UNIVERSITY OF VENDA

DEPARTMENT OF MINING AND ENVIRONMENTAL GEOLOGY

TOPIC: TSHIPISE GEOLOGICAL FIELD-MAPPING REPORT.

GROUP C (PROFILE A)

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1. Introduction

Geological mapping is a highly interpretive, scientific process that can produce a range of map products for many different uses, including assessing groundwater quality and contamination risks; predicting earthquake, volcano, and landslide hazards; characterising energy and mineral resources and their extraction costs; waste repository siting; land management and land-use planning; and general education (Johnson *et al*., 2006). In particular, our geological mapping was for general education i.e. it was to enhance our knowledge; put our theory into practice, such as interpretation of different type of rocks, their characteristic lithology and their relation to one another; identification of geological structures in the field; and to explore working environment of a geologist. The purpose was to stabilise or balance our theoretical knowledge with actual field experience. It was also to introduce us to the basics of geological mapping i.e. to familiarise us with the use of instruments, general methodologies and procedures of geological mapping.

2. Literature review

The study area was situated in the northern part of South Africa, Limpopo Province at Klein Tshipise village which is about 67.7km south east of Musina and about 51.5km north east of Sibasa. Geologically, this area forms part of the Soutpansberg Group which is subdivided into seven most recognised formations (Brandl, 1999). In relation to our mapping, only summary of Soutpansberg stratigraphy, structural geology and economic geology will be reviewed.

2.1 Stratigraphy of the Soutpansberg Group

The Soutpansberg rocks rest unconformably on gneisses of the Limpopo Belt and Bandelierkop Complex (Barker, 1983). Along the eastern and most of the northern margin the Soutpansberg juxtaposed against, rocks of the Karoo Supergroup. The contact relationship between the Soutpansberg and Waterberg Group rocks is a tectonic one, though the latter rocks are believed to be younger (Barker, 1979; 1983). The Group is best developed in the eastern part of the Soutpansberg, where the maximum preserved thickness is about 5000m (Johnson *et al*., 2006).

The Soutpansberg Group represents a volcano-sedimentary succession within its seven formations (Brandl, 1999). The basal discontinuous Tshifhefhe Formation is only a few metres thick, and made up of strongly epidotised clastic sediments, including shale, greywacke and conglomerate. The Sibasa Formation on the other hand is dominantly a volcanic succession with rare discontinuous intercalations of clastic sediments, having a maximum thickness of about 3000m. The volcanics comprise basalts, which were subaerially extruded, and minor pyroclastic rocks. The basalts are amygdaloidal, massive and generally epidotised. The clastic sediments include quartzite, shale and minor conglomerate; can reach locally a maximum thickness of about 400m (Johnson *et al*., 2006).

The overlying Fundudzi Formation is developed only in the eastern Soutpansberg, and wedges out towards the west. It is up to 1900m thick, and consists mainly of arenaceous and argillaceous sediments with a few thin pyroclastic horizons (Brandl, 1999). Near the top of the succession up to four, about 50m thick layers of epidotised basaltic lava are intercalated with the sediments (Johnson *et al*., 2006). It is followed by the Wyllie's Poort Formation, which is an almost entirely clastic succession, reaching a maximum thickness of 1500m. Since the formation overlies, from east to west, progressively older units, its lower contact is interpreted to form a regional unconformity (Barker, 1979). Resistant pink quartzite and sandstone with minor pebble washes dominate the succession, with a prominent agate conglomerate developed at the base (Brandl, 1999).

The uppermost unit is represented by the Nzhelele Formation, which consists of a 400m thick volcanic assemblage (Musekwa Member) at the base, followed by red argillaceous and then by arenaceous sediments. Maximum preserved thickness is of the order of 1000m. The volcanics consist of basaltic lava and several thin, though fairly consistent horizons of pyroclastic rocks of which one is copper-bearing (Barker, 1979; Brandl, 1999; Johnson *et al*., 2006).

North of the main Soutpansberg outcrop two additional units, the Stayt and Mabiligwe Formations, are recognised. The former succession which is preserved between two prominent faults has a maximum thickness of 1800m (Johnson *et al*., 2006). Basaltic lava is developed at the base, followed by argillaceous sediments with thin interbeds of pyroclastic rocks. Agate conglomerate and pink quartzite are capping the top. Copper mineralisation is known to occur in strongly fractured portions of the succession. The Mabiligwe Formation is confined to a small area along both banks of the Limpopo River, having a thickness of at least 50m. It is entirely a clastic succession, with no volcanics developed except for a thin tuffaceous horizon (Barker, 1979).

2.2 Structural geology of the Soutpansberg Group

The Soutpansberg strata which are tilted gently towards the north are truncated by numerous extensional faults. Two fault systems are recognised, the dominant one trending ENE (parallel to the regional strike) and the other one NW to WNW. These structures generally delineate discrete elongated blocks. The majority of faults are believed to have been initiated in pre-Karoo or even during Soutpansberg times, with most of the structures having been reactivated in post-Karoo times. The Soutpansberg rocks are unfoliated, but are in places strongly fractured (Barker, 1979).

2.3 Economic geology of the Soutpansberg Group

The Soutpansberg rocks are not well endowed with economic minerals, and only copper mineralisation, considered to be sub-economic, is reported from its eastern part. Salt is produced at the "Soutpan" from brines pumped up from deep wells. A number of thermal springs occur, and they are invariably associated with recently re-activated post-Karoo faults. The mountains, which receive exceptional high rainfall, play a unique role in recharging the regional groundwater, in particular the area north of Soutpansberg (Barker, 1979; 1983; Brandl, 1999).

