DOT POINT

QCE EARTH AND ENVIRONMENTAL SCIENCE
UNITS 3 AND 4

• Diana Entwistle •

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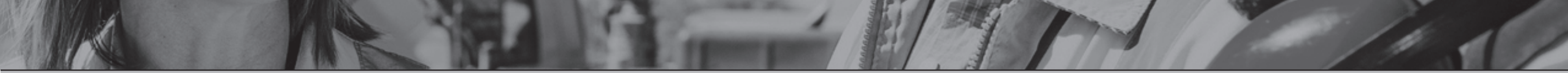

Contents

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Words to Watch

account, account for State reasons for, report on, give an account of, narrate a series of events or transactions.

analyse Interpret data to reach conclusions.

annotate Add brief notes to a diagram or graph.

apply Put to use in a particular situation.

assess Make a judgement about the value of something.

calculate Find a numerical answer.

clarify Make clear or plain.

classify Arrange into classes, groups or categories.

comment Give a judgement based on a given statement or result of a calculation.

compare Estimate, measure or note how things are similar or different.

construct Represent or develop in graphical form.

contrast Show how things are different or opposite.

create Originate or bring into existence.

deduce Reach a conclusion from given information.

define Give the precise meaning of a word, phrase or physical quantity.

demonstrate Show by example.

derive Manipulate a mathematical relationship(s) to give a new equation or relationship.

describe Give a detailed account.

design Produce a plan, simulation or model.

determine Find the only possible answer.

discuss Talk or write about a topic, taking into account different issues or ideas.

distinguish Give differences between two or more different items.

draw Represent by means of pencil lines.

estimate Find an approximate value for an unknown quantity.

evaluate Assess the implications and limitations.

examine Inquire into.

explain Make something clear or easy to understand.

extract Choose relevant and/or appropriate details.

extrapolate Infer from what is known.

hypothesise Suggest an explanation for a group of facts or phenomena.

identify Recognise and name.

interpret Draw meaning from.

investigate Plan, inquire into and draw conclusions about.

justify Support an argument or conclusion.

label Add labels to a diagram.

list Give a sequence of names or other brief answers.

measure Find a value for a quantity.

outline Give a brief account or summary.

plan Use strategies to develop a series of steps or processes.

predict Give an expected result.

propose Put forward a plan or suggestion for consideration or action.

recall Present remembered ideas, facts or experiences.

relate Tell or report about happenings, events or circumstances.

represent Use words, images or symbols to convey meaning.

select Choose in preference to another or others.

sequence Arrange in order.

show Give the steps in a calculation or derivation.

sketch Make a quick, rough drawing of something.

solve Work out the answer to a problem.

state Give a specific name, value or other brief answer.

suggest Put forward an idea for consideration.

summarise Give a brief statement of the main points.

synthesise Combine various elements to make a whole.

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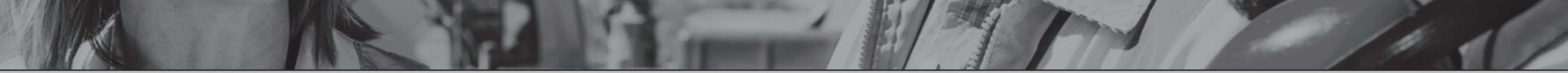

Introduction

What the book includes

This book provides questions and answers for each dot point in the Queensland Certificate of Education syllabus for the Year 12 Earth and Environmental Science course:

Unit 3 Living On Earth – Extracting, Using and Managing Earth Resources

- Topic 1 Use Of Non-Renewable Earth Resources
- Topic 2 Use Of Renewable Earth Resources

Unit 4 The Changing Earth – The Cause and Impact Of Earth Hazards

- Topic 1 The Cause and Impact Of Earth Hazards
- Topic 2 The Cause and Impact Of Global Climate Change

Also included are typical experimental results for you to analyse where the syllabus indicates that you should carry out first-hand investigations.

Format of the book

The book has been formatted in the following way:

1.1 Subtopic from syllabus.

1.1.1 Assessment statement from syllabus.

1.1.1.1 First question for this assessment statement.

1.1.1.2 Second question for this assessment statement.

The number of lines provided for each answer gives an indication of how many marks the question might be worth in an examination. As a rough rule, every two lines of answer might be worth 1 mark.

How to use the book

Completing all questions will provide you with a summary of all the work you need to know from the syllabus. You may have done work in addition to this with your teacher as extension work. Obviously this is not covered, but you may need to know this additional work for your school exams.

When working through the questions, write the answers you have to look up in a different colour to those you know without having to research the work. This will provide you with a quick reference for work needing further revision.

