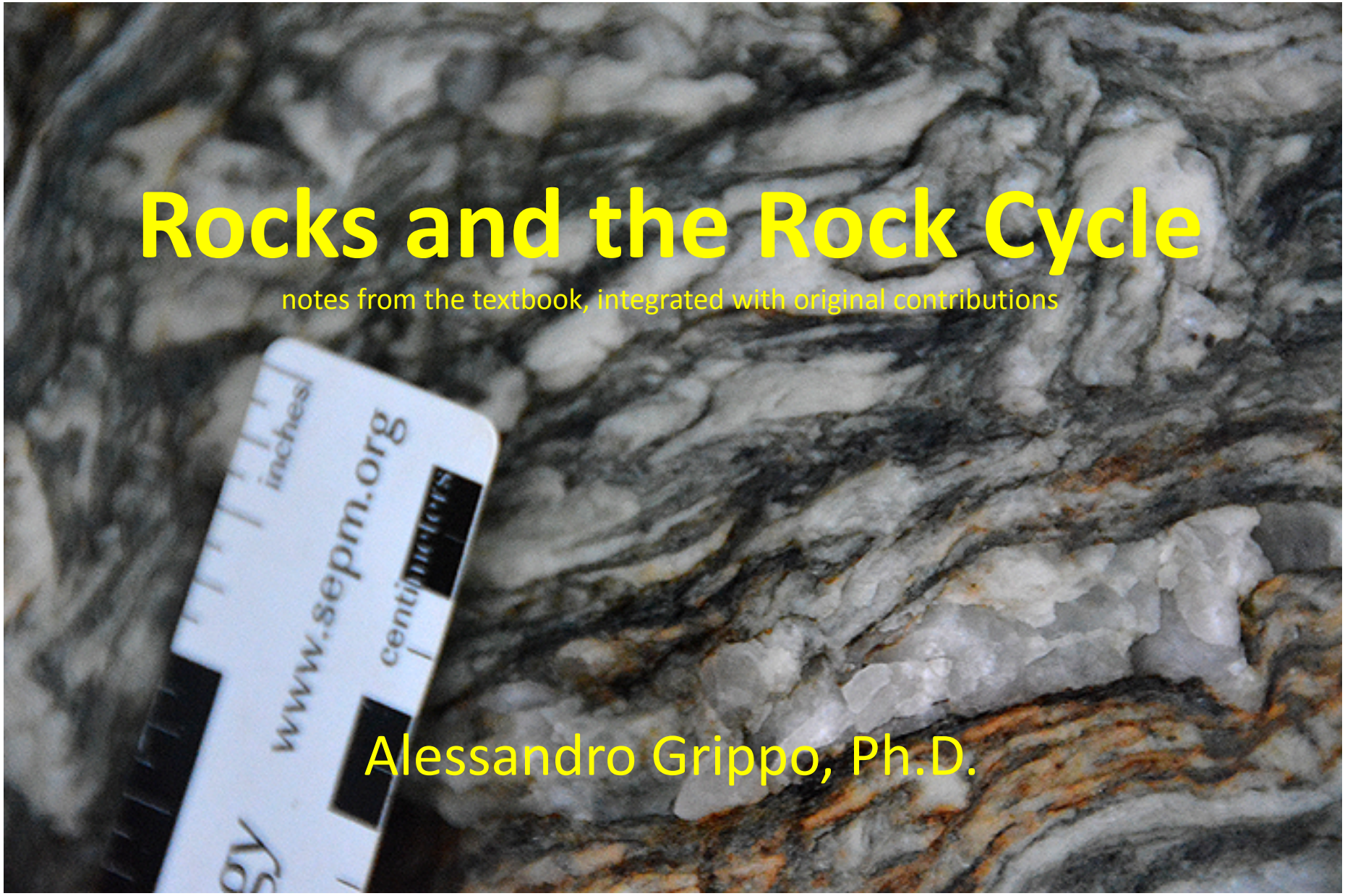
Rocks and the Rock Cycle

notes from the textbook, integrated with original contributions



Alessandro Grippo, Ph.D.

