Environmental Geology Course Geo 262

Introduction to environmental Geology (Basic Concept of Environmental Geology)

Course Director

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Main Objective of Introduction to Environmental Geology

- Gaining and understanding the interactions between geologic processes, ecological processes, and society.
- Determine our individuals living standard, and the quality of our lives and of the broader environment of our home, and Earth.
- Scientifically combined our values will directed to many important decisions that will have far-reaching consequences for this and future generations.
- To develop an understanding of how geology interacts with major environmental problems that are facing people and society.

Main Objective of Introduction to Environmental Geology

- Introducing the basic concepts and principles of physical and environmental geology, that are focusing on the Earth's materials and processes.
- Providing a sufficient information concerning most of natural hazards and the geological environment that you will be a more informed via citizens.
- You will be better prepared to make decisions concerning where you live and how society responds to natural hazards and catastrophes such as earthquakes, volcanic eruptions, and flooding.
- Help you to develop an understanding of relationships between natural resources and pollution.

Main Objective of Introduction to Environmental Geology

- To seek, to find, and to use resources and, as a result, may pollute our environment. Thus, it is important to know how we might minimize pollution problems.
- Help you to understand the basic concepts of environmental management as they relate to the geologic environment in areas such as waste management, environmental health, global change, and environmental assessment.
- To have more specific information concerning how Earth works, to natural processes and hazards, to understanding natural resources and their management, with the objective of minimizing environmental degradation

Basic Concept

I. Environmental Geology:

➢ ***Environmental Geology*** is the study of the earths systems and their interaction with human, it is an applied geology, in order to:

- Help in solving conflicts in land use.
- Minimize environmental degradation.
- Miximize the beneficial results of using our natural and modified environment, by including the study of:
  - ✓Natural Hazards (such as floods, lanslides, earthquakes and volcanic activities) in order to minimize the loss of life anf property.
  - ✓Landscape for site selection, land-use planning, and environmental impact analyses.
  - ✓Earth materials (such as minerals, rocks, anf soil) to determine their potential use as resource or waste disposable sites and their effects on the human health.

Basic Concept

✓Hydrologic processes of the ground water and surface water to evaluate water resources and water pollution problems.

✓Geological processes (such as deposition of sediments on the ocean floor, the formation of mountains, and the movement of water on and below the surface of the earth) to evaluate local, regional, and global changes.

II. Fundamental concept of the Enviromental Geology are:

- Humans are the agents of geological changes.
- The earth is unique.
- The earth is a closed system.
- Materials and energy tend to cycle from one reservoir to another.
- The physical structure and chemical composition of the earth affect our lives in many different ways and manners.
- Geologic processes and human being operate on different time scales.

Basic Concept

- Hazardous geologic processes arenatural and have always existed.
- Risk is characteristic of human-planet relationship.

We are fundamentally dependent on Earths resources for the conduct of modern society as:

- ✓ Earth resources are limited.
- ✓ Earth resources can be managed properly in a sustainable fashion.
- ✓ There is no way to throw things to: our garbage and pollution remains with us.
- ✓ Managing the environmental means managing the human behavior.
- ✓ Restoration and preservation are also part of the human- planet relationship.

Thus, the concept is the geology is considered as a basic of environmental Science.

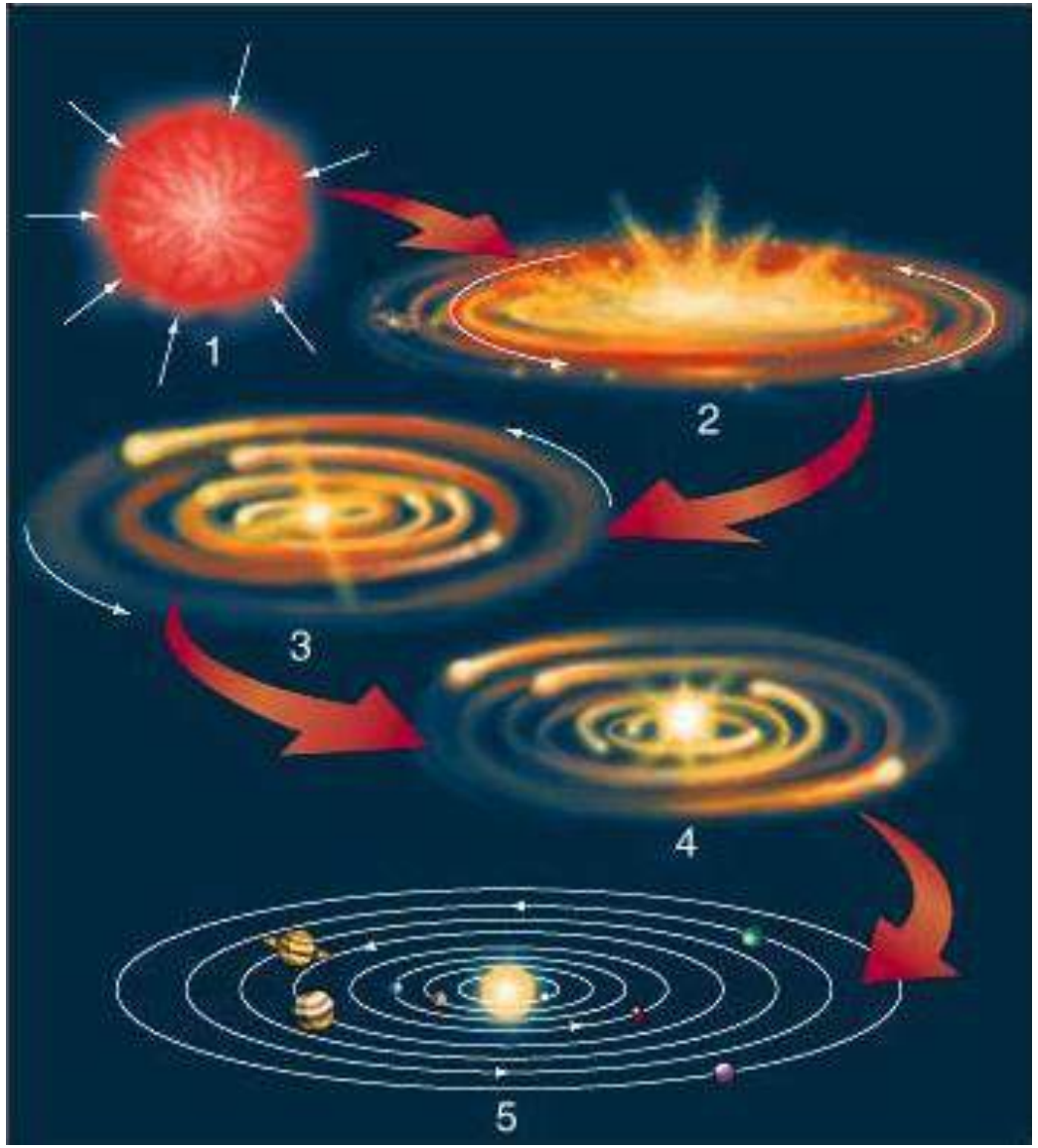
III. The fundamental components of every persons environment is the geologic component, and understanding of our environment requirements on a broad-based comprehension and appreciation of the earthscience related disciplines.

Earth's Placed in Space

- *Earth's created from the debris and Gas of stars, and then compressed to a solid as subjected to centrifugal force , and* to the gravitional forces, and due to the heat generated by radioactivity.
- The *earth shaped and mineralized (solidified) by 4.6 billion years of crustal evolution, warmed and peopled by the Sun*.
- In this short, moving statement, *Cloud (debris and Gas) tell us the origin of Earth, and to the concept of sustainability that today lead to think positively to protect our our planet environment from any pollution and contamination influences , to safeguard our life future, and to sustain it as greenhouse*.

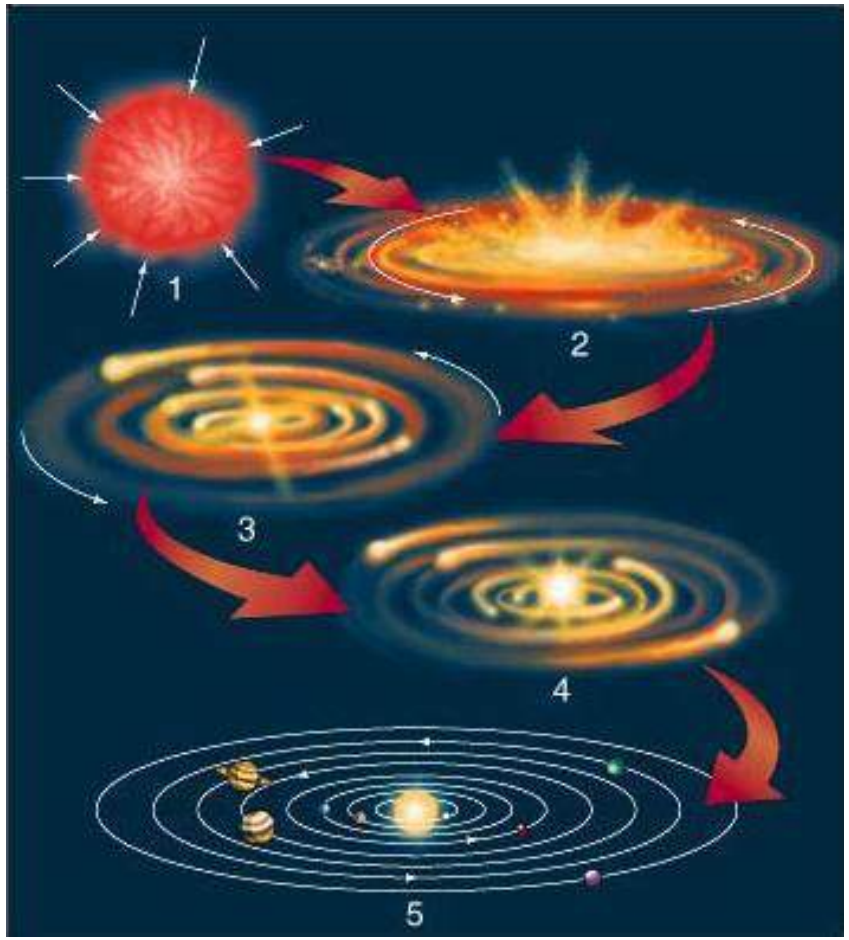
Origin of the Universe

- The *figure presents an idealized view the universe history to emphasis on the origin of our solar system and Earth evolution*.
- The *Scientists whom studying stars (Universe) determined its origin and found their age* is about 12 billion years ago.
- There was a *giant explosion known as the big bang.*
- This *explosion produced the atomic particles that later formed galaxies, stars, and planets*.
- It is believed that, have been found from about 7 billion years ago.
- The *first generations of giant stars exposed to a tremendous explosion* ***known as a supernova.***