3. Methodology and procedures

During our geological field-mapping, basic items of equipment for undertaking geological mapping was used. Each item of equipment was serving a distinctive purpose i.e. making a very important contribution to the information collected or otherwise obtained during our mapping through and with respect to every function served by each item of equipment. Items of equipment include:

- **Geological Hammer**- used to break part of the outcrops into portable samples, and also for the purpose of providing a fresh (unweathered) part of the outcrop for accurate and precise interpretation.
- **Topographic/Chisel Hammer**- it serves almost the same purpose as the geological hammer but smaller in size compared to a geological hammer. Moreover, it can also be used to reduce the size of sample, sharp edges of a sample (for carrier purposes) and further breakage of the sample (providing more fresh surfaces of the sample for additional/secondary interpretation of the sample).
- **Compass**- the compass serves many different purposes including measuring the attitudes, directions and analysing the sample. In the case of attitudes, the compass is used to measure the strike directions, dip directions and dip angles of outcrops of different lithology (especially of sedimentary and metamorphic); the compass is also used to identify the north, east, south and west directions including the bearings in relation to a location in the field; and the compass also has a hand lens that allows the analysis of a sample in the field e.g. understanding through visualising, the grain sorting of a sedimentary rock sample.
- **Topographic map/Base map**- it was used to indicate the literal extension of the lithologies along traverse lines; for locating ourselves in terms of relating the reference features we identified in the field such as mountains, streams, etc. with those presented in the map; and for providing first-hand information such as areas that are covered by man-made features within the study area, the general topography of the study area (either mountainous or flat), highest elevations, and the steepness and gentleness of the slopes within the study area.
- **GPS(Global Positioning System)**- this was also used for locating ourselves in terms of specific geographic coordinates of the area in terms of longitudes and latitudes;

marking specific locations (by coordinates) of outcrops on a map; also used to keep our traverse lines when moving during our field mapping; recording or reading elevations (above the mean sea level) at specific locations in the field; and measuring distance between two points in the field.

- **Hand lens**- used for magnification, allowing the visualisation of mineralogy of both rock samples and soil samples for analysing the properties (especially physical properties of a given sample) for proper geological interpretation. It was about twenty times magnification and most minerals that are not visible to naked eyes were visible.
- **Tape measure**- for measuring distance between two points; measuring pace to allow a more accurate pacing method; and measuring the extent of an outcrop. The tape measure was only 100m so distance measurement was limited to short distances and it was most used in measuring the joints and faults to understand the strength of the forces acted on the rock body during their formation.
- **Clinometer**- this instrument was specifically for measuring the dip angle besides the compass, consist of a protractor (angles) and a string joined to the protractor with metal on the other end for determining the angle.
- **Field Bag**- this was for the purpose of carrying collectively the samples and other instruments as we move along our traverses.
- **Sample Bags**- used to put the samples before we actually put them in a sample field bag and also the sample identification was recorded on them.
- **Field Notebook**- used for recording the short notes about any analyses and interpretation made in the field to allow additional/secondary interpretation (that's interpretation after the field visit (mainly in office or other area besides in the field)).
- **Protractor**- used to measure the angles (dip angles) when drawing the cross-section of the lithologies mapped.
- **Colour pencils**- they were used to mark along the traverse lines, the area covered by the lithology and each colour was a representative of a certain lithology e.g. sandstone (otherwise sandy soil) indicated by yellow. The colours used were in reality the formal colours to represent lithologies in a map.
- **Pencil**- it was used to indicate the attitudes such as strike direction on a map in the field and all other drawings were performed using a pencil e.g. cross-section, boundaries of lithologies, and also indicating lithologies such as those of calcrete.
- **Pen**- it was used in noting the notes, and all writings including calculations.
- **Permanent marker**- it was used to mark the samples on both the sample bags and the samples itself.
- **Camera**- it was used in capturing the outcrops of lithologies and also the geological structures that cannot be represented by samples such as faults, interbeds, joints and others.
- **Tracing paper**- this was one of the vital item of equipment in terms of tracing the overall geological map (made possible by its transparency).

The other items of equipment (not mentioned) are also of important role and these include: **calculator, ruler, eraser, pencil sharpener** and many others, were used interchangeably with other items of equipment mentioned or listed.

4. Interpretation

The interpretation is one the main purpose of the visit and as such the detailed information of all the study areas i.e. the Klein Tshipise geological field mapping; the Domboni structural geology studies; and the Folovhodwe Mine visit will be elaborated at this point following the order at which there are listed above.

4.1 Klein Tshipise Geological Field Mapping

The setting of the area is that described at or within the first paragraph of the literature review of this document, as such the interpretation proceeds to the development of the traverses and the overall analyses of the rock samples that we collected during the field mapping; including the production of both the overall geological map of the area and the cross-section of the selected area on the geological map.

The traverse lines were developed in such that they cut across the striking directions of possibly maximum lithologies and they were extending at a distance of about 5km starting immediately on the southern side of the tarred road (general main road of Klein Tshipise) proceeding southwards. The traverses were developed in such that in each out of five groups was having four traverses and the division was specified in terms of profiles in which ours was **profile A.**

4.1.1. Reconnaissance

In mentioning all, the field mapping started by reconnaissance where we practiced how to locate ourselves in preparation to the real field mapping; acquiring first-hand information such as the general climate of the area, the dominant vegetation and the general soil type; and also as geologist we were to get the feel of the area before actually conducting the field mapping including the search for clues as to what kinds of lithologies are we to expect in the area during our mapping. The main idea was also to familiarise or otherwise verify the development of traverse lines in accordance to cut across the lithologies.

4.1.2. Field-mapping and sample interpretation

The field mapping will not be described in terms of traverse lines rather the collective general process of the profile with respect to each sample collected provided is that of different lithologies; therefore each sample that will be described is representing the lithology encountered in the field during the mapping and also their order in description represent the order at which lithologies are set in terms of mapping findings and clarity will be represented on the general geological map produced after the collective information of the mapping.

During our field mapping we were encountering generally the sandy soil at the beginning of our traverses and mostly flots (weathered boulders from outcrops) with an exception of one outcrop we encountered immediately at the beginning of our traverse, in particular the first traverse. The sample from this outcrop was taken for analysis and interpretation; the following properties were identified using the hand lens to magnify the parts of the sample that did not give clear interpretation:

❖ **SAMPLE 1A1**

- Location: -22^{o}31'29.6''S
  -30^{o}31'6.2''E
- Elevation: 472m above mean sea level.
- Attitudes: not measurable
- Colour: creamy or whitish
- Texture: a mixture of fine and coarse (depending on the part of the sample that is viewed,
- Composition: whitish material was suspected to be that of chemical sedimentary in the field which was confirmed to be calcite through the fizz in respond to the HCL acid used at camp-site, and also composed of some sand and gravel (concrete);
- Sorting: was agreed to be poor since the rock sample contain both chemical and clastic sediments;
- Packing: well compacted or well packed;
- Maturity: matured in relation to its resistance during the hammering of the sample;
- Percentage Composition: about 85% is calcite and the remaining 15% is concrete;
- Environment of Deposition: the overall composition of the rock was discussed to be that of a basin deposition, and further reasoning considered the presence of turbidity current in deep waters since calcite is associated with deep waters and the concrete with high energy waters;

