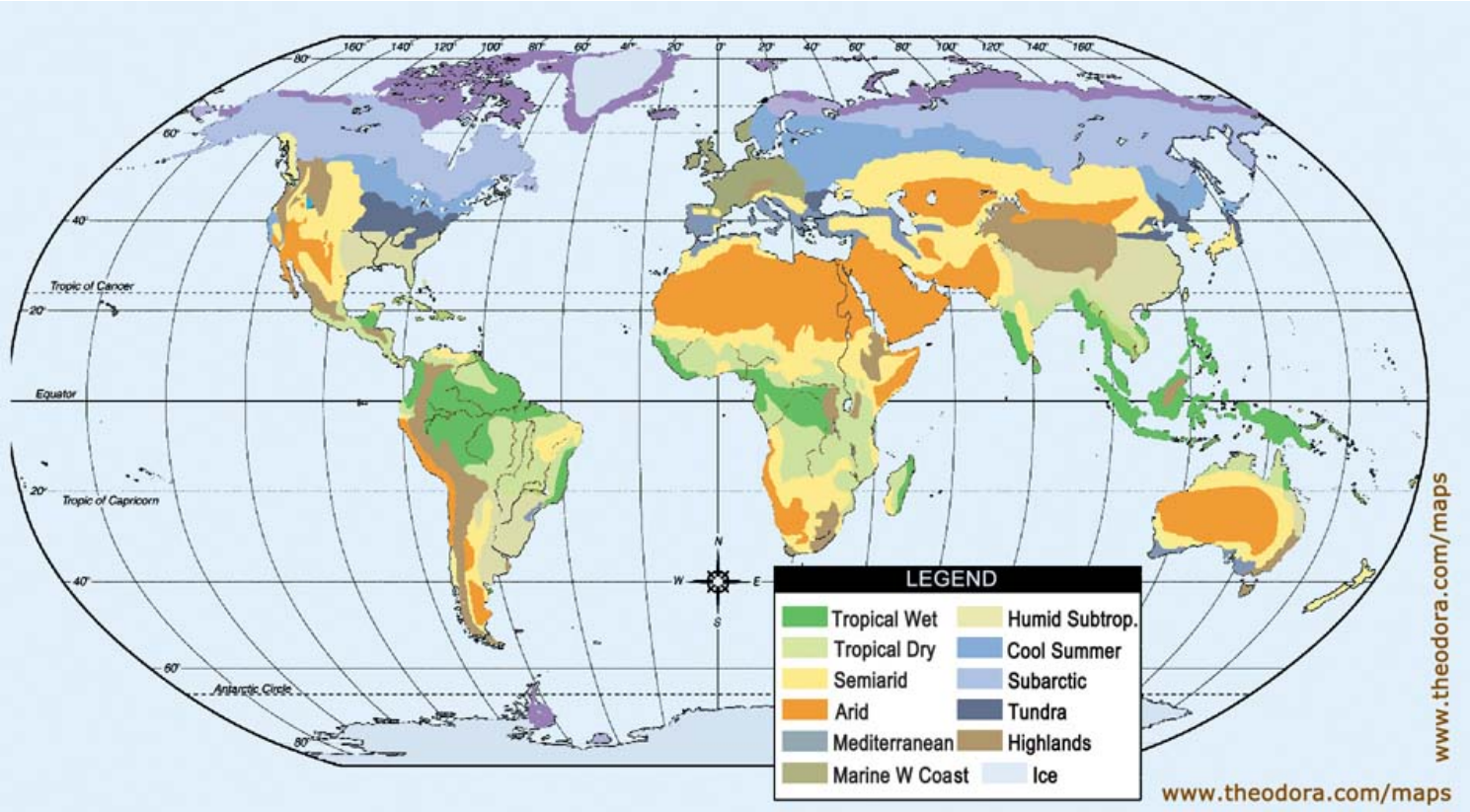


Outline

Latitude and climate

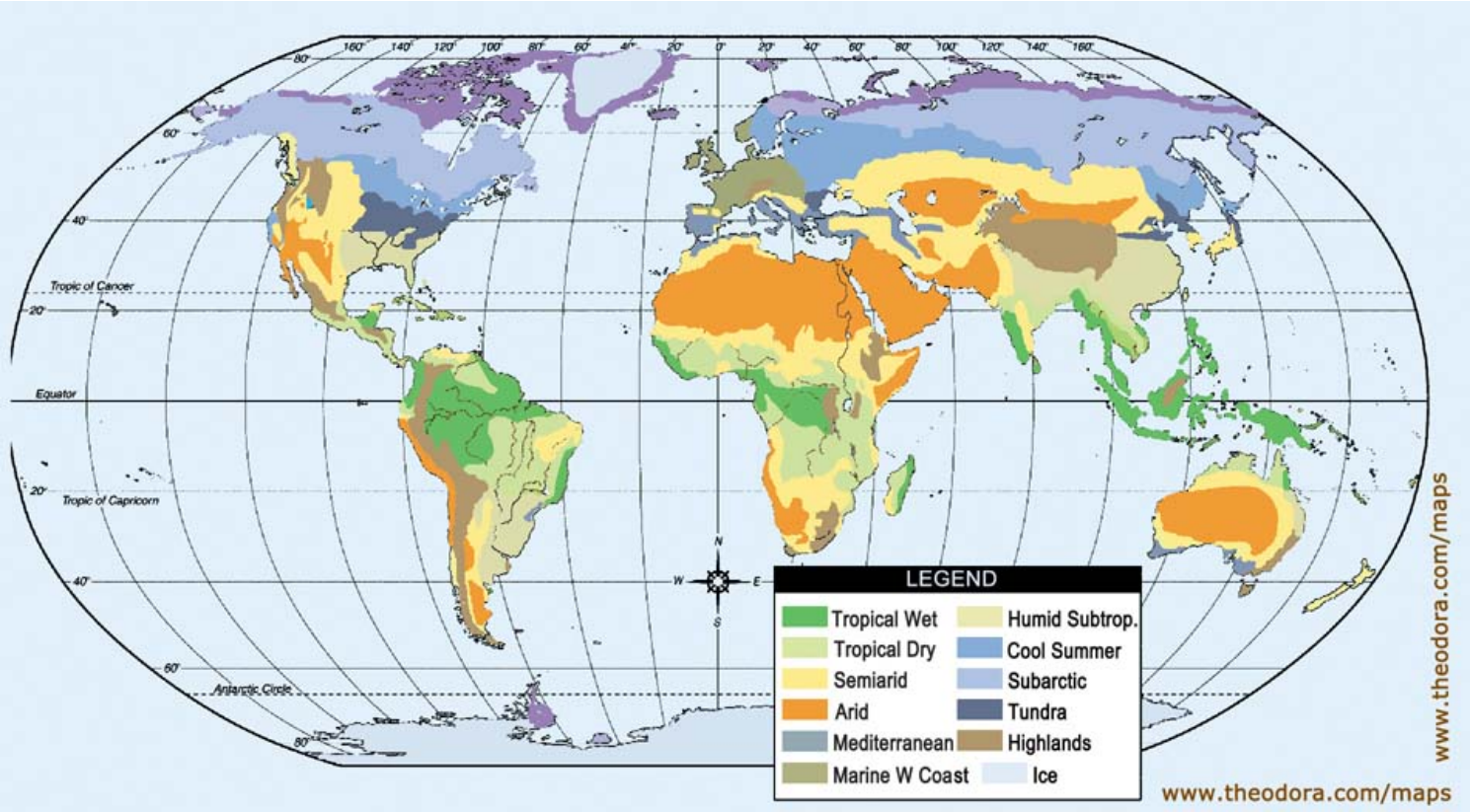
Climate roughly depends on latitude (קו רוחב).



Latitude and climate

Climate roughly depends on latitude (קו רוחב).

Proximity to sea → Intra-annual temperature fluctuation is reduced (in comparison to continental climate of similar latitude).



Rainfall and rain shadow

- Evaporated water from sea → High humidity.

