Geology

Upper Secondary

Teacher Guide

Papua New Guinea
Department of Education

Issued free to schools by the Department of Education

Published in 2008 by the Department of Education, Papua New Guinea

ISBN 978-9980-9925-8-3

Acknowledgements

The Upper Secondary Geology Teacher Guide was written, edited and formatted by the Curriculum Development Division of the Department of Education. The development of the teacher guide was coordinated by Pako Gau.

Writers from schools, tertiary institutions and non-government organisations across the country have contributed to the writing of this teacher guide through specialist writing workshops and consultations. Quality assurance groups and the Science Subject Advisory Committee have also contributed to the development of this teacher guide.

This document was developed with the support of the Australian Government through the Education Capacity Building Program.

Contents

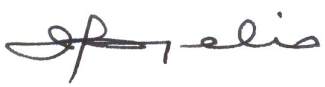
Secretary's message

This teacher guide is to be used by teachers when implementing the Upper Secondary Geology Syllabus (Grades 11 and 12) throughout Papua New Guinea. The Geology syllabus identifies the learning outcomes and content of the subject as well as assessment requirements. The teacher guide gives practical ideas about ways of implementing the syllabus: suggestions about what to teach, strategies for facilitating learning and teaching, how to assess and suggested assessment tasks.

A variety of suggested learning and teaching activities provides teachers with ideas to motivate students to learn, and to make learning relevant, interesting and enjoyable. Teachers should relate learning in Geology to real people, issues and the local environment. Teaching using meaningful contexts and ensuring students participate in appropriate practical activities assists students to gain knowledge and understanding, and to demonstrate skills in Geology.

Teachers are encouraged to integrate Geology activities with other subjects, where appropriate, so that students can see the interrelationships between subjects and that the course they are studying provides a holistic education and a pathway for the future.

I commend and approve the Geology teacher guide for use in all schools with Grades 11 and 12 students throughout Papua New Guinea.



DR JOSEPH PAGELIO

Secretary for Education

Introduction

The purpose of this teacher guide is to help you to implement the Geology syllabus. It is designed to stimulate you to create exciting and meaningful teaching programs and lessons by enabling you to choose relevant and purposeful activities and teaching activities. It will encourage you to research and look for new and challenging ways of facilitating students' learning in Geology.

The teacher guide supports the syllabus. The syllabus states the learning outcomes for the subject; and outlines the content and skills that students will learn, and suggested assessment tasks.

The teacher guide provides direction for you in using the outcomes approach in your classroom. The outcomes approach requires you to consider assessment early in your planning. This is reflected in the teacher guide.

This teacher guide provides examples of learning and teaching activities, and assessment activities and tasks. It also provides detailed information on criterion-referenced assessment, and the resources needed to teach Geology. The section on recording and reporting shows you how to record students' marks and how to report against the learning outcomes.

The outcomes approach

In Papua New Guinea, the Lower Secondary and Upper Secondary syllabuses use an outcomes approach. The major change in the curriculum is the shift to what students know and can do at the end of a learning period, rather than a focus on what the teacher intends to teach.

An outcomes approach identifies the knowledge, skills, attitudes and values that all students should achieve or demonstrate at a particular grade in a particular subject (the learning outcomes). The teacher is responsible for identifying, selecting and using the most appropriate teaching methods and resources to achieve these learning outcomes.

Imagine the student is on a learning journey, heading to a destination. The destination is the learning outcome that is described in the syllabus document. The learning experiences leading to the learning outcome are to be determined by the teacher. The teacher uses curriculum materials, such as syllabus documents and teacher guides, as well as textbooks or electronic media and assessment guidelines, to plan activities that will assist students achieve the learning outcomes. The outcomes approach has two purposes. They are:

- to equip all students with knowledge, understandings, skills, attitudes and values needed for future success
- to implement programs and opportunities that maximise learning.

Three assumptions of outcomes-based education are:

- all students can learn and succeed (but not on the same day or in the same way)
- success breeds further success
- schools can make a difference.

The four principles of the Papua New Guinean outcomes approach are:

1 *Clarity of focus through learning outcomes*
This means that everything teachers do must be clearly focused on what they want students to be able to do successfully. For this to happen, the learning outcomes should be clearly expressed. If students are expected to learn something, teachers must tell them what it is, and create appropriate opportunities for them to learn it and to demonstrate their learning.

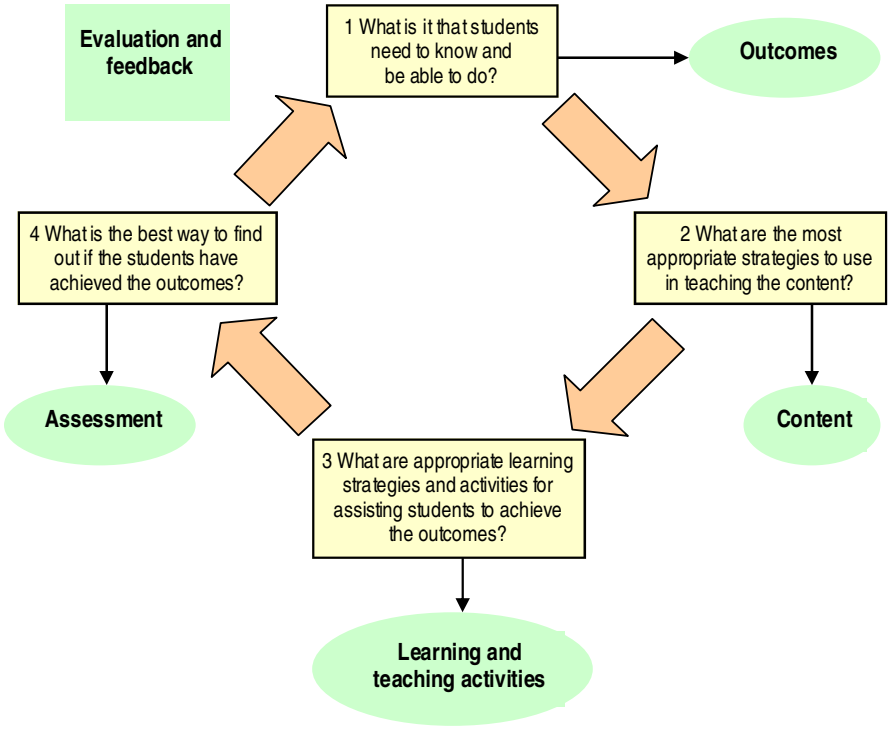
2 *High expectations of all students*
This means that teachers reject comparative forms of assessment and embrace criterion-referenced approaches. The ‘principle of high expectations’ is about insisting that work be at a very high standard before it is accepted as completed, while giving students the time and support they need to reach this standard. At the same time, students begin to realise that they are capable of far more than before and this challenges them to aim even higher.

3 *Expanded opportunities to learn*
This is based on the idea that not all students can learn the same thing in the same way in the same time. Some achieve the learning outcomes sooner and others later. However, most students can achieve high standards if they are given appropriate opportunities. Traditional ways of

organising schools do not make it easy for teachers to provide expanded opportunities for all students.

4 *Planning and programming by 'designing down'*
This means that the starting point for planning, programming and assessing must be the learning outcomes—the desired end results. All decisions on inputs and outputs are then traced back from the learning outcomes. The achievement of the outcome is demonstrated by the skills, knowledge and attitudes gained by the student. The syllabuses and/or teacher guides describe some ways in which students can demonstrate the achievement of learning outcomes.

Outcomes-based approach



Learning outcomes provide teachers with a much clearer focus on what students should learn. They also give teachers greater flexibility to decide what is the most appropriate way of achieving the learning outcomes and meeting the needs of their students by developing programs to suit local content and involve the community. The outcomes approach promotes greater accountability in terms of student achievement because the learning outcomes for each grade are public knowledge—available to teachers, students, parents and the community. It is not the hours of instruction, buildings, equipment or support services that are the most important aspect of the education process but rather, what students know and can do, as they progress through each grade. The outcomes approach means that learning

- has a clearer purpose
- is more interactive—between teacher and students, between students
- has a greater local context than before
- is more closely monitored and acted upon by the teacher
- uses the teacher as a facilitator of learning as well as an imparter of knowledge.

Learning outcomes

The syllabus learning outcomes describe what students know and can do at the end of Grade 12. The level of achievement of the learning outcomes should improve during the two years of Upper Secondary study, and it is at the end of the study that students are given a summative assessment on the level of achievement of the learning outcome. The learning outcomes for Geology are listed below.

Students can:

1. demonstrate an understanding of fundamental concepts of geology
2. design or use geological models to explain the interior and exterior activities of the earth
3. describe and explain the impact of geological events on the community and the environment
4. design and undertake investigations to solve geological problems in Papua New Guinea
5. analyse, evaluate and interpret geological data and information
6. communicate geological information in different ways
7. demonstrate an understanding of traditional geological knowledge and practices in their societies.

Learning and teaching

You, as a teacher, must teach the knowledge that is included in the syllabus documents. Not only do you have to be able to teach what students should know, you must also be able to interpret that knowledge for students in a way that makes it relevant to them, and enables them to begin to acquire skills of analysis and problem solving, which will support learning and teaching. You also need to give students some opportunities to apply their knowledge, to be creative and to solve problems.

