ROCKS AND SOILS

D. ARMSTRONG
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Exploring the Environment Series

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Rocks and Soils

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TO THE TEACHER

This book is one of a series entitled *Exploring the Environment.* The other titles are listed on the back cover of this book. The basic aim of the series is to provide pupils and teachers with a wide variety of investigations, activities and insights into the Australian outdoor environment. The books are suitable for young people from approximately nine to fourteen years of age. Each book is designed so that children can follow lines of open-ended investigation into various aspects of the environment. Outdoor, enquiry-based activities are included wherever possible and are complemented with follow-up classroom activities.

There are seven books in the series; one of these is a *Teacher's Manual and Resource Book.* The essential function of this book is to provide vital information for the teacher which cannot be provided in a discovery-orientated students' book. Areas covered include: techniques and apparatus for outdoor activities; where, when, and how to organise outdoor activities; and suggestions for follow-up work and evaluation. A most important part of this book is a chapter which deals with each of the other six books in the series. This is particularly useful to the teacher as it provides much essential background information, such as: answers to specific questions which have been asked in the children's books; predicted outcomes which the teacher can expect children to find out; factual background information; teacher references and teacher notes on experiments. The *Teacher's Manual and Resource Book* is for use in conjunction with any of the other books in the series. In this way any teacher can be confident that he or she will have sufficient background information to adequately cope with learning activities in the outdoor situation.

PREFACE

In writing this book about rocks and soils for young people we have tried to encourage the reader to develop the habit of asking questions and attempting, with the help of classmates and teacher, to find some of the answers.

We are aware that many of the questions which will be asked about our environment have no definite answers. This is one of the real challenges of science today. While we are understanding more and more about the structure of the atom and examining soil samples collected from the surface of Mars, there are still many common features and processes on our earth which, when we examine them in detail, leave us with a final unanswered question such as why or how does it happen?

It is our sincere hope that this book will help the reader to be more aware of the relationships and processes operating in the world outside the classroom and to realise that rocks and soils are the fundamental materials from which our agricultural, fossil energy and mineral resources are developed.

Like other parts of our environment, we can only attempt to manage our rock and soil resources when we have acquired some understanding of the nature of the materials and the processes involved in their development. The young people of today are destined to become the managers of their own environment in the future and we trust that this book, and the others in the *Exploring the Environment* series may help them to accept this responsibility.

D. Armstrong
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Toowoomba

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Chapter 1

Why are rocks and soils important?

What are the needs of an animal if it is to survive? Probably the first to come to mind is FOOD. AIR and WATER are more urgent needs, but often we overlook these because they are so readily available. If it is a cold, wet day you might think that SHELTER makes life more comfortable, but a mouse being chased by a cat finds shelter to be an urgent need.

It may seem strange to begin a book on rocks and soils by talking about what animals and people need if they are to survive; but what better reason is there for studying rocks and soils if the knowledge gained helps us to survive, and to live more comfortably.

How does an animal in its natural environment provide for its needs? Consider a native cat. It hunts for its food which might be birds, mice or small possums. All of these animals might eat grass, leaves or seeds. The plants need soil to grow in and the soil is made from rock. This chain of events can be written as rock → soil → plant → mouse → native cat. A similar chain can be constructed for any animal. This chain can be written in general terms as in Fig. 1.1. This is not a food chain but rather a chain of dependence, each item depending on the previous item.

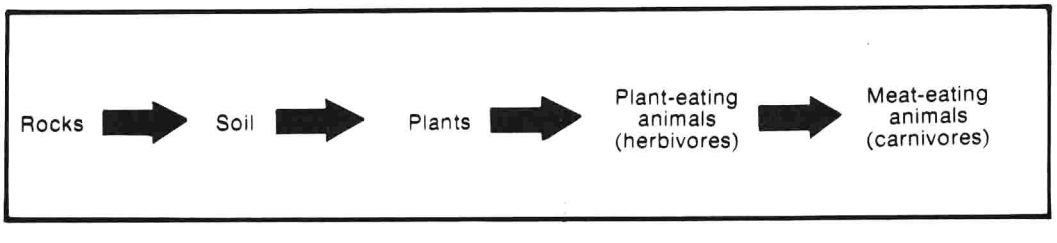


Fig. 1.1

ACTIVITY 1.1: How are our needs satisfied?

