¶ 2.1

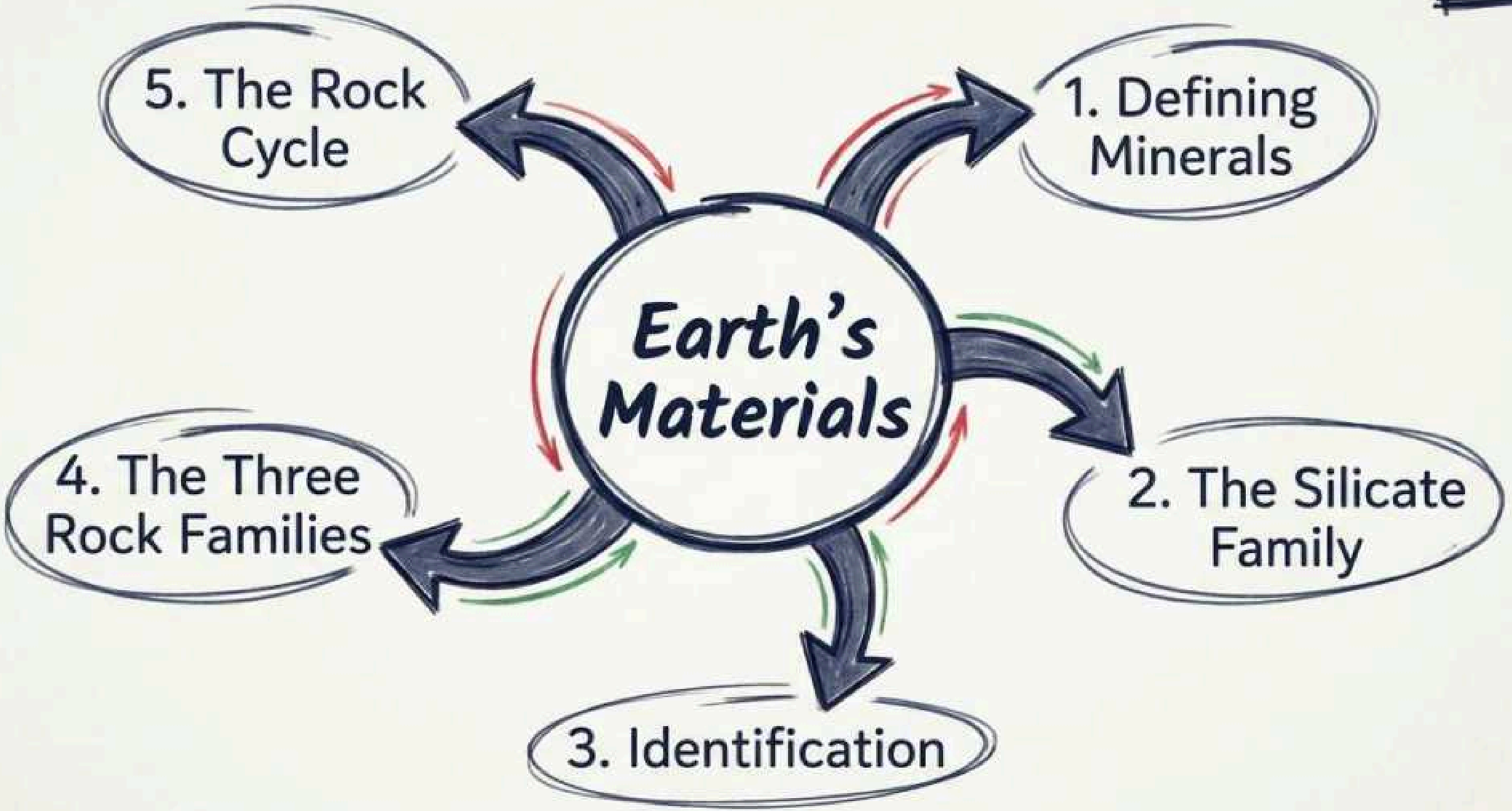


GEOL 101 B – Lecture 2

Minerals, Rocks, and the Rock Cycle

Gemini Notebook

¶ 2.2



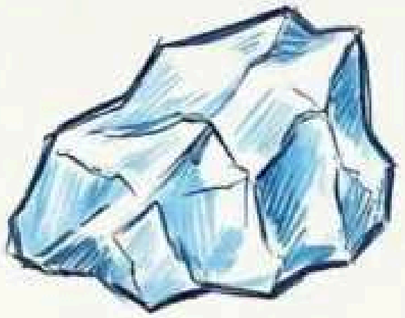
Gemini Notebook

What is a Mineral?

¶ 2.3

1. Naturally occurring
2. Solid
3. Inorganic
4. Definite chemical composition
5. Orderly crystal structure

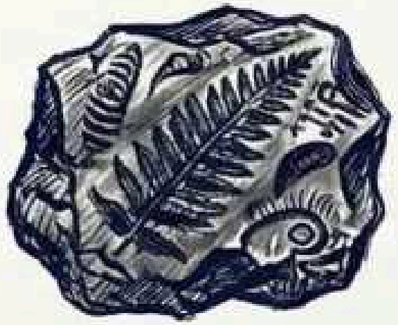
Test Case



✓ Yes (meets all 5)



✗ No (fails test 2: not a solid)



✗ No (fails test 3: organic/from plants)

Gemini Notebook

The Crust's Chemical Recipe

¶ 2.4

The Giants:

Oxygen (47%)
+
Silicon (28%)



Al (8%)

Fe (5%)

Ca (3.6%)

Na (2.8%)

K (2.6%)