Learning and teaching strategies

Students who participate in guided instruction learn more than students who are left to construct their own knowledge (Mayer 2004). You need to employ a variety of learning and teaching approaches because all students do not learn in the same way. The 'auditory learner' prefers to use listening as the main way of learning new material whereas a 'visual learner' prefers to see things written down. Students should be actively involved in their learning and therefore you need to design appropriate practical activities or experiments, using resources that can be found in your location.

In Grades 11 and 12, students will already have had a wide variety of experiences. You need to make use of your students' experiences when designing and conducting learning in class; learning that is connected to your students' world. Many learning and teaching strategies are described in the Lower Secondary teacher guides. Teaching strategies include:

- fieldwork
- project work
- group work and cooperative learning
- classroom displays
- tinkering table and models
- using analogies and metaphors
- learning games and role play
- mind maps or concept maps
- reflective learning
- task cards

The most efficient and long-lasting learning occurs when teachers encourage the development of higher-order thinking and critical analysis skills, which include applying, analysing, evaluation and creating. Attention should also be paid to developing students' affective and psychomotor skills. To make sure that this takes place, you should encourage deep or rich—rather than shallow—coverage of knowledge and understandings.

Developing Geology skills

Students need to develop geology skills and techniques. Skills development should happen as a part of students' learning experiences and the learning and practising of skills needs to take place in the context of geology.

Skills learning tends to be most effective when:

- students go from the known to the unknown
- students understand why it is necessary to master specific skills
- skills are developed sequentially at increasing levels of difficulty
- students identify the components of the skill
- the whole skill and the components of the skills are demonstrated
- there are frequent opportunities for practice and immediate feedback
- the skills being taught are varied in terms of amount and type, according to the needs of students
- the skill is used in a range of contexts.

What do students do in Geology?

Students become familiar with geological concepts and processes through:

- describing and identifying rocks and minerals
- investigating impacts of mining and exploration
- observing natural processes, such as erosion and deposition
- identifying and discussing different types of mining
- explaining the causes and effects of geological hazards
- interpreting, analysing and communicating seismic data
- educating the community on risks, policies, earthquakes, tsunami, volcanoes, landslides and so on.

Fieldwork

Fieldwork is an essential part of the study of Geology. It is essential that this activity promotes the understanding of geological processes and inquiry. Fieldwork can enhance learning opportunities for a wide range of students because it caters for a variety of learning and teaching styles. Fieldwork enables students to:

- acquire knowledge about geology through observing, mapping, measuring and recording phenomena in the real world in various places
- explore the geological processes that form and transform geological environments
- use different kinds of geological tools including information and communication technology to assist in the interpretation of, and decision-making about, geological phenomena
- locate, select, organise and communicate geological information
- explore different perspectives on geological issues.

Research

Research is also an essential activity in the study of Geology. It allows students to search for and gather information, either within or outside the classroom. It supplies students with past and present geological information. Research enables students to gather information about geology through reading and fieldwork.

Laboratory work

Laboratory work is a simulation of the natural world. It helps students understand what goes on in the real world. This activity also promotes the understanding of geological processes and inquiry. Laboratory work enhances learning opportunities for a wide range of students because it caters for a variety of learning and teaching styles. Laboratory work enables students to:

- conduct experiments to test various geological theories
- enhance their observation and analytical skills
- report scientific experimental findings
- encourage group work and interactions

Listening to guest speakers

Listening to guest speakers is an invaluable learning activity in the study of Geology. It can update students on current geological issues, information and practices; and encourages students to develop a critical and enquiring mind. Listening to guest speakers will enable students to:

- acquire updated knowledge about mining, exploration, policies and other related issues
- listen, analyse, synthesise and interpret disseminated information.

Awareness

Awareness is a useful activity in that it educates students on benefits and/or new information about hazards. Students in turn are better equipped to carry out their own awareness. Awareness enables students to:

- acquire knowledge and bring awareness to the community
- select, organise and communicate geological information
- explore different perspectives on geological issues.

Multimedia presentations

Multimedia is a tool that can be used to explain abstract geological processes, concepts and systems. It enhances learning and teaching skills through audio, and visual colour and motion, in a variety of ways. Multimedia presentations enable students to:

- acquire knowledge about geology through video, slide and print media
- expand knowledge through the use of information and communication technology
- explore the micro-world; for example, micro-fossils

What do teachers of Geology do?

The Geology teacher:

- is interested in and concerned about events and movements in the local, national and global community
- actively seeks to keep informed while maintaining a critical stance towards sources of information

- takes a principled stand, and supports others who do so, against injustices and inequalities relating to race, gender, class, physical or mental attributes
- informs him or herself about environmental issues as they impact upon his or her community and on communities and ecological systems globally
- values democratic processes as the best means of bringing about positive change
- engages in some form of social action to support her or his beliefs.

As a teacher, she or he will:

- model democratic values of fairness, justice and equal respect
- use a range of teaching styles that foster both individual development and group cooperation and enable learners to make the best use of their differing learning styles
- encourage her or his learners to adopt a reflecting and questioning position in relation to geological knowledge
- teach the prescribed curriculum well with an emphasis on infusing issues dealing with human rights, relationships, self-esteem and respect for diversity
- be a critical and thoughtful teacher.

Developing a program

A teaching program outlines the nature and sequence of learning and teaching necessary for students to demonstrate the achievement of the learning outcomes. The content of the syllabus describes the learning context and the knowledge required for the demonstration of each outcome. The relevant learning outcomes for each unit or topic are stated at the beginning of the unit and the requirements of the outcomes are elaborated.

Teachers must develop programs that include appropriate learning activities to enable students to develop the knowledge and skills identified in the outcome statements.

The content prescribed in the units indicates the breadth and depth with which topics should be treated. The sequence of teaching is prescribed by the sequence of content. The learning outcomes and assessment, however, must be central to the planning of the teaching program.

Planning and programming units

The main purpose of planning and programming is to help you to arrange the presentation of the unit in an organised manner. This will help you to know what to teach and when to teach it. It is strongly recommended that you make plans with the other teachers who teach the same subject. By planning together, you will *all* have better lessons and make better use of your limited resources.

Points to consider when programming

- Which outcomes are students working towards?
- What is the purpose of this unit or topic or learning experience?

- Which learning experiences will assist students to develop their knowledge and understandings, skills, values and attitudes in Geology?
- What are the indicators of student learning that you would expect to observe?
- How can the learning experiences be sequenced?
- How do the learning experiences in the unit relate to students' existing knowledge and skills?
- How are individual learning needs to be catered for?
- What are the literacy demands of this unit or learning experience?
- What authentic links can be made with the content of other subjects?
- How can school events and practices be incorporated into the program?
- Do the assessment methods address the outcomes and enhance the learning?
- How can the assessment be part of the learning and teaching program?

The planning process

In this teacher guide, ideas for programming and organising have been provided. These have been arranged in steps to help you teach the unit. The steps follow the thinking processes involved in the outcomes approach.

Step 1: Interpreting the learning outcomes

The first step is to read the description in the syllabus. Then study the learning outcomes and what students do to achieve the learning outcomes, in order to determine what students will know and be able to do by the end of the unit.

You need to look at the action verb, concept and context of each learning outcome. This will help you to see what skills and knowledge are embedded in the outcome.

Step 2: Planning for assessment

It is necessary to plan for assessment early to ensure that you teach the content and skills students need to achieve the learning outcomes.

You will have to decide when to schedule assessment tasks to allow yourself time to teach the required content and time for students to develop the necessary skills. You will also need time to mark the task and provide feedback. Practical tasks may, for example, be broken into a series of stages that are marked over several weeks as students progress with making their product. It is not appropriate to leave all assessment until the end of the unit.

This teacher guide provides performance standards and examples of a marking guide. You should develop marking guides when you are marking tasks to ensure consistency in your assessment. You must also develop clear and detailed instructions for completing the task and make sure all students know exactly what they have to do.

Step 3: Programming a learning sequence

This step requires you to develop a program outlining a sequence of topics and the amount of time spent on each topic. If the unit involves a project, for example, you may plan to teach some theory at appropriate stages during the project, rather than teaching all the theory before the students start the project.

To develop your program you need to study the topics listed in the syllabus and to think about which learning activities will best provide students with the opportunity to learn the content and practise the appropriate skills, and how long the activities will take. You will have to think about some major activities that last several weeks and smaller activities that may be completed in a single lesson.

Step 4: Elaboration of activities and content

Once you have mapped out your program for the term, you must then develop more detailed plans for each topic in the unit. All units require students to be actively engaged in learning, not just copying from the board. Make sure you develop a range of activities that suit all learning needs—some reading and writing, some speaking and listening, some observing and doing.

Browse through the textbooks and teaching resources you have access to and list the chapters, pages or items that you will use for each topic in your program. The textbooks should also provide you with ideas for activities related to the topic. You may have to collect or develop some resources for yourself.

Once you have sorted out your ideas and information, you can then develop your more detailed weekly program and daily lesson plans.

This teacher guide gives some suggested learning and teaching activities for each unit and some suggested assessment tasks that you might like to use to ensure active learning. It also gives background information on some of the content.

Using the internet for classroom activities

Planning

- Where appropriate, incorporate computer sessions as part of planned learning experiences.
- Be aware that computers can be time-consuming and may require extra teacher support at unexpected times.
- Consider methods of troubleshooting, such as having students with computer expertise designated as computer assistants.
- Design activities that provide the opportunity for students to access, compare and evaluate information from different sources.
- Check protocols, procedures and policies of your school and system regarding the use of the internet.