Origin of the Universe

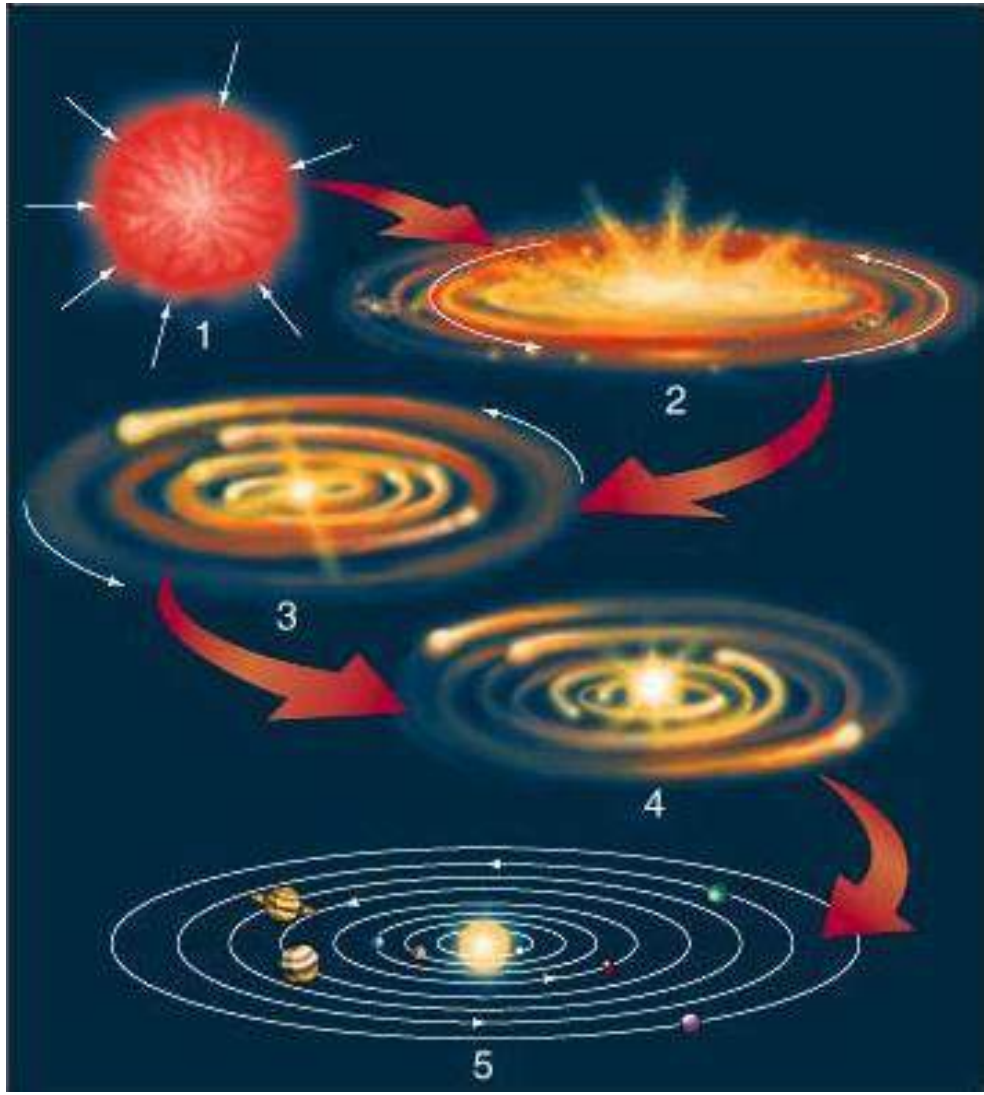
- This released **huge amounts of energy, producing** a **solar nebula**, which is thought to be a spinning cloud of dust and gas.
- The **solar nebula condensed as a result of gravitational processes, and our Sun formed at the centre of it**, but some of ***the particles may have been trapped in solar orbits as rings, similar to those we observe around the planet Saturn.***
- The **density of particles in individual rings was evidently not constant**, *so gravitational attraction from the largest density of particles in the rings attracted others until they collapsed into the planetary system* we have today.



Origin of the Universe

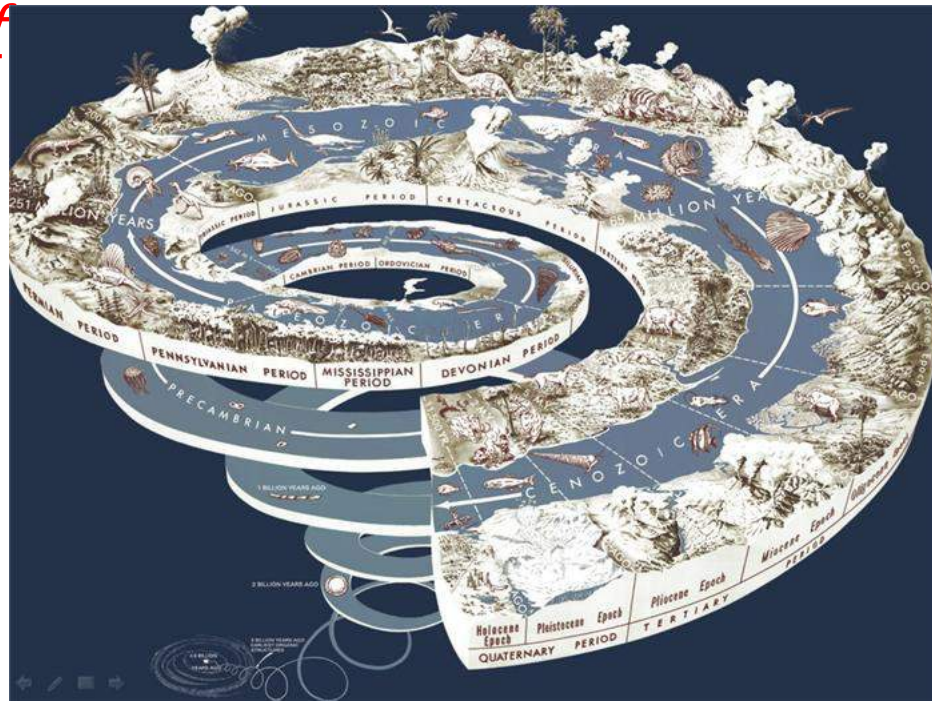
Thus,

- The **early history of planet Earth, as well as that of the other planets in our solar system**, was characterized by the forceful bombardment of meteorites.
- This ***bombardment was associated with accretionary processes.*** that is,
- The amalgamation of various-sized particles, from dust to meteorites, stony asteroids, and ice-rich comets with many kilometers in diameter—that resulted in the formation of Earth about 4.6 billion years ago.
- This is the part of ***Earth's history shows that the cloud refers to when the states when the Earth was born from the wreckage (Debris) of stars and compressed into a solid state by the force of its own gravity***.
- *Heat generated deeply within Earth*, along with gravitational settling of heavier components (particles) to the earth's center.



