EES 2018 Field Trip Report- Yilgarn Craton

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Year : 12

Subject : Earth and Environmental Science Yr. 12

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Summary of field trip

Over the period of 5 days, a field trip along Yilgarn Craton was conducted by two teachers and 8 students. The Yilgarn Craton is a large craton that constitutes the bulk of the Western Australian land mass. It is bounded by a mixture of sedimentary basins and Proterozoic fold and thrust belts. We gained a lot of experiences and knowledge about the whole unit of year 12 throughout this field trip.

The Yilgarn Craton appears to have been assembled between ~2.94 and 2.63 Ga by the accretion of a multitude of formerly present blocks or terranes of existing continental crust, most of which formed between 3.2 Ga and 2.8 Ga. This growth event is recorded by broad granite and granodiorite interruptions, which include more than 70% of the Yilgarn craton; voluminous tholeiitic basalt and komatiite volcanism; regional metamorphism and deformation as well as the emplacement of the vast majority of the craton's endowment in gold mineralization. However, these accretion events happened in a few stages, most likely by accretion of continental fragments separated by pauses in subduction, with renewed activity occurring episodically. The craton is essentially made out of roughly 2.8 billion years old (~2.8 Ga) granite gneiss metamorphic terrain (the Southwestern Region and Western Gneiss Belt), and three granite-greenstone terrains (the North-East Goldfields, the Southern Cross and the greenschist metamorphic Murchison Provinces). Some greenstone belts and granites are as old as 3.1-2.9 Ga, and some are younger, at ~2.75-2.65 Ga. The main concepts learned were**:**

Day 1

- Regional & Dynamic metamorphism
- Bowen's series- Partial melting
- Deep earth processes (Rock cycle, water cycle, Wilson cycle)
- Igneous rocks
- Structural Geology- Law of intrusion
- Renewable energy
- Geohazard
- Dryland salinity

Day 2

- Greenstone belt
- Environmental
- Value train
- Hydrothermal mineralization
- Introduced species
- Mapping
- Indigenous culture
- Dryland salinity
- Structural geology

Day 3

- Nitrogen, Carbon and Biogeochemical cycles.
- Environment- Introduced species
- Value train
- Metamorphism

Day 4

- Metamorphism
- Structural geology
- Eutrophication
- Wind patterns
- Climate change

Day 5

- Structural geology- metamorphism

Day 1- 01/03/18

Sponty 1: Noble Falls

Photographed by: Jodie-An, writer • Location: Noble falls • Date of picture taken: 04/02/2010

1.0 Introduction

Noble Falls is in the southwest of Western Australia which is in the west of Australia. It is located at a latitude of -31.76736 decimal degrees and a longitude of 116.23928 decimal degrees. Noble Falls is at an elevation/altitude/height above sea level of 178 m above sea level. The nearest village to Noble Falls is Wooroloo about 8.08 km away. Wooroloo has a population of about around 240 (based on the 2001 census).

The introduction to metamorphic rocks and the quarter flower petal diagram is observed in Noble falls. Noble falls showed a series of high grade metamorphic rock. The main concepts observed in Noble falls are metamorphic rocks, Bowen's reaction series, deep earth processes, Rock cycle, Wilson cycle and the melting textures. In the following pages, the observations taken in Noble falls will be explained in detail with related pictures and diagrams.

Dot points addressed:

SIS (Science Inquiry Skills)

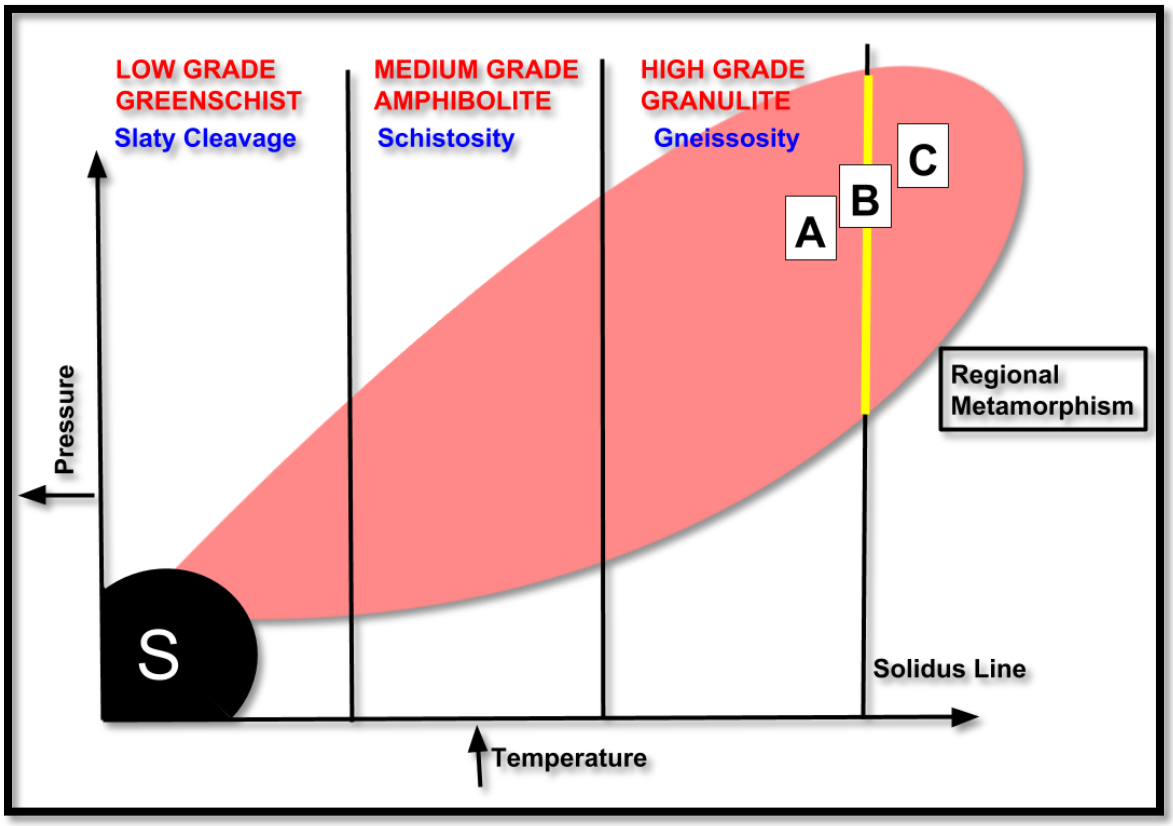
4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs.

SHE (Science Human Endeavour)

1. Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources.

1.1 Noble falls

Diagram 1.1: Diagram of the Quarter petal flower diagram in Noble falls



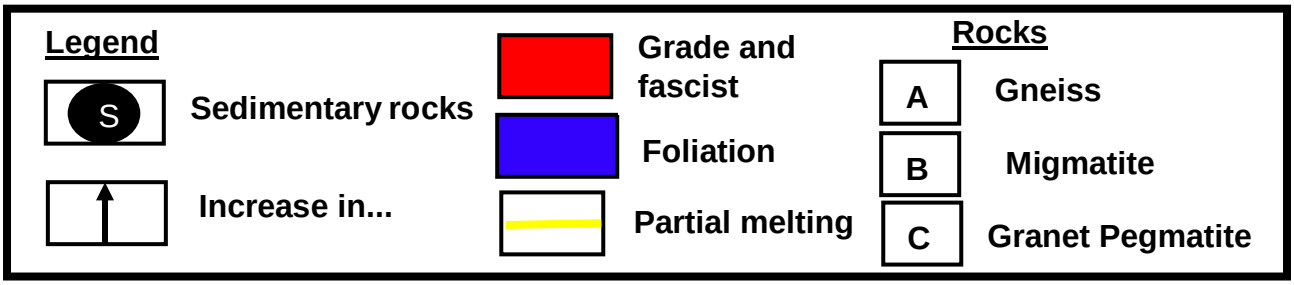


Diagram 1.1: The above diagram shows the rocks changing from solid to liquid state as the partial melting occurs in the solidus line due to the increase in pressure and temperature. This process is under regional metamorphism. Migmatite is created when a metamorphic rock such as gneiss partially melts, and then that melt recrystallizes into an igneous rock (pegmatite granite), creating a mixture of the unmelted metamorphic part with the recrystallized igneous part. This process is observed in Noble falls and it is drawn on the Quarter petal flower diagram (Diagram #). Observations were made by the students around the area near the waterfall and a designated area was observed by each student during this field trip. Water was used to observe the metamorphic structures such as boudinage and leucosomes on the surface of the waterfall.

1.1.1 Observations:

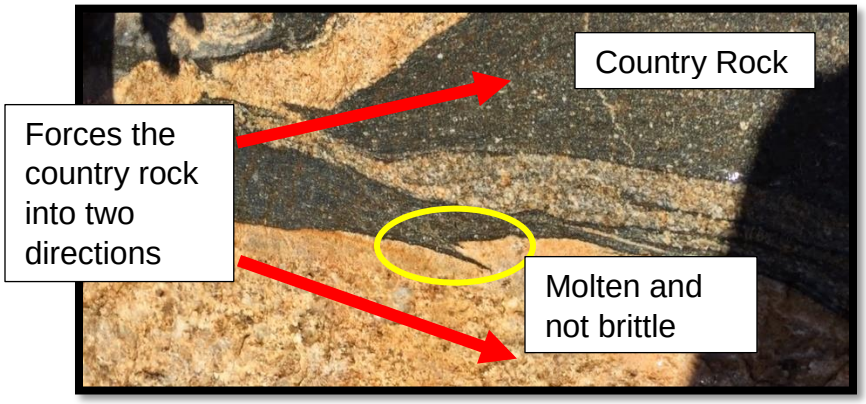


Diagram 1.1.1. shows the country rock forcing its way into direction as it cools down. The country rock is observed to be molten. The group has concluded that the country was molten and not brittle because there is an intrusion of the country rock into the source rock.

Figure 1.1.1: The above picture shows the country rock forces its way into two directions

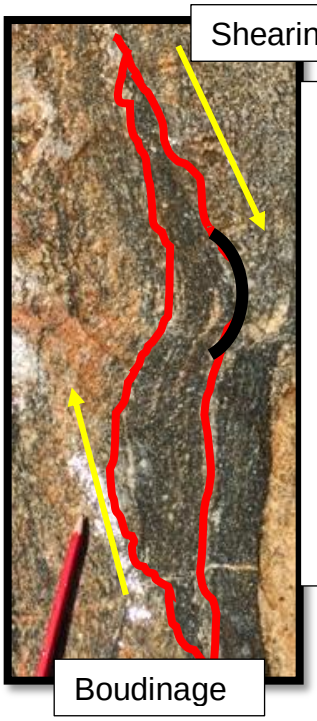
The intense directional which regionally metamorphosed rocks are subjected to while buried deep underground can produce aligned textures, forming characteristics mineral banding and deformed mineral shapes within the rocks. Foliation is one of the main metamorphic texture observed in Noble falls. Foliation is the term given to the near-parallel orientation of platy minerals in rocks. As the grade of metamorphism increases, the degree of foliation within the metamorphic rocks also changes.

Figure 1.1.2: The above picture shows the banded foliation on the country rock which is known as the Gneiss.

Gneiss is a foliated metamorphic rock. Layers of dark and light minerals stripe the rock, and sometimes it is possible to see how the direction of pressure deep in the Earth changed as the minerals formed. High grade metamorphic rocks exhibit a gneissic texture known as gneissosity. These are coarse grained rocks with a distinct banding of light and dark minerals. The sheet silicate minerals become unstable and dark colored minerals like hornblende (an amphibole) and pyroxene begin to grow, forming elongated crystals with their long axes lying perpendicular to the direction of maximum stress. The minerals become segregated into distinct bands of dark and light minerals known as mineral bands (Figure 1.1.2).

There were a few melting textures observed in Noble falls such as Boudinage, leucosomes, shearing and bending.

1.1.2 Example of the melting textures



In figure 1.1.3, the sausage-like or stretched "Z" structure is observed as the shearing occurs. Boudinage refers to structures deformed by extension in ductile shear zones. Boudinage structures contain a rigid tabular body that has been stretched and deformed where embedded within more deformable (less competent) rocks. There's also an anticline hinge which is going in the east direction.

The shape of Boudinage | **The direction of shearing** | **Anticline hinge**

Figure 1.1.3: The above picture shows the sausage like structure created due to shearing.

Newtonian fluid is a solid behaving like a liquid. A Newtonian fluid is a fluid in which the viscous stresses arising from its flow, at every point, are linearly proportional to the local strain rate—the rate of change of its deformation over time. That is equivalent to saying those forces are proportional to the rates of change of the fluid's velocity vector as one moves away from the point in question in various directions. Under constant temperature and pressure conditions, the viscosity of a Newtonian fluid is the constant of proportionality, or the ratio, between the shear stress that builds in the fluid to resist flow and the shear rate applied to the fluid to induce flow; the viscosity is the same for all shear rates applied to the fluid. In figure 1.1.4, Newtonian fluid allows to curve as it is a liquid which flowed into the source rock.

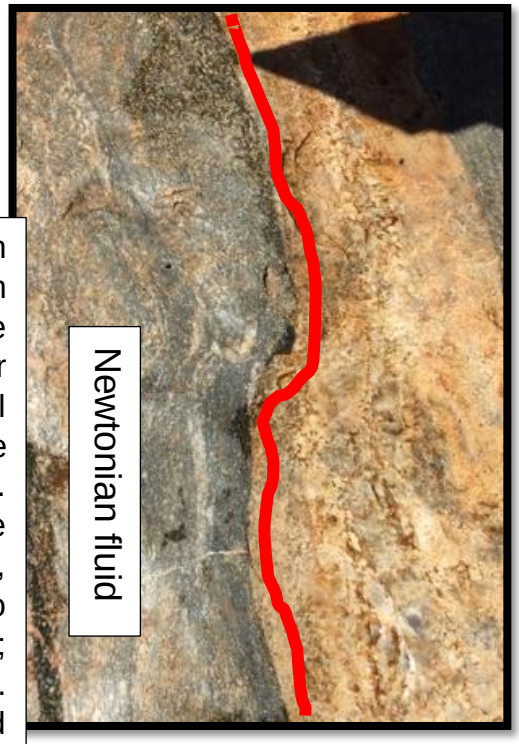


Figure 1.1.4: The above picture shows the curvature of the rock due to the Newtonian fluid.

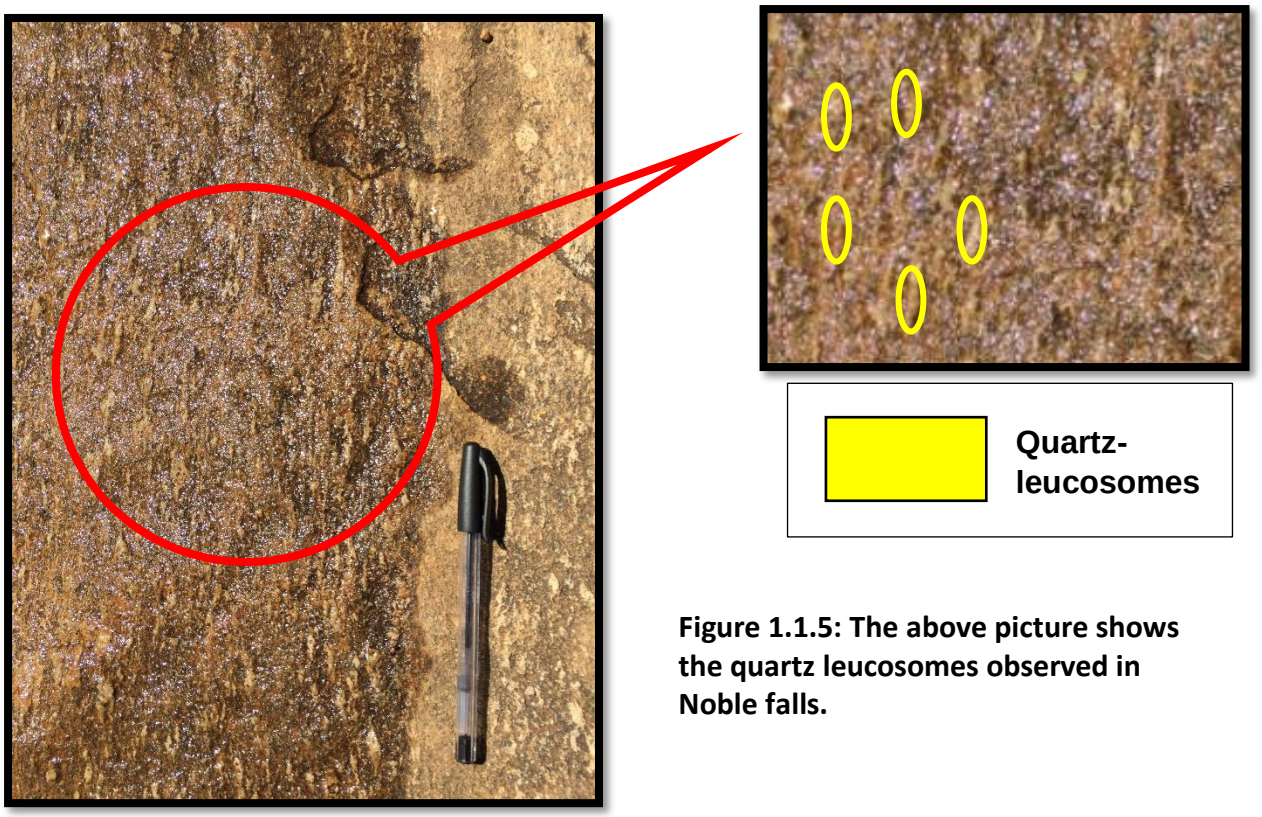


Figure 1.1.5: The above picture shows the quartz leucosomes observed in Noble falls.

The leucosomes are the lightest colored part of Migmatite. The melanosome is the darker part, and occurs between two leucosomes or, if remnants of the more or less unmodified parent rock (mesosome) are still present, it is arranged in rims around these remnants. The pattern observed was that the leucosomes were parallel to the foliation. As shown in figure #, quartz are sweating out along the foliation as leucosomes. This is because the quartz is the minerals which is melting first. The quartz leucosomes proves the theory of quartz melting first in Bowen's reaction series, shown in figure 1.1.5.

Migmatite textures are the product of thermal softening of the metamorphic rocks. When a rock undergoes partial melting, some minerals will melt (neosome, i.e. newly formed), while others remain solid (paleosome, i.e. older formation). The neosome is composed of lightly-colored areas (leucosome) and dark areas (melanosome). The leucosome lies in the center of the layers and is mainly composed of quartz and feldspar, shown in figure 1.1.6.

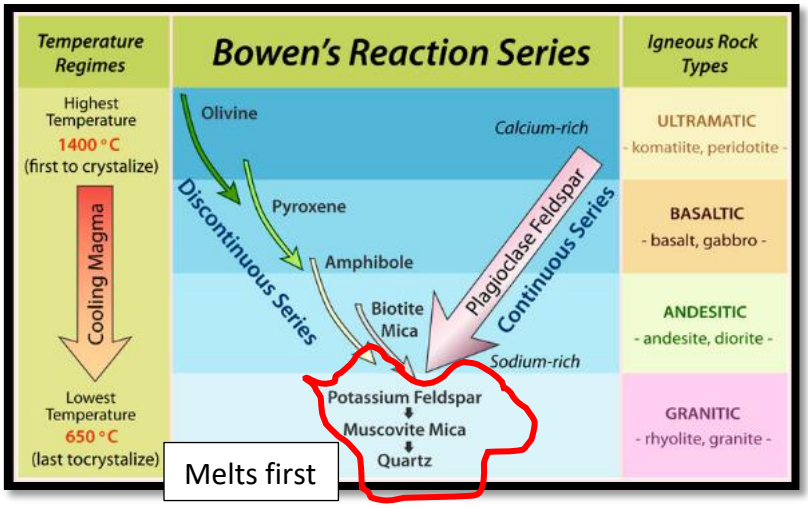


Figure 1.1.6: The above picture shows how the Bowen's Reaction series integrates with the melting of quartz.

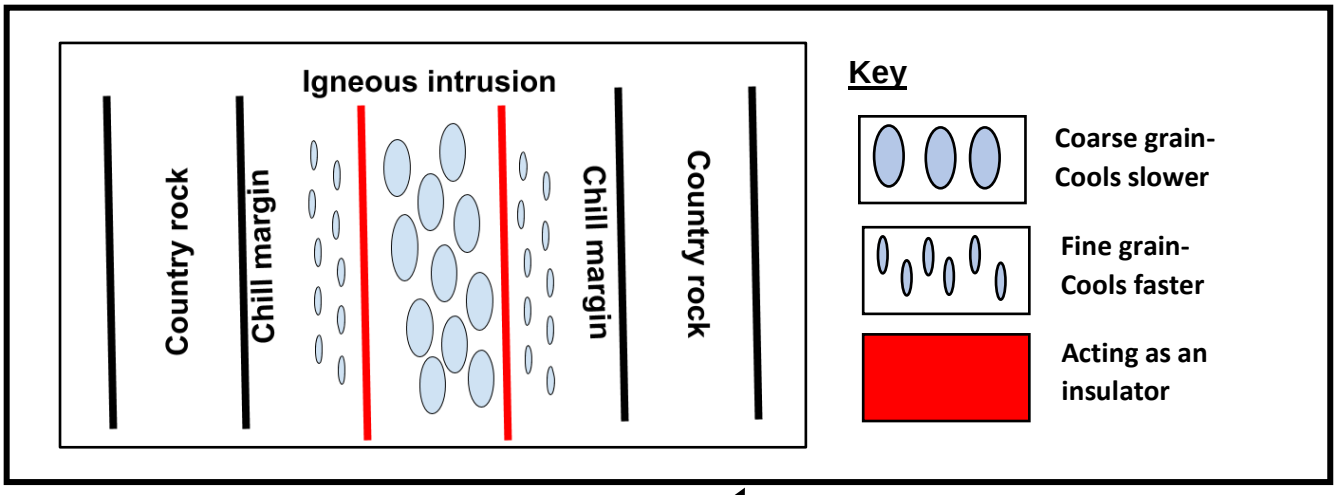


Figure 1.1.7: The above picture shows the drawing interpretation of the igneous intrusion between country rocks.

Figure 1.1.8: The above picture shows the xenolith created due to shearing of parent rock.

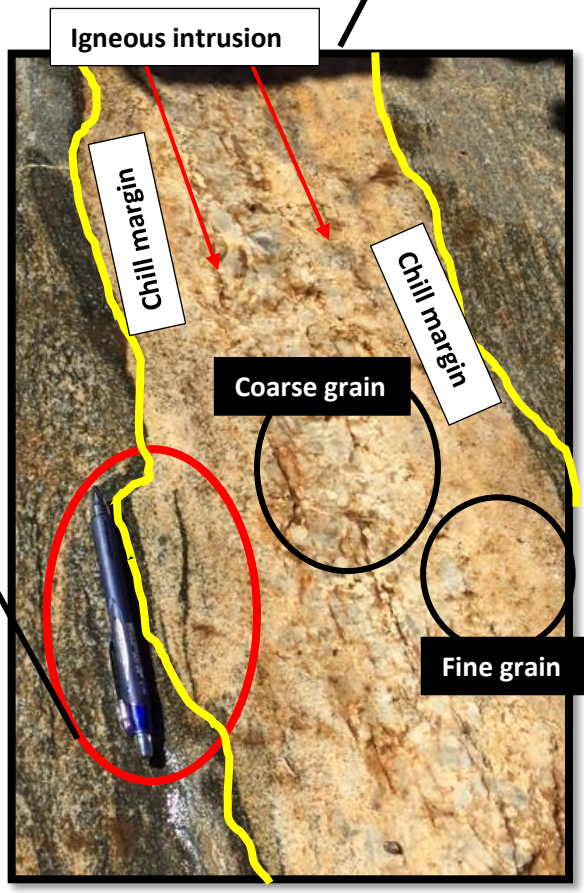


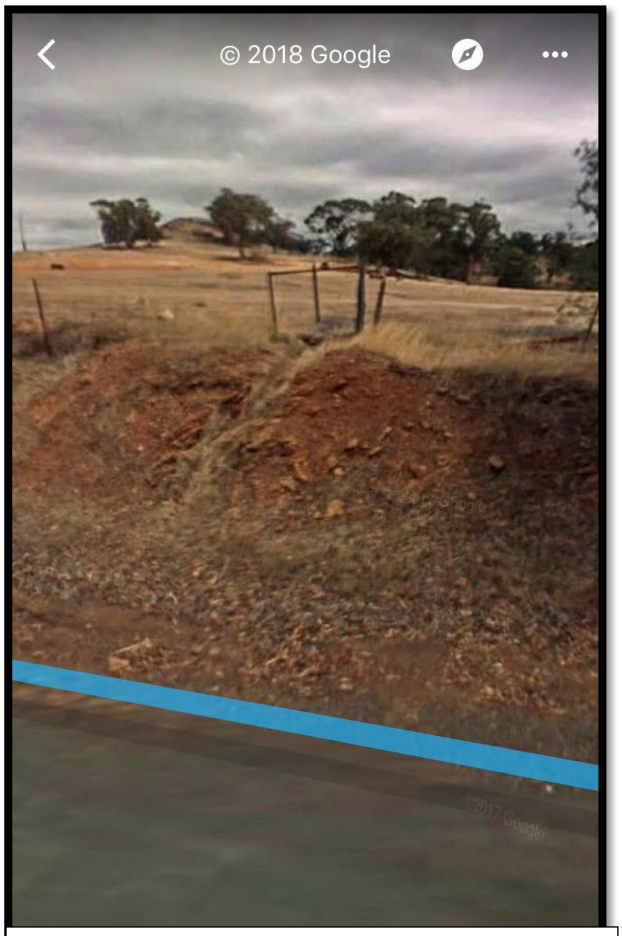
Figure 1.1.9: The above picture shows the igneous intrusion between the country rocks.

The above figure 1.1.7shows the drawing interpretation of the igneous intrusion between the country rocks. The location where the coarse grain is created is hotter than the location where the fine grain is. The chill margin acts as an insulator allowing the intrusion to cool slower. So, as the intrusion cools slower it creates a coarser grain. The fine-grained crystals are observed near the chill margin because it cools faster.

Figure 1.1.8 shows a piece of rock within an igneous mass which is not derived from the original magma but has been introduced from elsewhere, especially the surrounding country rock, known as the xenolith. As observed, the parent rock encapsulates the country rock.

Figure 1.1.9 shows the igneous intrusion between the country rock and the different observation taken around this certain area. The grains are observed to vary in sizes in different positions. However, there is an observation of xenolith encapsulating the country rock as it cooled down.

Stop 1: Lovers Lane 1



Photographed by: Google
Location: Latitude: -31.6096 Longitude: 116.3951

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs.

7. Select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations such as block diagrams and strategic columns, to communicate conceptual understanding, solve problems and make predictions

1.2.1 Lovers lane 1

Lovers lane features a rock surface where strike and dip direction can be measured. The rock surface is made up of medium grade metamorphic rock known as Andalusite schist. Strike is the pattern of the direction and it is perpendicular to the dip direction.

Figure 1.2.1: The above picture shows the strike and dip direction of the rock surface in lovers lane 1.

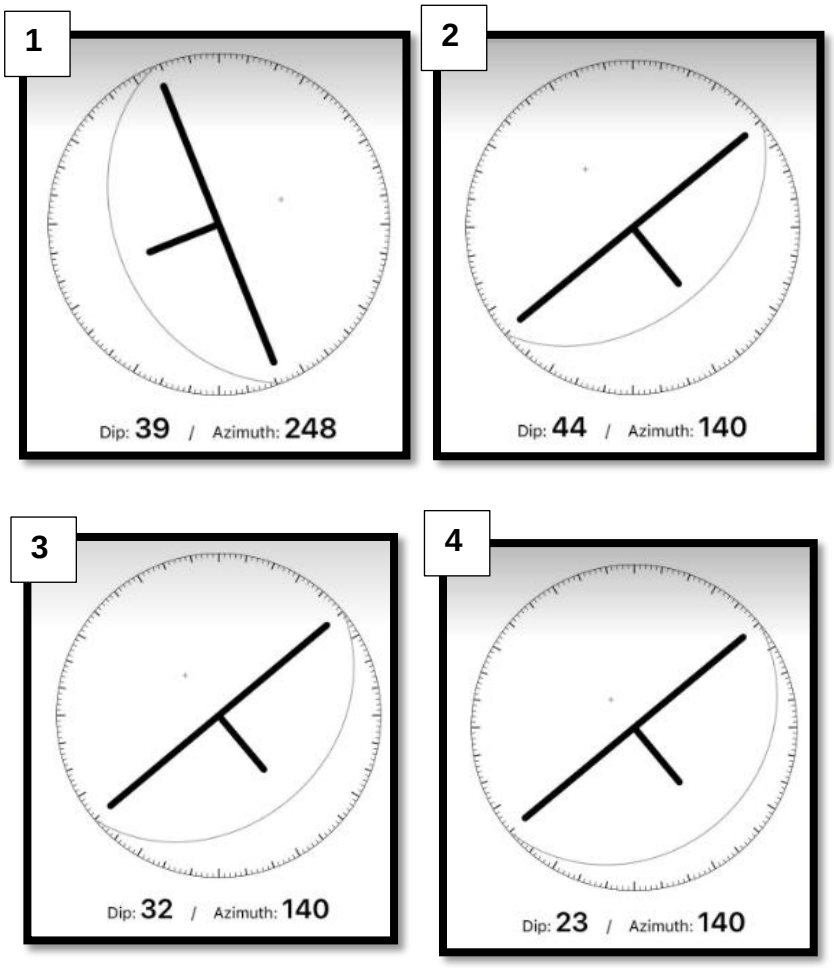


Figure 1.2.1 shows the strike and dip direction of the andalusite schist observed in lovers lane 1. The foliation is observed as the students reached lovers lane 1. The plane was striking in southwest direction. The dip direction was approximately 45° south east.

