The Geological Mapping of the EL Shereik Area of River State, North Sudan

Abstract:
The present study focused on details geology of the lithostratigraphy, phenomena and petrogenesis, with full classification of rock units and correlate by the regional geology in the study area. The previous studies, focused on regional geology, which can be divided in Bayuda Terrane, represented by Dem El Tor Shear Zone (DTSZ), its Precambrian to Tertiary ages (isotopic signatures of later cooling 590 to 550 Ma), with dominated by metamorphic and intrusive rocks belonging to the Pre-Nubian basement complex. The study area lies at El Shereik, River Nile State, Sudan. It is characterized by low-lying bed plains, covered with superficial deposits, with an arid climate. The techniques of this work, represented in an official, field works and laboratory test, with used Land Sat Images ETM. And Nubian Arabian Shield, represented by the Keraf Shear Zone (KSZ), its Precambrian to Phanerozoic ages (Neoproterozoic, Pb isotope ages dating, of forms is -730 -710Ma and ended in -565Ma), with dominated by metamorphic, ophiolitic mélange, volcano-sedimentary sequences, and Phanerozoic sediments. But through this detailed surveyed, we discovered different types of rock units; they were found as accumulated and highly deformed, affected by various thrusting faults. collected more than 40 samples, through six traverses, for classification and petrographic studies and classified more than 9 types of rooks units didn't mentioned before in previous study, all of them well exposed as following: metamorphic rocks, included, migmatites, calc-silicates, wollastonite, talc-schist, carbonaceous (dolomitic marble), amphibolites, graphitic schist, mica schist, quartzo-feldspathic schist, and grey gneiss, While the Igneous rocks, consisted of dykes, as dolerite, trachy-basaltic, Rhyolite porphyry, pegmatites, diorite, and quartz veins, whereas the superficial deposits, included, of aeolian, fluvial, and collovial. These rocks extend and spread to the outside of the limits of the study area and most of them oriented parallel with KSZ SE - NW region and a few of them are oriented E-W, This is maybe due to the collusion of contact boundary between KSZ and DTSZ Bayuda Terrane. Talc-schist, wollastonite and graphitic schist, represent a strategic stockpile besides gold mining. Studies conducted with DTSZ, its old age, occurred before Neoproterozoic compared to KSZ. Because it has the first deformation of the folding of pre- KSZ proportion to the presence of folding in the west and east of the Nile zone, according to the border between Bayuda Terrane and Nubian Arabian Shield, as the suggest result. And the previous studies of the ages dating confirm it.

Keywords: Details mapping, petrographic study, Keraf Sheer Zone, litho-stratigraphy, Al Shereik area

1. INTRODUCTION:

The study area lies southeast of El Shereik town which lies at River Nile State, Rubatab District, Sudan. Furthermore, this area has been a favourite target for gold hunters during the past few years after discovering rich gold around the area. A study area characterized by low undulatory relief formed mostly of wide, low lying bed plain on the relatively rocky grounds and almost flat, wide plans covered by superficial deposits, with arid climates, it is typical desert climate. The purpose of this study, it targeted a part of the Sudanese Nubian Arabian shield, to discuss, the details geology and the lithostratigraphy. The previous studies in the study area, it's limited and focused on regional geology aspects. But this work

focused to study the detail geological mapping, lithostratigraphy, phenomena and petrogenesis, with full classification of rock units and correlate by the regional geology in the study area. The techniques of this work, represented in an official, field works and laboratory test, with used Land Sat Images ETM as remote sensing to delineate, identify, describe, explain and interpret the geological phenomena within the study area.