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Unit 3 Living On Earth – Extracting, Using and Managing Earth Resources

Unit 4 The Changing Earth – The Cause and Impact Of Earth Hazards

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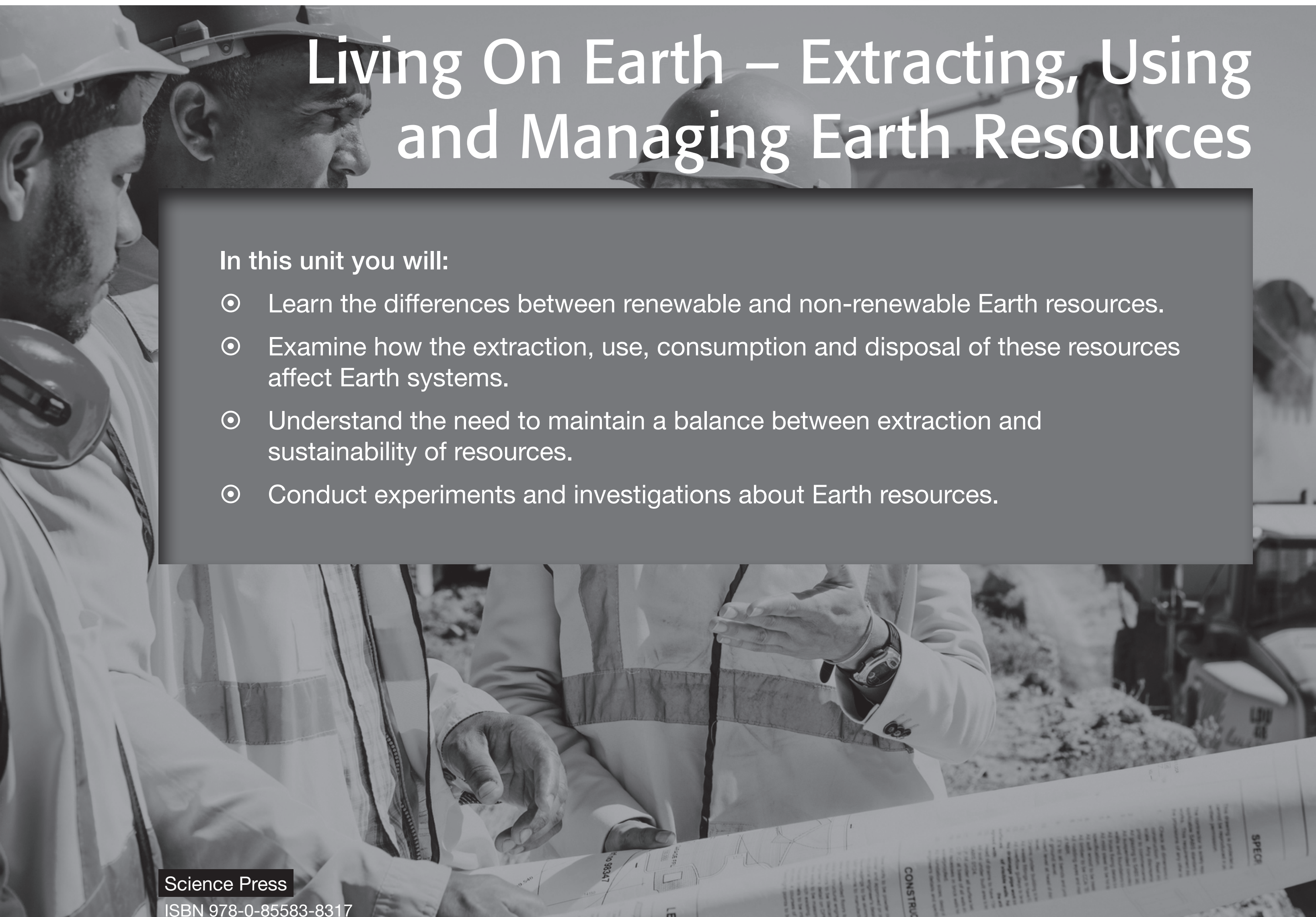
DOT POINT

Unit 3

Living On Earth – Extracting, Using and Managing Earth Resources



In this unit you will:

- Learn the differences between renewable and non-renewable Earth resources.
- Examine how the extraction, use, consumption and disposal of these resources affect Earth systems.
- Understand the need to maintain a balance between extraction and sustainability of resources.
- Conduct experiments and investigations about Earth resources.

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TOPIC 1

Use Of Non-Renewable Earth Resources

In this topic you will:

- Learn to differentiate between metallic, non-metallic and energy resources.
- Explain how metallic resources (e.g. bauxite, gold, and iron ore), non-metallic resources (e.g. mineral sands) and fossil fuels (e.g. coal, oil and natural gas) have formed and how this prevents replenishment of the resource within a typical human lifetime.
- Explain how the location of non-renewable resources is related to their geologic setting.
- Describe the processes involved in exploration of mineral and energy resources.
- Explain how the application of exploration techniques (e.g. literature review, remote sensing and direct sampling) are used to identify the location and spatial extent and quality of a resource.
- Relate the physical properties of resources to the method of exploration required.
- Analyse and interpret geophysical and geochemical data to predict the presence of a resource.
- Explain how method of extraction (e.g. dredging, open cut, drilling, fracking, room and pillar and sloping) is dependent on type, volume and location of the resource.
- Explain separation and processing techniques (e.g. crushing, milling, sluicing froth flotation, smelting, fractional distillation and fracking).
- Analyse the relationship between the properties of resources and their mode of extraction, separation and processing.
- Describe how resource extraction affects atmosphere, hydrosphere and biosphere.
- Explain how environmental factors (e.g. air, water and soil quality, noise pollution and distribution and abundance of organisms) are monitored to minimise environmental impacts.
- Analyse and evaluate the effectiveness of environmental monitoring strategies.