The medium grade metamorphic rock has a **schistosity**. Geological foliation (metamorphic arrangement in layers) with medium to large grained flakes in a preferred sheet like orientation is called schistosity. The names of various schists are derived from their mineral constituents.

1.2.2 Rock cycle

Diagram 1.2.2: Diagram of the rock cycle in Lovers lane 1

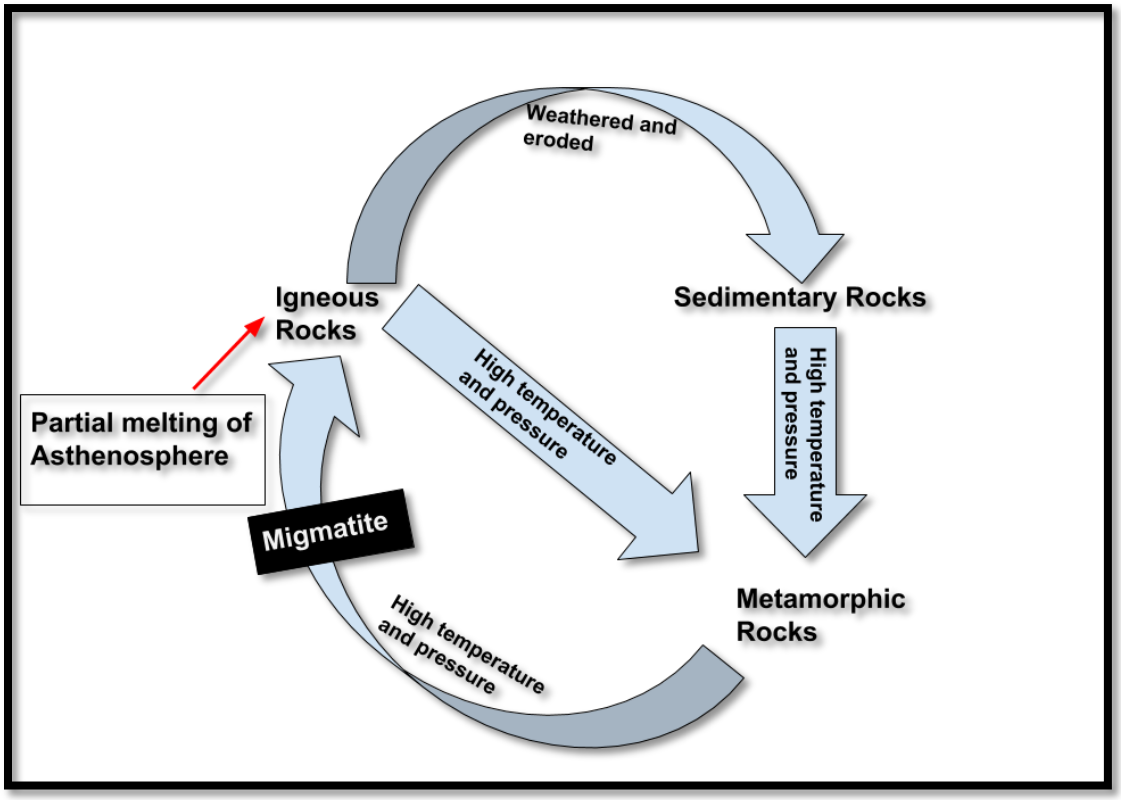


Diagram 1.2.2: The above diagram shows the rock cycle explaining how metamorphic rocks are formed. The beginning of the formation of igneous rock is due to the partial melting of asthenosphere. Like most Earth materials, rocks are created and destroyed in cycles. The rock cycle is a model that describes the formation, breakdown, and reformation of a rock as a result of sedimentary, igneous, and metamorphic processes. All rocks are made up of minerals. A mineral is defined as a naturally occurring, crystalline solid of definite chemical composition and a characteristic crystal structure.

Metamorphic rocks form when sedimentary, igneous, or other metamorphic rocks are subjected to heat and pressure from burial or contact with intrusive or extrusive igneous rocks. ("Meta" means change, and "morph" means form.) Heat and pressure from burial cause molecules of flat minerals like mica to line up perpendicular to the direction of greatest compression. Deep burial means higher pressure and hotter temperatures, and very high temperature and pressures cause the formation of new minerals, and mineral grains. Low-grade metamorphic rocks like slate and phyllite break in flat pieces and have a sheen on the surface. Schist is shiny, and many schists contain garnets, staurolites or other mineral crystals that have grown within the rock.

1.2.3 Rocks in Lovers lane 1

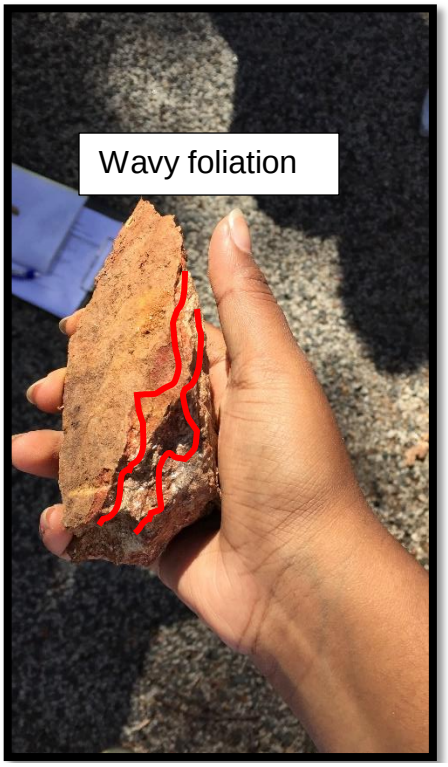


Figure 1.2.3: This picture shows a medium grade metamorphic grade, Andalusite schist.

Observations:

The rock has a wavy foliation. This shows that the metamorphic rock is a schist. Schist is medium grade metamorphic rock, formed by the metamorphosis of mudstone / shale, or some types of igneous rock, to a higher degree than slate, i.e. it has been subjected to higher temperatures and pressures.

The resulting foliation is coarser and more distinct than that of slate due to the higher degree of crystallization of mica minerals (biotite, chlorite, muscovite) forming larger crystals, and is often referred to as schistosity. These larger crystals reflect light so that schist often has a high luster, the shiny surface. The muscovite is occurring on the foliation. Schist is usually muscovite or biotite in the foliation planes. It usually forms on a continental side of a convergent plate boundary where sedimentary rocks, such as shales and mudstones, have been subjected to compressive forces, heat, and chemical activity. This metamorphic environment is intense enough to convert the clay minerals of the sedimentary rocks into platy metamorphic minerals such as muscovite, biotite, and chlorite.

To become schist, a shale must be metamorphosed in steps through slate and then through phyllite. If the schist is metamorphosed further, it might become a granular rock known as gneiss.

As shown in figure 1.2.4, the banded foliation known as the gneissosity is a higher grade metamorphic rock and the wavy foliation known as the schistosity is a medium grade metamorphic rock. Sigma 1 (S1) is used in both the foliation and Sigma 2 (S2) is used in the schistosity foliation.

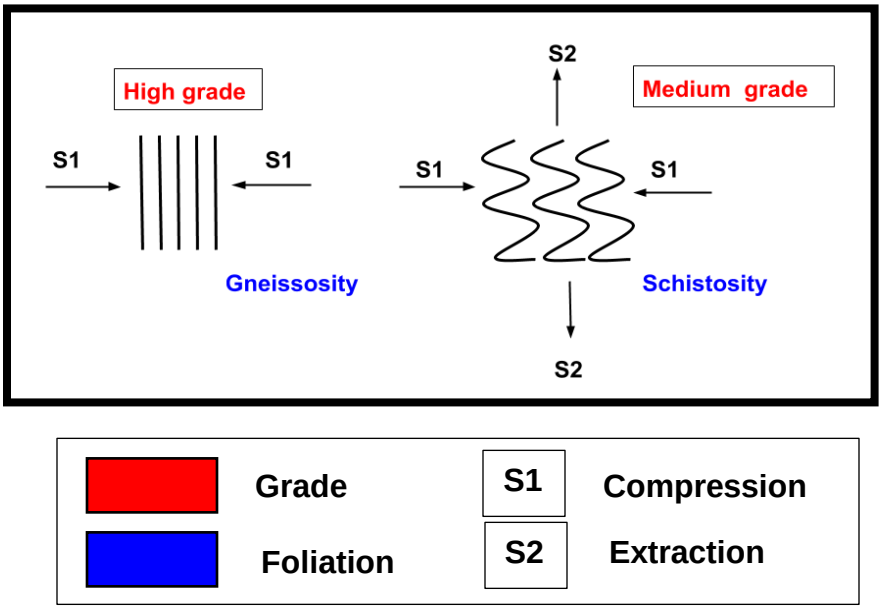


Figure 1.2.4: The above diagram shows the difference between the banded and the wavy foliation.

The foliation is parallel to the basal cleavage. Andalusite is an aluminum nesosilicate mineral with the chemical formula Al2SiO5 (Figure 1.2.5) Andalusite is trimorphic with kyanite and sillimanite, being the lower pressure mid temperature polymorph. At higher temperatures and pressures, andalusite may convert to sillimanite. Figure 1.2.5 shows the mineral composition in the andalusite schist found in Lovers lane 1.

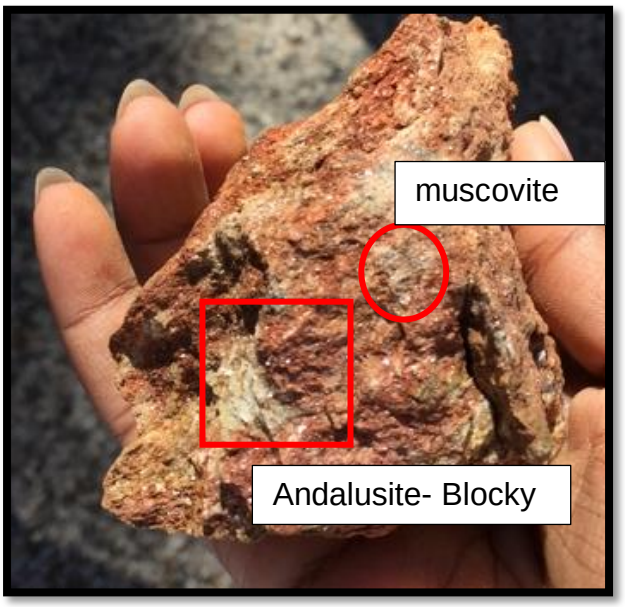


Figure 1.2.5: This picture shows the wavy foliation on the metamorphic rock. It is an andalusite schist.

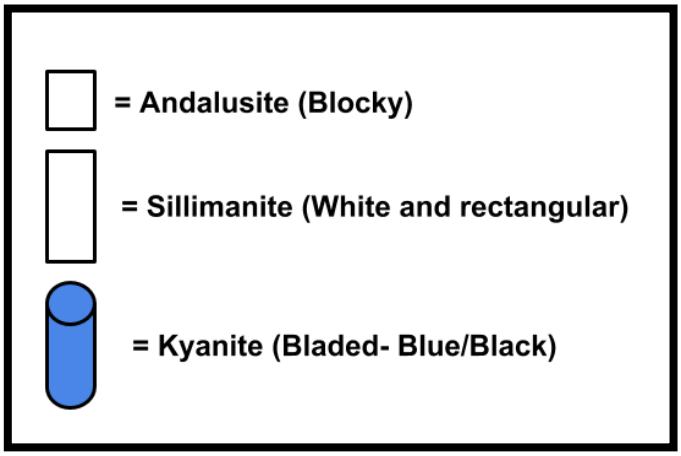


Figure 1.2.6: This diagram shows the difference between the shape of the minerals.

A polymorph is two or more minerals that contain the same chemical composition but differ in their atomical arrangement and crystal structure. Figure # shows the difference in the shape of the minerals such as the andalusite, sillimanite and kyanite. The diagram below (figure 1.2.7) is representing the change in crystal structure in the ¼ petal flower diagram and which grade they belong into.

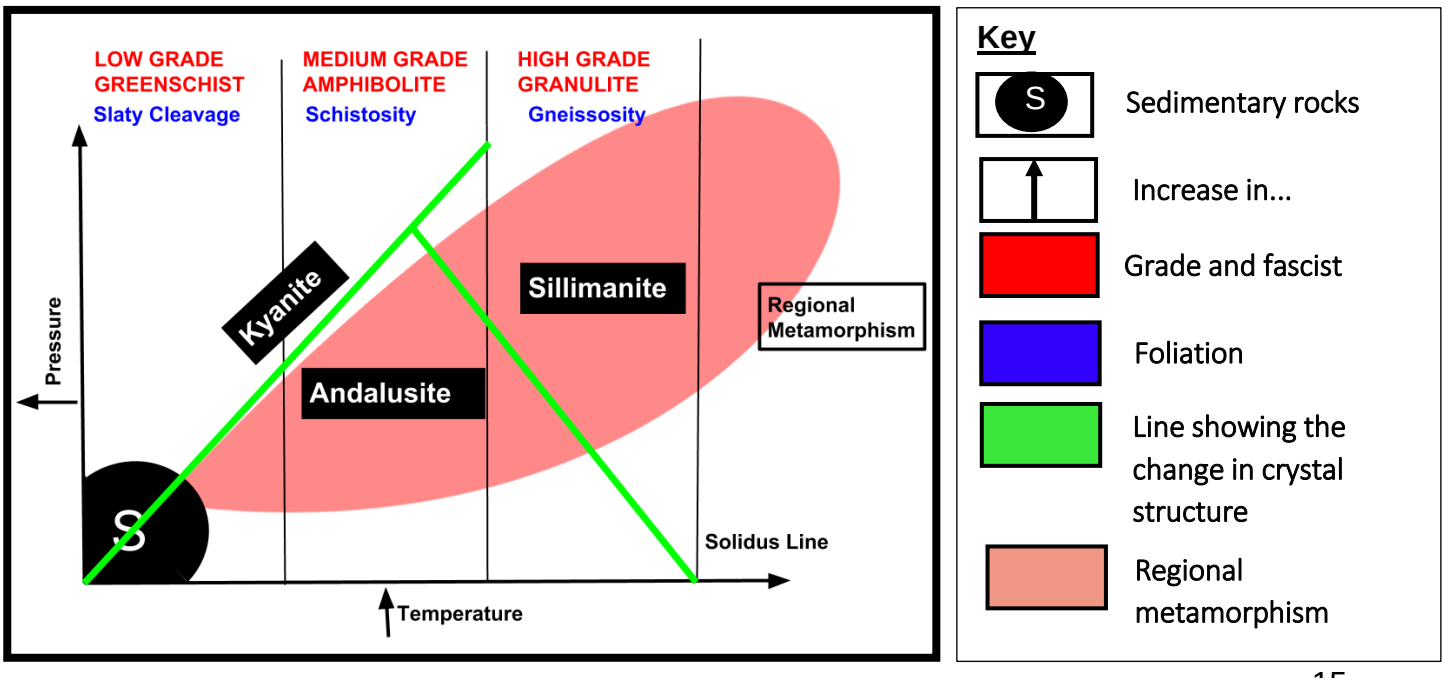


Figure 1.2.7: This diagram shows the change in crystal structure in the ¼ petal flower diagram.

Stop 2: Lovers Lane 2

Photographed by: Vinodaarshini• Location: 31°46’08” S 116°14’29” E • Date of picture taken: 01/03/18

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs.

7. Select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations such as block diagrams and strategic columns, to communicate conceptual understanding, solve problems and make predictions

1.3.1 Lovers lane 2

Diagram 1.3.1: Diagram of the cross-section of the rock surface in Lovers lane 2

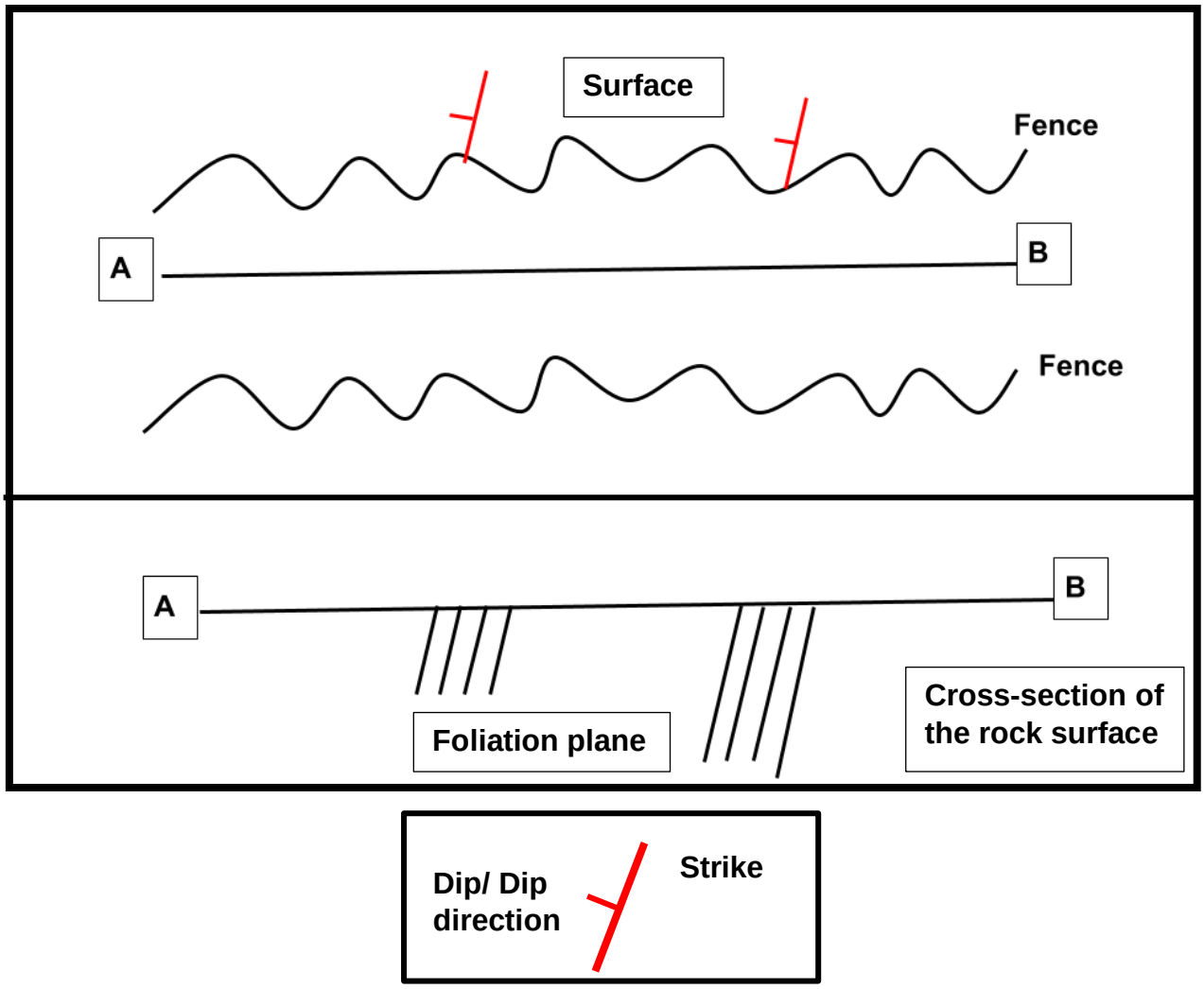
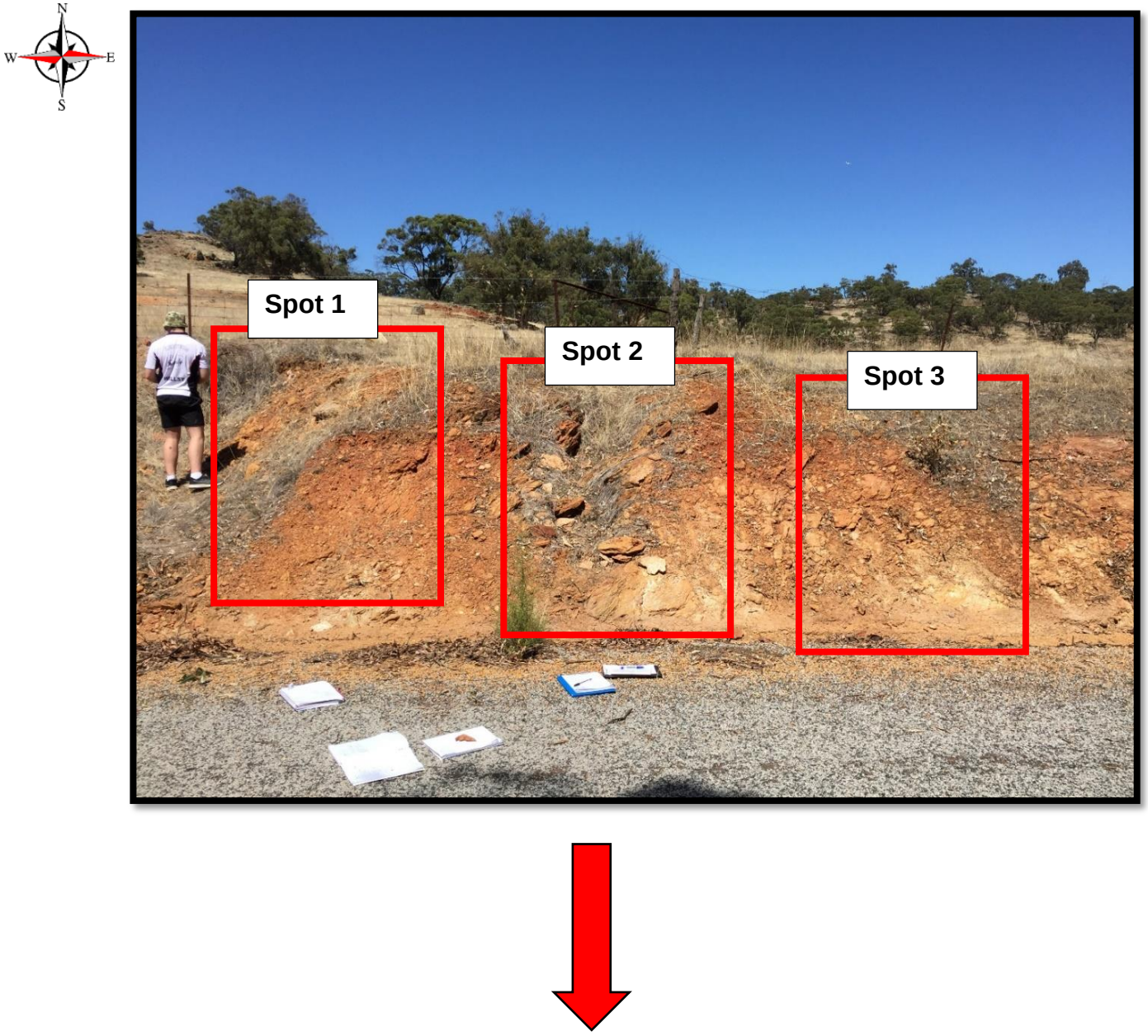


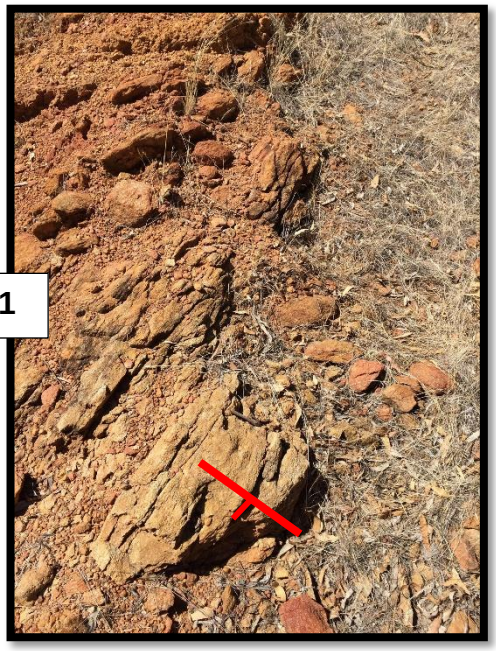
Diagram 1.3.1: The above diagram shows the cross section of the rock surface in Lovers lane 2. The foliation plane is perpendicular to the cross section from the surface. There are a few measurements of the strike and dip direction of the rock surface. The foliation is observed to be wavy. This infers to the rock being a schist. The low grade metamorphic rock is observed to have a slaty cleavage and it is known to be a green schist facies. The cross section is a part of a mountain fault belt. Lovers lane 2 is under the lower grade metamorphic rocks.

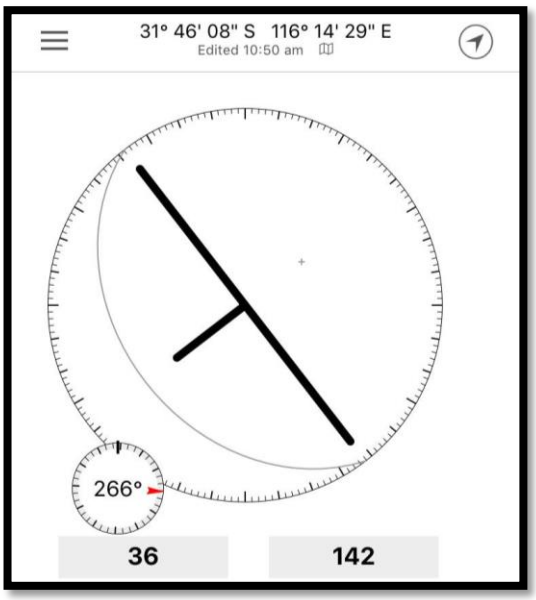
1.3.2 The strike and dip direction of the topography of lovers lane 2.