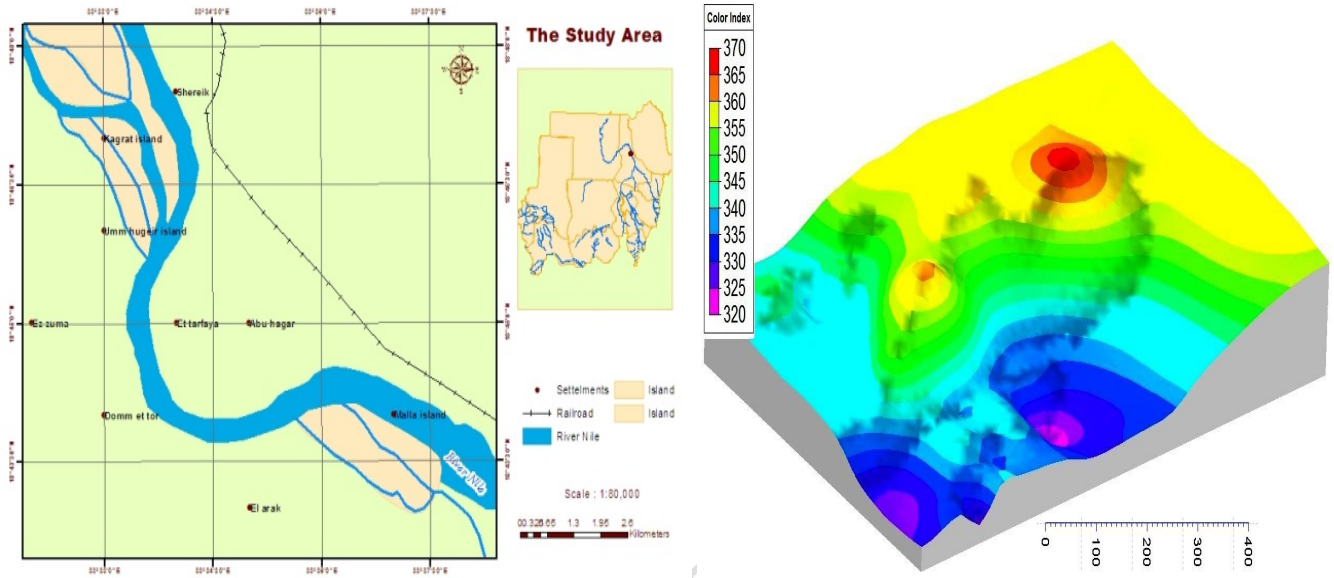


Fig: (1): Location map of the study area in the River Nile State north Sudan.
Fig: (2): 3D topographic map showing different elevations and each 100 = 1km.

2. Geological setting:

2.1 Regional geology:

The regional geology of the Al Shereik area can be divided as well as Bayuda Desert west River Nile Zone, which has different historical of rocks types, from Precambrian to Tertiary(isotopic signatures of the Bayuda later cooling from 590 to 550 Ma) [Fig. 1 & 2]. And Keraf Shear Zone, which historically ages between Precambrian to Phanerozoic(Neoproterozoic time Pb isotope of ages dating, KSZ curst formed -730–710Ma and that orogenic activity ended by -565Ma) [3, 4]. The west area is dominated by gneisses, meta-sediments, meta-volcanic rocks and intrusive rocks belonging to the Pre-Nubian basement complex. But the general geology of the Al Shereik area is similar to that in other parts of central Sudan [5], but its belong to the central Sudan, Nile unit [6].Also to the north comparable units are encountered in the third cataract region of the Nile [7].