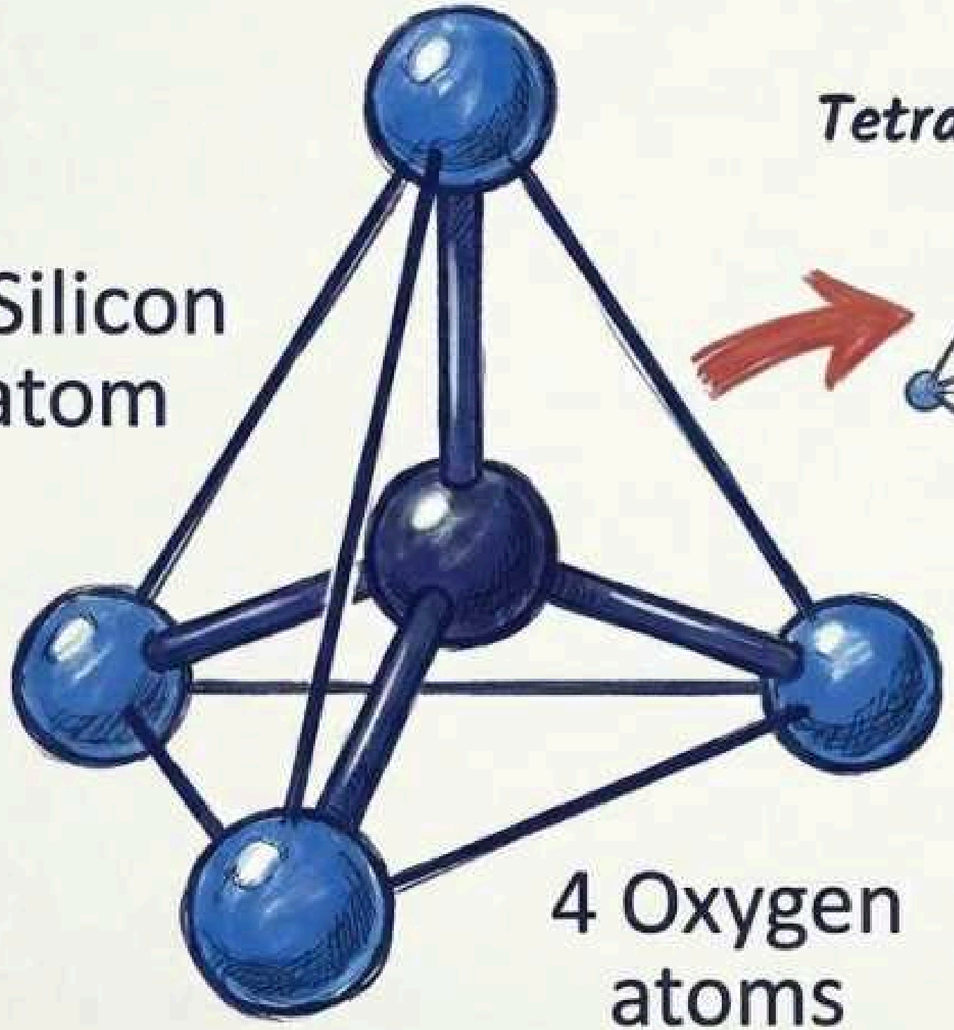
Mg (2.1%)

Just 8 elements = ~99% of the crust by mass.

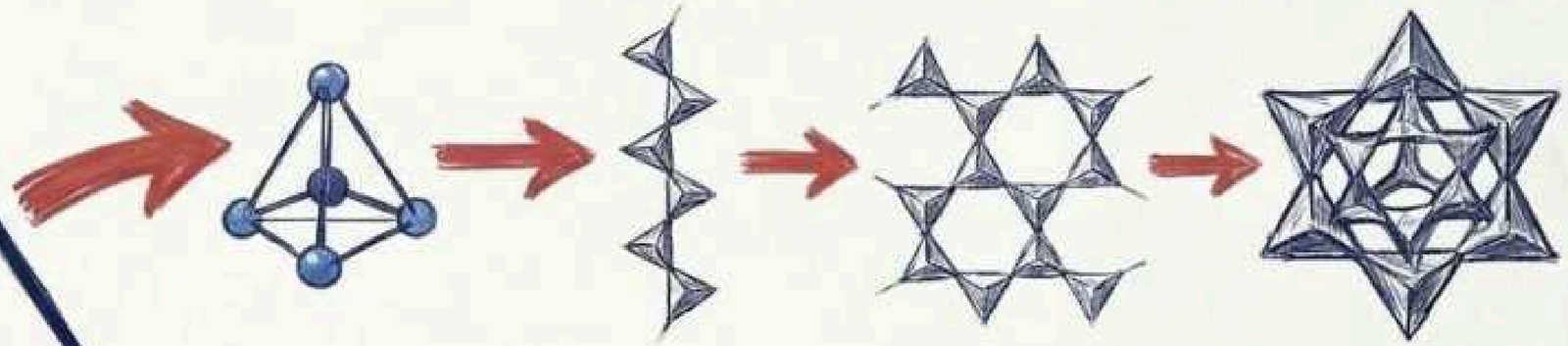
Gemini Notebook

The Silicate Family SiO_4^{4-}

¶ 2.5



Tetrahedron → Chains → Sheets → 3D Frameworks

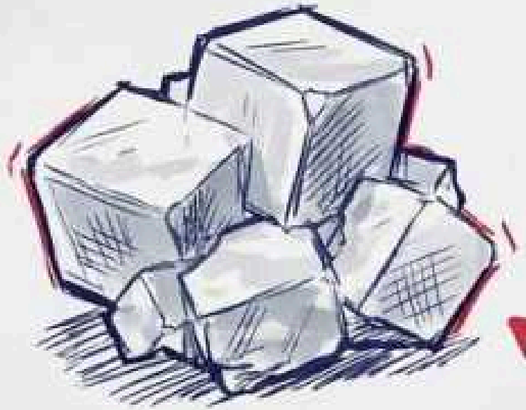


Common Examples: Quartz (pure silica), Feldspars (add Al, Na, K, or Ca; most abundant).

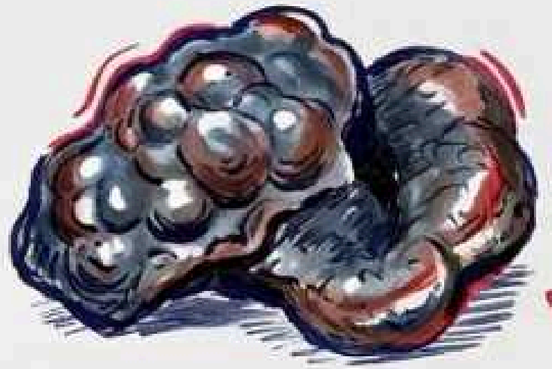
Gemini Notebook

Other Important Mineral Families

¶ 2.6



Carbonates. **Includes Calcite ($CaCO_3$).**
Forms limestone.



Oxides. **Includes Hematite & Magnetite.**
Main iron ores.



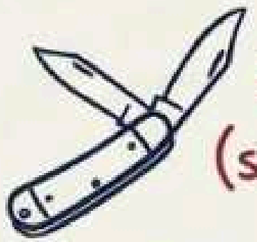
Sulfides. Includes **Pyrite** & **Galena**.
Main lead ores.



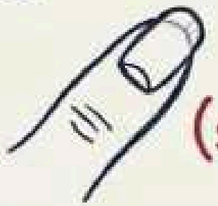
Native Elements. Single elements.
Includes **Gold (Au)**, **Copper (Cu)**, **Diamond (C)**.