Gneiss (a metamorphic rock) from Catalina Island, California

review

- Rocks
  - naturally formed aggregates of minerals
  - can be composed of many individual minerals of the same kind (e.g., limestone) or different minerals (e.g., granite)
  - some rocks are composed of non-mineral substances (e.g., obsidian, coal)

- Minerals
  - solids
  - that are naturally occurring
  - are inorganic
  - are crystalline
  - have a specific chemical composition
  - have distinctive physical properties

Rocks

- Rocks are classified into three groups, based on the processes by which they were formed
  - igneous rocks
  - sedimentary rocks
  - metamorphic rocks

Igneous Rocks

- Solid rocks of any kind can melt in the upper mantle and in the crust, crating pockets of magma (or lava, if magma comes to the surface)
- Any rock that forms from cooling of magma or lava is called an igneous rock
- Cooling can occur slowly within Earth's surface (*intrusive igneous rocks*) or quickly at Earth's surface – for instance because of a volcanic eruption (*extrusive igneous rocks*)
- Most igneous rocks show interlocking arrangements of mineral crystals that develops as magma (or lava) cools and solidifies

Interlocking crystals in a pegmatitic granite (intrusive igneous rock)

white: Na-Plagioclase
gray: Quartz
pink: K-feldspar
black: Biotite

Sedimentary Rocks

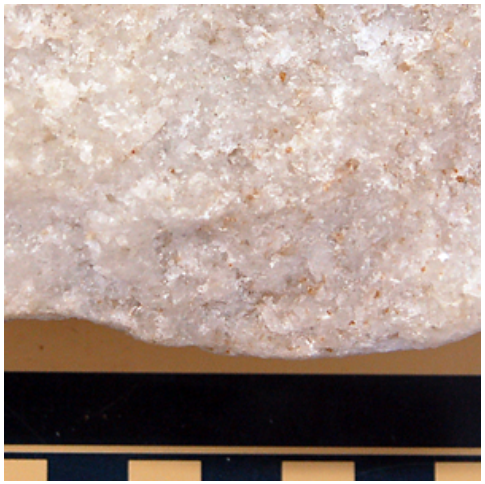
- Any rock at or near Earth's surface can be weathered into sediment
  - broken down in smaller fragments, called gravel, sand, silt, clay
  - dissolved into ions, such as Na^{+}, Ca^{2+}, K^{+}, Mg^{2+}, etc.
- Sediment is transported by running water, wind, ice; it is then deposited and turned into a sedimentary rock
- Sedimentary rocks can be clastic (detrital), chemical, organic
- They characteristically develop horizontal layers

Rounded grains of gravel are cemented in this clastic sedimentary rock called conglomerate

Metamorphic Rocks

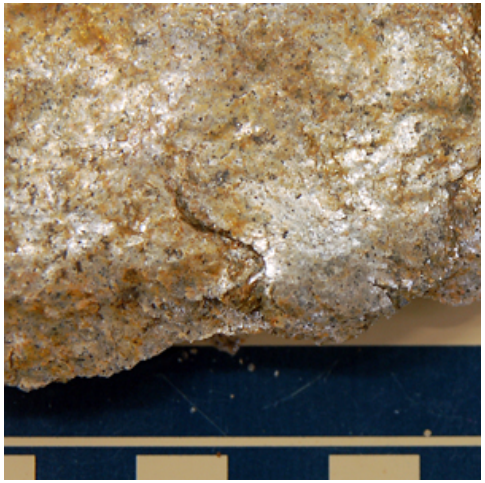
- Any rock subject to conditions that are different from those under which they originally formed, are changed, or metamorphosed as a solid (without melting, without needing water, like when you bake an apple)

- metamorphism occurs within Earth and it is mainly by contact (with a source of heat) or regional (in regions of intense, non-uniform pressure)



Above:
contact metamorphic rock (marble)

Below:
regional metamorphic rock (schist)



