

EARTH'S RESOURCES

Earth and Environmental Science
Stage 6: Module 1
Educator-led activities



ACTIVITY 1

THE CLASSIFICATION OF ROCKS

INTRODUCTION

Everything you see is formed from elements. Minerals are naturally occurring, inorganic solids (apart from liquid mercury and a few organic minerals) made up of chemical elements. Each mineral is defined by its particular chemical composition and crystal structure. Minerals are made in lots of different ways. Some form when salt water evaporates or when chemicals come out of hot fluids. Others are made when hot gases or molten rock cool or when heat and/or pressure change pre-existing minerals.

Minerals make rocks. Rocks can be made of just one mineral, such as quartzite, or a group of different minerals, such as granite (Fig. 1) . They have no set chemical composition or atomic structure. This means no two pieces of granite are the same. The types of minerals found in a rock, and the way they are arranged, give a rock its name. Rocks are classified into three main groups according to how they are formed.

No rock is forever. Our active Earth – from storms and rivers to glaciers and volcanoes – recycles rocks from one form to another. Changes in heat and pressure or exposure to the elements can melt, dissolve, freeze and erode rocks; this is the **rock cycle**.

INSTRUCTIONS

Now you will identify a collection of sedimentary, igneous and metamorphic rocks using the dichotomous keys on pages 7-9. Fill in the table on page 6 by writing the features and name of each rock. As you work thorough this activity, also fill in the missing words in the rock cycle diagram (Fig. 2) on the next page, along with examples of each rock type (sedimentary, igneous (intrusive and extrusive) and metamorphic).

FIG. 1. ROCKS ARE MADE OF MINERALS

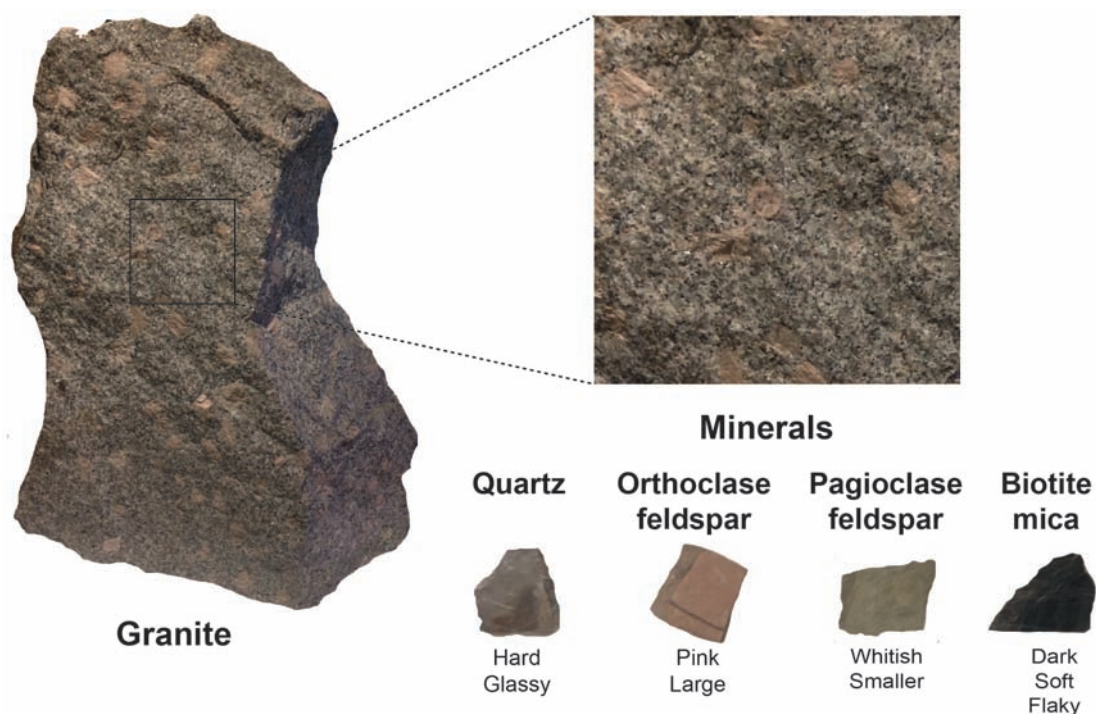


Figure 1. Granite is a common igneous rock made up of at least three rock-forming minerals: feldspar, quartz and mica. The minerals form in different cooling stages of the molten rock. This gives the granite an interlocking crystal pattern.