Gemini Notebook

Identification: The Mohs Hardness Scale (1812)



Steel Knife
(scratches ≤ 5.5)

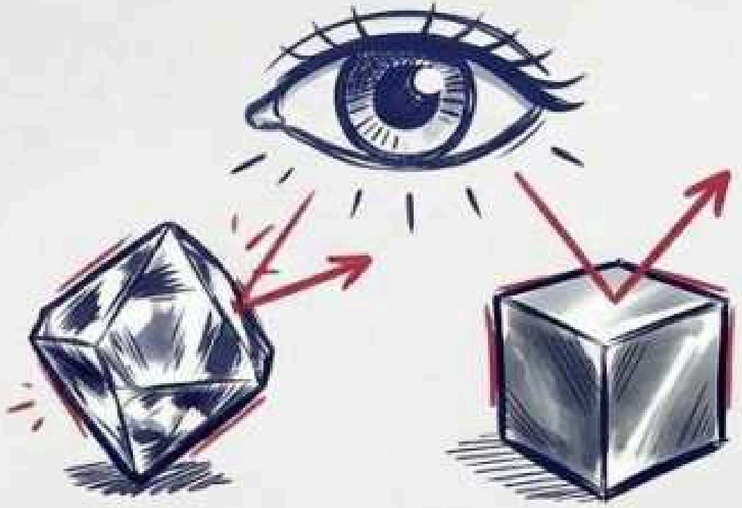


Fingernail
(scratches ≤ 2.5)

10: Diamond
9: Corundum
8: Topaz
7: Quartz
6: Orthoclase
5: Apatite
4: Fluorite
3: Calcite
2: Gypsum
1: Talc

A harder mineral scratches a softer one.

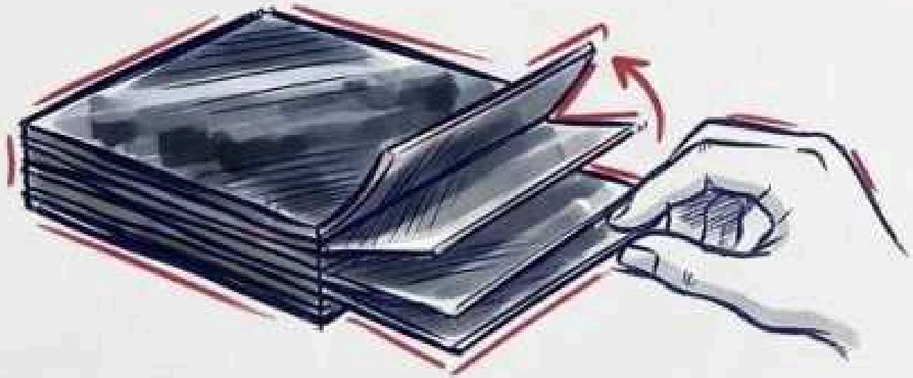
Gemini Notebook



Luster: Surface light reflection (glassy vs. metallic)



Streak: Color of the powder left on a rough white plate



Cleavage: Breaking along perfectly flat planes



Density: Gold is nearly 19x denser than water. Pyrite is only 5x.

Gemini Notebook

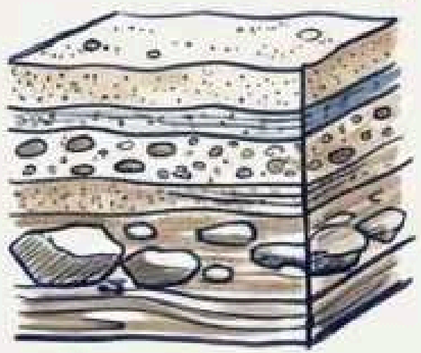
¶ 2.9

Rocks = Aggregates of Minerals





Igneous:
Molten rock cools & hardens.



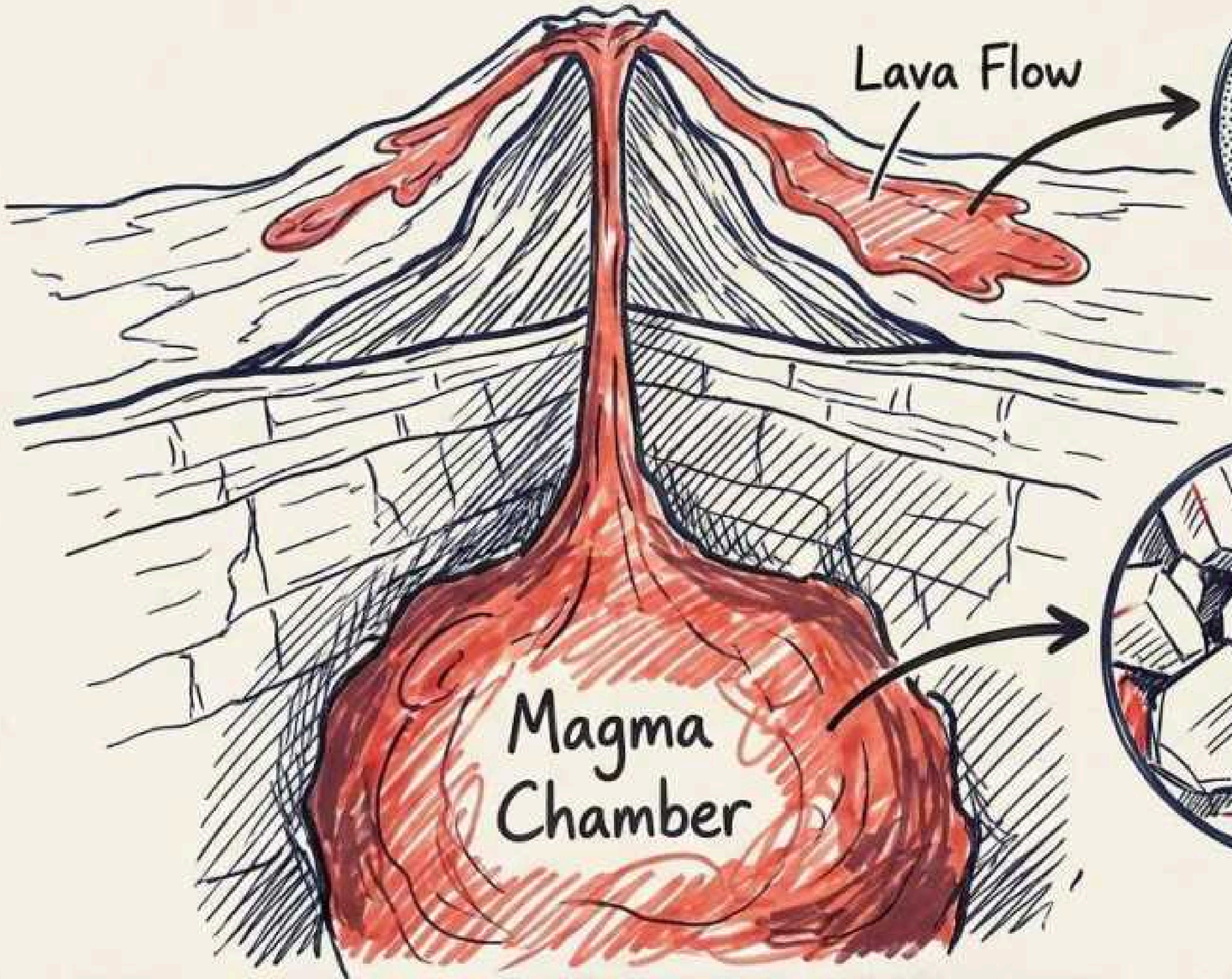
Sedimentary:
Pieces of older rock or dissolved material settle & compress.