Managing

- Ensure that all students have the opportunity to explore and familiarise themselves with the technologies, navigation tools, e-mail facilities and texts on the internet. It is likely that students will have varying degrees of expertise in searching for information and navigating the internet. Students will also have varying experiences of, and be more or less familiar with, the way texts are presented on the World Wide Web.
- Ensure that all students understand how to access the internet and perform basic functions such as searching, sending and receiving e-mail.
- Students with more experience in using the internet may have information that will benefit the whole class. Provide opportunities for students to share their experiences, interests, information and

understandings. As well as planning lessons to instruct students in these skills, pairing students and peer tutoring on the computer can enable more experienced students to assist other students.

- Ensure that students critically analyse geology information gathered on the internet, just as they would for any other text. They should be aware that material posted on the Web is not necessarily subject to the conventional editorial checks and processes generally applied to print-based publications. When evaluating information, students might consider:
  - the intended audience of the site
  - bias in the presentation of information, or in the information itself, including commercial or political motives
  - accuracy of information
  - balanced points of view
  - currency of information, including publishing dates
  - authority of source or author (institution, private individual)
  - ownership of the website (such as corporate, small business, government authority, academic)
  - cultural or gender stereotyping.
- Ensure that software and hardware (computer, modem) are maintained in good working order.
- Ensure that all students are given equal opportunities to use the computer.

Assessing student work containing material from the internet

- Students can download large quantities of information from the internet. In itself, such information provides very little evidence of student effort or student achievement. Students must make judgements about the validity and safety of information when working from the Web. They must consider the purpose of the text, identify bias, and consider the validity of arguments presented and the nature and quality of the evidence provided.
- When assessing student work that includes material drawn from the internet, it is therefore important to recognise how students have accessed the information, what value they place on it and how they have used it for the topic being studied in class. It is useful to look for evidence of critical evaluation, and the development of students' capacities to access, manipulate, create, restore and retrieve information.

Geology requirements

There are eight units, which all students must complete: four in Grade 11 and four in Grade 12. There are also two assessment tasks, which must be completed by students.

Geology requirements

Grade	Weeks	Term	Unit	Essential resources for activities and assessment
11	9–10	1	11.1 Introduction to Geology	Models, rock samples, classification charts, geological maps
11	9–10	1, 2	11.2 Fossils and Geological Age	Models, fossil samples, geological timeline, pictures, slides, film strips
11	9–10	2, 3	11.3 The Dynamic Nature of The Earth	Models, posters
11	9–10	3, 4	11.4 Continental Drift and Plate Tectonics	Models, charts, maps, rock samples
12	9–10	1	12.1 Volcanism and Earthquakes	Models, charts, maps, VCD, DVD, slides, seismogram
12	9–10	2	12.2 Earth's Resources	Sample policy documents, charts, samples of economic minerals
12	11-12	3	12.3 Exploration and Mining	Sample policy documents, charts, video, slides
12	7-8	4	12.4 Environmental Monitoring and Management	Sample policy documents

Assessing Geology

Assessment is an important part of learning and teaching. It is used to:

- evaluate and improve learning and teaching
- report achievement
- provide feedback to students on their progress
- provide feedback to stakeholders.

Criterion-referenced assessment

Assessment in Geology is criterion-referenced and measures students' achievement of the learning outcomes described in the syllabus. In criterion-referenced assessment, particular knowledge, skills or abilities are specified as criteria that must be achieved. The extent to which they are achieved is assessed and facilitated by the teacher.

Criterion-referenced assessment often takes on a problem-centred orientation, rather than a knowledge-based orientation. To achieve an outcome means having to demonstrate the attainment of skills and attitudes, not just write about them. Assessment then becomes more than just a means of judging knowledge and performance—it becomes an integral part of the learning process itself. Criterion-referenced assessment is:

- standards or criterion-referenced; that is, outcomes are judged against pre-defined standards (see table below)
- direct and authentic, related directly to the learning situation. This has the potential for motivating learning, since students can see a direct relevance between what is learnt and what is assessed.

Norm-referenced assessment

'Norm-referenced assessment' makes judgements on how well the student did in relation to others who took the test. It is often used in conjunction with a curve of 'normal distribution', which assumes that a few will do exceptionally well and a few will do badly and the majority will peak in the middle, normally judged as average.

Example of a criterion-referenced test

The driving test is the classic example of a criterion-referenced test. The examiner has a list of criteria, each of which must be satisfactorily demonstrated in order to pass; for example, completing a three-point turn without hitting either kerb. The important thing is that failure in one criterion cannot be compensated for by above-average performance in others; nor can a student fail in spite of meeting every criterion (as they can in norm-referenced assessment) simply because everybody else that day surpassed the criteria and was better than him or her. Criterion-referenced assessment has the following characteristics:

- a syllabus that describes what students are expected to learn in terms of aims, outcomes and content

- a syllabus that provides a clear sense of the syllabus standards through its aims, outcomes and content
- tasks designed to produce an image of what students have achieved at that point in the learning and teaching process relative to the outcomes
- standards of performance at different levels: the 'performance standards'
- a report that gives marks referenced to predetermined standards
- assessment tasks that refer to syllabus outcomes, content, assessment components and component weightings
- external examinations that are based on syllabus outcomes and content. External markers use standards-referenced marking guidelines developed by the Science Examination Committee.
- assessment that is better-integrated with learning and teaching.

Criterion or standards-referenced assessment in Geology

Learning outcomes performance standards					
Learning outcomes	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
1.Demonstrate an understanding of fundamental concepts of geology	Demonstrate a very clear understanding of fundamental concepts of geology	Demonstrate a clear understanding of fundamental concepts of geology	Demonstrate a fair understanding of fundamental concepts of geology	Demonstrate limited understanding of fundamental concepts of geology	Has failed to meet the minimum standard required
2. Design or use geological models to explain the interior and exterior activities of the earth	Design or use exceptionally outstanding geological models with very clear explanation of the interior and exterior activities of the earth	Design or use outstanding geological models and clearly explain the interior and exterior activities of the earth	Design or use appropriate geological models to satisfactorily explain the interior and exterior activities of the earth	Design or use geological models but poorly explain the interior and exterior activities of the earth	Has failed to meet the minimum standard required
3. Describe and explain the impact of geological events on the community and the environment	Excellent description and explanation of the positive and negative impact of geological events on the community and the environment	Very good description and explanation of the positive and negative impact of geological events on the community and the environment	Good description and explanation of the positive and negative impact of geological events on the community and the environment	Poor description and explanation of the positive and negative impact of geological events on the community and the environment	Has failed to meet the minimum standard required
4. Design and undertake investigations to solve geological problems in Papua New Guinea	Design and undertake thorough investigations to solve geological problems in Papua New Guinea	Design and undertake very good investigations to solve geological problems in Papua New Guinea	Design and undertake good investigations to solve geological problems in Papua New Guinea	Design and undertake poor investigations to solve geological problems in Papua New Guinea	Has failed to meet the minimum standard required

Learning outcomes performance standards					
Learning outcomes	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
5. Analyse, evaluate and interpret geological data and information	Critically analyse, evaluate and interpret geological data and information	Detail analysis, evaluation and interpretation of geological data and information	Satisfactory analysis, evaluation and interpretation of geological data and information	Poor analysis, evaluation and interpretation of geological data and information	Has failed to meet the minimum standard required
6. Communicate geological information in different ways	Use wide variety of methods in communicating geological information	Use sufficient ways of communicating geological information	Use reasonable methods in communicating geological information	Use limited methods in communicating geological information	Has failed to meet the minimum standard required
7. Demonstrate an understanding of traditional geological knowledge and practices in their societies	Demonstrate clear understanding of traditional geological knowledge and practices in their societies	Demonstrate sound understanding of traditional geological knowledge and practices in their societies	Demonstrate fair understanding of traditional geological knowledge and practices in their societies	Demonstrate limited understanding of traditional geological knowledge and practices in their societies	Has failed to meet the minimum standard required

Assessment *for* learning

Assessment *for* learning is often called 'formative assessment'. It is assessment that gathers data and evidence about student learning during the learning process. It enables you to see where students are having problems and to give immediate feedback, which will help your students learn better. It also helps you plan your program to make student learning, and your teaching, more effective. Often it is informal—students can mark their own work or their friend's. An example is a quick class quiz to see if students remember the important points of the previous lesson.

Assessment *of* learning

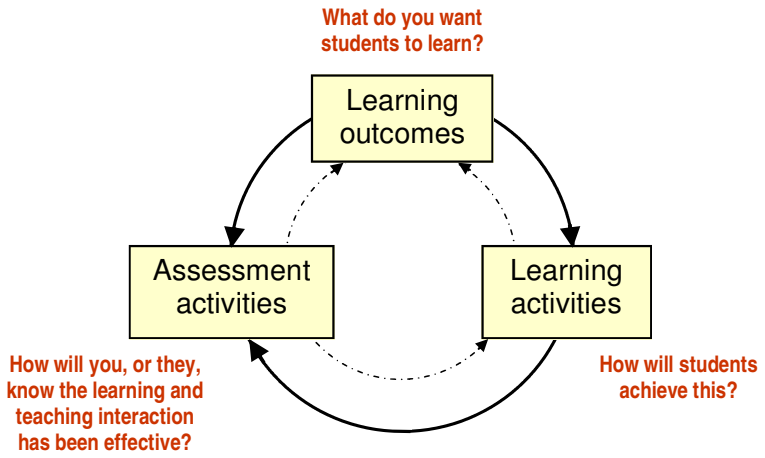
Assessment *of* learning is often called 'summative assessment'. Summative assessment is used to obtain evidence and data that shows how much learning has occurred, usually at the end of the term or unit. End-of-year examinations are examples of summative assessment. It is usually done for formal recording and reporting purposes.