With all mentioned characteristics the rock was concluded to be **calcrete.**

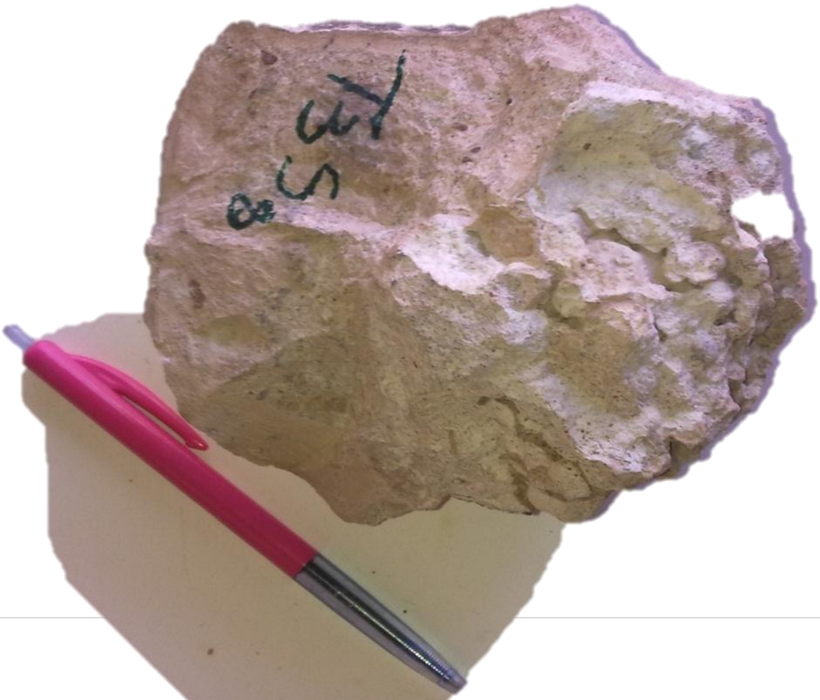

Figure 1.1

❖ **SAMPLE 1A2**

- Location: -22°32'35''S
  -30°39'22.2''E
- Elevation: 492m above mean sea level.
- Attitudes
  - Strike direction- N80°E
  - Dip direction- North-West
  - Dip angle- 22°
- Colour: pinkish;
- Texture: coarse-grained (with gritty feel);
- Composition: composed of light-coloured grains of quartz and feldspars including very little amount of other materials;
- Sorting: well sorted;
- Packing: well packed;
- Maturity: matured;
- Percentage Composition: consist of 85% quartz, 10% feldspars and 5% of other materials;
- Compositional maturity: mature;
- Textural maturity: sub-mature;
- Environment of Deposition: marine environment

The above characteristics supported the conclusion that the rock sample is **sandstone.**

Figure 1.2

❖ **SAMPLE 1A3**

- Location: -22°31'52.6''S

-30°31’2.1’’E

- Elevation: 544m above mean sea level.
- Attitudes
  - Strike direction- N86°E
  - Dip direction- North-West
  - Dip angle- 36°
- Colour: pinkish (darker compared to sample 1A2);
- Texture: crystalline;
- Composition: composed of recrystallized quartz grains;
- Sorting: the rock did not show any sorting but rather metamorphism. The sample displayed a high grade metamorphism since the characteristics of the protolith are completely altered with only composition resembling that of the protolith.
- Foliation: non-foliated, no parallel alignment was shown by the rock sample;
- Percentage composition: composed almost of quartz about 90% including 10% of feldspar and other materials such as cementing materials from the protolith, it was also including clearly visible quartz veins which were tested for hardness using the steel nail (5.5 in hardness) and were found not stretchable i.e. confirmed that is composed of quartz since is 7 in Mohr scale of hardness (Tarbuck *et al.*, 2011);
- Type of metamorphism: contact metamorphism since the rock sample did not show any foliation but with a high grade of metamorphism.

The above physical characteristics lead to a conclusion that the rock sample is a **quartzite.**

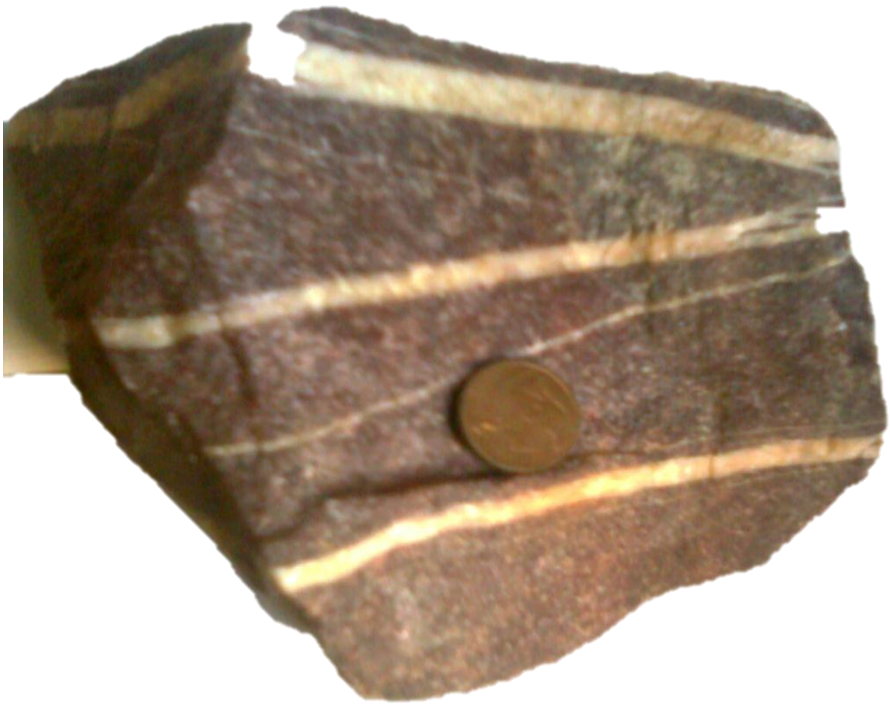

Figure 1.3

❖ **SAMPLE 1A4**

- Location: -22°34'7.4''S
  -30°39'12.8''E
- Elevation: 532m above mean sea level.
- Attitudes**:** not measurable.
- Colour: milky or whitish
- Texture: phaneritic texture (coarse-grained);
- Composition: composed almost completely of quartz;
- Percentage composition: 98% quartz (that's silica SiO_2) and the 2% is thought to be of those minerals that crystallise at almost same temperature with quartz in Bowen's reaction series (Tarbuck *et al.*, 2011) such as the potassium-feldspars.
- Type of magma: rhyolitic magma considering the high composition of silica.