The drawing in Fig. 1.2 represents the natural environment, and shows how an animal's needs might be satisfied.

- What changes do animals make to their natural environment?
- How permanent are these changes?

Consider the tribal way of life of the Australian Aborigines.

- What foods do they eat?

- Make a chain such as Fig. 1.1, putting in particular foods which Aborigines would eat.
- Would a single chain be sufficient to represent their foods?

Make a copy of Fig. 1.2 and change the columns to show the needs and activities of the Aborigines.

- Compare this with Fig. 1.2.
- What changes do the Aborigines make to the natural environment?
- How permanent are these changes?

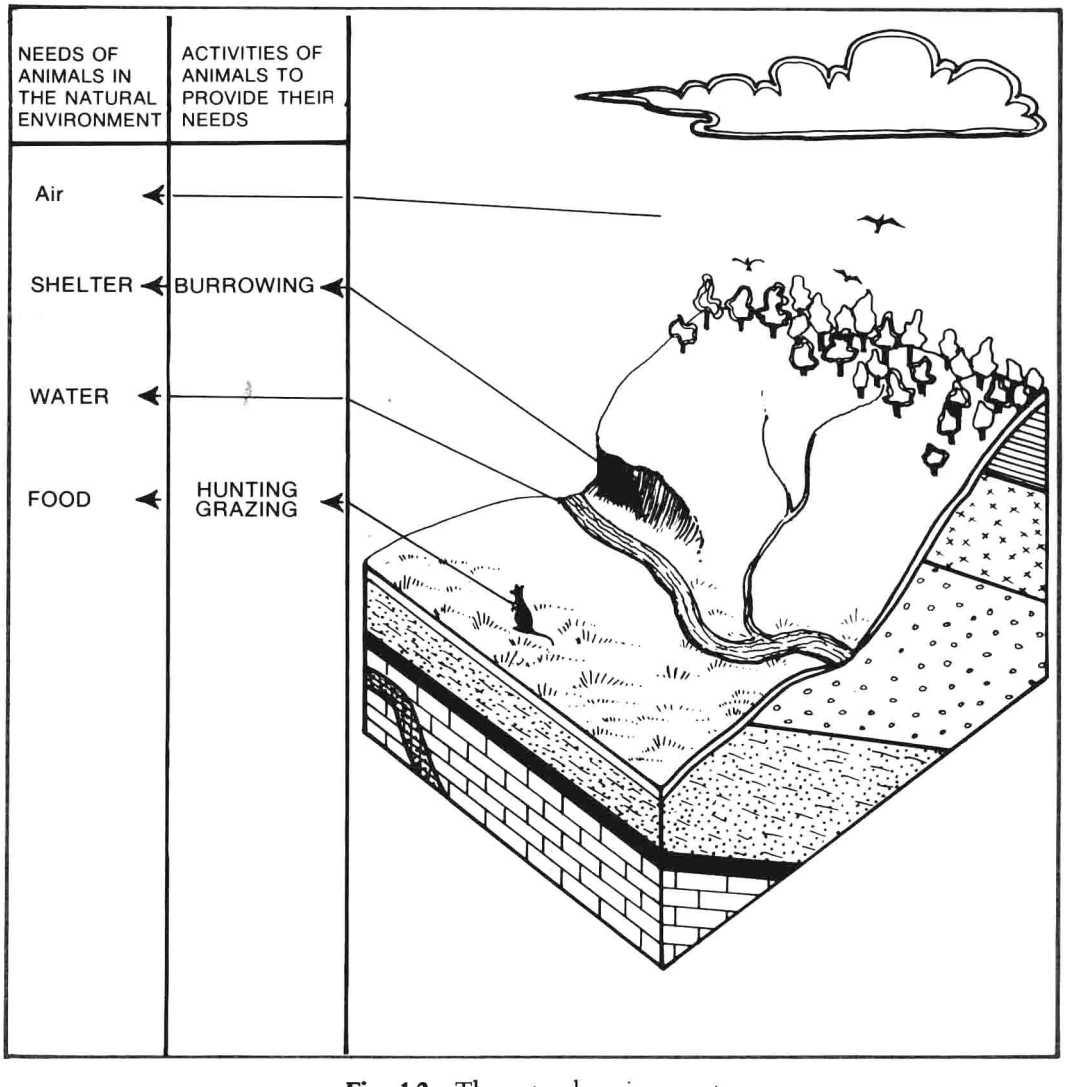


Fig. 1.2 The natural environment

Your own way of life is probably typical of most people in developed countries. We might call it the modern way of life.