FIG. 2. THE ROCK CYCLE

Fill in the missing words on the dotted lines:

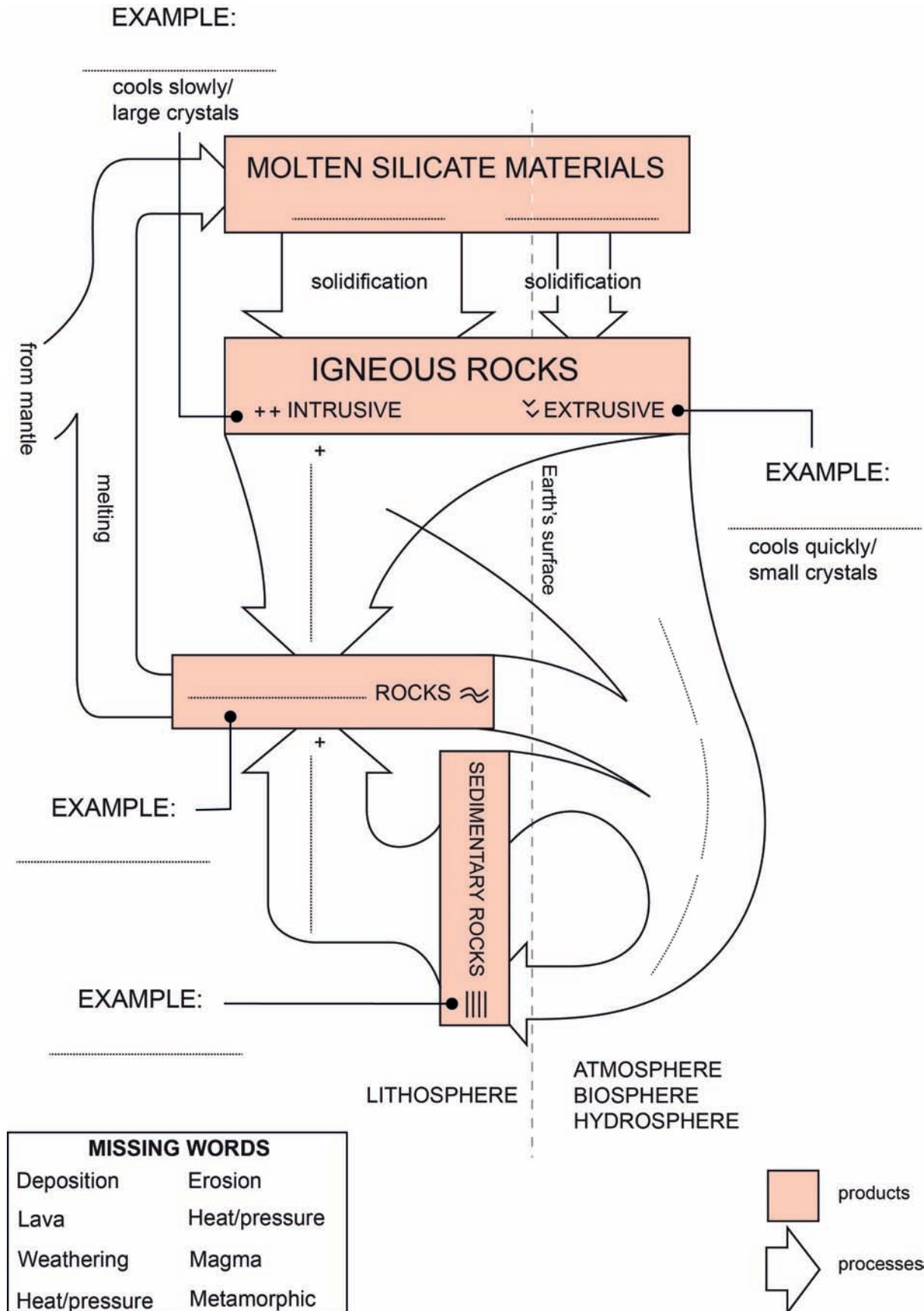


Figure 2. The rock cycle is a collection of processes which shape the surface of the Earth. Rocks are constantly recycled by burial, melting, uplift and erosion.