Assessing Geology units

In Geology the learning outcomes are assessed using the range of assessment methods specified in the syllabus. In deciding what to assess, the starting point is: 'what do you want students to do and/or learn?' and following from this: 'how will the students engage with the material?' which in turn leads to the design and development of learning tasks and activities. It is crucial that at this point the assessment tasks clearly link back to the

learning outcomes and are appropriate for the learning activities. The assessment can be used for formative and summative purposes. Assessment can be represented as follows:

Assessment process



Once it is clear what needs to be assessed and why, then the form of the assessment needs to be determined. There are many types of assessment tasks that can be implemented; factors that determine choices include:

- the students—how many are there, what is expected of them, how long will the assessment task take?
- learning outcomes of the subject and how they might be best achieved.

During the year you must set assessment tasks that ensure that all the learning outcomes of the subject have been assessed internally. Each task you set must include assessment criteria that provide clear guidelines to students as to how, and to what extent, the achievement of the learning outcomes may be demonstrated.

Marking guides and assessment criteria help you with the marking process and ensure that your assessment is consistent across classes. It is important that marking guides and assessment criteria are collectively developed. Students must complete the assessment tasks set. Each task must provide clear guidelines to students for how the task will be completed and how the criteria will be applied.

When you set a task, make sure that:

- the requirements of the task are made as clear as possible to the student
- the assessment criteria and performance standards or marking guides are provided to students so that they know what it is that they have to do
- sources or stimulus material used are clear and appropriate to the task
- instructions are clear and concise
- the language level is appropriate for the grade
- it does not contain gender, cultural or any other bias
- materials and equipment needed are available to students
- adequate time is allowed for completion of the task.

Assessment methods

Although assessment components and weightings are stipulated in the syllabus, you decide which assessment method to use when assessing the learning outcomes. You should use a variety of assessment methods to suit the purpose of the assessment. Assessment can be classified into four categories:

- tests
- product or project assessments
- performance assessments
- process skills assessments

Because each has limitations, maintaining a balance of assessment methods is very important.

Tests

A 'test' is a formal and structured assessment of student achievement and progress, which the teacher administers to the class. Tests are an important aspect of the learning and teaching process if they are integrated into the regular class routine and not treated merely as a summative strategy. Tests allow students to monitor their progress and provide valuable information for you in planning further learning and teaching activities.

Tests will assist student learning if they are clearly linked to the outcomes. Evidence has shown that several short tests are more effective for student progress than one long test. It is extremely important that tests are marked and that students are given feedback on their performance.

There are many different types of tests. Tests should be designed to find out what students know, and also to find out about development of their thinking processes and skills. Open questions provide more detailed information about achievement than a question to which there is only one answer.

Principles of designing classroom tests

Tests allow a wide variety of ways for students to demonstrate what they know and can do. Therefore:

- students need to understand the purpose and value of the test
- the test must assess intended outcomes
- clear directions must be given for each section of the test
- the questions should vary from simple to complex
- marks should be awarded for each section
- the question types (true or false, fill-in-the-blank, multiple-choice, extended response, short answer, matching) should be varied.

Tests should:

- be easy to read (with space between questions to make reading and writing easier)
- reflect an appropriate reading level
- involve a variety of tasks
- make allowance for students with special needs
- give students some choice in the questions they select

- vary the levels of questions to include gathering, processing and applying information
- provide enough time for all students to finish.

Product or project assessments

A ‘project’ can be an assessment task given to an individual student or a group of students on a topic related to the subject. The project results in a ‘product’ that is assessed. The project may involve both in-class and out-of-class research and development. The project should be primarily a learning experience, not solely an assessment task. Because a great deal of time and effort goes into producing a quality product from a project assignment task, you should allow class time to work on the project. A product or project:

- allows the students to formulate their own questions and then try to find answers to them
- provides students with opportunities to use their multiple intelligences to create a product
- allows teachers to assign projects at different levels of difficulty to account for individual learning styles and ability levels
- can be motivating to students
- provides an opportunity for positive interaction and collaboration among peers
- is an alternative for students who have problems reading and writing
- increases the self-esteem of students who would not get recognition on tests or traditional writing assignments
- allows for students to share their learning and accomplishments with other students, classes, parents, or community members
- can achieve essential learning outcomes through application and transfer.

Assignments

‘Assignments’ are unsupervised pieces of work that often combine formative and summative assessment tasks. They form a major component of continuous assessment in which more than one assessment item is completed within the term. Any of the methods of assessment can be set as assignments, although restrictions in format, such as word limits and due dates, are often put on the assessment task to make them more practical.

Investigations

An ‘investigation’ involves students in a study of an issue or a problem. Teachers may guide students through their study of the issue; or individual students, or groups of students, may choose and develop an issue in consultation with the teacher. This assessment component emphasises the student’s investigation of the issue in its context, by collecting, analysing, and commenting on secondary data and information.

Students should be encouraged to consider and explore a variety of perspectives as they develop and state their position on the issue. Students may present the investigation for assessment in a variety of forms, including one or a combination of the following: a written report, an oral presentation, a website, linked documents, multimedia, a video or audio recording.

Criteria for judging performance

The student's performance in the investigation will be judged by the extent to which the student:

- identifies and describes the issue or problem
- describes and explains the causes and effects
- critically analyses information and outlines possible steps leading to a solution or recommendation.

Portfolios

Portfolios provide evidence for judgements of student achievement in a range of contexts. Portfolios contain a specific collection of student work or evidence. This collection of work should provide a fair, valid and informative picture of the student's accomplishments.

Computer-based tasks

Using computers to administer student assessment can provide flexibility in the time, location or even the questions being asked of students. The most common type of computer-based assessment is based on multiple-choice questions, which can assist teachers to manage large volumes of marking and feedback.

Process skills assessments

This method of assessment involves assessing students' understanding of concepts based on the practical skills that can be used, the evaluation of work done and/or the reporting of information. These skills include, for example:

- interpretation skills
- evaluation skills
- reflection skills
- communication skills (such as writing, speaking, and listening)

Types of assessment tasks

Using different assessment tasks is the way to make sure that students are able to demonstrate the range of their abilities in different contexts. Each category has advantages in assessing different learning outcomes. For example, a selected-response assessment task, such as a series of multiple-choice questions, is able to assess all areas of mastery of knowledge, but only some kinds of reasoning.

Assessment ideas for individual students or groups

Tests	Products or projects	Performances	Process skills
Essay	Diaries of historical periods	Activities	Analysing
Multiple-choice	Document critiques	Cooperative learning group activities	Observing
Matching	Graphs, charts, diagrams	Debates	Evaluating
Short answer	Inventions	Demonstrations	Predicting
	Lab reports	Discussions	Interpreting
	Models	Experiments	Hypothesising
	Posters	Explanations	Investigating
	Projects	Field trips	Explaining
	Proposals	Laboratory experiences	Classifying
	Research papers	Oral histories of events	Experimenting
	Results of surveys	Presentations	Estimating
		Reports	Communicating
		Role plays	Researching
		Surveys	Designing
		Warnings	Manipulating
			Collecting data
			Synthesising
			Critiquing

Feedback

When you assess the task, remember that feedback will help the student understand why he or she received the result and how to do better next time. Feedback should be:

- *constructive*, so students feel encouraged and motivated to improve
- *timely*, so students can use it for subsequent learning
- *prompt*, so students can remember what they did and thought at the time
- *focused on achievement*, not effort. The work, not the student, should be assessed
- *specific to the unit learning outcomes*, so that assessment is clearly linked to learning.

Types of feedback

Feedback can be:

- *informal* or *indirect*—such as verbal feedback in the classroom to the whole class, or person to person
- *formal* or *direct*—in writing, such as checklists or written commentary to individual students, in either written or verbal form
- *formative*—given during the topic with the purpose of helping the students know how to improve
- *summative*—given at the end of the topic with the purpose of letting the students know what they have achieved.

Who assesses?

Teacher assessment

Assessment is a continuous process. You should:

- always ask questions that are relevant to the outcomes and content
- use frequent formative tests or quizzes
- check understanding of the previous lesson at the beginning of the next lesson, through questions or a short quiz
- constantly mark or check the students' written exercises, class tests, homework activities and so on
- use appropriate assessment methods to assess the tasks.

Frequency of assessment

You should schedule the specified assessment tasks to fit in with the teaching of the content of the unit that is being assessed. Some assessment tasks might be programmed to be undertaken early in the unit, others at the end of the unit. You should take care not to overload classes with assessment tasks at the end of the term.

Judging student performance

Student achievement is recorded and reported against standards. You must use performance standards or marking guides, examples of which are provided in this teacher guide, when making a decision about the achievement of your students in relation to the learning outcomes. The performance standards describe the level at which the student has to be working to achieve a particular standard or mark.