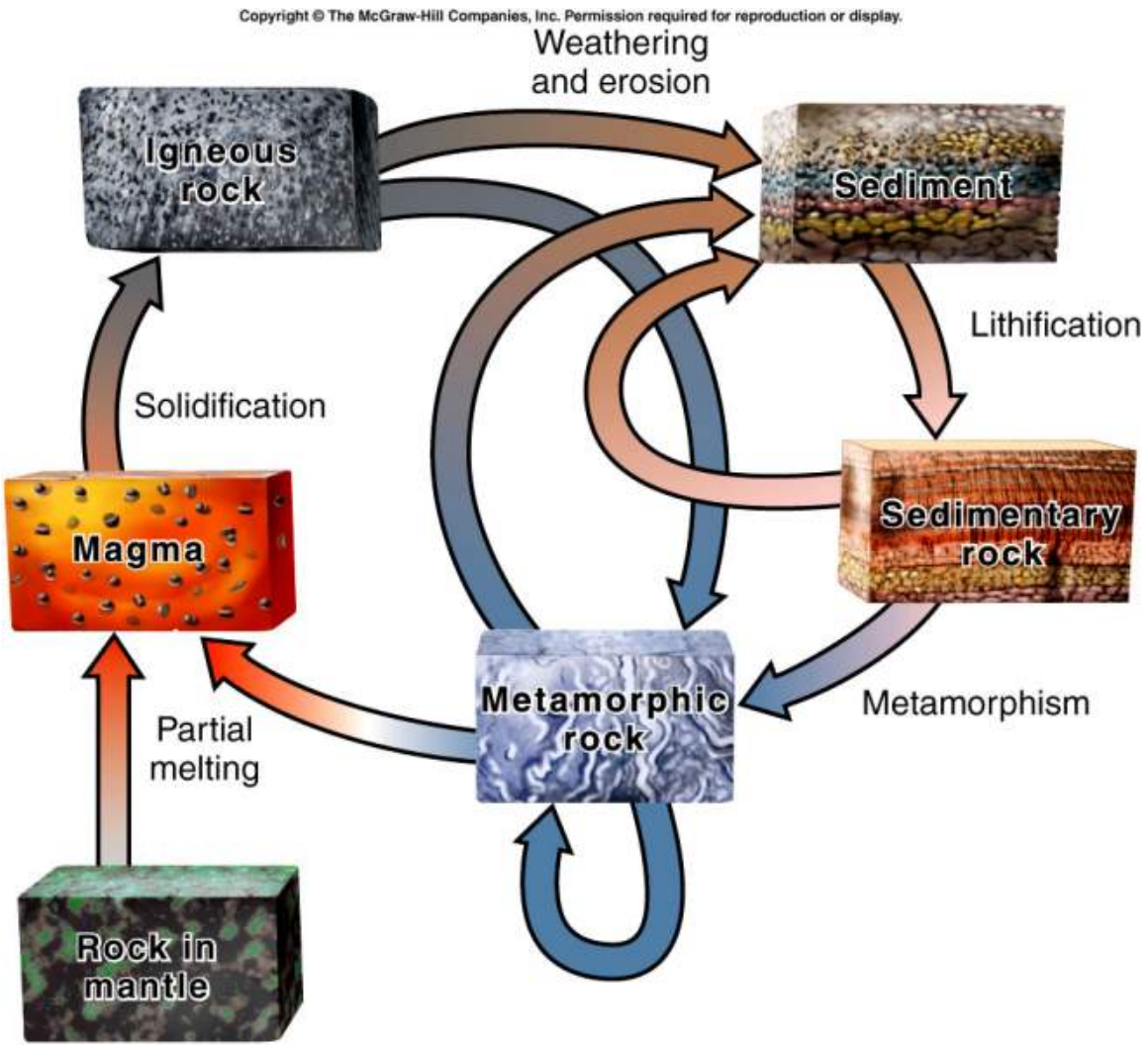
Fresh apple
vs. baked apple
(metamorphic apple)

The Rock Cycle

- We have just described how any kind of rock can be turned, given the right conditions, into any other kind of rock

- These changes can be summarized into what we call the Rock Cycle

The Rock Cycle



Rock Textures and Compositions

- Recognizing texture and composition of rocks allows us to distinguish among the three groups of igneous, sedimentary, and metamorphic

- In a few words:
  - texture is how the rock looks like
  - composition is what the rock is made of

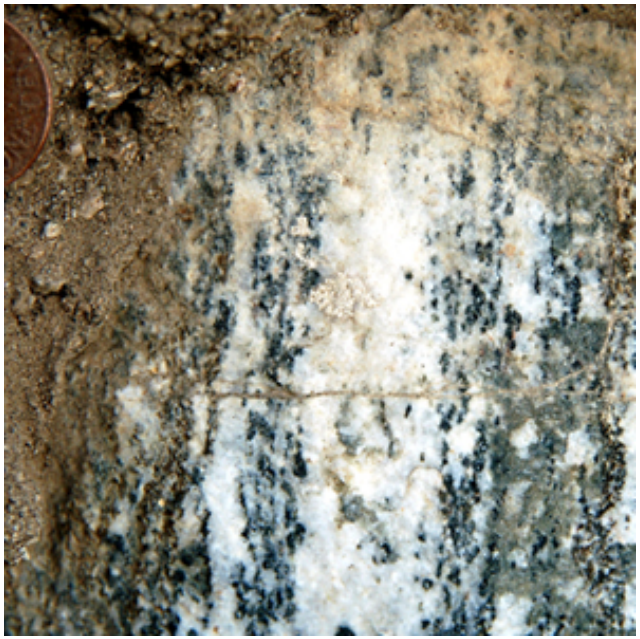
Texture

- Texture refers to the size, shape, and/or arrangement of its mineral grains
  - Igneous rocks
    - crystals (sometimes visible, sometimes microscopic, not always uniform)
  - Sedimentary rocks
    - crystals, but also fragment of previous rocks (gravel, sand, silt, clay) that are cemented together
  - Metamorphic rocks
    - crystals (usually large and uniform in size, visible)