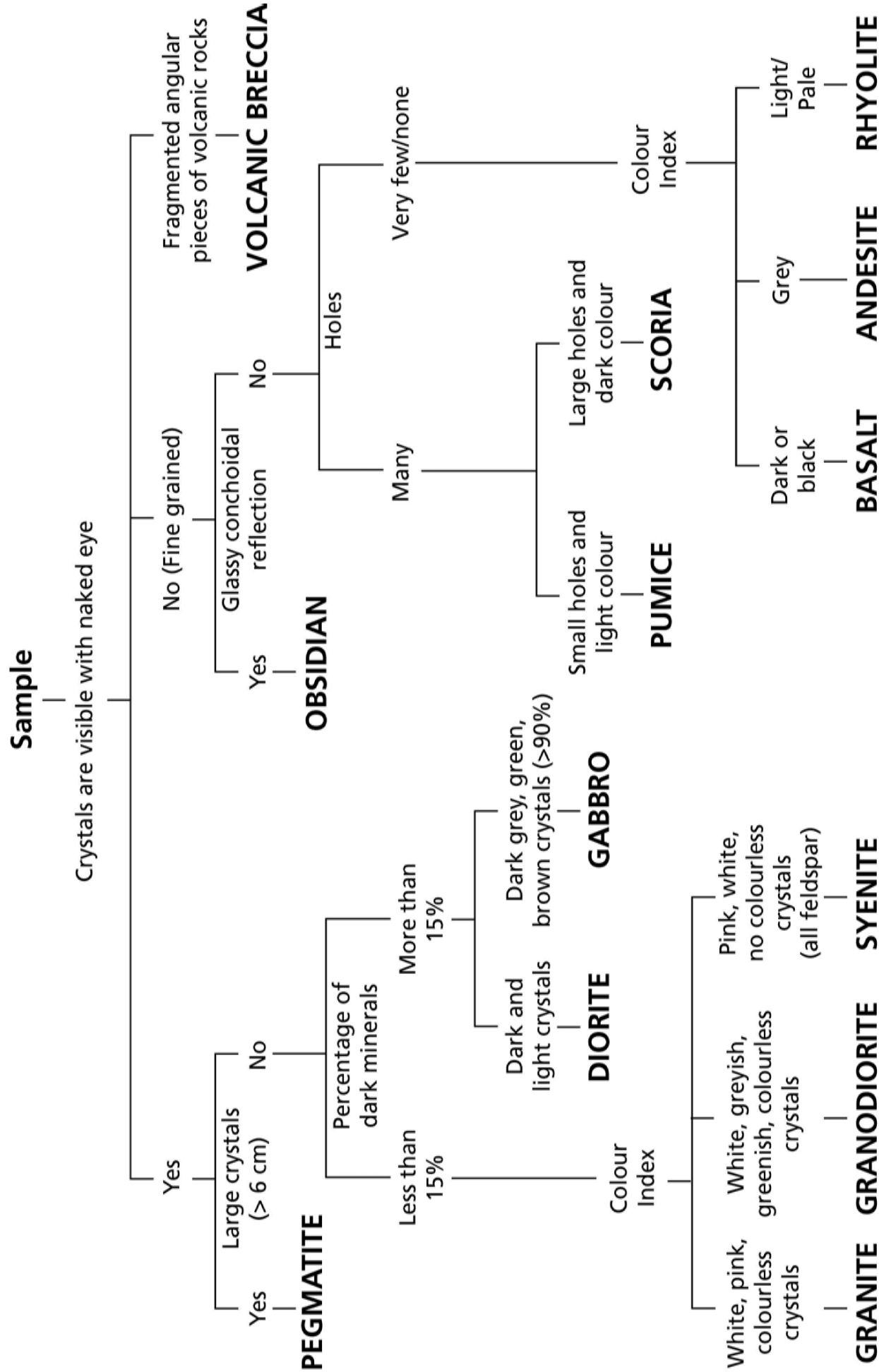
TABLE 1. THE CLASSIFICATION OF ROCKS

GROUP	SPECIMEN	FEATURES	NAME
SEDIMENTARY			
IGNEOUS			
METAMORPHIC			

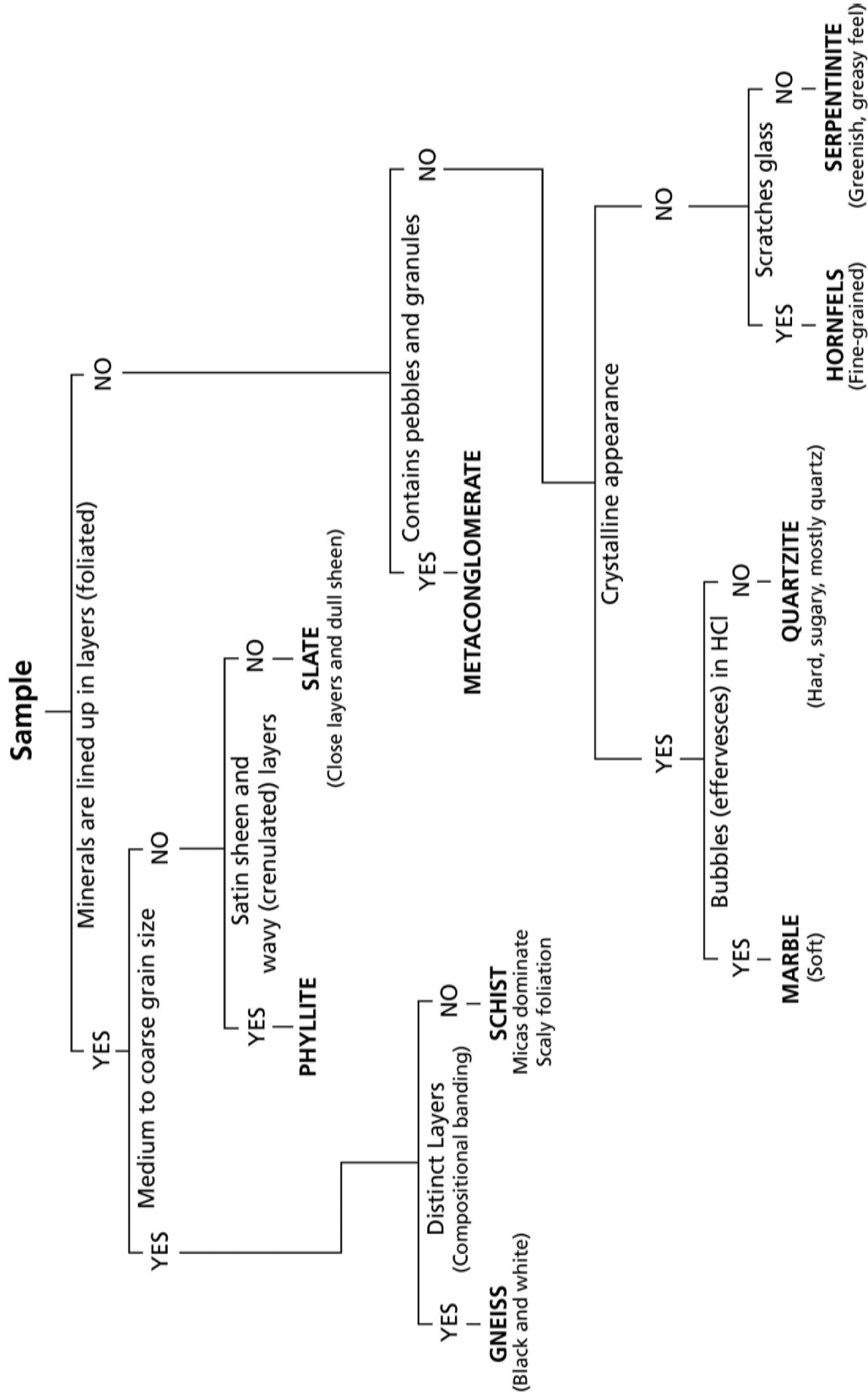
SEDIMENTARY ROCK KEY



IGNEOUS ROCK KEY



METAMORPHIC ROCK KEY



ACTIVITY 2

ABORIGINAL QUARRYING

Ground-edged artefacts from the central coast of NSW

Read the introduction about ground-edged artefacts and then complete the activities on the next page.

INTRODUCTION

Ground-edged artefacts are stone implements that are shaped by grinding and are often designed to have a wooden handle (hafted). Examples include stone axes, bulga knives and hammers. Aboriginal people used water worn pebbles and large pieces of rocks from ancient lava flows, naturally weathered from outcrops, or collected from quarries. Archaeologists have found quarries in many parts of Australia, where large rocks were shaped into blanks and taken away to have their blades ground.²

Ground-edged artefacts were made of hard igneous or metamorphic (e.g. hornfels and quartzite) rocks. In this activity you will be learning about ground-edged tools from the central coast of NSW (Fig. 3). The lithography of this area is dominated by Triassic sandstone and shale, as well as localised outcrops of mafic igneous rocks, such as dykes and plugs, and remnant mafic flows high on the landscape.³

Portable X-ray Fluorescence (pXRF) is a non-destructive technique that has recently been used by researchers at the Australian Museum to locate the geological source of rocks used to make ground-edged artefacts by the Aboriginal people on the central coast of NSW. Unlike more traditional geological techniques, such as thin-sectioning to determine the mineralogy of a rock specimen, pXRF does not destroy the valuable artefact. pXRF determines the elemental 'signature' of an artefact and cross matches it to the signature at a geological site.³



Hafted, ground-edge tool
Australian Museum collection

Ground-edged artefacts from Peats Ridge-Popran Creek have been found throughout the central coast of NSW, with most of it coming from the outcrops at Mangrove Mountain (Fig. 3). Rock from this site consists of relatively hard minerals (pagioclase feldspar, clinopyroxene, and olivine) and very fine-grained mineral crystals (0.02 – 0.3 mm); ideal for making strong and durable tools.³



Out-cropping of columnar basalt at Mangrove Mountain. Photograph by F. D. McCarthy (1936), Courtesy of Australian Museum Archive.

