Some Basic Physics, Chemistry and Geology followed by and Introduction to the Earth Interior

Today's Quiz

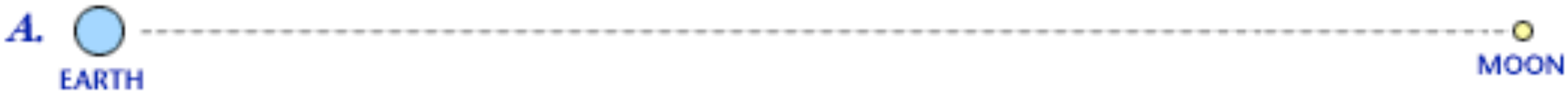
1) Vocabulary Chapters 1a and 11
2) Review of Chapter 1a and Previous Lecture

A Private Unvierse?

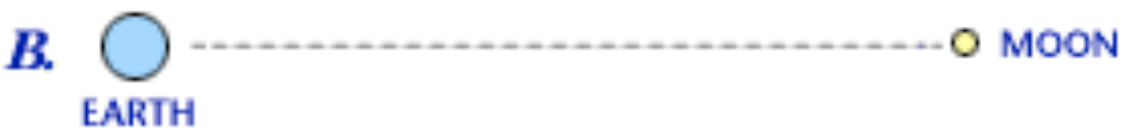
5 of 5

Which of the following diagrams most closely depicts the distance between Earth and the Moon?

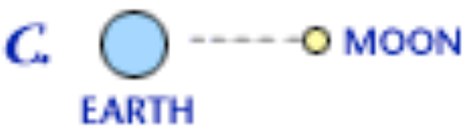
A.



B.



C.



- Diagram A
- Diagram B
- Diagram C

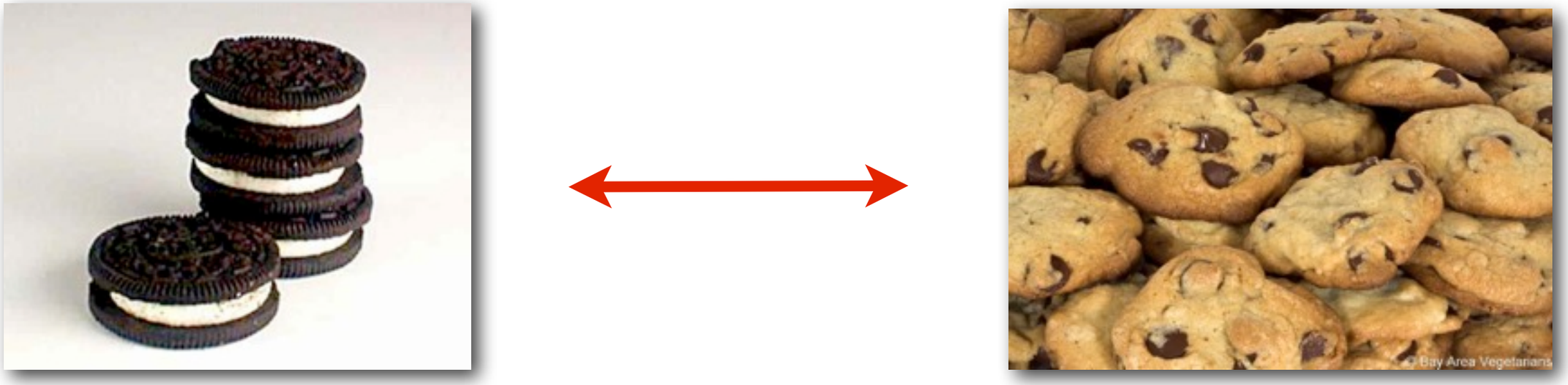
Some Basic Physics and Chemistry and Geology

Equilibrium

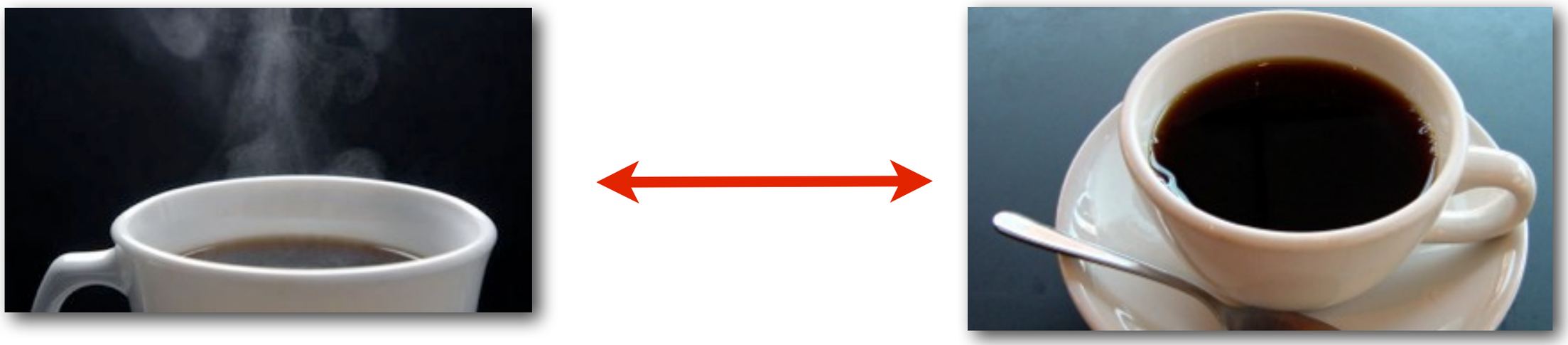
Cookie Equilibrium

Coffee Equilibrium

Equilibrium



Molecular (H2O)Equilibrium



Temperature (heat) Equilibrium

Phase Change

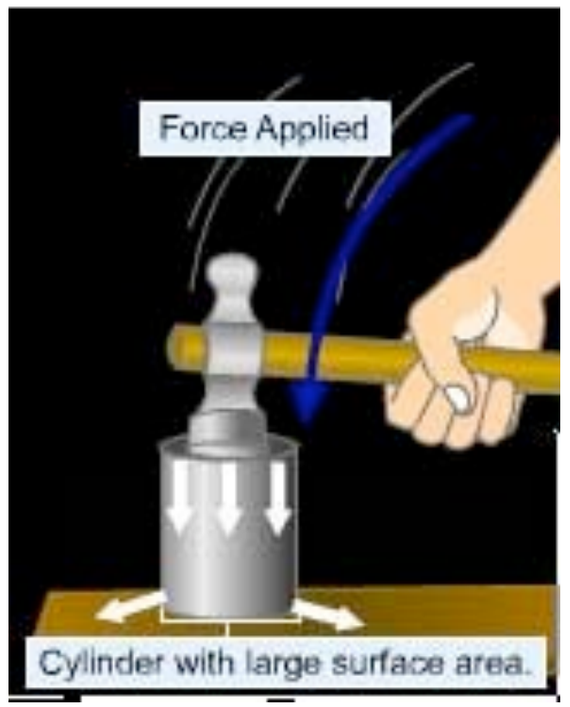
Solid

Gas

Liquid

Temperature (heat) and Pressure

Temperature is a measure of Heat



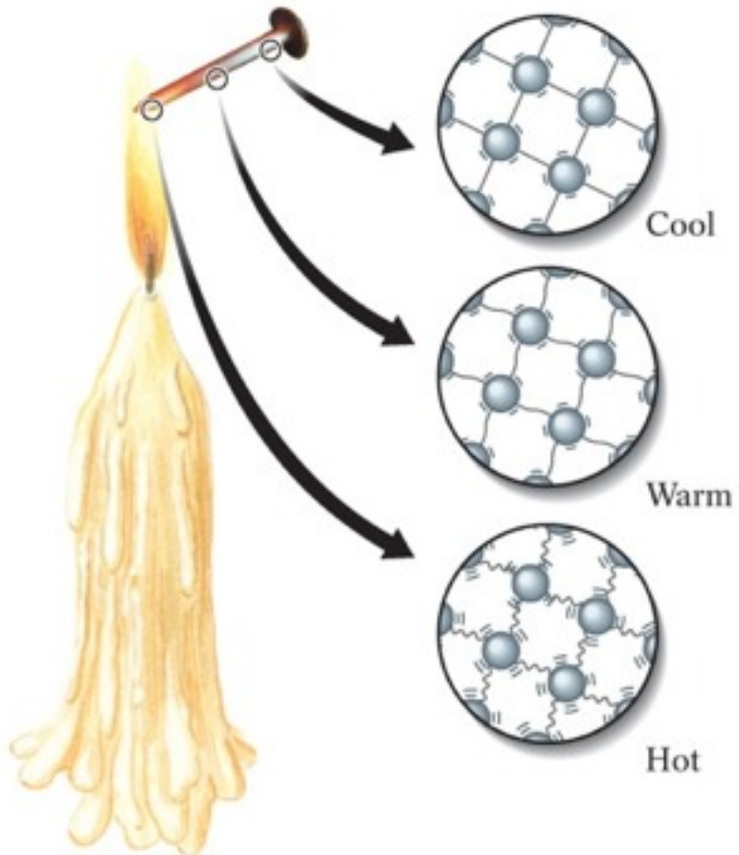
Accretionary heat
(energy transfer)