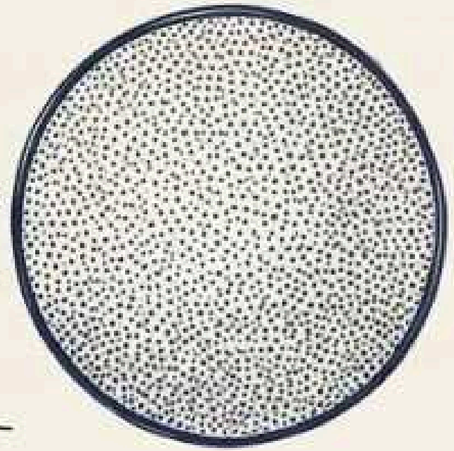


Metamorphic:
Older rocks transformed by heat & pressure (no melting).

Gemini Notebook

Igneous Rocks: Magma vs. Lava





Surface (Lava):

Cools fast
→ Tiny crystals
→ e.g., Basalt (dark ocean floor rock).



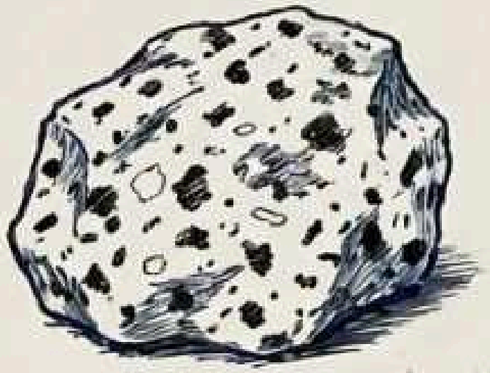
Underground (Magma):

Cools slowly
→ Large crystals have time to grow
→ e.g., Granite (coarse, speckled).

Gemini Notebook

Igneous Composition & Texture

Continental



- Silica-Rich
- Light Color
- Lower Density
- Example: Granite
- Forms most continents

Oceanic



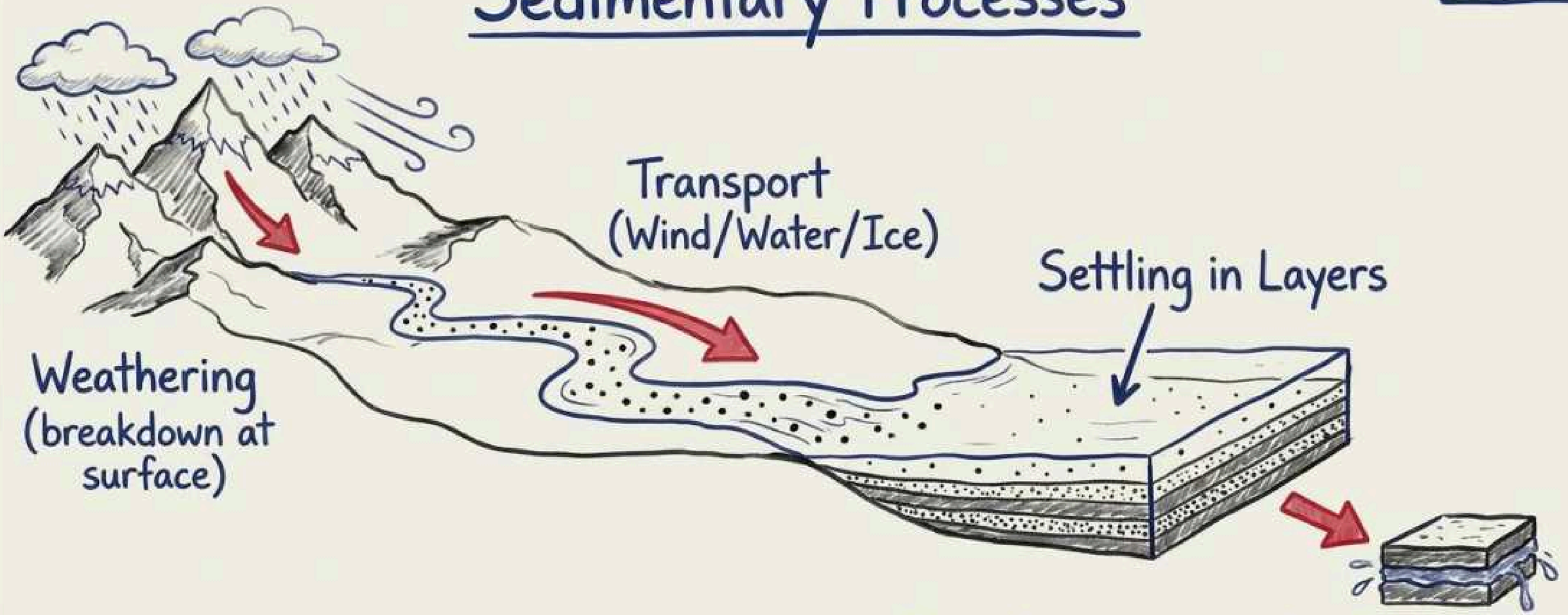
- Silica-Poor (Fe/Mg rich)
- Dark Color
- Higher Density
- Example: Basalt
- Forms oceanic crust

Note: This density difference will return in Lecture 3.

