LECTURE #3: Rocks & the Rock Cycle

Date: 27 January 2021

I. Remainder of Lecture #2

- *we are a bit behind in the lectures and I will finish the notes from lecture #2 first and then begin today's topic (below)*

II. Rock Types

- *why do we care about rocks for a course in Natural Disasters!?*
  - certain minerals, rock compositions and rock textures can tell a geologist a lot about the hazardous conditions present in the past, for example:
    - the explosive potential of a nearby volcano
    - the ability of rocks/soil to absorb water during a flood
    - the composition of rocks and their orientation as potential landslide locations
    - *others that you can think of?*

- so what is a rock?
  - rock: a naturally occurring solid made of one or more minerals *or other solid substances*
    - this is a simpler and more open definition than we had for a mineral

  - examples: sandstone that is made of only quartz mineral grains is a rock, a limestone that is made up of only fossils *(living matter)* is also a rock
    - is coal a rock?? _____
    - why/why not?

- Igneous Rocks
  - form when molten (melted) rock cools and solidifies either under or on the Earth's surface
    - solidifies underground then cools slowly: large mineral crystals form
    - solidifies on the surface then it cools very quickly: glass forms
    - solidifies slowly (but only partially) underground *and then* erupts: large mineral crystals in a finer-grain matrix
      - known as a *porphyritic* texture

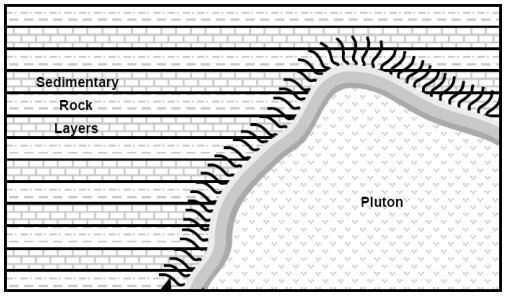
    - with a large amount of water present in the magma
      - very explosive volcanoes

    - with little water present in the magma
      - very effusive *(non-explosive)* volcanoes

- range of igneous rock types
  - from light to dark minerals, extrusive vs. intrusive cooling, etc.
    - ➢ <u>intrusive:</u> slow-cooling rock with many large grains
    - ➢ <u>extrusive:</u> fast-cooling rock with many small grains
  - granite *(intrusive)*
    - ➢ average composition of the continental crust
    - ➢ more light-colored grains
  - gabbro *(intrusive)*
    - ➢ average composition of the oceanic crust
    - ➢ mostly dark-colored grains

granite

- <u>Metamorphic Rocks</u>
  - form when an existing rock of *any* rock type re-crystallizes (but does **<u>not</u>** melt)
  - it experiences elevated temperatures and/or pressures
    - known as a "solid-state transformation"
  - a rock that is metamorphosed starts as a "parent" rock first
  - *parent rock:* *metamorphic rock*
    - limestone → _____
    - shale → _____
    - sandstone → _____
  - contact metamorphism
    - high temperature (T), low pressure (P)
    - occurs where a hot magma intrudes colder rocks
    - "cooks" the surrounding host rocks *(aka, country rocks)*
    - no foliation (banding) present in these



  - regional metamorphism
    - high T and high P
    - occurs where continental collisions form mountain belts
    - deep core of the mountains experience much higher temperatures and pressures
    - results in foliation of minerals
      - ➢ light/dark bands

- Sedimentary Rocks
  - form on/near the Earth's surface or under the oceans
  - accumulation of fragments of other rocks *(e.g., sandstones)*
  - fragments of organic remains *(fossil plants, shells, bones)*
  - solids precipitated from liquids *(e.g., salt)*
  - mechanical formation style
    - lithification of sediments/rock fragments
    - examples:
      - sandstones
      - mudstones
      - shales
      - breccia

  - chemical formation style
    - evaporation, precipitation of minerals from a liquid like water
    - examples:
      - limestone ($CaCO_3$)
      - gypsum ($CaSO_4 \cdot 2H_2O$)
      - salt (NaCl)

    - $CaCO_3$ → very important when it comes to carbon-cycle!
    - *why?*

- recycling of rocks (occurs from weathering and Plate Tectonics)
  - we will examine Plate Tectonics next week
  - there is a difference between the rocks of the oceanic and continental crust
    - age and composition are two important distinctions
    - oldest continental rocks are 3-4 billion and found in areas known as *cratons*
    - cratons:
      - located in the continental interiors
      - the earliest crust (proto-continents)
      - new material constantly being added to the cratons: *from volcanoes*
      - material constantly being removed from the cratons: *from erosion*

