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Detailed Geological Mappping of the Semarule Igneous Complex (SIC) South East Molepolole, Botswana

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Molepolole

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ABSTRACT

An outcrop geological map showing lithotypes within the Semarule Igneous Complex (SIC) (approx. 12.3 km2) is presented in this study. The complex is located in Kweneng District, about 10 kilometers SE of Molepolole Village. The field mapping revealed a complex geological context that resulted from multiple, compositionally varied magma pulses. The field relationships and lithotype characteristics indicate three main syenite bodies, a dolerite intrusion, and mafic minerals-rich veins within the complex. The basement unit in the area is composed of the Gaborone Granite, which was intruded by three phases of compositionally varied syenite bodies forming a roughly circular complex. The syenite bodies within the complex are texturally classified as fine-grained, porphyritic and pegmatitic syenite. Within the complex, three compositionally contrasting syenitic dykes were also observed and they include K-rich, Na-rich and melanocratic varieties. The mafic minerals-rich veins recognized within the complex probably account for a different magmatic event. The outcrop geologic map of the Semarule Syenite Complex is presented at a 1:26,000 scale as a reference for field-oriented geologic and Rare Earth Elements (REE) studies.

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INTRODUCTION

The demand for Rare Earth Elements (REE) is growing globally, hence the need to identifying new deposits. This project is part of the investigation focused on REE and battery metals in Botswana. This report covers the detailed geological mapping of the Semarule Igneous Complex (SIC). In order to identify possible new REE deposits, we need to understand the geological environment in which REE deposits form.

The SIC comprises of different syenite rocks, dykes and mafic intrusions. The SIC was previously studied by Cullen (1953); Lock (1984); Lusty et al. (2012). The studies included geology, geochemistry and petrography of the SIC.

Cullen (1953) carried out a reconnaissance survey that included petrographic studies of the syenitic and granitic rocks of the complex and the following observations were made:

1. There is a widespread presence of alkali feldspar, particularly microcline and orthoclase with some allite;
2. The presence of titanium-bearing minerals such as sphene and ilmenite;
3. The occurrence of considerable quantities of green sodic pyroxene in most syenitic rocks;
4. The presence of melanocratic syenite, which was first thought to be dolerite dykes.

Lock (1984) stated that, within the SIC there may be a great range of chemical composition ranging from units with equal content of potassium and sodium, to those with K >> Na. According to Lock (1984), this illustrates the syenitisation process involving an increase in the ratio $(K_2O+Na_2O)/SiO_2$.

Lusty et al. (2012) focused on the petrogenesis and REE enrichment within the SIC. This study suggested that the Semarule Syenite Complex developed from several phases of magma emplacement. Lusty et al. (2012) also reported anomalous values of Total Light Rare Earth Elements (TLREE) within the complex.

Objectives

The primary objective of this study is to investigate textural, mineralogical composition and the emplacement sequence of the syenites, dolerite intrusion and zoned dykes within the SIC. The results of the detailed mapping will be covered in the report.

The secondary objective is to use remote sensing technique (satellite images and geophysics) to define the mapping framework, which includes: surficial and bedrock mapping, nature of the geological terrain, and surficial conditions and degree of exposure.

1 STUDY AREA

1.2.1 Topography, drainage and access

The SIC is exposed to undulating high ground SE of Molepolole Village (Fig. 1). The complex falls within the Geological Quarter Degree Sheet (QDS) no. 2425e. Three prominent peaks (Hamogwane, Diserane and Semarule Hills) within the complex rise above, forming a line of summits at 1170, 1180 and 1195 m elevation, respectively, while Tshiping and Gamolele rivers drain the area. The vast majority of the area is covered by weathered rocks. Several primary and secondary roads form a network across the mapped area. Additionally, the region falls in a semi-arid environment with thin vegetation, and occasional breaks in the regolith cover offer extensive outcrops, making fieldwork less difficult.

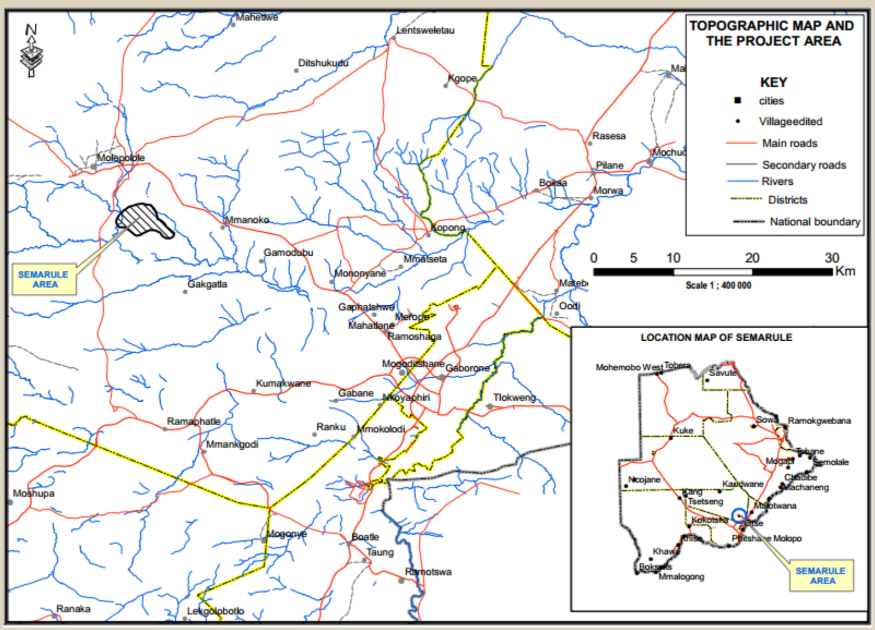

Figure 1: Location of the study area (Semarule Igneous Complex)

2 GEOLOGICAL SETTING OF THE COMPLEX

The SIC is a small, Neoarchaean plutonic intrusion, within the Gaborone Granite of the Kaapvaal Craton. Gobbler (1966) indicated that the Gaborone Granites facies are peralkaline, and their distribution is not well known. Gaborone Granite displays an evident concentric distribution of the main lithological subdivisions. The subdivisions are texturally described as equigranular granites emplaced at the periphery of the outcrop (Kgale Granite), with finer-grained marginal facies (Ntlhantle Granite), while megacrystic granite, including rapakivi-textured (Thamaga Granite) varieties, are found at the core of the Gaborone Granite (Carney et al., 1994). Furthermore, Gobbler (1966) indicated that the Kgale Granite, for instance, particularly near its margins and in certain granophyric facies, contains aegirine-augite and riebeckite, which are path finders of REE.

The SIC is found in the western periphery of the Gaborone Granite. Jones (1973) suggests that the complex was formed by alkali metasomatism and mobilization of Gaborone Granite minerals. Lusty et al. (2012) however, suggested that the intrusion emplacement was controlled by a preexisting fracture within the Gaborone Granite.

The SIC is described as a roughly circular plutonic igneous complex, approximately 12.3 km^2 in area. It consists of igneous rocks ranging from predominantly alkaline rocks (syenite), granites and dolerites. Four main intrusive units were identified within the complex (Lusty et al., 2012). The first pulse of magma, which corresponds to the medium-grained, equigranular syenite was intruded by the second phase of slower crystallizing magma, forming a very coarse-grained to pegmatitic syenite. The third pulse of magma emplacement involved the injection of medium-grained, equigranular syenite dykes.

Lusty et al. (2012) indicated that Karoo dolerite emplacement post-dated the main period of syenitic magmatism, although field relationships suggest that the dolerite emplacement may been coeval with the late zoned mafic veins.