Gemini Notebook

Sedimentary Processes

¶ 2.12



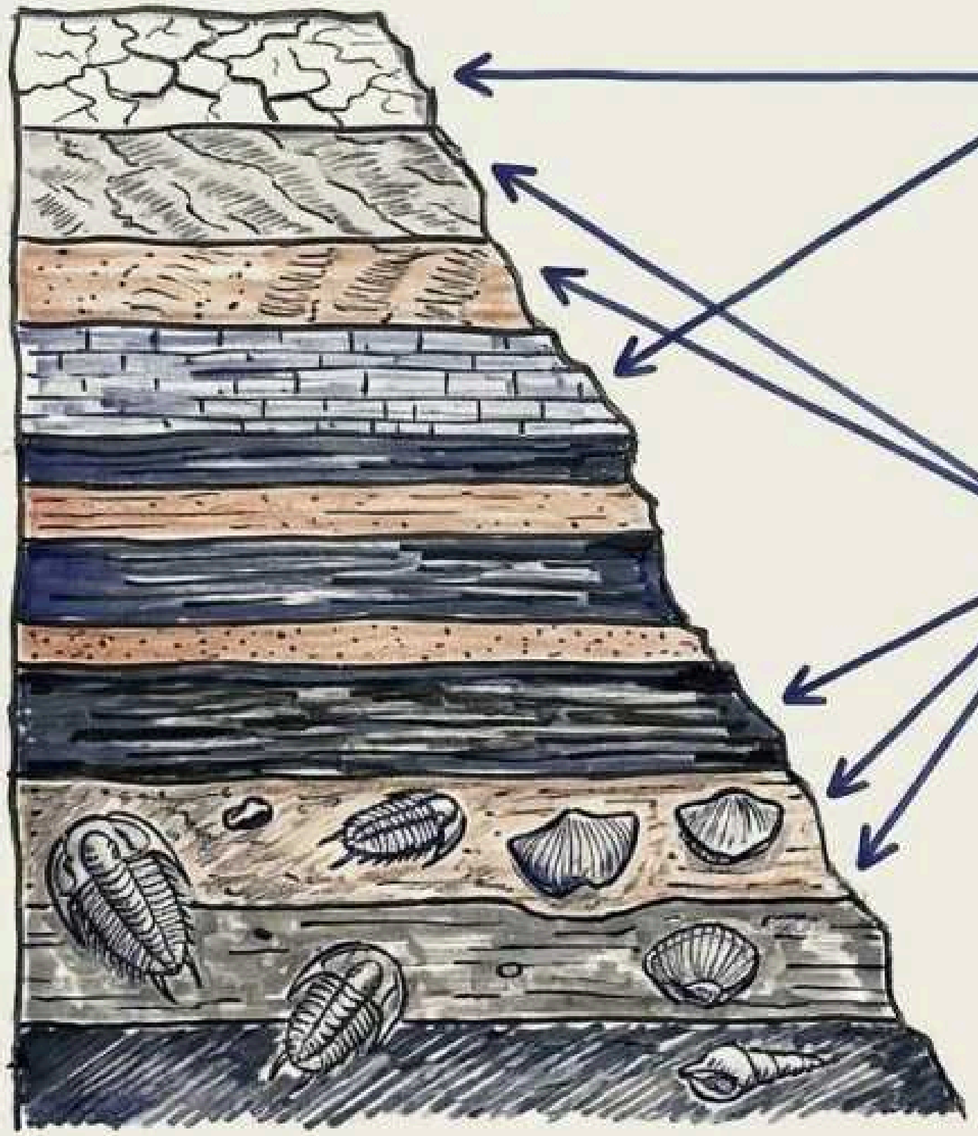
Burial (squeezes water) → Cementation

Sand → Sandstone Mud → Shale Shells/Calcium Carbonate → Limestone

Gemini Notebook

The Earth's History Book

¶ 2.13



Principle of Superposition (Steno, 1669): Oldest layer at the bottom, youngest at the top.

Features frozen in time: Fossils, ripples, mud cracks.

The Grand Canyon exposes nearly 2 billion years of layers.

Gemini Notebook

Metamorphic Transformations

¶ 2.14



Limestone → Marble

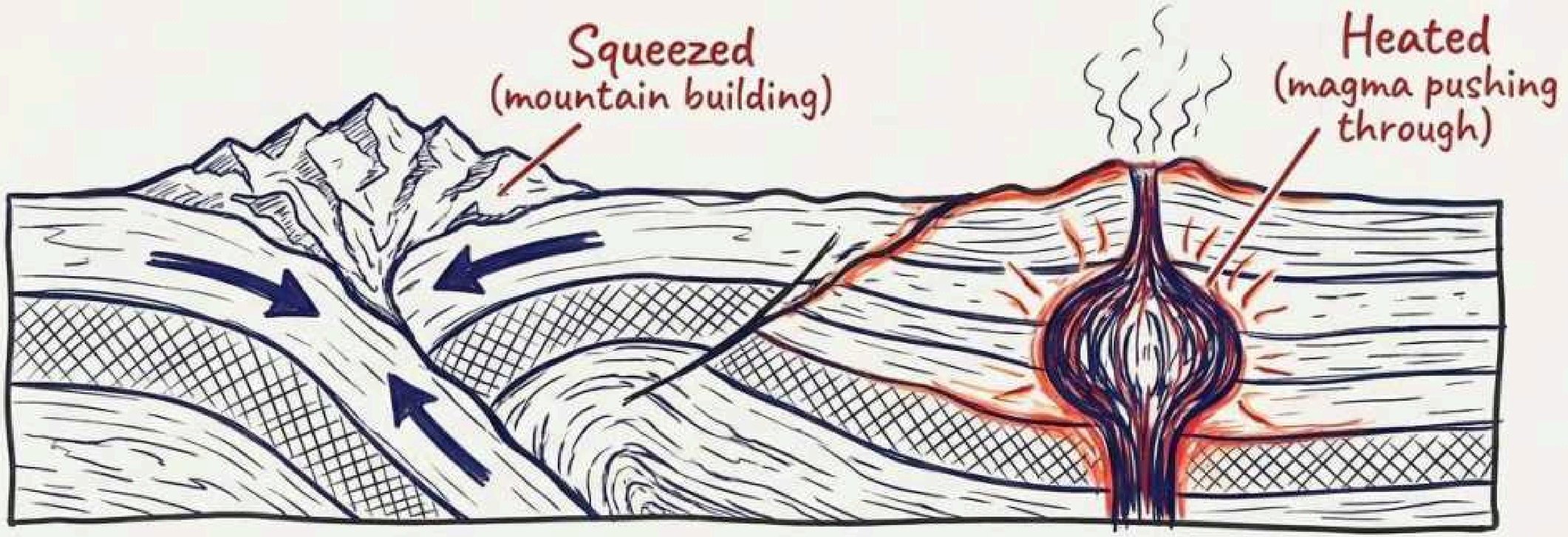
Shale → Slate
→ Schist
→ Gneiss

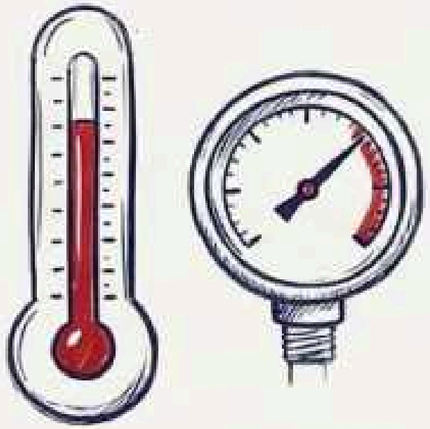
(increasing heat/pressure)

Solid-state transformation. Minerals recrystallize and align into bands. If it melts, it becomes magma (igneous).

