Quadrant II – Transcript and Related Materials

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Notes

What is geology?

Geology (from the ancient Greek, *gē* means "earth" and *–logia* means "study of" or "discourse") is an earth science concerned with the material of which it is made, the structure of those materials, and the processes acting upon them and change them over time. It also deals with the study of the history of all that is ever lived on planet or living on the earth now. Modern geology is extended to any terrestrial planet or natural satellites such as Mars or the moon and overlaps all other earth sciences like hydrology, atmospheric sciences so treated as major aspect of integrated earth system science.

Mineralogy

Mineralogy is the science of minerals – their crystallography, chemical composition, physical properties, and genesis, their identification, and their classification. Mineralogy is the subdivision of geology, since minerals constitute the rocks of the earth's crust, mantle and deeper interior of our planet and are scattered in the hydrosphere and atmosphere. However, meteorites, lunar rocks and the smallest particles of cosmic dust provide us with samples of minerals from outside the earth, and geophysical measurements furnish some indication of the nature of the minerals below the accessible crust.

Definition of the term ***mineral*** range from the historical (any material that is neither animal nor vegetable) through the legalistic (something valuable that may be extracted from the earth and is subjected to depletion) to the scientific **(a naturally occurring homogenous solid, generally formed by inorganic processes, with an ordered internal arrangement of atoms and a chemical composition and physical properties that either are fixed or that vary within some definite range).** A good introduction to the science of mineralogy can be gained by examining each part of this scientific definition.

The qualification ***naturally occurring*** is considered necessary by some mineralogist and superfluous by others. Gemologists consider it particularly important to subscribe to this aspect of the definition. In fact, they consider it imperative that man-made substances especially those that are essentially identical to naturally occurring gem minerals, be referred to as synthetic (e.g., synthetic diamond and synthetic ruby…).Artificial minerals or synthetic minerals are those produced (synthesized) by man.

The requirement that a mineral be *solid* eliminates liquids and gases. This may seem arbitrary in that ice is thereby called a mineral whereas water is not. In practice, a few mineralogists ignore this restriction and include water and native mercury as minerals.

The phrase *generally formed by inorganic processes* is probably superfluous. Its purpose is merely to remind us of a former view that even the inorganic substances that are naturally produced by plants and animals (e.g., the aragonite that makes up the shells and pearls produced by oysters) should be called minerals. This former restriction, however, never did eliminate the possibility of an organic compound's being classified as a mineral; a few such substances (certain solid hydrocarbons, calcium oxalates, and similar compounds) have long enjoyed the status of minerals.

An *ordered internal arrangement of atoms* is the criterion of the crystalline state. Another way of expressing this is to say that minerals are crystalline solids. Under favorable conditions of formation, the ordered atomic arrangement may be expressed by an external crystal form. In fact, more than a century before X-ray provided the means of demonstrating the presence of an ordered internal arrangement of "building blocks" within crystalline solids; their existence had already been deduced from the external regularity of crystals. [A few minerals, such as opal, are not crystalline initially but become at least partly crystalline with the passing of geological time; also, a few other minerals, generally referred to as metamict, have had their original crystallinity partially destroyed as a result of irradiation by their radioactive constituents.]

Strictly speaking, the last part of the definition-a chemical composition and physical properties that either are fixed or vary within some definite range-merely adds the requirement of a defined chemical composition. As long as the internal atomic arrangement of their constituents is set, minerals with fixed chemical compositions also have fixed physical properties (The crystal structure restriction is required because of *polymorphism* [1]) as the definition also indicates, however, the chemical composition and consequently the physical properties of a mineral may vary within a definite range. (This phenomenon is related to *solid solution* [2])

[1] An element or compound that can exist in more than one crystallographic structure is said to exhibit Polymorphism e.g., diamond and graphite

[2] A solid that has an homogeneous crystal in which some equivalent sites are occupied by different ions e.g., albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$)

Crystallography

The word "crystallography" is derived from the Greek words *crystallon* "cold drop, frozen drop", with its meaning extending to all solids with some degree of transparency, and *graphein* "to write". It is the experimental science of determining the arrangement of atoms in crystalline solids, and study the elements of symmetry of crystals like center, axis and planes of symmetry. In July 2012, the United Nations recognized the importance of the science of crystallography by proclaiming that 2014 would be the International Year of Crystallography.