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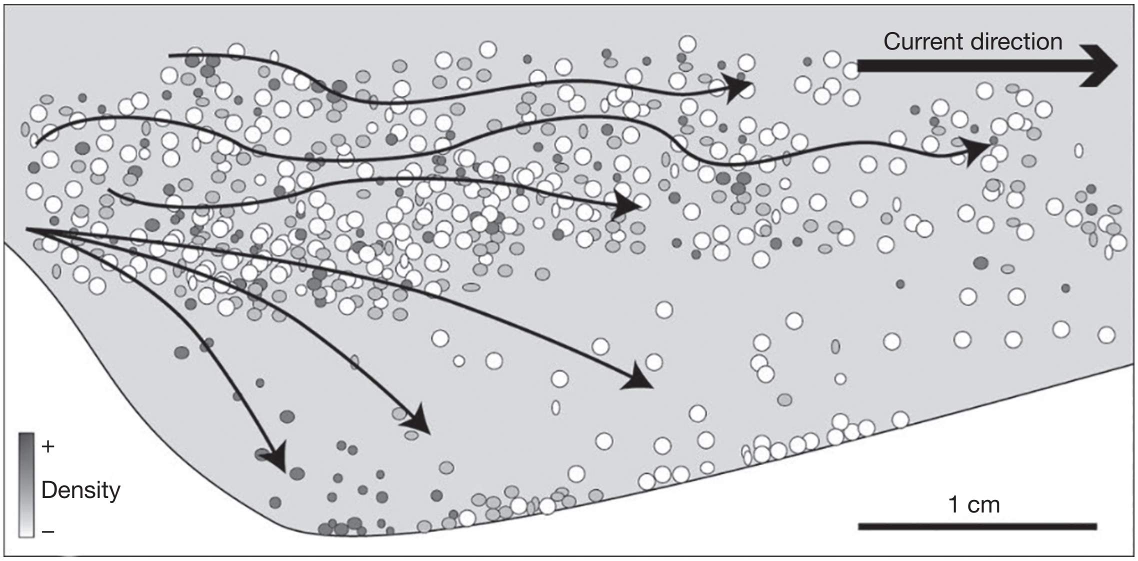
3.1.1.12 The image below shows the sedimentary process responsible for the formation of mineral ore deposits.



(a) Identify the type of mineral deposit which would result from the process represented in this image.

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(b) Identify three mineral resources likely to be found in this setting.

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(c) Construct a caption for this image.

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3.1.1.13 Account for the occurrence of a fossil fuel which you investigated during your studies of geologic resources in Australia.

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Unit 4

The Changing Earth – The Cause and Impact Of Earth Hazards

In this unit you will:

- Learn about the cause and effect of naturally occurring Earth hazards and also how strategies are developed to manage and mitigate them.
- Examine how human activities can contribute to the frequency, magnitude and intensity of Earth hazards.
- Evaluate actions to mitigate hazards in agriculture and climate change.
- Participate in a range of experiments and investigations about Earth hazards and associated processes and techniques.

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TOPIC 1

The Cause and Impact Of Earth Hazards

In this topic you will:

- Describe and explain a range of plate tectonic processes and their interactions with Earth's systems.
- Explain the interactions of hazards associated with plate tectonics (e.g. earthquakes, volcanic eruptions and tsunamis) on society and the environment.
- Evaluate strategies used to mitigate the impacts of these hazards.
- Analyse and evaluate secondary data to predict and map potentially hazardous zones.
- Learn how to classify cyclones and explain the causes of major weather systems.
- Explain the occurrence of major weather systems (e.g. cyclones, floods and droughts) based on topographic maps and meteorological data.
- Predict the impacts of major weather systems on habitat, distribution of vegetation, erosion, river systems and ecosystem regeneration.
- Explain how human activities have altered frequency, magnitude and intensity of droughts, floods, bushfires and landslides.
- Explain how humans, other organisms and ecosystems are affected by location, magnitude and intensity of droughts, floods and bushfires.
- Explain how the configuration of Earth materials including biomass and substrate influence droughts, floods and bushfires.
- Use run-off coefficients of different surfaces to model the impact of different surfaces on rate of run-off in flood events.