Gemini Notebook

Where Metamorphism Happens



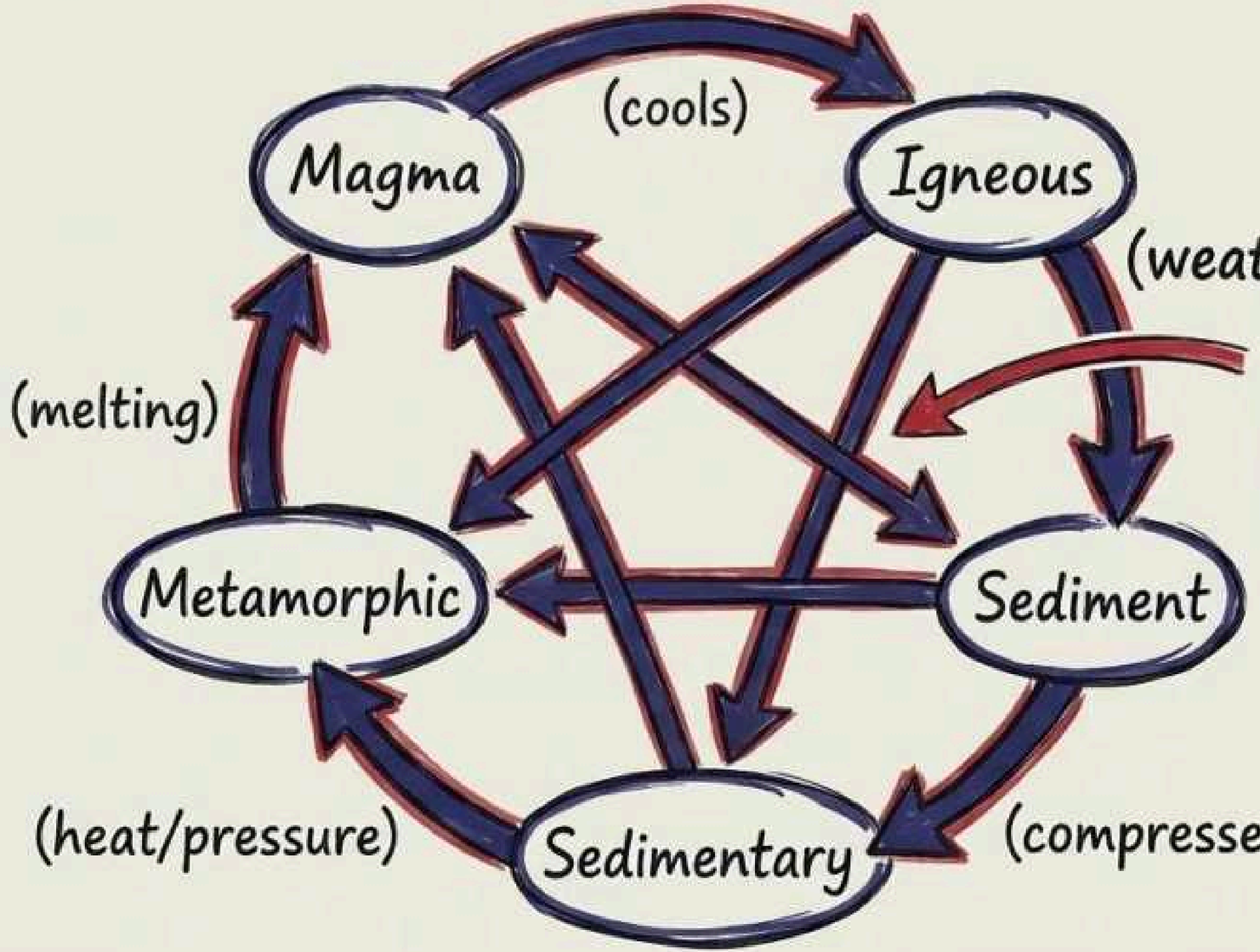


Geologic Thermometer & Gauge:
Certain minerals ONLY appear at specific temperatures/pressures. They record exactly how deeply the rock was buried.

Gemini Notebook

The Rock Cycle

¶ 2.16



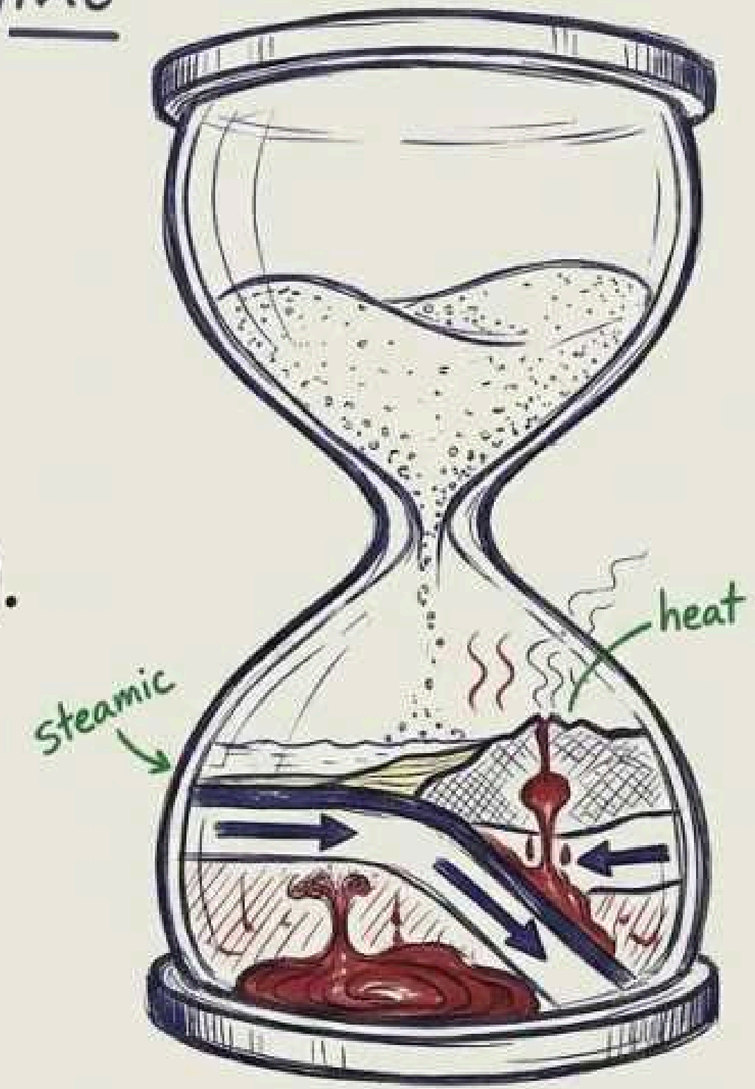
The Shortcuts:
Any rock can be weathered, buried, heated, or melted.

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Deep Time & The Engine

¶ 2.17

Time Scale:
Geological speed
(No start, no end).