- What foods do you eat?

- Make chains similar to Fig. 1.1, putting in the foods you eat.

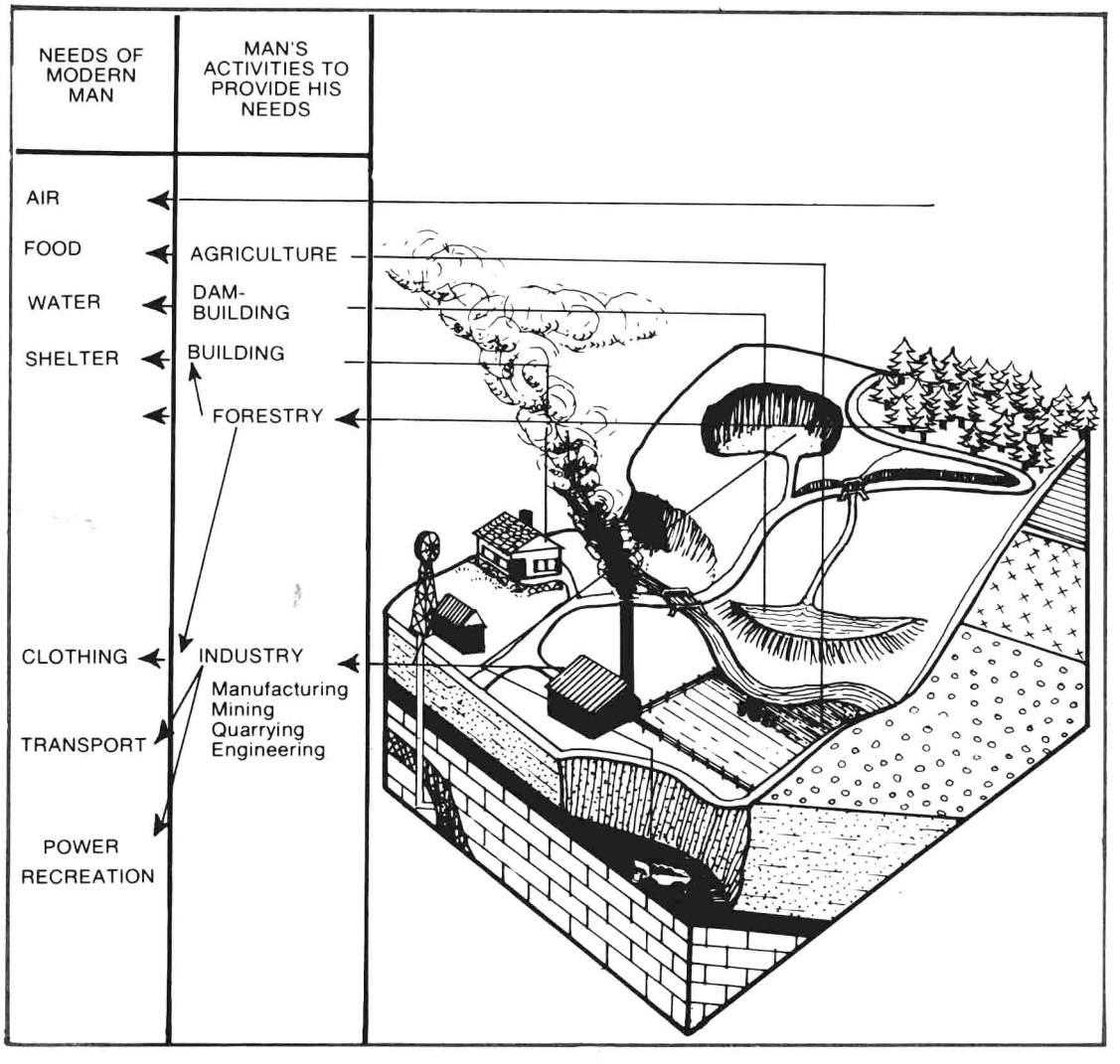


Fig. 1.3 The environment of modern man

Fig. 1.3 shows some of the needs for a modern way of life and some of the things people do to provide for these needs.