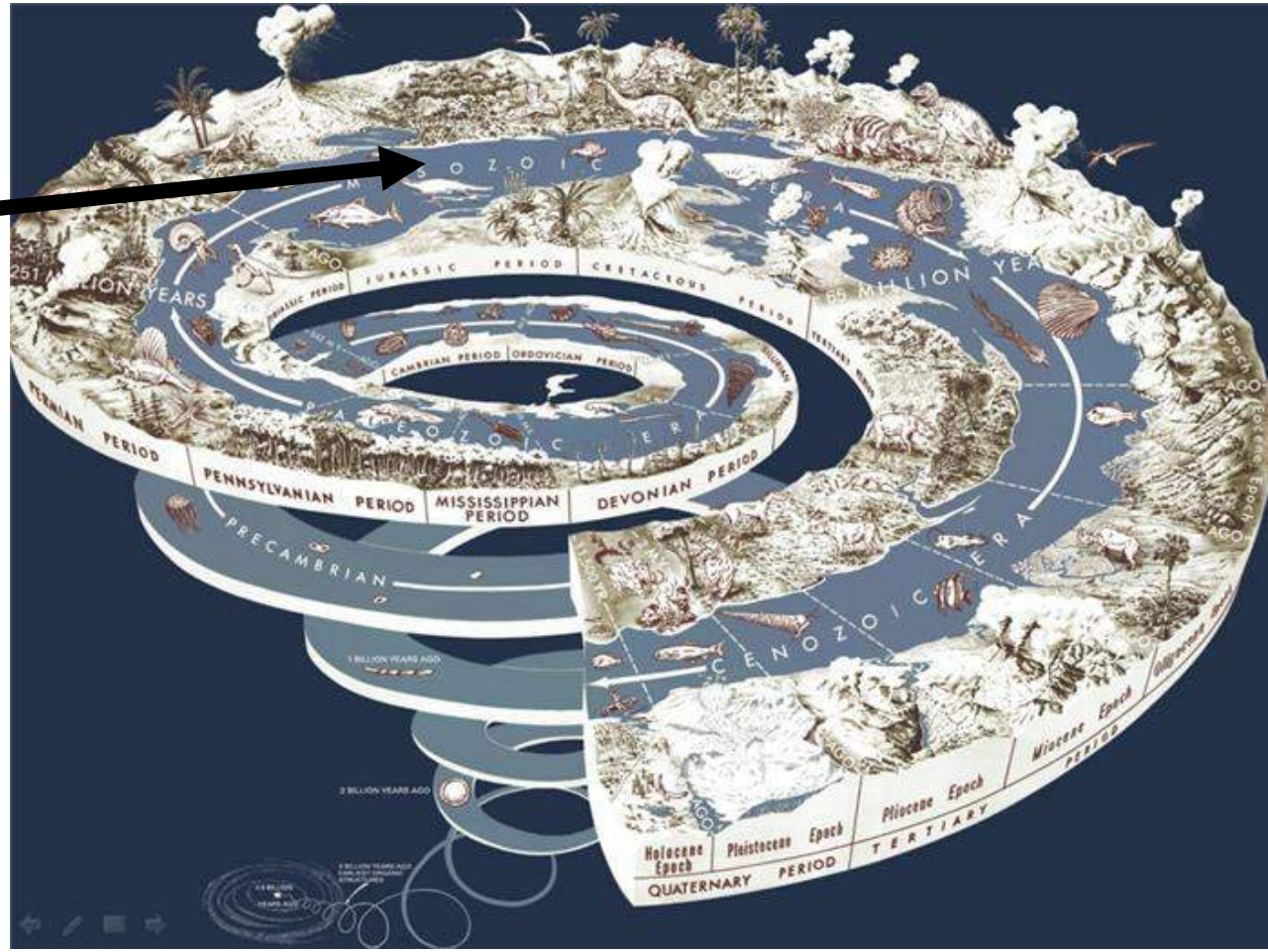
Origin of the Universe

- Our *Earth began about 4.6 billion years ago, as the cloud of interstellar gas known as a solar nebula collapsed, forming protostars and planetary systems*.
- ***Life on Earth began about 3.5 billion years ago**, and, since then, droves a diverse of organisms that have been occurred, grown, and died out, leaving only fossils to mark their place in Earth's history.*
- Just a few million years ago, our family tree set the stage for the present dominance of the human species.
- *Viewing the earth's history in terms of billions of years, we can say our role in Earth's history may be unimportant, but, nowadays for now living of us, and for our children, Thus, our impact on the environment is/ and will be significant indeed.*



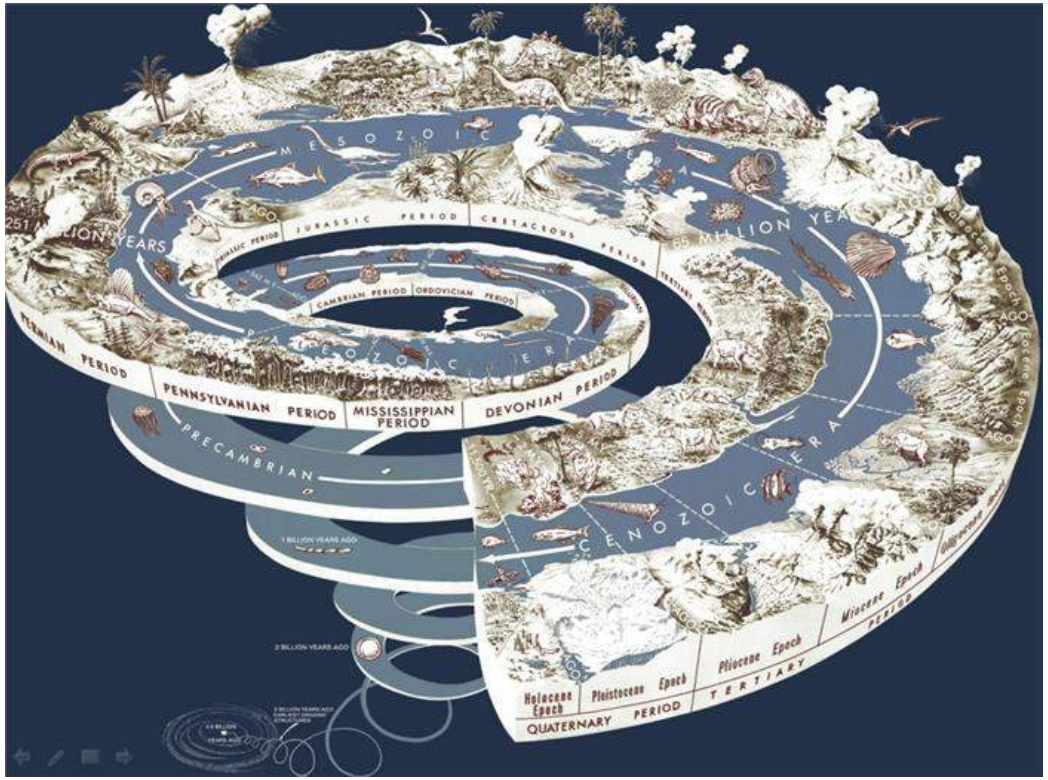
Origin of the Universe

- Geologically speaking, we have been here for a very short time.
- Dinosaurs, for example, ruled the land for more than 100 million years.
- Although we do not know how long our own reign will be,
- The fossil record suggests that all species eventually become extinct.



Origin of the Universe

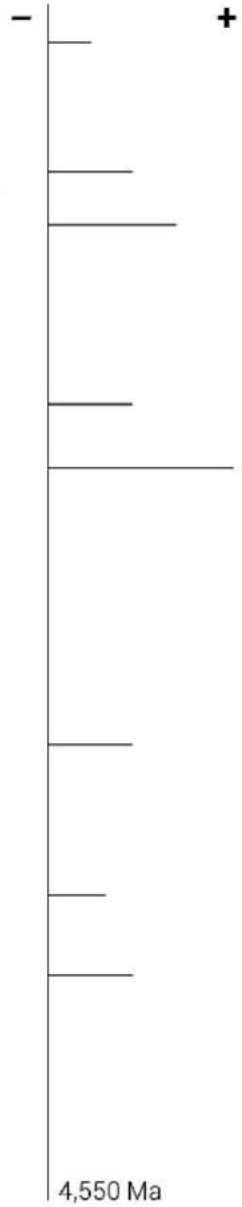
- The ***spiral of life generalized*** in Figure **explains evolution as life changed from simple to complex over several billion years of Earth's history.**
- The names of the eras, periods, and epochs,
- **geologists use these time duration to divide earth's geologic time**
- **This geologic time** are labelled with their range in millions or billions of years aged from the present date (**Table 1.2**).



Standard Geologic Timescale

Era	Period	Epoch	Succession of Life
Cenezoic Recent Life	Quarternary 0–2 Million Years Rise of Man	Recent Pleistocene	
	Tertiary 64 Million Years Rise of Mammals	Pliocene Miocene Oligocene Eocene Paleocene	
Mesozoic Middle Life	Cretaceous 80 Million Years Modern Seed-Bearing Plants, Dinosaurs		
	Jurrasic 56 Million Years First Birds		
	Triassic 49 Million Years Cycads, First Dinosaurs		
Paleozoic Ancient Life	Permian 48 Million Years First Reptiles		
	Carboniferous: Pennsylvanian 19 Million Years First Insects		
	Carboniferous: Mississippian 41 Million Years Many Crinoids		
	Devonian 57 Million Years First Seed Plants Cartlidge Fish		
	Silurian 28 Million Years Earliest Land Animals		
	Ordovician 44 Million Years Early Bony Fish		
	Cambrian 54 Million Years Invertebrate animals, Brachiopods, Trilobites		

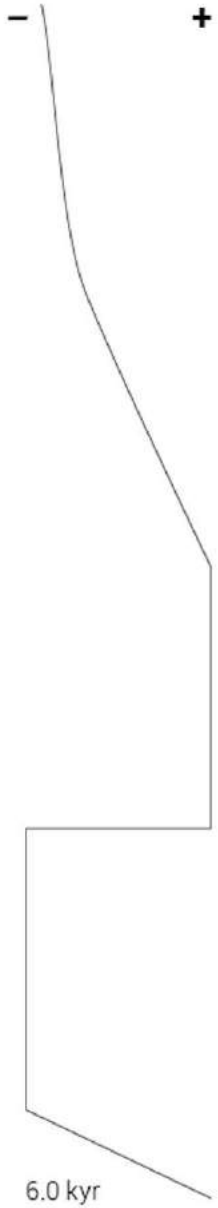
Mass Extinction Events



Biblical Geologic Timescale

Timeframe	Period
Present Age	Upper
	Middle
	Lower
Ice Age	Upper
	Middle
	Lower
Flood Event	Upper
	Middle
	Lower
Antediluvian (Pre-Flood World)	
Creation Week	Day Seven
	Day Six
	Day Five
	Day Four
	Day Three
	Day Two
	Day One