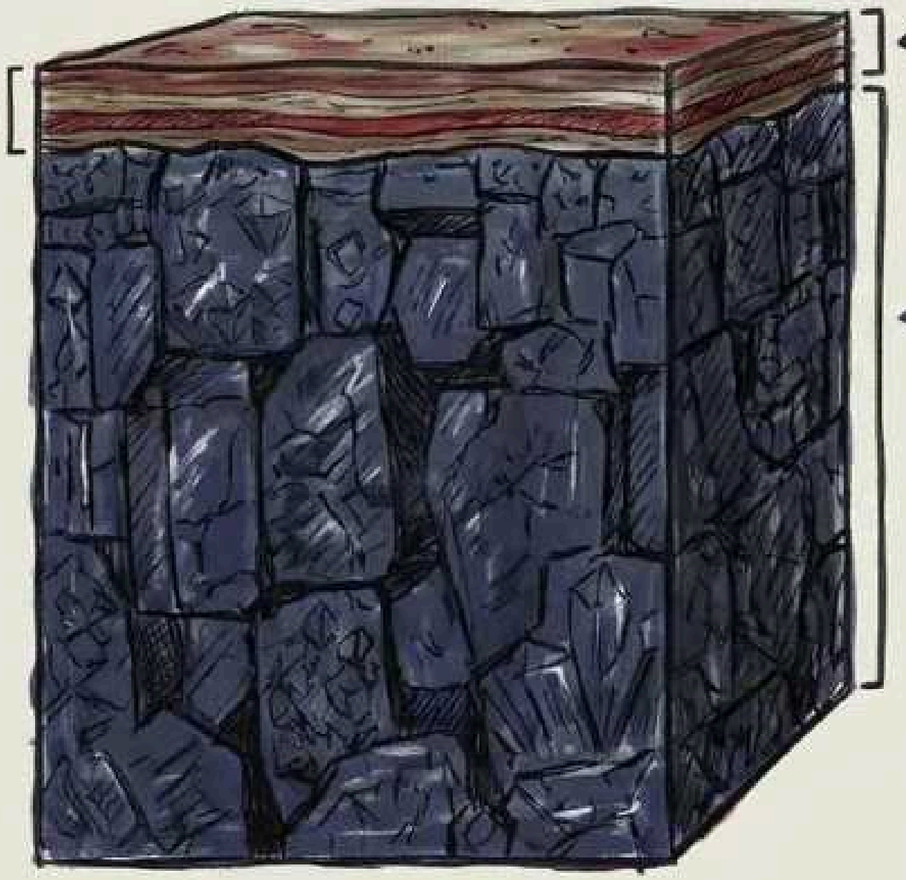
Journey of a Sand Grain:
In a mountain
(100M years ago)
→ Seafloor Sandstone
→ On a beach today.

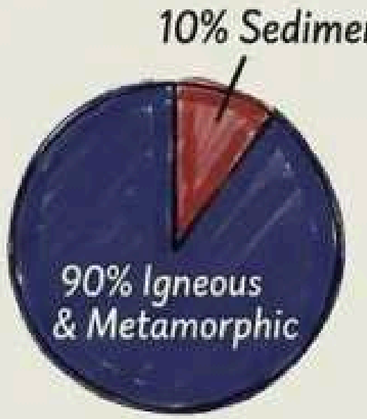
The Engine: Plate Tectonics (lifting rock up, carrying it down)

Gemini Notebook

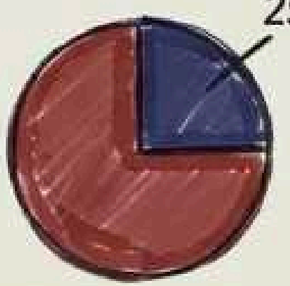
The Proportions Paradox

¶ 2.18





Volume of the Crust:
90% Igneous & Metamorphic
(The deep Crystalline Foundation).



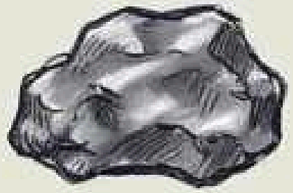
Land Surface Area:
75% Sedimentary
(The Thin Veneer).

Takeaway: What you walk on is usually just a thin veneer, not what the Earth is mostly made of.

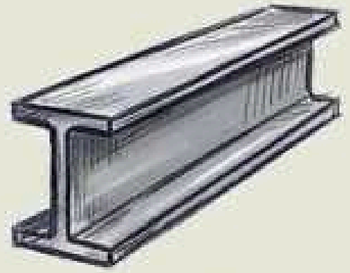
Gemini Notebook

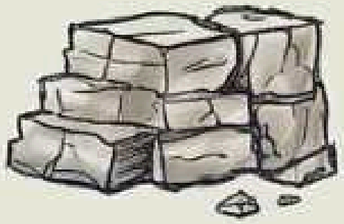
Rocks & Minerals as Resources

¶ 2.19



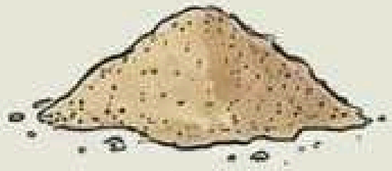
Iron Ore → Steel



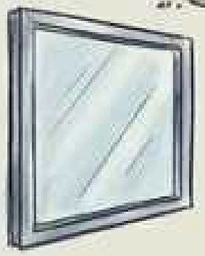


Limestone → Cement



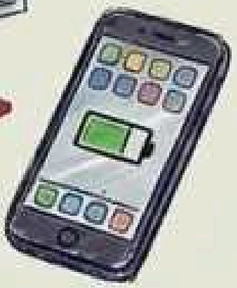


Sand → Glass





Rare Minerals → Phones & Batteries



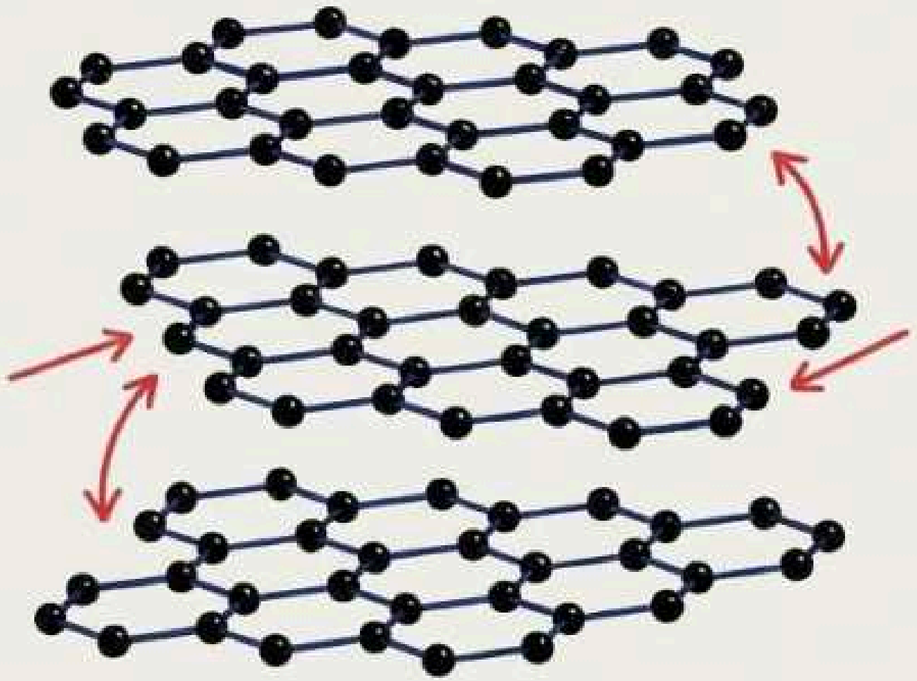
The Challenge: Ores only form where heat, water, and rock concentrate metals. Resources are finite; recycling matters.