- What changes have been made?
- How permanent are these changes?
- Do people today live in the natural environment?
- Do people today use more of the earth's products than the Aborigines did?
- How do rocks and soils help provide these products?

The world's population is steadily increasing so the production of food and manufactured goods must increase all the time. People around the world are striving for a better standard of living. A better standard of living means more food, more possessions, better community facilities than before. The common saying, "More people wanting more", states the situation very well.

Most of the world seems to be striving to achieve the standard of living enjoyed by the people of the United States of America. However their high standard of living requires a large part of the world's energy resources. If everyone in the world was to have this standard of living, the energy required would be six to seven times the present usage. This means six to seven times as many coal mines, oil wells and power stations.

It also means that we would use up our reserves of coal and oil six to seven times faster than at our present rate. The figures given below are approximate only but you could easily find similar figures in books or magazines on mining, and do similar calculations.

Coal

Present annual usage	=	3 000 million tonnes
Usage at 6 to 7 times	=	20 000 million tonnes
Estimates of known reserves	=	5 000 000 million tonnes
Years of coal left if used at higher rate	=	$\frac{\text{reserves}}{\text{annual usage}}$
	=	250 years

Petroleum

Present annual usage	=	2 600 million tonnes
Usage at 6 to 7 times	=	16 500 million tonnes
Estimates of known reserves	=	100 000 million tonnes
Years of petroleum left if used at higher rate	=	6 years

This frightening prospect of using all the world's supply of petroleum in the foreseeable future has been labelled "the energy crisis". Throughout the world, geologists are striving to understand the patterns of rocks and so find more petroleum to increase this period of time. Will it always be possible to increase the world's known resources by exploration?

Rocks and soils, either directly or indirectly, provide nearly all our needs. They are neither unlimited in supply nor are they replaced in a few short years. To supply our increasing demand, careful management is needed. This management requires a knowledge and understanding of rocks and soils by all people – the geologist, the farmer, the business executive, even you and me.

Chapter 2

Outdoors, our best laboratory

If we want to study rocks and soils, the best place to start our study is where we find rocks and soils, outside in the world around us.

Scientists who work outdoors in the bush call their place of work the "FIELD". They do not mean a paddock with a fence around it or a field of wheat, although such places are often the scene of field work.

One of the problems of trying to do scientific work in the field is the lack of laboratory equipment suitable for field operation. Most laboratory equipment requires electrical power and a lot of equipment needs a regular water supply, so the field scientist has to work with a minimum of equipment, often only a tape-measure, notebook and pencil, and a map and compass.

The main job is observing and recording information. Often samples or specimens have to be collected for further study in the laboratory.

Great care must be taken when collecting material in the field. Soils can be seriously changed by rough handling. The moisture in the soil can be lost when it is stored in containers which are not airtight. The exact position of a sample must be recorded and we must be careful not to destroy the natural condition of the sample site if we can avoid it. We may want to return and collect another sample or perhaps take a photograph, only to find that we have spoiled the site due to carelessness.

We must beware of sampling only the UNUSUAL things we find because these samples will be taken back to the laboratory where we may look upon them as representing the NORMAL conditions in the field. If we did this all the time we would end up with a collection of interesting curiosities and a very distorted idea of what was going on in the field.

Observing everyday

Human beings are unconsciously observing all the time they are awake. We use all our senses to make observations but most people allow their everyday observations to slip out of their minds. Some training is required before we can consciously observe and record in our minds what we have observed. To prove this you might like to write down in your notebook a list of all the things that you can remember are in your bedroom at home. Check the list when you get home and you will probably find that you have left out at least a few important things.