Gemology

Gemology or gemmology is the science dealing with natural and artificial gemstone materials. It is a geoscience and a branch of mineralogy.

Petrology

Petrology (from the Ancient Greek: πέτρος romanized: *pétros*, lit. 'rock' and λόγος, *lógos*) is the branch of geology that studies rocks and the conditions under which they form. Rocks are aggregates of minerals. The rocks are classified into Igneous, Sedimentary and metamorphic rocks.

Petrology has three subdivisions: igneous, metamorphic, and sedimentary petrology.

Igneous Petrology

Igneous rocks are formed from the crystallization, solidification of hot molten magma. hey can be intrusive formed at depth, in the interior of the earth, e.g. Granite whereas extrusive rocks are formed at or near the surface by cooling of lava, e.g. Basalt, sometimes without undergoing stage of crystallization e.g. Obsidian.

Magma is a multi-component system consisting of following oxides:-

SiO_2, Al_2O_3, FeO, Fe_2O_3, MgO, K_2O, Na_2O, CaO, P_2O_5 etc.

The magma has a temperature range between 600^oC to 1200^oC and a pressure of more than 5 to 6 Kbar. The igneous rocks that are formed at very great depth are called plutonic rocks, those that are formed shallow depth are called hypabysal rock and those which are formed due to the solidification of magma on the surface of the earth in the form of lava flows are called as volcanic rocks.

Sedimentary Petrology

When the pre-existing rocks are subjected to the process of denudation, the material derived give rise to the sedimentary rocks. The deposition of resulting sediments either sold or by precipitation of dissolved material resulting into Sedimentary rocks. They are typically layered & formed on the surface of the earth. Example: Sandstone, Limestone

The key to understanding sedimentary rocks is to realize that all sedimentary processes of weathering, transportation, and deposition are aimed at one goal - reaching the three final end products of all sedimentary processes, quartz sand, shale (clay), and limestone ($CaCO_3$).

Metamorphic Petrology

Metamorphic petrology deals with metamorphic rocks. When the pre-existing rocks, igneous, sedimentary or even metamorphic in origin are subjected change when they are exposed to high temperature, pressure & or chemically active fluids results into metamorphic rocks.
Example: Gneiss, Schist.

Structural Geology

Structural geology is the study of structures present in the rocks caused due to deformation. The primary goal of structural geology is to use measurements of present-day rock geometries to uncover information about the history of deformation (strain) and to deduce the cause of deformation in the rocks, and ultimately, to understand the stress field that resulted in the observed strain and geometries. This understanding of the dynamics of the stress field can be linked to important events in the geologic past; a common goal is to understand the structural evolution of a particular area with respect to regionally widespread patterns of rock deformation (e.g., mountain building, rifting) due to plate tectonics.

Plate tectonics

Plate tectonics (from the Late Latin: *tectonicus*, from the Ancient Greek: τεκτονικός, lit. 'pertaining to building') is a scientific theory describing the large-scale motion of seven large plates and the movements of a larger number of smaller plates of Earth's lithosphere, since tectonic processes began on Earth between 3.3 and 3.5 billion years ago. The model builds on the concept of continental drift, an idea developed during the first decades of the 20th century. The geoscientific community accepted plate-tectonic theory after seafloor spreading was validated in the late 1950s and early 1960s.The theory builds on the concept of continental drift and seafloor spreading. It aims in explaining major geological activities such as distribution of earthquakes, volcanoes and large scale crustal deformation.

Physical geology

Physical geology is the branch of geology that deals with geologic events and materials occurring at the present time, or in the very near past.
Physical geologists study current processes, erosion, weathering by natural agencies of erosion such as river, ocean, glaciers and wind etc. They use their understanding of historical geological processes to understand what might be causing current geologic processes to take place.

Physical geologists study current processes, like volcanoes, earthquakes, erosion, weathering, and glaciers. They use their understanding of historical geological processes to understand what might be causing current geologic processes to take place, as well as utilizing new technologies and techniques.