Global Geologic Energy Curve



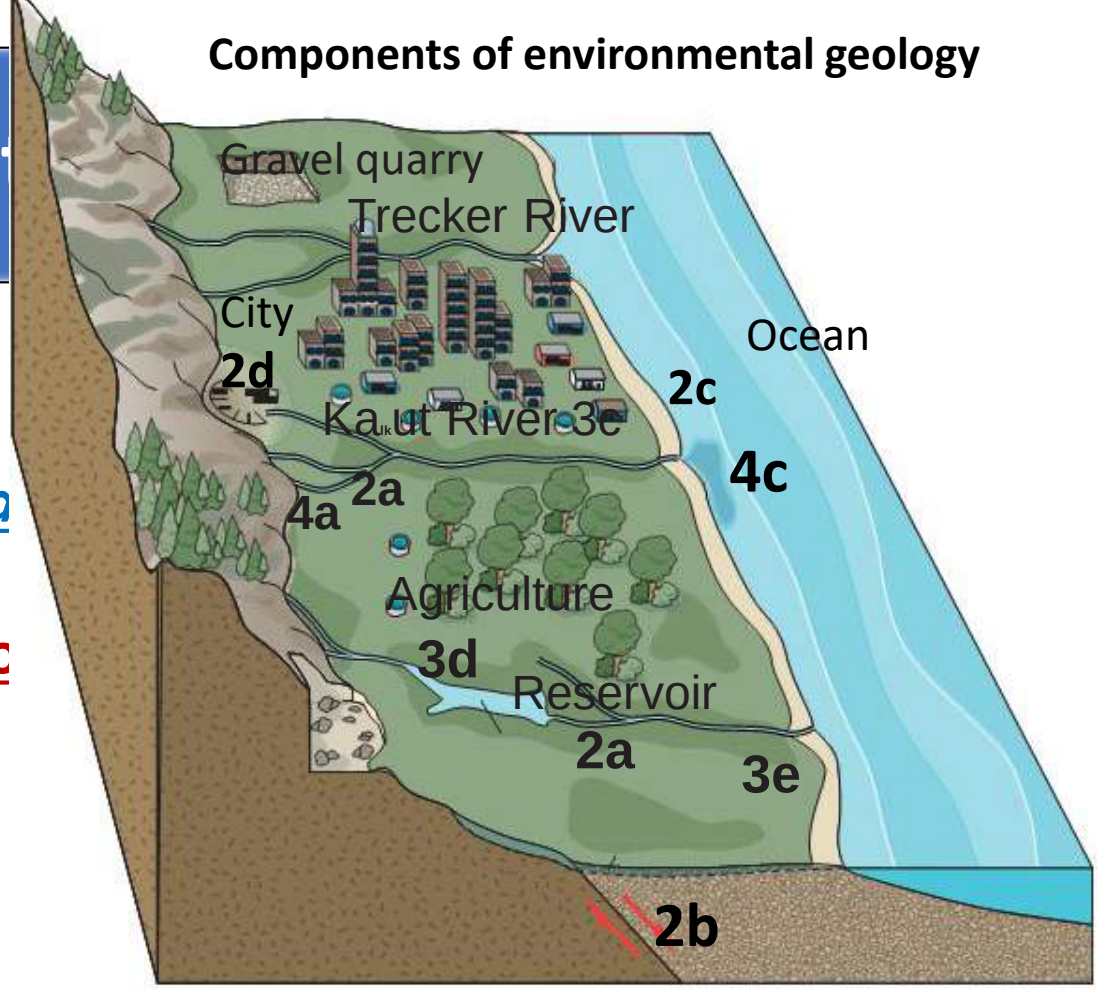
Origin of the Universe

- The **boundaries between eras, periods, and epochs are based on both the 1) study of what was living at the particular time,** and 2) on **important global geologic events in Earth's history.**
- *Relative ages of rocks are based on the assemblage of fossils* that are, evidence of the past life,
  - ✓such as shells, bones, teeth, leaves, seeds—that are found in rocks or sediments.
- **This a general principle of geology, known as the law of faunal assemblages states** that **rocks with similar fossils are most likely of a similar geologic age.**
  - ✓For example, if we find bones of dinosaurs in a rock, we know that the rocks are Mesozoic in age.
- **Fossils provide relative ages of rocks**

Geology and Environment

I. Geology and its applications:

- *It is the science of processes related to the composition, structure, and history of Earth and life.*
- **Geology is an inter disciplinary science, relying on aspects of chemistry** *(composition of Earth's materials), physics (natural laws), and biology (understanding of life-forms).*



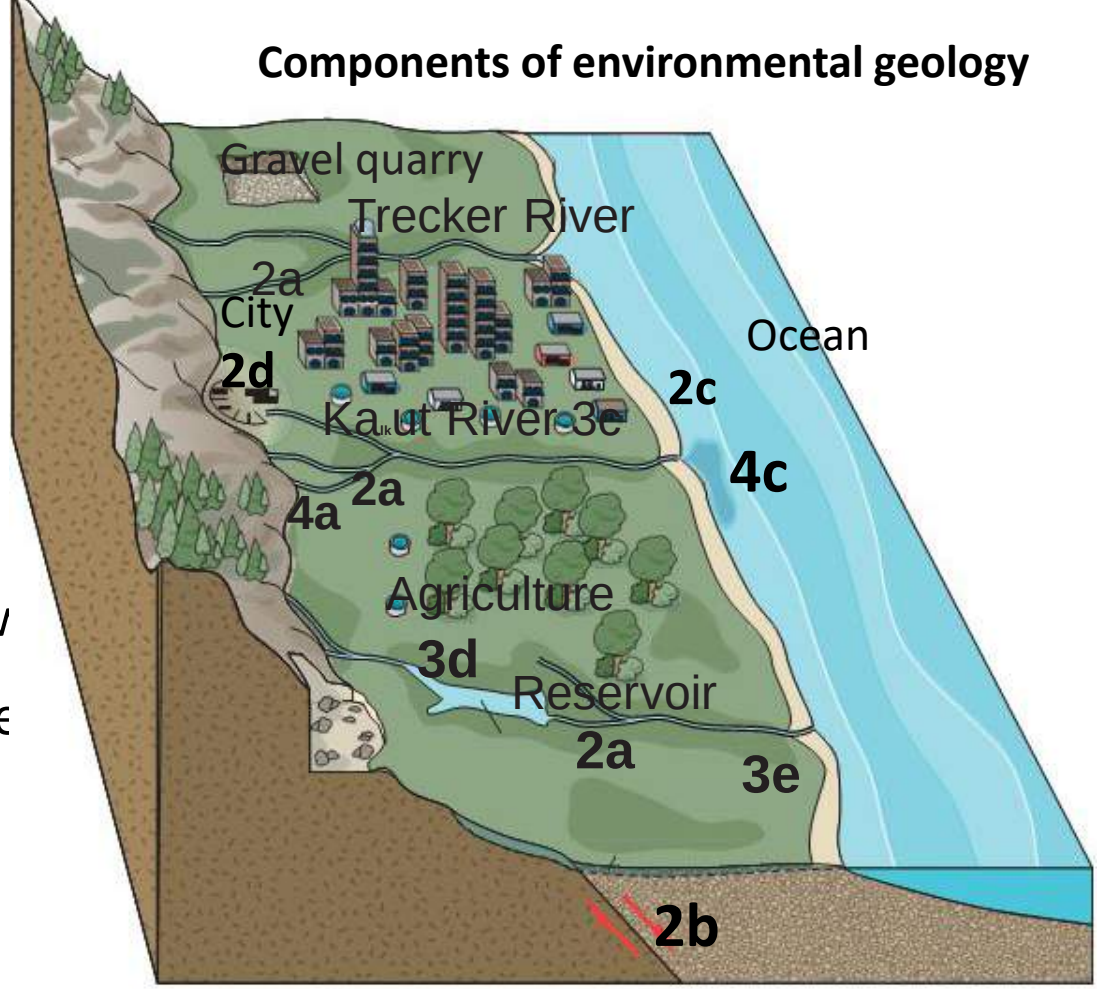
Components of environmental geology

1. **Earth materials** Gravel quarry (1a) and rock quarry (1b)
2. **Hazards** Flooding from rivers (2a), earthquake fault (2b), coastal erosion (2c), landslide (2d)
3. **Land-use planning and environmental impact** Urban and coastal lands, rivers, and reservoirs (3a–e)
4. **Hydrologic processes**

Surface rivers (4a), and groundwater (4b), water pollution (4c)

Geology and Environmental Geology

Components of environmental geology



2. The application of geology stick to these problems includes the study of the right Figure:

1. Earth materials,

- such as minerals, rocks, and soils, to determine hov they form, their potential use as resources or waste disposal sites, and their effects on human health

Components of earth's materials

1. **Earth materials** Gravel quarry (1a) and rock quarry (1b)
2. **Hazards** Flooding from rivers (2a), earthquake fault (2b), coastal erosion (2c), landslide (2d)
3. **Land-use planning and environmental impact** Urban and coastal lands, rivers, and reservoirs (3a–e)
4. **Hydrologic processes** Surface rivers (4a), and groundwater (4b), water pollution (4c)

Geology and Environmental Geology

- *Origin of Atmosphere and Water on Earth produced via the following:*

  - ***Water*** *from ice cored and earth's outgassing, or the release its gases, such as carbon dioxide and water vapor from volcanoes and other processes, produced Earth's* ***early atmosphere and water.***

  - ***About 3.5 billion years ago,*** **the first primitive life-forms appeared on Earth in an oxygen-deficient environment.**

  - Some of *those primitive organisms began producing oxygen through photosynthesis, which profoundly affected Earth's atmosphere*.

Geology and Environmental Geology

- The *Early primitive earth, oxygen-producing life probably lived in the ocean, protected from the Sun's ultraviolet radiation*.
- However, *as the atmosphere evolved and oxygen increased, an ozone layer was produced in the atmosphere that shielded Earth from harmful radiation*.
- *Plants evolved and colonized the land surface, producing forests, meadows, fields, and other environments that made possible the evolution of animal life on the land*.

Geology and Environmental Geology

II. *Environmental geology and its applications:*

- As it is an applied geology, Definitely, it is depend on geologic information:
  - to help us solve conflicts in land use,
  - to minimize environmental degradation, and
  - to maximize the beneficial results of using our natural and modifying our environments as following :

1. ***Earth materials***, *such as minerals, rocks, and soils, to determine how they form, and their potential resources or waste disposal sites use, and monitored their effects on human health and life.*
2. ***Natural hazards,*** *such as floods, landslides, earthquakes, and volcanic activity maximize loss of life and property*

Geology and Environmental Geology

3. **Land for site selection**, land-use planning, and their environmental impact analysis
4. ***Hydrologic processes*** of groundwater and surface water to evaluate water resources and water pollution problems
5. ***Geologic processes***, *such as deposition of sediment on the ocean floor, the formation of mountains, and the movement of water on and below the surface of Earth, to evaluate local, regional, and global change*

Geology and Environmental Geology

Therefore,

❖The **environmental geology defined** as *the branch of Earth science that studies the entire scale of human interactions with the physical environment.*

✓So, the ***environmental geology is a branch of environmental science, the science of linkages between physical, biological, and social processes in the study of the environment***.