This had put some difficulties in coming up with a proper name since they have been arguments as to whether is a quartz vein or quartz intrusion but in considering the scale of the area we were mapping, it agreed to be a **quartz intrusion.**

Figure 1.4

❖ **SAMPLE 1A5**

- Location: -22°34'30.2''S
  -30°39'13.5''E
- Elevation: 519m above mean sea level.
- Attitudes
  - Strike direction- N52°W
  - Dip direction- North-East
  - Dip angle- 18°

- Colour: brownish;
- Texture: clastic fine texture;
- Composition: composed of clay-sized particles of different minerals, most of those less resistant to weathering; in particular, the alumina-silicate minerals (Tarbuck *et al.*, 2011).
- Sorting: well sorted;
- Fissility: the rock was fissile i.e. able to break along planes of weakness;
- Maturity: matured;
- Percentage composition: the estimation of percentage was difficult since the clay-sized particles can be from any rock of any composition and also the magnification of hand lens is limited to 20x; assumption were made that the rock sample is composed of 85% alumina-silicate minerals, 10% ferromagnesian minerals and 5% others;
- Composition maturity: matured;
- Textural maturity: matured;
- Environment of deposition: the sample has characteristics of those rocks deposited in deep quiet water environments such as those of a basin or marine environment.

Above characteristics are used in the conclusion that the rock sample is a **shale.**

Figure 1.5

❖ **SAMPLE 1A6**

- Location: -22°34'7.4''S
  -30°39'12.8''E
- Elevation: 524m above mean sea level.
- Attitudes: not measurable.
- Colour: greenish or greyish;
- Texture: aphanitic (fine-grained);

- Composition: the green mineral was concluded to be olivine, the other greyish mineral assumed to pyroxene, amphibole and some calcium-rich feldspars;
- Percentage composition: olivine is the dominant mineral in this rock sample about 65% and the remaining 35% consist of pyroxene, amphibole and calcium-rich feldspars which cover about 25%; the rest is pyroxene and amphibole.
- Type of Magma: basaltic magma because of the relative low silica concentration and high in ferromagnesian minerals.

Interpreting the above physical properties helped us to come up with the name of the rock which is **basalt.**

Figure 1.6

4.1.3. Geological Map and nature of the area

In general terms, these were the different samples we collect during the field mapping we conducted. After the necessary information is being collected, we used the colour pencils to join the rock units that had the same characteristics and same physical properties i.e. correlating. The information used was the one we noted during the mapping including especially the attitudes such as the strike direction which were assessed for the lateral extend of the lithologies, the dip directions which was used to the direction at which the rock is dipping; and by this we were able to understand the behaviour of lithologies at boundaries or otherwise their type of contact was noted during the mapping and as such it was indicated on the map in terms of a dotted line (gradational contact) or solid line (sharp contact). Considering all the information the geological map of the area was produced to show the lateral extend of the lithologies and as such was to fulfil one of the objectives of the geological mapping. The map produced was of the all combined groups.

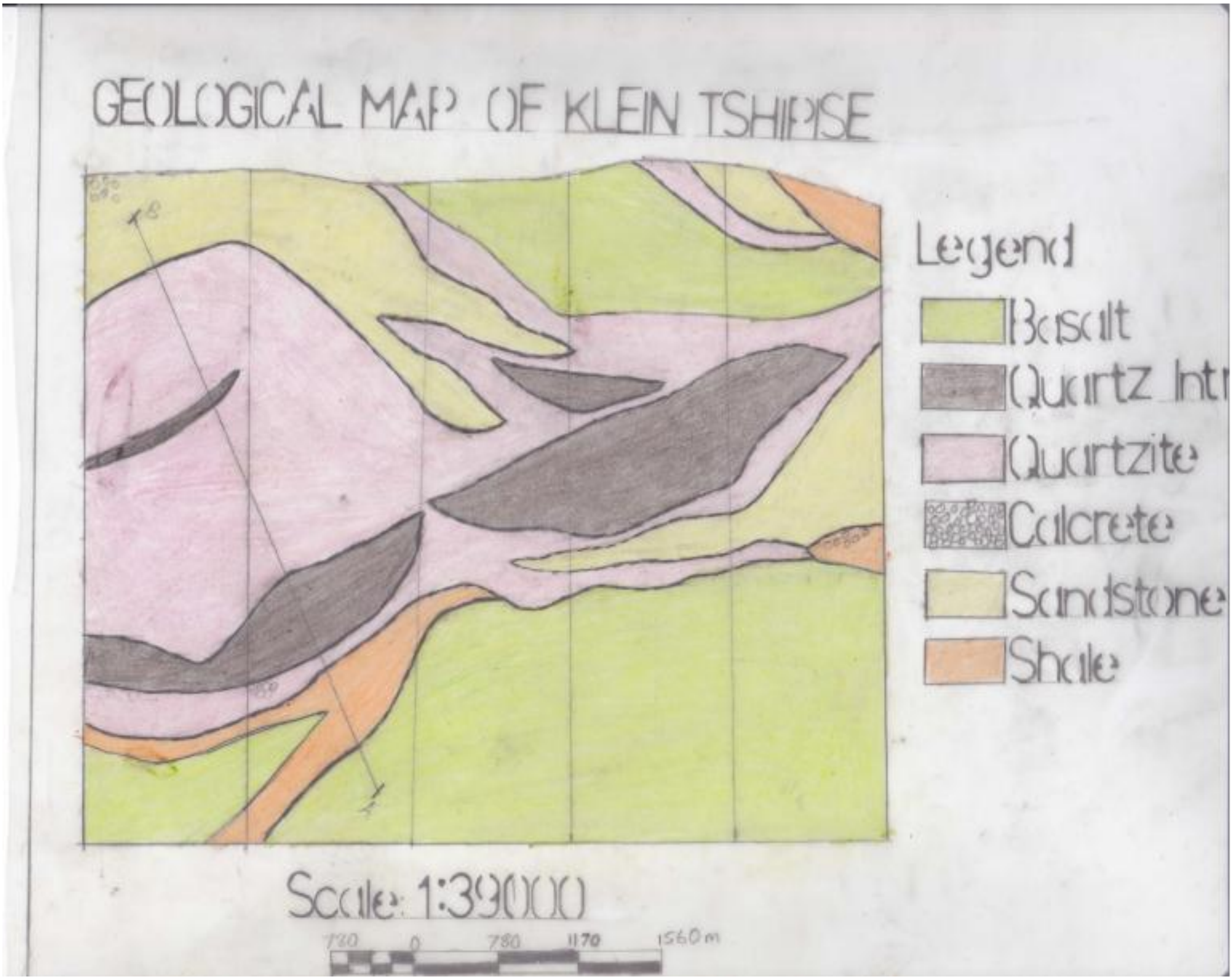

Figure 1.7

After the general map has been produced, further studies were conducted about the nature of the area as to the origin of such lithology distribution. The studies or the discussion had concluded that at first this area was a basin and this influenced the deposition of the sedimentary rocks at which sandstone was the one relatively covering a much larger area and the shale a smaller area compared to the sandstone. As the time goes on, it came a time of volcanic eruptions at which the sandstone was metamorphosed to quartzite through contact metamorphism. Although the volcanic eruptions are associated with metamorphism, it seemed not the case to the shale that still existing unaltered; this put on the table proposals that the basaltic magma might have just in spreading came to contact with the shale and lead to little or no alteration to the pre-existing rock which is shale in this case.