Sources of Earth's Heat

- Accretionary heating (original heat)
- Latent heat (heat of crystallization)
- Radioactive Decay

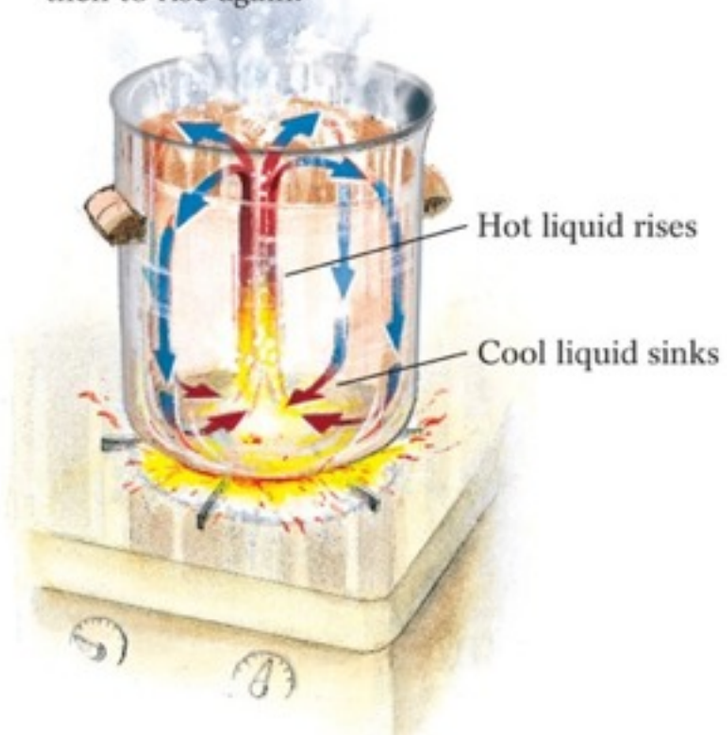
Heat Transfer (cooling)

Conduction of heat involves the passage of thermal energy from atom to neighboring atom. Thus, the atoms in the hot part of the nail, which is directly in the flame, vibrate very rapidly. Farther from the heat source, the atoms vibrate less rapidly. And at the end of the nail, which is still cool, the atoms vibrate very slightly. Eventually the heat will be conducted throughout the length of the nail.



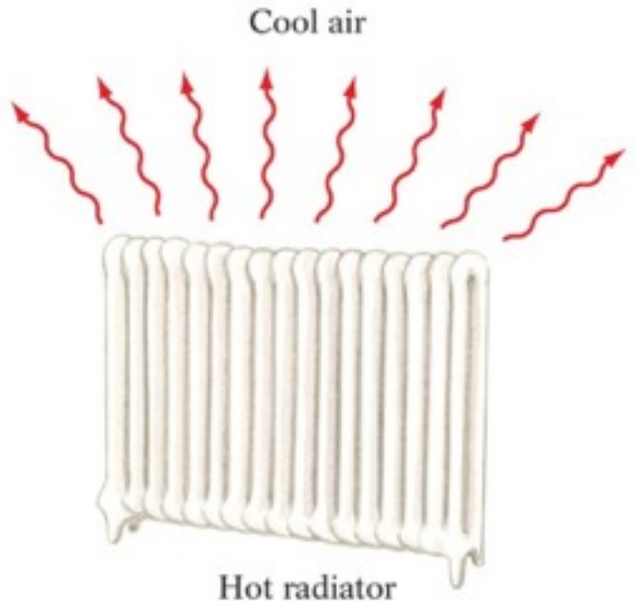
(a) Conduction

Convection involves the movement of heat from place to place by a flowing medium. Because the soup at the bottom of the pot is closer to the flame, it is the first part of the soup to become hot. As it heats up, it expands (becoming less dense) and rises, and the cooler (more dense) soup above it sinks to the bottom, displacing it and forcing it upward. When the warm soup arrives at the top, it encounters the relative coolness of the air and contracts in volume (becomes more dense) as it begins to cool. The cooled soup then sinks back toward the bottom, to be reheated and then to rise again.



(b) Convection

Radiation involves the transfer of heat from a hot object to its cooler surroundings. The hot radiator heats up the cool air that surrounds it.



(c) Radiation

Buoyancy

Gravitational Equilibrium

Density = mass/volume (g/cm^3)

Buoyancy

Density = mass/volume (g/cm^3)