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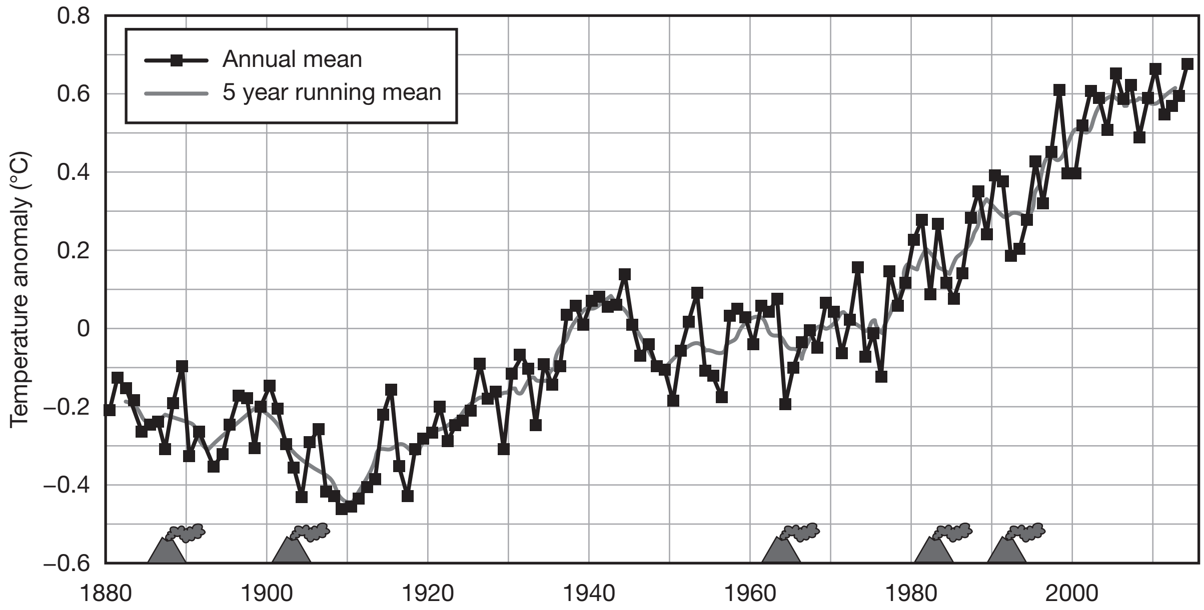
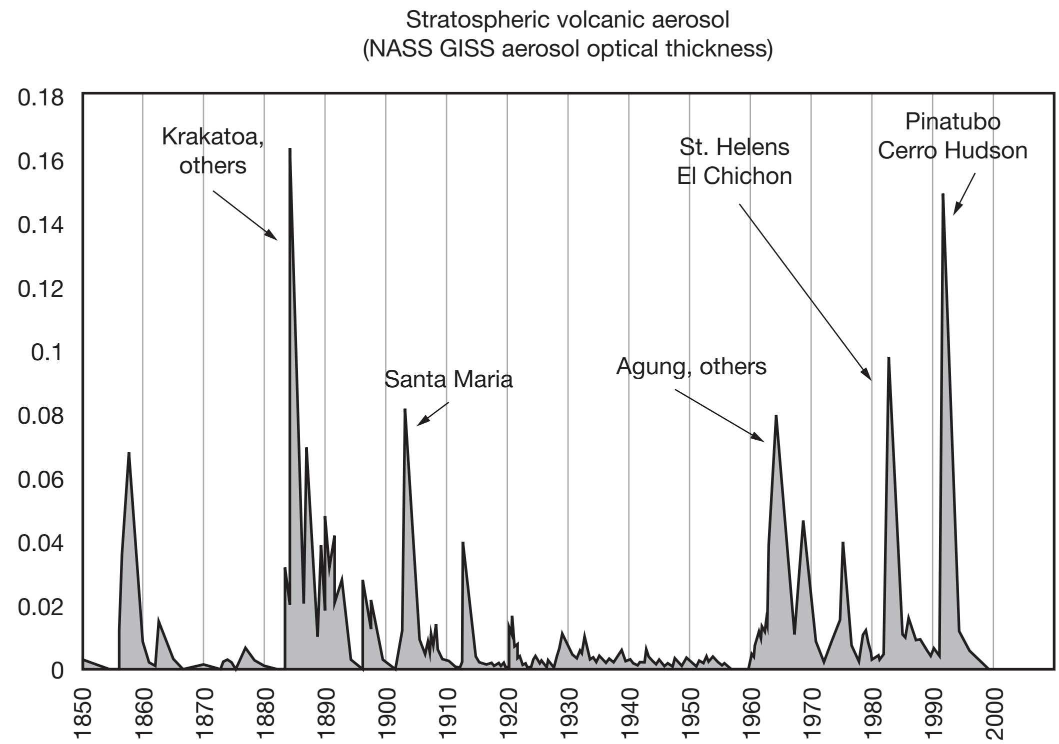
4.1.1.20 Examine the data provided in the two graphs below.

Graph 1 Global surface temperatures from 1880 to 2014 compared to the 1950 to 1970 mean.



Graph 2 The relative volcanic aerosol thickness in the stratosphere from 1850 to 2000.



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Answers

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Unit 3 Living On Earth – Extracting, Using and Managing Earth Resources

3.1.1.1 Australian resources.

Metallic	Non-metallic	Energy
Bauxite Iron ore Gold Chalcopyrite	Diamonds Opals Sand Rock/gravel	Coal Oil Gas Uranium

3.1.1.2 Both resources are found within the lithosphere. Most metallic resources such as aluminium and iron need to be separated from their ores using chemical processes following extraction, while non-metallic resources such as diamond, limestone and sand are easily separated from impurities using simple physical separation techniques.

