1. **Overview of Class/Introduction to Geology**
   - Science and Scientific Inquiry*
   - How we do science (scientific method)*
   - Distinguish between hypothesis and theory
   - The impact of geology on society (population, resources, hazards, etc.)
   - Understand the effect people can have on their surroundings
   - Be able to summarize the general aspects of the Earth’s major systems (plate tectonics, hydrologic cycle, rock cycle)
   - Origins of modern geology (neptunism v. plutonism; catastrophism v. uniformitarianism)
   - Know what geologists do* (what kinds of problems they study, how they study these, kinds of geologists, kinds of jobs, importance to society)

2. **Plate Tectonics**
   - Be able to summarize the basic idea of plate tectonics (earth divided into plates that move relative to one another along three types of boundaries)
   - The relation between plate tectonics, the locations of earthquakes, volcanoes, and mountain belts
   - Be able to sketch and label different types of plate boundaries (divergent, convergent, and transform), indicating some of the important processes that occur along each boundary
   - Be able to sketch or summarize the main tectonic features (rifts, mid-ocean ridges, trenches, island arcs, continental shelves, passive margins, mountain belts, hot-spot island chains) and the plate-tectonic setting of how each forms
   - Evidence for continental drift
   - Sketch and label a series of cross sections illustrating the stages of continental rifting and formation of a new ocean basin
   - General impression of which continents used to be attached to one another

3. **Minerals and Matter**
   - Parts of an atom
   - How the number of electrons in an electron shell of an atom influences its charge and whether the atom will from bonds
   - Be able to sketch the different types of bonding (how they work, not the names)
   - The three most common elements in the crust
   - Silicates and silicate structures
   - The most common rock-forming minerals
   - Know what some specific minerals are used for
   - How you might identify a beautiful mineral you find on a hike

4. **Igneous Rocks and Processes**
   - The different ways that heat is transferred (conduct, radiate, convect)*
   - Geothermal gradient*
   - How rocks melt (atomic processes and plate-tectonic settings)
   - Be able to sketch the relation of igneous activity to plate tectonics (what causes melting at mid-ocean ridges v. subduction zones)
   - The four types of igneous rocks and where they are most abundant: felsic (e.g. granitic) = continent; intermediate (e.g. andesitic) = volcanic arc; mafic (e.g. basaltic)= oceanic crust; ultramafic = mantle
   - How the grain size of an igneous rock is related to its cooling rate
   - The difference in appearance of an igneous rock formed from volcanic explosions v. those formed from solidifying magma

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1 Note: Also review any topics covered in a “highlight box” in the textbook.
• The processes that accompany crystallization of a magma (fractional crystallization, crystal settling)
• How we classify igneous rocks (composition and texture)
• How to distinguish from a distance volcanic rocks from plutonic rocks
• Ways that mineral deposits can be formed by igneous-related processes

5. Volcanoes and Volcanic Hazards
• Plate-tectonic settings of felsic, intermediate, and mafic magmas, and the different kinds of volcanoes they form
• Factors that influence how explosive an eruption will be (composition-viscosity, gasses, local factors*)
• Be able to sketch and label different types of volcanoes (shield, cinder cone, composite, caldera) and describe how each forms
• Different types of volcanic hazards
• How we might predict and/or cope with volcanic hazards
• Why volcanic activity affects climate
• How eruption forecasting is done
• Benefits from volcanoes
• Where igneous rocks are found in Arizona*
• Locations of the most recent volcanic activity in Arizona*

6. Weathering and Soils
• Understand the distinction between chemical and mechanical weathering
• Be able to sketch different types of mechanical weathering
• The main products of weathering (quartz, clay, iron oxides, material that ends up dissolved in water) and where these things go after they are formed
• Factors that influence weathering
• Controls on soils formation and why different types of soils form in different climates
• Differences between the upper, middle, and lower parts of soil
• How clay minerals in soils can cause damage to structures or roads