Diagram 1.3.2: Diagram of the topography of Lovers lane 2



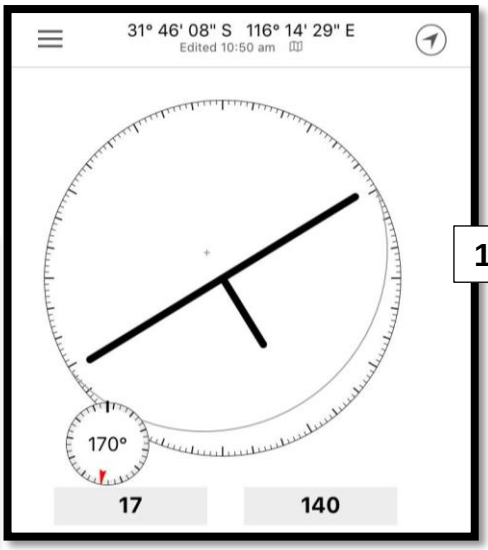
Spot 1



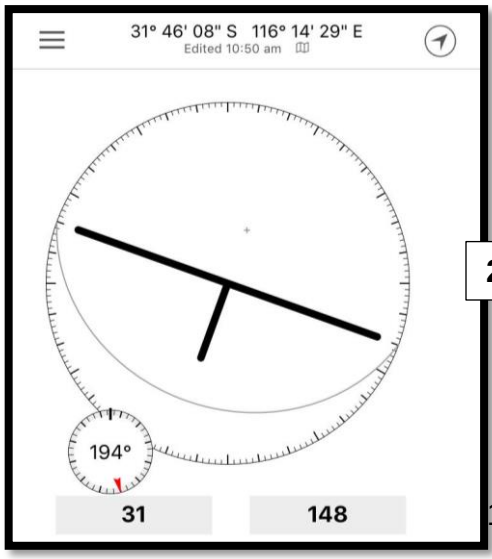


Spot 2

1



2



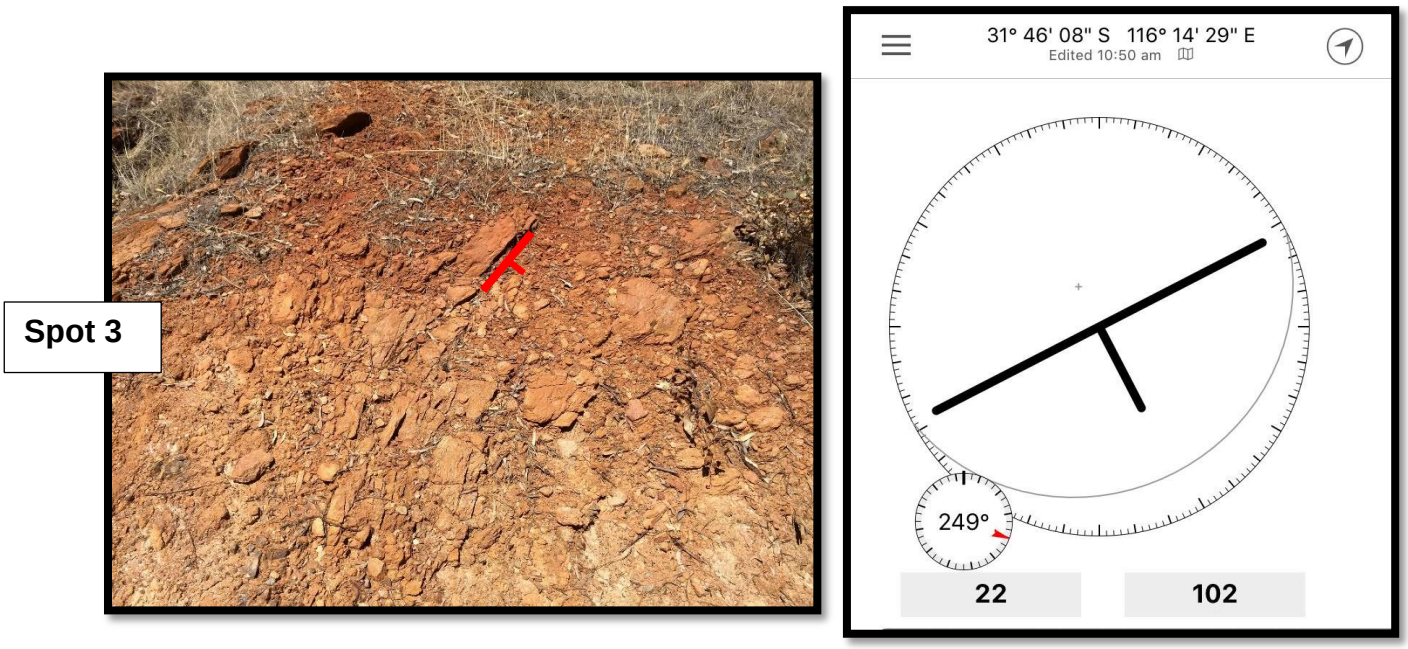
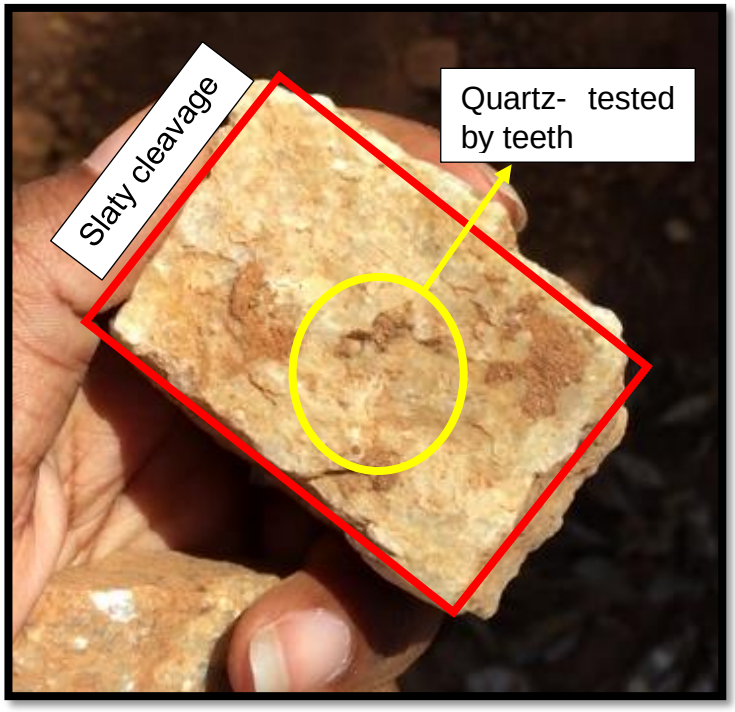


Diagram 1.3.2: The above diagram shows the measurements of the strike and dip in three different spots. The strike and dip direction show the anticline of the cross section in the rock structure in lovers lane 2. The strike was observed to go in the south west direction. The foliation is wavy, and the rock has a gritty structure. So, this rock might have a shale as the parent sedimentary rock. This slaty cleavage and the planner shows that it is a low grade metamorphic rock.



Slaty cleavage goes to schistosity and to gneissosity. This shows that this rock is in the lower grade and it is a green schist facies. Slaty cleavage refers to the extremely closely spaced, parallel planes of weakness that give a rock like slate its ability to split into very thin, platy layers. (Figure 1.3.3)

Greenschist facies, one of the major divisions of the mineral facies classification of metamorphic rocks, the rocks of which formed under the lowest temperature and pressure conditions usually produced by regional metamorphism.

Figure 1.3.3: This picture shows the slaty cleavage and the quartz on the rock observed in lovers lane 2

1.3.3 Summary

Diagram 1.3.3 : The ¼ flower diagram of Noble falls, lovers lane 1&2

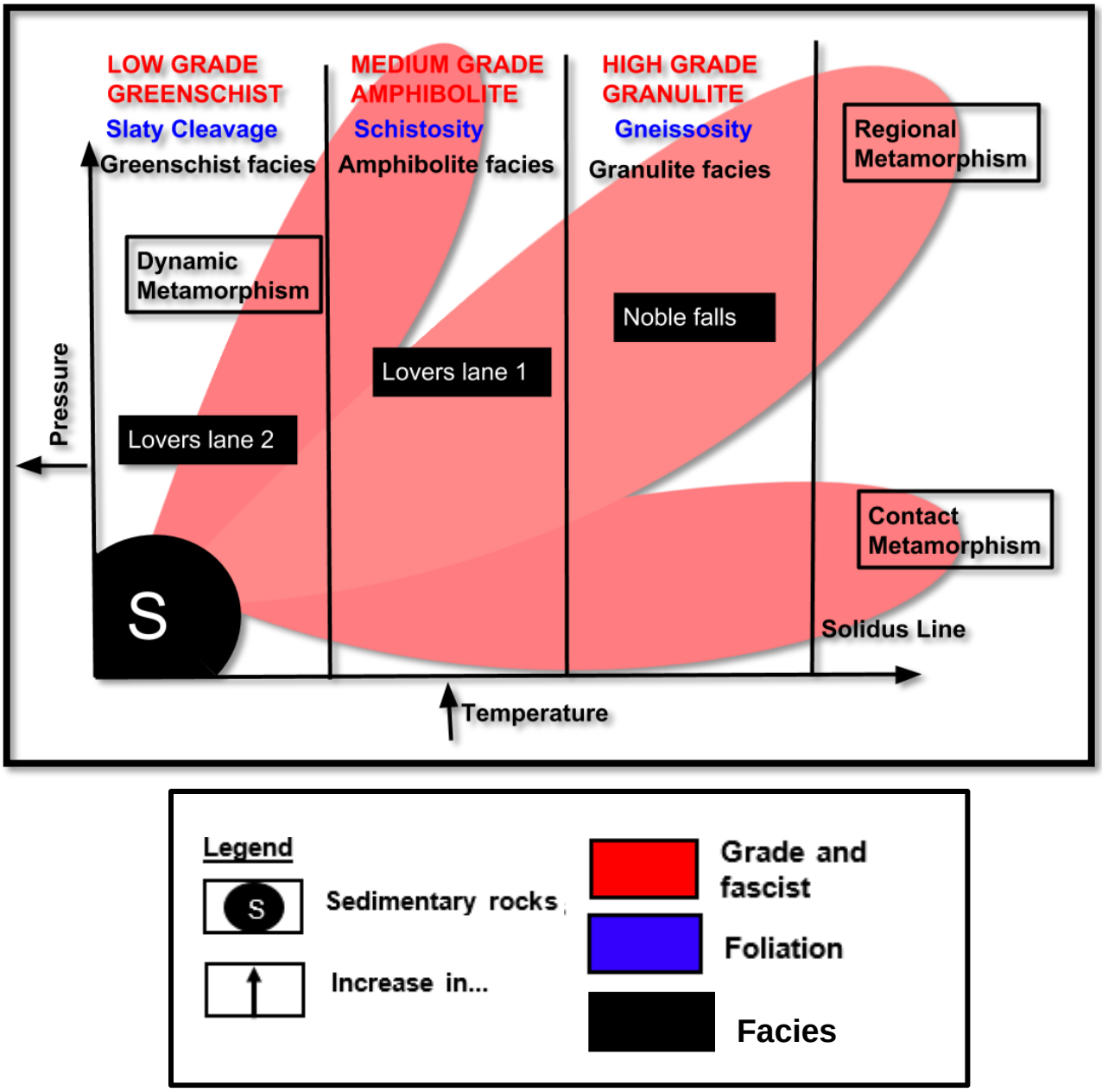


Diagram 1.3.3: The above diagram shows where the rocks in Noble falls, Lovers lane 1 and 2 fit into the ¼ petal flower diagram. The rocks found in Noble falls was a gneiss and it is a high grade metamorphic rock. The rocks in Lovers lane 1 was an andalusite schist and it is a medium grade metamorphic rock. However, the rocks in Lovers lane 2 was a rock with a slaty cleavage and it is a lower grade metamorphic rock. Day 1 was working its way from the gneissosity foliation through the schistosity foliation and to the slaty cleavage.

Stop 3: Poison creek

Photographed by: Vinodaarshini• Location: Poison creek • Date of picture taken: 01/03/18

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs.

7. Select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations such as block diagrams and strategic columns, to communicate conceptual understanding, solve problems and make predictions

1.4.1 Poison creek

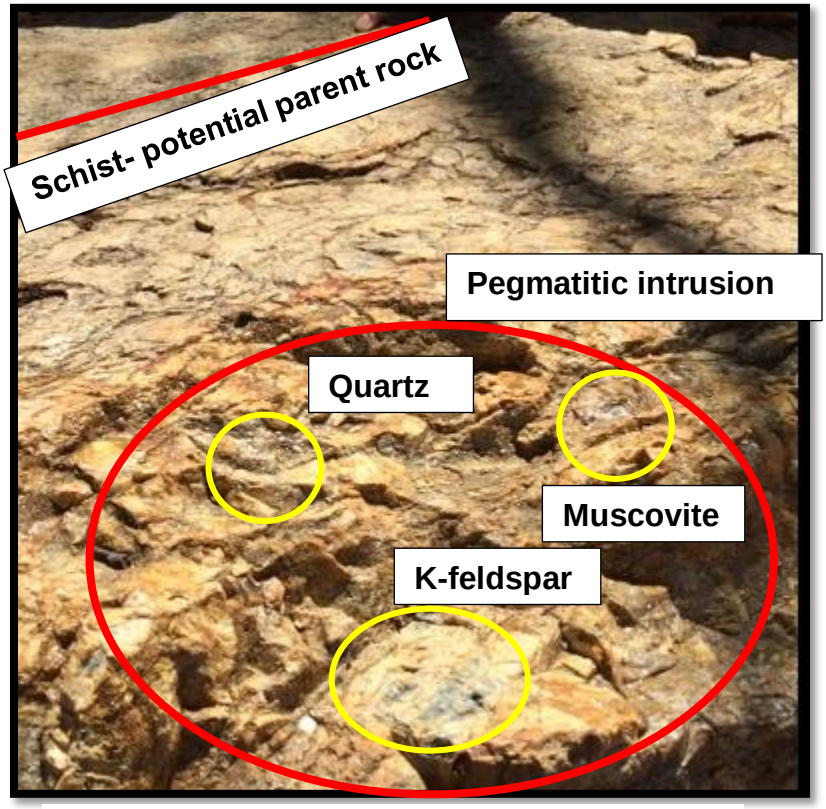


Figure 1.4.1: This picture shows the pegmatitic intrusion into the schist which could be a potential

Figure 1.4.1 shows the pegmatitic intrusion into a potential country rock which is a schist.

The students identified the metamorphic rock by looking at the foliation on the rock bed. The foliation was wavy, therefore a schist. Wherelse, in the other side minerals such as quartz, k-feldspar and muscovite were observed. This was identified as an igneous rock known as the Pegmatite.

The students concluded that the partial melting of the schist has resulted in the pegmatitic intrusion. The pegmatite must be formed when the partial melting of migmatite recrystallized to Pegmatite.

1.4.2 Drawing interpretation of the pegmatitic intrusion

Diagram 1.4.2: Diagram of the drawing interpretation of the pegmatitic intrusion into schist

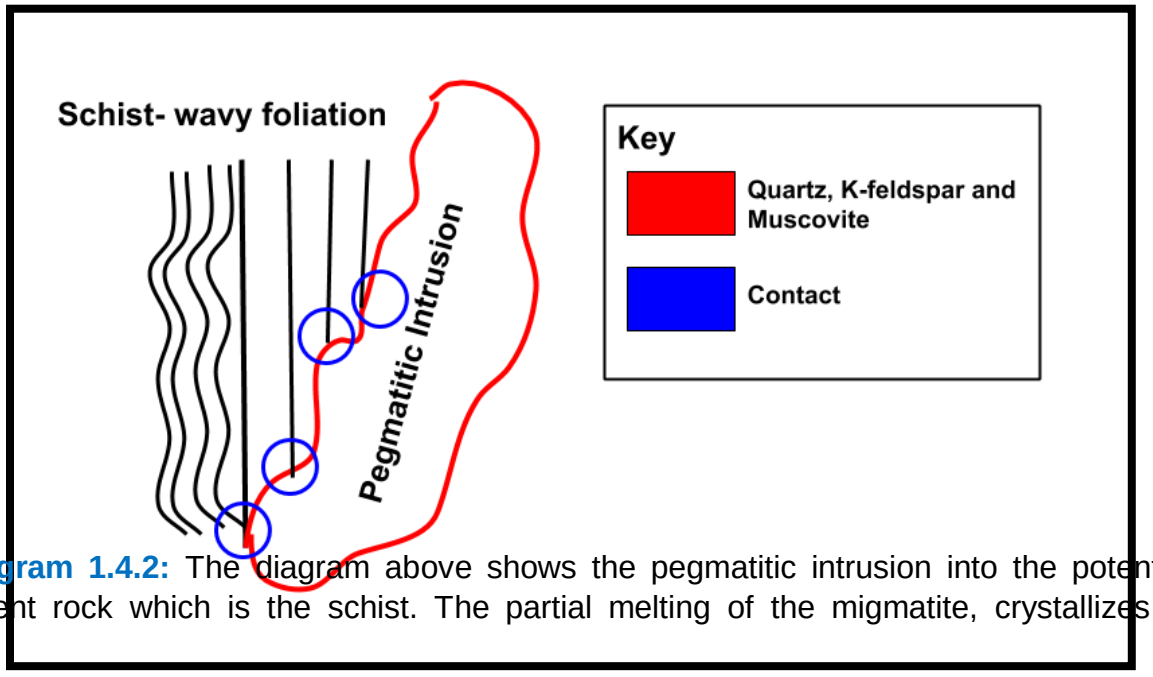


Diagram 1.4.2: The diagram above shows the pegmatitic intrusion into the potential parent rock which is the schist. The partial melting of the migmatite, crystallizes to

pegmatite. The pegmatite consists of quartz, K-feldspar and muscovite minerals. The figure 1.4.3 shows how the Bowen's series applies to this pegmatitic intrusion.

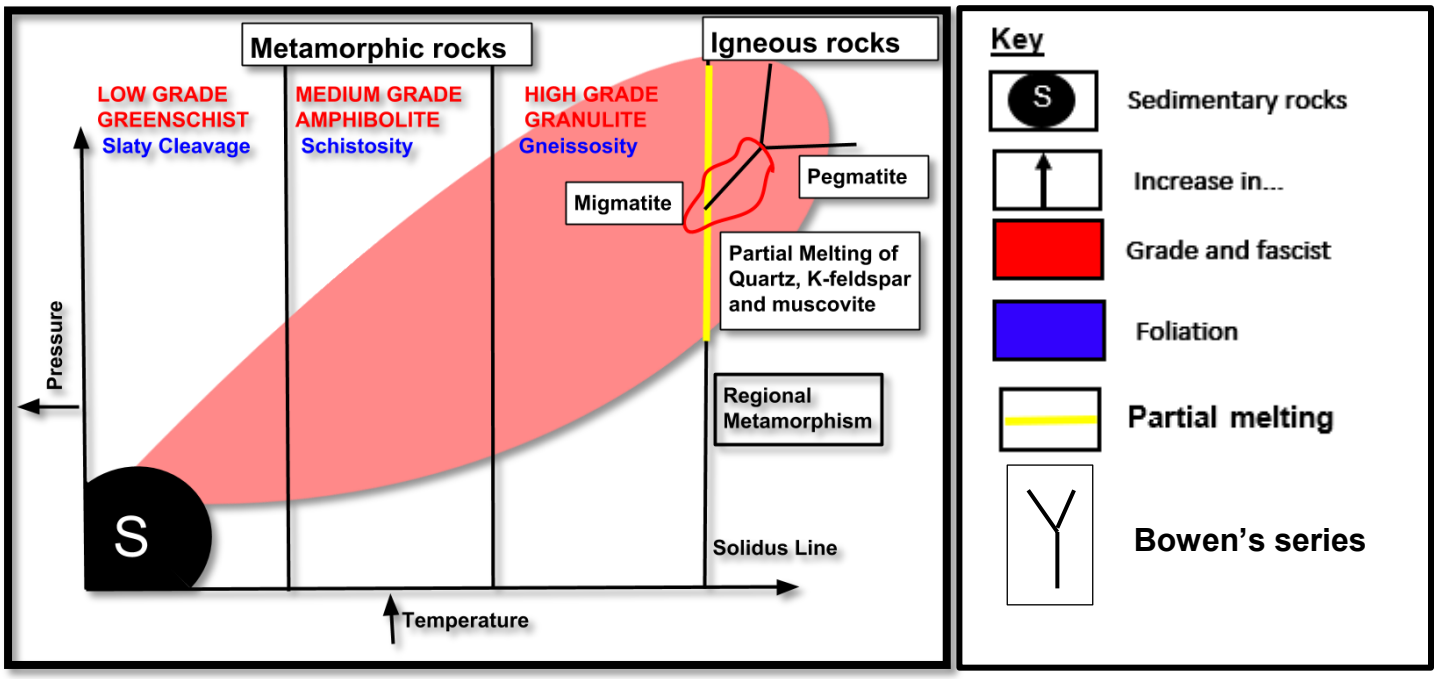
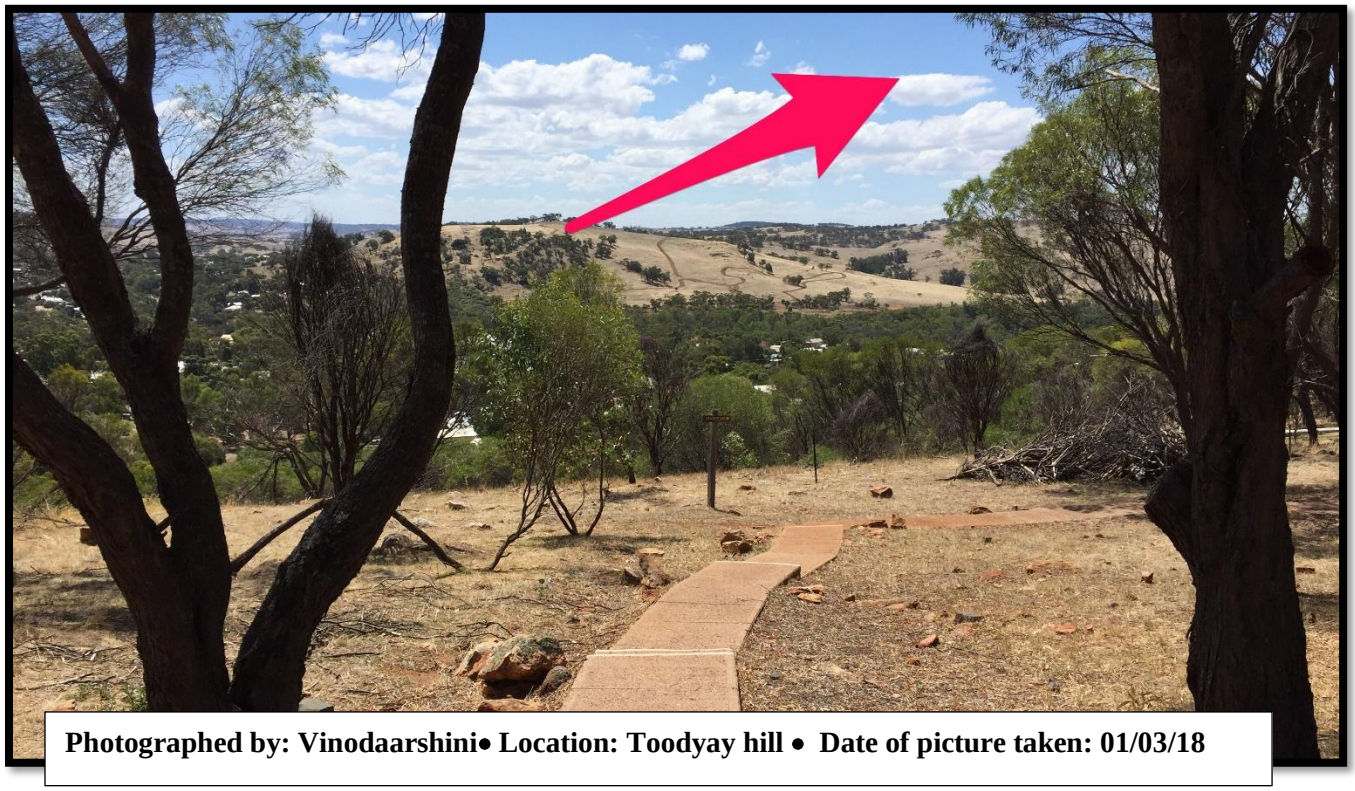


Figure 1.4.3: This picture shows the ¼ petal flower diagram and how the pegmatite is formed.

Stop 4: Toodyay hill



Photographed by: Vinodaarshini• Location: Toodyay hill • Date of picture taken: 01/03/18

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs.

7. Select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations such as block diagrams and strategic columns, to communicate conceptual understanding, solve problems and make predictions

1.5.1 Toodyay hill

In this stop high grade metamorphic rocks, medium grade metamorphic rocks and Banded Iron Formation (BIF) was observed by the students.

Figure 1.5.1: This picture shows the High grade metamorphic rock, Gneiss.

Gneiss- high grade metamorphic rock

Figure 1.5.1 is a foliated metamorphic rock identified by its bands and lenses of varying composition, while other bands contain granular minerals with an interlocking texture. Other bands contain platy or elongate minerals with evidence of preferred orientation. It is this banded appearance and texture - rather than composition - that define a gneiss.

Gneiss usually forms by regional metamorphism at convergent plate boundaries. It is a high-grade metamorphic rock in which mineral grains recrystallized under intense heat and pressure. This alteration increased the size of the mineral grains and segregated them into bands, a transformation which made the rock and its minerals more stable in their metamorphic environment. Gneiss is a granulite facies. There's also a red spot on the rock. This could be due to the rock going through oxidation.

Schist- Medium grade metamorphic rock

Figure 1.5.2 is a foliated metamorphic rock made up of plate-shaped mineral grains that are large enough to see with an unaided eye. It usually forms on a continental side of a convergent plate boundary where sedimentary rocks, such as shales and mudstones, have been subjected to compressive forces, heat, and chemical activity.

This metamorphic environment is intense enough to convert the clay minerals of the sedimentary rocks into platy metamorphic minerals such as muscovite, biotite, and chlorite. To become schist, a shale must be metamorphosed in steps through slate and then through phyllite. If the schist is metamorphosed further, it might become a granular rock known as gneiss. Schist is a rock that has been exposed to a moderate level of heat and a moderate level of pressure.

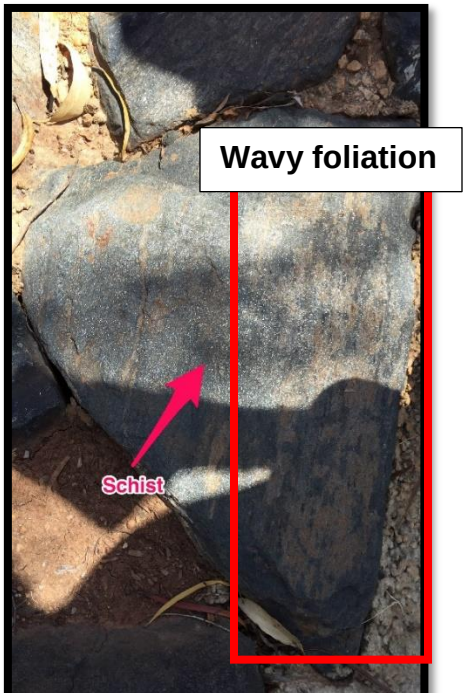


Figure 1.5.2: This picture shows the Medium grade metamorphic rock, Schist.

Stop 5: Fault scarp

Photographed by: Vinodaarshini• Location: Meckering Fault scarp • Date of picture taken: 01/03/18

1.6 Introduction

Meckering is only a tiny wheat farming town, but it is nonetheless famous in Western Australia for being the site of a massive earthquake that rocked Perth and the wheat belt in 1968.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

2. Advances in knowledge and understanding of seismic processes have led to improved design of ground-shake resistant structures and identification of areas likely to be affected by earthquakes

SU (Science understanding)

2. Plate tectonic processes generate earthquakes, volcanic eruptions and tsunamis; the occurrence of these events affects other earth processes and interactions, including the influence of volcanic emissions on climate and weather.

1.6.1 Meckering fault scarp

Figure 1.6.1: These pictures show the Meckering fault scarp in the two years. (2017 & 2018)

Just west of Meckering not long before you reach the town a big brown tourist sign announces that you're crossing the Meckering fault line (figure #). In the aftermath of the Meckering Earthquake the Faultline was clearly visible on the land and judging by the photos in figure 1.6.2, the fault line is visible. But today only 1.5km of the 32km-long fault line remains as it was just after the earthquake. You can view this section at a point about a 12km drive south-west of town where it is close to Quellington Road. The fault is observed to be a reverse fault.

The town of Meckering was devastated by an earthquake with a force of 6.9 on the Richter scale at 10.59am on Monday 14 October 1968. It was the most severe earthquake recorded in Australia to that time. In the space of 40 seconds virtually the whole town was destroyed. More than 40 tremors were felt, some up to 5 on the Richter scale, in the 24 hours that followed the main quake. The quake's epicenter was 9km south west of the town. It left a fault line 32km long. In some areas the ground was pushed up 1.5m. In others deep crack in the Earth opened up- deep enough for a man to stand in.

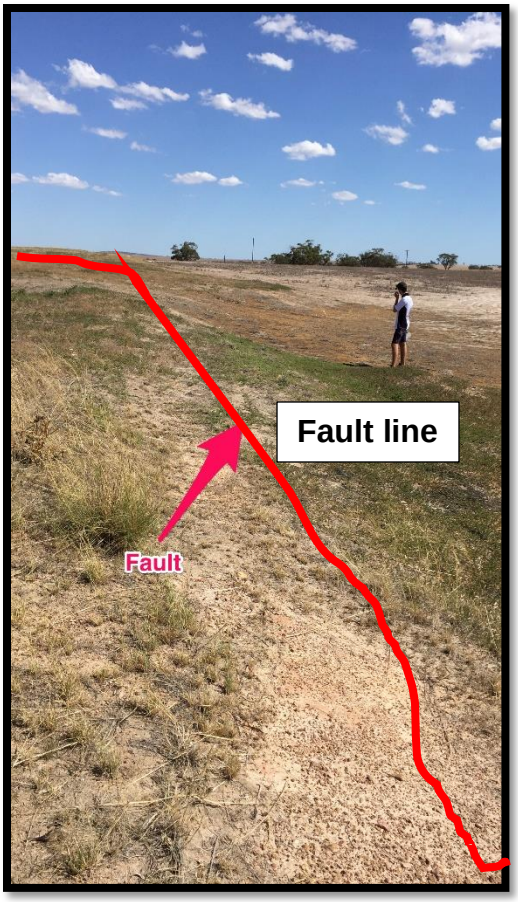


Figure 1.6.2: The picture shows the fault in Meckering.