The isolation of quarries meant that people would travel long distances to obtain valuable rocks. Rocks could not simply be taken, and exchange took place at ceremonial gatherings. Valuable rock may have been exchanged for other objects such as net bags, grinding slabs, wooden objects such as spears and shields, and ochre. Exchanges may have taken place at quarries or at the borders between clans. Ground-edged artefacts from the central coast of NSW have been found as far as 430 km away from their geological source.³

QUESTION 1

Use the Aboriginal languages map to identify the traditional custodians of the land at Peats Ridge. Mark the region on the map of Australia. An interactive map can be found at:

<https://aiatsis.gov.au/explore/articles/aiatsis-map-indigenous-australia>

Who are the traditional custodians of the land upon which your school is located? _____

Extension: Who are the neighbouring Aboriginal communities of your school. What language do they speak? Are there any local landmarks with an Aboriginal name? You could find out more information about your local Aboriginal communities through the NSW Aboriginal Land Council (<http://alc.org.au/>).

THE LOCATION OF _____ COUNTRY



FIG. 3. ABORIGINAL ROCK TRADE AT PEATS RIDGE

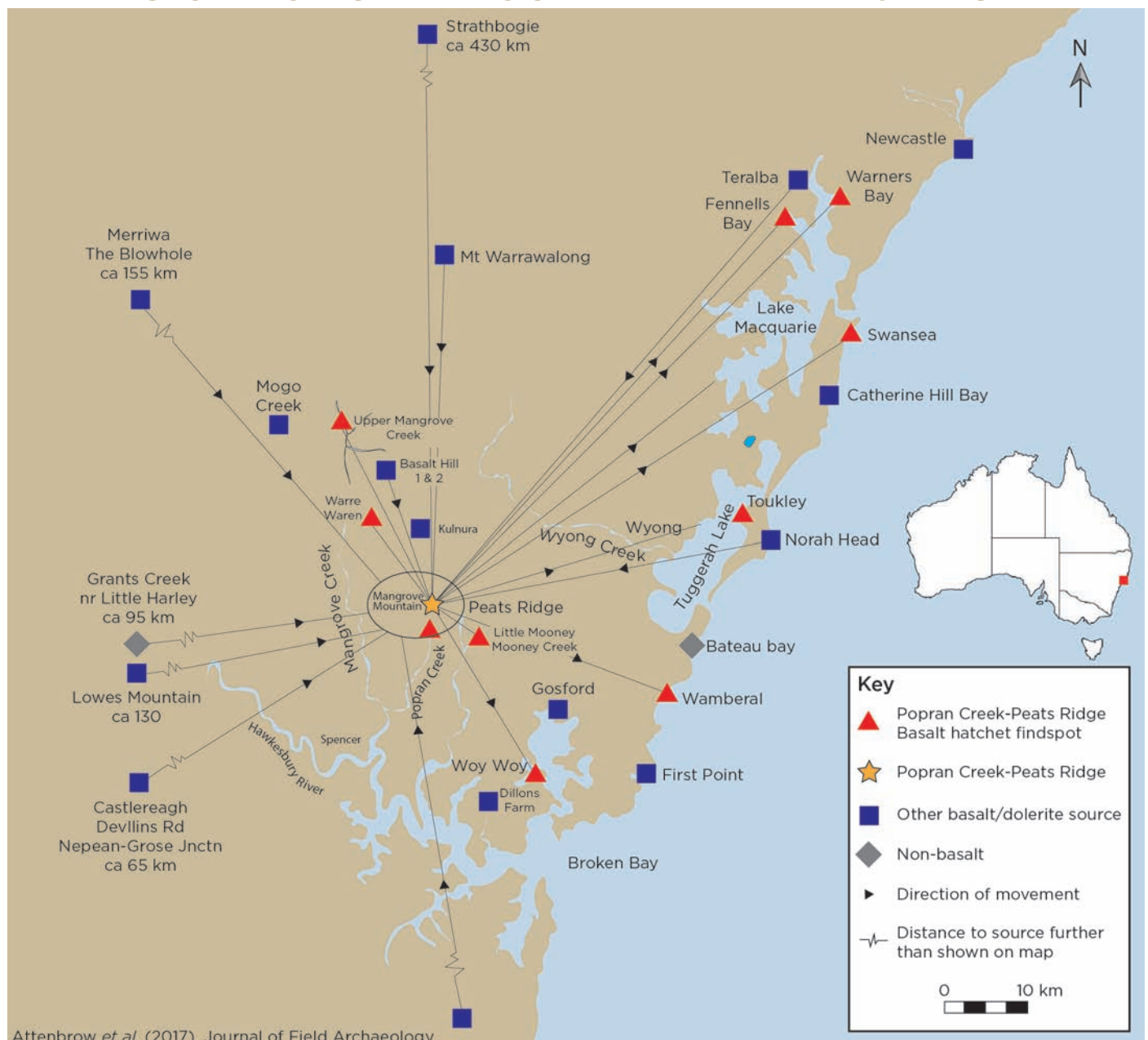


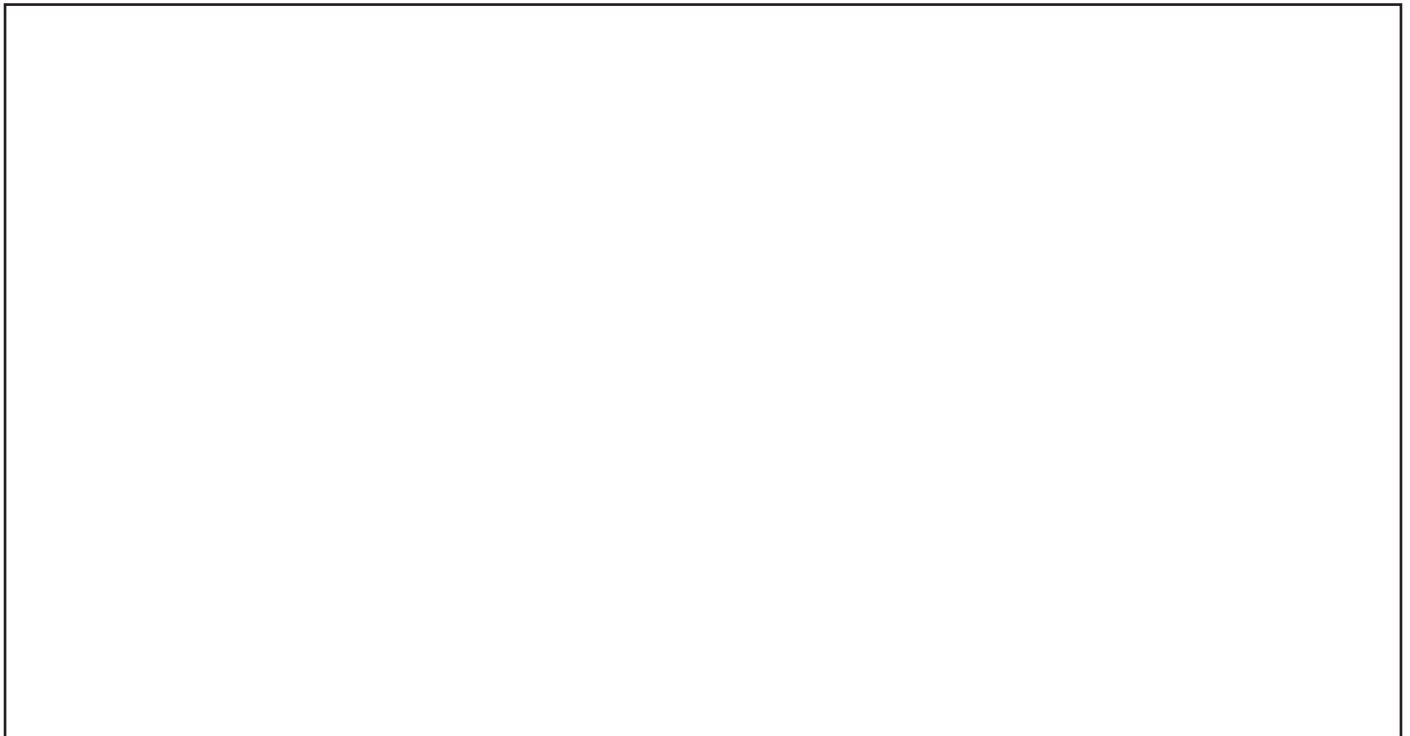
Figure 3. Distribution of ground-edged artefacts on the central coast of NSW.

QUESTION 2

1. Use the igneous rock key on p.8 to identify the rock that was used to make the tool. _____

2. Closely examine the tool, taking note of its shape, size, edges and texture. What type of tool is it? What do you think the tool was used for? _____

3. Draw a labelled diagram of the tool:



4. List two properties of the rock that would have made it useful as a tool?

(i) _____

(ii) _____

5. How would the rock have been processed into useable pieces? _____

6. How would the rock have been shaped? _____

ACTIVITY 3

KNAPPING AND ARCHAEOLOGY

Read the introduction about knapping and then complete the activities on the next page.