3.1.1.3 Mineral resources provide substances required in building and construction, however, energy resources provide a source of energy for heat and electricity required for a range of industrial and everyday activities.

3.1.1.4 Most bauxite deposits in Australia formed during the Cretaceous from clay rich sediments originating from ancient aluminium rich granites and basalts. Exposure to high rainfall and intensive weathering has leached away all soluble ions, leaving behind sediments enriched in the highly insoluble aluminum oxide minerals. Since the parent rock for these sediments are ancient and have been exposed to weathering over such long periods there is no chance of renewal of this resource within our lifetime.

3.1.1.5 (a) Garnets, sapphires and diamonds.

(b) Sand sized grains of minerals resistant to weathering remain behind as a result of the weathering and erosion of igneous and metamorphic rocks over millions of years. These mineral rich sands were carried to the ocean by fast flowing rivers where wave action washed the sands back up onto the beach leaving behind the heavier mineral sands while carrying the lighter minerals back out into the ocean. Over time this wave action produced deposits enriched in the heavier minerals. Changes in sea level over time resulted in the burial of mineral sand deposits under quartz sand and protected from further wave action.

3.1.1.6 (a) Iron oxide minerals formed as a result of the introduction of oxygen into the environment. Dissolved iron in the oceans and rivers reacted with the dissolved oxygen to form iron oxide minerals. These minerals accumulated as the iron rich sediments of the BIFs and red beds.

(b) Since the oceans and atmosphere are now oxygenated, iron can no longer exist in the soluble form in large enough quantities needed for the formation of new iron oxide ore deposits to replace the ones being currently consumed.

3.1.1.7 Fossil fuels form from the remains of plants and animals deposited in sedimentary basins and altered as a result of the intense pressure and temperature associated with burial and lithification. This can take hundreds of millions of years, therefore once these resources are used up they cannot be replenished within our lifetime.

3.1.1.8 Opals formed as a result of the leaching of silica from deeply weathered Cretaceous sandstones and mudstones into ground water which moved through joints and small faults in these rocks. Underlying impermeable rocks prevented further downward movement of the ground water allowing it to harden into a gel forming veins and lenses of opal. Opals are only found in rocks of this age and required unique conditions for their formation. This means that not only are these resources unable to be replaced during our lifetime, but it is unlikely for them to ever be replaced.

3.1.1.9

Igneous setting	Mineral resources
Hydrothermal	Manganese, iron, copper, zinc
Magmatic	Gold, copper, lead, silver, zinc, tin
Exhalative	Iron, copper, lead zinc

3.1.1.10 Exhalative minerals such as iron sulfide formed as a result of the precipitation of sulfides carried in metal rich plumes as they came into contact with sea water. The precipitates were deposited on the ocean floor adjacent to hydrothermal vents and submarine volcanic activity.

3.1.1.11 The Mt Isa Pb-Zn-Ag and Cu deposits are located in the north-western regions of Queensland where extensive faulting and the presence of superbasins provide evidence of continental rifting. These deposits commonly form as a result of rifting due to the percolation of hydrothermal fluids through deep seated volcanics and granitic plutons associated with the rifting, picking up metallic minerals and depositing them along fault lines and on the floor of the basin. Fold belts indicate subsequent crustal shortening, emplacement of granitic plutons and metamorphism which are responsible for the magmatic release of mineral rich fluids and subsequent deposition of the Fe-Cu-Au ores in the basin.

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3.1.1.12 (a) Placer deposit.

(b) Gold, platinum and diamonds.

(c) Chemically resistant heavy minerals are washed downslope from weathered rocks into fast flowing rivers. The densest minerals have a high specific gravity so are deposited quickly as the current velocity slows forming placer deposits. The minerals and sediments that are least dense are carried further downstream from the source.

3.1.1.13 The Carnarvon gas and oil deposits formed from the deposition of marine sediments in a depositional basin in the north-west of Australia over 200 million years ago. Heat and pressure from overlying sediments transformed the organic material trapped within the sediments into oil and gas. Uplift, tilting, and faulting of the basin as Australia, India and Eurasia converged during the late Cretaceous produced structural traps allowing the accumulation of the oil and gas reserves in the basin.

3.1.1.4 (a) The dead bodies of marine organisms, in particular tiny microscopic organisms known as plankton.

(b) Dead bodies of marine organisms settle on the ocean floor and become mixed with the fine sediments forming an organic rich mud. Rapid burial and lithification prevent decomposition producing an organic shale. Once the shale is buried to a depth of 2 to 4 km the increase in heat and pressure transforms the organic material into waxy kerogens. If the temperature increases to between 90°C to 160°C the kerogen is transformed into oil.

(c) The reservoir rock is a permeable rock which holds oil and water within its pores. Since oil is less dense than water it rises until it reaches an impermeable rock layer. If there is a structural feature such as an anticline or fault which creates a barrier or cap preventing any further upward movement, then the oil becomes trapped and will accumulate below the cap.

3.1.1.15 The heat generated by contact and regional metamorphism is responsible for the generation of hydrothermal fluids which are able to dissolve and carry mineral deposits to areas where they can become concentrated. Resources formed in this manner include gold, sulfides and emeralds.