Five Environmental Fundamental Concepts

- *The five fundamental concepts of environmental geology focuses on:*

  1) Human Population Growth, 2) Sustainability, 3) Earth as a System, 4) Hazardous Earth Processes, and 5) Scientific Knowledge and Values,

- These ***five fundamental concepts are important to environmental geologists***, that for general ***understanding of each concept that will help geologist: to comprehend and evaluate***,

  1. ***to comprehend and evaluate***, *to designed ,to provide a unforgettable, moveable, framework of understanding the interaction in the earth's environment.*
  2. *To know the* ***effect of environmental problem in relation with the environmental geology and geologic processes****, they are as follows:*

Geology and Environmental Geology

1) ***Human population growth:***

- ✓ **Population growth *is the number-one environmental problem*. *As population increases, so do our effects and demands on the environment.***

2. **Sustainability:**

- ✓ Sustainability ***is the long-term environmental objective of providing preventing sciences planes for the future of humans (Population)*** , and ***to the other living things who share the earth planet.***

3. ***Earth as a system:***

The Earth's systems often are affecting the global environment by the human activities causes an important effects on human life, and on the global enviromrntany .

Five Fundamental Concepts

4. Hazardous Earth processes:

- *Earth's hazardous processes are* ***always occurred as earthquakes, volcanoes, hurricane, flooding, landslide …etc.***
- **Population (Human beings) need to recognize the danger of hazards, and assessing their risk to theirour life and properties**, therefore, *either to act for avoiding or escaping from these hazards or to set plans to avoid the risk of the hazardous processes , accordingly.*

5. Scientific knowledge and values:

- **Scientific knowledge and values inquiries are** often the culture ***to provide a variety of potentialty solutions to avoiding the environmental hazardous problems.***
- **These Scientific solutions**, *we choose and planned will be directed and run due to the reflection of our value system against environmental hazardous,* we are facing.

Fundamental Concept of Environmental Geology

I. Human Population Growth:

- The *Human growing of human population, as shown in the human history on the earth*. So, *it is considered the number-one of our environmental problem and impact (influence)* .
- The *total environmental impact from people is estimated by* :

  = the impact per person multiplied X by the total number of people.

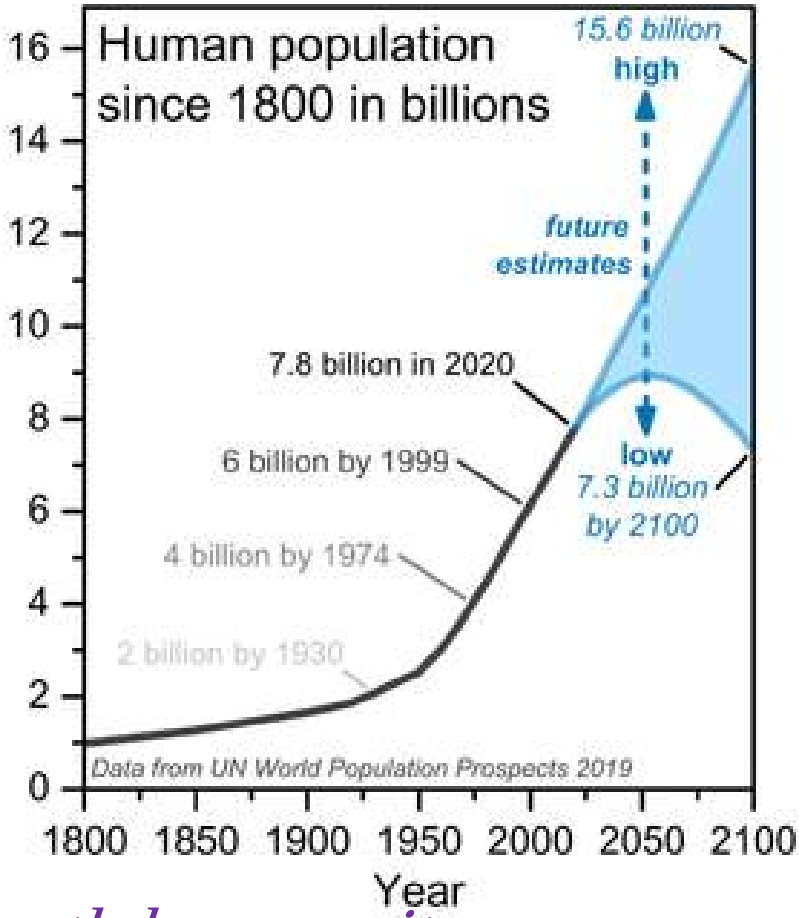
- ❑ Therefore, *as population increases, the total impact must also increase.*
- ❑ As ***population increases, more resources are needed and greater environmental interruption results occur***.
- ❑ In addition, *When and where local population density increases as a result of political disruption and wars, starvation may result see* (**Figure**).

Fundamental Concept of Environmental Geology

2. ***Exponential Growth:***

- ***Defined as the number of*** *humans increase, means (i.e. the number of people added to the population of each year is not constant); rather, a constant percentage of the current population is added for each year.*
- *There are two important aspects of exponential growth*:

1. The **growth rate**, measured as a percentage.
2. The **doubling time**, or the time it takes for whatever is growing to double.



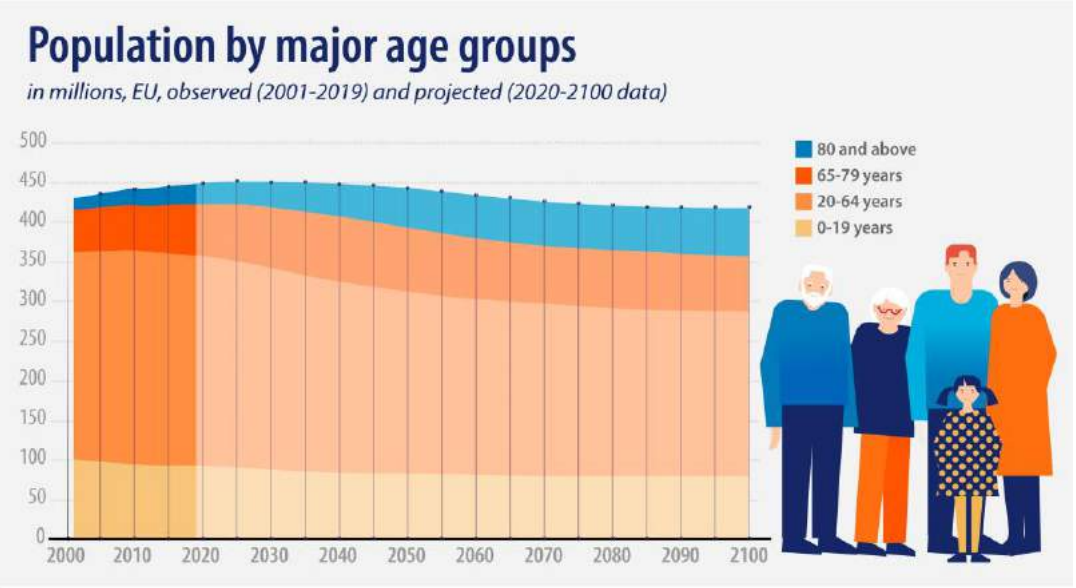
so it is *important that we be able to recognize such growth because it can eventually yield an extremely large numbers of populations*.

Fundamental Concept of Environmental Geology

➢ ***How Fast Does Population Double*?**

- A general rule of fast population is doubling time (D) is calculated *roughly equal to 70* divided by ***the growth rate (G):***

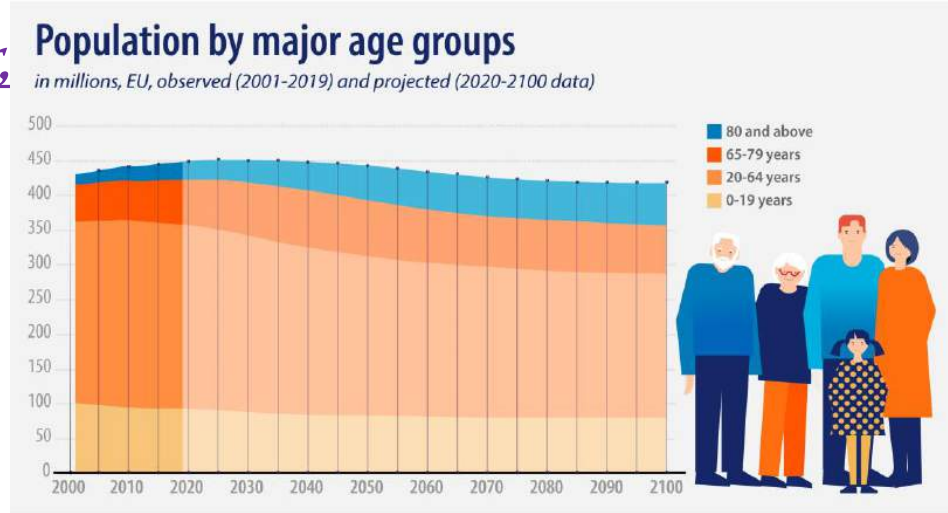
D = 70/G

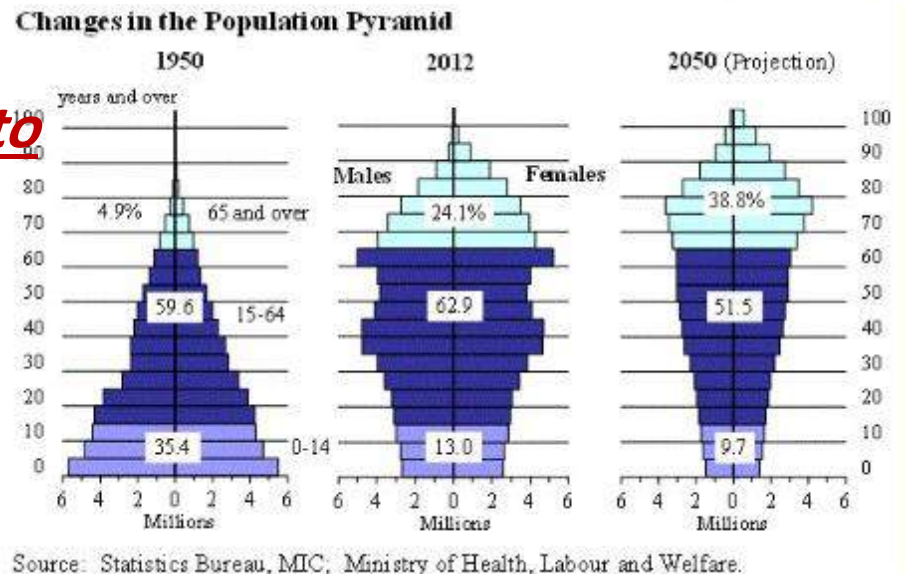


- *Using this approximation, we find that a population added in (2%) annually, the growth rate would double in about 35 years.*

Fundamental Concept of Environmental Geology

- **Thus,** *when the growth of the human in about 1% a year, the growth would double in about 70 years time.*
- ***The Human age structure is important because it is related to socio-economic issues.***
- **Moreover,** ***countries with a high percentage of young people under age 15, such as Kenya and Haiti, will have to invest more in education than in youth programs.***
- *Countries with a young population also may also face a difficulty with employment* .