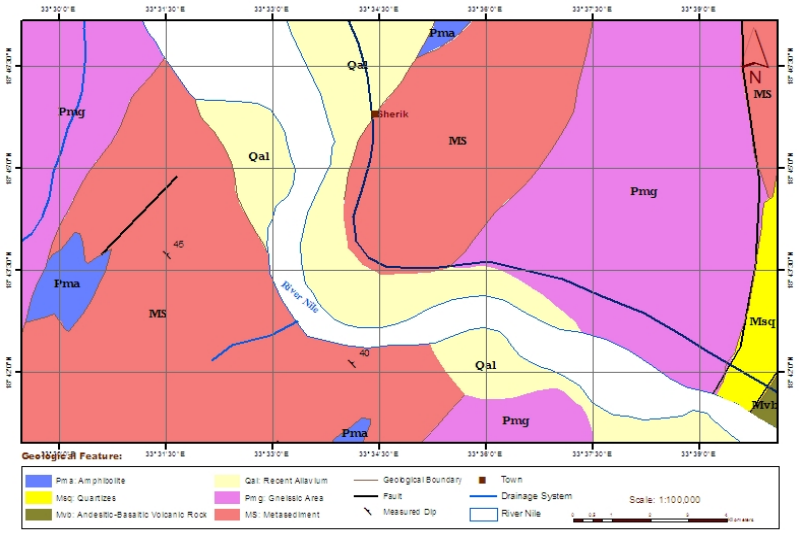


Figure :(3) Regional geological map of the study area, complied by Geological Research Authority of the Sudan, and Robertson Research, 1988.

2.2 Regional Geology and Tectonic Setting of Bayuda Desert West River Nile:

2.2.1 Granitic Gneisses and Migmatites:-

These rocks are most probably ancient rock and are exposed in as coarse structures. These coarse structures are elongated in form and parallel to prevailing regional strike (Fig. 3). The relation between the gneisses and overlying meta-sediments is not clear as no sharp contacts between the two rock groups were observed anywhere. Its difficulty to determining beyond any doubt relationship of the gneisses with the meta-sediments was due to the masking effect of metamorphism and deformation[1].

2.2.2 Meta-sediments:

These rocks mainly confined to a belt stride of the Nile and thus trending approximately north-south. It's thought that the meta-sediments constitute a single group in outcrops separated in some places by belts of meta-volcanic rocks green schist facies. The meta-sediments upper amphibolites facies grade as regional metamorphism. Significant metamorphic minerals include garnet, Sillimanite, hornblende and Diopside. Basmatic rocks are abundant among the meta-sediments and pure quartzites are found in many localities [8]. Pelitic rocks are widespread and thin, patchy graphitic bands are common within them. One of the important minerals in politic rocks is kyanite particularly abundant west of Shereik and Atbara and currently being investigated for its economic potential by the Sudanese German Exploration Project team. Pure coarse-grained crystalline marble form characteristic and important lithological units and extend in some places for many kilometers along the strike. Dark coloured amphibolites bearing rocks is widespread. Gabbroic and amphibolitized gabbros are found as small bodies and appear to constitute an important and significant basic igneous activity in spite of their limited size.

2.2.3 Meta-volcanic Rocks:

These are exposed only at localities, of the neighborhood of the fifth cataract northwest of Nadi, west of Dagash and south of the Wadi Halfa. These outcrops only appear in the Nile Valley and mark the western limit of the dominantly volcanic assemblage of green-schist facies beneath which are amphibolites facies gneisses with a more complicated history. On a regional scale, this important boundary is to have inter-folded relations with the older rocks[9].

2.2.4 Older Granites:

The term of older granite is used here to differentiate certain deep front the post-orogenic younger granite igneous complexes. The older granite includes both Syn-tectonic and late-post tectonic intrusions. Granites of this type are now recognized to constitute a characteristic and a dominant element in the basement complex in the Sudan. These both granites are distinguished from the Syn-tectonic granites by their greater thermal metamorphic effects and absence of deformation fabrics. The Syn-tectonic granites characteristically form strongly foliated bodies elongated parallel to the strike of the regional foliation and show no signs of contact metamorphic effect of their country rocks.

2.2.5 Younger Granites:

Five igneous complexes belonging to the younger granite association are known in the area. These are Singeir complex, Abu Handale complex, Abu Nahal complex, Razam El Atshan complex and Razam El Rawian complex. They vary in size from more than twenty kilometres in diameter in the Abu Nahal complex to about two kilometres diameter in Razam Al Atshan ring complex. All the younger granite complexes are composed of intermediate to acidic rocks, mostly syenites, quartz-syenites and granites. Two in the north of Mesheriba, and Grienat complex are composed of trachytic dykes and plugs and may not belong to the same association. Others may not be related to the emplacement of these complexes and are possibly older.

