GLG 101 – CHAPTER 22 - EARTH'S EVOLUTION THROUGH GEOLOGIC TIME

- Elements in the Earth (and everything on it) began forming during the *Big Bang* at the start of our universe, which astronomers estimate to have occurred around 13.7 billion years ago. This occurred about 9 billion years *before* the formation of our solar nebula (think *Nebular Hypothesis*), perhaps by a more localized Supernova explosion.
- Earth and the other planets (and our Sun) began forming from the solar nebula about 4.6 billion years ago. Once Earth grew to nearly its present size (by *accretion* of meteoritic/planetesimal materials), it was hot enough that it was partly or entirely molten, allowing the metallic materials (mostly iron) to sink to its core and the silicate (rocky) materials to concentrate above them to form the mantle and crust.
- Earth's early crust and atmosphere, as well as the water in its oceans, originated from igneous processes (volcanism and intrusions). Ions dissolved in the volcanic water vapor, as well as dissolved into running water flowing across the surface, produced the saltiness of the oceans, which filled in the low areas on the surface as massive rains reduced what was initially total cloud cover over the early Earth. Most of the rest of the early atmosphere would have been carbon dioxide (CO_2), leading to a massive *greenhouse effect* and high surface temperatures (many hundreds of degrees).
- According to chemical evidence and microscopic fossils, primitive life began on Earth by 3.8 billion years ago (possibly earlier). Photosynthesizing bacteria began to release oxygen into Earth's atmosphere by around 3.5 billion years ago – after over a billion years, enough oxygen had been released to oxidize massive amounts of iron dissolved into the seas up to that point, forming massive quantities of *banded iron formations*, which are mined today as sources of iron ore. Once the iron oxidized in this way, free oxygen (O_2) was finally able to build up in the atmosphere starting a little over 2 billion years ago, setting the stage for larger oxygen-breathing life forms later on.
- During the *Precambrian* period (which makes up nearly the first 90% of Earth's history), most of the continental crust formed by a combination of igneous extrusion and intrusion, as the silicate interior of the Earth *differentiated* into a less dense mafic to felsic crust over the more dense ultramafic mantle. Plate tectonics allowed fragments of such crust to raft around, crunch together, and grow into the *cratons* (ancient cores) of the continents we see today.
- *Supercontinents*, which are the chance clumpings of most continental crust into one large mass, have occurred at least twice in the past, with *Rodinia*, *Gondwana* and *Pangea* being the three most recent versions. Splitting and reassembling of such continents has produced most of the mountain belts we see on the continents today. Even older (now mostly or entirely eroded away) mountain ranges formed from continental collisions even earlier in Earth's history.
- The most recent 542 million years of Earth's history, known as the *Phanerozoic eon*, is the time during which large complex life forms have proliferated on Earth, as evidenced by abundant fossils in rocks of this age. This is divided into the *Paleozoic* (age of fishes), *Mesozoic* (age of reptiles), and the *Cenozoic* (age of mammals).

- *Paleozoic* dominated by mountain building during assembly of Pangea (Ural, Appalachian and Caledonian mountains). Began with the emergence of widespread hard parts in animals (shells, then teeth and bones), greatly increasing the ability of creatures (with hard parts) to become fossilized – ended with *mass extinction* event when 90% of all sea life and 70% of land vertebrates died out.
- *Mesozoic* saw Pangea begin to break apart and many shallow seas invading the central, SE and western parts of North America. Widespread desert climate existed in huge continental interior. Began and continued with widespread success of reptiles, such as the dinosaurs, (as well as seed-bearing trees) on land and in the sea – ended with mass extinction of dinos and many other species as a result of huge *impact* of an asteroid or comet. North America began to override oceanic plate to the west, building the Rocky and Sierra mountains along the western margin of the continent.
- *Cenozoic* dominated by erosion of uplifted western North America, followed by extensional/normal faulting of the crust in the SW, producing the Basin and Range province that dominates NV, SE CA, southern NM, and S and SW AZ today. Volcanism was extensive in what is now the SW U.S. Mammals diversified and spread widely across Earth to fill niches left empty by the extinction of the dinosaurs. Flowering plants came to be during this period. Many mammal species evolved to become very large during the Cenozoic until a mass extinction at the end of the most recent Ice Age around 12,000 to 10,700 years ago. The rise of humans (primarily over the past several hundred thousand years) probably contributed to this most recent mass extinction event.