Fundamental Concept of Environmental Geology

- ***This point is being considered that world 's population grows will be a quite slowly growth at first, then begins to increase more rapidly, and then continues to be at a very high rapid rate of growth.***
- **Eventually**, ***undefined human growth rates will produce very large increases in population growing.***

➢ Population Growth and the Future

- It is known that Earth's population as increasing exponentially, many scientists are concerned that will be impossible to supply and to source them enough resources, and; *in addition; it is impossible to provide them a high-quality environment for the billions of people who may be added to the world population.*

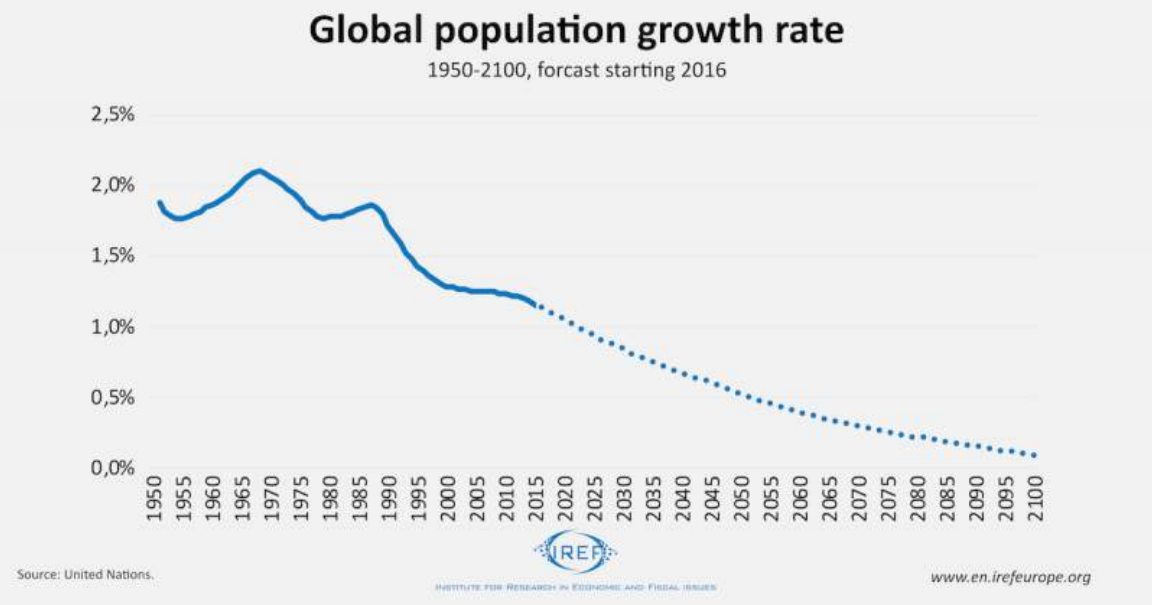
Fundamental Concept of Environmental Geology

- *So, Three billion more people will be inhabited by 2050, with almost of all of the growth, and in the developing countries is cause for local*, regional, and global *concern* levels nearly all causing environmental geology problems, throughout the pollution of ground and surface waters; production and management of hazardous waste; and exposure of people and human structures,
- In addition, problems due to natural processes (hazards), such as floods, landslides, volcanic eruptions, and earthquakes.

- ***Moreover, the resource and other environmental data are combined with population growth data, the conclusion is clear, that it is impossible, in the long run, to support exponential population growth with a fixed resource base.***
- ✓ ***Therefore, one of the primary goals of environmental work is to ensure that we can resolve the population bomb***

Fundamental Concept of Environmental Geology

- **Fortunately,** It is not all bad news concerning human population growth; that's because *in the first time since the mid of1900s, the increasing rate of in human population is decreasing*.
- Figure below, shows that the number of people added to the total population of Earth peaked in the late 1970s and has generally decreased since then.



Fundamental Concept of Environmental Geology

3. *Sustainability:*

What is sustainability?

- **Sustainability** is something that we are struggling to define. Or
- **Sustainability** is development which ensures the future generations will have equal access to the resources that our planet offers.
- **Sustainability** also refers to types of development that are economically viable, do not harm the environment.
- **Sustainability** is a long-term concept, something that happens over decades or even over hundreds of years. It is important to acknowledge that sustainability with respect to use of resources which are possible for renewable resources such as air and water.

Fundamental Concept of Environmental Geology

- Sustainable development with respect to non-renewable resources such as fossil fuels and minerals is possible by:
  - ✓ ***first***, extending their availability through conservation and recycling; and
  - ✓ ***second***, rather than focusing on when a particular non-renewable resource is depleted, focusing on how that mineral is used and developing substitutes for those uses.

Therefore;

- ❑ To *meet future resource demands and to sustain our resources, we will need large scale recycling of many materials.*

- ❑ The **challenge is to find** ways to do it that do not harm the environment, that increase the quality of life, and that are economically viable.

Fundamental Concept of Environmental Geology

Are We in an Environmental Crisis?

- **Environmental crisis is due to** shrinking of resources by a growing human population.
  - ***Moreover***, the increasing production rate of human waste.
  - This *crisis throughout the world is a result due to overpopulation, expansion, and industrialization, combined with to little concern regard our land and insufficient institutions to manage the environmental impact.*
- The ***rapid consuming and utilizing of the resources will continues to cause environmental problems on a global scale***, as the following:
  1. *Deforestation and accompanied by soil erosion,water and air pollution that take place on many continents* (**Figure**).
  2. *Mining of resources, such as metals, coal, and petroleum, wherever they occur , they produces a variety of environmental problems* (**Figure**).
  3. *Development of both groundwater and surface water resources results in loss* , and *damage of many environments in a global scale*.

Fundamental Concept of Environmental Geology

4. Earth as a System → **(i.e. to understanding Earth's systems, their changes, and it is serious to solving their environmental problems, too.**

- ***Earth's system***, *contains several component that mutually adjusted to a function; together; as a whole, via changes in one component* that will *bring changes in other components of earth's system.*
  - ✓ ***For example, the our global system components are:***
    1. Water (Hydrosphere).
    2. Land (Geosphere),
    3. atmosphere, and
    4. Bio-life (Biosphere).

These components are usually mutually adjusting each others for helping to keep the entire Earth system operating and functional as follows:

Fundamental Concept of Environmental Geology

A. Input–output analysis

- is an important method for analysing change in open systems. **Figure.**
- ***identifies three types of change in a pool or stock of materials***; **that is** the ***net change depends*** on the ***relative rates of the input and output.***
- ***Where the input into the system is equal to the output (Figure),*** a *rough steady state is established, and no net change occurs*.
  - ✓For instance: a university in which students enter as freshmen and graduated after 4 years later, at a constant rate.
- **Thus, the pool of University students remains a constant size till graduate stage.**

Fig.:

- The *blue is water of the Amazon that is heavily laden with sediment,* whereas the water of the Rio Negro is nearly clear. *Note that as the two large rivers join, the waters do not mix initially but remain separate for some distance past the confluence.* The Rio Negro is in flood stage.
- **The red** is the Amazon rain forest, and
- The *white lines are areas of human-caused disturbances such as roads.*