ACTIVITY 2.1: The memory game

Let one person from your group take a tray and place on it ten everyday objects such as a match, a twenty cent piece, a rubber, a needle, etc.

Fig. 2.1 A tray prepared for the memory game

Allow the rest of the group one minute to observe the contents of the tray and then take it away and ask everyone to write down the ten objects immediately.

Repeat the game with ten different objects but this time wait for thirty minutes before writing down the list of objects. Most people score more correct objects immediately after seeing the tray. Compare the scores in your group and see if this is true.

If you were allowed to make your list while you could still see the tray you would score ten out of ten unless you did not know the names of some of the objects. When making observations in the field, it is best to record them as you make them rather than relying on your memory which can often play tricks on you.

Travelling in a car, bus or train can be very boring. Here is a game which you can play when travelling by road to liven up the journey and also smarten up your powers of observation.

Each person in the car has a turn at identifying the next vehicle travelling in the opposite direction to the car.

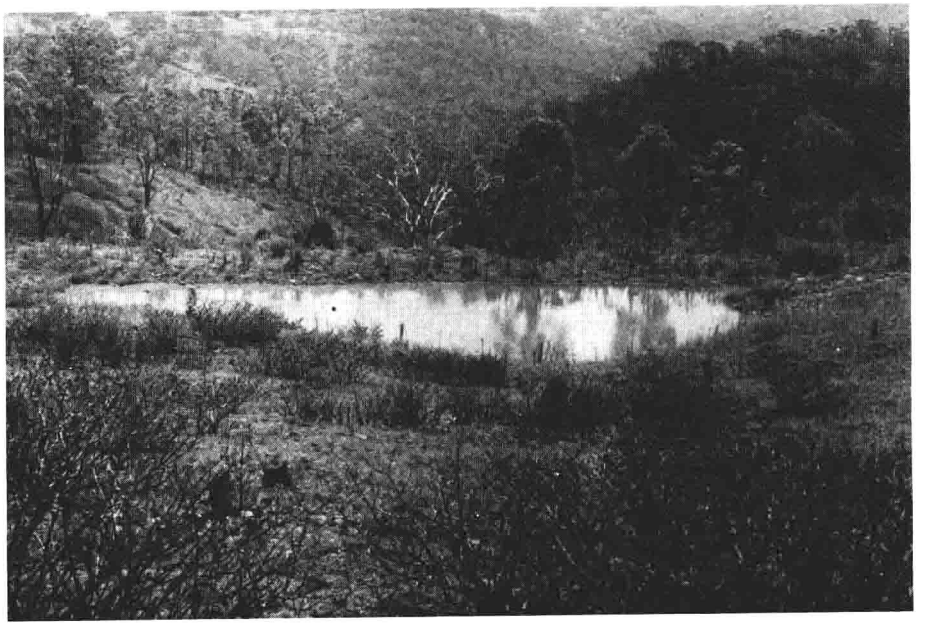
Points are scored as follows:

Truck, lorry or semitrailer	4 points
Utility or Land Rover	3 points
Station wagon	2 points
Sedan	1 point

Rare sights like ambulances or fire-engines can count five points. The winner is the person scoring the most points during the journey.

When travelling by train the game can be based on animals observed. A suitable scoring table would be:

Kangaroos	5 points
Horses	4 points
Cows	3 points
Sheep	2 points
Birds	1 point



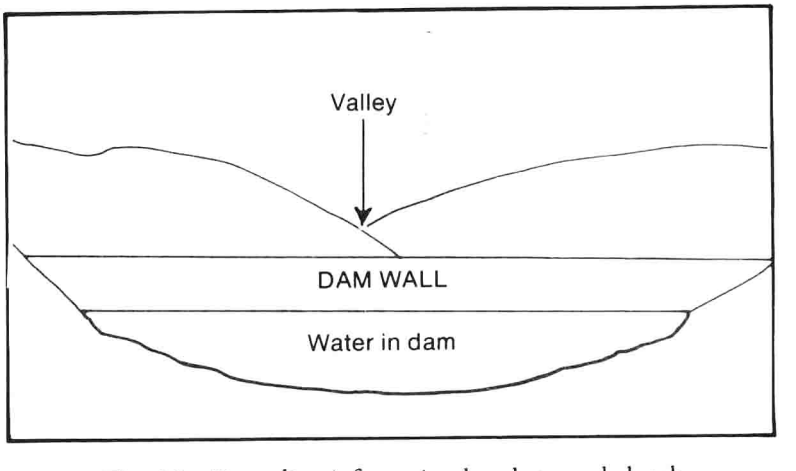


Fig. 2.2 Recording information by photo and sketch

Recording information

The pencil and notebook are the traditional tools-of-the-trade of the field scientist. Although the camera and cassette recorder are sometimes used, the notebook and pencil are still very important.

When you take a photograph, everything appears on the picture whether it is important or not. When you make a sketch of something you usually draw only the important lines and leave out the unimportant. Perhaps the best way of recording what something looks like is to take a photograph and then make a sketch (see Fig. 2.2).

Written descriptions of things you see in the field often contain words like "big" or "wide". How big? How wide? You can always make some kind of an estimate and write "big (1 m) boulders" or "wide (30 cm) cracks". Your sketches can also contain information on the size of things.

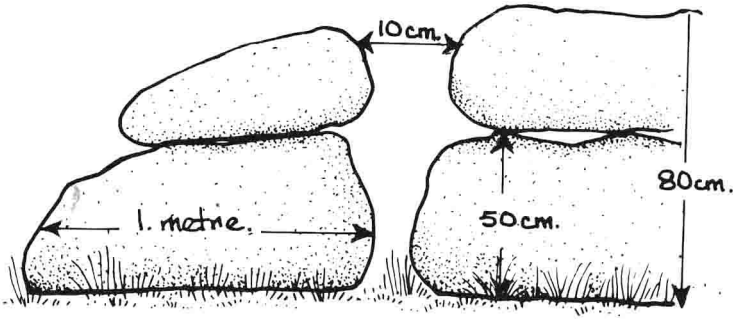


Fig. 2.3 Add dimensions to your sketch

If you want to be very accurate you can even measure things with a ruler or tape-measure. For very large dimensions you can measure with paces or a trundle wheel (measuring wheel), or estimate using a football field (approximately 100 m in length) as a unit of measure. A paddock about four football fields long would be about 400 m long.

Sketch maps are sometimes used to show where things are. They do not have to be accurate or full of details but they should always have some indication of the position of north and some important features such as roads or buildings which make it easier to locate the area described on the map (see Fig. 2.5).

Map-makers usually use a kind of shorthand to represent things like trees, marshes or churches on their maps.