Sponty 2: Bandee lakes

Photographed by: Vinodaarshini• Location: Bandee lakes• Date of picture taken: 01/03/18

Dot points addressed:

SHE (Science Human Endeavour)

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

1.7.1 Bandee lakes

Figure 1.7.1: The picture shows the Bandee lakes and resulted in the white death.

Geologically the Wheatbelt is an ancient stable area with a very low drainage profile. The rain that falls is slow to get away and is held a large shallow depression. This leads to lots of evaporation and the formation of lakes of salt. Unless the rainfall is very heavy over a number of seasons many of the lakes are dry for most of the year.

Bandee lake shown in figure 1.7.1 is located slightly east of Doodlakine along the Great Eastern Highway. The Bandee lake is an ancient river course. The lake is always dried up due to dryland salinity also known as the white death. Dryland salinity is a natural process for soil, just like other processes such as wind erosion. Salinity degrades land by an increase in soil salt concentration in the environment, watercourse or soil in unirrigated landscapes, being in excess of normal soil salt concentrations in dryland regions. The below figure # shows the precipitation reaction of the salt water in Bandee lakes.

The precipitation reaction of the salt water:

Spectator ion

$$NaCl + H20 \rightarrow HCL + Na + OH$$

Halite

Precipitation reaction

Figure 1.7.2: This diagram shows the precipitation reaction of the salt water.

1.7.2 The water table in Bandee lakes

Diagram 1.7.2: Diagram of the drawing interpretation of the water table rising due to dryland salinity

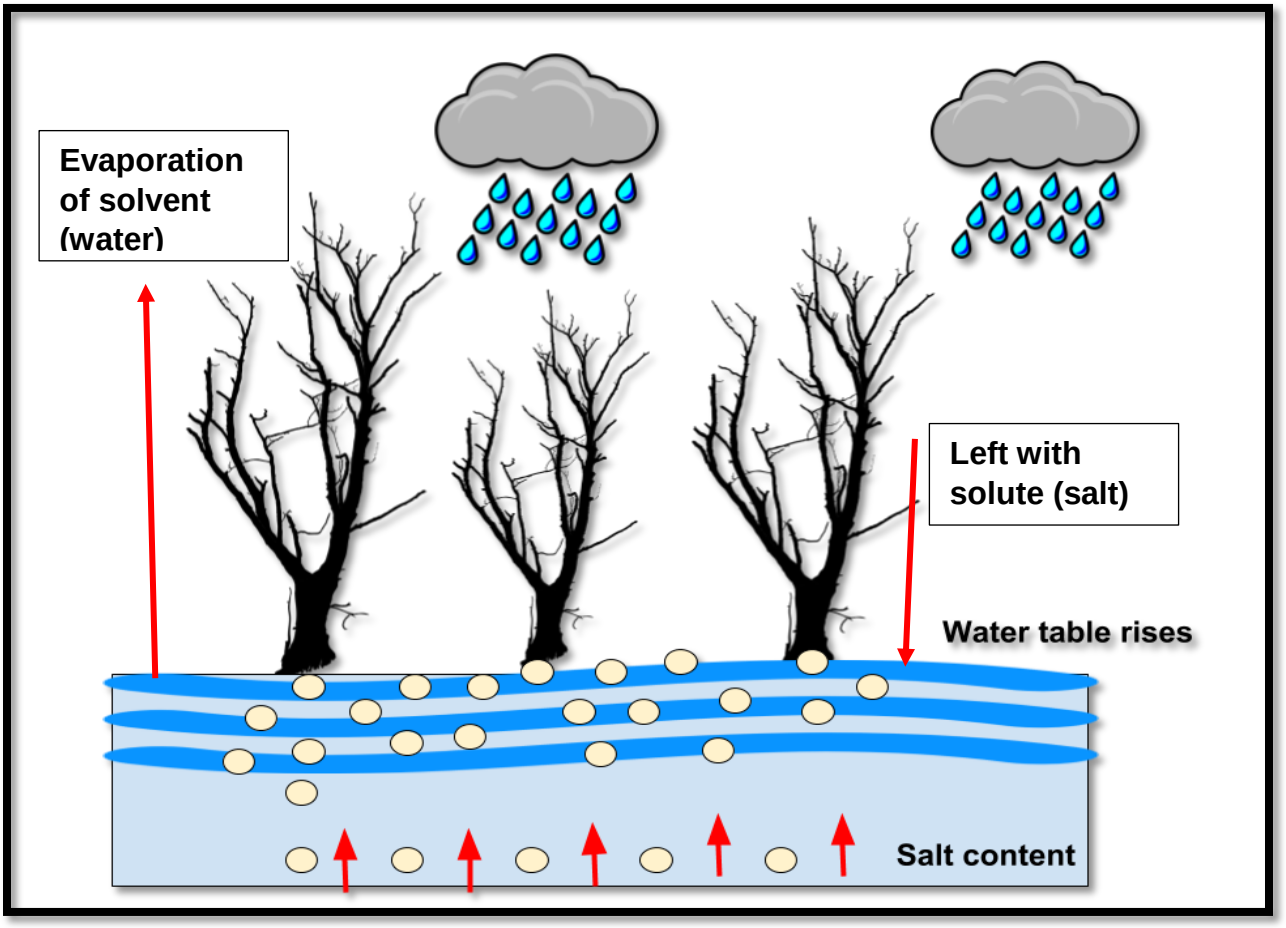
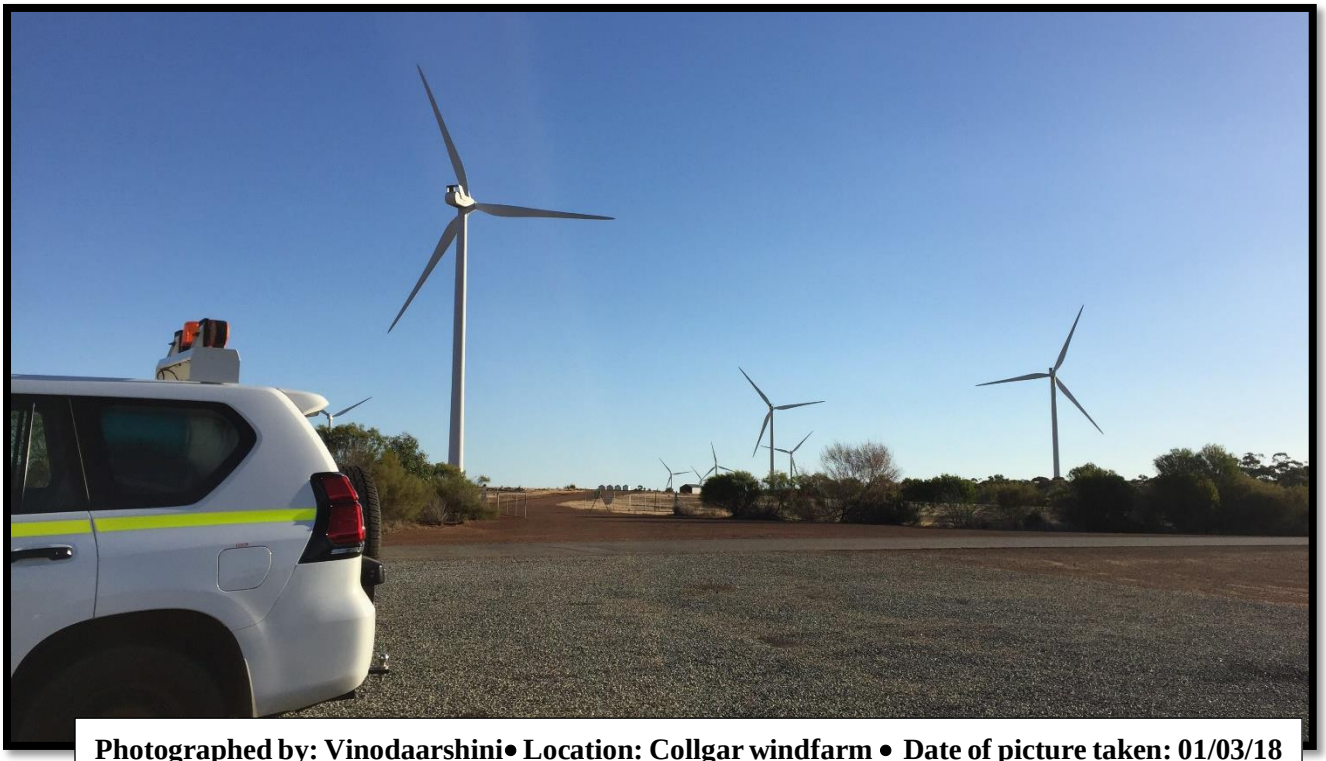


Diagram 1.7.2: As a result of rising water tables (shown in the above diagram) in irrigated and non-irrigated areas or the use of saline water supplies—salinity can have significant impacts on the following aspects. Water moves into plant roots by a process known as osmosis, which is controlled by the level of salts in the soil water and in the water contained in the plant.

If the level of salts in the soil water is too high, water may flow from the plant roots back into the soil. This results in dehydration of the plant, causing yield decline or even death of the plant. Crop yield losses may occur even though the effects of salinity may not be obvious. The salt tolerance of a specific crop depends on its ability to extract water from salinized soils. Salinity affects production in crops, pastures and trees by interfering with nitrogen uptake, reducing growth and stopping plant reproduction. Some ions (particularly chloride) are toxic to plants and as the concentration of these ions increases, the plant is poisoned and dies.

Sponty 3: Collgar Windfarm



Photographed by: Vinodaarshini• Location: Collgar windfarm • Date of picture taken: 01/03/18

1.8 Introduction

Collgar Wind Farm is a $750 million renewable power project at Merredin in Western Australia's central wheatbelt. Merredin farmers have leased portions of their properties to Collgar Wind Farm for the largest single stage wind farm in the southern hemisphere to date.

The Collgar Wind Farm, built over a land envelope of 18,000 Ha, has 111 Vestas V90 turbines with a total power production capacity of 206 MW, generating between 650GWh to 850GWh per year, enough to provide electricity to power a small city of 120,000 and 170,000 homes. This is more than double the size and power generating capacity of the next two biggest wind farms in WA, at Walkaway near Geraldton and Emu Downs near Cervantes. The Collgar Wind Farm has almost doubled the level of renewable energy in the South West Interconnected System (SWIS) from 5 percent to 9 percent. Government policy has established a target 20 percent renewable energy by 2020 across Australia.

Collgar Wind Farm generates and delivers clean, renewable electricity into the SWIS each year, thereby making a major contribution to Western Australia's greenhouse gas reductions. The main concepts learned in Collgar windfarm is renewable and non-renewable energy

Dot points addressed:

SU (Science understanding)

1. Renewable resources are those that are typically replenished at timescales of years to decades and include harvestable resources (including water, biota and some energy resources) and ecosystem services.

4. The cost-effective use of renewable energy resources is constrained by the efficiency of available technologies to collect, store and transfer the energy resource.

1.8.1 High pressure to low pressure in Collgar windfarm

Diagram 1.8.1: Diagram of the how the blade of the wind turbine goes from high pressure to low pressure.

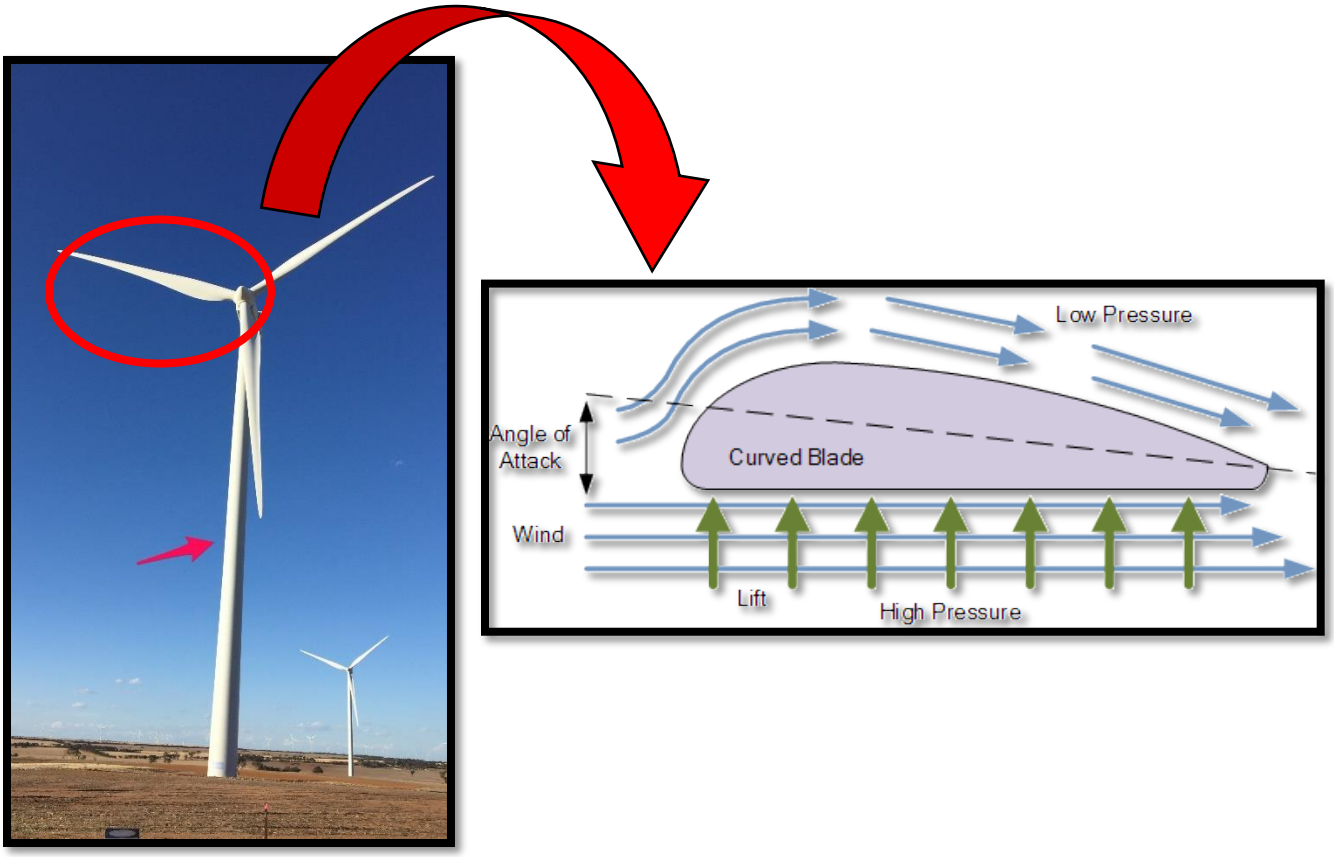


Diagram 1.8.1: The above diagram shows how the curved blade in the wind turbine helps the turbine to go from high pressure to low pressure. The shape of the blade forces wind up and over it, speeding it up on one side. This causes a difference in air pressure: lower on top and higher on bottom, forcing the blade to lift towards the low-pressure air. The blades are designed so that when wind passes, a low-pressure pocket of air is created by faster moving wind on the curved side of the blade. This sucks the blade in the downwind direction, creating lift. The blades are then connected to a series of shafts that spin an electromagnetic induction generator, and this creates electricity. The blade height to tip of the Colgar windfarm is 125m, the blade diameter is 45m, the blade weight is 6.3 tonne and the Nacelle weight is 93 tonne. The more higher the wind turbine, the more pressure is applied in its atmospheric condition.

Stop 6: Meckering Memorial site

Photographed by: Ms. Urbaniak • Location: Meckering Memorial site• Date of picture taken: 01/03/18

1.9 Introduction

The town of Meckering was devastated by an earthquake with a force of 6.9 on the Richter scale at 10.59am on Monday 14 October 1968. The quake's epicenter was 9km south west of the town. It left a fault line 32km long. In some areas the ground was pushed up 1.5m. In others deep crack in the Earth opened up- deep enough for a man to stand in.

Many of the town services were cut including road and rail connections and power. The students and teachers pulled over into the Memorial Park near the start of town. The park has a detailed display featuring signs that explain the history of the town and the 1968 earthquake, and some memorabilia from the earthquake's aftermath including pieces of bent and buckled railway tracks and pipeline that were damaged in the quake.

The main concepts observed is Geohazard and the supporting concept is plate tectonics caused an earthquake.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

2. Advances in knowledge and understanding of seismic processes have led to improved design of ground-shake resistant structures and identification of areas likely to be affected by earthquakes

SU (Science understanding)

2. Plate tectonic processes generate earthquakes, volcanic eruptions and tsunamis; the occurrence of these events affects other earth processes and interactions, including the influence of volcanic emissions on climate and weather.

1.9.1 Meckering Memorial site

Figure 1.9.1: The above picture shows the cut off of the railway track when the earthquake occurred.

Many of the town services were cut including road and rail connections and power. The students and teachers pulled over into the Memorial Park near the start of town. As shown in figure 1.9.1, railway lines, power lines, communication line and the water supply pipeline pass through Meckering. On the Queen's birthday holiday, October 1968, tectonic plates clashed, pushing a fault line longer than 30km to a maximum height of about 2 meters, west of the town. The force of the earthquake twisted and buckled both the standard gauge railway lie connecting Perth to Kalgoorlie and the eastern States, and the narrow-gauge railway line going Western Australia's South west.

As shown in figure 1.9.2, the water supply pipeline pass through Meckering. On October 14th, 1968, tectonic plates clashed, pushing a fault line longer than 30km to a maximum height of about 2 meters, west of the town. The force of the earthquake severed the pipeline and the railway tracks. Two duplicate pipes on the Goldfield Water Supply Scheme burst about 6km west of the town. The road and rail reopened within 24hours. Electricity and telephones were restored within days.

Figure 1.9.2: The above picture shows the severed water pipeline.

Day 2- 02/03/18

Sponty 1: Weathered granite and Magnesite dam

Photographed by: Vinodaarshini• Location: Magnesite dam • Date of picture taken: 02/03/18

2.0 Introduction

This magnesite dam is located in Frog rock Rd. Weathered granite are found around this area. Along Frog Rock Rd, white rocks are observed at the side of the road. This indicates that there's wheatbelts ahead. The main concepts learned in this location are the igneous rocks and Bowen's reaction series.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

2.1 Weathered Granite and magnesite dam

Diagram 2.1: Diagram of the weathered granite and the magnesite dam

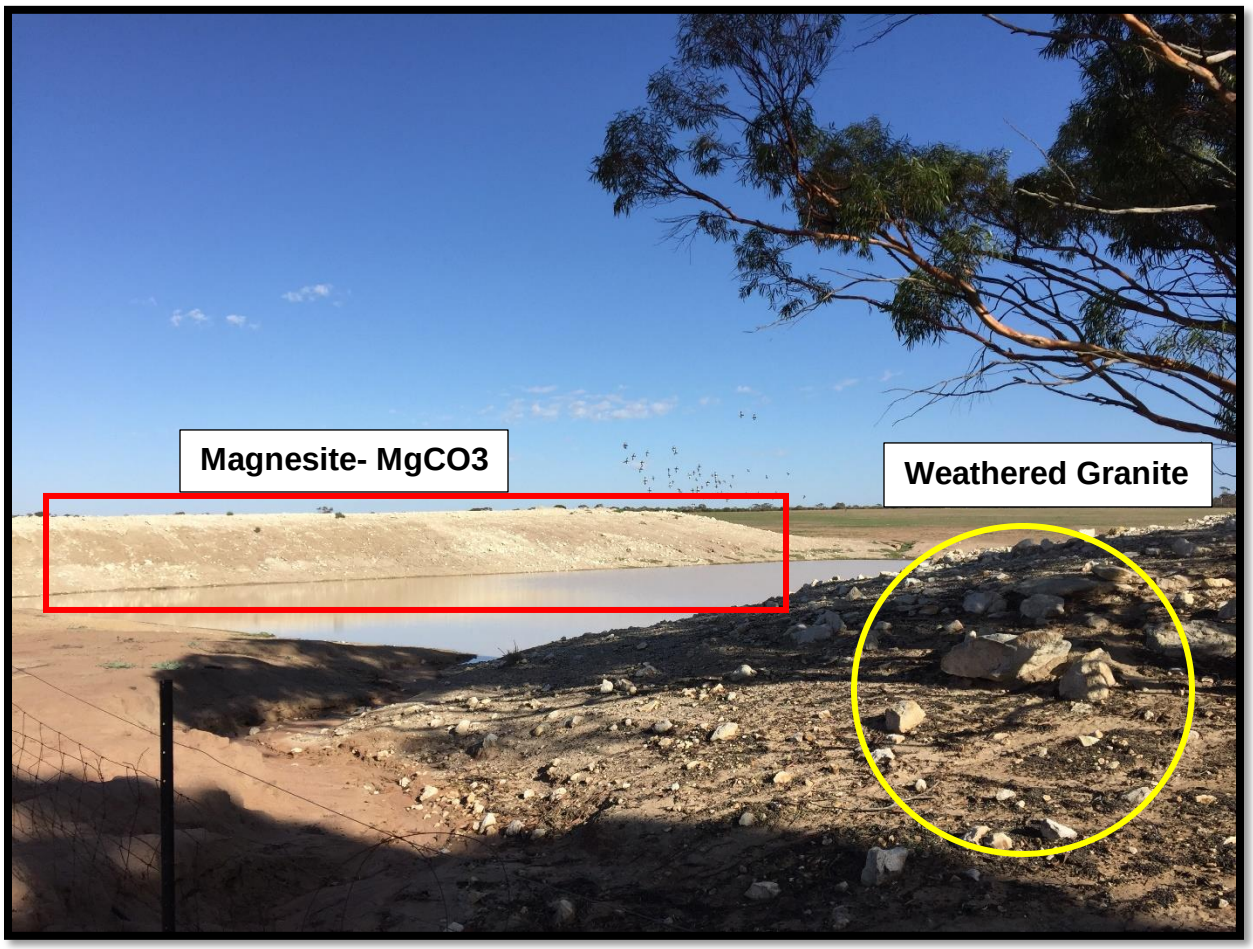


Diagram 2.1: The diagram above shows the weathered granite along the magnesite dam. Magnesite is an important industrial mineral composed of magnesium carbonate (MgCO3). Magnesite is a product weathered magnesium. Magnesite is formed according to figure 2.1. Magnesium is derived from an ultramafic igneous rock and carbonate is derived from the air.

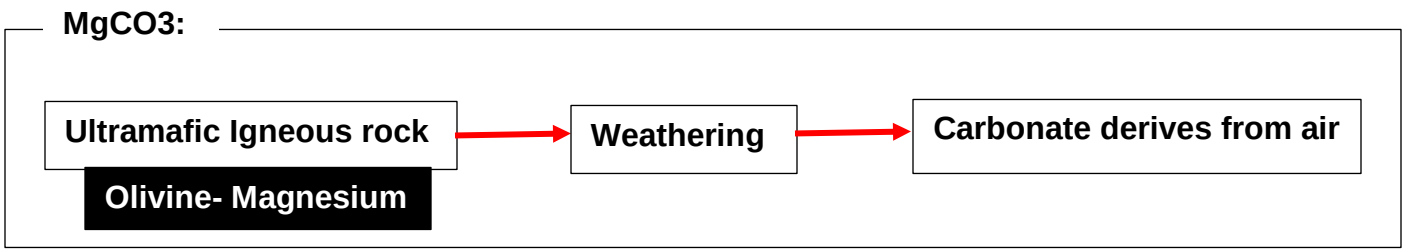


Figure 2.1: The above diagram shows the formation of magnesite (MgCO3)

2.1.1 Weathered Granite- Extreme weathering of Komatiites and Komatiitic basalt

In figure 2.11, the minerals observed in the rock were K-feldspar, quartz, hematite and Limonite. K-feldspar is observed to weathered to clay. However, there are two iron oxides found in the rock, these two iron oxides are Hematite (red) and Limonite (yellow). Quartz is observed to not be affected due to Moh's hardness scale.

This rock is also observed to be physically and chemically resistant. Due to the stable condition in Earth, quartz is more resistant. This is the reason why beaches are made of quartz.

During the process of weathering, the higher temperature minerals are to weathered first such as the olivine and basalt. They also weather to iron oxides. Weathering is a process opposite to crystallization.

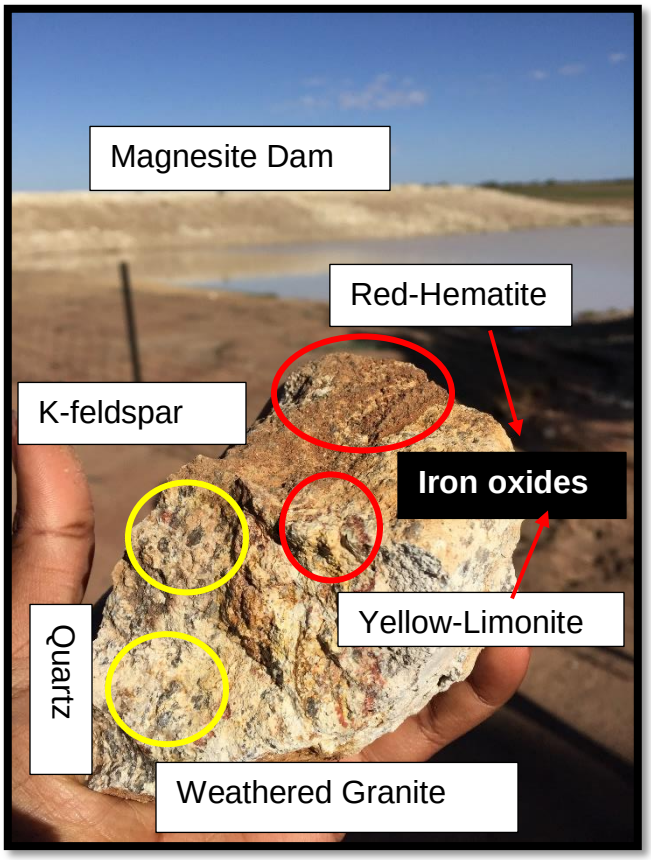


Figure 2.1.1: The above picture shows the weathered granite and the minerals observed.

Sponty 2: Strawberry rock

Photographed by: Vinodaarshini• Location: Strawberry Rock• Date of picture taken: 02/03/18

2.2 Introduction

Strawberry rock is a sponty done by the students and teachers. This particular location has an ecosystem which is observed by the students. Strawberry rock also consists of granets alongside the lake. However, mudcracks are observed through the water on this location.

The main concepts observed here are ecosystem, igneous rocks and sedimentary structures (learned from Year 11.)

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SU (Science understanding)

7. Ecosystems provide a range of renewable resources, including provisioning services (including food, water, timber), regulating services (including carbon sequestration, climate control), and supporting services (including nutrient, air and water cycling.

2.2.1 Strawberry Rock – Ecosystem

Diagram 2.2.1: Diagram of the ecosystem in strawberry rock.

Diagram 2.2.1: The above diagram shows the ecosystem in strawberry rock. As shown in the diagram there are green grasses and dragonflies flying around this area. However, this also means that animals will be attracted to this area due to the ecosystem with hydrosphere. Fishes can also be a part of this ecosystem as it's eggs goes into the clay and rebirth occurs. This is a typical piece of land left in Yilgarn Craton. The ecosystem is unique and it is a perennial ecosystem because it is intermittent.

2.2.2 The mudcracks and the granite rock

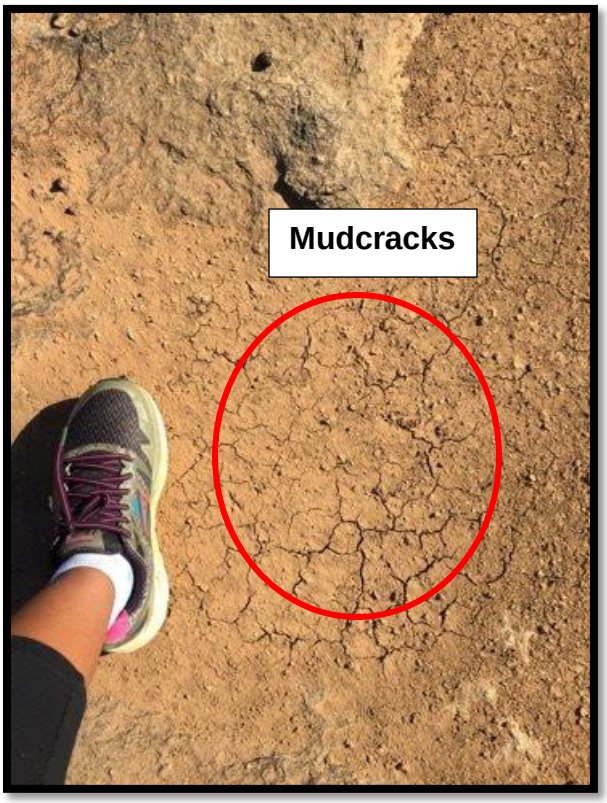


Figure 2.2.2: The above picture shows the mudcrack on the surface of strawberry rock, a sedimentary structure.