Students should always have access to a copy of the assessment criteria and the performance standards, so that they know what it is they have to know and be able to do to get a good mark in a particular task. The performance standards will help you in your marking and will help your students improve their performance in the future. They are useful when providing feedback to students, as they explain what it is the student needs to do to improve.

Moderation

To make sure that you are interpreting the performance standards correctly when assessing your students, it is important to undertake Geology moderation of student work within your school and with teachers of nearby schools. To moderate student work, a common assessment task must be used and a marking scheme developed so that all students complete the same task under the same conditions, and all teachers use the same marking scheme. Teachers can then compare (moderate) the students' work and come to a common understanding of the performance standards and the requirements for a particular mark or level of achievement.

Moderation enables you to be sure that your understanding of the required standards for levels of achievement is similar to the understanding of other teachers and that you are assessing students at the appropriate level.

Self-assessment and peer assessment

Self-assessment and peer assessment help students to understand more about how to learn. Students should be provided with opportunities to assess their own learning (self-assessment) and the learning of others (peer assessment) according to set criteria. Self-assessment and peer assessment:

- continue the learning cycle by making assessment part of learning
- show students their strengths and areas where they need to improve
- engage students actively in the assessment process
- enable students to be responsible for the learning
- help to build self-esteem through a realistic view of their abilities
- help students understand the assessment criteria and performance standards.

Managing assessment tasks for Geology

Usually, the marking of assessment tasks is done by the teacher. To reduce the amount of work it is necessary to develop a strategic approach to assessment and develop efficiencies in marking. In Geology there are some assessment tasks that may be new to teachers and students. Below are suggestions on how to manage some of these tasks to minimise marking or presentation time.

Develop efficiency in marking

Clarify assessment criteria

Plan the assessment task carefully, and make sure that all students are informed of the criteria before they begin. Discuss the task and its criteria in class, giving examples of what is required. Distribute a written copy of the instructions and the criteria, or put them on the board. Making the assessment criteria explicit speeds marking and simplifies feedback.

Supply guidelines on what is required for the task

Supplying guidelines reduces the amount of time wasted evaluating student work that is irrelevant.

Use attachment sheets such as marking guides

An assignment attachment sheet, which is returned with the assessed work, rates aspects of the task with a brief comment. Such a system enables each student's work to be marked systematically and quickly. This strategy can be applied to posters, presentations and performances.

Assess in class

Use class time to carry out and to assess tasks. Presentations or projects that are marked by you or the students enable instant developmental evaluation and feedback. Brief assessments of projects, stages of the design process, or practical work take less time to mark and are useful because they give immediate feedback to students on their progress and allow you to mark the project in stages with minimum effort.

Feed back to the whole class

Giving feedback to the whole class can cut down on the amount of individual feedback required. On returning assessed work, emphasise the criteria for judging the work, discuss the characteristics of good and bad answers, and highlight common strengths and weaknesses.

Set group-work alternatives

Assess one performance per group. The student's mark is the group mark, but may include a component based on the contribution of the individual. A strategy for allocating an individual mark includes each member of the group using criteria to evaluate the relative contributions of individuals, with the marks averaged for the individual.

Set clear deadlines

Set aside a time for marking. Be careful about extending this period (by allowing students to hand in work late).

Shift the responsibility

Introduce self-assessment and peer assessment

Develop in students the skills to evaluate their own work and that of their peers. With the students, use the assessment criteria against which work is judged, highlighting strengths and weaknesses. Self-assessment increases the amount of feedback students get. It can supplement or replace teacher assessment.

Treat each task differently

Every piece of work need not be evaluated to the same degree; a mark need not be the outcome in every case; and every piece of student work need not contribute to the final grade. Assessment is designed to enhance the learning and teaching experience for the teacher and the learner, not just to give marks.

Sample assessment tasks

All assessment tasks must test whether or not the student has achieved the outcome or outcomes. Each task must have clear and detailed instructions. Students must know exactly what they have to do. You should develop marking guides when you are marking tasks to ensure consistency of your assessment.

The following are examples of assessment tasks and marking guides for units 11.3 and 12.3. The sample assessment tasks and assessment criteria can be used to assess the outcomes of those units. Teachers can use these samples to develop other assessment tasks, criteria and performance standards.

Grade 11

Sample task: Report on cycles of the earth systems (unit 11.3)

Students research and present a report on the different cycles of earth systems.

Learning outcomes

Students can:

1. demonstrate an understanding of fundamental concepts of geology
3. describe and explain the impact of geological events on the community and the environment
5. analyse, evaluate and interpret geological data and information
6. communicate geological information in different ways.

Assessment criteria

Students will be assessed on the extent to which they can:

- research and collate information (20%)
- demonstrate an understanding of the topic being investigated (20%)
- analyse and evaluate information collected (30%)
- communicate the findings through written and/or oral presentations (30%).

Total marks: 30

Task specification

1. Visit a library to find books that relate to the subject of research.
2. Go through and take notes.
3. Analyse and evaluate the information collated.
4. Present the findings through written and/or oral presentation.

Example of a marking guide

Marking guides like the one below should be used to assess the tasks you set. You can tick the appropriate box, look at the performance standards and the students' overall achievement and give an on-balance assessment.

If, for example, the students gets two ticks in the 'Very high achievement' (VHA) column, most of their ticks in the 'High achievement' (HA) column, several ticks in the 'Satisfactory achievement' column and one tick in the 'Low achievement' column, then on balance you would give the students a 'High achievement' and a mark between 70 and 89.

Sample marking guide for a report

11.3 Report on cycles of the earth systems					**30 marks**
Criteria		**VHA**	**HA**	**SA**	**LA**
Research and collate information	Introduction (1 mark) Appropriate or relevant information collected (4) Conclusion (1) Referencing (1)				
Demonstrate an understanding of the topic being investigated Evaluate and describe information collected	Report contains: • description of the cycles: nitrogen, carbon, water, rock (choose 1) (4) • illustration of the cycle (4) • describe the effect on the participating processes in the cycle (8)				
Communicate the findings through written and/or oral presentations	Report is on time (1) Correct length (1) Correct report format used (1) Oral presentation (4)				

Grade 12

Sample task: Critique of existing management policies (unit 12.3)

Write a critique of existing management policies and offer alternatives.

Learning outcomes

Students can:

1. demonstrate an understanding of fundamental concepts of geology
3. describe and explain the impact of geological events on the community and the environment
5. analyse, evaluate and interpret geological data and information
6. communicate geological information in different ways.

Assessment criteria

Students will be assessed on the extent to which they can:

- research and collate information (20%)
- demonstrate an understanding of the topic being investigated (20%)
- analyse and evaluate information collected (30%)
- communicate findings through written and/or oral presentations (30%).

Total marks: 20

Task specification

1. Visit a library to find a copy of a management policy.
2. Go through the policy and take notes.
3. Critically analyse and evaluate the information collated.
4. Present the findings through written and oral presentation.

Example of a marking guide

Marking guides like the one below should be used to assess the tasks you set. You can tick the appropriate box, look at the performance standards and the students' overall achievement and give an on-balance assessment.

If, for example, the students gets two ticks in the 'Very high achievement' (VHA) column, most of their ticks in the 'High achievement' (HA) column, several ticks in the 'Satisfactory achievement' column and one tick in the 'Low achievement' column, then, on balance you would give the students a 'High achievement' and a mark between 70 and 89.

Sample marking guide for a critique

12.3 Critique of existing management policies and offer alternatives		**20 marks**			
Criteria		**VHA**	**HA**	**SA**	**LA**
Research and collate information	Introduction (1 marks) Appropriate or relevant information collected (2) Conclusion (1) Referencing (1)				
Demonstrate an understanding of the topic being investigated Analyse and evaluate information collected	Report contains: • arguments for (2) • arguments against (2) • suggested alternatives (2) • logical flow of argument (2) Report is • clear, precise and concise (2)				
Communicate the findings through written and/or oral presentations	Report submitted on time (1) Oral presentation (2) Recommendations (2)				

Learning activities and assessment tasks

Examples of learning activities and assessment tasks for each of the Geology units are provided in the following sections. Some examples are explained in detail.

Grade 11 units

11.1 Introduction to Geology

Suggested activities

- compare and contrast the earth's structure and its composition using charts, pictures, and models
- list the characteristics (solid, molten, temperature, thickness, density and so on) of the layers of the earth's structure; that is, inner core, outer core, mantle, crust
- use the earth's model to identify and locate different layers of the earth
- use a geological map of Papua New Guinea to explain the history of geological locations in Papua New Guinea; for instance, the occurrence of shells and bioclastic limestones in the Highlands of Papua New Guinea (such as in Simbu Province)
- use a geological map of Papua New Guinea and the Pacific to give an overview of the general geological features (trenches, plate boundaries and so on) and their locations
- compare and contrast the rocks by physical appearance with regard to weathering and erosion (rock colour, hardness (easily weathered or eroded?), shape and so on)
- describe the rock cycle using samples of igneous, sedimentary and metamorphic rocks
- explain how the different rock types are formed
- use different rock samples to identify and classify rocks
- conduct physical and chemical tests of rock samples and classify them based on their physical and chemical characteristics. (Physical tests include colour, grain size and hardness. Chemical tests include flame test, acid test.)