INTRODUCTION

The Australian Museum holds a large number of items obtained from Aboriginal archaeological sites in NSW, as well as items from other regions of Australia. They include camping sites, quarries and ceremonial sites. The evidence, in the form of cultural material and remnants of various craftworks, bones of animals, rock art and ceremonial arrangements, carved trees and fireplaces, can be found on the land surface or beneath in stratified positions.

Knapping, or stone tool flaking, is the process by which a rock is shaped by striking it with a harder object, such as a hammer stone, to typically produce a tool or weapon. Aboriginal people used fine-grained rocks with a **conchoidal** fracture, such as silcrete, flint, chert, jasper, chalcedony, tachylyte and quartzite, to make their knapped implements.²

Aboriginal people made a great variety of knapped implements, which were often hafted to a piece of crafted wood to make tools such as chisels, knives and woomeras (Fig. 4). Tools were used for digging, cutting, wood working, and hunting.

Some specialised knapped artefacts were only made in certain regions of Australia, such as tulas in western NSW, Bondi Points in south eastern Australia and Kimberley Points from the Kimberley region (Fig. 4). Kimberley points are intricate and were traditionally made from fine grained stone. After European settlement, Aboriginal people from this region applied skills previously developed to fashion stone tools, to create beautiful and intricate glass points with sharp edges and symmetrical bodies.

FIG. 4. ABORIGINAL STONE FLAKES AND TOOLS

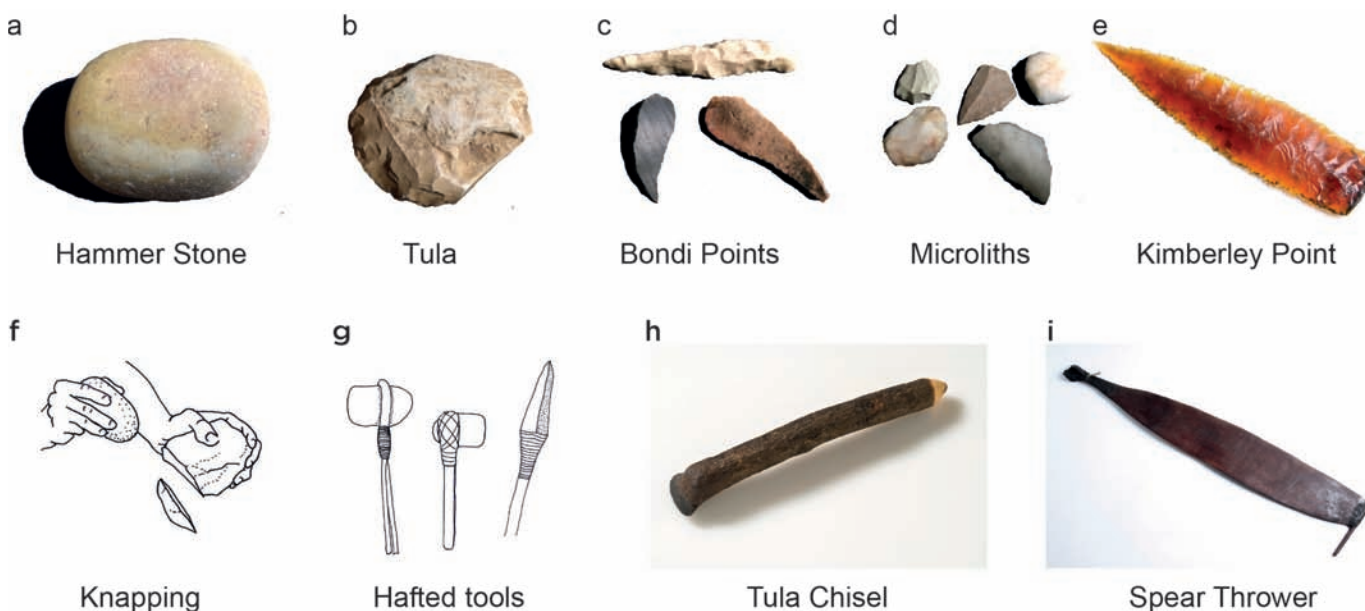


Figure 4. A selection of Aboriginal stone artefacts. **a.** Hammer stones were used to create flakes by striking a rock platform. **b-e.** Various knapped implements. **f.** Stone flaking - a rock being hit with a hamerstone. **g.** A variety of hafted tools. **f.** Tula chisels had a wooden shaft, tipped with a tula that was produced by knapping. This tool was used for making and cutting and shaping coolamons, ceremonial objects, disembowelling animals and occasional digging. **g.** Spear throwers were wooden tools that were often tipped with a sharp stone tool that was prepared by knapping.