3. MULTIDISCIPLINARY APPROACH AND FIELD MAPPING

Different data set such as remote sensing, geophysical, and geological data were used to give a better understanding of the study area. The interpretation of the data sets was also used to produce a base map prior to field mapping.

3.1 Remote Sensing

The objectives of the remote sensing technique were to define the mapping framework, which includes location of outcrops, identification of surface conditions (vegetation cover), structural geology and lithological mapping. Aster image for the area was preprocessed and different band combinations were used to extract geological information.

3.1.1 False Colour Composition (FCC)

This image was obtained by combining visible to near infra-red (VNIR) bands data. R:G:B = 3:2:1. These bands have a high resolution of 15 m and are used for identification of outcrops, vegetation and oxide minerals. The outcrop outline of Semarule was obtained using this image as shown in Figure 2 below.

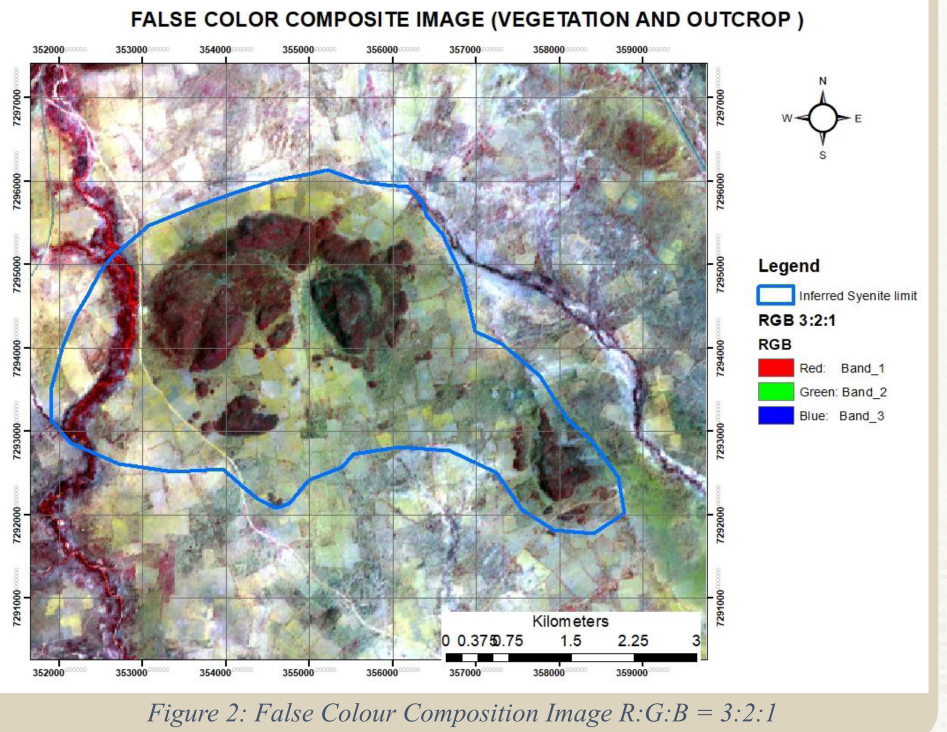

Figure 2: False Colour Composition Image R:G:B = 3:2:1

3.1.2 Thermal Infra-Red (TIR)

Thermal infra-red image was obtained by combining low resolution (90 m resolution) bands of R:G:B =14:12:10. Interpretation of this image (Fig. 3) enables the identification different rock types. Lithological discrimination using TIR is based on their emissivity characteristics, as different rocks emit heat differently and this will be shown by different colours on the image, normally the white colour corresponds to mafic rocks and the red to felsic rocks.

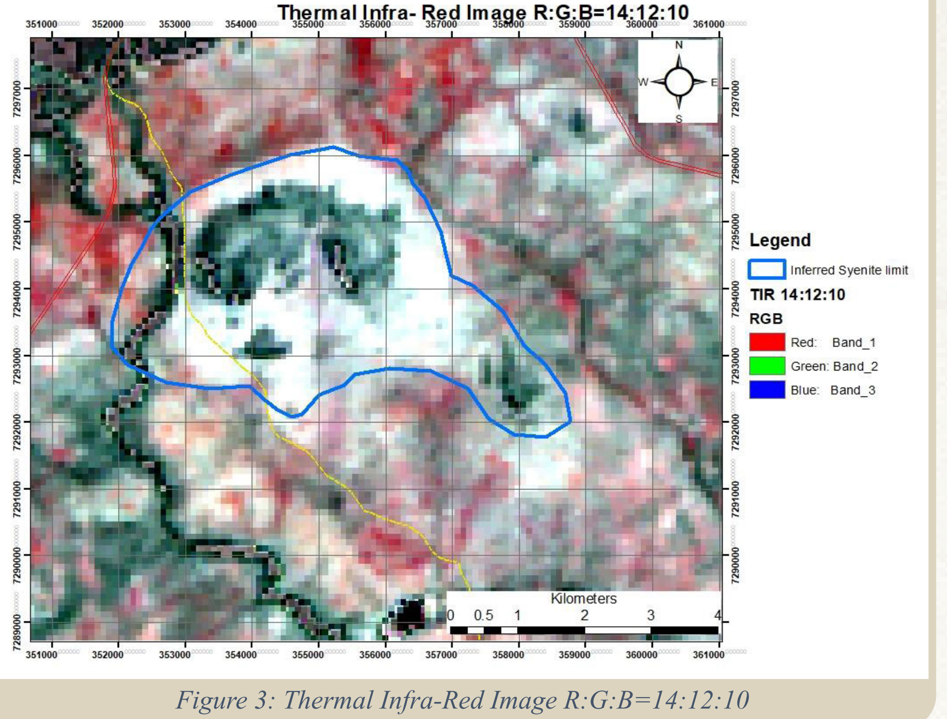

Figure 3: Thermal Infra-Red Image R:G:B=14:12:10

3.1.3 Digital Elevation Model (DEM) Shaded Relief

A shaded relief digital elevation model image was produced to enable mapping of geological structures and the terrain of the study area. It was also used to confirm the exposure of the area together with the false colour composition image. The elevation angle was set at 45 degrees and the azimuth at 135 degrees. This image (Fig. 4) was used together with 1st vertical derivative magnetic data to identify any regional structure passing through the study area. Figure 4 below shows shaded relief DEM image.