Buoyancy

Brass
on
Mercury

Gravitational Equilibrium

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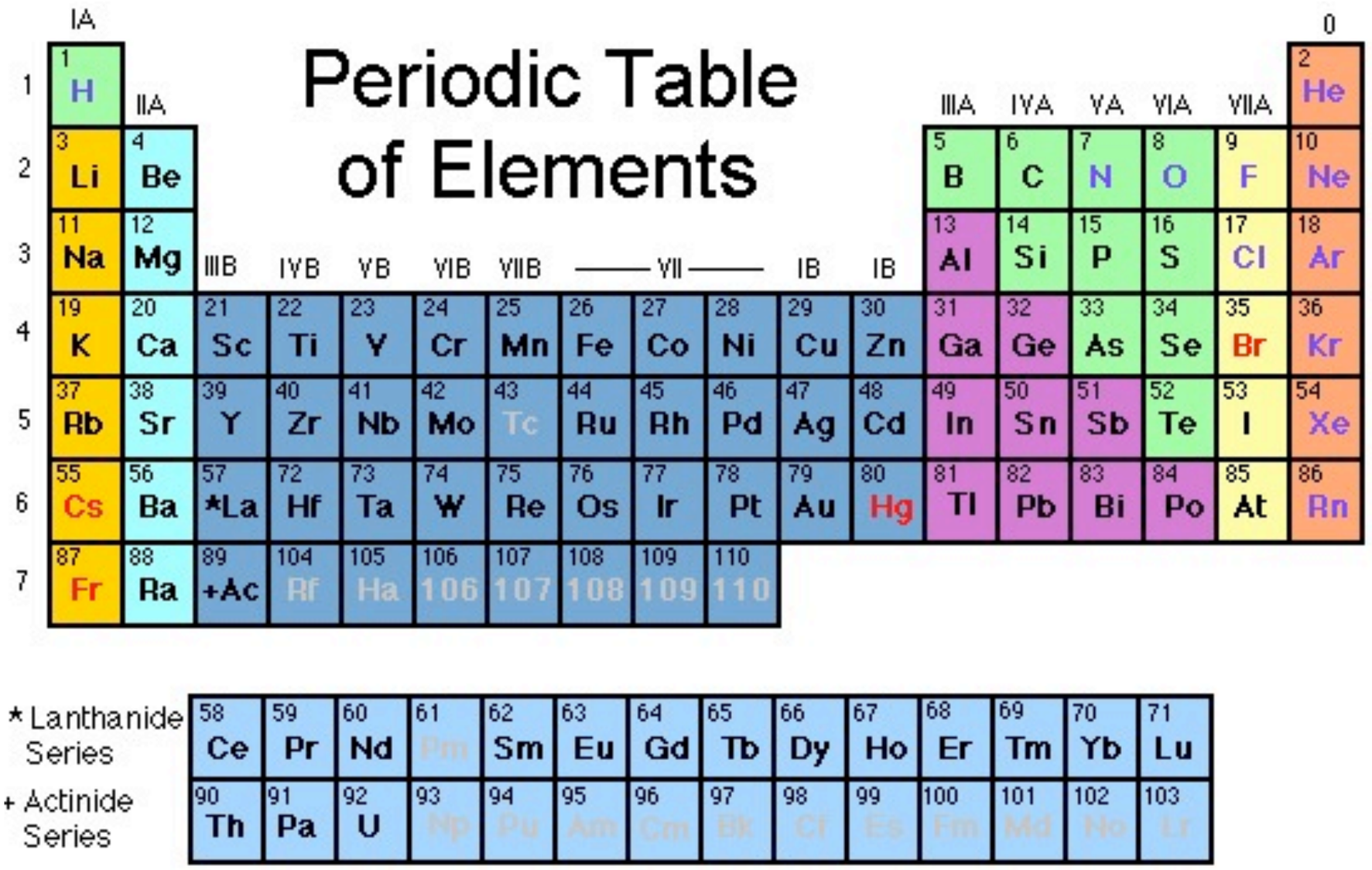
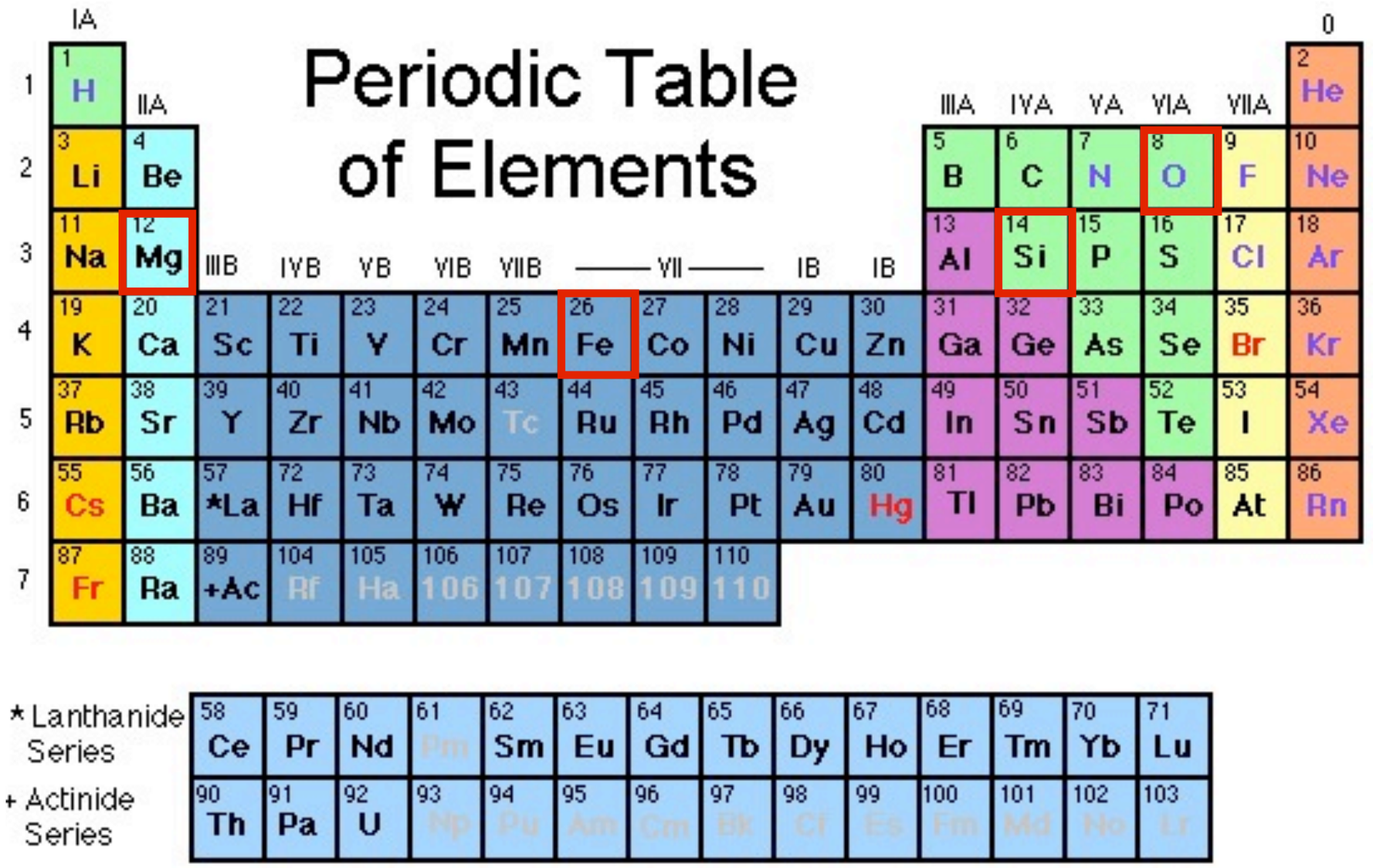
Observable Matter

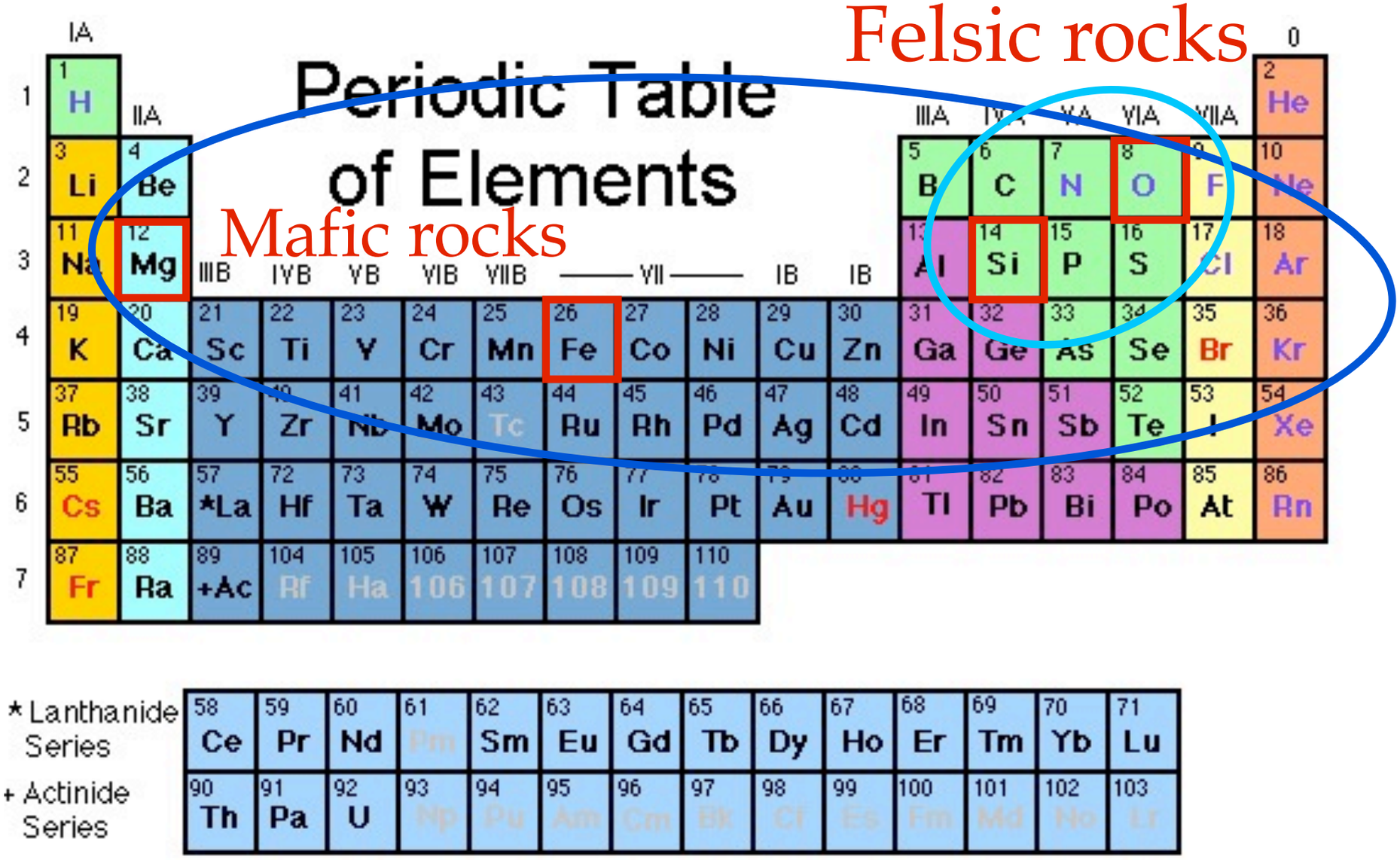


Observable Matter



Silicate Rocks- Rocks composed dominantly of Silicon (Si) and Oxygen (O)

Observable Matter



Silicate Rocks- Rocks composed dominantly of Silicon (Si) and Oxygen (O)