Metamorphism is also responsible for the production of valuable construction materials such as slate and marble. Low grade metamorphism transforms shale into slate and high grade metamorphism transforms limestone into marble.

3.1.1.16 (a) Lead, copper, zinc and silver.

(b) Many mineral deposits are formed from source rocks which have been altered by heat and pressure generated through igneous and metamorphic processes. When molten rock cools, minerals crystallise at different temperatures allowing the denser sulfide minerals to settle at the bottom of the molten mass. Less dense minerals are carried in solution filling cracks surrounding the mass forming veins of quartz or feldspar which often carry rare earth metals such as gold and silver.

(c) The iron ores of Western Australia formed in ancient sedimentary environments of Western Australia. Eastern Australia did not exist at this time and by the time the eastern states had formed, the environmental conditions needed for the formation of iron oxide deposits no longer existed. Many of the mineral deposits of Central and Eastern Australia identified on the map were formed from magmatic and hydrothermal processes associated with volcanic activity.

3.1.1.17 (a) Structural features such as sedimentary basin, folds and faults.

Type of rocks found at the location, e.g. volcanic, plutonic, sedimentary or specific rock types such as granite or shale.

The age of the rocks and/or structures.

(b) Sedimentary basins are likely to have coal deposits, particularly if they formed during the Permian as this was a time when tropical rainforests dominated the Australian continent. Superbasins or geosynclines form as a result of continental rifting and are likely to contain copper and gold deposits as a result of the transport of minerals by hydrothermal fluids generated by the intense heat associated with rifting.

3.1.1.18 (a) The type of minerals found in an area is determined by the geologic processes forming the minerals. These processes are also responsible for the formation or modification of the geologic structures observed in the region.

(b) The Galilee Basin is an intracratonic sedimentary basin located in Central Queensland. There are three distinct episodes of sedimentary deposits from a range of terrestrial and shallow marine environments such as lakes, swamps and deltas. The sedimentary sequences range in age from the Permian to Triassic and Jurassic to Cretaceous which coincide with the major coal forming periods of Australia's geologic past.

3.1.2.1 An exploration licence which will allow exclusive rights to conduct exploration for a specific resource needs to be obtained. Permission to access the land must also be given by the government or land owner in order for exploration to proceed.

3.1.2.2 (a) An exploration licence, entitles the holder to exclusive rights to explore a specific region of land for a specific mineral or energy resource. The licence covers exploration only and does not guarantee that permission will be given to mine any resource found on the land.

(b) Geologic mapping, ground surveys, aerial surveys, direct sampling, geochemical testing, ground based surveys such as magnetic, gravity, seismic and radiometric surveys and drilling.

(c) A written permission to access land in the area of exploration must be obtained following consultation with government officials, land owners or representatives of native title groups who own or manage the land where exploration will be conducted.

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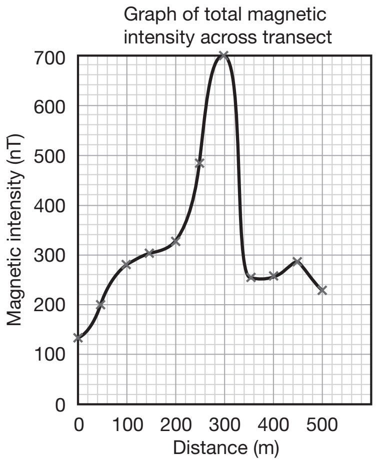
3.1.2.12 (a) Coal has a lower density than the surrounding sedimentary rock.

(b) Variations in density from the top to the bottom of a coal deposit will identify the thickness of coal seams and the location of rock bands within the deposit. The denser the coal and the fewer rock layers within the deposit, the better the quality of the coal. The density of the surrounding rock would provide an indication of the strength of the surrounding rocks which would provide information about the ability of the surrounding rock to support overlying rock once the coal is removed.

3.1.2.13 (a)



(b) There is likely to be an ore body between 200 m and 350 m along the transect.

(c) The data needs to be interpreted by geologists trained in the interpretation of geomagnetic data and who have a good knowledge of the geologic environment of the region being studied.

3.1.3.1

Method	Factors
Open cut	Small amount of overburden Small horizontal extent Low structural integrity of the rock surrounding the ore deposit
Room and pillar	Large amount of overburden Flat or low angle deposits Large horizontal extent Restricted use of surface land Surrounding geology can support tunnelling
Dredging	Placer deposits Underwater deposits

3.1.3.2 This form of mining is most appropriate for extensive flat deposits such as coal and deposits in environmentally sensitive areas. Bord and pillar mining is a safer option as it leaves behind a pillar of ore which acts as a support for the overlying rock above the mine and helps prevent roof collapse which can trap miners and reduces the incidence of ground subsidence above the mine.

3.1.3.3 Both room and pillar and stoping involve the opening up of large underground spaces or rooms. Room and pillar is most appropriate for extensive horizontal or low dipping deposits such as coal, while stoping is better suited for steeply dipping ore bodies such as lead and zinc. In room and pillar, some of the ore is left behind as pillars which support overhead rock, but with open stoping methods, the vertical stopes are backfilled with waste rock material, allowing the removal of supporting rock columns once the initial stopes have been backfilled.