Suggested assessment tasks

- Observe and investigate rock samples and classify them based on their physical and chemical characteristics.
- Using different rock samples, identify and classify the three major rock types.
- Produce a chart showing the rock cycle and processes.
- Testing physical and chemical characteristics of rocks.

11.2 Fossils and Geological Age

Suggested activities

- carry out library research and construct a geological timeline (timescale)
- differentiate between era, period and epoch of the geographical timeline
- list different methods of determining geological age of rocks; for example, using fossils to determine the relative ages of rocks, radiometric dating and so on
- state the types of fossils that existed in each one of the time periods
- study the main fossil groups and describe their formation and state their relative ages in millions of years
- study the age of the main fossil assemblages and correlate it to the geological timeline
- draw a chart showing the main divisions of the geological timescale
- use models, samples and pictures to identify and describe the different fossil groups
- use diagrams to discuss the law of superposition and determine the order of deposition of rock strata
- construct models to show formation of fossils; for example, using plasticine to produce moulds and casts
- conduct lab activities on fossil dating (using correlation) of rock samples
- carry out a field visit to a suitable site, investigate fossil bearing rocks and determine the relative age of the rocks
- visit fossil-bearing rock sites; correlate different stratigraphic rock units

Suggested assessment tasks

- Carry out library research and construct a geological timeline.
- Study the main fossil groups, describe their formation and state their relative ages in millions of years.
- Use the law of superposition and determine the order of deposition of rock strata.

11.3 The Dynamic Nature of the Earth

Suggested activities

- research the earth's systems and present findings
- define and describe the different earth systems such as atmosphere, hydrosphere, lithosphere
- compare physical compositions of atmosphere, hydrosphere, lithosphere
- state the relationships between the earth's major systems

- investigate and explain the effects of ground water; for example, leaching effects on limestones to form caves
- explain the different cycles; for example, nitrogen, carbon or water cycles
- visit a nearby stream or a waterway, such as a drain, and observe evidence of erosion and deposition
- research or visit a nearby cave and observe evidence of leaching of limestone, stalactites and stalagmites
- carry out measurements of stream depth, width and speed (time the pace at which a coloured dye travels between two points) and observe grain size, sorting and sphericity of clasts of sediments

Suggested assessment tasks

- Research and present findings of the processes of the earth systems.
- Explain the different cycles of the earth systems.
- Describe weathering, erosion and depositional processes.

11.4 Continental Drift and Plate Tectonics

Suggested activities

- cut a world map to fit as jigsaw puzzle of the hypothetical land mass (Pangaea or Gondwanaland)
- conduct a debate on the hypothetical land mass based on evidence such as matching of coastlines, similar rock types and fossilised plants
- conduct library research on Wegener's theory and its supporting clues, as well as the palaeomagnetic evidence of continental drift
- view a video simulation or observe and investigate movement of continents using models
- identify and interpret geological features on a geological world map
- construct and or use models of plate boundaries to explain the concept of folding and faulting
- design models that demonstrate the activities of the ocean floor
- use a geological map of Papua New Guinea and the Pacific to identify trenches and ridges
- construct models of different folds and faults using mattress foam and cardboard paper
- conduct field study of different folds and faults such as a quarry site, road cut, river site or beach cut. Discuss the sequence of geological events

Suggested assessment tasks

- Conduct research on the palaeomagnetic evidence of continental drift.
- Construct models of different folds and faults.
- Conduct a field study and present a field report.

Grade 12 units

12.1 Volcanism and Earthquakes

Suggested activities

- construct and/or use models of volcanoes to demonstrate how they erupt
- list the different types of volcanoes and explain how they are formed
- draw a diagram of a volcano and label its parts
- use a geological map to identify the distribution of volcanoes in Papua New Guinea and the world
- trace the chain of volcanoes that form the 'ring of fire'
- visit a volcanic site or a geological feature related to volcanoes and explain how it eventuated
- discuss the effects of volcanoes on communities and environment
- do a case study on volcanic activities and their effects in Papua New Guinea: Rabaul, Madang and so on
- use geological data and interpret intensity of earthquakes
- determine the focus and epicentre of earthquakes through calculation of seismic data
- discuss the effects of earthquakes on communities and environment
- do a case study on earthquake activities and their effects in Papua New Guinea: Rabaul, Aitape and so on
- discuss, write and report traditional knowledge of and practices to do with volcanoes and earthquakes
- collect print articles on volcanic eruptions and earthquakes and do a presentation of the aftermath analysis of the extent of destruction
- write and present traditional knowledge of predicting natural disasters related to geological activities
- describe, with the aid of diagrams, the relationships between the plate interaction, volcanism and earthquakes
- invite a person to share an experience about past volcano or earthquake activities

Suggested assessment tasks

- Use geological data and interpret intensity of earthquakes.
- Determine the focus and epicentre of earthquakes through calculation of seismic data.
- Describe, with the aid of diagrams, the relationships between the plate interaction, volcanism and earthquakes.
- Write and present traditional knowledge of predicting natural disasters related to geological activities.
- Describe plate boundaries, interactions, volcanism and earthquakes.

12.2 Earth's Resources

Suggested activities

- state the types and uses of earth's resources
- state the names of minerals of economic importance
- use samples and charts of minerals to identify mineral types
- use simple tests, such as colour, hardness, streak, acid, flame and magnet, to identify mineral types
- explain the formation of different forms of minerals and fossil fuels
- describe the characteristics and discuss the importance of fossil fuels
- use maps (world, Papua New Guinea) to identify major oil and gas fields

Suggested assessment tasks

- Use simple tests, such as colour, streak, hardness, acid, flame and magnet, to identify mineral types.
- Research, write and present a report on the formation of fossil fuels.

12.3 Exploration and Mining

Suggested activities

- invite a mining person to give a talk on methods of exploration, processing and extraction of ore minerals
- visit a nearby mine, oil or natural gas site and describe mineral or oil or gas extraction processes
- visit a sea, land or forest habitat and study the impacts of mine operation
- state and describe methods involved in prospecting, exploration and mining
- identify and describe the different types of exploration (drilling, geophysical—such as magnetic, seismic and resistivity—and geochemical–sediments sampling) and mining (alluvial, underground, open cut and underwater) activities presently being carried out in Papua New Guinea
- view video or slides or DVD of extraction and processing of minerals, crude oil and natural gas
- describe how these earth resources are explored, extracted, processed and refined to be used
- review existing resource management policies and provide a critique from a resource owner's viewpoint

- write a critique of existing exploration and mining policies and offer alternatives
- invite a guest speaker to give a talk on policy matters relating to sustainability, resource and environmental management
- develop a case study of a mine in Papua New Guinea (such as Porgera, Ok Tedi, Lihir, Tolukuma)
- evaluate written agreements existing between various stakeholders involved in resource development and apply it to their context
- discuss some common landowner issues relating to exploration and mining activities
- list some environmental issues due to mining activities
- develop a chart of print news on mining activities

Suggested assessment tasks

- Describe how these earth resources are explored, extracted, processed and refined to be used.
- Research, write and present a report on environmental and social impacts of exploration.
- Write a critique of existing management policies and offer alternatives.

12.4 Environmental Monitoring and Management

Suggested activities

- identify and develop risk strategies (such as evacuation drills or measures, transport, pick up points, assigning care centres, food and water supply) for specific natural geological disasters
- state methods of communication (radio, pamphlets, television, phones, kundu, conch shell) of early warning signs of natural geological disasters
- invite a person from the Emergency and Disaster Committee to speak on risk and evacuation strategies and disaster management for any geological disaster
- put in place a simple evacuation strategy for a geological disaster
- devise a management structure that will manage the aftermath of disaster
- describe the traditional practices of risk strategies and management (watchman, living in family units, living away from disaster-prone areas, food and water supply, temporary shelter such as caves)
- develop a case study on the management of the risks and aftermath of a geological disaster
- list some environmental issues due to mining
- do a case study on environmental impacts of any mine in Papua New Guinea (such as Misima, Ok Tedi, Bougainville, Tolukuma)
- write a critique on existing environmental management policies and offer an alternative

- invite a speaker to give a talk on policy matters relating to sustainability and environmental management and impacts of mining on the environment

Suggested assessment tasks

- Develop a simple evacuation strategy or plan for a geological disaster.
- Read articles on tsunamis, volcanoes or earthquakes and write about how the risks and the aftermath were managed.

Recording and reporting

All schools must meet the requirements for maintaining and submitting student records as specified in the *Grade 12 Assessment, Examination and Certification Handbook*.

Recording and reporting student achievement

When recording and reporting student achievement you must record the achievement of the students in each unit and then, at the end of the year, make a final judgement about the overall achievement, or progress towards achievement, of the learning outcomes. To help you do this, descriptions of the levels of achievement of the learning outcomes are provided in the 'Learning outcome performance standards' table.

When reporting to parents, the school will determine the method of recording and reporting. In an outcomes-based system, student results should be reported as levels of achievement rather than marks.

Remember that the final school-based mark will be statistically moderated using the external exam results. The students' overall level of achievement may change.

Levels of achievement

The level of achievement of the learning outcomes is determined by the students' performance in the assessment tasks. Marks are given for each assessment task, with a total of 100 marks for each 10-week unit, or 50 marks for each 5-week unit. The marks show the students' level of achievement in the unit, and hence their progress towards achievement of the learning outcomes. There are five levels of achievement:

- Very high achievement
- High achievement
- Satisfactory achievement
- Low achievement
- Below minimum standard

A **very high achievement** means overall that the student has an extensive knowledge and understanding of the content and can readily apply this knowledge. In addition, the student has achieved a very high level of competence in the processes and skills and can apply these skills to new situations.