2.2.6 Nubian Sandstone Formation:

Unreformed, flat lying sedimentary rocks belonging to the Nubian Sandstone Formation are present as an outlier west of Amaki and along the western bank of the Nile west of Berber. They also form the southern boundary of the area west of Atbara. At most certainly they formerly extended over the whole area. Poorly sorted, cross-bedded sandstone and conglomerates are dominant.

2.2.7 Basalts:

Post Nubian basic igneous rocks occurring as flows and plugs are widespread. It is of interest to note their particular abundance within the Nubian sandstone outliers. These outliers are fault controlled which may indicate that the faults acted as channel ways for the magmas.

2.2.8 Regional Structures by Bayuda Desert West River Nile:

The correlating major structures over large distances it’s the problem, just only possible to make a preliminary analysis of the whole regional area, which has given a more detailed account of the structures in the southern part. Three phases of deformation are recognized which affect the whole area. The earliest structures are only preserved as a refolded small scale folds. The second generation of folds dominates the structural pattern of the area and is responsible for the regional strike of the foliation. Large scale folds are characteristic of this phase throughout the region. Thrust and slides are closely associated with this phase of folding and are conspicuous at the contact between the meta-volcanic rocks and the meta-sedimentary rocks. The third phase of folding is characterized by the development of open folds throughout the entire area. Large scale swings of strike such as west of Amaki and Abu Diss are associated with granitic intrusion. The intersection of these structures with the second phase folds produces interference patterns of various dimensions. One good example is the Dem El Tor structure southwest of Shereik province. Both the granitic gneisses and the meta-sediments have been subjected to amphibolites facies of metamorphism. Evidence from migmatites indicates that thermal conditions

during this metamorphism reached to partial melting. On the other hand, the meta-volcanic rocks were subjected only to green-schist facies metamorphism. Considerable contact metamorphism is associated with the intrusion of the late to post-tectonic older granites.[6].

2.3 Tectonic Setting and Regional Geology of the Keraf Shear Zone East River Nile (Al Shereik Area):

1- High-grade gneisses (oldest).
2- High-grade supra-crystal meta-sediments.
3- Low-grade meta-sediments.
4- Ophiolitic mélange rocks.
5- Volcano-sedimentary sequences.
6- Molasse-type sediments.
7- Magmatic rocks.
8- Phanerozoic sediments (youngest).