Texture

An example of clastic texture:
grains of sand deposited over time as horizontal layers, then cemented together to form a sandstone
(a clastic sedimentary rock)

Zion National Park, Utah



An example of crystalline texture: bands of light-colored minerals (feldspars, quartz) and dark-colored minerals (biotite, amphiboles) in a gneiss
(a regional metamorphic rock)

San Gabriel Mountains, California

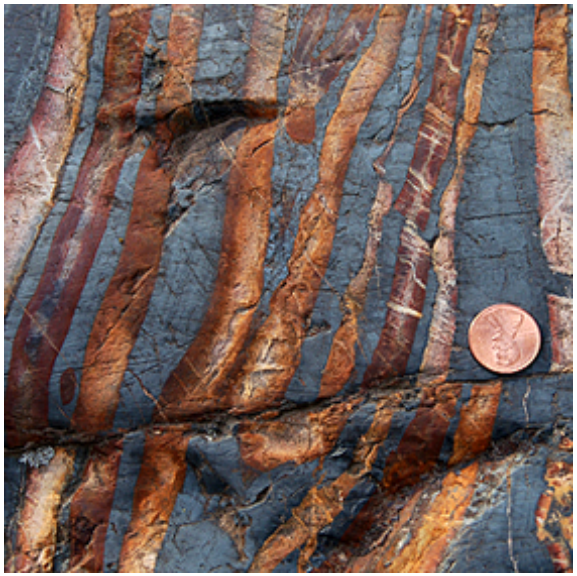
Composition

- Composition refers to the type and abundance of minerals contained in a rock
  - Large minerals can be identified by sight
  - Small minerals can be identified through a hand lens
  - Extremely small minerals can be identified with a microscope
  - All minerals have characteristic physical properties
  - Some minerals have distinct diagnostic properties
  - Ultimately, a composition is rendered through a chemical formula and a name:
    - Quartz SiO_2 Calcite $CaCO_3$ Hematite Fe_2O_3 Olivine $(Fe,Mg)_2SiO_4$

Composition

Black bands of chert (SiO_2) alternating with red bands of hematite (Fe_2O_3)

Banded Iron Formations, Minnesota

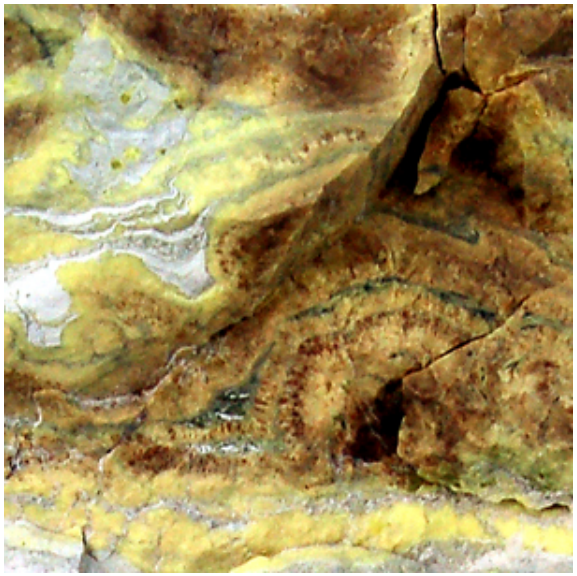


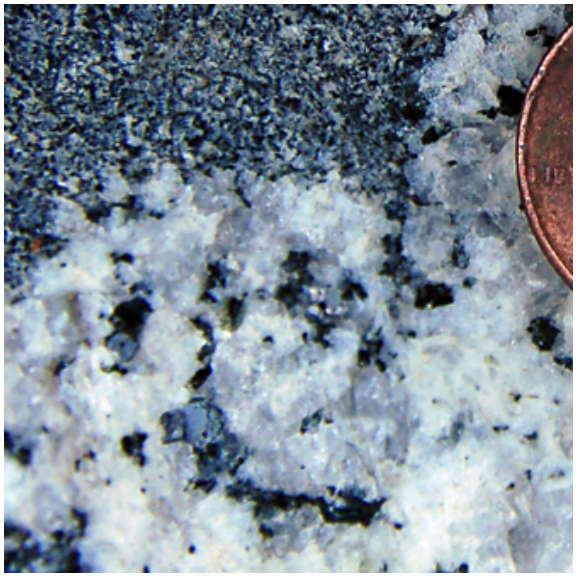
Tubular structures of halite (NaCl), aka table salt

Searles Lake, Trona, California

Yellow bands and crystals of sulfur (S)

Death Valley, California





Two sizes of crystals in granite: quartz (SiO_2), Na-plagioclase ($NaAlSi_3O_8$), and hornblende $(Ca,Na)_2(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH)_2$

Sierra Nevada, Bishop, California

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