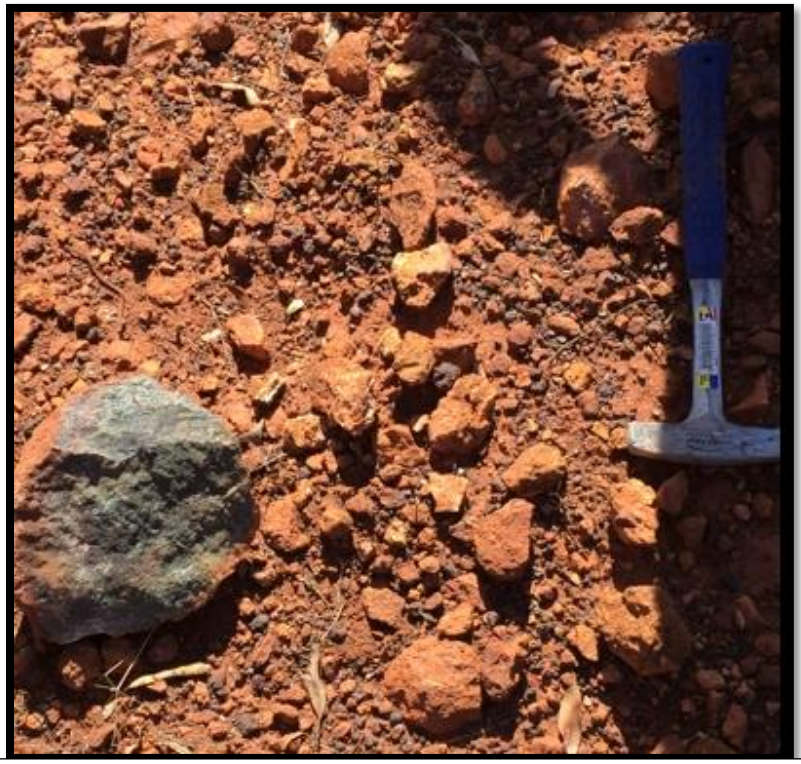
Figure 2.2.2 is showing us mud cracks. It is not a sedimentary structure which is telling us that the clay is drying out. The sand came out but the mud as in still water. Muscovite structure is in a mud structure and it also preserves ripple underneath. Raindrops are preserved in the mud as well. It is also observed to break easily. These are sedimentary structures. Wind ripples has a bigger force. Climate of flash flooding, water flowing and has dried out. They are ephemeral which indicates semi-errored climate

As shown in figure 2.2.3, the granite found in strawberry rock is consisting of quartz, k-feldspar and biotite. Each of this mineral are determined by their color and texture. Quartz is identified by the glassy texture, wherelse the k-feldspar and biotite are identified their color; white and black.

Granite if found in this area due to the huge partial melting of lower crust. Mantle plume might have melted and glued all the continents together. The crystal size in this granite is observed to be finer than the granite observed in the magnesite dam, Frog Rd.

Figure 2.2.3: The above picture shows the granite which consists of quartz, K-feldspar and biotite.

Sponty 3: Greenstone belt 1



Photographed by: Vinodaarshini• Location: Greenstone belt 1• Date of picture taken: 02/03/18

2.3 Introduction

Green stone belts are zones of variably metamorphosed mafic to ultramafic volcanic sequences with associated sedimentary rocks that occur within Archean and Proterozoic cratons between granite and gneiss bodies. Typically, a greenstone belt within the greater volume of otherwise homogeneous granite-gneiss within a craton contains a significantly larger degree of heterogeneity and complications and forms a tectonic marker far more distinct than the much more voluminous and homogeneous granites.

Additionally, a greenstone belt contains far more information on tectonic and metamorphic events, deformations and palaeogeologic conditions than the granite and gneiss events, because the vast majority of greenstones are interpreted as altered basalts and other volcanic or sedimentary rocks. The main concepts learned in this location is greenstone belt and Bowen's reaction series.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

2. Advances in knowledge and understanding of seismic processes have led to improved design of ground-shake resistant structures and identification of areas likely to be affected by earthquakes

SU (Science understanding)

2. Plate tectonic processes generate earthquakes, volcanic eruptions and tsunamis; the occurrence of these events affects other earth processes and interactions, including the influence of volcanic emissions on climate and weather.

2.3.1 Greenstone belt 1

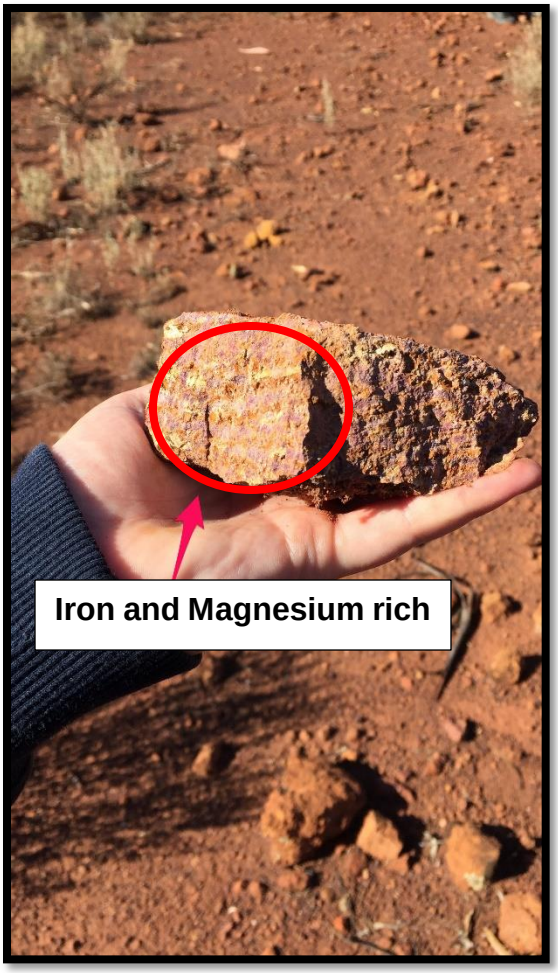


Figure 2.3.1: The above picture shows the iron and magnesium rich homogenous granite-Gneiss.

Figure 2.3.1 shows the iron and magnesium rich rock. This rock is observed to be very dense and it could be straight out of the asthenosphere. The mineralization of the greenstone belt might have Komatiite as a parent rock.

The below figure 2.3.2 shows an iron rich olivine as it is brown in color. It has a really glassy texture and it also looks like a pillow. It is a pyroxene.

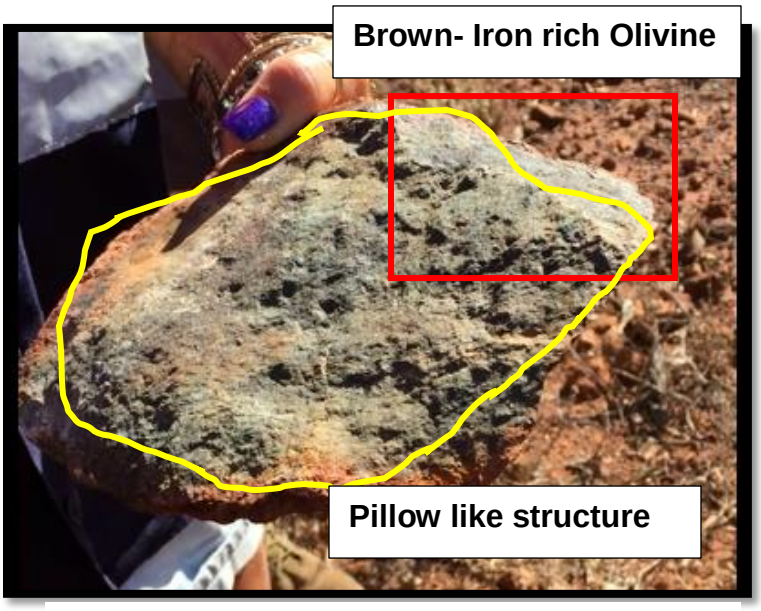
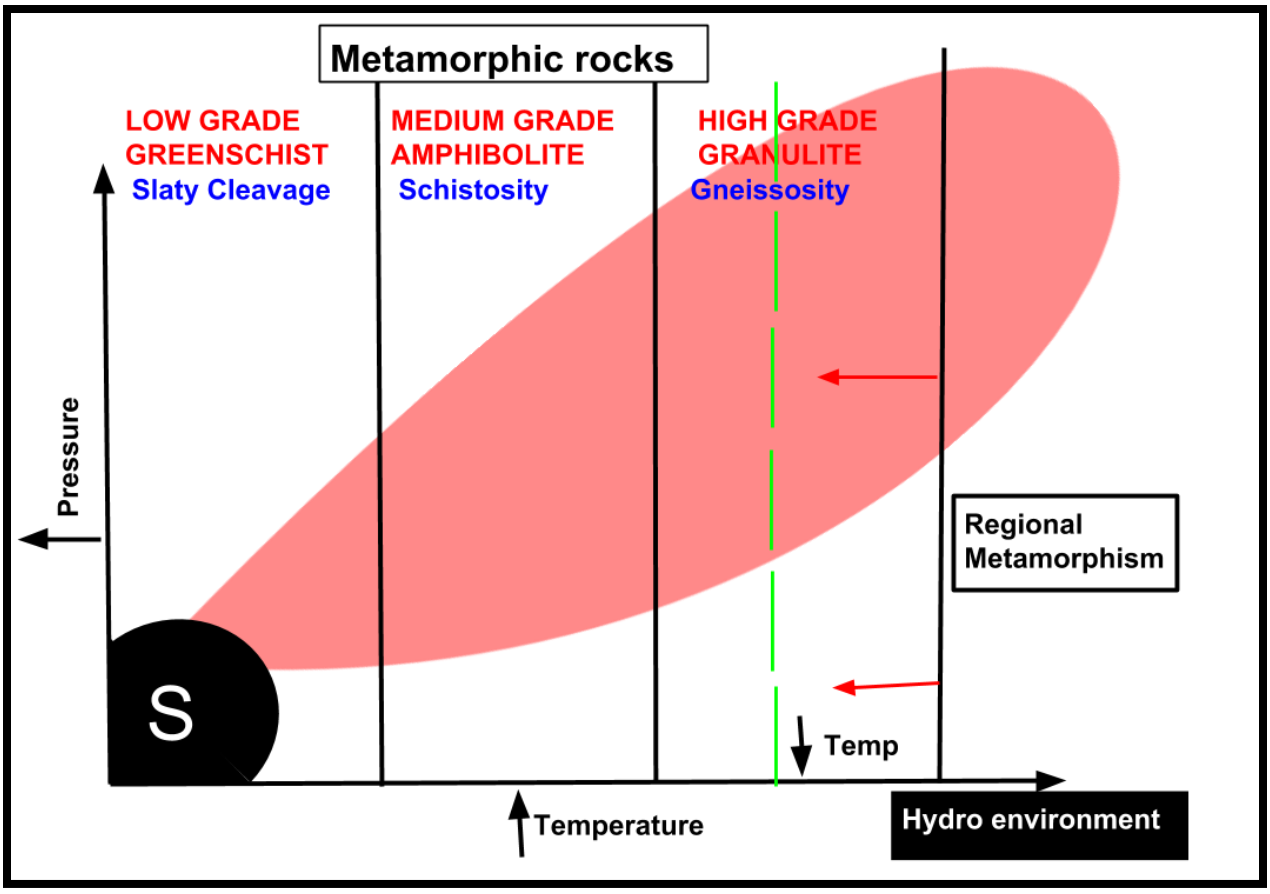
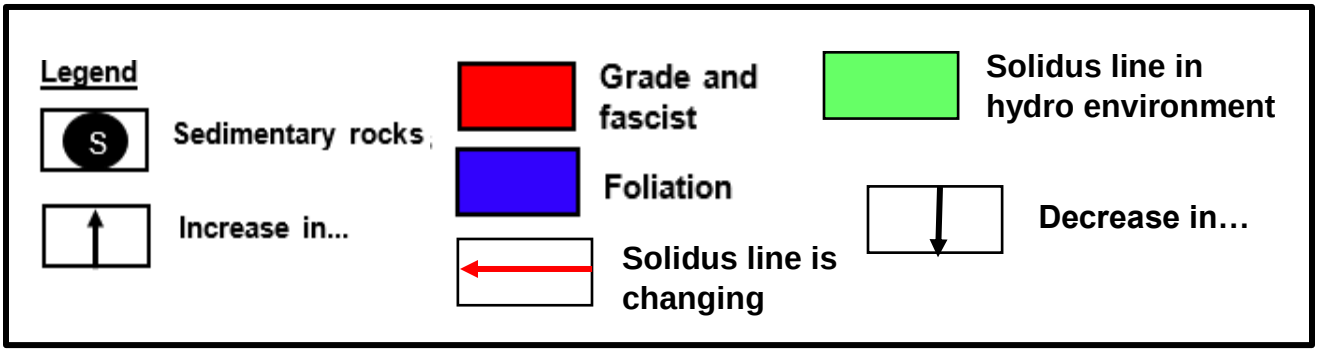


Figure 2.3.2: The above picture shows the iron rich olivine.

2.3.2 Diagram of the ¼ petal flower diagram when it is in the igneous rock sequence

Diagram 2.3.2: Diagram of the ¼ petal flower diagram when it is in a hydro environment





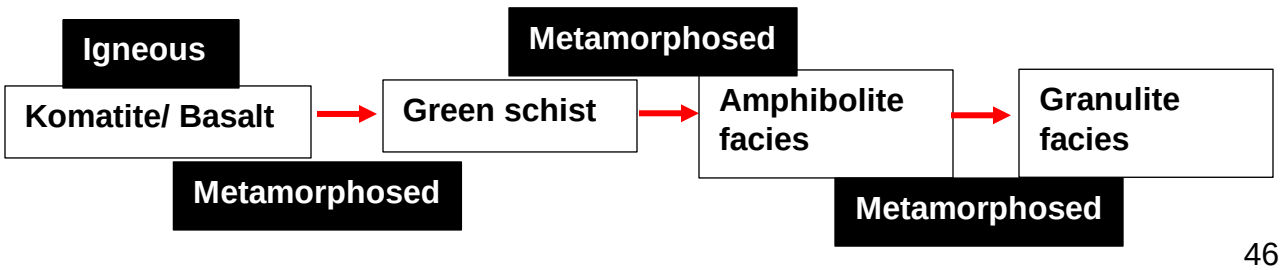


Diagram 2.3.2: The above diagram shows how the ¼ petal flower diagram looks when igneous rock is the parent rock and under a hydro environment. When Komatiite/Basalt is metamorphosed, it tuns into green schist. When green schist is metamorphosed, it turns into amphibolite facies and when it is metamorphosed, it turns into granulite facies, also known as the pyroxenite.

Sponty 4: Transvaal Mining Rehabilitation

Photographed by: Vinodaarshini• Location: Transvaal Mine Rehabilitation• Date of picture taken: 02/03/18

2.4 Introduction

The mine is 5 kilometers south of Southern Cross. The last mining took place in the 1990's by St Barbara Ltd for gold. The Transvaal Mine is located in the Southern Cross Greenstone belt. The main concept learned in this location was the environment and the value train.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

SU (Science understanding)

4. Environmental considerations are important in the exploration, extraction and processing of non-renewable resources, and the decommissioning of resource sites

2.4.1 Transvaal Mining rehabilitation

Figure 2.4.1: The above picture shows the Transvaal Gold mine rehabilitation

Rehabilitation refers to the process of returning mined land its preexisting condition or to a predetermined post-mining use. Rehabilitation is a process that is required by governments and mine is contingent on the miner proposing a feasible rehabilitation program prior mining activity.

As shown in figure 2.4.1, it is observed to be a man-made hill by the amount of vegetation on the contour (very less). That shows that this mine is at least 15 years old. It has a plateau top which keeps the soil on place.

Sponty 4: Southern cross mine

Photographed by: Vinodaarshini• Location: Southern Cross mine• Date of picture taken: 02/03/18

2.5 Introduction

Water table is observed to be rising due to the dryland salinity. The southern cross mine is used to mine gold. There are a lot of low grade metamorphic rock observed in this area. Three grades (Low grade, medium grade and high grade) are observed around this area. Metamorphosed BIF's are also observed in this Southern cross mine. BIF is observed because it might have been in a deep ocean, black smoker and mid oceanic setting. Granites are also observed because of the partial melting of basalt.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

2.5.1 Southern cross mine

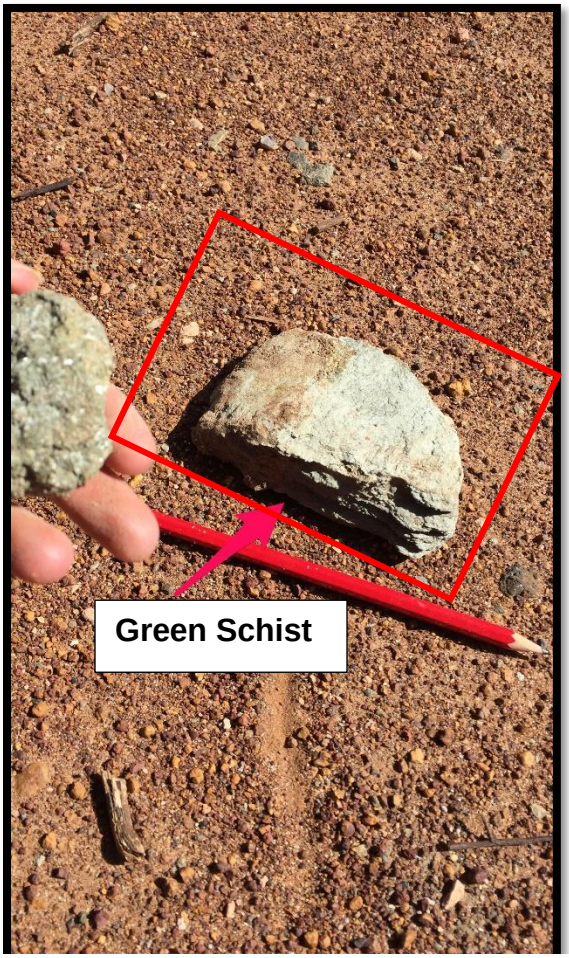


Figure 2.5.1: The above picture shows the medium grade metamorphic rock found in Southern cross gold mine

Medium grade metamorphic rock

The rock in figure 2.5.1 is observed to be a green schist because it has a bended foliation. It has a green color on this rock. This might show that Komatiite could be the parent rock of this schist. So, this could infer that this must have been in a deep ocean, black smoker or a mid-oceanic ridge situation. Greenstone is metamorphosed equivalent to the Komatiitic

Lower grade metamorphic rock

Slate is a product of low grade metamorphism. Low-grade metamorphism takes place at temperatures between about 200 to 320oC, and relatively low pressure. Low grade metamorphic rocks are generally characterized by an abundance of hydrous minerals. With increasing grade of metamorphism, the hydrous minerals begin to react with other minerals and/or break down to less hydrous minerals. In figure 2.5.2, slaty cleavage shows that this rock is a low grade metamorphic rock.

Figure 2.5.2: The above picture shows the low grade metamorphic rock found in Southern cross gold mine

Figure 2.5.3: The above picture shows the BIF in the Southern cross gold mine.

Banded Iron Formation

As shown in figure 2.5.3, the mixture of pink rocks, red and brown color identifies the rock as a BIF. The colors act as an iron oxide as well. It is also inferred that BIF is found in that area because this area must have been in an Oceanic crust and in a mid-oceanic ridge setting.

Stop 1: Yilgarn Star Gold mine

Photographed by: Vinodaarshini• Location: -31.53275,119.61457 • Date of picture taken: 02/03/18

2.6 Introduction

The Yilgarn Star gold mine also has the whole spectrum of the lower grade to higher grade metamorphic rocks. Pegmatite is also observed in the Yilgarn star gold mine.

This mine site is used to mine gold. There was a secondary quartz found in this mine site, it could potentially carry gold in it. The main concept learned in this area is the hydrothermal mineralization in green schist. Green schist facies and rocks going into Amphibolite facies. There was also Bornite (primary sulfite) oxidized to copper carbonate (Azurite and malachite green).

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

2.6.1 Yilgarn Star Gold Mine

Figure 2.6.1: The above pictures shows the change in facies within the same area in Yilgarn Star Gold mine.

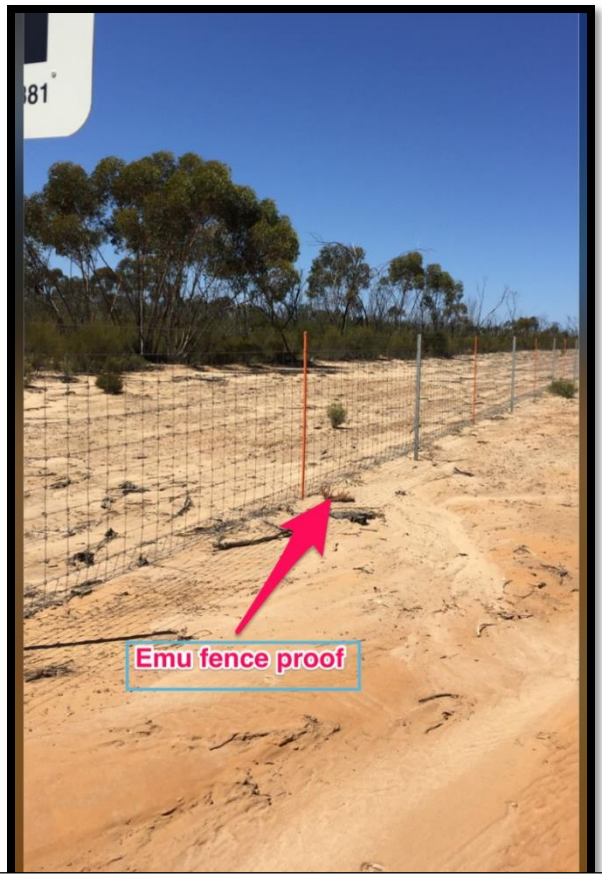
The above figure 2.6.1 shows the change in facies within the same area in Yilgarn Star Gold mine. All these rocks have the same parent rock; Komatite. They are observe to change in colour as they metamorphosed from lower grade to higher grade. The hydrothermal mineralization in the green schist is observed as the time progressed.

Figure 2.6.2: The above pictures shows the oxidized Bornite which contains calcium carbonate.

The picture shown in figure 2.6.2 shows oxidized Bornite when the calcium carbonate was observed on the rock. The copper carbonate is attached with hydroxide. The blue color on the rock could contain the mineral azurite.

The blue color shows the calcium carbonate and this could be due to the oxidized reaction.

Stop 2: Emu proof fence



Photographed by: Vinodaarshini• Location: Emu proof fence • Date of picture taken: 02/03/18

2.7 Introduction

The emu proof fence is used for the environmental control. The increase in introduced species had took a toll on Australia for a very long time. The emu proof fence was also observed in last year's Shark Bay field trip. It is known as Project Eden. The emu proof fence is the environmental aspect of the geological study. The fence consists of 200million hectares along coastline and half a million hectares is protected by containing the problem. The main concept learned here was the environment and the introduced species.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SU (Science understanding)

1. Earth hazards result from the interactions of Earth systems and can threaten life, health, property, or the environment; their occurrence may not be prevented, but their effects can be mitigated

2. Plate tectonic processes generate earthquakes, volcanic eruptions and tsunamis; the occurrence of these events affects other earth processes and interactions, including the influence of volcanic emissions on climate and weather.

2.7.1 Emu Proof Fence

Figure 2.7.1: The above pictures shows the Emu proof fence.

According to Ranger Chris from last year's Shark Bay Field trip, Project Eden is a feral prove fence which is too kill hooved animals. The reason for this is due to the hooved animals destroying the vegetation. Feral rabbit burrowed underground, foxes, cats and dogs killed native wild lives (birds) and during the 1970's and 1980's, nothing was left. So, Western Shield took the initiative in preserving what's left and trying to restore whatever that has damaged. The fence is right across the peninsula. The Poison 1080 is used to kill the feral animals.

As shown in figure 2.7.1, the fence was built for the emu's as a barrier in the 1980's. Before the army took things into matter, the emu proof fence was up. Dogs went for native animals to kill them. The fence is also observed to be bended so that the introduced species can't dip under and have access to the other side.

Stop 3: Emu proof fence mapping

Photographed by: Lucy Howe• Location: Emu proof fence • Date of picture taken: 02/03/18

2.8 Introduction

This mapping exercise was to gain our knowledge about andalusite schist and how dip and strike works. Dip and strike refers to the angle and trend direction of the bedding plane of a rock, respectively. The dip and strike direction of the rocks at the outcrop could be measured using the Fieldmove Clino application on our phones.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4. Identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs

7. Select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations such as block diagrams and strategic columns, to communicate conceptual understanding, solve problems and make predictions

SU (Science understanding)

2. Plate tectonic processes generate earthquakes, volcanic eruptions and tsunamis; the occurrence of these events affects other earth processes and interactions, including the influence of volcanic emissions on climate and weather.

2.8.1 Mapping activity in the Emu Proof fence outcrop

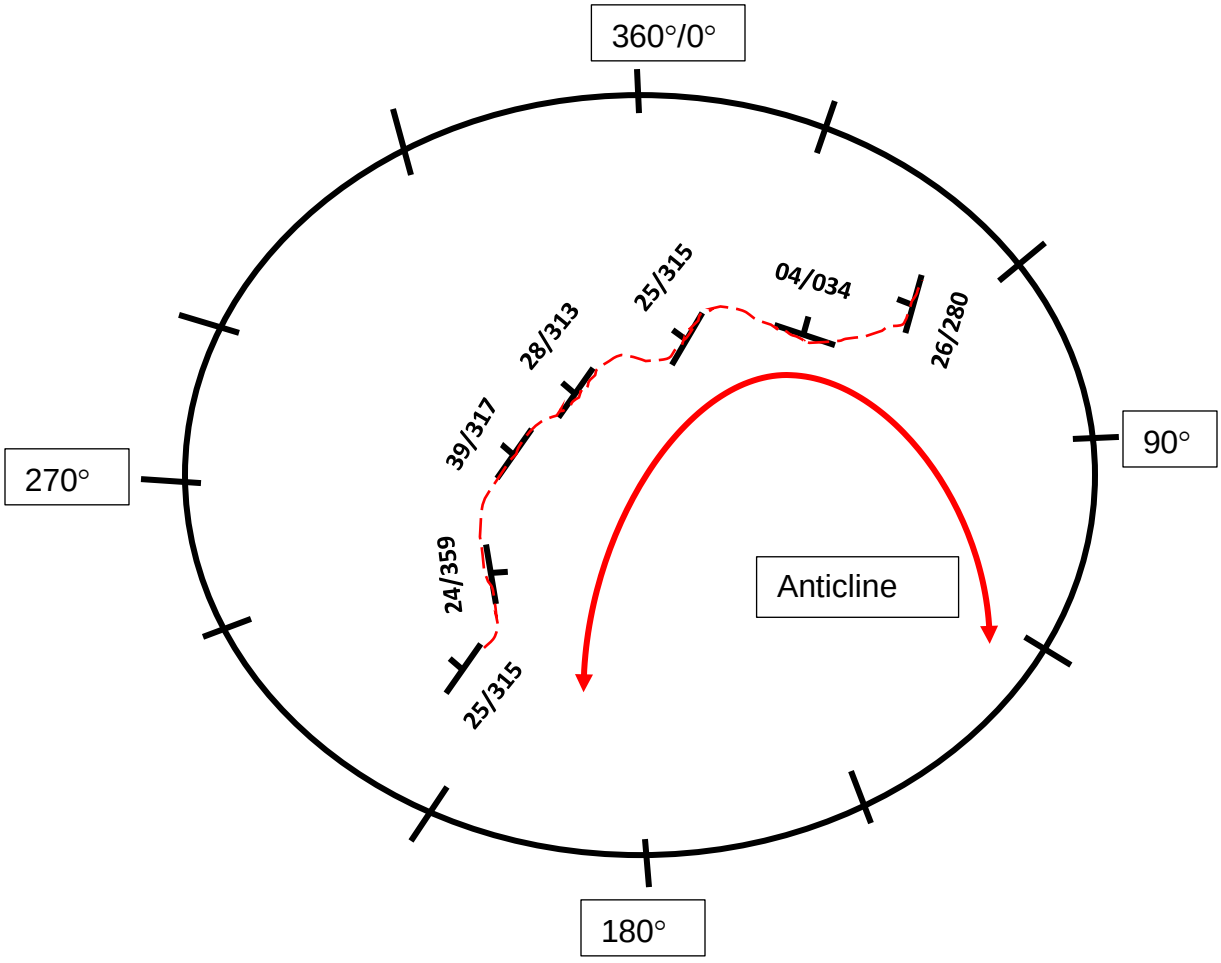


Figure 2.8.1: A map of the strike and dip direction at the Emu proof fence outcrop.