ACTIVITY - ROCK OR TOOL?

Knapped implements have physical features such as scars, bulges, ripples and chip marks. Archaeologists use these pieces of evidence to distinguish between a rock fragment formed by natural weathering and a flake produced by a person. **Conjoins** are two or more artefacts that have been fitted together by an archaeologist. By refitting artefacts, archaeologists can determine the sequence of flaking that took place when implements were made. They can also learn about the method used to remove the flakes from the core.

FIG. 5. A DIAGRAM OF A FLAKE AND A CORE

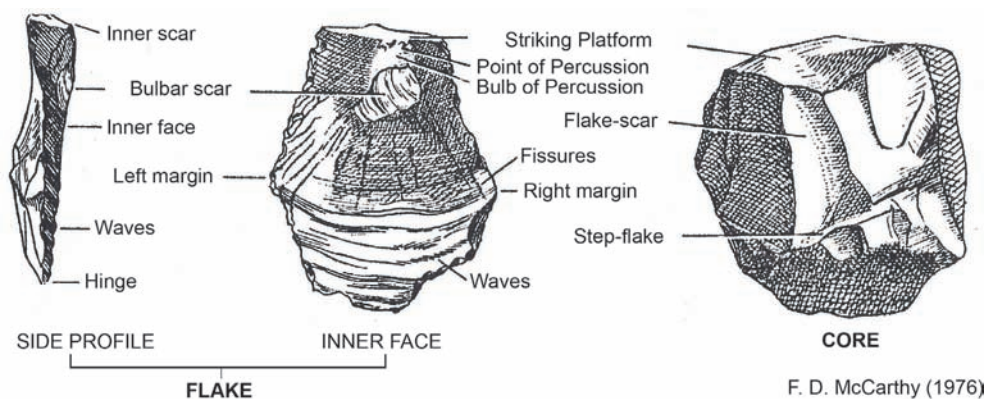


Figure 5. A diagram of a flake (left) and a core (right) labelled with the main features.

1. Look at the pieces of rock in the cardboard box. Which ones formed naturally? Which ones were produced by a human hand?
2. Draw a labelled diagram of the core and a flake in the boxes below. Use the diagram at the bottom of the page to identify the following key features: **striking platform**, **point of percussion**, **bulb of percussion**, **flake scar** and **waves**.

DIAGRAM OF CORE

DIAGRAM OF A FLAKE

3. What do you think archaeologists you can learn about Aboriginal quarrying and tool making by studying knapped implements? _____

GLOSSARY

Conchoidal fracture

A break in a solid that results in a smoothly curved surface.

Conjoin

Two or more artefacts that have been fitted together by an archaeologist.

Crust

The thin, outer rocky shell of Earth.

Cubic cleavage

A cubic surface resulting from breaks along three, intersecting 90° planes.

Element

A pure substance made of only one type of atom.

Fossil

Evidence of past life preserved in rock.

Hafting

The fitting of a handle to an artefact such as a shaped stone or piece of bone.

Igneous Rock

A rock formed through the cooling and solidification of magma (intrusive) or lava (extrusive).

Inner Core

The primarily solid centre of Earth that is mainly composed of iron-nickel alloy.

Knapping

The process by which a rock is shaped by striking it with a harder object, such as a hammer stone.

Lithification

The process whereby sediment is converted into rock by the action of compression and cementation.

Mafic

A silicate mineral or igneous rock that is rich in magnesium and iron.

Mantle

The layer between the crust and the outer core of Earth.

Metamorphic Rock

A pre-existing rock whose mineralogy and/or texture has been changed by processes within the Earth.

Meteorite

Extraterrestrial debris that lands on Earth's surface.

Mineral

Minerals are naturally occurring, inorganic solids with a definite chemical composition and a regular atomic structure.

Outer core

The fluid layer of mostly iron and nickel that lies between the mantle and inner core.

Rock

A naturally occurring aggregate of minerals.

Sedimentary Rock

Rocks formed by the breakdown, deposition and lithification of pre-existing rocks.

REFERENCES

1. Chambers, J. and Mitton, J. (2013). *From Dust to Life: the origin and evolution of our solar system*. Princeton University Press, USA.
2. F. D. McCarthy (1976). *Australian Aboriginal Stone Implements*. Australian Museum Trust.
3. Attenbrow, V. et al. (2017). Non-destructive provenancing of ground-edged mafic artifacts: a holocene case study from the Sydney basin. *Journal of Field Archaeology*.