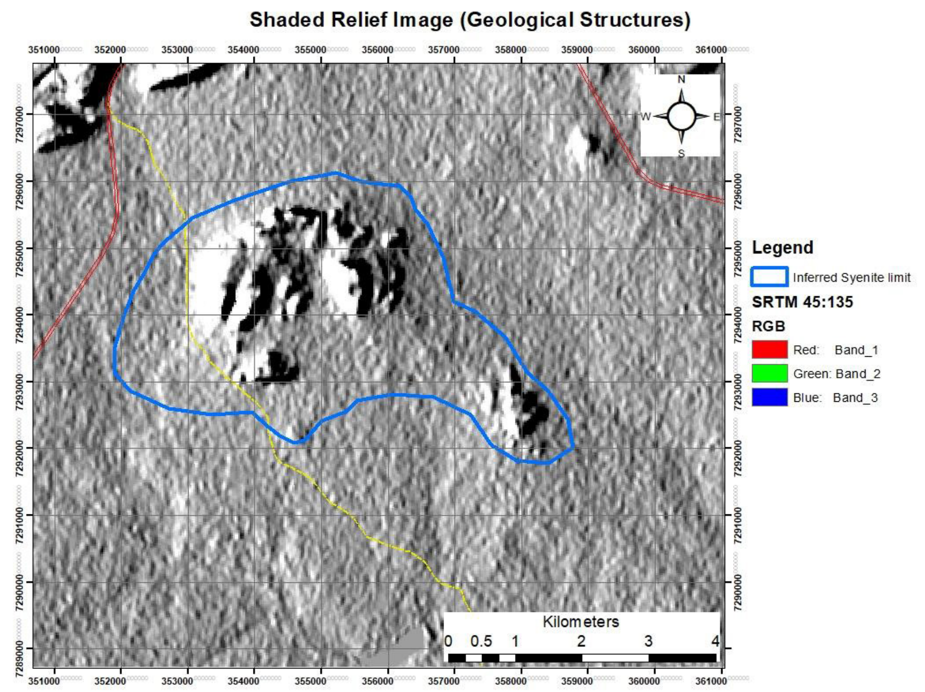

Figure 4: DEM Shaded Relief Image

3.2 Geophysics

The aeromagnetic data set used in the project was acquired by the then Department of Geological Survey (now BGI) at a line spacing of 250 m and a flight clearance of 80 m. Magnetic data is useful in areas where there is poor outcrop and where accessibility is difficult. Therefore, bedrock mapping of the SIC can be archived from the interpretation of magnetic data due to variations in magnetic susceptibility of underlying lithologies and geological structures. The total magnetic intensity (TMI) was used for the interpretation of the geological units, while the 1st vertical derivative was used for structural interpretation.

High magnetic intensity was observed on the TMI in the center of the aeromagnetic map (Fig. 5B). These high magnetic anomalies correspond with the SIC, while the high anomalies in the northeast (NE) corner correspond to the already mapped Kanye volcanics in the area (Fig. 5B). The high anomalies within the inferred syenite limit coincide with the already-mapped syenite and dolerite. The output data for the 1st vertical derivative is more pixelated since area coverage of the complex is small, thus making it difficult to draw the magnetic anomaly (Fig. 5A). The magnetic anomaly was better depicted in TMI data (Fig. 5B).

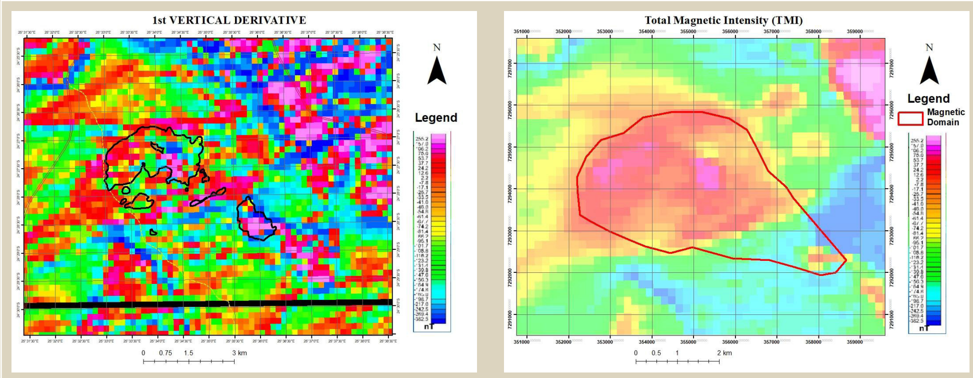

Figure 5. Enhanced airborne magnetic data (A) 1st vertical derivate – black polygons show outcrops drain from remote sensing data (B) total field – magnetic domain shows red polygon

3.3 Data Integration

Different data sets were overlaid together as shown in Fig. 6, the SIC boundaries from the existing geological map did not coincide with any of the data set used. Generally, the shape of the magnetic anomaly is similar to the shape of SIC from the existing geological map. SIC is shifted southwards with a shift of about 0.8 km in the north and about 2 km in the south (Fig. 6). The big shift observed between the geological map and the magnetic anomaly maybe due to errors from field mapping method used in the past, for example they used features such as hills, rivers and roads as their reference points. Secondly, the precision of locations was far improved during the magnetic surveys since they used the geographic positioning system (GPS), while the old map locations were inferred.

The remote sensing images mapped the outcrop rocks rather than the geological contacts, whereas magnetic data was used to map the underlying geology. All the outcropping units of the SIC fall within the magnetic anomaly which is a good correlation with the magnetic data (Fig. 6). DEM data was overlaid with geophysical data to identify geological structures passing through the study area at regional level.

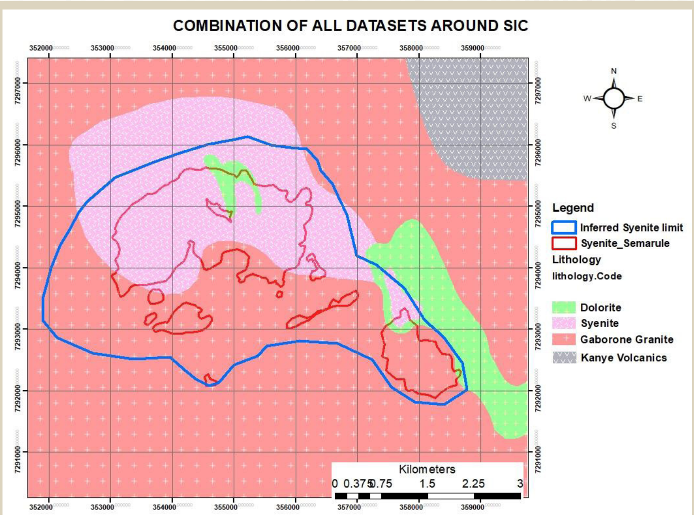

Figure 6. Base map derived from the integration of magnetic data (black dotted polygon-define the magnetic domain/anomaly), remote sensing data (red polygons – define the outcrop boundary of the complex) and historical geology map.

4 FIELD MAPPING AND OBSERVATIONS

The field mapping was done using a GPS along parallel traverse lines in the field and across lithological boundaries. Approximately 1254 observation points were made, GPS coordinates were taken at each point and the rocks were described according to their texture, fabric, structure, mineralogy and geological relationships. Forty-five rock samples (see appendix A for a more detailed descriptions of hand specimen), were collected for petrological studies. Detailed description and petrography of each lithology mapped are given below; only features and minerals visible in hand specimens are described in this section.

4.1 Granite

Two facies of the Gaborone Granite (Ntlhantlhe and Thamaga granites) are exposed in the north to northwestern and southwest parts of the SIC. Thamaga Granite is porphyritic, characterized by the presence of varied medium-to coarse-grained alkali feldspar and is rapakivi- textured, mesocratic with abundant K feldspar phenocrysts (Fig. 7A). Micro-granites were observed as enclaves within the Thamaga Granite in the northwestern part of the study area. The microgranites are fine-grained, quartz-rich, with little to no mafic minerals. The microgranites are interpreted as the Ntlhantlhe Granite (Fig. 7B). Another medium-to fine-grained granite was seen towards the SE of the investigated area (Fig. 7C).

In the north part of SIC, Thamaga Granite forms contact with fine-grained and porphyritic syenite, while in the south, the granite is intruded by dolerite. A gradual contact between Thamaga Granite and both porphyritic and fine-grained syenite was observed. In the NW part of the complex, change in color was observed at the contact between the syenite and the granite (both fine and coarse-grained) due to contact metamorphism from the dolerite intrusion. The contact between the granite and the dolerite is defined by a chilled margin. Fine-grained syenite dykes (Fig. 7D) were observed throughout the Thamaga Granite (sharp contact).