Observable Matter

Earth's Composition by Mass

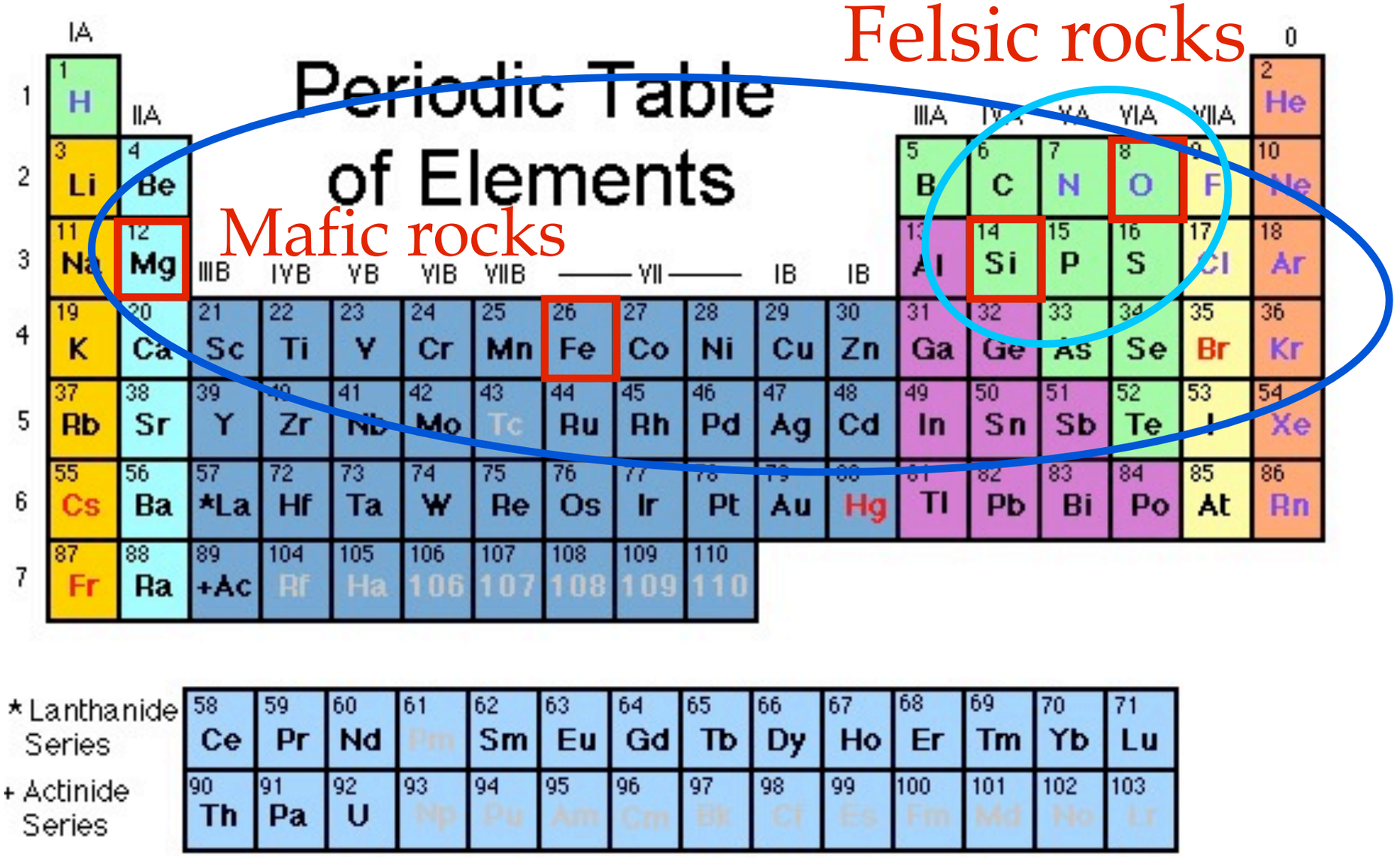
-35% Fe

-30% O

-15% Si

-12% Mg

-8% all other



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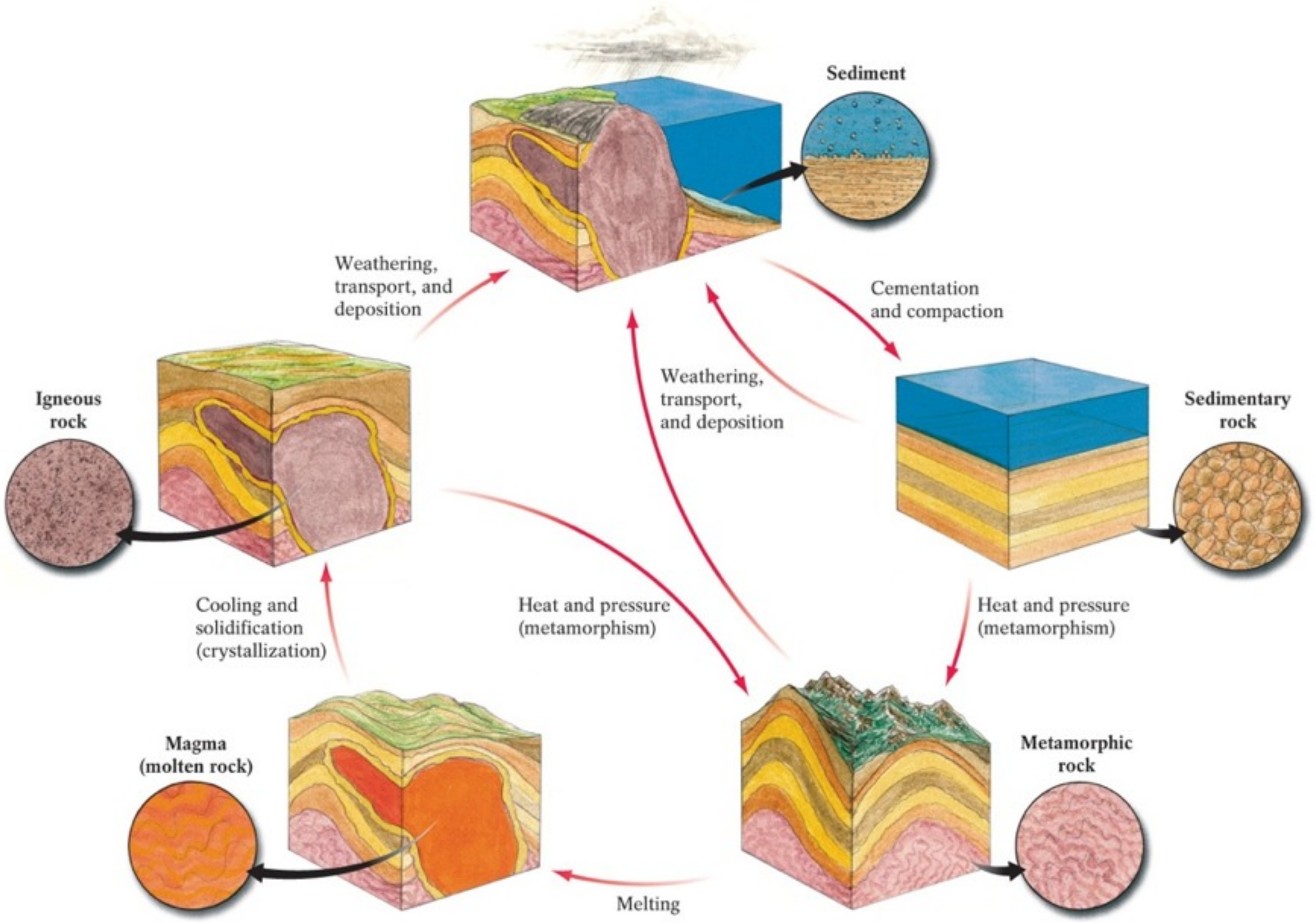
The Rock Cycle



