FUNDAMENTALS OF GEOLOGY

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Scientific interests: morphology, systematics and taphonomy of organic walled macroalgae; taphonomy of Ediacar biota; dynamics of the morpho-functional diversity of macroalgae at the Precambrian and Cambrian boundary; study of redox conditions in paleo-basins in late Precambrian and Cambrian Periods.

Course Goal

This course is designed for students who do not have a Bachelor's Degree in "Geology" or who need to refresh their knowledge of the subject. The course will help students without a field-specific (geological) background successfully adapt to this new discipline. The course will introduce students to basic geological knowledge and the most important theories and paradigms in geoscience. They will learn the structure of the planet Earth, the properties of minerals and rocks (learn to identify the most important), geological processes that occur on the surface and inside of our planet, and get acquainted with the main groups of organisms that lived on our planet. The course includes a lecture and lab component.

Course Outline

1. **The Geologic Time Scale** – an introduction to the concept of geologic time. Students will learn about the geologic time scale as well as some of the major events that have taken place throughout the Earth's history. The international chronostratigraphic chart is presented with the beginning and end of time segments, in millions of years or Ma which stands for Mega-anna.

2. **Seismic Data and Earthquakes** – students will gain knowledge about earthquakes, the way they form, and their outcome at the Earth's surface. They will learn about types of waves and how they propagate through material. Students will become familiar with seismic data and graph it to construct and evaluate travel time curves for different types of seismic waves and use seismograms and travel-time curves to locate the epicenter of an earthquake.

3. **Earth Structure and Introduction to Plate Tectonics** – this unit will help students understand large-scale forces that shape the Earth's surface and control topography. They will discuss whether Earth is increasing, decreasing, or maintaining its size, learn how to measure and calculate rates related to tectonic activity, understand how magma relates to plate tectonics and be introduced to the plate tectonic paradigm.

4. **Minerals: Their Properties and Uses** – introduction to minerals, how they form, and where we use them. Students will learn how to identify different mineral properties (e.g., hardness, luster, color, streak color etc.), and use those properties to diagnose the most common minerals of igneous, metamorphic, and sedimentary rocks.

5. **Melts, Magmas, and Igneous Rocks** – this unit is dedicated to the formation and description of igneous rocks. Students will learn how to describe compositional features of igneous rocks (e.g., mineralogy, color index, texture), how to classify them, describe and interpret their textural features, explore the geometry and origin of some intrusive and extrusive bodies of igneous rocks, and infer the origin of common igneous rocks.

6. **Metamorphism and Metamorphic Rocks** – we will look at how rocks change as they are heated and deformed in the Earth, describe how the buried rock environment varies at depth (heat, pressure, fluid type) to produce a variety of metamorphic rocks, recognize how changing heat, pressure, and fluid content can change rocks, predict how changes in burial conditions might affect the texture and mineral content of buried rocks, and link metamorphic rocks to the type of metamorphism they were formed by studying their texture and mineral content.

7. **Weathering, Sediments, and Sedimentary Rocks** – an investigation of weathering, transport, and depositional processes. Learning the types of sediments that form in various sedimentary environments, matching rocks to their depositional environment by observing, recognizing, and interpreting simple sedimentary textures and structures.

8. **Depositional Environments and Facies** – sedimentary rocks are formed in a variety of depositional environments. This topic will relate different rock types to different depositional environments, as well as to different levels of environmental energy. Students will gain an understanding of which depositional environments generally produce different sedimentary rocks, learn how to relate transportational energy to different depositional environments and their corresponding rocks, and familiarize themselves with general sequences of rocks in different environments

9. **Relative Dating and Geochronology** - geologic time can be described in two ways, relative time (assigning an age to an event as it relates to other events, either older or younger), and absolute time (assigning a numerical age to an event through radiometric dating). This unit will introduce the principals used to determine the relative ages of strata, geological structures, and events in Earth's history. Students will learn to use these principles to determine the orders of events in given cross section examples. This unit will also provide information on how radiometric dating works and how to apply these methods to examples of isotope samples.

10. **Stratigraphy, Sea Level Fluctuations, and** Correlation – stratigraphy is the study of the spatial and temporal relationships of sedimentary layers and their implications for the change of environmental conditions over time. Students will learn lithologic correlation (match rocks and depositional environments) and chronologic correlation (match fossils and time) across several stratigraphic columns that represent an area, recognize transgressions, regressions, and unconformities within sets of stratigraphic columns.

11. **Evolution of Life on Earth** – this unit will introduce the concepts of phylogenetics and the molecular clock method and discuss the current representation of the tree of life. Students will learn how to differentiate between systematics, taxonomy, and phylogeny and how to demonstrate an understanding of the hierarchical system of nomenclature (and basic conventions of taxonomy).

12. **Paleontology, Invertebrate Fossils** – paleontology is the study of life in the geologic past. To study the morphologies, living habits, and other aspects of past organisms, paleontologists examine fossils. Fossils can include actual remains of the organism, imprints of the organism's body in the surrounding sediment, trails, and trackways once made by organisms, and even molecular evidence left by a past life. Fossils can also help scientists hypothesize about which environment strata deposition took place, and to determine the ages of strata through the use of biostratigraphy. In this chapter, an introduction to several major invertebrate phyla of fossil organisms will be given (e.g. different types of mollusks, arthropods, echinoderms, graptolites, brachiopods, corals, sponges), students will learn how to recognize characteristics of various invertebrate taxa and to identify these taxa based on those characteristics

13. **Biostratigraphy** – biostratigraphy is the branch of stratigraphy that focuses on correlating and assigning relative ages of rock strata by using the fossil assemblages contained within them. The primary objective of

biostratigraphy is a correlation, demonstrating that a particular horizon in one geological section represents the same period of time as another horizon in a different section. In biostratigraphy, fossils are used as a tool in the chronological correlation of rock strata and geologic events. This unit will apply fossil identification skills learned in the previous set of lectures/labs to figure out which taxa comprise given assemblages, and then use the combination of these taxa time periods to assign a specific time period to each assemblage. It will also relate assemblage ages to their corresponding lithologies in a stratigraphic column and use geologic principles to determine if the assigned ages are logical. Students will also learn how to identify different types of biozones and try graphic correlation of sections.

14. **Geologic Maps** – students will be introduced to geological maps and the historical data they contain. They will also learn to derive information from maps to answer a variety of questions dealing with the area's geologic history as well as current structures and processes by relating knowledge of rock properties, geologic principles, and stratigraphy to map data. Finally, they will learn how to construct a stratigraphic column of the history of a specific area using only data from the geologic map.