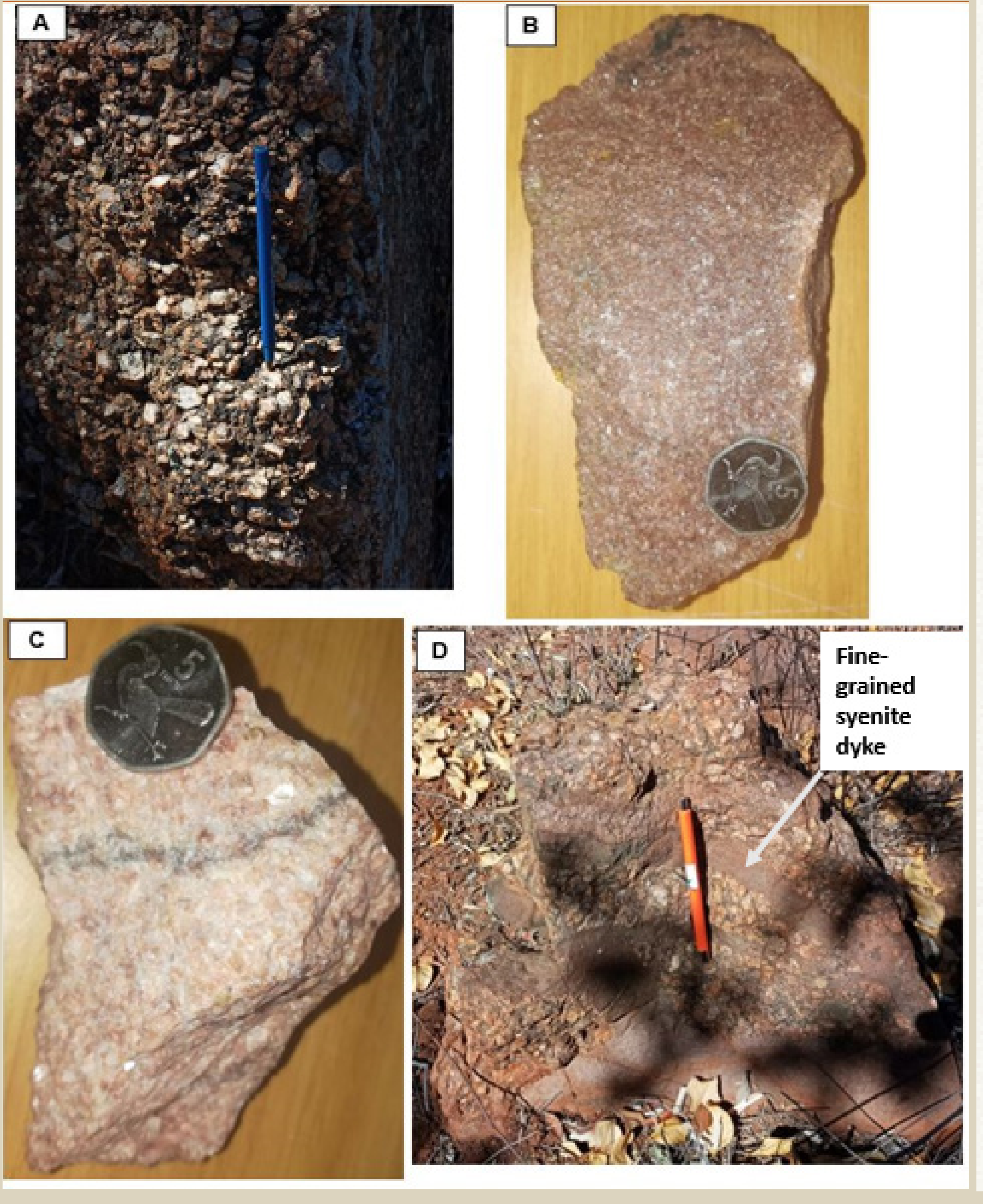

Figure 7: (A) Coarse- grained, rapakivi textured Thamaga Granite. (B Fine- grained Ntlhantlhe Granite.) (C) Fine-to medium-grained granite. (D syenite dykelets forming sharp contact with Thamaga Granite.).

4.2 Syenite

The syenite is widespread and is well exposed across the SIC, it has been classified according to its texture and mineralogy.

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4.2.1 Fine-Grained Syenite

The unit is fine-to medium-grained, K-feldspar-rich syenite (~70%), pink in color and shows dissemination of few mafic minerals (~30%) (Fig 8). The fine- grained syenite intrudes Thamaga granite in the investigated area. Syenite is ubiquitous over the study area as shown in Figure 16.

Figure 8 Fine grained K-feldspar rich syenite

4.2.2 Pegmatitic Syenite

The pegmatite syenite occurs as enclaves within the fine-grained syenite with a maximum width of ~15 m, with most crystals being larger than 2.5 cm of K-feldspar and plagioclase, displaying a grain to grain pattern (Fig. 9). The massive blocky texture can probably be related to the final stage of a magma's crystallization. This pegmatite syenite dyke occurs within the fine-grained syenite and exhibits gradational contact. All these rocks have fairly homogeneous basic to intermediate chemical compositions.

Figure 9: Pegmatite with euhedral crystals of about 2-6 cm width feldspar crystals

4.2.3 Porphyritic Syenite

Porphyritic syenite is widely distributed in the area and is characterized by two units varying in composition (mafic and felsic rich).

1. Mafic-rich syenite with the mineral content of plagioclase (~10%), K-feldspar (~55%), disseminated mafic minerals (amphiboles) (~30%), and quartz (~5%), (Fig. 10A).
2. Alkali feldspar rich syenite (~70%), pink in color and show low dissemination of mafic minerals, presence of amphibole, (~20%), and quartz grains (~10%), (Fig. 10B).

Porphyritic syenites forms a gradational contact with the fine grained syenites in the northwestern part. In the far south of the investigated area, a chilled contact between the syenites and the dolerite was observed.

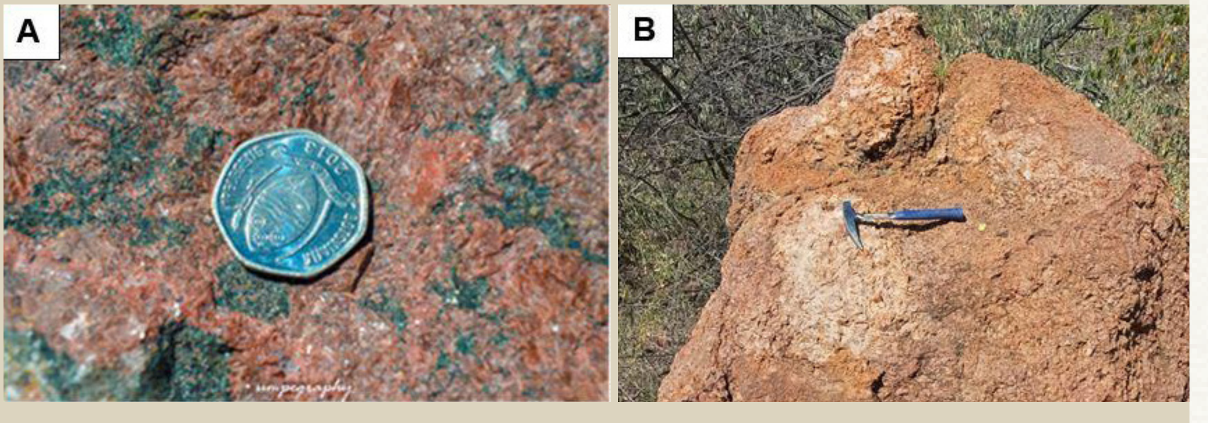

Figure 10. (A) Mafic-minerals- rich porphyritic syenite (B) K-feldspar rich porphyritic syenite with a lower dissemination mafics.