A **high achievement** means overall that the student has a thorough knowledge and understanding of the content and a high level of competence in the processes and skills. In addition, the student is able to apply this knowledge and these skills to most situations.

A satisfactory achievement means overall that the student has a sound knowledge and understanding of the main areas of content and has achieved an adequate level of competence in the processes and skills.

A low achievement means overall that the student has a basic knowledge and some understanding of the content and has achieved a limited or very limited level of competence in the processes and skills.

Below the minimum standard means that the student has provided insufficient evidence to demonstrate achievement of the learning outcomes.

Achievement level					
Total marks	**Very high achievement**	**High achievement**	**Satisfactory achievement**	**Low achievement**	**Below minimum standard**
600	540–600	420–539	300–419	120–299	0–119
500	450–500	350–449	250–349	100–249	0–99
400	360–400	280–359	200–279	80–199	0–79
300	270–300	210–269	150–209	60–149	0–59
200	180–200	140–179	100–139	40–99	0–39
100	90–100	70–89	50–69	20–49	0–19
60	54–60	42–53	30–41	12–29	0–11
50	45–50	35–44	25–34	10–24	0–9
40	36–40	28–35	20–27	8–19	0–7

Sample format for recording Geology assessment task results over two years

Student name: Muruasa Choi

Grade 11 assessment task results			
Unit	**Assessment task**	**Mark**	**Student mark**
11.1	Classify rock samples using rock classification keys	30	
	Illustrate rock cycles and processes using diagrams	30	
	Carry out rock identification tests to determine rock types as well as physical amd chemical characteristics of rocks	20	
11.2	Carry out library research and construct geological time line	20	
	From diagrams, determine the order of deposition of rock strata using Law of superposition	30	
	Identify and describe fossil groups and their formation	30	
11.3	Carry out library research on processes of the earth's systems	30	
	Explain weathering erosion and deposition using diagrams	30	
	Identify and describe the different cycles of the earth's systems	30	
11.4	Carry out library research on palaeomagnetic evidence of continental drift	20	
	Explain folds and faults, plate boundarie and continental drift	30	
	Total marks Grade 11	**300**	

Student name: Muruasa Choi

Grade 12 assessment task results			
Unit	**Assessment task**	**Marks**	**Student mark**
12.1	Using geological data, interpret intensity of earthquakes	30	
	Determine the focus and epicentre of earthquakes through calculation of seismic data	30	
	Explain the relationship between plate interaction, volcanism and earthquakes	20	
	Describe plate boundaries, interactions, volcanism and earthquakes with the aid of diagrams	30	
12.2	Use simple tests, such as colour, streak, hardness, acid, flame and magnet, to identify mineral types	30	
	State and describe types and uses of earth's resources and their economic importance	30	
	Research, write and present a report on formation of fossil fuels	20	
12.3	Write a critique of existing management policies and offer alternatives	20	
	Do research and report on environmental and social impacts of exploration	20	
	Explain exploration, extraction, processing and refining of the earth's resources	30	
12.4	Design a simple evacuation strategy or plan for a geological disaster	20	
	Do research and report on management of the risk and aftermath of a geological disaster	20	
	Total marks Grade 11	**300**	
	Total marks Grades 11 and 12	**600**	

Learning outcomes and levels of achievement

Levels of achievement in Grade 11 and Grade 12 are recorded and reported against the learning outcomes. The performance standards for the levels of achievement are described in the table on pages 14 and 15.

Steps for awarding final student level of achievement

1. Assess unit tasks using unit performance standards and assessment criteria.
2. Record results for each task in each unit.
3. Add marks to achieve a unit result and term result.
4. Add term marks to get a year result.
5. Determine the overall achievement using the achievement level grid.
6. Report results using the learning and teaching learning outcome performance standards.

The following is an example of reporting using the learning outcomes performance standards descriptors.

Using the learning outcomes performance standards descriptors

Student	**Muruasa Choi**
Subject	**Geology**
School-based assessment	**High achievement**
This means Muruasa Choi:	
Demonstrates a clear understanding of fundamental concepts of geology	
Designs or uses outstanding geological models and clearly explains the interior and exterior activities of the earth	
Gives a very good description and explanation of the positive and negative impact of geological events on the community and the environment	
Designs and undertakes very good investigations to solve geological problems in Papua New Guinea	
Conducts detailed analysis, evaluation and interpretation of geological data and information	
Uses sufficient ways of communicating geological information	
Demonstrates sound understanding of traditional geological knowledge and practices in her society	

Resources

Geology becomes more interesting and meaningful when you use a variety of resources and local materials in your teaching.

You should always try to adapt, improvise, make, find or write material that will be useful for lessons. Geology can be taught without expensive equipment by making use of what is around you, though there are some equipment and materials that are essential to teach the Geology syllabus.

Types of Geology resources

Materials and equipment	Natural and human resources
multimedia projector	old and new mining sites
slide projector	mining personnel
audiovisual aid	environment sites
rock and mineral samples	– rivers, creeks, springs, geysers
specimens	– beaches
models	– rock pools
geological maps and charts	– forests
geological tools	– cliffs
geological data banks; for example, seismic data	– caves
textbooks, reference books	– road cuts
magazines	stakeholders
diagrams, posters	– community elders
worksheets, information sheets	– teachers
pamphlets, brochures	– parents
television and radio broadcasts	– public servants
video, film, film strips	– resource developers
audio recordings	
computer software	
pictures, photographs	
newspapers	
made or found objects	
policy and agreement documents	

General guidelines for selecting and using resources

How effective a resource is depends on whether it is suitable for the knowledge or skill to be learned and the attitude of the students. Classroom organisation is the key to using resources successfully.

You need to:

- prepare thoroughly. Make sure that you are familiar with the resource so that you use it with confidence and assurance. If equipment is involved, check that it is in working order, make sure that you know how to operate it and that it is available when you need it
- use the resource at the right place and time—it should fit in with the flow and sequence of the lesson and serve a definite teaching purpose
- (if the resource is radio, film, video or television), introduce the program by outlining the content. You might also set some questions to guide listening or viewing. Follow up after using the resource, by discussing and drawing appropriate conclusions.

Useful resource books

The following resource books are recommended to be used with the Upper Secondary Geology curriculum. This list is by no means exhaustive. You are encouraged to look up other resource books as well.

Press, F and Siever, R 1986 *Earth*, *Fundamental Science* (book 4) Freeman and Company, New York.

Chernicoff, S 1999, *Geology: An Introduction to Physical Geology*, 2nd edn, Houghton, Boston.

Chorley, RJ et al. 1985, *Geomorphology* Methuen & Co., New York, N.Y.

Duff, D (ed.) 1992, *Holmes Principles of Physical Geology*, 4th edn, Chapman and Hall, London.

Spencer, EW 1983, *Physical Geology* Addison Wesley Publishers, Reading Mass..

University of Papua New Guinea 2008, Physical Geology: Earth Science Course, University of Papua New Guinea, Port Moresby.

Clowes, A and Comfort, P 1987, *Process And Landforms: Conceptual Frameworks in Geology*, 2nd edn, Oliver and Boyd, Robert Stevenson House. Edinburgh.

Papua New Guinea Chamber of Mines and Petroleum 2007, *Profile: PNG Mining and Petroleum Investment by PNG*

Lutgens, FK and Tarnbuck, J 1993, *The Earth: An Introduction to Physical Geology*, 4th edn, Prentice Hall, Upper Saddle River, NJ

References

Anderton, J (ed.) 1993, *Fundamental Science for Melanesia*, Longman Cheshire.

Arnold, N 1998, *Volcanoes and Earthquakes*, Wayland.

Clark, I and Cook, B 1983, *Geological Science Perspectives of the Earth*, Australian Academy of Science, Canberra.

Davies, H 1994, *Earth-Wise: An introduction to composition, structure, process and hazards from a Papua New Guinean perspective*, University of Papua New Guinea, Port Moresby.

Department of Education Queensland 1986, *Earth Topic Book 1: Guidelines for Secondary Schools Years 8-10 Science.*

Dixon, D 1992, *The Changing Earth*, Wayland.

Dodd, B and Cranna, S 1989, *Discover your World*, Jacaranda.

Dolan, C 1989, *Hazard Geography*, Longman.

Dudman, J 1992, *The Violent Earth: Earthquake*, Wayland.

England, N 2004, *Physics Matters,* 2nd edn, Hodder and Stoughton.

Garton, A 1997, *Science Moves*, Heinemann.

Hefferman, D and Learmonth, M 1981, *The World of Science: Book 2,* Longman Cheshire, Melbourne.

Hefferman, D and Learmonth, M 1984, *The World of Science: Book 3,* Longman Cheshire, Melbourne.

Heller, R et al. 1973, *Earth Science: Challenges To Science*, McGraw-Hill.

Mayer, R 2004, 'Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction', *American Psychologist,* vol 59, no. 1, pp. 14–19.

Nielson, A, Ford, S and Doherty F 1996, *Science and Life: Work, Leisure, Technology and the Environment,* 2nd edn, Oxford University Press, Melbourne.