3.1.3.4 George Fisher Mine at Mt Isa uses open cut and bench stoping to extract Pb, Zn and Ag from an underground ore body 1100 m below the surface. The ore body which dips at 65° ranges in thickness from 650 m to 800 m. An open cut pit mine above this ore body extracts Pb and Zinc from ore bodies closer to the surface. The ore is crushed on site and sent to the Mt Isa mills for processing. Rod and ball milling and froth flotation produces Pb-Ag, Zn and Cu concentrates. The Pb-Ag and Cu concentrates are sent to blast furnaces for purification and the resulting Pb-Ag ingots are sent to the UK for further processing. The final Cu cathodes are 99.995% pure and ready for export, but the Zn concentrates are exported for further processing.

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3.1.3.5 (a) Holes must be drilled deep into the Earth's crust to reach the oil deposit. Once the hole is drilled it is coated with cement to prevent leakage of the oil into surrounding rock. The initial flow or primary recovery is carried up by the pressure of the oil, but the remainder must be forced out by enhanced recovery techniques such as by pumping gas, water, steam or chemicals into the source rock to force the oil to the well where it can then be pumped out.

(b) Onshore drilling rigs are faster to construct as the ground provides a firm base for the rig. Offshore drilling rigs, however, must be anchored to the sea floor to provide a stable platform able to withstand the motion of waves and deep sea currents. This means that onshore drilling can begin sooner and may be shut down quickly if needed. Offshore drilling rigs, however, take longer to build and cannot be shut down quickly but they are capable of producing much more oil per day than onshore drilling.

3.1.3.6 (a) Hydraulic fracturing also known as fracking, creates an extensive system of long cracks in rock formations deep underground. Pressurised liquids pumped through well bores, fracture the rock surrounding the well and stimulate the release of oil, gas and water from the rock into the wells where it is pumped to the surface.

(b) Fracking is used to access gas from deposits where the gas is spread throughout a shale or coal deposit. These deposits have low to moderate permeability which prevent the accumulation of gas into pockets which can be easily extracted by conventional means. Fracking can also be used to connect coal seams with limited thickness such as those in the Surat Basin, which are usually less than 50 cm thick, to an operational seam of 2 to 5 metres.

3.1.3.7

Process	Description	Metals
Sluicing	Uses wooden boxes with a set of transverse riffles. The ore is mixed with water and trickles over the riffles. Water flushes out the less dense material leaving the denser ore particles behind the riffles.	Gold
Froth flotation	Chemical reagents added to powdered ore increase the ability of minerals to adhere to air bubbles which rise through the pulp carrying the minerals to the surface where the minerals are skimmed off leaving the remaining minerals in the pulp.	Lead, copper, silver and zinc
Smelting	Heat and chemicals (usually a reducing agent) drive off impurities leaving behind the metal in a more purified form.	Iron, copper, lead, zinc, silver

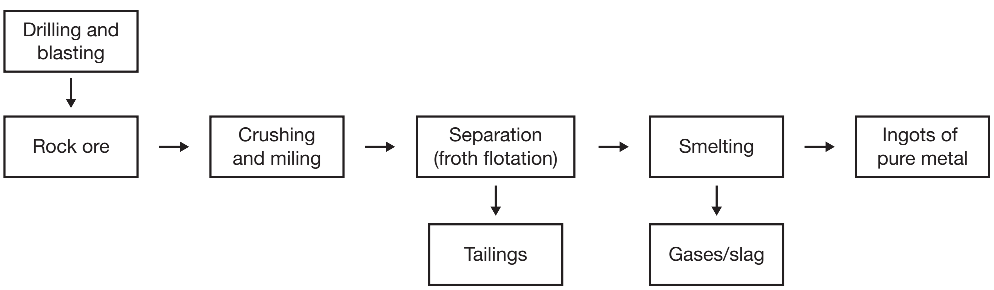
3.1.3.8 Unreactive elements such as gold are often found as nuggets or granules. Even though they do not need purification, they must still be separated from surrounding alluvial material. These metals are generally quite dense, so simple gravity separation such as panning or sluicing is sufficient. Reactive elements such as aluminium, copper and lead are mostly found as compounds and need some form of chemical separation to remove the impurities. Smelting uses heat and chemicals to drive off impurities.

3.1.3.9 Both processes break down rock material into smaller particles. Crushing breaks large chunks of ore into smaller pieces no larger than 14 mm. This is followed by milling which grinds the smaller pieces into a fine powder. Crushing occurs as the ore passes between metal surfaces such as jaws and rollers, while milling uses a tumbling action where metal balls or rollers inside a tumbler collide with fine rock fragments grinding them into a powder.

3.1.3.10 (a) Lead and iron.

(b) Smelting involves the use of heat and chemical additives such as CO to drive off impurities. The impurities react with the additives as the ore melts, forming gaseous or liquid wastes known as slag, leaving behind the pure metal.