The above figure shows the strike and dip direction at the Emu proof fence outcrop we did the mapping exercise in. The results from Clino was transcribed into a circular diagram with the angles 0°, 90°, 180°,270° and 360° labelled on the circumference of the circle. The 7 localities measured were a meter area around the location. The main purpose of this mapping activity was to understand how to take measurements of the strike and dip direction and how it correlates together. The longer line represents the strike and the shorter line perpendicular to the strike is the dip. A line is drawn to connect the strikes together and it is observed that the outcrop is in an anticline position.

Stop 4: Mulka's cave

Photographed by: Vinodaarshini● Location: Mulka's cave ● Date of picture taken: 02/03/18

2.9 Introduction

Mulka's Cave is located within the vicinity of Wave Rock in Hyden Western Australia. The name Mulka comes from an Aboriginal legend associated with the cave. Mulka was the illegal son of woman who fell in love with a man with whom marriage was forbidden according to their law.

It is believed that a result of breaking these rules, she bore a son with crossed eyes. Even though he grew to be an outstandingly strong man of colossal height, his crossed eyes prevented him from aiming a spear accurately and becoming a successful hunter.

Out of frustration it is said Mulka turned to catching and eating human children and he became the terror of the district. He lived in Mulka's Cave, where the imprints of his hands can still be seen, much large and higher than that of an ordinary man. Mulka's Cave is located 18 kilometers north of Wave Rock off Lovering Road.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

2.9.1 About Mulka's cave

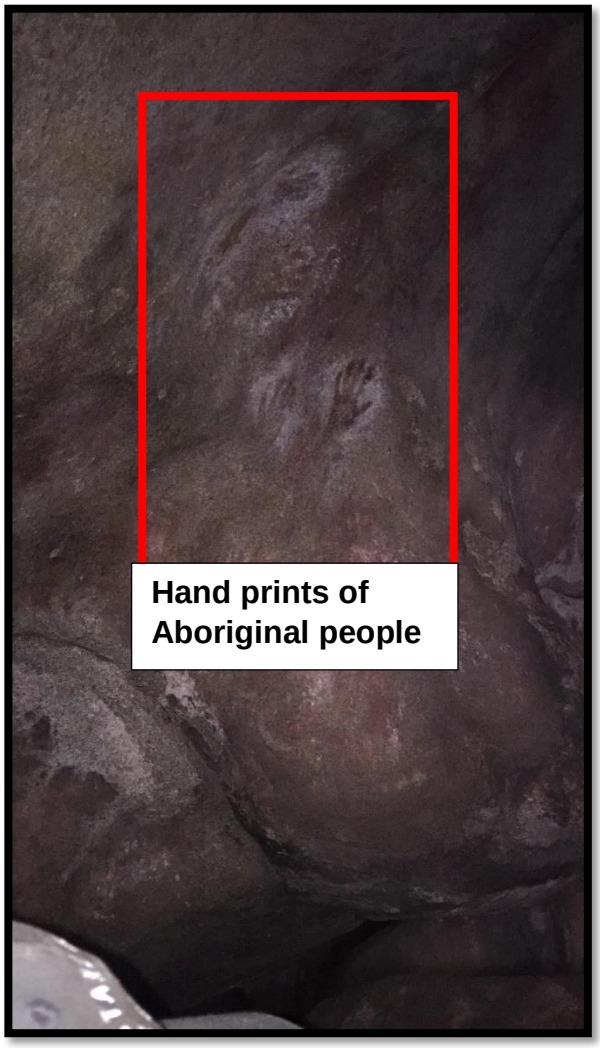


Figure 2.9.1: A picture of the handprints of the Aboriginal people.

Why are the handprints important to them?

The picture in figure # shows the handprints (Aboriginal paintings) in the Mulka's cave. Hand stencils and other motifs occur quite commonly in the region, but while most other sites have fewer than 20 there are over 450 at Mulka's Cave. This is a clear indication of the significance of this site and the associated myths that connect with areas from the desert to the coast.

According to an information board near Mulka's cave, most of the artwork takes the form of hand stencils. These are made by placing the hand on the rock, then blowing over it with pigment. (shown in figure #). There are so many reasons to make the stencil, but principally they are a lorm of signature left by those who had rights to an area.

2.9.2 Granite inside the Mulka's cave

The massive granite rock formation is known as the Humps. Concave structure is because the soil used to be that level when it was weathering. Groundwater erodes the structure. Typically, Archean granites are found in Yilgarn Craton.

The rocks surrounding the caves are very characteristic. Tafone (Erosion type) hollows from inside, leaving a shelf which will eventually fall. The most resistant mineral in a granite is quartz. The feldspars, biotite and micas preferentially weather out. This is because these minerals are less stable in the surface at higher temperature mineral crystallization.

20 Mya, the last separation of Gondwana was when the whole of Australia separated from Antarctica. When plates are falling apart, the plates sink where the crack occurs.

Figure 2.9.2: Medium grade granite found in Mulka's cave

Stop 5: Hyden lake

Photographed by: Liz and Pete, Mobile marshies • Location: Lake Hyden• Date of picture taken: Saturday, 25 April 2015

2.10 Introduction

Lake Hyden is located only 1 kilometer north of the famous Wave Rock. The water is clear but salty and the lake is surrounded by white sand. It is also known as the Lake magic. Lake Magic is a naturally occurring Salt Lake with a gypsum base. The Wheatbelt is an area with low drainage, which means rainwater pools and evaporates, creating salt lakes. The main concept learned in lake Hyden is Dryland salinity.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

2.10.1 Lake Hyden

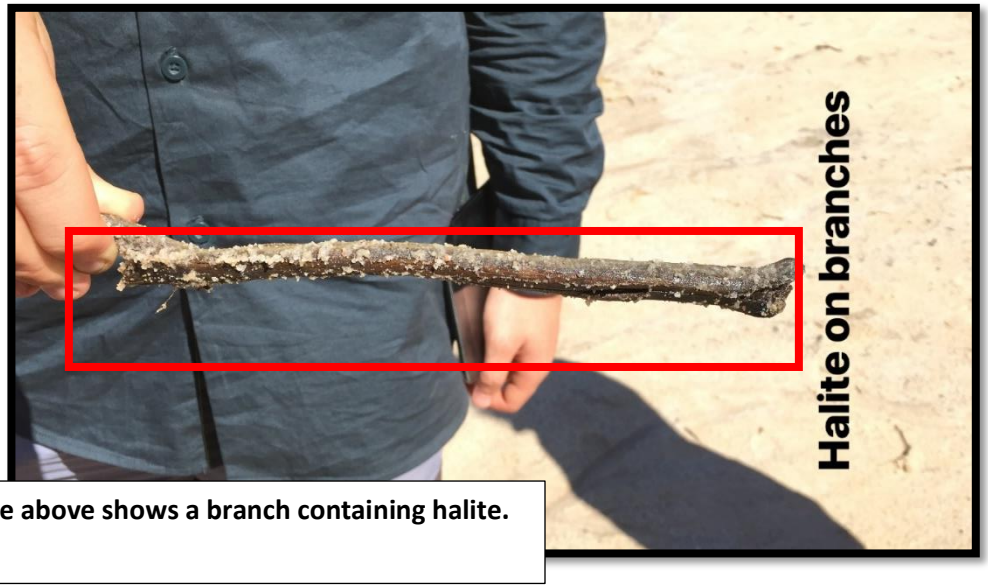


Figure 2.10.1: The above shows a branch containing halite.

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In a body of water like Lake Magic, gypsum forms through the process of water depositing and then evaporating. It is known as an evaporite rock or mineral. Saline, or salt lakes like Lake Magic will often contain evaporites, because they have limited drainage, allowing the sediments to pool and the water to evaporate.

Many of the salt lakes in the Wheatbelt are playa lakes, which means they only contain water at certain times. Many of these playa lakes will also contain gypsum or other evaporites, as they are subject to water pooling then evaporating. Other salt lakes in the Wheatbelt region are the Pink Lake at Quairading; Lake Grace, which is rarely completely full due to its size.

The above picture in figure 2.10.1 shows a branch encapsulated by Halite. Many of the lakes are observed to be dry year-round, unless there is heavy rainfall. Lake Magic does have water, but because of the gypsum content, nothing lives or grows in it. Gypsum is a common mineral containing calcium, sulphur and water. It can be synthetic or natural and is mined or produced for a variety of uses, such as gypsum board (also known as drywall or plasterboard) for building.

Stop 6: Wave Rock

Photographed by: Mr. Oisin McFadden • Location: Wave Rock• Date of picture taken: 02/03/18

2.11 Introduction

Hyden is the closest town to Western Australia's Wave Rock and is a four-hour drive east of Perth, along the Brookton Highway. Wave Rock is a granite cliff 15 meters high and 110 meters long. Its rounded-like shape has been caused by weathering and water erosion which has undercut the base and left a rounded overhang. Water from the springs running down the rock during wetter months dissolve minerals adding to the coloring of the wave. In 1960, crystals from Hyden Rock were dated at being 2700 million years old, which are amongst the oldest in Australia. The main concept learned were Nemaholes, conjugate sets and Dykes.

Dot points addressed:

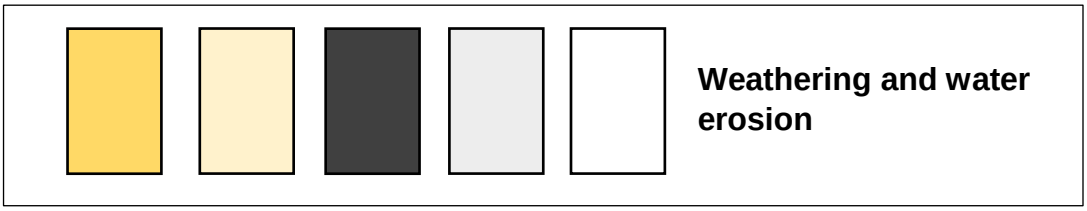
SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

7. Select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations such as block diagrams and strategic columns, to communicate conceptual understanding, solve problems and make predictions

2.11.1 Wave Rock

Figure 2.11.1: The above diagram shows the pattern of the wave rock.



The picture of wave rock shown in figure 2.11.1 has a different combination of colors. Its rounded-like shape has been caused by weathering and water erosion which has undercut the base and left a rounded overhang. Water from the springs running down the rock during wetter months dissolve minerals adding to the coloring of the wave. Its rounded-like shape has been caused by weathering and water erosion which has undercut the base and left a rounded overhang. Water from the springs running down the rock during wetter months dissolve minerals adding to the coloring of the wave.

2.11.2 Wave Rock mapping- Dykes

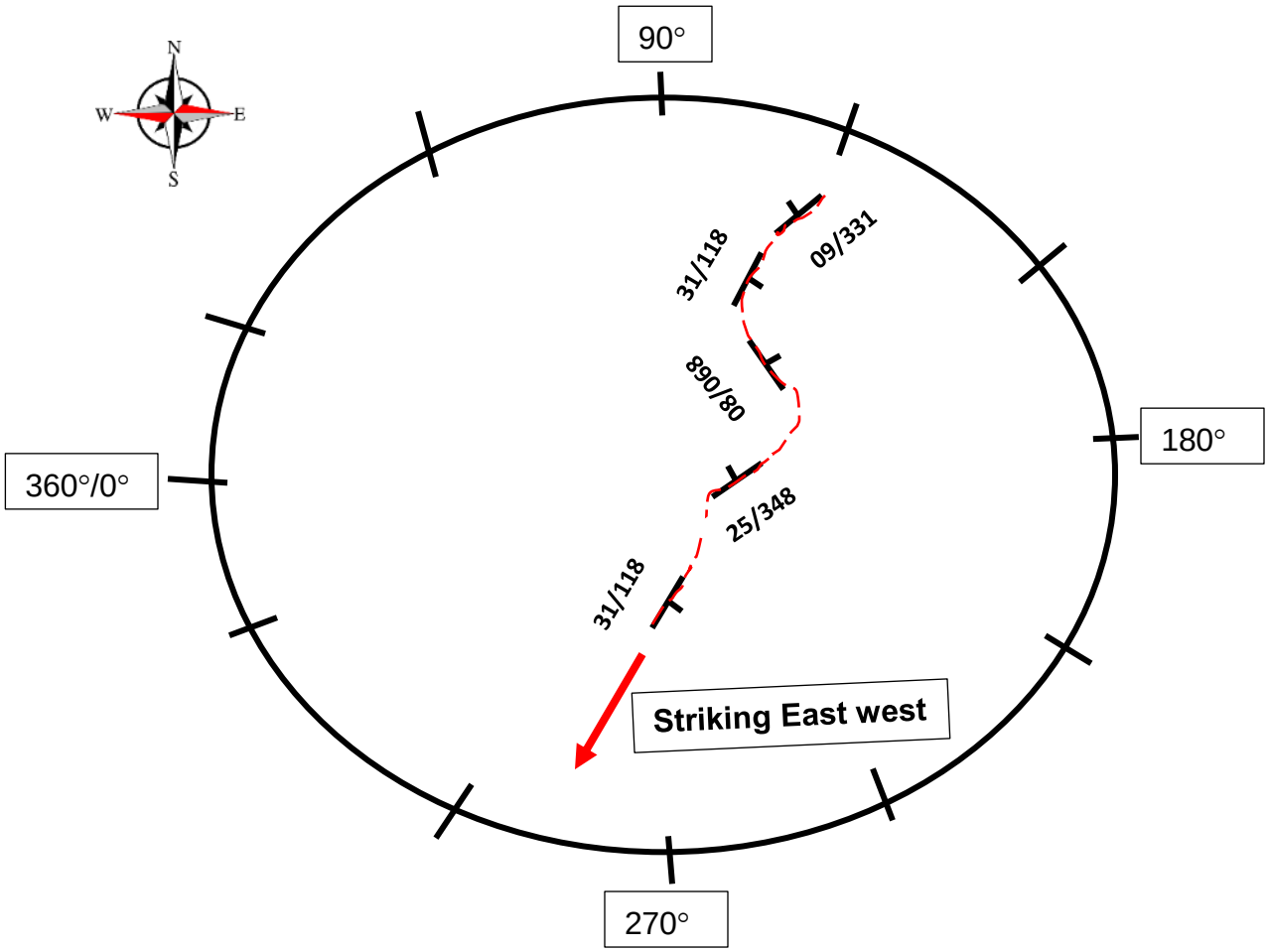


Figure 2.11.2: The above diagram shows the strike and dip direction of dykes.

The above figure 2.11.2 shows the strike and dip direction of the dykes in Wave rock. The results from Clino was transcribed into a circular diagram with the angles 0°-360° labelled on the circumference of the circle. The strike and dip measurements were taken when a dyke was observed by the students at the top of Wave rock. The dykes were observed to be striking East West. Due to some technical problem with the Clino, further measurements were not recorded. According to other students measurements, the dyke was striking 040° EW, 320° NE and 270° NW.

2.11.3 The conjugate sets of the Gnamma holes

Figure 2.11.3: The above picture shows the Gnamma holes.

The above picture in figure 2.11.3 shows the Gnamma holes. The traditional owners of the lands surrounding Kalgoorlie depended on and protected such seemingly hidden water sources for many thousands of years.

One of the main sources of water for the Aboriginal people were ‘gnamma’ holes. These natural cavities are commonly found in hard rock, particularly granite outcrops, and as such act as natural water tanks, which are replenished from underground stores and rainwater run-off. Gnamma holes vary in shape and depth, and the small surface area of the hole helps to minimize evaporation. The Gnamma holes are formed by the structural development of Dykes.

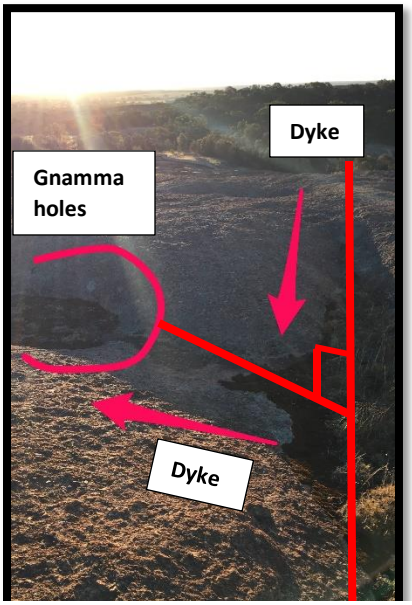


Figure 2.11.4: The above picture shows how two dykes are in conjugate sets and it leads to the Gnamma hole.

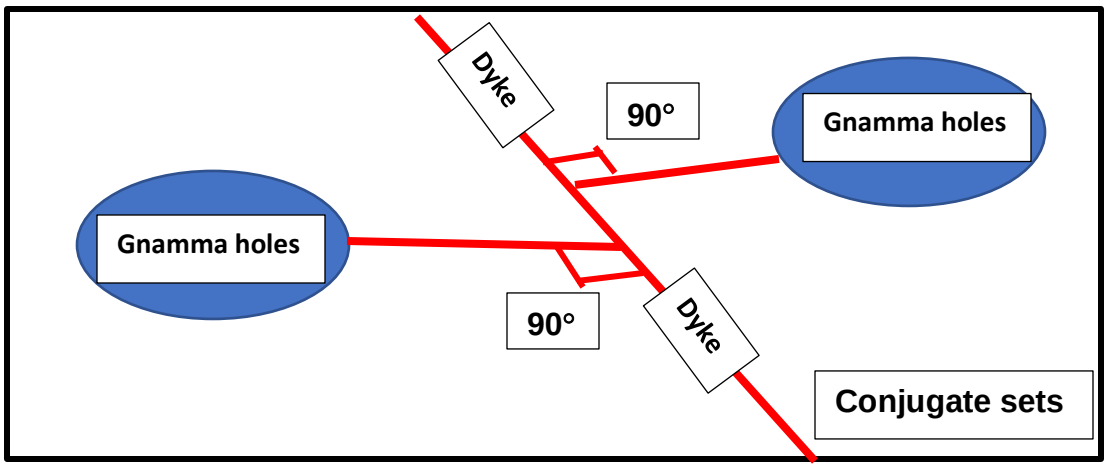
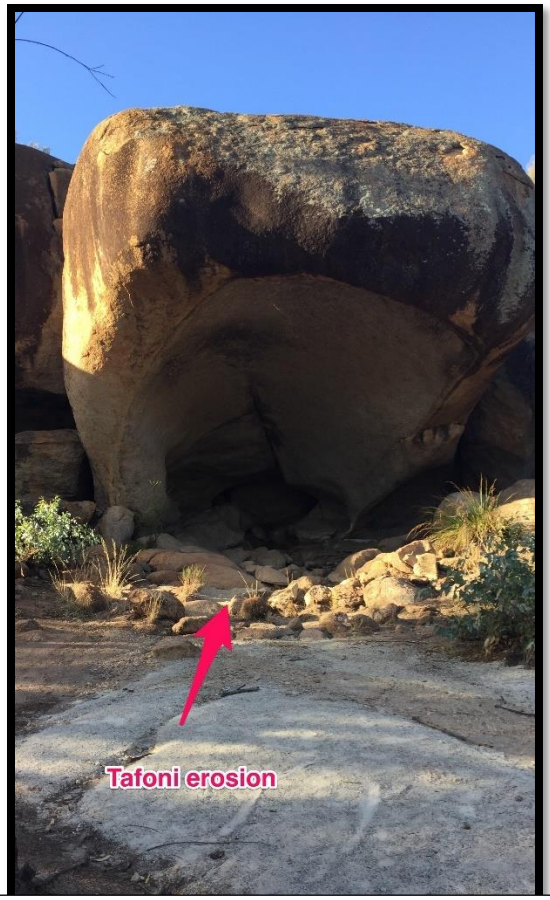


Figure 2.11.5: The above diagram shows the drawing representation of the conjugate sets of the dykes which leads to the Gnamma holes.

The above picture in figure 2.11.4 and diagram in figure 2.11.5 shows how the Gnamma holes are formed by the structural development of the dykes. Students observed that each of the gnamma holes observed, there is a dyke leading towards the Gnamma holes. This concluded that the dykes are the conjugate sets of the Gnamma holes because it forms a 90° angle between two dykes (shown in figure 2.11.5).

Day 3- 03/03/18

Sponty 1: Hippos Yawn



Photographed by: Vinodaarshini • Location: Hippos Yawn• Date of picture taken: 03/03/18

3.0 Introduction

Hippo's Yawn is a little-known rock near Wave Rock in Hyden. The rocks resemblance to a yawning hippo has given it its name. The main concepts learned here were the Nitrogen cycle, carbon cycle and the biogeochemical cycle.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

3.1 Significance of Hippos Yawn

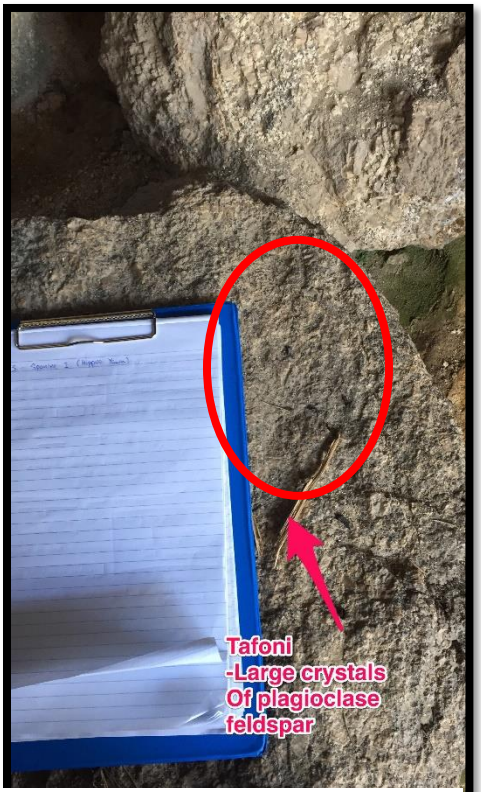


Figure 3.1: The above diagram shows the tafone erosion on the Hippo's Yawn.

The Hippo's yawn is a tafone within a very large boulder. As shown in figure 3.1, the tafone erosion has large crystals of plagioclase feldspar and granites. White "tafone" might look like some kind of exotic ice cream it is in fact the Italian word for window or aperture. In geology it refers to the large hollows or caverns which develop in big boulders like this, and beneath sheet structures up on the outcrop.

The diagram in figure 3.2 shows how the water erodes the boundary between the minerals as they are the weakest/least stable point of the rock. Since the contact between each mineral are weak, it allows the water to penetrate easily

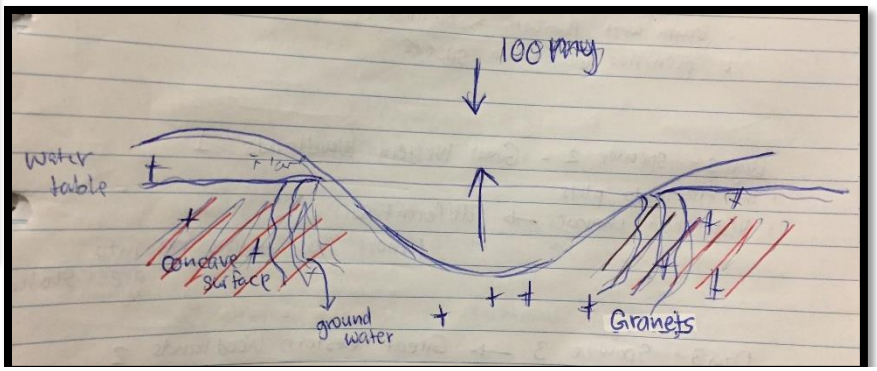


Figure 3.2: The above diagram shows how the groundwater penetrates the minerals.

Stop 1: Rabbit Proof fence

Photographed by: Amusing Planet ● Location: Rabbit Proof fence ● Date of picture taken: 2016

3.2 Introduction

Stretching from north to south across Western Australia, dividing the entire continent into two unequal parts, is a flimsy barbed-wire fence that runs for a total length of 3,256 km. The fence was erected in the early 1900s to keep wild rabbits out of farm lands on the western side of the continent. Today, the Rabbit Proof fence, now called the State Barrier Fence, stands as a barrier to entry against all invasive species such as dingoes, kangaroos and emus, which damage crops, as well as wild dogs which attack livestock.

The main concepts learned were about the environment and the introduced species. The introduced rabbits destroyed the land. Since the rabbit proof fence was built, it is very well maintained. The fence is also part of the Granite Woodlands.

3.2.1 Rabbit Proof fence

Rabbits were first introduced in Australia in 1788 for their meat, and originally bred in rabbit farms and enclosures, until one October morning in 1859, when an English settler by the name of Thomas Austin released twenty-four wild rabbits on his property so that his guest could entertain themselves by hunting. At that time, he had stated that "the introduction of a few rabbits could do little harm and might provide a touch of home, in addition to a spot of hunting."

Figure 3.2.1: The above diagram shows the rabbit proof fence

As shown in figure 3.2.1, the rabbit proof fence barricaded a lot of rabbits since it was built. By good fortune, for the rabbits, Australia was the ideal place for rabbit procreation. Rabbits usually stop breeding in winter because baby bunnies are born without fur and hence susceptible to cold. But winters in Australia are mild so rabbits could breed all throughout the year. Rabbits are also well known to be one of the primitive Gondwana species.

Under the management of the Department of Agriculture's Chief Inspector of Rabbits, fence maintenance was carried out by boundary riders who travelled the fence line using bicycles, camel buggies and horse drays. For some 30 years the fence minimized the movement of rabbits into agricultural areas.

Sponty 2: Great Western Woodlands 1

3.3 Introduction

This was a location for a Sponty. It's called the Great Western Woodlands. The coordinates for this location is 32°24'54" S/ 119°32'01" E. The students were told to take pictures of various type of plant species within 1meter of each plant. Then, the pictures and the notes of the texture were jotted down using Fieldmove Clino Application. As the car locates further South, there is a change in vegetation and the color of the soil. This implies that more iron rich soil is moving into greenstone.

3.3.1 The different species of plants within the area

Diagram 3.3.1: Diagram of different plant species in different localities

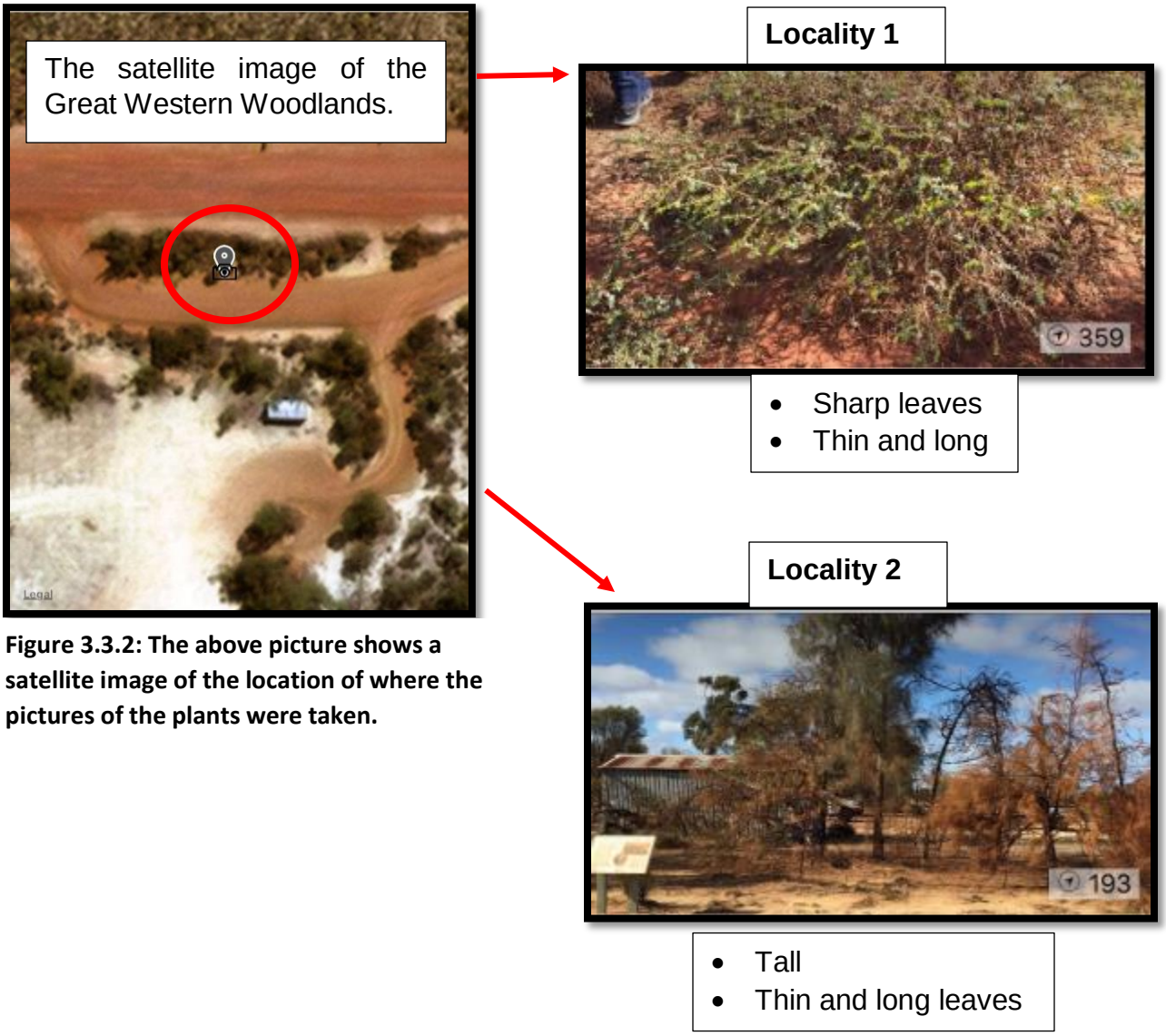


Figure 3.3.2: The above picture shows a satellite image of the location of where the pictures of the plants were taken.