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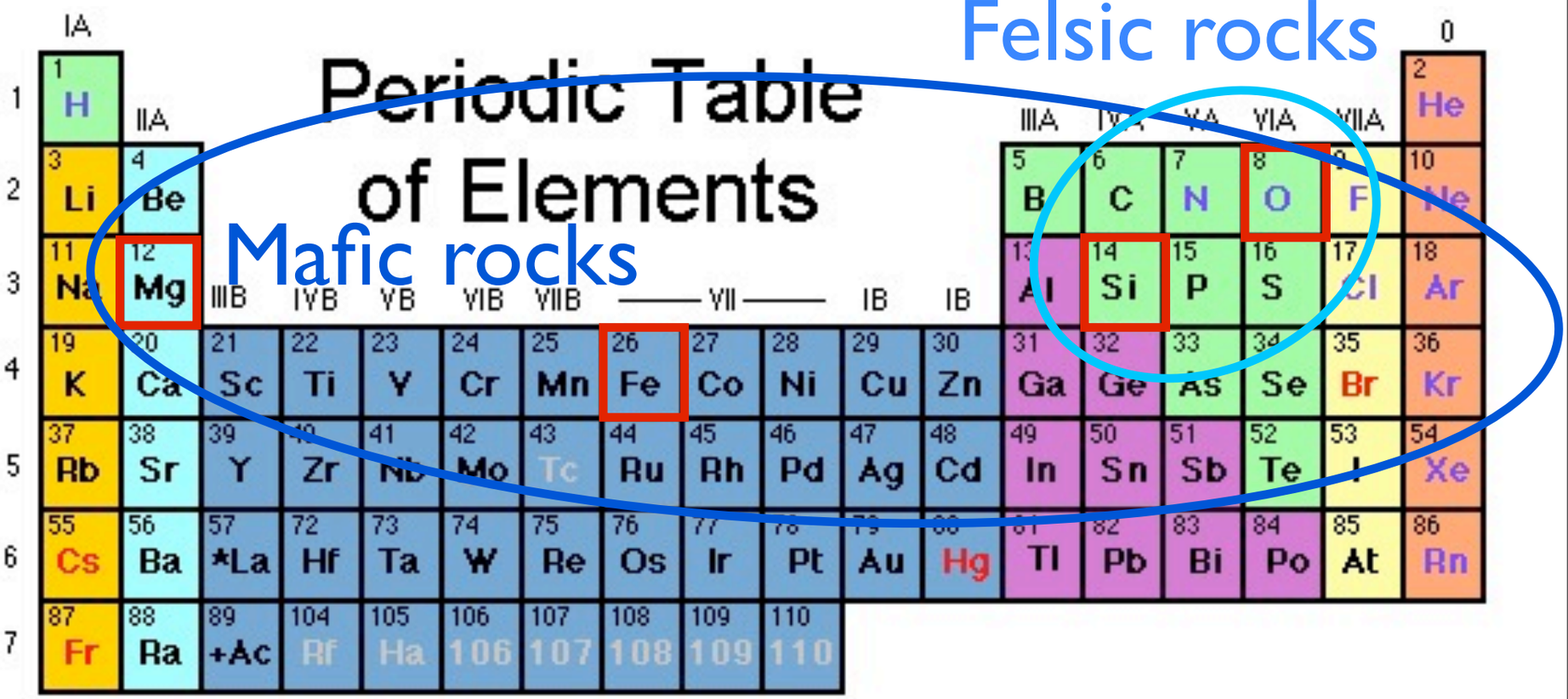


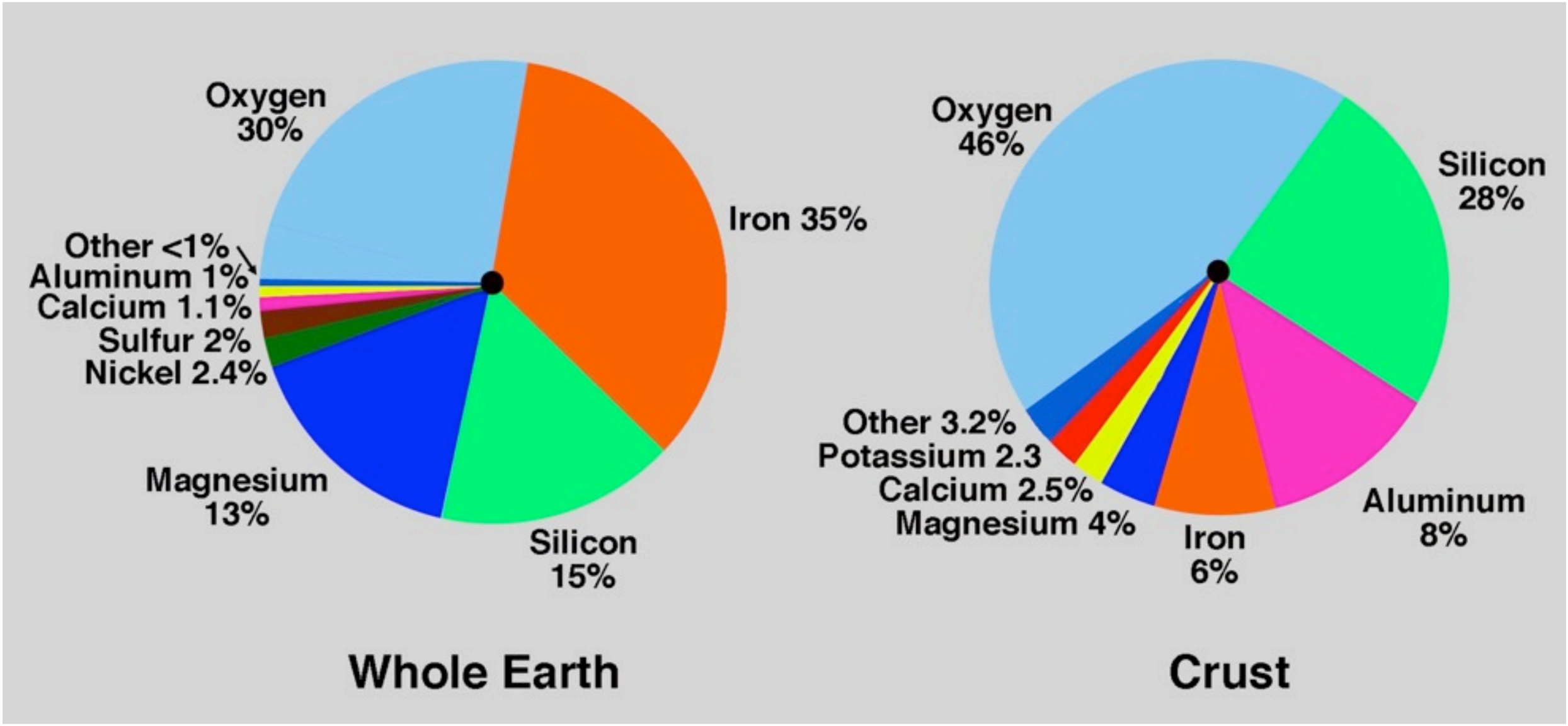
Felsic Rocks Greater than 55% SiO_4 (silica) → Continental Crust