3.1.3.11



3.1.3.12 Wells are drilled into the deposits. Walls of the well are sealed with cement to prevent leakage. Water is pumped under pressure into the well. This fractures the rocks creating large cracks in the rock and forcing them to open up. This allows the gas to move more freely through the rock. Sand and other additives keep the cracks open ensuring a continual flow of water, gas and oil through the rock once the high pressure water flow is stopped. The gas, oil and water is then pumped back up the well where they are separated from the water.

3.1.3.13 Mineral sands are a mixture of many different minerals. Each of these minerals have characteristic physical and chemical properties which require individualised means of separation. Differences in magnetic and conductive properties and differences in density are used initially to separate minerals into groups according to these properties. Gravity separation removes the lighter minerals such as mica and quartz, leaving the denser heavy minerals behind. Magnetic separation is usually the next step used to separate the highly magnetic minerals ilmenite and monazite. Heating the minerals during magnetic separation, increases the magnetic properties of the ilmenite as oxygen is removed from the mineral increasing its metallic iron content. Electrostatic separation techniques are used to separate conductors such as ilmenite from non-conductors such as monazite. Froth flotation which uses chemical properties of the minerals may also be used in the final stages of separation.

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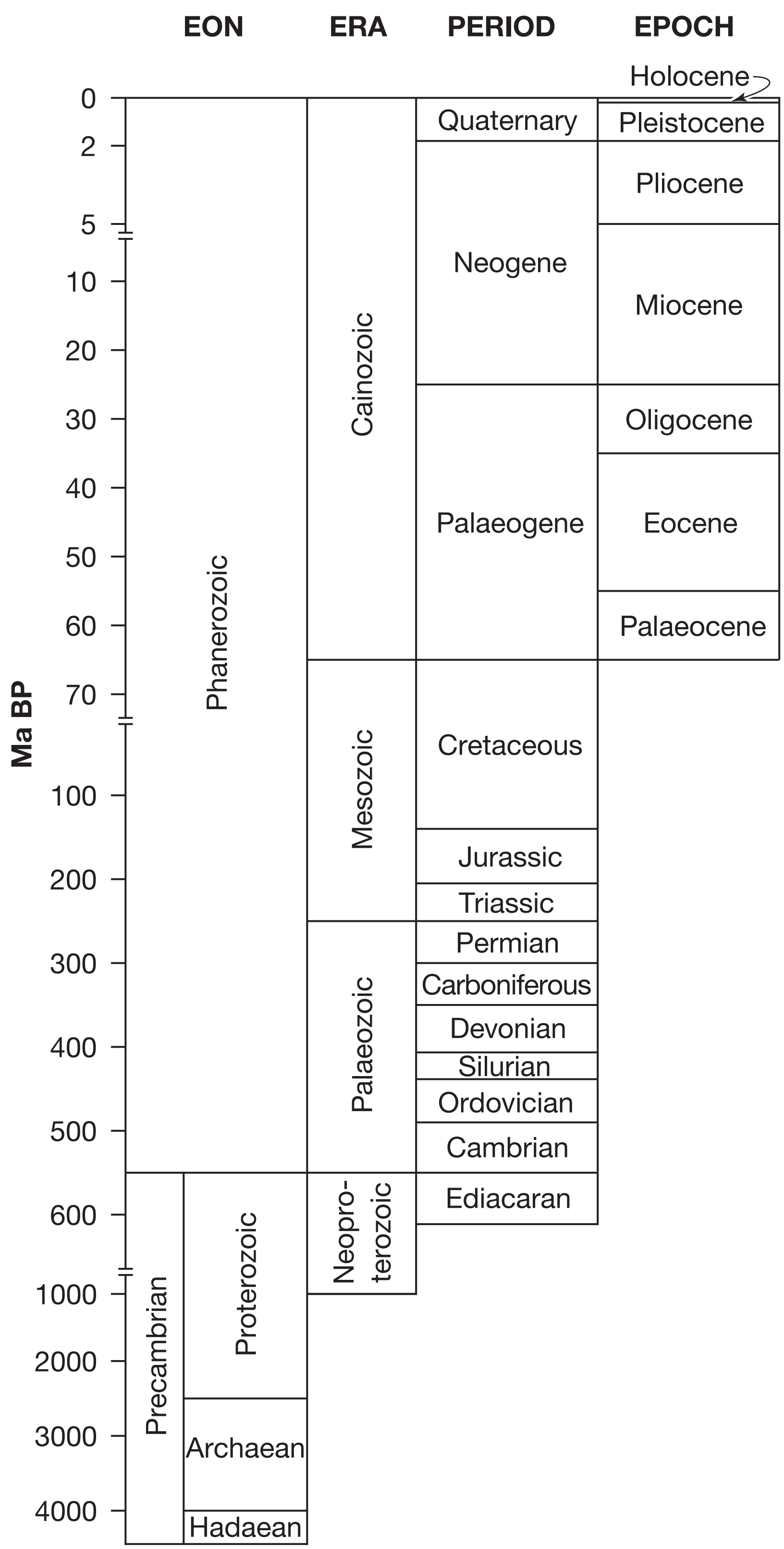
Geologic Time Scale



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