4.2.4 Composite syenite

Composite syenite is described as a mixture of fine-grained and coarse- grained syenite lenses within a small area which could not be mapped individually. The fine and coarse-grained syenite pose the same properties as the fine grained and porphyritic syenites described above (Fig. 11).

Figure 11: Composite syenite showing a mixture of porphyritic syenite with fine grained potassic syenite.

4.2.5 Syenite dykes

The third pulse of magma emplacement involved the injection of medium-to fine-grained, equigranular K-rich syenite dykes. The syenite dyke is pinkish and is essentially composed of K-feldspar, quartz, magnetite, and amphiboles are visible under the hand lens. These dykes crosscut through porphyritic syenite (Fig. 12 A), Thamaga Granite (Fig. 12 B) and the pegmatite (Fig. 12 C).

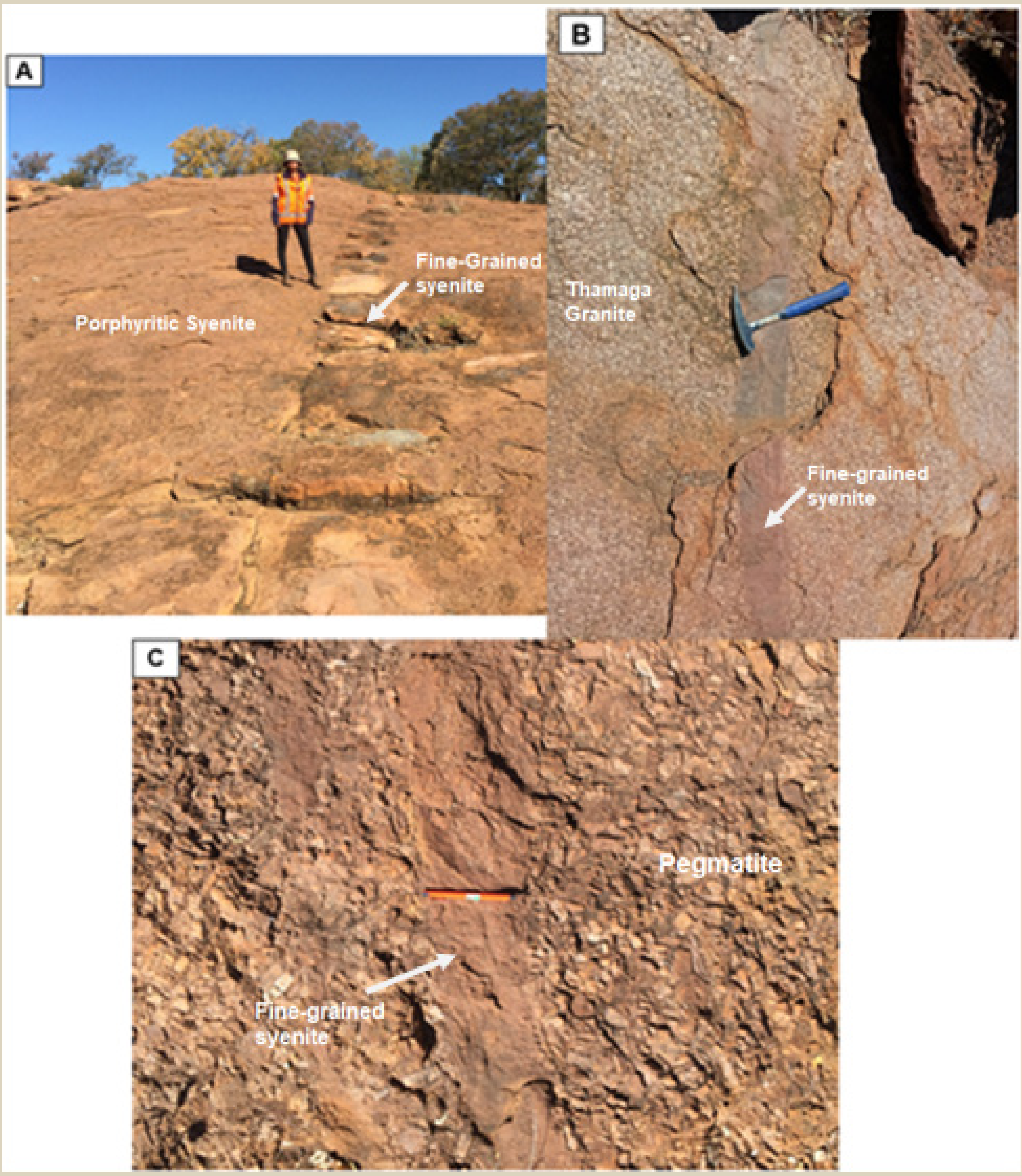

Figure 12. (A) Fine- grained syenite intruding porphyritic syenite. (B) Fine grained syenite intruding granite. (C) Fine grained syenite intruding a pegmatite.

Two other fine-grained syenite were observed within SIC, namely; (i) Na-rich unit (Fig. 13A) and (iii) melanocratic syenite (Fig. 13B).

The Na-rich unit is whitish with elongated plagioclase, and less amount of amphiboles, and quartz. Another dyke system, not common across the complex is melanocratic in composition. The rocks are light gray in color and mineral composition include amphibole, plagioclase, and quartz.

The Na and melanocratic syenite dykes are more restricted to the granite outcrops in the southeastern flank of the complex. A small granitic hill is intruded by known Na- rich syenite dyke (Lock, 1984) trending NE/SW. Melanocratic syenite type is seen towards the southeast of the area intruding Thamaga Granite.

Figure 13. (A) Na-rich syenite with elongated plagioclase crystals. (B) Melanocratic syenite dyke

A sharp contact between Thamaga granite and Na-rich syenite was observed as shown in (Fig. 14A) below, and a gradational contact was observed between potassium- rich syenite and Thamaga granite (Fig. 14B).

Figure 14: (A) Sodium-rich syenite forming a sharp contact with the Thamaga Granite. (B) A gradational contact between Thamaga Granite and potassium rich fine syenite.

4.3 Dolerite Intrusions

The dolerite sills are found in the center and southeast of the study area, intruding the fine-grained and porphyritic syenites, as well as granite. The dolerite intrusions form a chilled margin with all the rock units they intrude in the SIC.

4.4 Mafic-Ultramafic dykelets

Veins of about 5 – 30 cm in width are common in the area and are found in almost all the rock units, especially the porphyritic syenites. The glassy texture made it difficult to identify individual minerals from the rock, however the vein has a strong magnetic character which indicates the presence of magnetite. The mafic-ultramafic veins seem to weather quite easily compared to the rocks with higher felsic content (Fig. 15 B and C). Towards the northeastern part of the study area, the rocks appear to have a subophitic whitish albite (Fig. 15D).