Gemini Notebook

Structure Matters (Pure Carbon)

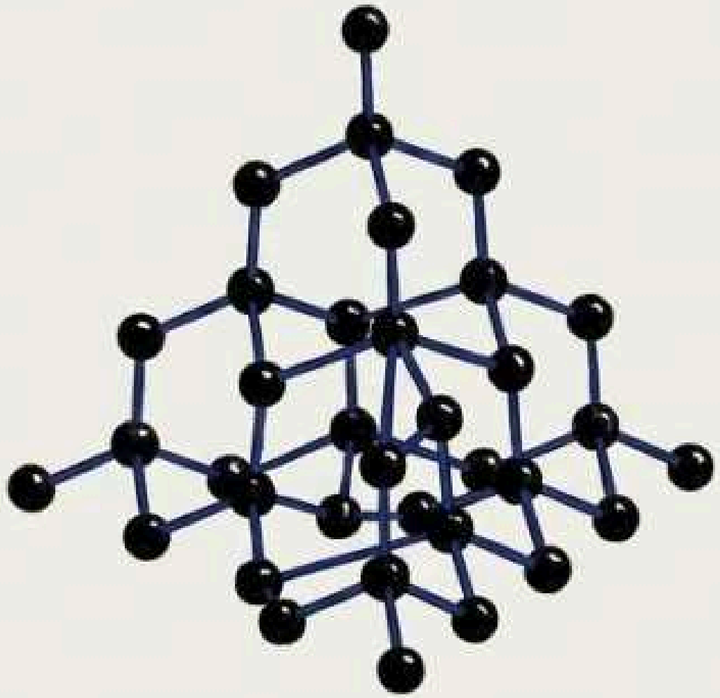
¶ 2.20

Graphite



Graphite: Loose sheets that slide over each other.
Soft (used in pencil lead)

Diamond



Diamond: Rigid 3D framework where each atom bonds to 4 others. Formed 150km deep under enormous pressure. Rises via rare volcanic kimberlite.

Gemini Notebook

The Takeaway Assignment

¶ 2.21

The Challenge:

Pick up a pebble from your street.



Task 1: Use hardness, luster, grain size, and layering to decide if it is igneous, sedimentary, or metamorphic.

Task 2: Describe one path it could take around the rock cycle over the next 100 million years (name each process on the way).

Gemini Notebook

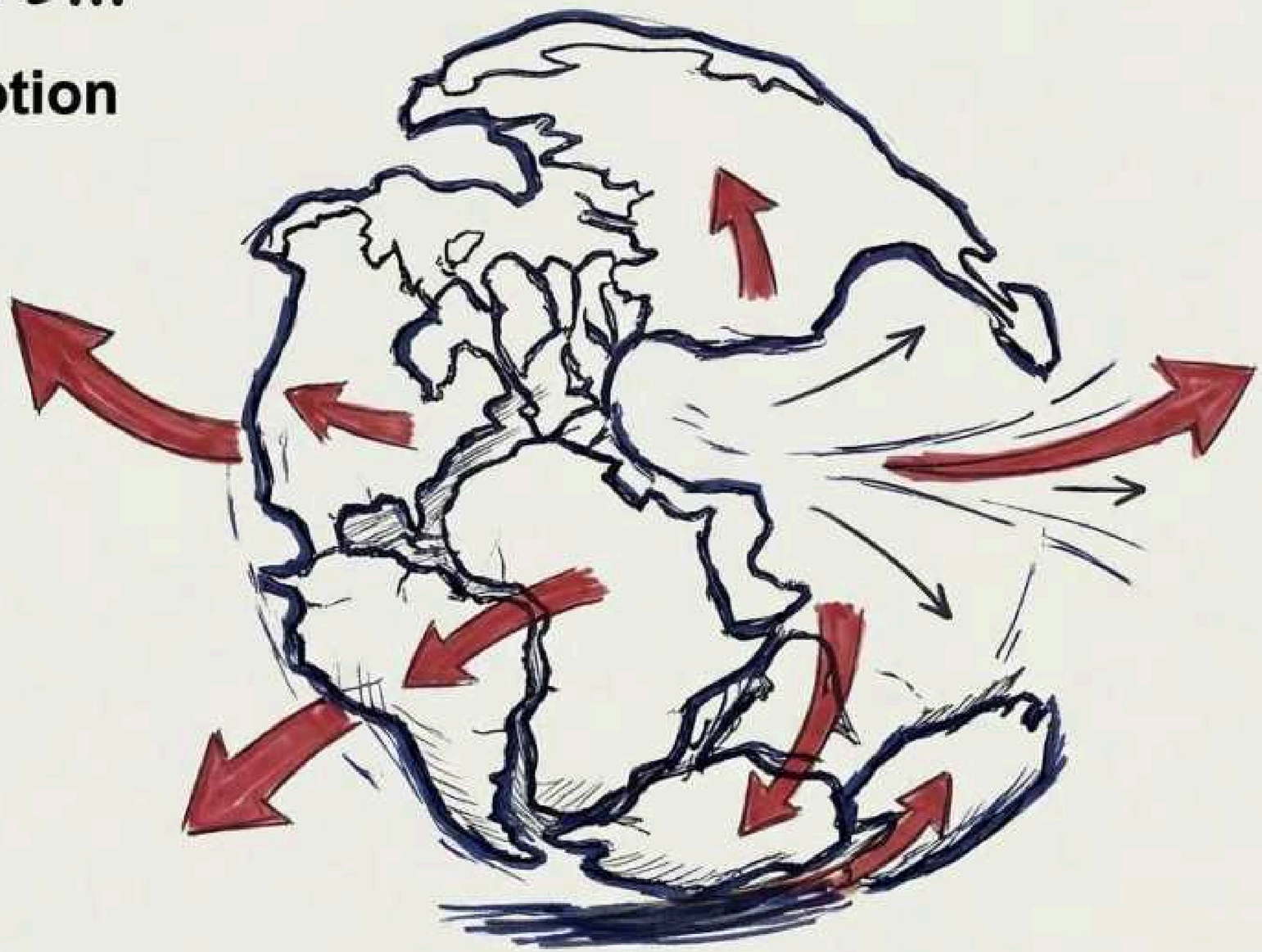
Coming up in Lecture 3...

Putting the Rocks in Motion

- How the continents drift.

- Why the ocean floor spreads.

- How tectonic plates build mountains.



Gemini Notebook