UNIVERSITY OF ZAMBIA, GEOLOGY DEPARTMENT

GGY_3049: STRUCTURAL GEOLOGY

Concepts, Objectives & Aims of Structural Geology.

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STRUCTURAL GEOLOGY

Introduction to

Concepts, Objectives & Aims

of Structural Geology.

Structural geology:
A study of Earth's Architecture

- Earth is a **dynamic planet** in which **tectonic** forces **deform** rocks in the crust.
- **Evidence** demonstrating the operation **of enormous forces** within Earth includes thousands of kilometers of **rock layers** that are **bent, contorted, overturned, and sometimes riddled** (mysterious) **with fractures**.

- In the Himalaya and the Canadian Rockies, for example, **some rock units have been thrust for hundreds of kilometers over other layers.**

- On a **smaller scale**, **crustal movements** of a **few meters** occur **along faults** during major **earthquakes**.

- In addition, **rifting** (spreading) and **extension** of the crust produce **elongated depressions** and, may even create **ocean basins** over long spans of **geologic time**,

- **Structural Geology** deals with the study of **deformation in rocks** at scales ranging from:

(1) Submicroscopic to

(2) Regional (micro-, meso-, and macro-scale)

- **Structural geologists** study the architecture of Earth’s crust and “how it got this way” insofar as it resulted from deformation.
- In other words, the **aim of structural geology** is to determine and explain the architecture of rocks as observed in the field;
- **Laboratory investigations** are supplementary means to attain this primary objective.

- Thus, **structural geologist's** deal with:

1. Ways in which **rocks respond** to the application of **deforming forces**, and
2. The **structure that results** from deformation.

- The ultimate **aim of structural geology** is to:

1. Establish the **history** of **displacement,**

2. **Stress- Strain** rates,

3. **Temperature** & **pressure** that the **crust** & associated **upper mantle** of the earth have experienced.

By studying the :

(1) O**rientations** of **faults** and **folds,** as well as

(2) Small-scale **features** of **deformed** rocks,

- **Structural geologists** can often reconstruct the original geologic setting and nature of the forces that generated these rock structures.

- In this way, the complex events of Earth's **geologic history** are unraveled.

In structural geology we examine the:

(1) **Forces** that deform rocks, and

(2) The **structures** that result.

The **basic geologic** structures associated with deformation are:

- Folds, faults, joints, and foliations (including rock cleavage).

- Tectonics and tectonic geology are terms that may be considered to be synonymous with **structural geology**.

- To some, however, **structural geology is concerned primarily with the geometry** of the rocks, whereas **tectonics deals with the forces and movements that produced the structure**.

- The movements that affect solid rocks result from forces within the earth, causing **folds**, **joints, faults**, and **foliation**.

- The **movement of magma**, is also a subject that lies within the domain of **structural geology** because it is often intimately **associated with the displacement of solid rocks**,

- The **deformation of the rocks of extraterrestrial bodies** is also the concern of **structural geology**, as well as the effect of collision between **bodies** in the **solar system**.

Importance of Structural Geology

- An **understanding of rock structures** is not only important in deciphering **Earth's history**; it is also basic to our **economic well-being**.

- For example, most **occurrences of oil and natural gas** are associated with geologic structures that act to trap these fluids in valuable "reservoirs".

- Furthermore, **rock fractures** are sites of **hydrothermal mineralization,** which means they can be sites of **metallic ore deposits**.

- Moreover, the **orientation of fracture surfaces**, which represent zones of weakness in rocks, must be considered when selecting sites for major **construction projects** such as: bridges, hydroelectric dams, and nuclear power plants.

Objectives of structural geology

The structural geologist is concerned with three major problems:

1. What is the structure?
2. When did it develop?
3. Under what physical condition did it form?

1. In general, the first question must be answered first.

- It is essential to determine the shape and size of the bodies.

Geological field work is indispensible to investigate structures, and it is this fact that distinguishes most phases of geology from many of the other sciences.

2. A second objective of the structural geologist is to relate the structure to some chronology.

- One phase of this study is to **determine the sequence** in which the structural features developed.
- For example, we may find an **anticline**, a **fault**, and a **dike**. **What are their relative ages?** The anticline may be the oldest and the dike may be the youngest, and so on.

- The structural geologist is interested not only in the **sequence of events** in the area in which he is studying but he also wants to **fit them into the geological history of the whole earth.**

- This can be done by paleontological methods or by radiometric dating (geochronology).

3. A third objective of the structural geologist is to determine the **physical processes** that produced the observed structure.

(1) What was the **temperature** and **pressure at the time the structural feature formed**, and

(2) what was the stress distribution?

It is desirable to answer these questions before we try to deduce the ultimate cause.

- Without knowing the **stress distribution** at the time the structural feature formed, it is difficult to decide whether a given fold was the result of sub-crustal convection current or the forceful injection of magma.

- **Structural geology provides information about the conditions during regional deformation using structures.**

Field Studies

- Many **tectonic problems** are approached by studying structures at outcrop scale, and smaller (microscopic) or larger (100's to 1000's of km) scales.

- Systematically observing/recording the patterns of rock **structures** (e.g., fault, fold, foliation, fracture).
- This gives the geometry of the structures.

Structure

A **geometric feature** in a rock whose **shape**, **form**, and **distribution** can be described

Microstructure

The **small-scale arrangement of geometric** and **mineralogical elements** within a rock

Texture

Preferred orientation of **crystallographic axes** in the sample

Microfabric

Comprises the **microstructure** and the **texture** of a material

Fundamental Structures

1. **Contacts**
2. **Primary Structures**
3. **Secondary structures**
   - *Fractures (Joints, Shear Fractures)*
   - *Vein -* Precipitated minerals from fluid flowing through fractures
   - *Fault*
   - *Fold*
   - *Foliation -* Preferred orientation of planar rock bodies and/or minerals
   - *Lineation -* Preferred orientation of linear minerals and rocks
   - *Shear Zone:* Zones of deformed rock that have accommodated movement

Thank you

END OFLECTURE


Pokhara Valley, western Nepal with Annapurna Range in the background. Photo by Bishal


The Everest peak 8848 m.
Photo courtesy: M. Yoshida