LECTURE 1

INTRODUCTION TO THE PRINCIPLES OF GEOLOGICAL FIELD MAPPING

1.0 INTRODUCTION

Welcome to lecture 1 of this unit and congratulations for having chosen this unit as part of your desire to learn more on the science of geology. Since this unit is field oriented, I have assumed that you have already acquired some elementary knowledge in the basic techniques used in the identification of common rocks, minerals and geologic structures.

To geologists, the field is where rocks or soils can be observed in their natural setting. Geologic mapping is essential to many field studies in that it assists in the production of maps that are used to measure rock bodies, plot structural measurements and relate many kinds of

data. Frequently these maps permit interpretations of features that are too large to be studied in single rock **exposures** and often are the ideal means of presenting large amount of information to other persons.

In this first lecture, you will be introduced to some general field definitions. Thereafter you will be shown the necessary planning procedures you need to undertake and field equipment you need to have before executing any successful geological field mapping exercise. Explanation on how geological maps are produced and their uses is well articulated in this chapter.

1.1 OBJECTIVES

Objectives

At the end of this lecture you should be able to:

a). Define the terms " Field, Field studies and Field Geology ".

b). Outline uses of geologic maps.

c). Describe the procedures to be followed when planning for a field mapping project.

d). Outline the process followed in producing a geological map

e). List the basic equipment needed for a geological mapping exercise

1.2 GENERAL BASICS OF FIELD MAPPING

We shall start off by giving some basic definitions relevant to the science of field mapping.

Basic Definitions:

Field - This is where rocks or soils can be observed in their natural setting.

Field studies - This is the primary means of obtaining geological knowledge e.g. by visiting a rock outcrop or quarry and making notes and sketches. This process may at times be tedious and involving. It may take weeks or months. Geological Mapping is very essential and has sometimes been considered synonymous with Field Geology.

Field Geology – When rocks and rock materials are investigated in their natural environment and in their natural relations to one another, the study is called field geology. Field geology seeks to describe and explain the surface features and underground structure of the lithosphere.

Having defined the above essential terms, it is important to realize that Geologic mapping is an important component in many field studies.

1.3 THE USE OF GEOLOGICAL MAPS

Some of the most important uses of geological maps are listed below:

- To measure rock bodies in order to quantify their aerial extend.
- To plot structural measurements and to relate many kinds of data for geotechnical and petroleum investigations.
- Geological maps are useful to soil scientists, mineral prospectors, hydrogeologists, builders, road workers, petroleum geologists and other professionals in carrying out research programs in their fields of study.
- Many structural features (e.g. faults and folds) can best be discovered through a geological mapping exercise. Their relative occurrence may assist engineers where to locate bridges, buildings, tunnels etc; guide geologists to possible sites of mineralization and groundwater resources.
- Geological maps are used to construct important projections such as cross-sections (i.e. the vertical and spatial distribution of rocks and structures beneath the earth surface).

Rocks have to be identified before they can be mapped. Many genetic relations of rock formations can be understood only after exposures are examined in detail. No amount of mapping can replace these crucial observations. For example, a detailed map of an igneous body might show only that it is a concordant layer between sedimentary formations. Relations at one or two outcrops, however, could demonstrate that the body is a lava flow (Fig. 1.1) rather than a sill (Fig. 1.2). Once this is established, obscure or hidden features associated with the flow might be identified and then utilized in further interpretations.

Figure 1.1 Basaltic lava streaming from the Kilauea Volcano, Hawaii.

Figure 1.2 Granitic Sill (light colour) intruded between layers of finely banded black shale

Why are observations made on individual outcrops necessary?

Because a geologist is continuously observing relations and making interpretations in the field, his general methods are comparable to other classical scientific methods. Once in the field, for example, the geologist should try to formulate hypotheses to interpret geological observations. He should write these immediately in his Field Notebook on the spot. The reason is because revisiting the place mapped may incur problems e.g. bad season, high financial cost, and time. Field studies must thus go far beyond mere mapping and collecting of individual rocks or structures.

ACTIVITY

List some of the reasons why you think field studies should go beyond the mere collection of rock samples.

1.4 PLANNING A FIELD PROJECT

Generally speaking, geologic field projects proceed in three stages, namely, the planning stage; the stage of mapping, observing and collecting field data and specimens; and the stage of preparing a report.

In this section we shall discuss the planning stage of the project. The other two stages will be discussed elsewhere in this course unit. Some of the most important recommendations that are required when one is planning for a field project include:

(i) Determine if other geologists are working (or have worked) in the area or near it. This avoids duplicating somebody's work.

(ii) Accumulate and study reports and maps of the region in order to have an understanding of the broader features of the area. Establish the known problems in this area.

(iii) Visit the area if possible to reconnoitre its topography and geology and to obtain permission for camping, mapping and collecting data.

(iv) Determine the scales and quality of maps, aerial photographs and satellite images of the area. Consider whether preparation of other topographical maps is required besides base maps. Establish the most efficient methods of surveying.

(v) Evaluate the probable schedule and costs of the project considering the mapping procedures, how well the rocks are exposed, and how accessible the area is from the camp.

(vi) Order maps, aerial photos, and various other field and office equipment allowing plenty of time for delivery.

(vii) Reread critically all reports that pertain to the area as well as books or papers that present basic ideas and methods relevant to the project.

(viii) Accumulate a complete field library as much as possible e.g. photographs, photocopies and other abstract items that cannot be taken to the field.

ACTIVITY

List three reasons why you think advance planning is necessary before executing a field-mapping program?