4.1.4. Cross-section and cross-section based interpretation

The proving and disapprovals of proposals were assessed in terms of cross-section of the geological map of the area, which was then drawn. In drawing the cross-section, a lot of things were to be put to practice; which at first we identified the area we wanted to draw the cross-section on the geological map and this was because the cross section was supposed to cover as much lithologies as possible. Then the information was transferred to a topographic map of the area to understand the difference in elevation of the area covered by the cross-section; this was done in terms of identifying the area of lowest elevation which was between 480m and 460m above the mean sea level and the highest elevation was just above 560m but below 580m; and with these elevations we able to calculate the contour interval, also considering other contours we identified on the topographic map and found the contour interval to be 20m. The contour interval helped us to deduce a scale that has little vertical exaggeration.

After producing the topography as a cross-section, we stressed much further to mark the boundaries of our lithology according to the distance they cover on the map which we used the ruler to measure. With all boundaries marked on the cross-section, we used the attitudes we recorded in the field especially the dip directions to know the direction at which the lithology is tilted and the dip angle to know at what angle is the strata tilted; and there we find out that the lithology with small value of dip angle are likely to be of shallow depth and in putting the exact dip-angles on the cross-section to produce as likely the behaviour of lithologies as possible a protractor was used. We also used the representative colours to shade the lithology coverage beneath the surface of the earth. For the horizontal scale, the calculations were not necessary since the area marked (i.e. marked **A** (starting point) and **B** (end point)) was transferred directly to the graph paper.

Our cross-section was covering also the area from the adjacent profile which was profile **B**, then the attitudes and some other detailed information we to ask for them from the other group, the we record them on the map where they were measured. This was to ensure that the attitudes we use to draw our cross-section was as close to the line of the cross-section as possible, and this was for precision and accuracy of the represented lithologies. As such the map was designed to cover only the area necessary to the cross-section or otherwise just cut from the general map and the line of cross-section was drawn even in the general map that it may be related to the map used for indicating only the cross-section. The keys or legend was only put as to ensure the basics of map interpretation and understand the relationship between the general map and the map showing the cross-section.

GEOLOGICAL MAP OF PROFILE A & B

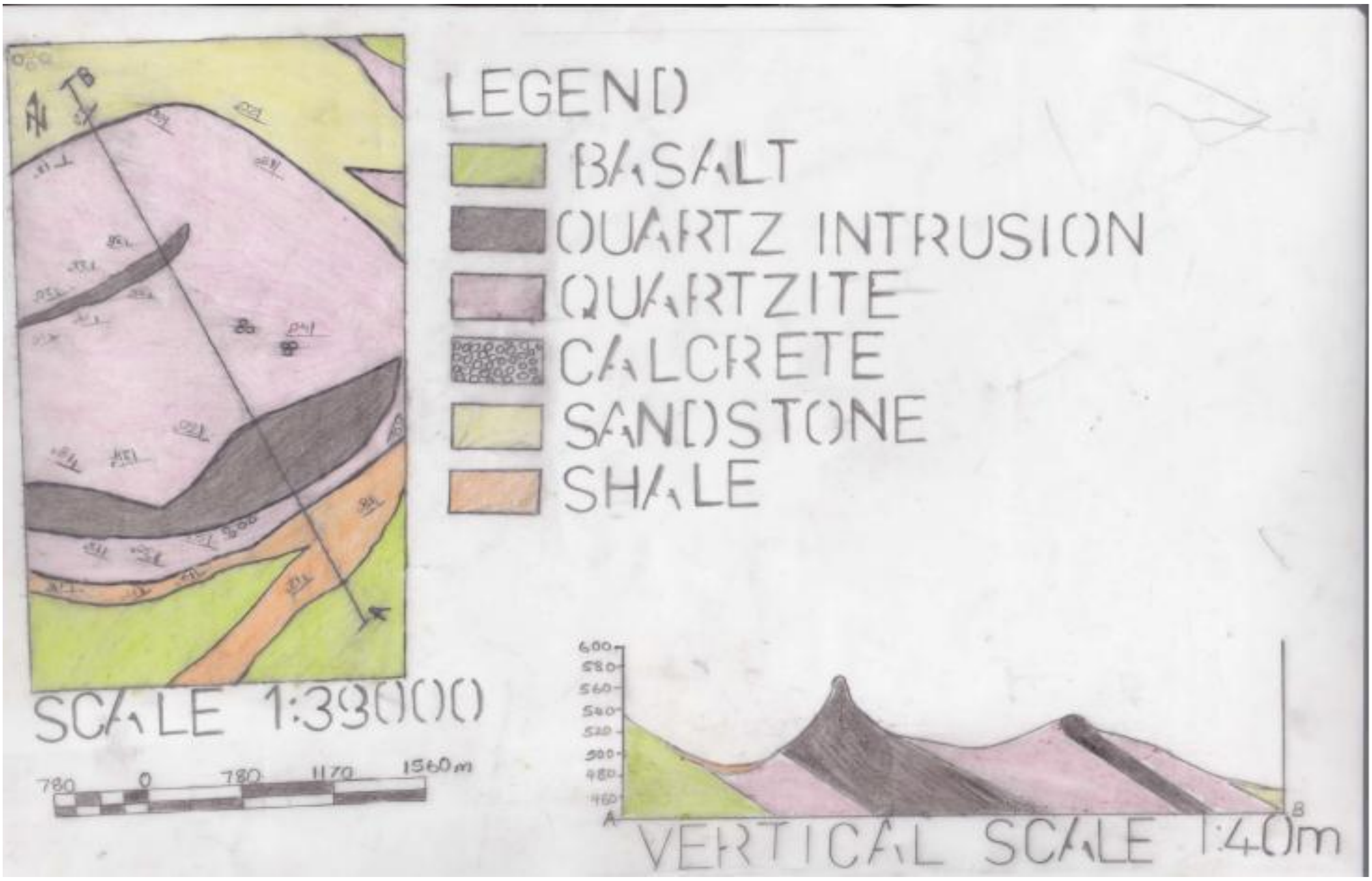

Figure 1.8

4.2 Domboni structural geology studies

Domboni village was the area that our geological structures were located i.e. the study area. The area was located on the western side of the village where we used a compass to locate the north in relation to the location we were, the name of the village to have the descriptive direction in relation to the village and the GPS to tell the specific coordinates of the area.