45% SiO2 < Mafic Rocks < 55% SiO_4 → Oceanic Crust

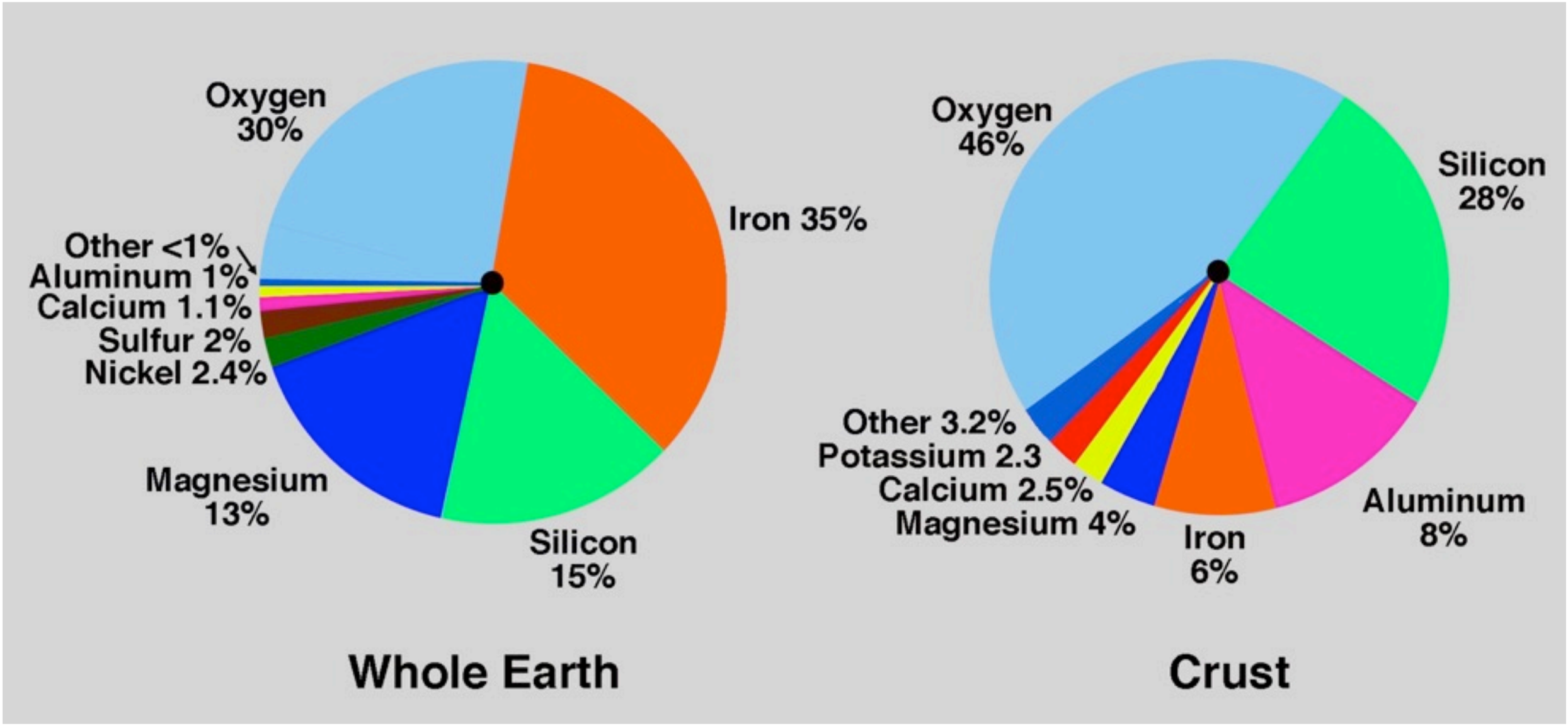
Ultramafic less than 45% SiO_4 → Mantle

Non-Silicate Rock (Ni-Fe alloy) → Core

Earth's Composition
Heterogeneous or Homogeneous?

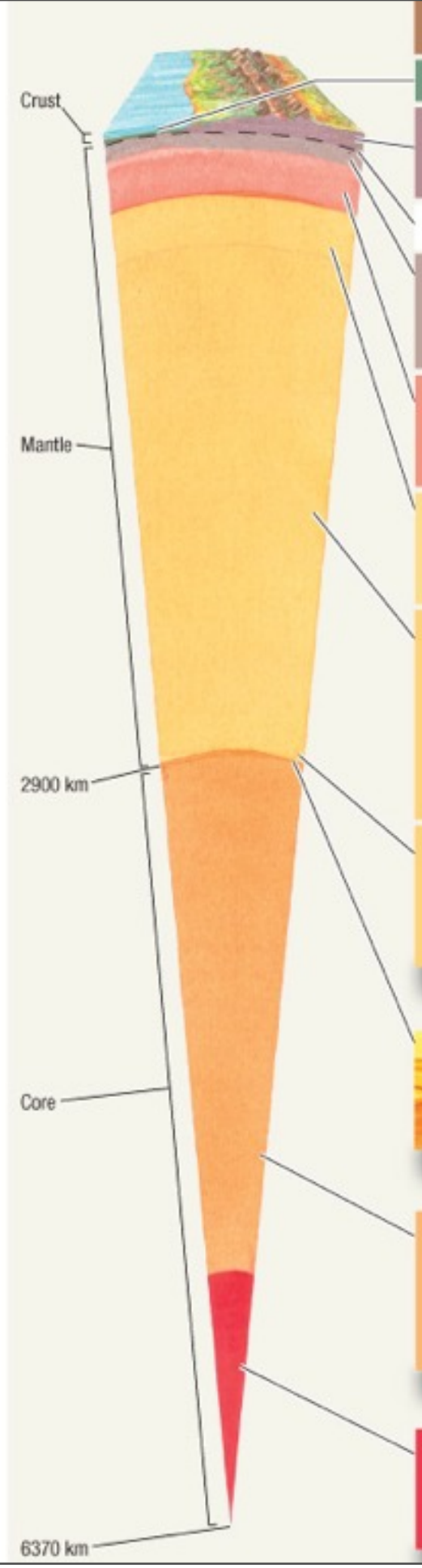


Earth's Composition
Heterogeneous or Homogeneous?



What is the crust enriched in?
What is the curst depleted in?

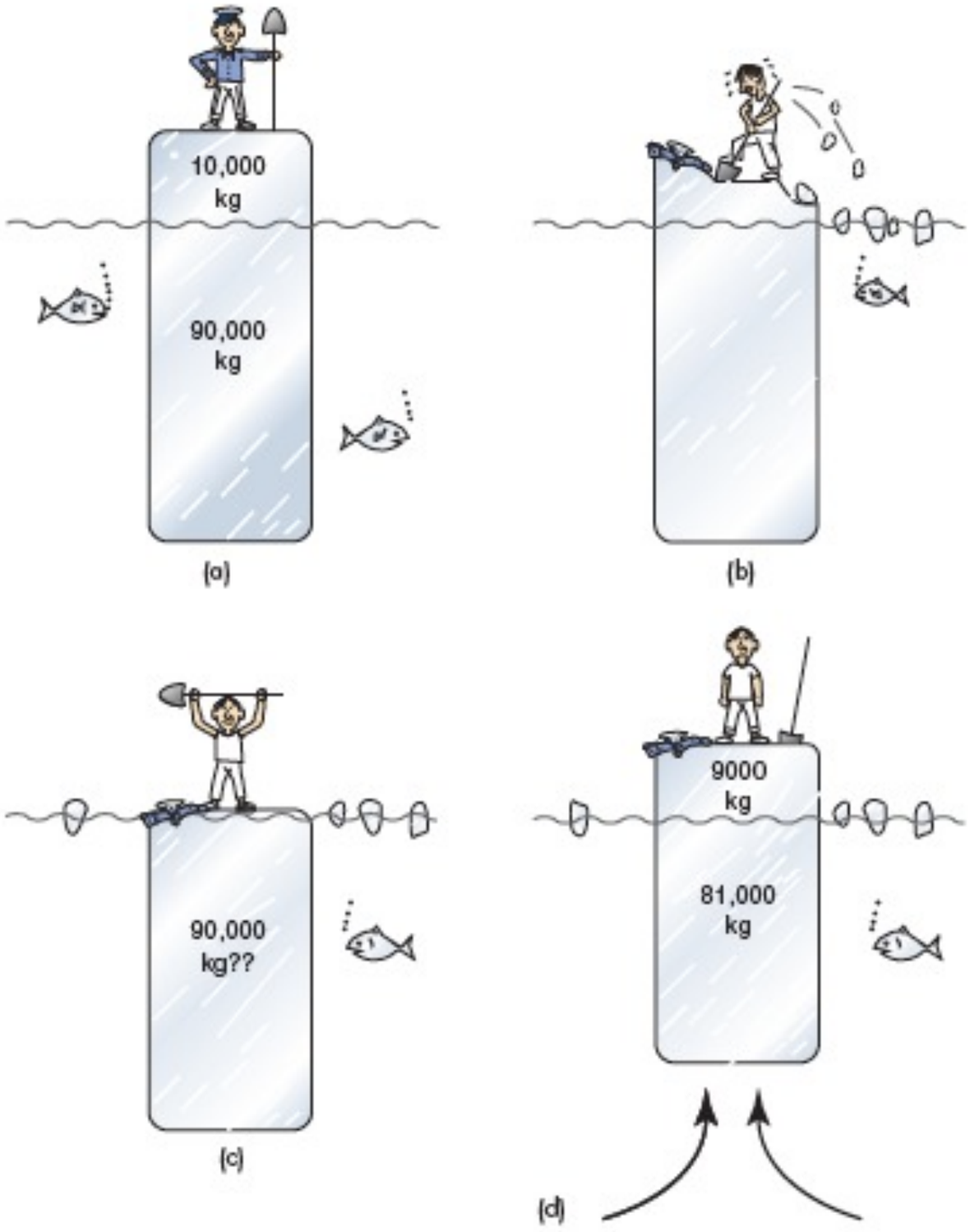
Modified "Geology at a Glance" 11.1



Layer/Depth	Composition	Key Physical Properties	P-wave Velocity
Oceanic crust (ca. 8 km)	Basalt (Mafic)	Density: 3.0 g/cm^3	7 km/sec
Continental crust (ca. 20–70 km)	Diorite (Felsic)	Density: 2.7 g/cm^3	6–7 km/sec
Moho			
Upper mantle (ca. 100 km)	Ultramafic silicate rocks (e.g., peridotite) Key mineral - olivine	Density: 3.3 gm/cm^3	8 km/sec
Asthenosphere (aka Low-velocity zone or Partial-melting zone) (ca. 350 km)	Ultramafic silicate rocks (e.g., peridotite)	Partially melted: 1–10% liquid Convective flow	7 km/sec
~~Transition Zone~~ (ca. 700 km) Lower Mantle	Ultramafic silicate rocks Ultramafic silicates (e.g., spinel, garnet, Mg-oxides)	Collapsed mineral structures	8–10 km/sec
Lower Mantle Lower Mantle	Ultramafic silicates (Mg- and Fe-silicates, e.g., perovskite) Ultramafic oxides (Mg- and Fe-oxides, e.g., periclase)	Density: 5.5 g/cm^3	13.6 km/sec
~~D" (ca. 2600–2900 km)~~	Ultramafic oxides and silicates	Variations in topography and temperature (due to sub-ducted cool lithospheric slabs)	8.1 km/sec
Mantle-Core Boundary (2900 km)		Partial melts (due to contact with hot/liquid outer core ULVZs (Ultra Low Velocity Zones)	
Outer Core (5270 km)	Iron-nickel metal (perhaps with small amounts of sulfur, silicon, oxygen)	Density: 10–13 g/cm^3 Liquid state (S-waves stop) Source of Earth's magnetic field	8.1 km/sec, increasing to 10.4 km/sec
Inner Core (6370 km)	Iron-nickel metal (perhaps with small amounts of sulfur, silicon, oxygen)	Solid (due to high pressure and insufficient temperature to melt	11.2 km/sec