III. The Rock Cycle

- processes:
  - each and every rock, no matter how dull looking, came into existence as the result of some process
  - deciphering the rock allows us to recognize that process, and therefore:
    - how it worked in the past
    - and how the Earth works today
    - because each mineral forms under specific conditions
      - geologists use the minerals to identify the rocks
      - and the rocks origin stories

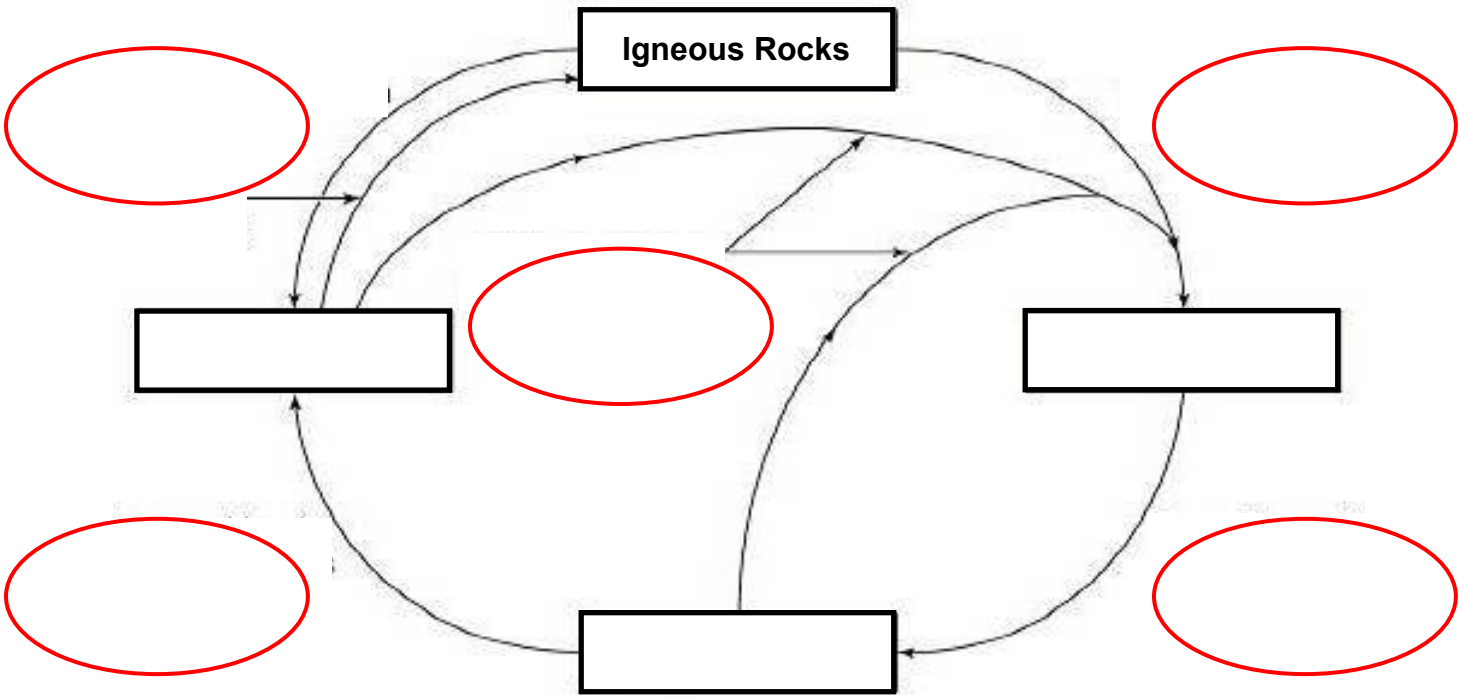
- describes pathways of the rock-formation process
  - consequence of Plate Tectonics

- estimated time of about 100 million years per cycle
  - much longer than the time elements are in the atmosphere or ocean!
  - much longer at continental interiors *(cratons)*

- not a completely closed loop
  - new input and exit pathways for rock material

- most material has been recycled many times from continent to the mantle
  - complete crustal replenishment every 2-3 billion years

- *we will fill out the missing blanks in the Rock Cycle below during lecture:*



IV. Informal Exercise/Homework:

- informal exercise: what rock types do you see when entering the Cathedral of Learning?
  - _____
  - _____