Historical geology or **paleogeology**

It is a discipline that uses the principles and techniques of geology to reconstruct and understand the geological history of Earth.[1] It focuses on geologic processes that change the Earth's surface and subsurface; and the use of stratigraphy, structural geology and paleontology to tell the sequence of these events. It also focuses on the evolution of plants and animals during different time periods in the geological timescale. The discovery of radioactivity and the development of several radiometric dating techniques in the first half of the 20th century provided a means of deriving absolute versus relative ages of geologic history.

Stratigraphy

The branch of geology concerned with the order and relative position of strata, correlation with the rocks of distant region and their relationship to the geological timescale.

Sedimentology

Sedimentology encompasses the study of modern sediments such as sand, silt, and clay, and the processes that result in their formation (erosion and weathering), transport, deposition and diagenesis. Sedimentologists apply their understanding of modern processes to interpret geologic history through observations of sedimentary rocks and sedimentary structures.

Sedimentary rocks cover up to 75% of the Earth's surface, record much of the Earth's history, and harbor the fossil record. Sedimentology is closely linked to stratigraphy, the study of the physical and temporal relationships between rock layers or strata.

Geochronology

Geochronology is the science of determining the age of rocks, fossils, and sediments using signatures inherent in the rocks themselves. Absolute geochronology can be accomplished through radioactive isotopes, whereas relative geochronology is provided by tools such as palaeomagnetism and stable isotope ratios. By combining multiple geochronological (and biostratigraphic) indicators the precision of the recovered age can be improved.

Paleontology, also spelled **palaeontology** or **palæontology**

The remains of animals and plants of prehistoric ages preserved in the rocks are known as fossils a term derived from the Latin word "**fossils**" meaning something dug up. The study of fossils is called paleontology after the Greek for ancient *palaios*, being/life-*onto,* and discourse-*logos*.

It includes the study of fossils to classify organisms and study interactions with each other and their environments (their paleoecology). Paleontological observations have been documented as far back as the 5th century BCE. The science became established in the 18th century as a result of Georges Cuvier's work on comparative anatomy, and developed rapidly in the 19th century.

Economic geology

Economic geology is concerned with earth materials that can be used for economic and/or industrial purposes. These materials include precious and base metals, nonmetallic minerals, construction-grade stone, petroleum, natural gas, coal, and water. Economic geology is a sub discipline of the geosciences; according to Lindgren (1933) it is "the application of geology". Today, it may be called the scientific study of the Earth's sources of mineral raw materials and the practical application of the acquired knowledge. The term commonly refers to metallic mineral deposits and mineral resources. The techniques employed by other earth science disciplines (such as geochemistry, mineralogy, geophysics, petrology and structural geology) might all be used to understand, describe, and exploit an ore deposit.

Petroleum geology

Petroleum geology refers to the specific set of **geological** disciplines that are applied to the search for hydrocarbons (**oil** exploration). **Petroleum geology** is principally concerned with the evaluation of seven key elements in sedimentary basins: Source, reservoir, seal, trap, timing, maturation and migration.

Mining geology

Mining geology is an applied science which combines the principles of economic geology and mining engineering to the development of a defined mineral resource. Mining geologists and engineers work to develop an identified ore deposit to economically extract the ore.

Geomorphology

Geomorphology (from Ancient Greek: γῆ, *gê*, "earth"; μορφή, *morphḗ*, "form"; and λόγος, *lógos*, "study") is the scientific study of the origin and evolution of topographic and bathymetric features created by physical, chemical or biological processes

operating at or near the Earth's surface. Geomorphologists seek to understand why landscapes look the way they do, to understand landform history and dynamics and to predict changes through a combination of field observations, physical experiments and numerical modeling. Geomorphologists work within disciplines such as physical geography, geology, geodesy, engineering geology, archaeology, climatology and geotechnical engineering. This broad base of interests contributes to many research styles and interests within the field.

Engineering Geology

Engineering Geology is the application of geology to engineering studies to ensure that the geological factors related to the location, design, construction, operation and maintenance of engineering works are recognized and taken into account.