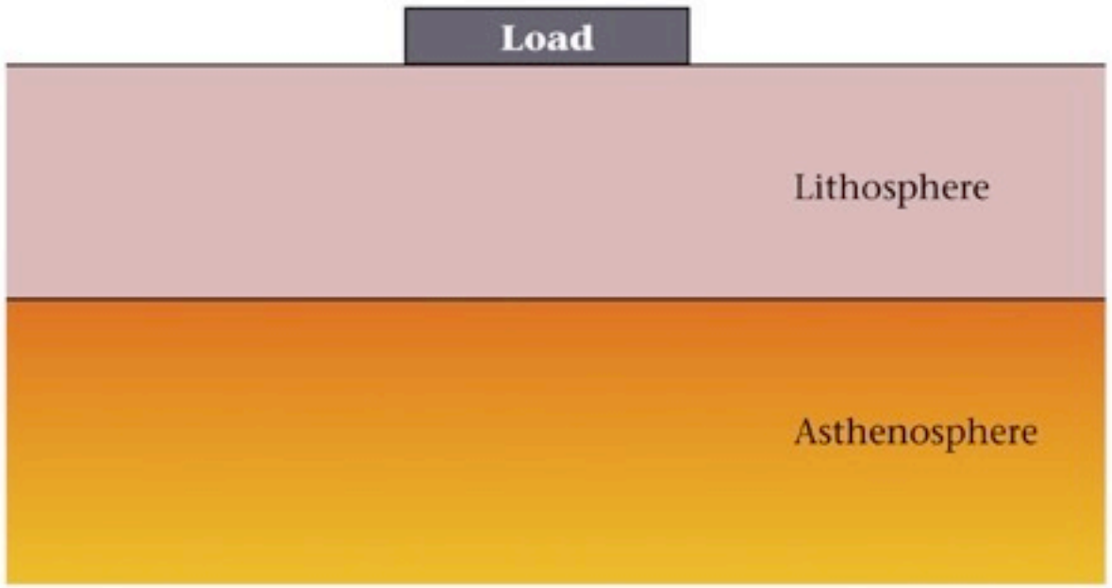
Buoyancy

Isostasy

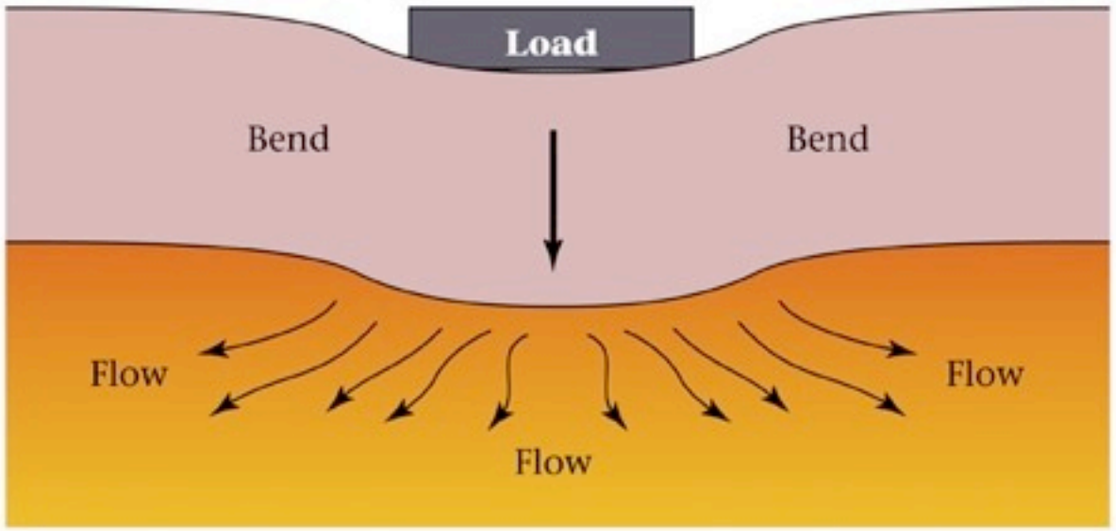


Isostasy

Time 1: A "load" is placed on top of the lithosphere.

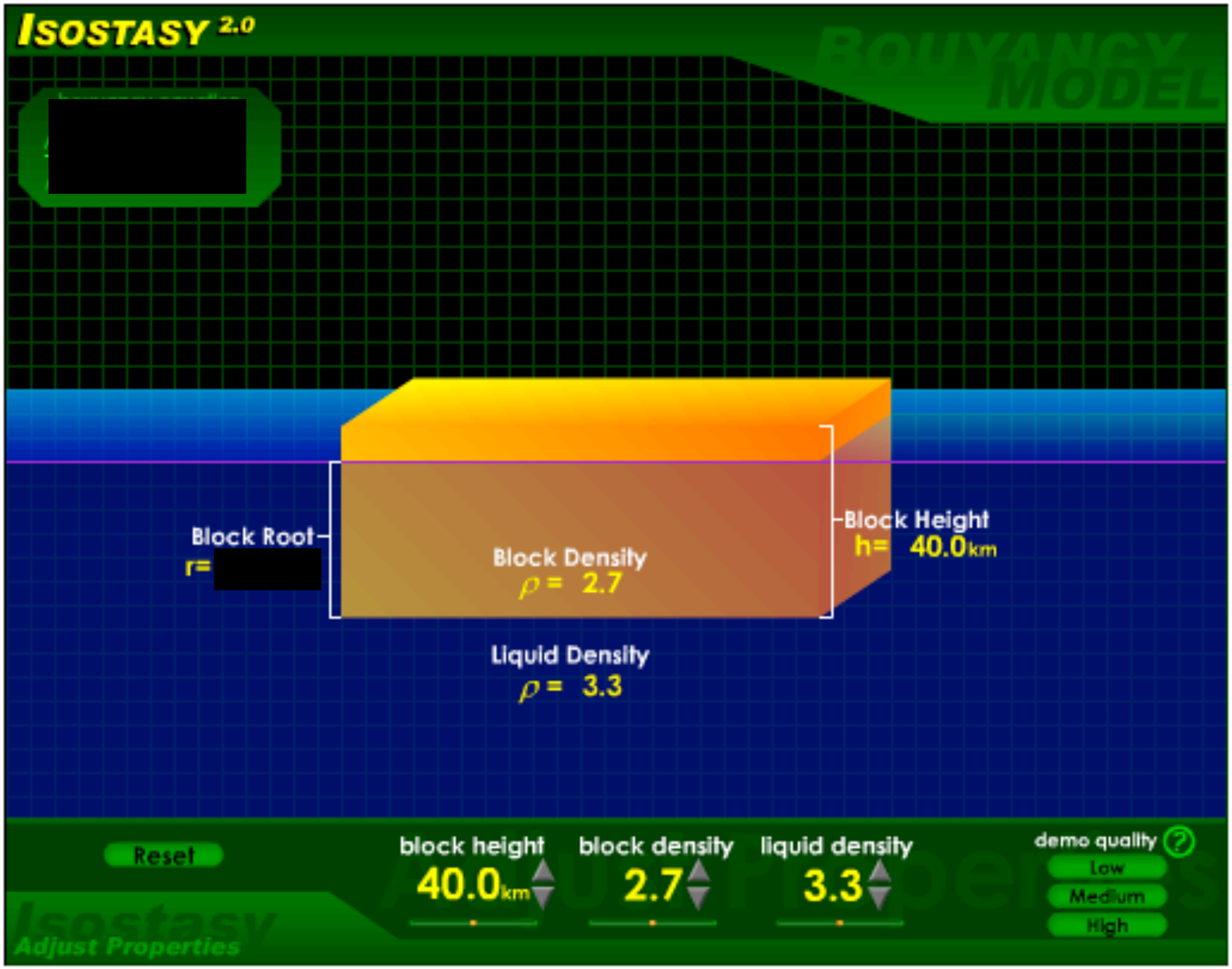


Time 2: The weight of the load pushes down. The lithosphere bends and its base moves down. The plastic asthenosphere flows out of the way.