- <u>Methods of locating ourselves in the field</u>
    - Compass

      Using a compass to locate oneself is one of the oldest and famous method to use in the field in which the compass is held in hand, bubble is centred, and then the compass is aligned to the direction at which the north is pointed. In this situation is where the reference features came into place, in our case we used the mountain south of the village, the stream from the mountain and the village as a whole.

Figure 1.9

- Name of the village
  In this case we used the name of the village to state our location i.e. we were in Domboni village. Also our location in relation to the village, in our case we were in the westerly direction of the village.
- Global Positioning System (GPS)
  GPS requires just a skilled user to switch it on, browsing through the menu and choose the right option; lastly to read the coordinates displayed on the GPS to locate oneself in terms of the specific coordinates of the area.

LOCATION A

Direction – west of the village and 5km southwards from the tar road.

Soils – shiny grey in colour composed mainly of the grains of the quartz mineral and small portion of mica likely muscovite with an approximation of 5-10% in composition. The surrounding floats were angular in shape, which gave us the information about their transportation i.e. transported for a very short distance from the parent material which is likely to be a rock that has more quartz as its composition such as the sandstone, granite and others.

Figure 1.10

LOCATION B

Sight estimation of distance was 45m and the accurate distance measured by a tape measure was 46m. We encountered light-coloured outcrops of sedimentary rocks indicating presence of felsic minerals, which were overlaid by bed forms, ripple marks. Major ripple marks identified were symmetrical. These indicated a water environment with weak currents where water motion was dominated by oscillations i.e. the ripple marks formed were as a result of back and forth movement of water on the surface of a basin or shallow marine environment.

Figure 1.11

LOCATION C

On location c, we identified bedding planes; and these were relatively flat surfaces along which rocks tend to separate or break. Series of beddings were also identified which were striking in a N20^{o}E direction and dipping at 12^{o} with a thickness of about 8.1cm. Layers of bedding planes were showing youngling-upwards. The layers were not overturned and generally conformed to the law of superposition and lateral continuity (Tarbuck *et al.*, 2011). Generally, each bedding plane marks the end of one episode of sedimentation and the beginning of another represent a different time of at which deposition has occurred.

Figure 1.12

LOCATION D

This location was apparently characterised with faults; and these are features that have experienced great shear displacements, usually exceeding a meter. A rock surface immediately above the fault is the hanging wall block and the one below it is the foot wall block.

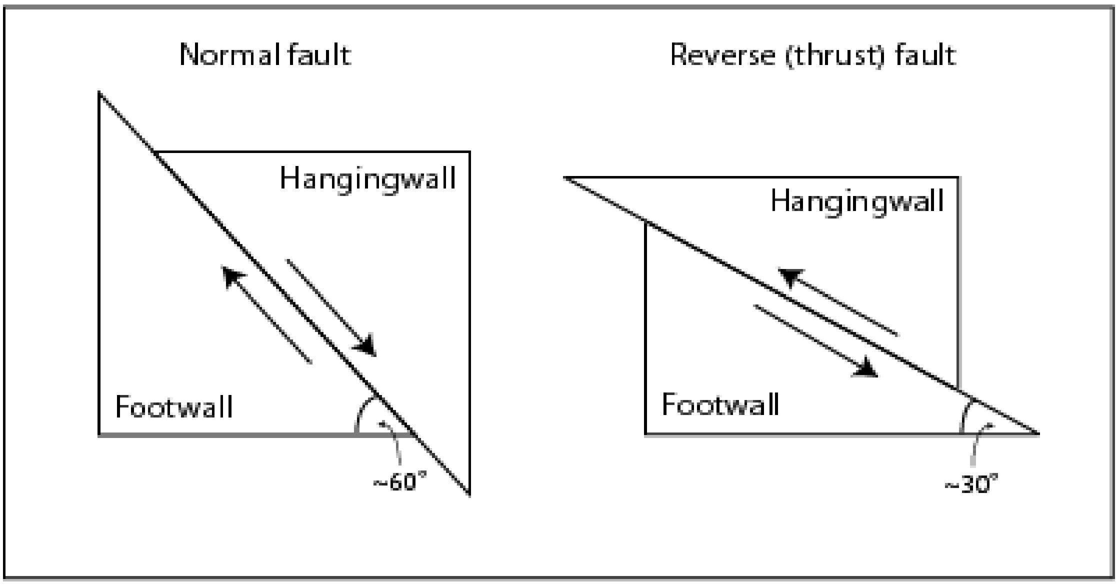

Figure 1.13

Reverse fault – these are dip-slip faults in which the hanging wall block moves up relative to the footwall block and they usually form an acute angle which the fault planes dip in the same direction.

Normal fault – they are also dip-slip faults with relatively lag, low diffs due to downward motion of the hanging block. We have also observed a large reverse fault with steep dip.

Figure 1.14

Also the other minor existing faults in the area are mostly reverse, their displacements are comparatively small to that of figure 1.14 showing relatively small amounts of tension or any other force that is applied to the rock.

Figure 1.15

Progressively we observed the joints in the most parts of the rock at which we measured the attitudes of these joints to understand the general force that normally exist and influence the structures in this area as to how much of it i.e. interpreted by the study of the size of each fault . The joints were very distinctive in terms of their distribution on the outcrop we conducted our studies on.

Figure 1.16

The attitudes measured were recorded in a table to provide information for further interpretation and detailed studies of the area.