7. Sedimentary Rocks and Processes
• Difference between detrital (clastic) and chemical sedimentary rocks
• How sediments are produced, transported, and deposited
• Modern sedimentary environments and the types of sedimentary deposits each produces (steep mountain fronts, rivers, deltas, swamps, lakes, reefs, beaches, sand dunes, glaciers)
• How we can read the environment in which a sedimentary rock was formed (size, shape, and types of clasts, fossils, sedimentary structures)
• How sediment is turned into rock
• How sedimentary rocks are classified
• Different types of cement (calcite, silica, iron oxide)
• How sedimentary facies explain how a single area can contain a sequence of many different sedimentary rock types
• Where the majority of sedimentary rocks are located in Arizona*

8. Metamorphism and Metamorphic Rocks
• Main processes associated with metamorphism and how these change rocks
• Be able to sketch and label the setting for different kinds of metamorphism (burial, regional, contact, hydrothermal, shock)
• Know main types of metamorphic rocks and how they are classified
• How rocks are changed by metamorphism
• Be able to match an original rock type with its metamorphic equivalent (e.g. shale = slate and schist, limestone = marble, sandstone = quartzite)
• How metamorphism is associated with mineral deposits
• Be able to sketch the geologic and plate-tectonic settings of metamorphism
• Where in Arizona metamorphic rocks are exposed*
9. Geologic Time
   - A general understanding for the magnitude of geologic time
   - Be able to sketch and explain the main principles of relative dating
   - Be able to use the principles of relative dating to determine the sequence of events expressed in a landscape
   - Be able to sketch and describe the significance of unconformities
   - How we might correlate a rock layer in one place to a rock layer in another place
   - How radiometric dating works
   - Be able to calculate the age of a rock if given the half life of radioactive decay and the relative abundances of parent v. daughter atoms
   - Main chapters in Earth’s history and what type of life each is known for (Precambrian = primitive life, Paleozoic = age of fishes, Mesozoic = age of dinosaurs, Cenozoic = age of mammals)
   - The order in which the main types of life appeared on Earth*
   - How the fossil record and stratigraphic rock relationships help determine relative ages

10. Crustal Deformation
    - Be able to sketch main types of folds (anticline, syncline, monocline) and the direction of stress involved
    - Be able to sketch different types of faults (normal, reverse, strike slip) and the direction of stress involved for each
    - Plate-tectonic settings for normal faults v. reverse faults v. strike-slip faults
    - How to interpret strike and dip symbols on a geologic map
    - How each of the following factors influences whether a rock flows or fractures: temperature, pressure, rock type, strain rate

11. Earthquakes
    - What causes earthquakes
    - Where most earthquakes occur
    - How we determine the location of an earthquake using seismographs
    - Why most earthquakes are distributed across the Earth in belts (the relationship of earthquakes to plate boundaries)
    - Whether each type of plate boundary (divergent, convergent, transform) has deep earthquakes in addition to shallow earthquakes
    - Which types of plate boundaries have the largest earthquakes
    - How magnitude is measured and relates to energy released
    - How to use eyewitness accounts of earthquake damage (Mercalli Intensity Scale) to study historic earthquakes*
    - Hazards associated with earthquakes
    - Controls on how destructive an earthquake might be
    - How to tell how often a fault may produce earthquakes*
    - Difficulties in predicting earthquakes
    - How human activity can cause earthquakes
    - How we might predict/anticipate/plan for earthquakes
    - History of earthquakes in Arizona and future earthquake potential*