(not to scale)

Isostasy



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What amount of the low density block is sticking above the more dense material?

a) ~12 km

b) ~33 km

c) ~17 km

d) ~7 km

e) Was unable to determine

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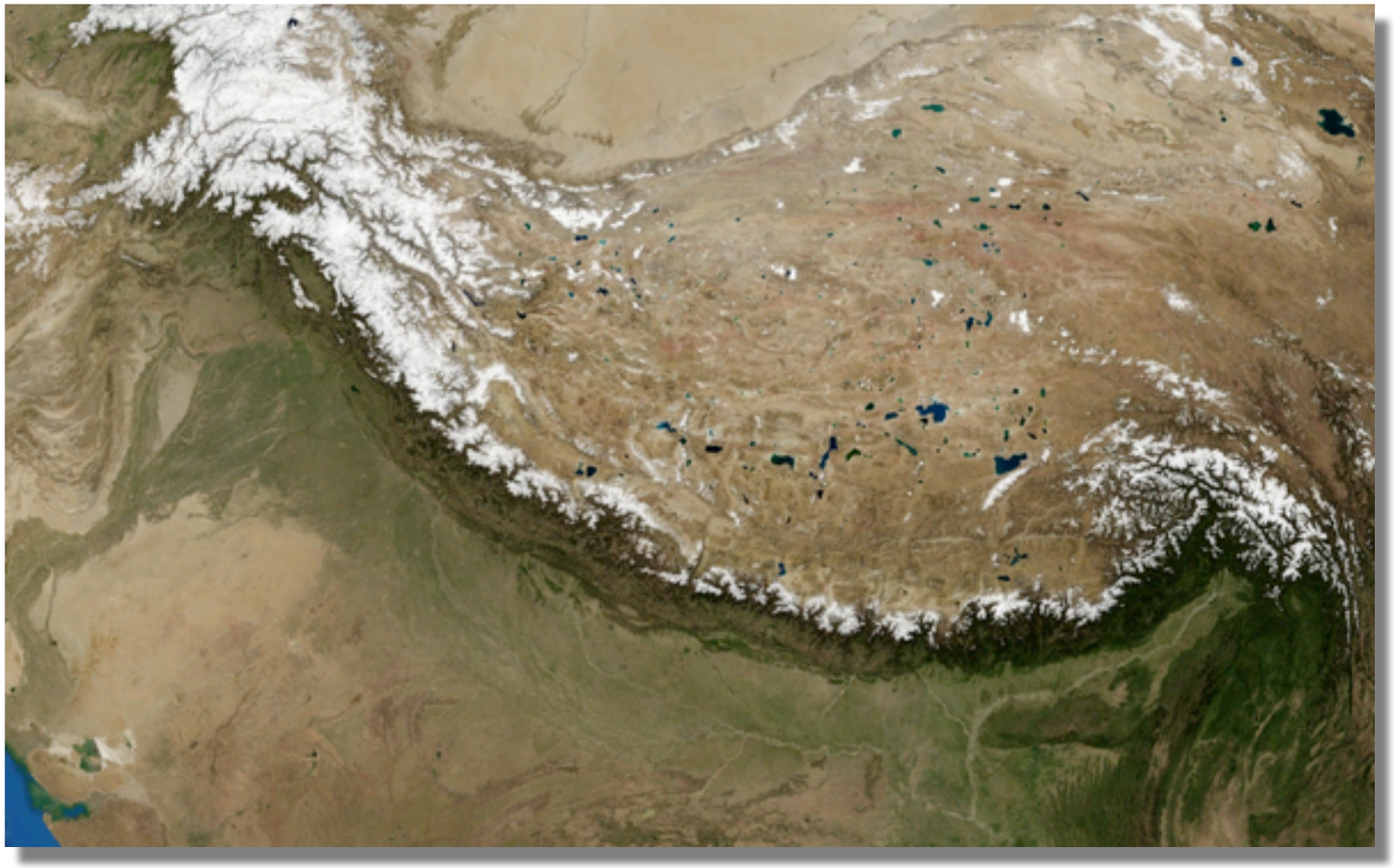
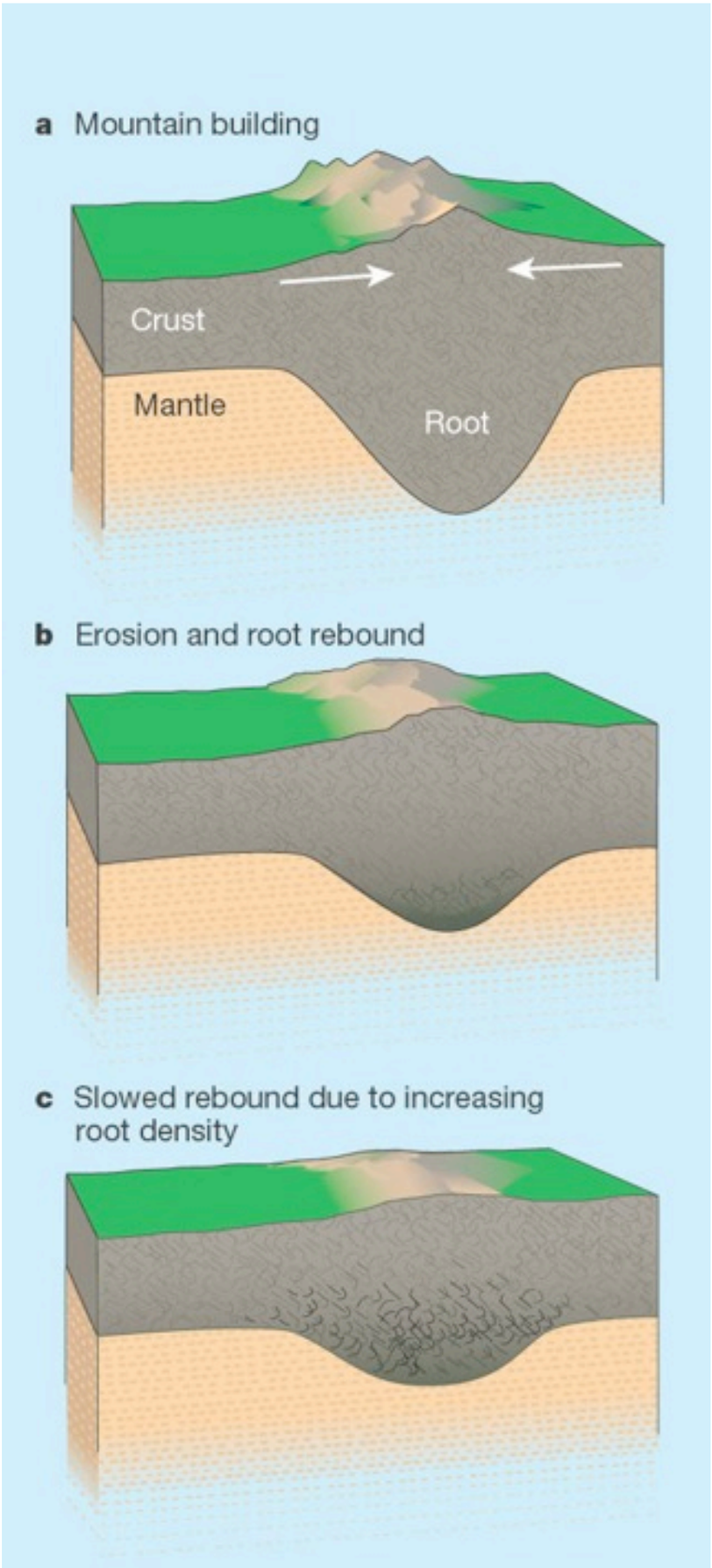


Himalayan Mountains



Earth's Structure
Group Work

Pages 17, and 19-21 in your Manual
Work in Groups of 2 to 3

Earth's Structure