Rainfall and rain shadow

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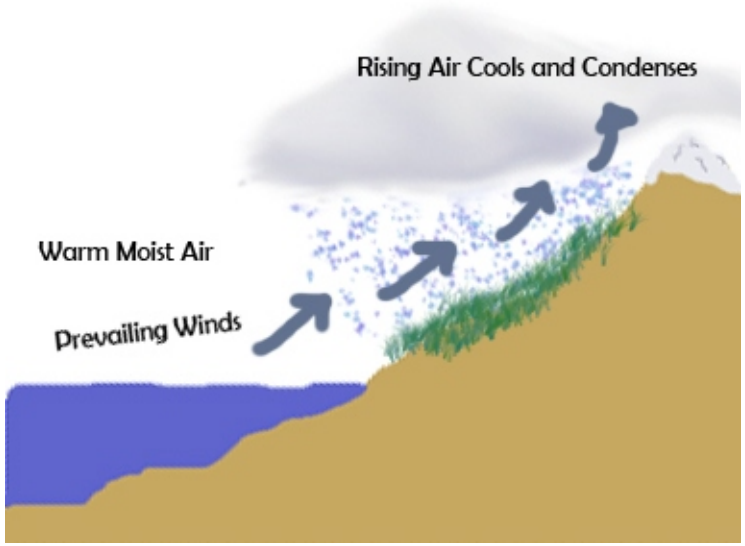
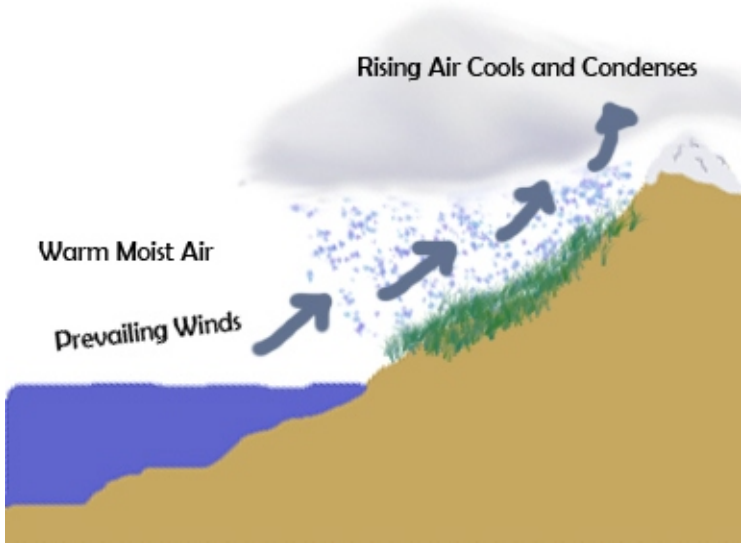
- On high island, evaporated water rises with wind, cools, condenses into clouds, and finally falls as rain.



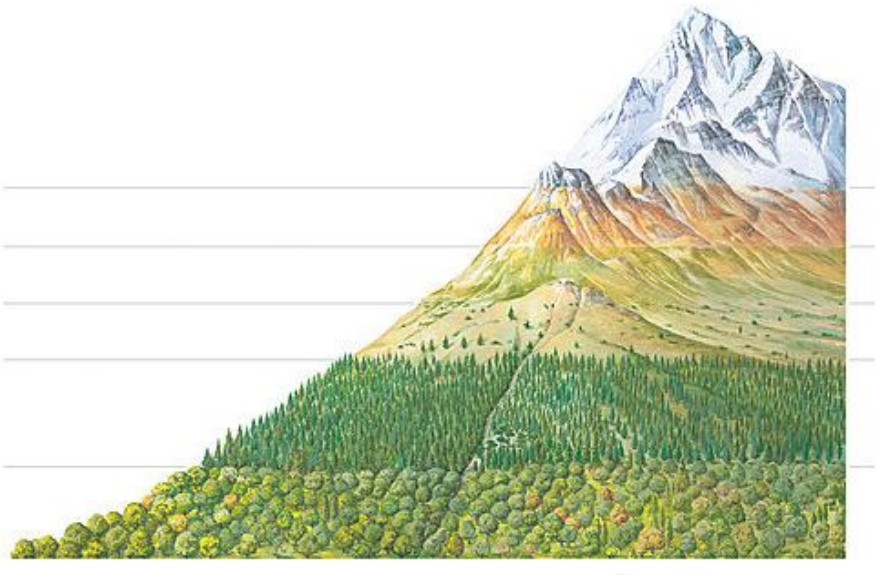
Rainfall and rain shadow

- Evaporated water from sea → High humidity.
- On high island, evaporated water rises with wind, cools, condenses into clouds, and finally falls as rain.
- On low islands, no such effect → Low islands are relatively dry.