Locality 3

Rottnest Island pine

- Sharp leaves
- Thin and long leaves

Locality 4

- Long-needle like leaves
- Thin and long

Locality 5

- Angular small leaves
- Thin and long stem

Locality 6

- Rough texture
- Thin and long leaves

Locality 7

- Rough texture
- Thin and long leaves
- Very sharp leaves

Diagram3.3.1: As shown in the above pictures, all the plants have the same type of leaves and the size of the plant. Different localities were used to take pictures of different species of plants which were 1m away from the other plant.

All the plants observed to have the same size leaves; thin and long. The plants are also observed to be small and short. This could be due to the composition of the soil. The soil these plants are located are iron rich, so the structure of the plants are equally the same.

Sponty 3: Great Western Woodlands 2

3.4 Introduction

This was a location for a Sponty. It's called the Great Western Woodlands 2. The coordinates for this location is 32°24'55" S/ 119°34'47" E. The students were told to repeat what they did in Great Western Woodland 1. Then, the pictures and the notes of the texture were jotted down using Fieldmove Clino Application. As the car locates further South, there is a change in vegetation and the color of the soil. This implies that more iron rich soil is moving into greenstone.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

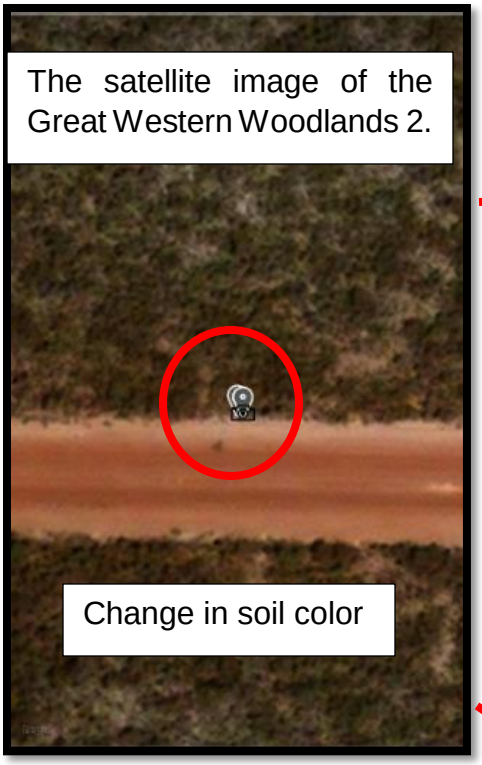
5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

SU (Science understanding)

4. Environmental considerations are important in the exploration, extraction and processing of non-renewable resources, and the decommissioning of resource sites

3.4.1 The different species of plants within the area

Diagram 3.4.1: Diagram of different plant species in different localities



Locality 1

- Sharp leaves
- Thick and long leaves

Locality 2

- Thick and long leaves
- Tall and rough surface

Locality 3

- Thick and long leaves
- Angular leaves

Figure 3.4.1: The above picture shows a satellite image of the location of where the pictures of the plants were taken.

Locality 4

- Thick and long leaves
- Tall tree
- Long and medium sized stem

Locality 5

- Tall tree
- Angular and wide leaves

Locality 6

- Thick and angular stem
- Tall
- Very green in color

Locality 7

- Thick and angular stem
- Tall tree
- Long and wide leaves

Diagram 3.4.1: As shown in the above pictures, all the plants have the same type of leaves, the size and the color of the plant. Different localities were used to take pictures of different species of plants which were 1m away from the other plant.

All the plants observed to have the same size leaves; long and wide. The plants in this location are way bigger than the plants observed in Great Western Woodlands 1. This could be because the soil approaching to be a greenstone. The plants are also healthy as they have a great biodiversity in this area. The higher the temperature, the higher the cloud base, according to the height of the trees.

Stop 2: Forestania Nickel Operations (Flying Fox mine site and Spotted Quoll)

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

SU (Science understanding)

4. Environmental considerations are important in the exploration, extraction and processing of non-renewable resources, and the decommissioning of resource sites

Figure 3.5: The above picture shows the underground mine- Flying Fox.

3.5 Flying Fox mine

The Flying Fox is located in the Yilgarn Craton within the Forestania Archaean Belt. We had a few presentations which went through the processes of how the Forestania Nickel Deposits are mined.

The Forestania Nickel Deposits are approximately 2900 Ma. Formed by ancient volcanoes spewing out lavas high in magnesium called Komatiites. The lavas were extremely hot 1800ºC – Hawaiian lavas around 1200ºC

They had distinct crusts which insulated them allowing them to flow large distances Nickel is contained in sulphides minerals, made up of Iron, Sulphur and Nickel. The deposits have been altered by metamorphism – heat and pressure

The foot wall of the mine is predominantly quartzile, silicified and metamorphosed sedimentary rock (sandstone). However, the foot wall is located underneath the ore body. The ore body itself is a nickel sulfide (Flying fox and Spotted Quoll are nickel mines), the nickel being deposited through a magmatic lava flow. Nickel-rich lava flowed from a source of magma and picked up a lot of sulphur as it flowed, hence why the ore is a nickel sulfide. The hanging wall consist of mainly of metamorphosed ultra-mafic igneous rock.

The main job for a geologist is essentially locating profitable ore and exploration in general. They choose where the mine and machines are going to be located and also give instructions on how to effectively mine the ore. The information on the ore body they collect is shared with everybody in the mine, such as the engineers, because communication is a must for a successful mine site. Once exploration has finished, engineers take over and are tasked with the actual extraction of the ore. They use a huge array of machinery to extract, transport and purify the ore to yield as much profit as they can.

Figure 3.6: The above picture shows the machinery used in mining known as the Bogger.

As the presentations were over, it was time for us to go check out some machinery that mining field uses. A bogger (LHD) is usually used to remove the broken material (shown in figure#). It also helps to bog out the fired dirt from the drill production holes.

A drilling jumbo was also shown to the students. Drilling jumbos are usually used in underground mining, if mining is done by drilling and blasting. They are also used in tunneling, if rock hardness prevents use of tunneling machines. (Figure #)

The drill pits are usually used as a bon for drilling. The holes on drill pits are for water to enter it. The jumbo is a single development drill which only works underground.

Figure 3.7: The above picture shows the machinery to drill holes, known as the Jumbo and a drill pit.

3.5.1 Flying Fox underground mine

Figure 3.5.1: The portal to the underground mine of Flying

The entrance to the Flying Fox Mine was through a box cut, the main entrance, which just consists of a road to the portal, the portal itself and windroves, birms and batters. The portal would have led directly to the decline, the layout of the underground mine being discussed during the earlier presentations.

As shown in figure 3.5.1, near the box cut is a vent that is used to generate a cement product to fill in the voids, or the sections underground that have been used up and need to be filled up again as part of the sustainability practices. The product is comprised of diluted cement, tailings (mine waste) and sand and is made homogenous. Flying fox also has an integrated waster dump (more than one) but this is the way they try to make use of the toxic tailings. The cement product at the end is like a paste and is used

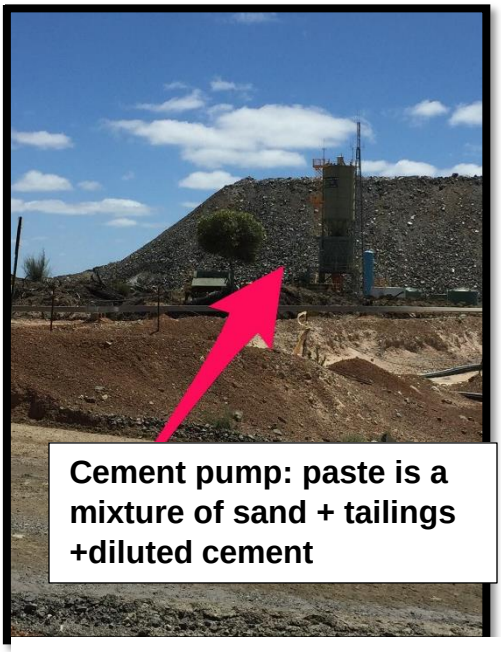


Figure 3.5.2: The shaft that creates the cement product to fill in the voids of the underground mine.

3.5 Spotted Quoll

Spotted Quoll is Western Areas' second mine and was discovered in October 2007, as a result of Western Areas ongoing investment in regional and near mine exploration. Production commenced only 24 months later, in mid-2009.

Spotted Quoll rivals, and in cases, exceeds the nickel grades of Flying Fox, also making it one of the world's highest-grade nickel mines. Spotted Quoll is a low cash cost operation, with nickel produced under US$2 per pound. Spotted Quoll Mine, essentially similar to Flying Fox, is also a nickel but also has traces of gold being mined as well. Flying fox was the host mine, with Spotted Quoll being the founded afterwards due to a lucky drill hole that caught the ore body. Both mines started out as open-pit but transitioned to underground once everything near the surface was mined. Spotted Quoll is a lot smaller that Flying Fox and is thus easier to fund. The ore bodies in both mines were deposited via magmatic lava flows.

At the windroves, overlooking Spotted Quoll, many features of the mine could be seen. There were usual birms, batters and windroves as well as a portal leading underground and into the decline. The geology of the mine could also be seen, both the hanging wall and the foot wall were comprised of a metamorphosed sedimentary rock and contained biotite minerals, however, the hanging wall also contained garnets. The hanging and foot wall were not as dense as the ore body (nickel sulfite), which was characterized as being very dense and metallic. It had a grey streak. Many of these rocks found inside the mine were found on the windroves. The open-pit mine wall also had granitic and pegmatitic sills and dykes intruding the ore body. (Figure 3.5)

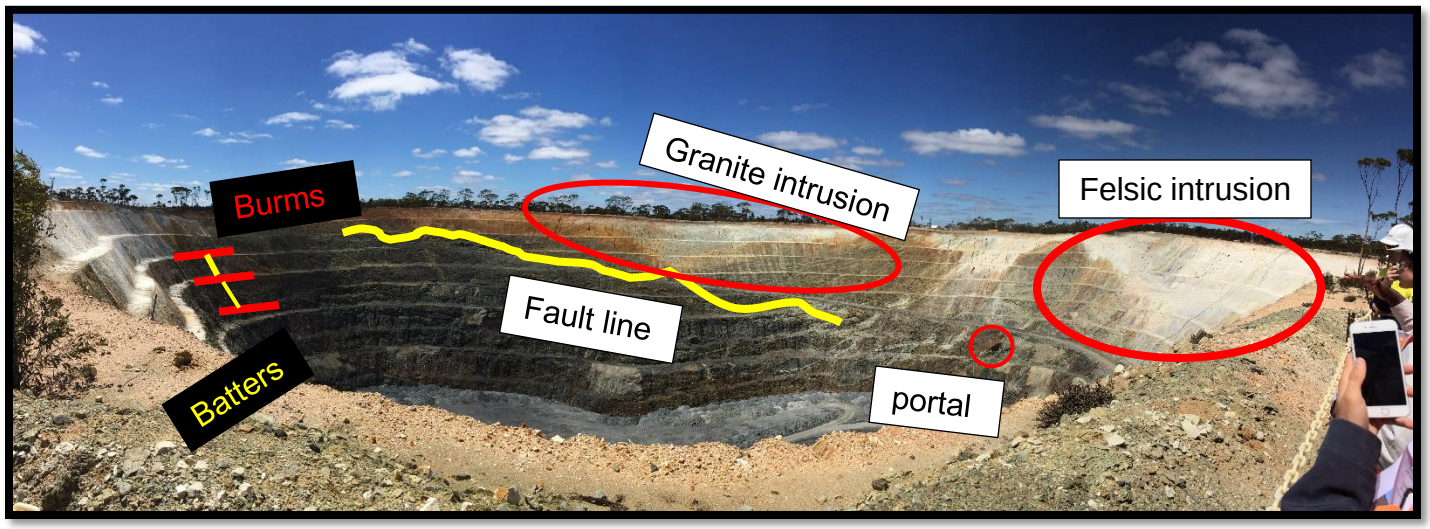


Figure 3.5: The panoramic view of spotted Quoll from the windroves.

Mine ore pad

Figure 3.6: The mine ore pad, where the stopes are separated according to their nickel grade.

Before our last stop in Emirates, we stopped in the mine ore pad. This is where pure ore sulphides are stoped. Here, the profitable ore that was mined (in the stopes underground) is separated according to its grade. In the mine ore pad, nickel sulphide with a grade less than 2% was considered to be low grade (in terms of profit), while a high-grade ore had some 3.5% nickel content in it. Overall, there was about 70 000 tonnes in the mine ore pad. This is the classification part to the value train; the ore is on its ay to be processed and purified at Cosmic Boy Village.

The Nitton gun, ASSA shown in figure 3.7 shows the exact readings of what mineral is in the rock. In the below figure #, ASSA shows that there is 3.48% of Nickel in the iron sulphides

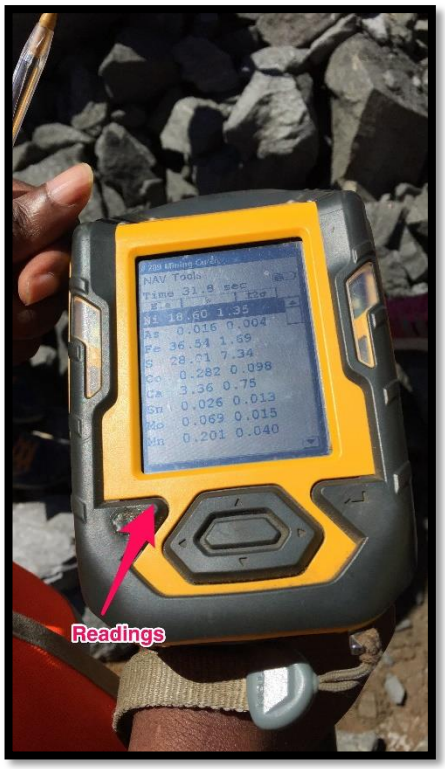


Figure 3,7: Nitton gun, ASSA was used to see what exactly is in the rocks in the Mine ore pad.

Figure 3.8: Nitton gun, ASSA shows the percentage of Nickel, Iron, Copper and any other minerals in the rock

Day 4- 04/03/18

Spot 1: Barrens beach

4.0 Introduction

Barrens beach is located near Fitzgerald river national park. Barrens Beach is a small, sheltered beach nestled between dunes and a rugged quartzite headland. In this location, kundip quartzite and kyanite schist is observed opposite to each other. The different foliation and colors were observed by the students as they started surveying the rocks. The kundip quartzite is hard and resistant, hence it has a nutrient poor base.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4.1 Barrens beach

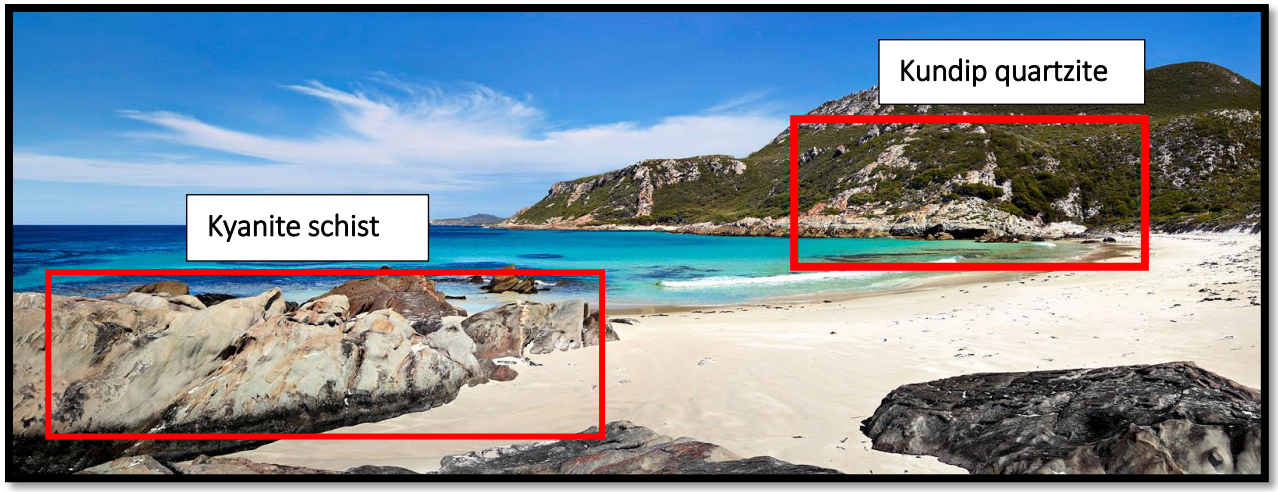


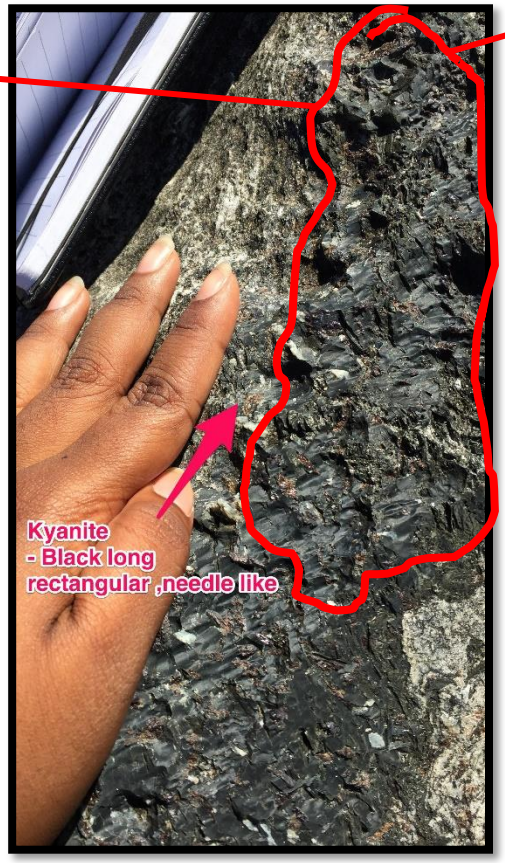
Figure 4.1: The picture of Kundip Quartzite and Kyanite schist

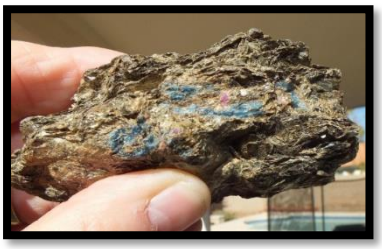
4.1.1 Kyanite schist

Rectangular-Schist

The rectangular structure and the color indicates that this rock is a Kyanite schist.

The bended foliation on the rock also shows that the rock is a kyanite schist.





Kyanite is a typically blue silicate mineral, commonly found in aluminum-rich metamorphic pegmatites and/or sedimentary rock. Kyanite in metamorphic rocks generally indicates pressures higher than four kilobars.

Kyanite also has vitreous to pearly luster which is easy to indicate not only by looking at the color (blue/black).

Figure 4.11: The picture shows and explain why it's a Kyanite schist

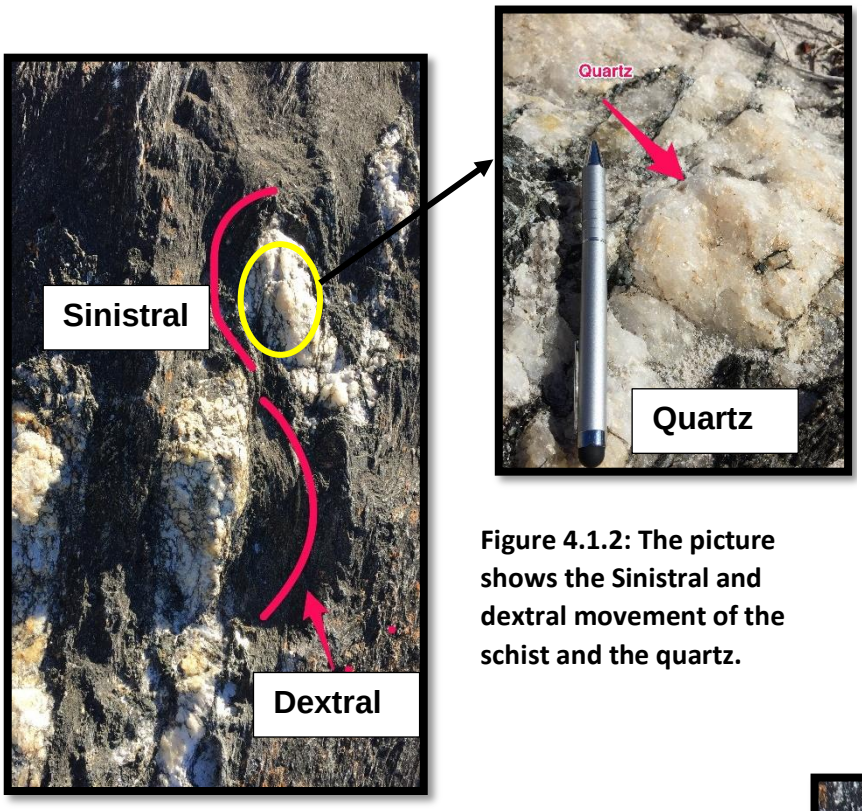


Figure 4.1.2: The picture shows the Sinistral and dextral movement of the schist and the quartz.

Sinistral and **dextral**, in some scientific fields, are the two types of chirality ("handedness") or relative direction.

Figure 4.1.2 shows the how the schist encapsulates quartz with the Sinistral and dextral movement. Quartz is formed by the partial melting of lower crust. So, when the quartz hits the surface, as it cools down, the country rock act as an insulator allowing the quartz to cool slower. This is why quartz is observed to have larger crystals size than the kyanites or the granites.

In figure 4.1.2, there are some leucosomes on a rock which shale or siltstone might be the potential parent rock. This is because shale is observed in the quartz found encapsulated by a country rock. The texture of the Quartz was sugary and blocky; therefore, it has a granular texture. This indicates that the shale (medium grade) in Quartz (lower grade) is a Barrovian sequence indicator. The sandstone on the other hand can't be a parent rock because it has an angular structure rather than shale and siltstone. Also, shale is ductile and its shearing (absorbs pressure),

The leucosome is the lightest colour of the country rock. Therefore, shale and siltstone are going through metamorphism as leucosomes are known to be melting textures. The leucosomes are also observed to be a little blue. This could be because of the oxidation reaction through the atmosphere, as it is located right next to the beach.

Figure 4.1.3: The picture shows some leucosomes on the location where the shale and the siltstone are going into metamorphism

4.1.2 Kundip Quartzite

Figure 4.1.2: The picture shows the quartz from kundip quartzite.

Kundip quartzite is located in Fitzgerald River National park. It is hard and resistant, and it is a very nutrient poor base. It is observed to be a clean quartz which has the same size. Thin layers of siltstone (shale + sandstone) has been observed on the quartzite. This could be due to increase in temperature; therefore, it increases the melt of clay, forming new minerals.

Kundip quartzite is a lower grade metamorphic rock because the foliation is observed to be planner which means it's a green schist facies. The cleavage is also observed to be very angular, therefore this can infer that the potential parent rock is sandstone.

4.1.3 Kyanite schist and Kundip Quartzite

Diagram 4.1.3: Diagram of how kundip quartzite is near to the kyanite schist

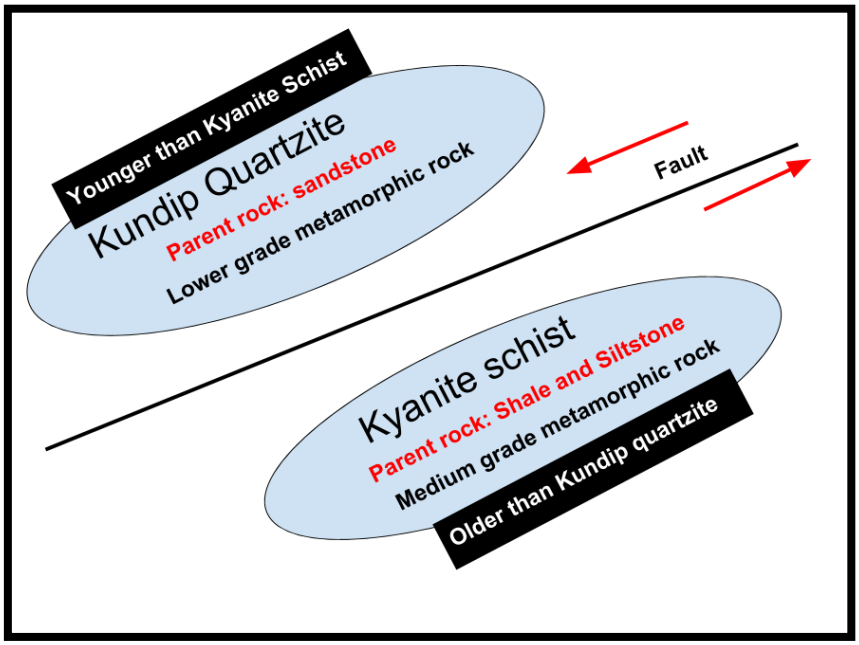


Diagram 4.1.3: The diagram shows the kundip quartzite is younger than the Kyanite schist outcrop. This is due to the fault in between the kundip quartzite and the kyanite schist.

Kundip quartzite's parent rock is the sandstone because the quartz is hard and brittle. The Kyanite schist is observed to have shale and siltstone as the parent rock.

Stop 2: Barrens Lookout

Photographed by: Vinodaarshini • Location: Barrens Lookout• Date of picture taken: 03/03/18

4.2 Introduction

Barren has 82 biodiversity hotspots. All the species are wanting to survive. Barren is where you can see biotic supporting abiotic. In this location, Eeamon, one of the student talked about the biodiversity of the plants surrounding this area. He talked a lot about the Hakea victorialis (Royal Hakea) because this is the only place when you can observed this species. Surrounding this barren lookout, there are over 72 endemic plants and 18000 biological species.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4.2.1 Introducing the biodiversity in barren's lookout point

Figure 4.2.1: The picture shows Hakea Victorialis, only in Kundip quarzite

The figure 4.2.1 shows the very beautiful, one and only hakea victorialis also known as the Royal Hakea. It has a very low surface area. Hakea Victorialis is very rare.

Another interesting fact about this Royal Hakea is that it has very little nutrient in it and a very tough leaf. This can act as a defense mechanism for them to avoid the consumption by animals. This is a good way to maintain their beauty and rareness.

Figure 4.2.2: The picture shows the poison peas

Banksia is also a part of the Hakea Victorialis family. There are 173 Banksia species, and all but one occurs naturally only in Australia. Th significance of banksia is, it only opens up when it has fire surrounding it, or else it's always closed.

Poison peas also has a very powerful defense mechanism, its leaves. It is observed to be very sharp. This is also to avoid the consumption of animals. Wherelse, the flowers are harmful and can be touched.

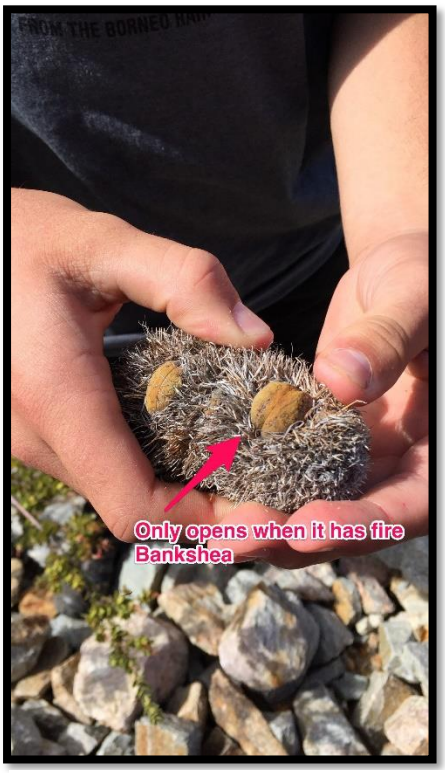


Figure 4.2.3: The picture shows the Banksia.

Sponty 1: Barrens

Photographed by: Vinodaarshini • Location: Barrens Mountain• Date of picture taken: 04/03/18

4.3 Introduction

Barrens mountain is a spot where the reflection of high sea water was. Barren has the wav planes which could be seen very clearly. There are at least 4 to 5 sea level changes just within this view. This gives a clear indication of the world undergoing global warming.