Patrick, A and Neil, J 1990, *The Earth: Home of Humanity*, 2nd edn, Longman Cheshire.

Richards, S 1990, *Living with the Physical Environment*, Unwin Hyman.

Stannard, P and Williamson, K 1991, *Science New Book 3*, Anteater.

Stannard, P and Williamson, K 1992, *Science Now Book 1*, McMillan.

Stannard, P and Williamson, K 1992, *Science Now Book 2*, McMillan.

Williamson, K 1991, *Science New Book 3*, Anteater.

Glossary for Geology

Alluvial mining	Small-scale mining that involves mining on river beds using simple techniques such as panning
Atmosphere	The gaseous envelope surrounding the earth where all the weather processes occur
Bioclastic	Contains shell or coral fragments
Calcite	The mineral CaCO3 that constitutes limestone. A drop of hydrochloric acid on calcite will fizz (bubble) giving off carbon dioxide gas
Caldera	A large basin-like depression, more or less circular, the diameter of which is many times greater than a vent
Chalcopyrite	An important ore of copper with a chemical formula CuFeS2. In hand specimen it is shiny, like pyrite, but the mineral grains do not show perfect cubes
Continent	Large land mass rising more or less abruptly above the deep ocean floor and including the marginal areas that are slowly submerged
Convergent boundary	A marginal region where two plates move towards each other and meet (collide)
Core	The innermost part of the earth. The core consists of the outer and inner core, of which the former is thought to be liquid while the inner core is solid
Crater	A steep-walled depression at the top of the volcanic cone or at the flanks of a volcano out of which volcanic materials are ejected
Crude oil	Petroleum liquid as it comes straight from the ground
Crust	The outermost thin layer of the earth
Crystal	A discrete solid particle bounded by definite faces or the external form of crystal due to ordered arrangement of atoms, molecules or irons within the bulk of the solid
Culture	Customs, lifestyles, way of life
Cycle	A process that is able to repeat itself
Demography	the study of human populations, including their size, growth, density, and distribution, and statistics regarding birth, marriage, disease, and death
Deposition	Laying down of rock-forming material after being broken down in water or precipitated through chemical action
Disaster	A serious disruption of the function of a society, causing widespread human, material or environmental loss which exceeds the ability of affected society to cope using its own resources
Divergent boundary	A marginal region where two plates move away from each other
Earthquake	Sudden motion or trembling of the earth caused by sudden release of slowly accumulating tension in the earth
Ejecta	Material thrown out by a volcano such as ash, lapilli, bomb
Environment	The surrounding: anything and everything around us
Epicentre	The point on the earth's surface directly above the focus of an earthquake
Epoch	Geological time units that are further derived from the periods
Era	A geologic timescale that mainly consists of Precambrian, Cambrian, Mesozoic and Cenozoic
Erosion	The general process or group of processes where by the material of the earth`s crust are loosened, dissolved, or worn away and simultaneously

	transported from one location to another by natural agents such as water and wind
Exploration	The search for deposits of usefull minerals and fossil fuels
Extrusive rock	Molten rock that is violently or quietly ejected and cooled on the surface of the earth
Fault	A fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture
Earthquake focus	The true centre of an earthquake, within which the strain energy is first released into elastic energy as seismic waves
Fold	A bend in rock strata
Fossil	An impression, cast, outline, track or body part of an animal or plant preserved in rock after the original organic material has been transformed or removed
Geologist	A person who studies rocks
Geology	Study of rocks and other geologic processes
Geomorphology	The study of the classification, description, nature, origin and development of present land forms and their relationships to the underlying structures and of the history of geological changes as recorded by these surface structures
Hazard	An activity, a situation or an environment, either man made or natural, which may be a danger or threat to human, material or environmental loss, if its risks are not minimised or contained
Hydrosphere	The portion of the earth that holds water
Igneous rock	Rocks that are formed when magma cools and solidifies
Intrusive rock	An igneous rock that that solidifies below the ground as opposed to extrusive rock
Lithosphere	A layer of strength relative to the underlying asthenosphere that consists of the crust and the upper part of the mantle
Management	Administration, handling, guidance, control, running, supervision, care, operation or oversight
Mantle	Layer of the earth found between the core and the crust bounded above by the Mohorovicic Discontinuity
Mercalli scale	An older method of measuring earthquake intensity based on 'observed damage'
Metamorphic rock	Rock that is formed when older rocks such as igneous and/or sedimentary rocks undergo change, mainly due to increased heat and temperature
Metamorphosis	Any change in form, structure, substance, and so on
Mid oceanic ridge	Mid-oceanic mountains where new material is created
Mineral	Solid chemical element or compound that compose rock which forms naturally in the earth
Moh's hardness scale	The hardness scale, consisting of 10 minerals, from talc (softest) to diamond (hardest)
Natural gas	Hydrocarbons that exist as gas or vapour at ordinary temperatures and pressures
Ore	A mineral or aggregate of minerals normally mixed with gangue (non-metalliferous minerals)
Palaeomagnetism	Faint magnetic polarisation of rocks that may have been preserved since accumulation of sediment
Palaeontologist	Person who studies fossils

Palaeontology	Study of fossils of plants and animals and geologic age
Period	A major geological time; divisions of era most of which are named for the area where the rocks were first studied
Law of Superposition	States that the rocks in the bottom layer are older than the rocks in the top layer
Process	Step-by-step cause of action, procedure, method
Prospecting	Searching for economically valuable deposits of minerals and fuels
Radio-carbon dating	Dating of rocks using radioactive elements because of their ability to decay
Resources	Anything considered by human beings to be of value
Richter scale	A numerical scale of earthquake magnitude developed by the seismologist, C F Richter
Ring of fire	The term used to describe active tectonic activities along the boundary of the oceanic Pacific Plate where many volcanoes are produced as aresult of subduction
Sedimentary rock	Rocks that are derived from pre-existing sedimentary, igneous and metamorphic rocks through weathering
Seismograph	An instrument that detects, magnifies and records vibrations of the earth, particularly earthquakes
Stakeholder	A person, an organisation or a government that owns a resource, contributes significant funds to develop a project or is considered to an indispensable component in a situation or a project
Stalactite	Cylindrical or conical deposits of calcite hanging from the roof of a cave
Stalagmite	Columns or ridges of lime rising from the floor of a cave formed by water charged with carbon of lime dripping from the stalactites above
Strategy	Plan, grand design, approach, procedure
Subduction zone	A zone in which one plate is pushed below the other as a result of a collision between two plates. This zone is characterised by earthquake foci
Surficial process	Physical and chemical processes that occur on the surface, particularly the surface of the earth
Sustainability	The condition of maintenance, continuing, keeping alive, keep going, prolonging or protracting
Tectonics	Study of the crustal movements of the earth plates
Trench	The deeper region at the zone where the continental crust and oceanic crust collide
Tsunami	A gravitational sea wave generated by any large-scale, short duration disturbance of the ocean floor by shallow submarine earthquake, submarine earth movement, subsidence of volcanic eruption
Volcanic island arc	Chain of volcanic islands resembling an arc, formed as a result of a collision between two oceanic crusts
Volcanism	Natural process resulting in the formation of volcanoes, volcanic rocks, lava flows and so on
Volcano	A vent in the earth's crust from which molten lava, pyroclastic materials and volcanic gases are emitted. It is also a name given to a mountain that has been built up by the materials ejected from the interior of the earth through a vent
Weathering	Physical and chemical breakdown of rocks and minerals through a group of processes

Glossary for assessment

Syllabus outcomes, criteria and performance standards, and examination questions all have key words that state what students are expected to be able to do. A glossary of key words has been developed to help provide a common language and consistent meaning in the syllabus and teacher guide documents.

Using the glossary will help teachers and students understand what is expected in response to examinations and assessment tasks.

Glossary of key words for assessment

Account	Account for: state reasons for, report on. Give an account of: narrate a series of events or transactions
Analyse	Identify components and the relationship between them; draw out and relate implications
Apply	Use, utilise, employ in a particular situation
Appreciate	Make a judgement about the value of
Assess	Make a judgement of value, quality, outcomes, results or size
Calculate	Ascertain or determine from given facts, figures or information
Clarify	Make clear or plain
Classify	Arrange or include in classes or categories
Compare	Show how things are similar or different
Construct	Make; build; put together (items or arguments)
Contrast	Show how things are different or opposite
Critically (analyse, evaluate)	Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to (analysis or evaluation)
Deduce	Draw conclusions
Define	State meaning and identify essential qualities
Demonstrate	Show by example
Describe	Provide characteristics and features
Discuss	Identify issues and provide points for and/or against
Distinguish	Recognise or note or indicate as being distinct or different from; to note differences between
Evaluate	Make a judgement based on criteria; determine the value of
Examine	Inquire into
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract	Choose relevant and/or appropriate details
Extrapolate	Infer from what is known
Identify	Recognise and name
Interpret	Draw meaning from
Investigate	Plan, inquire into and draw conclusions about

Justify	Support an argument or conclusion
Outline	Sketch in general terms; indicate the main features of
Predict	Suggest what may happen based on available information
Propose	Put forward (for example, a point of view, idea, argument, suggestion) for consideration or action
Recall	Present remembered ideas, facts or experiences
Recommend	Provide reasons in favour
Recount	Retell a series of events
Summarise	Express, concisely, the relevant details
Synthesise	Putting together various elements to make a whole