LENGTH	STRIKE DIRECTION	DIP ANGLE
27.5 cm	S70°E	34°
21cm	N72°E	26°
32.5cm	N60°E	39°
23cm	N78°E	31°
20cm	N54°E	19°
13.5cm	N74°E	23°
32cm	N82°E	41°
28.3cm	S20°E	26°
30cm	N48°E	27°
29cm	N82°E	24°
28cm	N30°W	44°
23.5	S60°W	37°

177.5cm	S20^{o}W	30^o
47cm	N68^{o}E	22^o
62cm	S86^{o}E	43^o
34.5cm	N54^{o}E	27^o
54cm	S60^{o}E	33^o
29cm	S70^{o}E	32^o
24cm	N64^{o}E	36^o
21.2cm	S26^{o}E	20^o
33cm	N86^{o}W	28^o
46.5cm	S70^{o}E	32^o
30cm	S70^{o}E	25^o
37cm	N42^{o}E	44^o
41.1cm	Due North	34^o
33.5cm	S70^{o}E	25^o
79cm	S70^{o}W	27^o
28cm	N40^{o}E	19^o
35.2cm	S68^{o}W	39^o
22cm	S2^{o}W	40^o
35cm	N48^{o}E	20^o
21cm	S28^{o}E	38^o
19.5cm	N56^{o}E	28^o
78cm	S70^{o}E	41^o
40cm	S70^{o}E	27^o
62cm	N10^{o}W	39^o
44cm	N10^{o}E	30^o
6.5m	N85^{o}E	28^o
2.15m	Due East	26^o
95cm	N28^{o}E	23^o
4.25m	N10^{o}E	33^o
83cm	S30^{o}E	34^o
1.25m	N60^{o}E	37^o
51cm	N60^{o}E	42^o
87cm	N30^{o}W	18^o
1.1m	N20^{o}W	22^o
28cm	S10^{o}E	36^o
71cm	S84^{o}E	40^o
3.9m	N20^{o}E	20^o
27.6cm	N4^{o}W	28^o
45cm	S46^{o}E	32^o
29cm	N29^{o}E	21^o
17cm	S46^{o}E	27^o
1.22m	N44^{o}E	37^o
1.8m	S76^{o}E	44^o
71cm	S30^{o}E	23^o
44cm	N20^{o}E	31^o
66cm	S30^{o}E	28^o

30.1cm	N20^{o}E	24^o
76cm	N29^{o}W	30^o
80cm	S30^{o}W	38^o
50cm	S86^{o}W	21^o
60cm	S6^{o}E	34^o
2.8m	N80^{o}E	27^o
15cm	S20^{o}E	22^o
60cm	N30^{o}W	35^o
3.9m	N31^{o}W	32^o
85cm	N70^{o}E	40^o
31cm	N54^{o}E	20^o
71cm	N10^{o}E	22^o
25cm	N30^{o}W	29^o
75cm	S22^{o}W	36^o
2.8m	N48^{o}E	30^o
84cm	S56^{o}E	28^o
1.9m	N6^{o}E	43^o
46cm	N36^{o}E	19^o
2.7m	S86^{o}E	32^o
69cm	S15^{o}E	34^o
89cm	N74^{o}E	23^o
56cm	N58^{o}E	33^o
32cm	S30^{o}E	41^o
1.1m	S20^{o}E	18^o
2.99m	S14^{o}E	20^o
4.5m	S16^{o}E	30^o
29cm	N20^{o}W	26^o
1m	S22^{o}E	37^o
34cm	S29^{o}E	28^o
35cm	S70^{o}W	40^o
98cm	N40^{o}E	34^o
15cm	S79^{o}E	23^o
23cm	S72^{o}E	35^o
33CM	S80^{o}E	19^o
1.4m	S81^{o}E	32^o
1.2m	S71^{o}E	37^o
40cm	S67^{o}E	41^o
85cm	N40^{o}E	26^o
70cm	N71^{o}E	18^o
67cm	N86^{o}E	23^o
60cm	S36^{o}W	34^o
39cm	N6^{o}E	41^o
50cm	N50^{o}E	36^o
67cm	N40^{o}E	25^o
60cm	S70^{o}E	43^o
29cm	N22^{o}E	35^o

23cm	N38°E	33°
17cm	N22°E	38°
53cm	N34°E	23°
21cm	N50°E	43°
4.73m	N51°E	45°
92cm	S12°E	32°
54cm	N28°E	25°
54cm	N72°E	23°
65cm	N68°E	29°
50cm	N38°E	37°
86cm	N80°E	19°
65cm	S21°E	34°
59cm	N24°E	42°
53cm	S44°E	23°
43cm	N42°E	33°
2.13m	N22°E	18°
65cm	N33°W	34°
50cm	N84°E	36°
86cm	N65°W	26°
45cm	N54°E	27°
1.3m	N67°E	44°
1.44m	S53°W	35°
67cm	N13°W	41°
78cm	S52°W	29°
4.1m	N63°E	37°
19cm	S67°E	30°
35cm	N67°W	43°
56cm	N68°E	27°
47cm	N59°E	32°
90.3cm	S2°E	21°
39cm	N56°W	40°
23cm	N65°E	25°
14cm	N72°E	35°
68cm	S43°W	39°
84cm	S66°W	18°
30.7cm	N15°W	28°
86cm	N87°E	22°
44cm	N48°E	19°
15.8cm	N23°W	43°
45cm	S45°W	39°
78cm	N67°E	37°
98cm	N55°E	24°
1.67m	S78°E	36°
32cm	S56°W	21°
64cm	N2°W	41°
55cm	N48°E	32°

14.6cm	N56°E	37°
95cm	S8°W	43°
83cm	N32°W	26°
74cm	S78°E	36°
33cm	N45°E	33°
87cm	S89°E	29°
34cm	S43°E	44°
99cm	N78°E	36°
44cm	N33°E	21°
67.4cm	N87°E	43°
55cm	N22°E	34°
83.2cm	N5°W	33°
2.34m	N67°E	18°
39cm	N34°E	26°
58.4cm	N56°W	28°
33.2cm	N43°E	42°
78.3cm	N78°E	45°
48.7cm	N47°E	29°
21cm	N39°E	33°
77cm	N16°E	37°
57.3cm	N66°E	36°
2.3m	N14°W	40°
11.8cm	N56°W	26°
56cm	N48°E	35°
81cm	N34°E	38°
66cm	S67°W	43°
46.2cm	S33°W	37°
68.3cm	N74°E	33°
1.4m	N77°E	41°
91.2cm	N21°W	23°
56cm	N76°E	36°
65cm	N55°E	31°
35.7cm	N42°E	22°
44.5cm	S46°E	45°
87cm	N63°E	33°
45.3cm	S64°W	24°
67.8cm	N57°W	34°
1.8cm	N43°E	19°
47.4cm	S32°E	23°
67cm	N61°E	38°
34cm	N68°E	30°
2.6cm	S74°W	25°
88.5cm	S58°W	26°
2.2cm	N33°E	43°
36cm	N83°E	33°
44.9cm	N45°E	38°