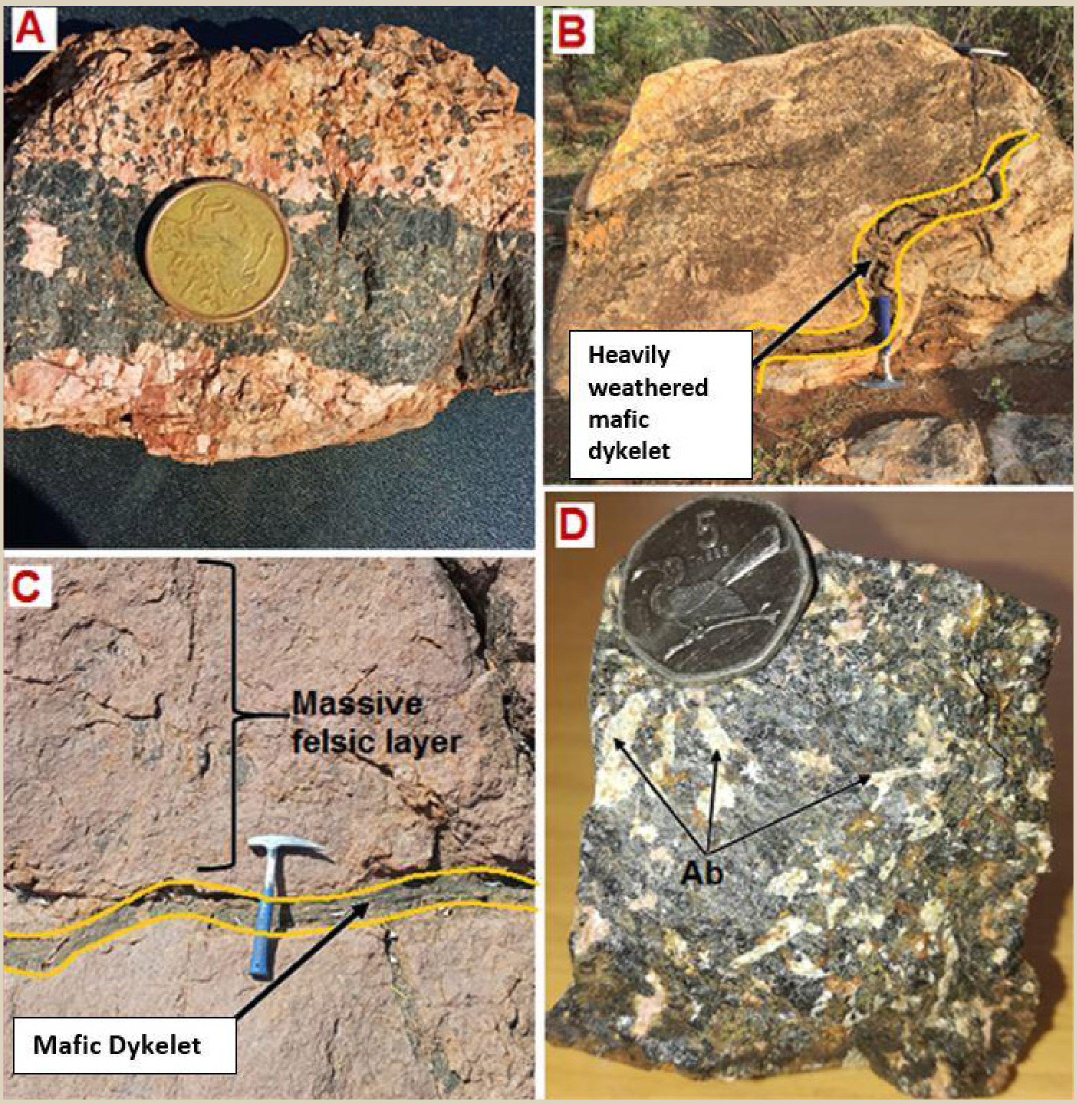

Figure 15: (A), Magnetite dykelet within porphyritic syenite. (B) Heavily-weathered mafic-ultramafic dykelet (C) Mafic- Ultramafic dykeletfc` within fine syenite (D), Magnetite with albite minerals.

4.5 Structures Observed

A minor fault was observed towards the southeast of the area, trending W-E. The fault cuts across the Thamaga granite and the fine- grained syenite as evidenced by the striations (Fig.16).

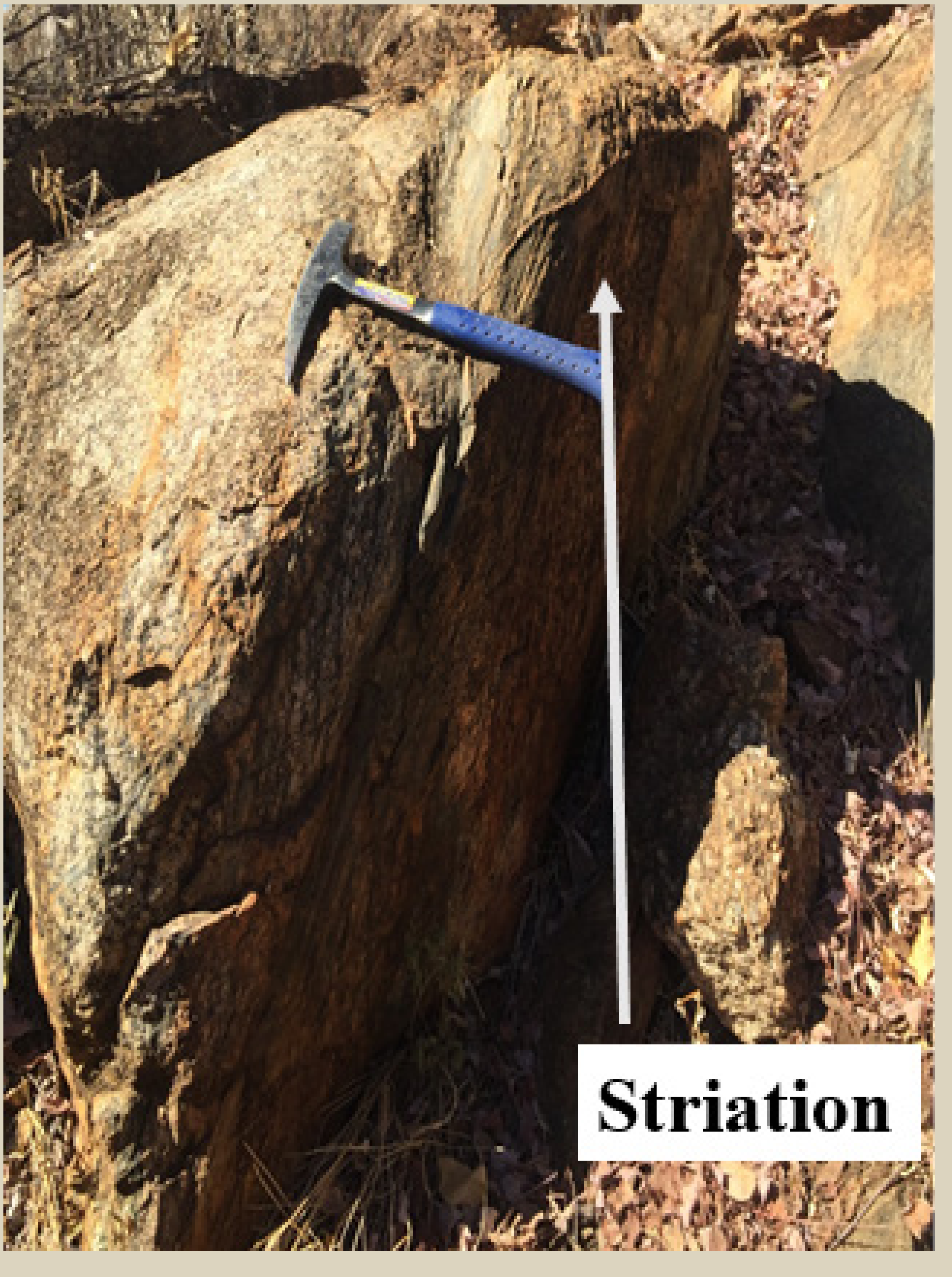

Figure 16: Striations within Thamaga granite gneiss observed along the fault

Detailed geological mapping incorporated remote sensing, geophysical and field data interpretation to produce an outcrop geologic map at 1:26.000 scale (Fig. 17).