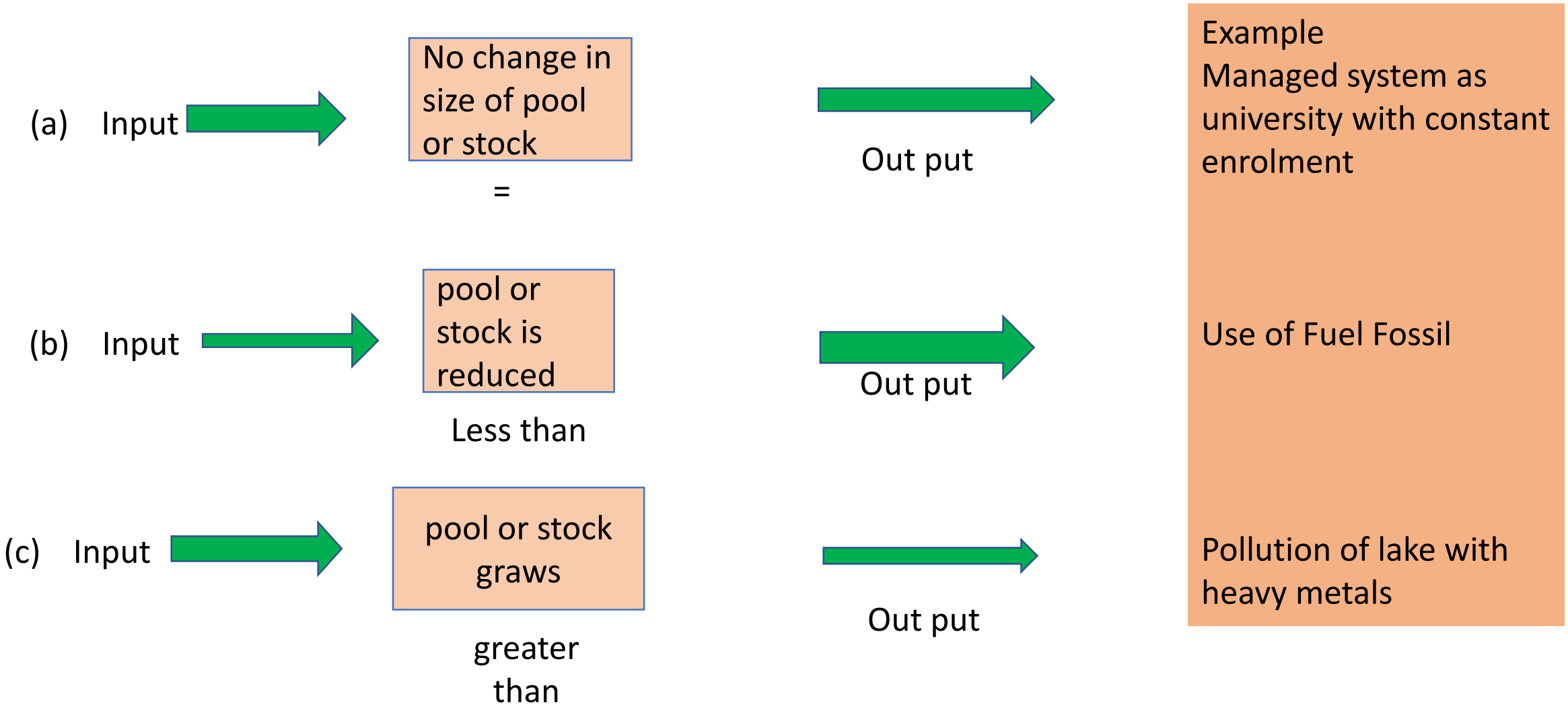
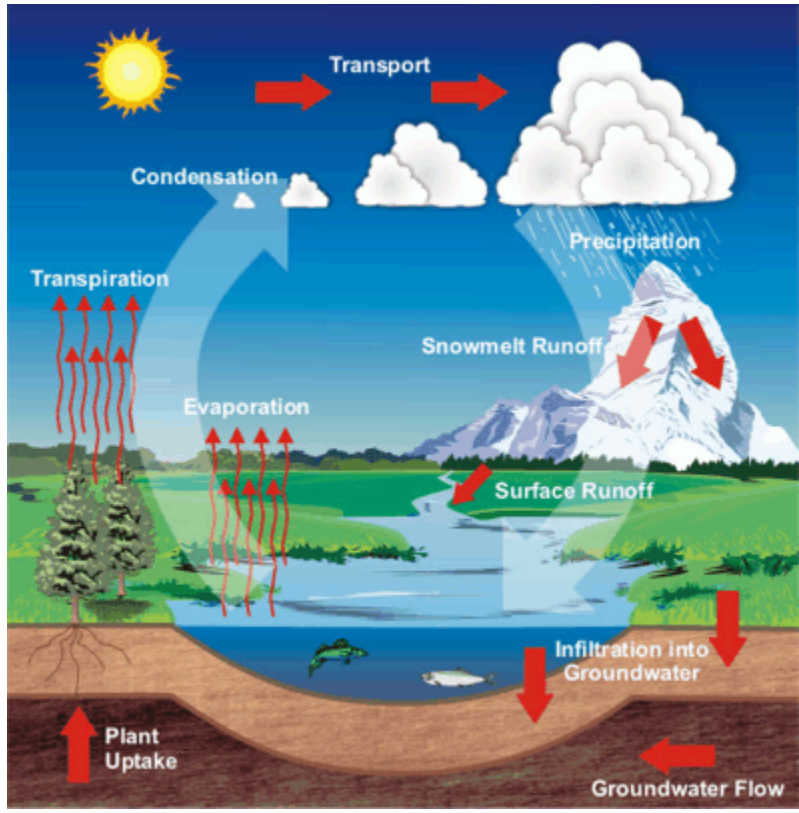


Fig. shows : Major ways in which a pool or stock of some material may change.

Fundamental Concept of Environmental Geology



- At the *our planet global scale is a roughly steady-state system with respect to energy due to the following:*
  - ✓ **Incoming solar radiation** is roughly balanced by outgoing radiation from Earth.
  - ✓ Secondly the changing of the system input into will be/or is less than the output (Figure).
    - Examples such as the use of resources, as fossil fuels or groundwater and mining.

Fossil	+	Fuel	=	Fossil Fuel
↓		↓		↓
Remains of dead Plants & Animals		Material burnt to produce heat		Fuel obtained from dead Plants & Animals

Fundamental Concept of Environmental Geology

B. How Can We Evaluate these Change?

- **By** evaluating the rates of change of the input to output of a system,

So,

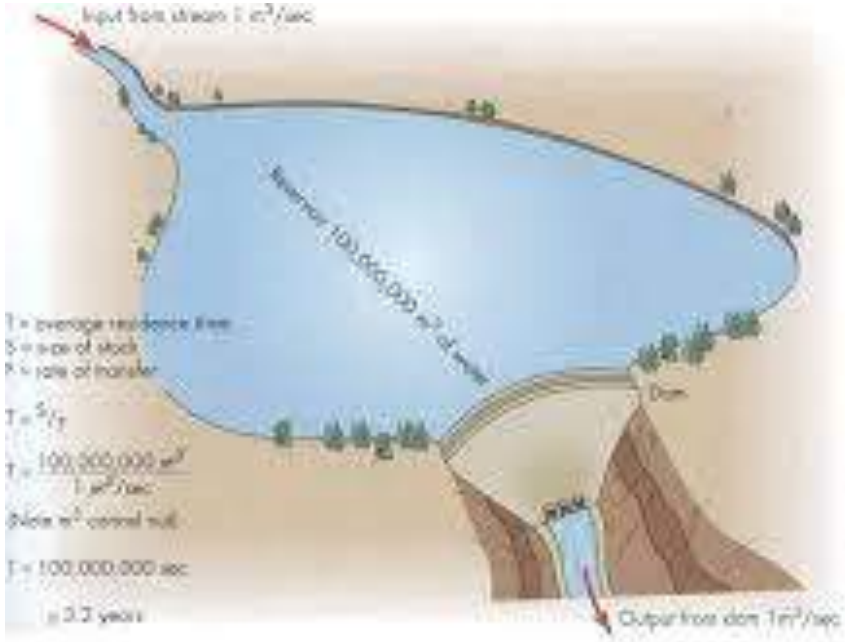
- *we can derive an* ***average residence time*** for a particular material, such as a resource.
- The ***average residence time is a measure of the time it takes for the total stock or supply of the material to be cycled through a system***.
- ***To compute the average residence time (T);***
  1. By **assuming constant size** of the system and constant rate of transfer,
  2. Thus, it is equal = the total size of the stock (S) / divide by its average rate of transfer (F) through the system: $T = S/F$

Fundamental Concept of Environmental Geology

- For example,

  ✓If a reservoir (Dam of water) holds *100 million cubic meters of water,* and both the average input from the streams incoming to the reservoir,

  ✓ and *the average of the output through the spillway are 1 cubic meter per second = (100,000,000 X 1 m^3/s = 100,000,000 second*



Therefore;

❖ *i.e. The **average of residence time for a cubic meter** of water in the reservoir **is 100 million seconds**, or about 3.2 years.*

Fundamental Concept of Environmental Geology

C. *Forecasting Changes in the Earth System*

- The ***idea is is to state the law "the present is the key to the past," called uniformitarianism, was popularized by James Hutton, in 1785.***
- It is ***indicated today as a fundamental concept of Earth sciences. As the uniformitarianism considered as a processes***
- we observe ***today the earth's changes and operated as in the past (e.g., flow of water in rivers, formation and movement of glaciers, landslides, waves on beaches, uplift of the land from earthquakes).***
- ***Uniformitarianism does not demand or even suggest that the magnitude (i.e., amount of energy expended) and frequency*** (***how often a particular process occurs) of natural processes remain constant with time***.
- We ***can suppose that***, as long as the ***Earth has had atmosphere, oceans, and continents are similar to those of today's present processes are operating***.

Fundamental Concept of Environmental Geology

D. Environmental Unity

- The ***principle of environmental unity***, **is the action causes other acted in a chain of actions,** (i.e. ***Environmental unity means that it is impossible to change only one thing; but, countering all (everything) affects the other things as well***.
- ***Unity is an important principle in the prediction in the changes system of /in the Earth.***
  - ✓ For example,
    - ❑ if we *constructed a dam on a river, a number of changes would take place due to Dam's construction*
      - Such as, *Sediment that moved down the river-down stream to the ocean before construction of the dam would be trapped in the reservoir*.
      - Consequently, the ***beaches in front of the dam would be poor ness in the sediment are coming from the river***, ***might be increased coastal erosion generating beach with less sediment ,that may also affect the coastal animals are using or living in the sand, such as crabs and clams…… etc>***

Fundamental Concept of Environmental Geology

- Thus, ***building and construction of a dam*** ***would create series chain of effects that would change the coastal environment and what bio-life lived there.***
- ***The Dam by its self*** ***would also change the hydrology of the river and would block fish from migrating upstream.*** ***We will consider it as global environmental linkages.***

E. The Earth System's Sciences

- ***Earth systems science*** is ***the study of the entire system of our planet in terms via of its components (The Gaia Hypothesis), which*** asks of how the earth's component systems acts.

➢ ***Gaia hypothesis****, stimulating the idea of a living Earth*.

The hypothesis is named for Gaia, the Greek goddess Mother Earth. The Gaia hypothesis is best stated as a series of hypotheses:

1. ***Life significantly affects the planetary environment.*** Very few scientists would disagree with this concept.