Rainfall and rain shadow

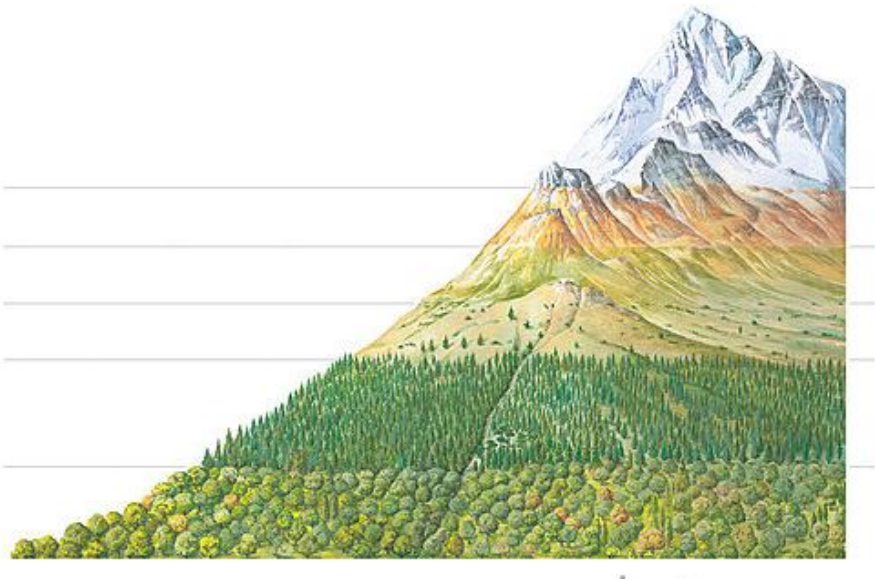
- On high islands, different combinations of rainfall and temperature as elevation increases lead to vegetation/elevation zones.

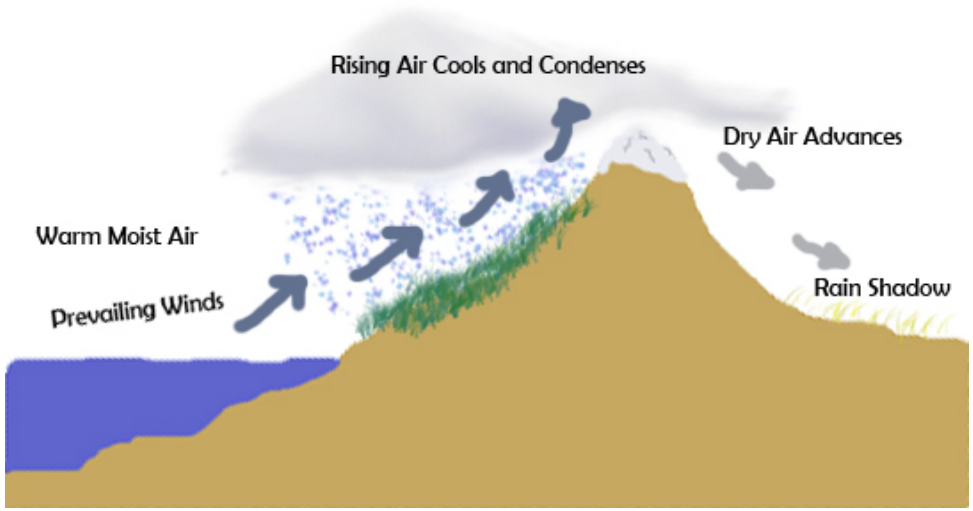


Rainfall and rain shadow

- On high islands, different combinations of rainfall and temperature as elevation increases lead to vegetation/elevation zones.
- On high island, rain shadow leads to arid/desert regions.

  Examples: Tenerife, Kauai.





Outline

Summary of Island Physics

1. Island classification
   - Continental (shelf) vs. Oceanic.
   - High vs. Low.
2. Three ways to form oceanic island volcanoes.
   - Mid-oceanic ridges – where plates diverge.
   - Island arcs – where plates converge.
   - Linear chains – intra-plate hotspot.
3. From high to low island – Coral reef growth on top of sinking volcanic rock.
   - Fringing reef → Barrier reef → Atoll.
4. Sea level changes – Repeated glaciations.
   - Land bridges to continental islands.
   - Oceanic islands exposed and flooded repeatedly.
   - Post-glacial rebound.
5. Island climates – Latitude and altitude/elevation.
   - Reduced temperature fluctuation, relative to latitude.
   - Wider range of climatic conditions on high islands (elevation zones, rain shadow).
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3. **Numerous and varied.**
4. **"Accelerated time".**
5. **"Telescoping" of environmental variability.**

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