Engineering Geology provide geological and geotechnical recommendations, analysis and design related to different types of structures like dams, tunnels etc.

Environmental Geology

Environmental Geology deals with the prevention, **analysis** and correction of interactions between human activities and natural systems, in terms of natural and cultural resources, environmental impacts (including impacts on geological heritage), geological hazards and environmental land use **planning** and management.

Hydrogeology

Hydrogeology, the science of groundwater, requires a multidisciplinary approach involving many other sciences: surface hydrology, climatology, geology, geography, physics, chemistry, biology, and more. This book takes a broad view, considers water as a single entity, and presents many examples illustrating the variety of existing hydrogeological problems and the diverse scientific, technical, and social approaches used in resolving them. It is intended primarily for students of Earth Sciences, Environmental Sciences, and Physical Geography. It will also be useful to all players involved in water-related issues: hydrogeologists, geologists, soil scientists, agronomists, civil engineers, and developers. The book considers water as a single entity, and presents many examples illustrating the variety of existing hydrogeological problems and the diverse scientific, technical, and social approaches used in resolving them.

Volcanology

Volcanology (also spelled vulcanology) is the study of volcanoes, lava, magma and related geological, geophysical and geochemical phenomena (volcanism).It is a discipline of the geologic sciences that is concerned with all aspects of volcanic phenomena.

Seismology

Seismology is - a science that deals with earthquakes and with artificially produced vibrations of the earth.

The word ***Seismology*** (/saɪzˈmɒlədʒi/; from Ancient Greek σεισμός (*seismós*) meaning "earthquake" and -λογία (*-logía*) meaning "study of") is the scientific study of earthquakes and the propagation of elastic waves through the Earth or through other planet-like bodies. The field also includes studies of earthquake environmental effects such as tsunamis as well as diverse seismic sources such as volcanic, tectonic, glacial, fluvial, oceanic, atmospheric, and artificial processes such as explosions. A related field that uses geology to infer information regarding past earthquakes is paleoseismology. A recording of Earth motion as a function of time is called a seismogram. A seismologist is a scientist who does research in seismology.

Geochemistry

Geochemistry is the science that uses the tools and principles of chemistry to explain the mechanisms behind major geological systems such as the Earth's crust and its oceans.[1] The realm of geochemistry extends beyond the Earth, encompassing the entire Solar System, and has made important contributions to the understanding of a number of processes including mantle convection, the formation of planets and the origins of granite and basalt. It is an integrated field of chemistry and geology/geography.

Geophysics

It involves geophysics investigation of subsurface conditions in the Earth through measuring, analyzing and interpreting physical fields at the surface. Some studies are used to determine what is directly below the surface (the upper meter or so); other investigations extend to depths of 10's of meters or more.

Planetary geology

Planetary geology, alternatively known as astrogeology or exogeology, is a ***planetary*** science discipline concerned with the ***geology*** of the celestial bodies such as the ***planets*** and their moons, asteroids, comets, and meteorites.

Oceanography

Oceanography (compound of the Greek words ὠκεανός meaning "ocean" and γράφω meaning "write"), also known as **oceanology**, is the study of the physical and biological aspects of the ocean. It is an important Earth science, which covers a wide range of topics, including ecosystem dynamics; ocean currents, waves, and geophysical fluid dynamics; plate tectonics and the geology of the sea floor; and fluxes of various chemical substances and physical properties within the ocean and across its boundaries. These diverse topics reflect

multiple disciplines that oceanographers blend to further knowledge of the World Ocean and understanding of processes within: astronomy, biology, chemistry, climatology, geography, geology, hydrology, meteorology and physics. Paleoceanography studies the history of the oceans in the geologic past. An **oceanographer** is a person who studies many matters concerned with oceans including marine geology, physics, chemistry and biology.

Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft). Special cameras collect remotely ***sensed*** images, which help researchers "sense" things about the Earth.

Photogeology /Aerial photography

Photogeology or Aerial photography is the taking of photographs from an aircraft and deduce from them the information of geologic interest.

Reference

Wikipedia