Fundamental Concept of Environmental Geology

2. *Life affects the environment for the progress of life. This hypothesis is supported by some studies showing that life on Earth plays an important role in regulating planetary climate, so that it is neither.*

3. **Life intentionally or consciously controls the global environment**.

   - ✓ *Interactions and the linking of processes that operate in the atmosphere*,, and in the oceans on the surface of Earth *are probably sufficient to explain most of the mechanisms by which life affects the* environment.
   - ✓ In contrast, *humans are beginning to make decisions concerning the global environment,*
   - ✓ **so the idea that humans can influence the future of Earth is not an extreme view**.

❖ Anyway a Very few scientists accept this third hypothesis.

Fundamental Concept of Environmental Geology

- ***The Gaia Hypothesis too hot nor too cold for life to survive.***

  - ✓ For example, *it is believed that single-cell plants floating near the surface of the ocean partially control the carbon dioxide content of the atmosphere and thereby global climate*.

  - ✓ The *real value of the Gaia* hypothesis *is that it has stimulated a lot of inter disciplinary research to understand how our planet works*.

  - ✓ ***Gaia interpreted by most scientists, as a hypothesis does not suggest foresight or planning on the part of life but***, it suggest ***the operating of natural processes.***

Fundamental Concept of Environmental Geology

4. ***Hazardous Earth Processes***

These are the natural hazards must be recognized and avoided when possible, and their threat to human life and property must be minimized.

- ***Such as storms, floods, earthquakes, landslides, and volcanic eruptions, that periodically damage property and kill us.***
- ***During the past 20 years, natural hazards on Earth have killed several million people.***
- ***The annual loss has been about 150,000 people, with financial damages of about $20 billion.***

Fundamental Concept of Environmental Geology

- An *initial principle concerning the results of natural hazards, and formed by human activities* (e.g., ***population increase and changing the land via agriculture, classification, mining, urbanization)***, what were before ***disasters are becoming catastrophes***.
- For example:

1. Human ***population increased and are forcing more people to live in a hazardous areas***,
   - ✓ such as in *floodplains, on steep slopes (where landslides are more likely), and near volcanoes.*
2. ***Land-use transformations, including urbanization, deforestation, and increase runoff and flood hazard, may weaken slopes***, making landslides more expected.
3. *Burning huge amounts of oil, gas, and coal has increased the concentration of carbon dioxide in the atmosphere, contributing to warming the atmosphere and oceans*.
   - ✓ As a result, ***more energy is fed into hurricanes. The number of hurricanes has not increased, then the intensity and size of the*** storms have increased

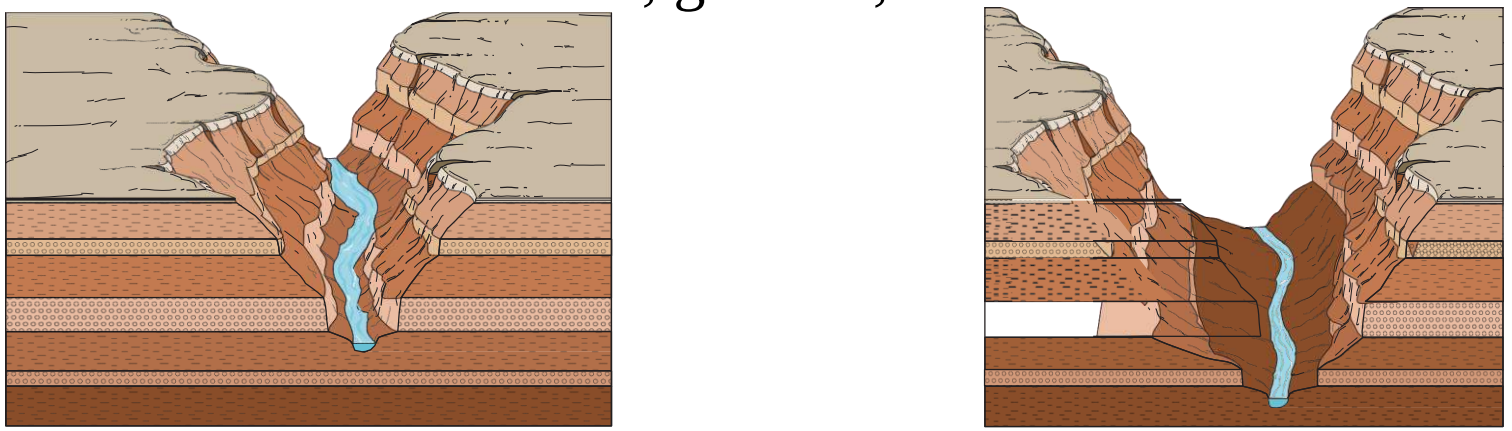
Fundamental Concept of Environmental Geology

5. Scientific Knowledge and Values → *It is the results of scientific inquiry to solve a particular environmental problem and often provide solutions consistent with the scientific findings. The chosen solution is a reflection of our value system.*

- The important variable that geology distinguishes more than the most of the other sciences. It is the consideration of time.
- Geologists' interest in Earth history over time periods **Fundamental Concepts of Environmental Geology** that are nearly incomprehensible to most people naturally leads to some interesting questions:
  1. How fast are mountains uplifted and formed?
  2. How fast do processes of erosion reduce the average elevation of the land?

Fundamental Concept of Environmental Geology

3. How fast do rivers erode canyons to produce scenic valleys such as Yosemite Valley and the Grand Canyon (**Figure**)?
4. How fast do floodwaters, glaciers, and lava flows move?



(a) Cut at about 250,000 yrs

(b) Incision at about 1,000,000 yrs

Figure:

- Idealized diagram of progressive **cut of a river into a sequence of horizontal rocks**.
- The side **slope is steep where rocks are hard and resistant to incision**, and
- the **rate of incision (opening) is generally less than about 0.01 mm per year** (about 0.0004 in. per year).
- **For softer rocks, where the side slope is gentle, the rate of incision may exceed 1 mm per yea**r (0.039 in. per year)
- **If the canyon incised about 1 km (0.62 mi) in 1 million years, the average rate is 1 mm per year** (0.039 in. per year)

Fundamental Concept of Environmental Geology

- The ***following table shows rates of geologic processes vary from a fraction of a millimetre per year to several kilometres per second***.
- ***The fastest rates are more than a trillion times the slowest***. ***The most rapid rates, a few kilometres per second, are for events with durations of a few seconds.***
  - ***For example,***
    - ✓ uplift of 1 m (3.3 ft) during an earthquake may seem like a lot, but when averaged over 1,000 years (the time between earthquakes),
    - ✓it is a long-term rate of 1 mm per year (0.039 in. per year), a typical uplift rate in forming mountains. Of particular importance to environmental geology is that human activities may accelerate the rates of some processes.

TABLE Some Typical Rates of Geologic Processes

Slow Rates	• Uplift that produces mountains. Generally 0.5 to 2 mm per year (about 0.02 to 0.08 in. per year). Can great as 10 mm per year (about 0.39 in. per year). It takes (with no erosion) 1.5 million to 6 million ye produce mountains with elevations of 3 km (around 1.9 mi).
	• Erosion of the land. Generally 0.01 to 1 mm per year (about 0.004 to 0.039 in. per year). It takes (with 3 million to 300 million years to erode a landscape by 3 km (about 1.9 mi). Erosion rate may be signi increased by human activity, such as timber harvesting or agricultural activities that increase the a water that runs off the land, causing erosion. Rates of uplift generally exceed rates of erosion, explai land above sea level persists.
	• Incision of rivers into bedrock, producing canyons such as the Grand Canyon in Arizona. Incision is c from erosion, which is the material removed over a region. Rates are generally 0.005 to 10 mm per y (about 0.0002 to 0.39 in. per year). Therefore, to produce a canyon 3 km (around 1.9 mi) deep would 300 thousand to 600 million years. The rate of incision may be increased several times by human act such as building dams, because increased downcutting of the river channel occurs directly below a
Intermediate Rates	• Movement of soil and rock downslope by creeping in response to the pull of gravity. Rate is genera mm per year (about 0.02 to 0.05 in. per year).
	• Coastal erosion by waves. Generally 0.25 to 1.0 m per year (0.82 to 3.28 ft per year). Thus, to provid protection from erosion, a structure should be built about 25 to 100 m (about 82 to 328 ft)back from edge.
Fast Rates	• Glacier movement. Generally a few meters per year to a few meters per day.
	• Lava flows. Depends on the type of lava and slope. From a few meters per day to several meters per sec
	• River flow in floods. Generally a few meters per second.
	• Debris avalanche, or flow of saturated earth, soil, and rocks downslope. Can be greater than 100 k per hour.
	• Earthquake rupture. Several kilometers per second.

Summary

- The ***causes of the environmental crisis are overpopulation, urbanization, and industrialization, which have occurred*** with too ***little ethical regard for our land and inadequate institutions to cope with environmental stress***.
- ***Solving environmental problems involves both scientific understanding and the raising of social awareness, economic, and ethical behaviour that allows solutions to be implemented.***
- Complex ***environmental problems can difficult to be solved, due to the possibility of exponential growth, lag times between cause and effect, and irreversible consequences.***
- *The ideas of new emerging policy tool is the precautionary principle* ***are potentially serious to prevent environmental problem exists***,

Summary

- *Five fundamental concepts establish a philosophical framework for our investigation of environmental geology:*

1. *The increasing world population is the number-one environmental problem.*
2. *Sustainability is a totally preferred solution to many environmental problems.*
3. *Having an understanding of the Earth system and rates of change in systems is critical to solving environmental problems.*
4. *Earth processes that are hazardous to people have always existed. These natural hazards must be recognized and avoided when possible, and their threat to human life and property minimized.*
5. *Results of scientific inquiry to solve a particular environmental problem is often resulted in a series of potential solutions and consistent with the scientific findings solutions, the choosed solution will reflects our value system.*