Fig. 2.4 Some map symbols

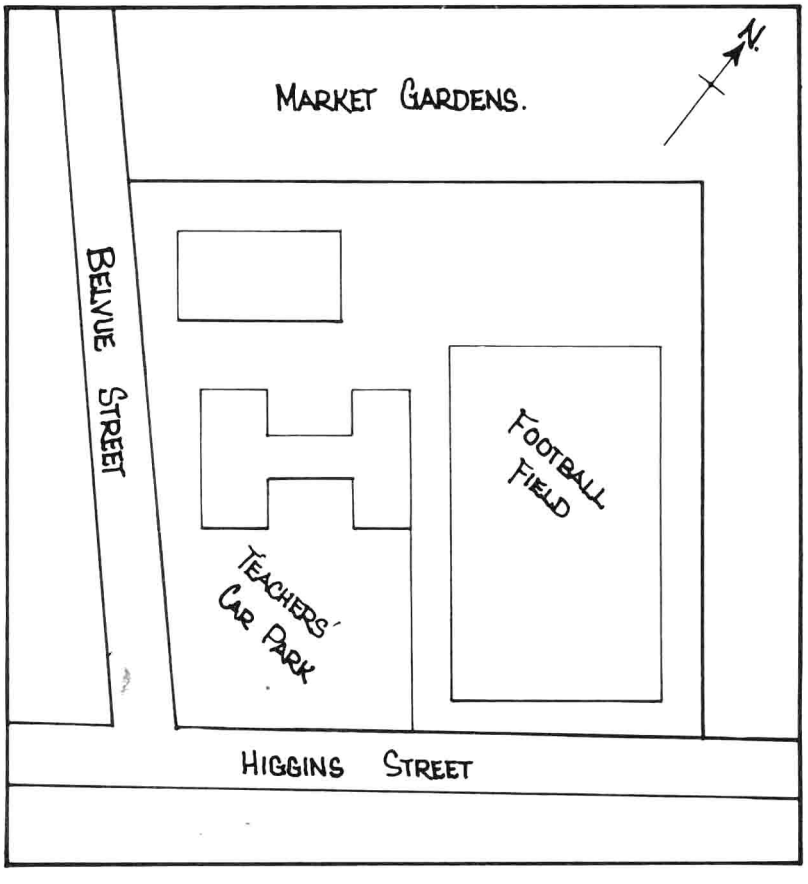


Fig. 2.5 A sketch map

Try to work out a set of symbols which you can use in map-making. You will probably need symbols for farmhouses, fences, windmills, gates, roads, footpaths, creeks, picnic spots and many more.

Relationships and associations

Observing a single object such as a tree or a rock is usually not sufficient for field studies. Very often it is the way in which two or more things are related to each other which is important.

For example, where part of the bed of a creek is very steep, the water flows very quickly, usually over bare rock, and there is often no sand or gravel in the creek bed where it is very steep. We can say that very fast-flowing water, bare rock and absence of sand and gravel are all related to the steepness of the slope. Which of these three features do you think is most closely related to the slope of the creek bed?

In some areas where tall trees are common we also find smaller trees and shrubs, while nearby there may be only open grassland. Here we have an association or relationship between tall trees, small trees and shrubs. There must be some reason for such an association. Can you think of any reason?

Other common associations are:

Willow trees, water.

Flat land beside rivers, cultivation.

Clay soils, dirt roads which are very boggy in wet weather.

During your normal schoolwork you do not often get the chance to study anything in the field. Maps and photographs and material collected in the field are often as close as you can get to nature.

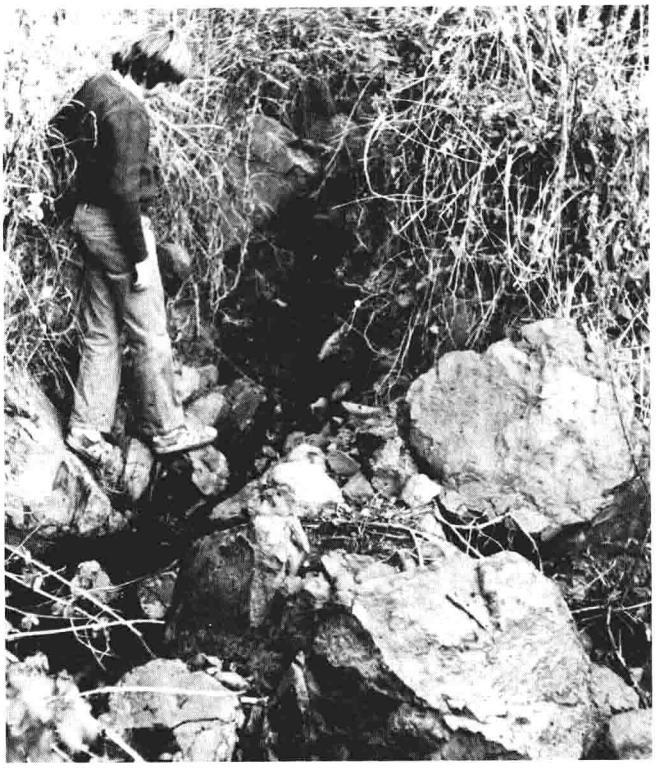


Fig. 2.6 The bed of a creek in steeply sloping country

One kind of photograph can take you outdoors without you even moving from your seat. Photographs taken from an aeroplane (air photos) cover large areas of ground and look like very detailed maps. Most modern maps are made from air photos.

The aeroplane flies along a straight line and an automatic camera takes a series of pictures which usually overlap each other by about two-thirds.

Using an instrument called a STEREOSCOPE or stereoviewer, it is possible to look at the overlapping parts of two air photos and see the ground in three dimensions.