1.5cm	N77°E	25°
86.4cm	N62°E	36°
57cm	S27°E	34°
47.3cm	S33°W	28°
68.5cm	N56°E	32°
78.9cm	N66°W	43°
47.4cm	S32°E	44°
1.8m	N23°E	28°
66.4cm	S53°E	21°
56cm	S34°E	38°
2.1m	N67°E	44°
37.5cm	N78°E	23°
44.8cm	N54°E	41°
93cm	N63°E	33°
89cm	S67°W	24°
34cm	N23°W	36°
55cm	S78°E	34°
67.4cm	Due East	36°
47.5cm	S87°E	32°
34.7cm	N62°E	21°
66cm	N22°W	34°
49.4cm	N57°E	19°
36.7cm	Due East	42°
78cm	N36°E	45°
55cm	N23°E	18°
45cm	N45°E	28°
67.9cm	N76°E	26°
34cm	N34°E	37°
56cm	N65°E	42°
92cm	N15°E	22°
44cm	N89°E	34°
19cm	N16°E	45°
2.1m	N56°E	28°
67.4cm	Due East	36°
67cm	N67°W	32°
23cm	N87°E	18°
34cm	N49°E	43°
87cm	S25°W	45°
36cm	S65°W	25°
56.4cm	S46°E	34°
49cm	N47°E	43°
67cm	N45°W	32°
1.2m	N67°E	34°
89cn	N43°E	45°
45cm	N16°E	25°
24cm	N88°W	23°

4.3 Folovhodwe Mine Visit

Location and description of the mine

Folovhodwe mine is an open-pit mining operation which is located about 20km east of Tshipise just north of the R525 provincial road and about 60km south-east of Musina which is the nearest town in the Limpopo Province of South Africa. The mine undertake prospecting and mining operations by methods involving very low capital investment and mining technologies which are not so specialized which make it a small scale mining operation. The type of mineral being mined is magnesite ($MgCO_3$), a whitish magnesium carbonate mineral that looks almost like calcite but it is much harder.

Purpose of the mine visit

The main purpose was to learn how the mine operates and also how to practice the mine safety measures. Another reason was to make ourselves familiar with a surface mining operation as future geologists since some of us will be working in such mines.

Prospecting

Prospecting is the physical search for minerals, fossils, precious metals or mineral specimens (Ratau, 2005). Prospecting is a small scale form of mineral exploration which is an organized, large scale effect undertaken by mineral resource companies to find commercially viable ore deposits. In this area the magnesite being mined was found in a form of veins which are continuous and are known as stock works. The magnesite which was being mined was white and clear with a good quality; the unwanted one had voids and looked stained. Prospecting is crucial for all mining operations because it gives further explanation about the life of the mine; the life expectancy of Folovhodwe mine is 10 years.

Workings area

Some trucks are used for transporting loose ore material which had been crushed by a scooper to an area where there is sorting taking place. The downward digging in the mine is determined by the water table because once interrupted it will flood the area, unlike in a place where flooding takes place when coal is being mined water can be pumped out by specific methods but in this case the water affects the important mineral and gives it a greenish color resulting into a loss of value of the mineral.

The type of sorting practiced in this area is a manual sorting called hand sorting. This type of sorting is time consuming and also depends much on the attitude of the workers, workers determined to do their job will do it well and therefore success and benefits for the mine. Hand sorting could explain the high rate of women being the ones performing it because they are perceived as hard working and dedicated people.

Mine safety and health maintains

There were some safety measures that were being practiced in this mine, the mine workers wore some garments that protected their bodies from any harmful substances that could be within the mine. They wore boots also to protect their feet, and some mouth and nose mask to prevent them from inhaling harmful gases and dust within the area. The mine also undertakes dust suppression using water. This mine has not encountered cases of workers being affected health wise because they take their workers for some regular medical exams to detect early infections.

Uses of Magnesite

- It can be used as a slag former in steelmaking furnaces, in conjunction with lime to protect the magnesium oxide lining.
- Used as a catalyst and filler in the production of synthetic rubber and in the preparation of magnesium chemicals and fertilizers.
- It can be burned in the presence of charcoal to provide MgO, otherwise known as periclase. Such periclase is an important product in refractory materials.
- Used as a binder in flooring material.
- In fire assay, magnesite cupels can be used for cupellation as the magnesite cupe will resist the high temperatures involved (Roberts, 1998).

Rehabilitation

Rehabilitation is a process whereby disturbed earth is taken back to its original form. Before mining takes place, the trees and other plants are removed in order to create space for the mine works. Most species lose their habitats in this process; rehabilitation is an important after mine practice (Bruce, 1990).

Leaving the mine sites not rehabilitated might lead to abandoned sites, when it rains flooding will occur, the land will be left out to degrade and there is an interference of an ecosystem within that particular patch. As environmental scientists it is important to consider this aspect. In this mine they practice rehabilitation by back filling the excavations with the waste rock materials separated during sorting and we considered it as an important practice.

5. Recommendations

Further study of the area may be required to develop a complete geological history which would also include a paleontological report, geochemical survey and a complete stratigraphic record. The geological mapping was fairly descriptive but the reconnaissance was not done at the exact location which we were going to carry out our field mapping.

6.Conclusion

Rock units are shown by colour and symbols to indicate where they are exposed at the earth's surface. Bedding planes and structural features such as faults, joints and foliations are shown in strike and dip which gives them 3D orientations. In identifying structural, we were able to identify where most of the joints were oriented towards and that gave us a general clue about a major fault where they enacted from.

In our traverse environment, vegetation and soils together with human farming activities covered the surface so that the underlying rocks and sediments were not directly visible or exposed. But however, for our mapping purposes, the materials beneath the soil were depicted and related to the ones appearing on the earth's surface.

The field mapping was successful as we were able to correlate our geological map with the adjacent and other traverses of other groups. The geological map enabled us to draw a cross section showing the dip direction, strike direction and dip angle. Upon drawing the cross-section, we took note of differing elevation points on contour lines. Our terrain was characterised by a contour interval of 20m. There was a general geomorphic relationship, for instance basalt was commonly encountered at the foot of the mountains. We were thus able to apply theory into practice by identifying geological structures in Domboni village which included beds, joints, faults and ripple marks and understanding the relative locations of different lithological settings owing to different geological processes occurring over time.

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