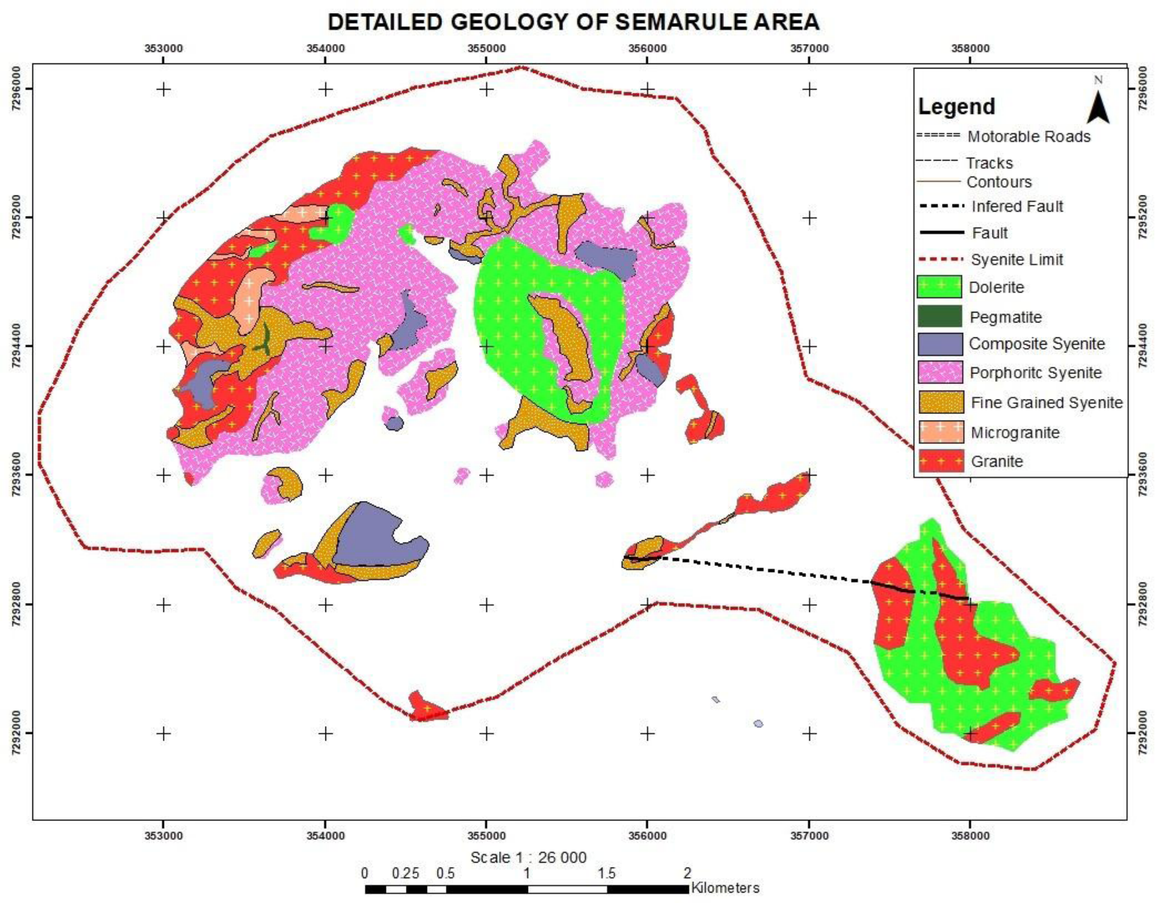

Figure 17. Detailed outcrop map of Semarule Igneous Complex.

5 DISCUSSION

Detailed geological mapping of the SIC revealed that geological setting is a result of multiple intrusions emplaced over a short time. Lusty et al. (2012) suggested that the intrusion emplacement was controlled by preexisting fractures within Gaborone Granite. However, there was no major faulting/fracturing observed both at local and regional scale. On the other hand, Jones (1973) suggested that the complex was formed by alkali metasomatism and mobilization of Gaborone Granite minerals. Evidence from the field indicate that there was gradational decrease in quartz content and increase in feldspar content as you move from granite into syenite, thus supporting Jones (1973) statement.

According to field relationships and lithological characteristics, three different magma pulses can be observed within the complex. The fine-grained syenite (first magmatic pulse) intruded the Gaborone Granite (Thamaga and Ntlhatlhe granites). This was followed by porphyritic syenite (second pulse of magma) covering a larger area of the complex. The third phase of the magmatic event was defined by the emplacement of fine-grained syenite dykes. The syenite dyke cut across the fine grained, porphyritic syenites and the pegmatites. The pegmatite appears within the fine-grained syenite, probably the last stage of magma crystallization of the first magmatic pulse. In general the syenite rocks of the SIC have about 45% K-feldspar, 30% plagioclase, 20% mafic minerals and <5% quartz, the overall similarity in mineral composition suggests that the three pulses might have come from the same magma chamber as also suggested by Lusty et al. (2012). The difference in the textures will therefore be related to the different crystallization periods.

There was no established relationship between the syenites and the fine- grained Na-rich and melanocratic syenite dykes. Dolerite sills and dykes crosscut the fine-grained, porphyritic syenites and the granite within SIC, suggesting that they postdate syenite emplacement period.

The magma composition between the different rock types does not vary, hence poor geophysical signature and reflectance of different rock types. This made it difficult to use geophysics and remote sensing techniques for detailed mapping. However, remote sensing was useful in mapping outcropping areas. The extent of the SIC mapped from TMI could not be confirmed because of lack of borehole information, sand cover and ground geophysics was not undertaken.

6 CONCLUSIONS

The SIC is the result of continuous emplacement of magmatic pulses with contrasting composition intruding the Neoarchaean Gaborone Granite of the Kaapvaal Craton. The remote sensing and cartographic data, together with field data, allowed us to outline several intrusive facies/lithologies within the SIC. The discrimination was done according to the emplacement sequence: (1) fine-grained syenite to pegmamtetic syenite (first pulse), porphyritic syenites (second pulse), emplacement of syenite dykes (third pulse), and finally dolerite emplacement that post-dates the main period of syenitic magmatism.

The syenitization of SIC is highly associated to alkali metasomatism and mobilization of Gaborone Granite. Within the SIC there is a presence of fine-grained syenite dykes, namely the K-rich, Na-rich and melanocratic. Further studies of these three magmatic pulses might bring some insights into potential mineralization in the area.

It must be noted that the field description and petrography of each lithology mapped was derived from hand specimen mineralogy, hence the need to do detailed geochemical and petrographic studies.

7 LIMITATIONS AND RECOMMENDATIONS

- The extent of the SIC mapped from TMI could not be confirmed because of lack of borehole information, sand cover and ground geophysics. Ground geophysics traverses are recommended over the SIC.
- Detailed petrographic studies and whole rock geochemistry analysis.