1.5 PRODUCTION OF A GEOLOGICAL MAP

Geological maps are produced through the following processes:

1. From the compilation of the field data that is obtained when a geologist studies rock outcrops. The rock outcrops in the field are usually studied by following:

(i) River courses from downstream to upstream

(ii) Making traverses across the strike in the survey area

(iii) Following roads and paths across the strike in the survey area

2. From aerial photograph interpretation and any other available satellite imageries. In this process, geologists interpret the geology from aerial photographs using stereoscopes and plot the map from these interpretations. Thereafter the geologist goes to the field area very briefly to observe and label the rock units that he has interpreted.

You will learn more about aerial photographs and their interpretation in Lectures 6 and 7 of this unit.

1.6 FIELD EQUIPMENT

There are two categories of equipment used by field geologists: (i) general or basic equipment most of which would normally be carried along, and (ii) more specialized equipment applicable only to certain types of survey.

1.6.1 Basic equipment

The basic equipment needed for examining, describing and collecting rocks for a geological mapping exercise is modest in amount and need not be costly. It consists essentially of the following: -

i) Hammers- A geological hammer with a pick or chisel point at one end (Fig 1.3) or a 2-pound hammer depending on the type of rock being investigated.

Figure 1.3 Geological Hammer

Your field hammer – popularly known as a geological hammer - must not be one of the ordinary household varieties, but must be designed for use with stone. Hammers have occasionally been known to shatter when used heavily on rock, and as a precaution against this and the very much greater chance of flying rock fragments striking you in your eyes, you should wear some sort of shatter-proof goggles when hitting hard rock. Your eyes are far too precious to run the risk of damage!

The actual weight of hammer will depend upon the kind of rock that you will be attacking. If it is very hard you must have a heavier hammer. For areas composed of hard rocks, a 2lb hammer is necessary. This heavy hammer is used for collecting hard rock specimens such as gneisses, lavas, and hornfelses.

ii) A hand lens (x10 or x15 aerial magnification is necessary).
iii) A pocket knife
iv) Chisel
v) A notebook (usually 5 by 7.5 inches) or loose leaf folder (clipboard)
vi) A 2H or 3H pencil or a good ballpoint pen
vii) A 20cm – scale
viii) Dilute acid – For carbonate or calcareous tests
ix) Collecting bags and marking pens
x) Waterproof bags for notebooks, maps and other stationary
xi) A knapsack (rack sack) for carrying lunch or field gear
xii) Base maps and aerial photos
xiii) Compass-clinometer – A liquid immersion variety is desirable.
xiv) A good camera – Geologists should try to buy a good camera early in their career. It is an advantage to have one with interchangeable lenses (for example, with focal lengths of 28 mm, 50 mm and 135 mm and extension tubes). Students should consider buying a good basic camera and adding interchangeable lenses as funds permit.
xv) Pocket stereoscope – This is essential for most field surveys, not only for locating position on aerial photographs, but also for the geological information which can be seen and plotted during mapping.
xvi) Knowledge of the theory

1.6.2 Specialized Equipment

Important specialized equipments commonly used in geological investigations include:

Augers – For sampling unconsolidated deposits (for example, Quaternary formations) an auger is usually used. For straight forward mapping a lightweight, small-diameter screw auger (say 3 cm) is sufficient, but a large-diameter type (15 or 40 cm) will be necessary for detailed sampling. The type will depend on upon the purity of sample required and on the lithology which is to be penetrated.

Aneroid barometer – This can be very useful particularly when mapping relatively unknown mountainous terrain in a reconnaissance style. Fairly reliable altitudes can be obtained provided there are frequent checks with a base camp reading.

Surveying apparatus - (level, plane table, theodolite, etc.)

Binoculars – These are particularly useful in mountainous areas for picking out detailed structures on distant hillsides, which might otherwise be missed.

Microscope – A binocular microscope at base camp can be particularly useful for examining specimens collected during the day.

1.6.3 Preparation of the Notebook

Before you begin fieldwork, the notebook should be made ready. Write your name and address on the inside of the front cover. On the first blank page, facing the front cover, record the name of the region where the investigation is to be made, and the year and date of beginning the work.

1.6.4 Preparation for Wet Weather

Wet weather should be anticipated; it can upset a field schedule seriously. Maps and aerial photographs can be waterproofed completely by enclosing them in transparent plastics. In order for the fieldwork to be thorough and consistently precise, geologists should clothe themselves comfortably and remember to carry raincoats and umbrellas.

1.7 Summary

SUMMARY

Geological maps have found wide application in the measurement of rock bodies and interpretation of their structural features, and are of use to many soil, water, mineral, construction and petroleum research programs.

We have further seen that geologic field projects generally proceed in three stages, namely, the planning stage; the stage of mapping, observing and collecting field data and specimens; and the stage of preparing a report.

We further noted that, during the planning stage for a field geological project, it is important to determine if other geologists are working in the proposed area of study in order to avoid duplicating somebody's work. We learned the necessity to accumulate and study reports and

maps of the region in order to have an understanding of the broader features and problems of the area. Once a reconnaissance survey has been done, it is important to evaluate the probable schedule and costs of the project. Thereafter make the necessary order of maps, aerial photos, and various other field and office equipment necessary for the fieldwork and allowing plenty of time for their delivery.

1.8 References

REFERENCES

Compton, R.R. 1968. Manual of Field Geology. John Wiley & Sons, Inc. New York. 378pp.

Lahee F.H. 1980. Field Geology. McGraw Book Company, Inc. New York. 926pp.