12. Earth’s Interior
    - Be able to sketch and describe the main layers in the Earth
    - How we study what’s beneath the surface of the Earth
    - The nature of seismic waves (P- and S-waves)
    - How seismic waves move through Earth’s different boundaries (reflection, refraction)
    - How heat flows in crust and mantle, and sources of heat
    - How Earth’s magnetic field is generated and its history
13. Divergent Boundaries and the Ocean Floor
- Main type of large features found on the seafloor (trenches, ridges, fracture zones, seamounts) and how each forms
- Sketch a mid-ocean ridge, showing how it forms an ophiolite
- Difference between a passive and active continental margin
- Understand how it is determined that the magnetic field has flipped back and forth over geologic time
- Are ocean basins young or old, and why?
- Development of submarine canyons and turbidity currents
- The importance of submarine hydrothermal vents in permitting unusual life forms to survive

14. Convergent Boundaries, Mountain Building, and the Evolution of Continents
- Be able to sketch the various ways you can make a mountain (build a volcano, faulting, folding, erode everything around)*
- Plate tectonic settings that form mountain belts
- How isostasy works and how it relates to the different types of folds and faults*
- How the main mountain belts of the world formed (Alps, Himalayas, Andes, Appalachian, Rockies)*
- How continents form and grow
- Why northern Arizona looks different than southern Arizona*

15. Mass Wasting
- Significance of the angle of repose for land-use planning*
- Sketch different types of mass movement (falls, slides, slump, creep) and understand why they occur
- Causes of mass movement
- The role of gravity and water in mass movement
- How to recognize and prevent slope instability and mass wasting
- Avoiding and preventing mass-movement disasters

16. Running Water–Streams and Floods
- Be able to sketch and label the hydrologic cycle
- Be able to sketch map views of main features formed by streams (floodplain, delta, alluvial fans, terraces)
- Be able to sketch map views of different types of streams (braided, meandering, straight)
- Be able to sketch how water velocity varies in a meandering stream and where deposition and erosion occur
- How streams erode and transport material
- Significance of gradient, discharge, and base level
- Be able to calculate discharge and gradient of a stream
- What happens to width, depth, discharge, and velocity downstream
- Manifestations of a flood (flow in channel, erosion of bank, flooding out of channel)
- How the frequency of flooding is determined
- Controlling or predicting floods
- Water resources of Arizona*
- The origin and societal significance of a floodplain*

17. Groundwater
- What is groundwater
- How groundwater accumulates and flows
- Sketch a typical geometry of the water table and discuss its significance
- How porosity and permeability influence whether a rock is a good aquifer
- Types of materials (rocks and unconsolidated deposits) that make for a good groundwater supply
- Springs, artesian springs, wells, and geysers
- How caves and sinkholes form
- How to find groundwater*
- Factors affecting groundwater quality
18. Glaciers and Glaciation

- What is a glacier
- How glaciers form and move
- Compare alpine v. continental glaciers and the resulting landscapes
- Glacial deposits
- Possible causes of glaciation
- Earth’s glacial history*
- Effects of glaciation on sea level and life
- Global warming

19. Deserts and Wind

- Why it rains*
- Types of deserts and why they form (factors that contribute to desert formation)
- Desertification and its impact on humans
- Features of desert landscapes (dunes, pavement, pediments, fans)
- Do not memorize different types of sand dunes!

21. Energy and Mineral Resources

Mineral Resources

- Metallic v. industrial mineral resources
- Geologic settings of gold, copper, diamonds
- The story of copper mining and its environmental problems*
- The setting where porphyry copper deposits (like those in Arizona) form*
- What a mineral resource is and how reserves are defined
- Economic and political factors that influence whether a mineral deposit can be mined

Energy Resources

- How petroleum forms and migrates
- Oil sands and oil shale
- Be able to sketch different settings that trap fossil fuels* (anticlines, salt domes, faults, sedimentary lenses, unconformities)
- How coal forms and where you might look for it
- The impacts of using fossil fuels on the environment
- Renewable v. nonrenewable resources
- Meeting our future use for natural resources

Alternative Energy Sources

- Nuclear energy
- Solar energy
- Wind energy
- Hydroelectric power
- Geothermal energy
- Tidal power
- Energy sources used in Arizona*