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Appendix 1 *Hand specimen description of Semarule Rock samples*

SAMPLE CODE	LAT	LON	ELEV	DESCRIPTION
SEM-01 SEM-01(A	-24.455713	25.555833	1154.559937	Rock transitions from black greenish to greenish to redish brown. Very fine grained with white plagioclase crystals. The area shows signs of fluid infiltration, dissolving the highly weatherable minerals and leaving out quartz grains.
SEM-02 SEM-02(A)	-24.456856	25.555903	1159.31897	Very course grained with crystals of about 2-4cm in size. The cryatals form euhedral rectangular shapes with the greyish mineral enveloped by the whitish mineral. Both the whitsh and grey mineral portray the same characters i.e have the same cleavage and hardness. The rock has a mafic rich matrix.
SEM-03	-24.458825	25.555208	1162.391724	Has a high mafic mineral content with about 40% plagioclase , 20% K-feldpaar, 30% mafic minerals and 10% quartz. Course graine d with a fine matrix. Mafic inclusions within the plagioclase and K-feldpar.
SEM-04	-24.459177	25.556377	1131.669312	Medium grained , redish brown color, has a higher magnetism. Plagioclase (dominant) forms laths with a clear cleavage. Another mineral of what appears to be magnetite is black and a shiny/glassy luster.
SEM-05	-24.459312	25.555985	1137.279175	Redish brown on the weathered part and pinkish grey on the fresh surface. 50% K-feldpar and 50% mafic minerals
SEM-06	-24.46483	25.556366	1094.626465	Has a high K-feldpar content, course grained feldpars with a fine grained mafic matrix. A porphyrytic syenite with about 60% feldpars and 40% mafics

SEM-06(A)	-24.464981	25.556444	1109.294067	Fine to medium grained, purplish-pink in color, high feldpar content with less mofic minerals. The plagiclase feldpar has enlongated laths . A fine syenite with 70% feldpars and 30% mafics
SEM-07	-24.457336	25.552377	1110.153931	Fine to medium grained with about 30% K-feldpar, 20% Quartz, 20% plagiclase and 30% mafic minerals. A fine granite.
SEM-08	-24.460034	25.551977	1104.151001	Fine grained pinkish black. A sign of hydrothermal alteration within the rocks, pinkish veinlets intrude the dark minerals and altered the color f the dark minerals to olive black. Pegmatite xenolith within the body, trends South-East
SEM-09	-24.477397	25.565966	1086.816895	Black in color, enlongated plagioclase crystals. Has a high mafic content with high magnetism, trending North-East, South-West direction.
SEM-10	-24.462028	25.583197	1101.200073	Fine grained with euhedral black minerals. Pinkish-green in color, with black shinny rounded minerals. Greenish minerals have a flaky texture. Enlongated plagioclase crystals are abundant in the rock. Trends North-East, approximately 60cm wide and 200m in length.
SEM-11	-24.466181	25.561398	1118.25769	Medium to fine grained. High mafic mineral content of up to 80% magnetite looking minerals and 20% feldpars, localized.
SEM-12	-24.460529	25.563402	1116.670898	Very large feldpar crysras of up to 2cm, the dominant minerals are the feldpar minerals of up to 80% and some dissemination of the mafic minerals forming euhedral shapes of up to 1-1.5 cm size. The rock is pinkish in color and has a pegmatitic texture.
SEM-13	-24.460892	25.563416	1127.949585	Very Fine grained mafic rich vein with a black minerals showing metallic lustre (magnetite), Flaky greenish minerals also present, K-feldpar also present

SEM-14 SEM-14(A)	-24.458061	25.564888	1129.213013	SEM-14 Mafic rich band with some K-feldpar. Greenish mineral also appears within the band. SEM-14(A) Also a mafic rich band with a metallic lustre and some inclusions of needle-like cream-whitish crystals. K-feldpar inclusions within the mafic minerals
SEM-15	-24.459061	25.566775	1100.166138	Pinkish -grey in color on the fresh surface. The plagioclase crystals form euhedral shapes with enlongated laths. About 80% feldpars and 20% mafic minerals. Medium to course grained ith porphyry plagioclase crystals.
SEM-16	-24.45876	25.567083	1113.999023	Fine grained crystals, greyish-pink in color. 90% feldpars and 10% mafic minerals, forms a dyke.
SEM-17	-24.45723	25.564101	1145.598022	Greenish flaky crystal present, pinkish K-feldpar also dominant and magnetite also present, porphyritic syenite.
SEM-18	-24.449244	25.560838	1161.775391	Reddish in color with some magmatic areoles, plagioclase, k-feldpar, mafic minerals of about 20% and little quartz of about 5%. Course grained
SEM-19	-24.450098	25.55977	1155.871338	Also Reddish in color, course-grained, plagioclase, K-feldpar, mafic minerals and a liitle quartz. SEM-19(A) fine grained, with enlongated plag-crystals (oriented in the same direction). Amphibole and K-feldpar present. More reddish than the usual fine syenite
SEM-20	-24.45186	25.568183	1142.10498	Medium grained. Plagioclase, K-feldpar, mafic mineral. Mostly plagioclase crystals surrounded by the fine grained K-feldpar. Greyish-pink in color.
SEM-21	-24.44895	25.566805	1148.404541	Course grained, 30% mafic minerals 80% feldpars, has no magnetism, greyish pink in color.

SEM-22	-24.450062	25.568226	1142.077759	Course grained. K-feldpar 60%, mafic minerals 40%, pinkish with a dissemination of mafic minerals.
SEM-23	-24.451658	25.56966	1126.299194	Reddish-brown in color with a dissemination of mafic minerals. Medium grained, K-Feldpar, magnetite, greenish mineral.
SEM-24	-24.451107	25.571166	1128.215576	Reddish in color, course grained K-feldpars of about 70% and about 30% dissemination of mafic minerals
SEM-25	-24.455119	25.574976	1210.609741	A whitish crystal forming a vein between the porphyritic syenite and the black vein, mineral looks like calcite with a clear twinning.
SEM-26	-24.455138	25.574759	1203.602661	Light pink plagioclase crystals with black and greenish minerals. Course grained. Magnetite shows a metallic luster. Rock is partly weathered showing some bit of oxidation.
SEM-27	-24.45311	25.570873	1128.205444	Olive color, flaky minerals with little dissemination of felsic minerals (plag+ K-feldpar), trends North-South, fine grained vein of about 100m in lenth and 30cm wide.
SEM-29	-24.452259	25.576405	1119.837769	Fine grained, Reddish brown in color, 70% K-feldpar + 10% mafic minerals + 20% plagioclases with enlongated needle-like crystals
SEM-28	-24.452608	25.573526	1132.358032	Dark purple in color, 70% feldpars and 30% mafic minerals, has a porphyritc texture, (magnetite+ K-feldpar+ amphibile), porphytic syenite.
SEM-30	-24.461652	25.572704	1109.57373	Pegmatitic texture,greyish in color, 90% feldpars + 10% mafic minerals, easy to break, occurs as a vein
SEM-31	-24.456101	25.580045	1163.687988	Fine texture, whitish grey (sodic syenite), intruding the course grained granites, plagioclase, minor quartz, minor mafic which also occur in small veins, about 4m wide and thins out in N-S direction.

SEM-32	-24.457439	25.577484	1143.178101	Porphyritic texture, K-feldpar rich, plagioclase, black minerals(amphiboles) wheathering into green minerals.
SEM-33	-24.462127	25.575581	1108.997192	Reddish pink porphyritic texture syenites, K-feldpar rich, Mafic minerals with bands of black minerals, plagioclse, small quartz content <5%.
SEM-34	-24.457711	25.572847	1164.491333	K-feldpar rich, crystals of mafic minerals, Euhedral garnet crystals, plagioclase, porphyritic texture.
SEM-35	-24.45965	25.574063	1166.26355	Fine grained, reddish pink, K-feldpar, Garnet, euhedral in shape, possible contact metamorphysm
SEM-36	-24.469519	25.577809	1096.385254	Sodic rich syenite, fine grained, whitish grey in color, minor K-feldpar, mafic minerals and plagioclase.
SEM-37				slightly magnetic black rock with elongated plagioclase crystals. Magnetite, garnet and pyroxenes present, the rock is fine to medium grained
SEM-38				Magnetic rock with (plagioclase+ magnetite+ K-Feldpar), has chloritic veinlets, reddish-brown in color, medium to fine grained.
KUB-01				greyish-green rock with a medium grain texture with clear elongated plagioclase crystals, amphibole and pyroxenes and about 5% quartz content.
KUB-02				greyish-green rock with a medium grain texture with clear elongated plagioclase crystals, amphibole and pyroxenes and about 5% quartz content.


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