Dot points addressed:

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

4.3.1 The changes in waves planes in Barren

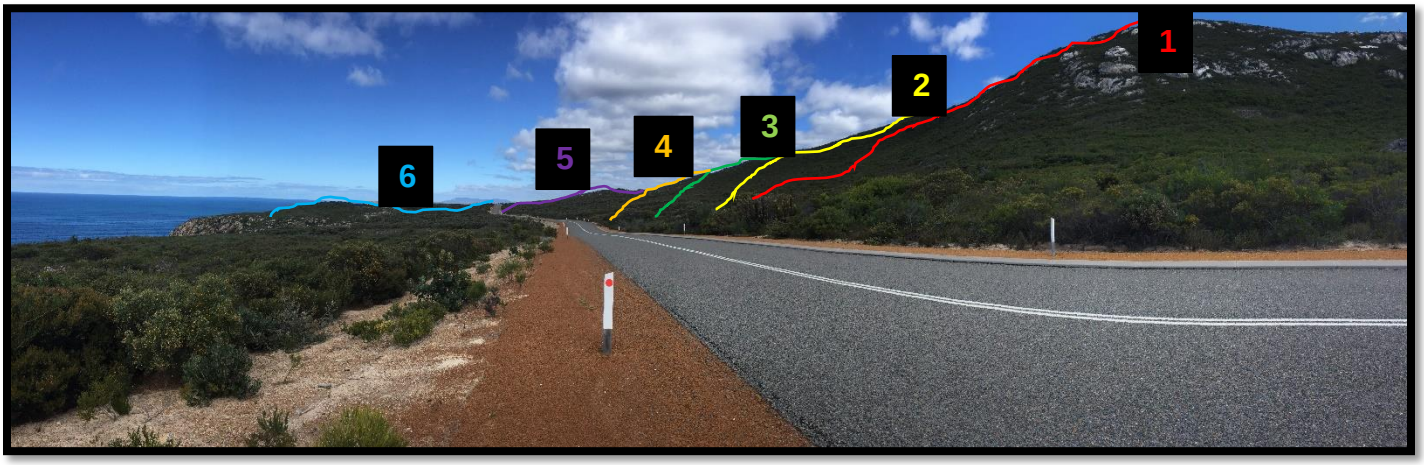


Figure 4.3.1: This photo shows the changes in waves plane within this one view

Each line and number represent the number of time the sea level in Barren has changed. The lines and numbers in figure 4.3.1 shows the waves planes left by the water level of the Barren beach a long time ago. This proves that our world is going through global warming over the years.

The decrease of sea level is due to the increase in temperature and it's going through regression. The more the heat, the more the evaporation occurs. So, this location was a Sponty to prove that we are in the period of global warming. This waves planes proves the observation and the inference is made. The amount of regression is determine by just looking at the planes where it's dipping downwards.

Stop 3: West Beach

Photographed by: Vinodaarshini • Location: West beach• Date of picture taken: 04/03/18

4.4 Introduction

West Beach is a scenic beach set in a small bay, with opportunities to explore water-washed rock formations. A formed path provides easy access to this delightful beach where the rocks have been sculpted by nature into intriguing shapes. The wave-washed surfaces of these weathered schists show delightful detail in alternating bands of light and dark minerals that include glistening mica and small deep pink garnets. A lookout with seating on the path is a good vantage point to enjoy the views and spot whales and their newborn young during winter when they may shelter close to shore.

Dot points addressed:

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

4.4.1 West beach

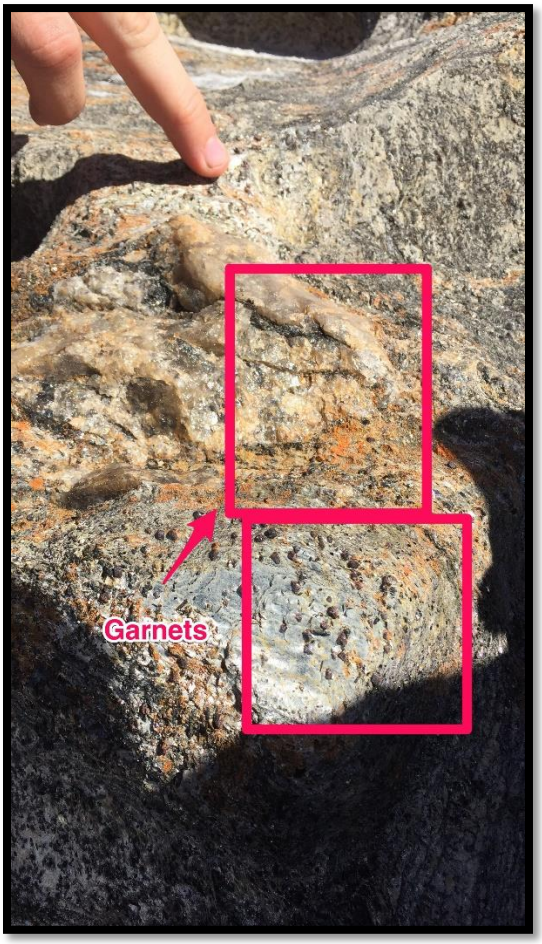


Figure 4.4.1: This photo shows garnets in a psammitic schist

Granets are observed to be in psammitic schist because it might be going into a higher-grade schist, like a granulite schist. The partial melting of lower crust has formed a quartz intrusion within the schist. This might change quartz into a higher grade.

The cream to orange grey rocks is known to be a psammitic schist. This is derived from a sedimentary rock. So, this shows that this rock is from a Barrovian sequence. If it was in deep water environment, then it might have derived from shale/siltstone. Wherelse, if it was in a shallow water environment, it is derived form a sandstone

Figure 4.4.2: This photo shows the huge quartz intrusion into the schist.

Garnets and kyanite is observed on the plane shown in figure 4.4.3. The garnets is observed with the kyanite because it might be in the process of going into a higher grade.

There's a very high possibility that the garnets want to turn into yangup schist High-aluminum metapelites are enriched in mineral phases which are informative for P/T condition of metamorphic processes and thus they are preferable object for investigation in the high-grade metamorphic terrenes.

The parent rock of the kyanite is the shale because it has a very rectangular structure and it has clays, sheets and is slippery at times. Wherelse, for the garnets, they are minerals so, it would be impossible to have a parent rock.

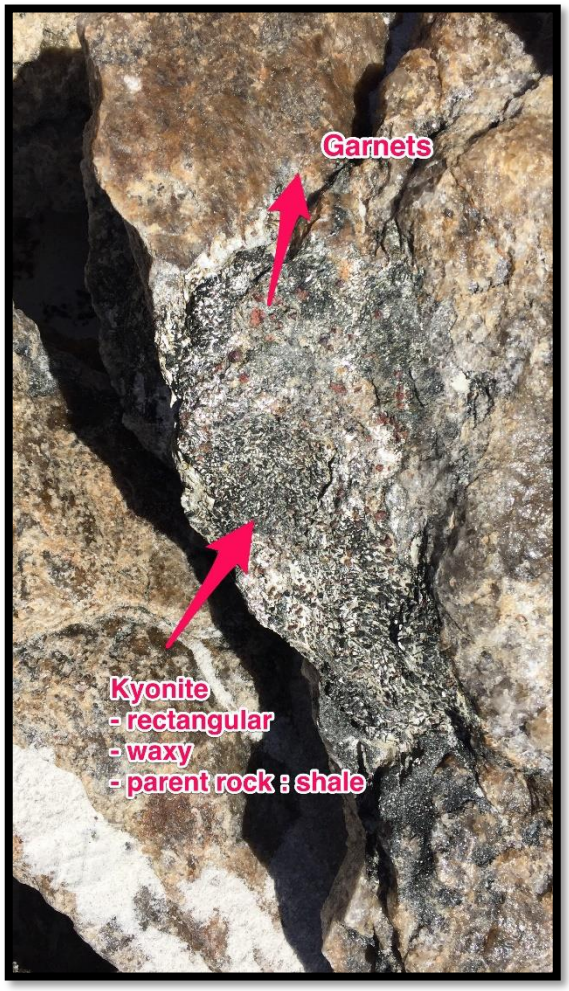


Figure 4.4.3: This photo shows garnets in a psammitic schist

Figure 4.4.4: This photo shows Dextral and the Sinistral direction

The Sinistral and the dextral direction is yet again observed in the west beach. This just show us how the rocks moved when they were molten before it crystallized.

It creates a pattern as this hearing happens because the rock was molten when it was undergoing this process. The structure shown in figure # shows the uplift of magma as the shearing took place.

Stop 4: Cave point

Photographed by: Vinodaarshini • Location: Cave point • Date of picture taken: 04/03/18

4.5 Introduction

Cave point is the location where would want to go because of the breath-taking scenery and the surrounding itself. It is also people and friendly gentleman who can guide us around here. The cave point is also a beautiful location to look at the geological structure of the hill, the wind patterns, the old coast- climate change and very lastly the very sad eutrophication caused by the anthropogenic activity.

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

4.5.1 Three + 1(Sponty 1) important things learned in Cave point

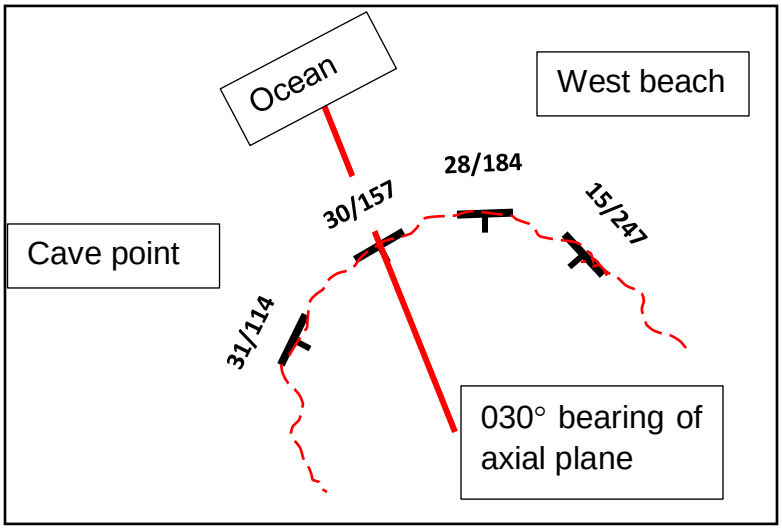


Figure 4.5.1: This diagram shows the syncline between cave point and west beach

1. Geological structure

The diagram shows the syncline between the cave point and west beach with a 030° bearing of the axial plane. This shows that both the location is symmetrical, therefore it might have the same minerals and rocks in both the location. The outcrop should have a Tamala limestone with the angular unconformity. But sadly, the students find anything around that area.

2. Wind patterns

Atmospheric circulation is the large-scale movement of air by which heat is distributed on the surface of the Earth.

The wind belts and the jet streams girdling the planet are steered by three convection cells: the Hadley cell, the Ferrel cell, and the Polar cell. While the Hadley, Ferrel, and Polar cells are major players in global heat transport, they do not act alone.

Disparities in temperature also drive a set of longitudinal circulation cells, and the overall atmospheric motion is known as the zonal overturning circulation.

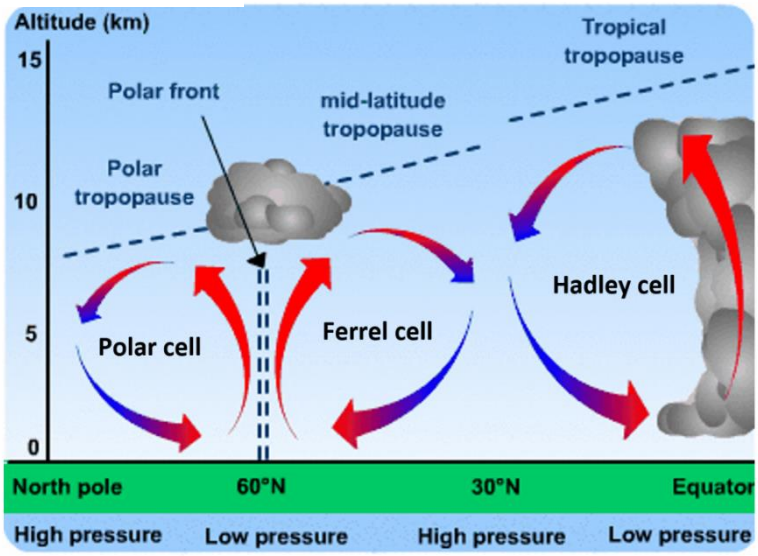
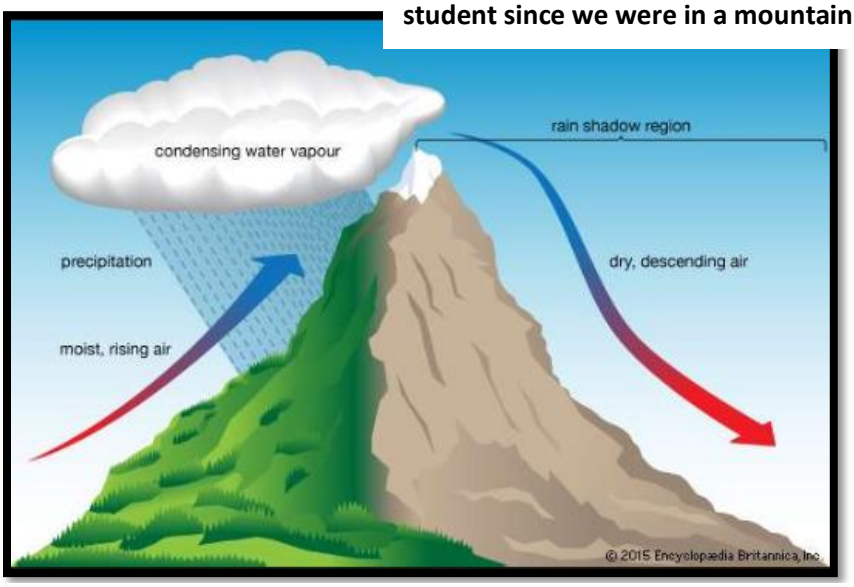


Figure 4.5.2: This diagram shows the atmospheric circulation led by Simon, one of the student.

Figure 4.5.3: This diagram shows the Orographic effect led by Simon, one of the student since we were in a mountain area.



In geography, the term 'orographic effect' refers to the weather condition triggered by upward movement of air mass on coming in contact with a mountain or some other elevated terrain. It has a crucial role to play in elevated mountainous regions of the world receiving more rainfall as opposed to the plains. Simply put, it is all about how mountains and other elevated terrain alter the weather conditions in a particular region.

When the air mass moves over a rising terrain, it is automatically forced to move upwards. This upward movement of air mass triggered by rising terrain is referred to as the 'orographic lift'. As the mass of air continues to rise, it is subjected to adiabatic cooling—cooling of a body of air without the addition or subtraction of heat or thermal energy. Some of the most prominent examples of regions receiving orographic rainfall include the northwestern United States, Appalachian Mountains in West Virginia, the Western Ghats and lesser Himalayas in India, eastern seaboard of Australia, etc.\While the windward side of a mountain experiences heavy rainfall, all the moisture in the clouds is drained, owing to which the air which descends on the leeward side is dry and warm. This, in turn, results in a dry spell, which is known as 'rain shadow effect' on the leeward side of the mountain. (showing in the figure #)

3. Eutrophication

Eutrophication is characterized by excessive plant and algal growth due to the increased availability of one or more limiting growth factors needed for photosynthesis such as sunlight, carbon dioxide, and nutrient fertilizers. Eutrophication occurs naturally over centuries as lakes age and are filled in with sediments. However, human activities have accelerated the rate and extent of eutrophication through both point-source discharges and non-point loadings of limiting nutrients, such as nitrogen and phosphorus, into aquatic ecosystems (i.e., cultural eutrophication), with dramatic consequences for drinking water sources, fisheries, and recreational water bodies.

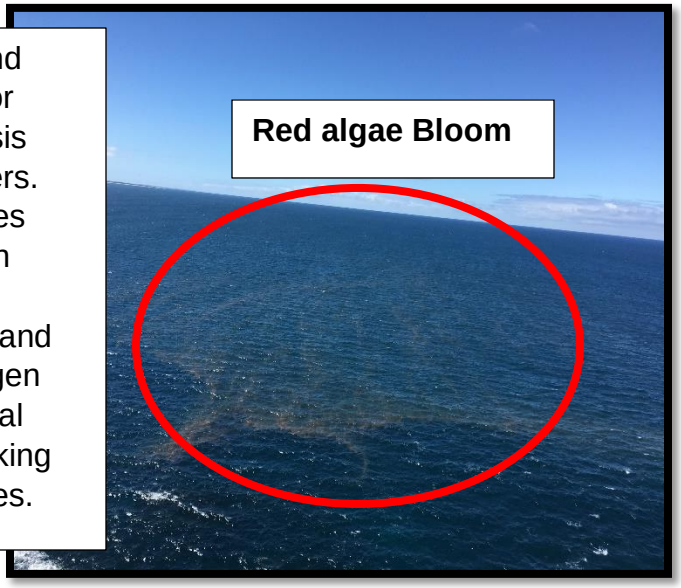


Figure 4.5.4: This diagram shows the eutrophication in the ocean from the cave point.

Sponty 2: Washout

Photographed by: Vinodaarshini • Location: Wash out of Philip River • Date of picture taken: 04/03/18

Dot points addressed:

SIS (Science Inquiry Skills)

3. Conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, completely and methodically for the collection of valid and reliable data

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of

4.6.1 About the wash out of Philips river

Figure 4.6.1: This diagram shows the cut-off of the road when the road was washed out

West of Ravensthorpe on the South Coast Highway, the Philips River bridges was ripped from its foundations at the height of the flood and now lies on the riverbank 80 meters downstream. Bridges and roads were damaged by flood waters a week ago isolating Ravensthorpe from Albany and Esperance.

The strength of the water was so strong that it damaged a well-build road (shown in Diagram 4.6.1). Businesses in Ravensthorpe have been hit hard by the loss of tourist trade and the limited supplies getting through. To get to Albany, motorists now have to take an 80-kilometer diversion on dirt roads. The damage bill was estimated to be around $20 million, but that has been constantly revised as the full cost of repairing the 840km of damaged roads in the south east region comes to light.

Day 5- 05/03/18

Sponty 1: Ravensthorpe

Figure 5.1: This diagram shows a fresh cut rock from alongside Ravensthorpe

These rocks were observed alongside the Ravensthorpe Rd. These were freshly cut slaty cleavage rocks just as a crop along the rock. The students observed how the greenschist with the slaty cleavage is going into amphibolite facies.

This is judged by the color and the planner of the rock itself. It is going from a bended foliation to a planner foliation. All the rocks over there were similar and most of the rocks are in the process of going from green schist to amphibolite. Other than that, this was the last stop before an eight-hour journey back home.

Dot points addressed:

SHE (Science Human Endeavour)

1.Sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources

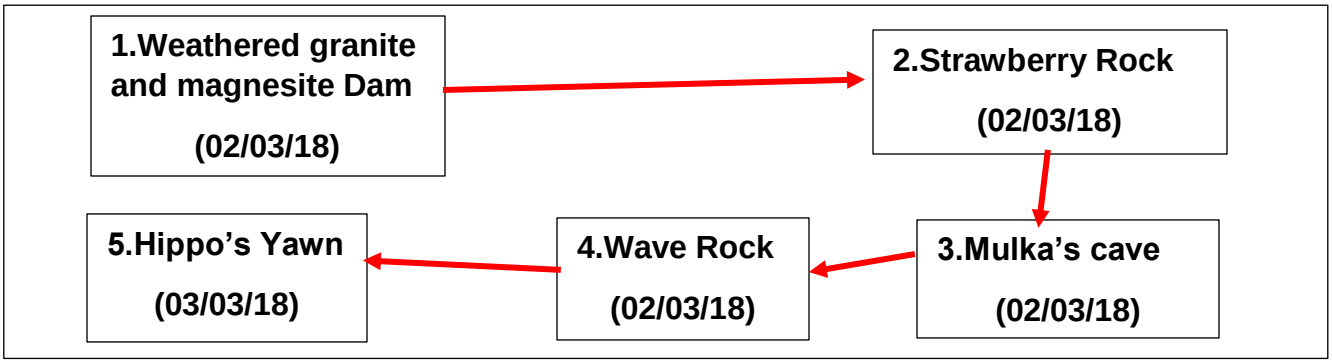
5. Studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines; these studies inform the concept of environmentally sustainable development

SU (Science understanding)

4. Environmental considerations are important in the exploration, extraction and processing of non-renewable resources, and the decommissioning of resource sites

The granite journeys

02/03/18 – 03/03/18



1.Weathered granite and magnesite Dam (02/03/18)

2.1.1 Weathered Granite- Extreme weathering of Komatiites and Komatiitic basalt

In figure 2.11, the minerals observed in the rock were K-feldspar, quartz, hematite and Limonite. K-feldspar is observed to weathered to clay. However, there are two iron oxides found in the rock, these two iron oxides are Hematite (red) and Limonite (yellow). Quartz is observed to not be affected due to Moh's hardness scale.

This rock is also observed to be physically and chemically resistant. Due to the stable condition in Earth, quartz is more resistant. This is the reason why beaches are made of quartz.

During the process of weathering, the higher temperature minerals are to weathered first such as the olivine and basalt. They also weather to iron oxides. Weathering is a process opposite to crystallization.

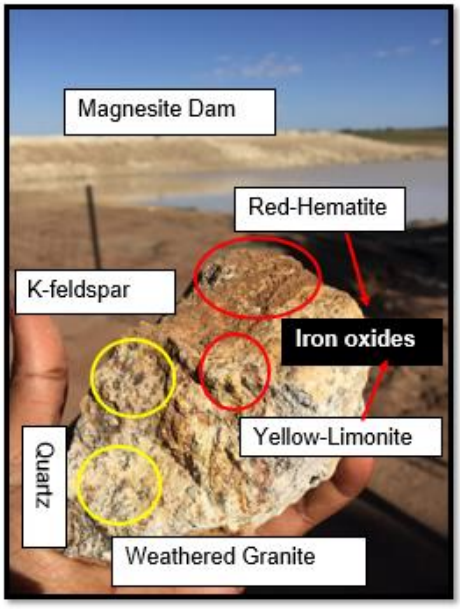


Figure 2.1.1: The above picture shows the weathered granite and the minerals observed.

2.Strawberry Rock

(02/03/18)

As shown in figure 2.2, the granite found in strawberry rock is consisting of quartz, k-feldspar and biotite. Each of this mineral are determined by their color and texture. Quartz is identified by the glassy texture, wherelse the k-feldspar and biotite are identified their color; white and black.

Granite if found in this area due to the huge partial melting of lower crust. Mantle plume might have melted and glued all the continents together. The crystal size in this granite is observed to be finer than the granite observed in the magnesite dam, Frog Rd.

Figure 2.2: The above picture shows the granite which consists of quartz, K-feldspar and biotite.

2.9.2 Granite inside the Mulka's cave

The massive granite rock formation is known as the Humps. Concave structure is because the soil used to be that level when it was weathering. Groundwater erodes the structure. Typically, Archean granites are found in Yilgarn Craton.

The rocks surrounding the caves are very characteristic. Tafone (Erosion type) hollows from inside, leaving a shelf which will eventually fall. The most resistant mineral in a granite is quartz. The feldspars, biotite and micas preferentially weather out. This is because these minerals are less stable in the surface at higher temperature mineral crystallization.

20 Mya, the last separation of Gondwana was when the whole of Australia separated from Antarctica. When plates are falling apart, the plates sink where the crack occurs.

Figure 2.9.2: Medium grade granite found in Mulka's cave

3.Mulka's cave

(02/03/18)

5.Hippo's Yawn

(03/03/18)

3.1 Significance of Hippos Yawn

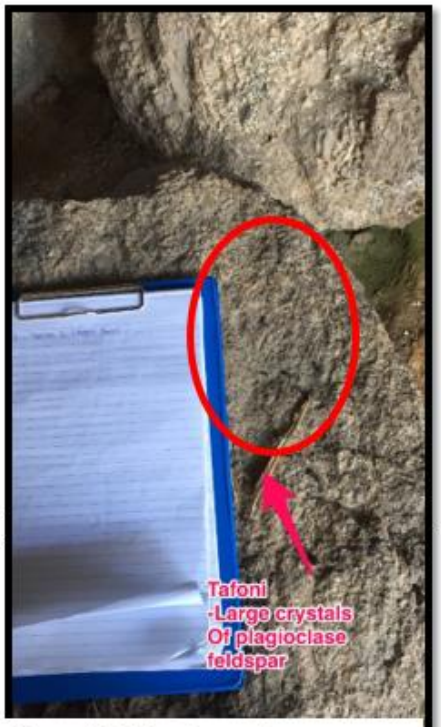


Figure 3.1: The above diagram shows the tafone erosion on the Hippo's Yawn.

The Hippo's yawn is a tafone within a very large boulder. As shown in figure 3.1, the tafone erosion has large crystals of plagioclase feldspar and granites. White "tafone" might look like some kind of exotic ice cream it is in fact the Italian word for window or aperture. In geology it refers to the large hollows or caverns which develop in big boulders like this, and beneath sheet structures up on the outcrop.

The diagram in figure 3.2 shows how the water erodes the boundary between the minerals as they are the weakest/least stable point of the rock. Since the contact between each mineral are weak, it allows the water to penetrate easily

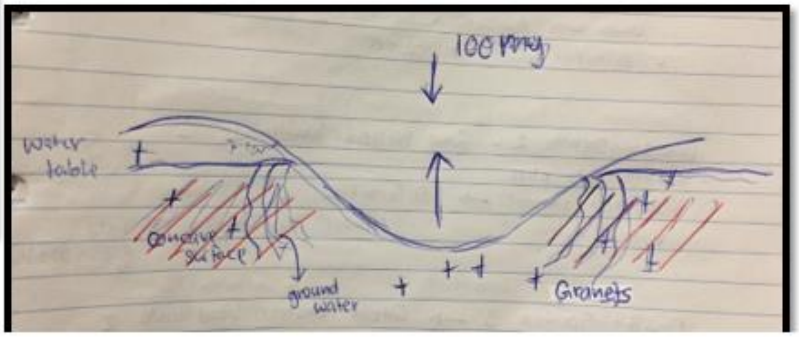


Figure 3.2: The above diagram shows how the groundwater penetrates the minerals.

Evaluation

Over this 5 days' period, many things have changed and progressed tremendously: good and bad. Personally, I believe #THEREALCLASSROOM made me grow into a better person and taught me to live outside my comfort zone. Positive attributes from this field trip kept me learning more about the environment we live in and this has not only taught me many things but it has taught me to overcome my fear and take any opportunities that comes by my way. One of the key highlights I've learned throughout this field trip is that I am the only person who can be the best motivation to keep learning about new things, every day. This gives me an opportunity to mold me to be a lifelong learner and to push through my limits, physically and emotionally. Moreover, I believe my peers have provided me with ample of hope, help, support and encouragement to be the person I am today.

Through this field trip, I have succeeded in learning so many different things, that I can apply not only to the classroom environment, but also the working environment, and of course in my life in general. In relation to year 12 Earth and Environmental Science course, we learned many new and enthralling concepts, which persuaded us on understanding the concepts in a more detailed manner. We learned about the metamorphic rocks in different grades (low grade, medium grade and high grade). This was observed and learned the most throughout this 5 days. The main concept learned throughout this field trip was about metamorphic rocks, Bowen's reaction series, environmental aspect and Mining& exploration. These concepts were mainly discovered in Weathered granite and magnesite dam strawberry rock, Noble Falls, Lovers Lane 1 and Lovers lane 2. We also learned about the value train in the Forestania Nickel Mine site. From exploration, to processing and mining was thoroughly explored in Flying Fox and Spotted Quoll mine site. Flying fox was a magmatic Nickel mine site and Spotted Quoll is a hydrothermal gold mine site. The highlight of the field trip was the spontaneous field test we did in Millie's beach near Fitzgerald National park. This activity made me learn and understand better ways of presenting my knowledge and idea. Another main highlight of the field trip for me was the mapping exercise we did in Emu Proof Fence Rd. I think it was a great idea to expand our knowledge on how to use the Field Move Clino app and measure the strike and dip direction.

This field trip has given me the platform to learn many new skills as well as the right mindset in anticipation of how I will need to perform in the working world, in the near future. I learned new things about myself, my peers and my surroundings, to prepare me for the better future sooner or later. I believe that acknowledging and learning about the environment we live in, is a very important thing to do. Now, that I've learned about many concepts about metamorphic rocks and the processes of the partial melting of the Bowen's series, would apply this knowledge to real life situations. This field trip has taught me lots of things about the unique environment I live in, and it is the best experience. Thank you Ms Urbniak for providing me with great knowledge and get to feel #THEREALCLASSROOM.

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