

Chapter 1: Meet Planet Earth



台大地質科學系
楊燦堯

超級火山：真正末日



- http://discoverychannel.com.tw/ontv_supervolcano/index.shtml

9月25日, 9pm-11pm 首播
9月26日, 3pm-5pm 重播



Introduction

- No other planet in the solar system currently has the right chemical and physical mix needed to support life.
- No conclusive evidence of life existing elsewhere in the universe has yet been discovered as far as we know.
- Earth is unique.

Human Influences

- We human are influencing Earth's external geologic processes.
 - More than 6 billion people.

Human Influences (2)

- **Our daily activities are having measurable effects on:**
 - **Rainfall.**
 - **Climate.**
 - **Air.**
 - **Water quality.**
 - **Erosion.**
 - **In North America, we use 20 tons of mineral resources per person/year.**

Geology

- **Geology is the science of Earth.**
- **Geologists study the Earth's processes, such as:**
 - **Volcanism.**
 - **Glaciation.**
 - **Stream-flow.**
 - **Rock formation.**

Geologists Also Study :

- Chemistry, to understand:
 - Minerals.
 - Dissolved minerals.
 - Minerals resources.
 - Rocks formation.
 - Ground water.

Geologists Also Study :(2)

- Physics, to understand:
 - Plate tectonics.
 - Volcanism.
 - Earthquakes.
 - Landslides.
- Biology, to understand:
 - How life processes integrate with other Earth systems.
 - How life has evolved.
 - Fossils in the rocks.

Geologists Also Study : (3)

- Meteorology, to understand:
 - Stream flow.
 - Groundwater levels.
- Oceanography, to understand:
 - Seafloor's role in plate tectonics.
 - Shorelines.

Geologists Also Study : (4)

- Astronomy.
- Mathematics.
- Computer sciences.
- Economics, to understand how humans employ:
 - Minerals.
 - Energy resources.

What Do Geologists Do ?

- They seek to understand all processes that operate on and inside the Earth.
- They study:
 - Our planet's long history.
 - Water bodies (rivers and lakes).
 - Hazardous processes such as earthquakes, volcanic eruptions, flood, and landslides.
 - Rocks.
 - Spot surface patterns.
- They use ground-penetrating radar.

Physical Versus Historical Geology

- Historical geology
 - Chronology of events, both physical and biological, that have occurred in the past.
 - The past is the biggest clue to the present.
- Physical geology
 - Concerned with understanding the processes and the materials.

Physical Geology Also Studies

- Plate tectonics.
- Volcanism.
- Earthquakes.
- Landslides.
- Floods.
- Formation of mineral deposits.
- Mountain-building.
- Shore erosion.
- Landscape formation.
- Rocks.
- Minerals.
- Air.
- Seawater.
- Soil.
- Sand

The Scientific Method (1)

- Geologists use a research strategy called the scientific method.
- The scientific method includes the following steps:
 - Observe and measure.
 - Form a hypothesis (a plausible, but unproved, explanation for the way something happens).

The Scientific Method (2)

- Test the hypothesis (by comparing the predictions against the new observations).
- Formulate a theory (a generalization about natural phenomena).
- Formulate a law or principle (statements that some natural phenomenon is invariably observed to happen in the same way, and no deviations have ever been observed).
- Continually reexamine the law or principle in the light of new evidence.

How Rapid Are Geologic Processes?

- During the seventeenth and eighteenth centuries, people believed that Earth's features (mountains, valleys, oceans, rivers) were permanent and had been produced by a few great upheavals.
- This theory is called *Catastrophism*.

James Hutton Applies the Scientific Method

- James Hutton (1726-1797), now known as the father of modern scientific geology, assembled evidence and proposed a counterhypothesis called *gradualism*.
- In 1795, he published “Theory of the Earth with Proofs and Illustrations.”
- He proposed *uniformitarianism*, which asserts that everything must move slowly in a repetitive, continuous cycle.

Uniformitarianism

- States that the same processes we observe today have been operating throughout Earth’s history.
- The cycle of uplift, erosion, transport, deposition, solidification into rock, and renewed uplift requires a great deal of time for its operation.
 - The Earth is 4.55 billion years old.

Catastrophism

- Recently, a thin and very unusual rock layer, rich in the rare metal iridium, has been discovered at many locations worldwide.
- It indicates that a catastrophic impact from a meteor may have occurred about 66 million years ago.
 - The mass extinction of dinosaurs occurred at that time.
 - More dramatic extinctions have occurred at other times in the past.
 - The mass extinction occurring about 245 million years ago eliminated almost 90 percent of all plants and animals living at the time.
- Events such as earthquakes, volcanic eruptions, tsunamis, floods, and landslides are local catastrophes.

Geologic Time and Earth's Age

- Stratigraphy is the study of the structure of sedimentary layers recording a sequence of past events.
 - The layers at the bottom of the pile are the oldest.
 - Those at the top are the youngest.
- Stratigraphy identifies the relative age of many geologic events.
 - Relative age identifies position in a limited sequence. (“This is older than that.”)
- Radioactivity can be used to establish the absolute age of geologic events.
 - Absolute age identifies position in a universal sequence (such as our current system of naming years in chronological order). (“This is 49,000 years old.”)

Geologic Time and Earth's Age

- The Appalachians rose about 300 million years ago.
- The modern Rockies about 70 million years.
- The most recent great ice sheets retreated about 12,000 years ago.

Homework of today

- Explain/describe following terms:
 - (1) catastrophism
 - (2) gradualism
 - (3) uniformitarianism
- Describe the *scientific method* which geologists usually use for research.