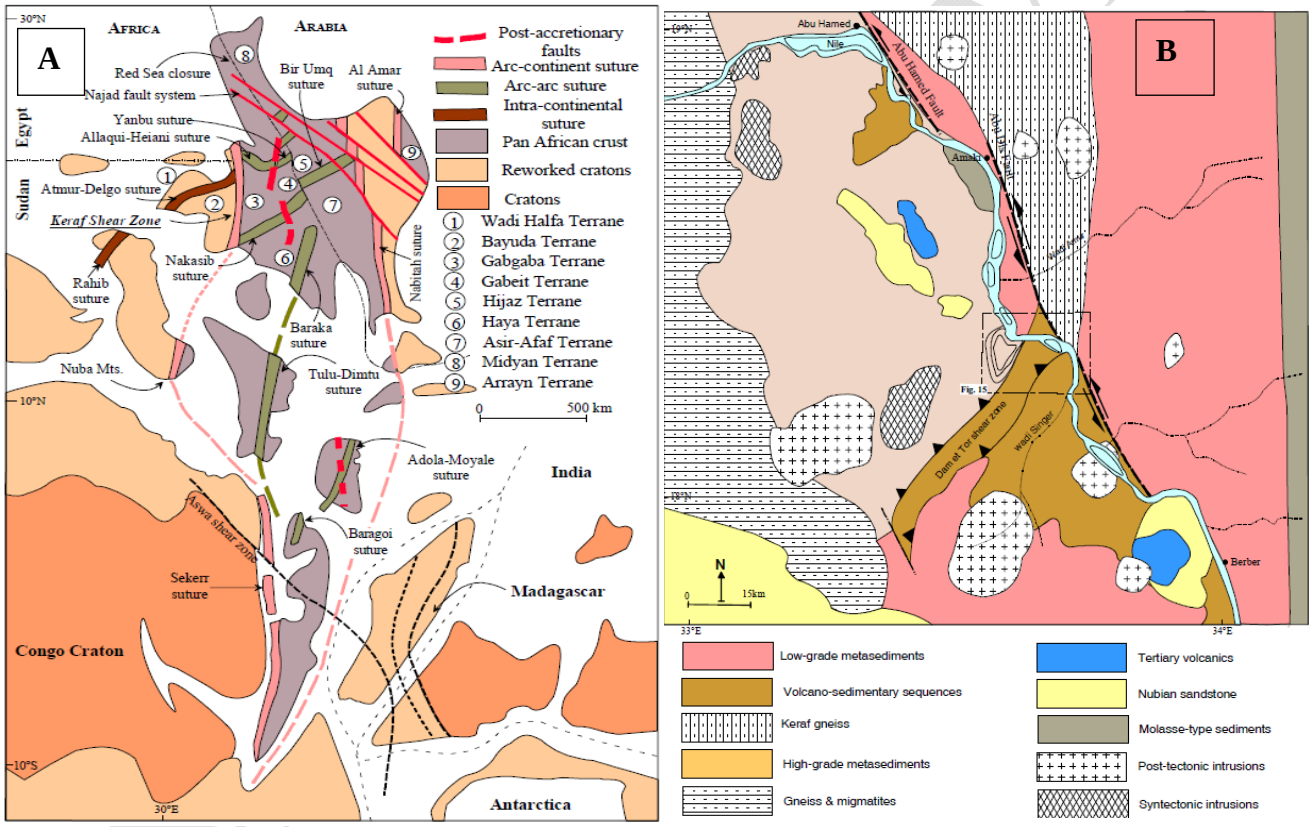


Fig: 4 (A) Tectonic map showing the Precambrian structures and Terrance in NE Africa and Arabia, Sutures are connected by dotted lines. The area enclosed by the E and W arc continent sutures is the Arabian-Nubian Shield (modified after Stern, 1994). Fig: 5 (B) Geological map of the southern sector of the Keraf Shear Zone note Shereik area. Note the dominance of the high-grade meta-sediments west of the Nile and the low-grade ones in the east (modified after Abdel Rahman, 1993; RIES et al, 1985).

2.3.1 High-grade gneisses and migmatites:

The high-grade gneisses occur in the central and the western sectors of the Bayuda Desert and in the area to the west of the Wadi Halfa [10]. They are poly-deformed, occupy the lowermost stratigraphic level and are in the upper amphibolites metamorphism. Similar lithologies are reported in the Wadi

Halfa, to the west of the Nile and in the Delgo area [11] [12]. High-grade metamorphic rocks reported in J. Uweinat and J. Kamel can be correlated with the gneisses in Bayuda Desert and Wadi Halfa Terranes on the basis of lithology and stratigraphy [13]. U/Pb Zircon age from high-grade gneisses is in the range of 700 – 900Ma [14, 15]. Nd model ages reported from the older granitic gneisses from Wadi Halfa-Bayuda Terrane and from the east Desert of Egypt is generally greater than 1.2 Ga [10, 11, 13, 16]. 87Sr/ 86Sr ratio, reported from 0.7060 - 0.7160 [10, 17, 18]. These ages and isotopic ratios indicate the presence of older (Pre-Pan African) material in the gneisses in Bayuda and Wadi Halfa Terrance. Lithologies with such isotopic characteristics were not reported from the Gabgaba Terrance.

2.3.2 High-grade supra-crystal meta-sediments and Keraf gneisses:

These are amphibolites, calc-silicates, biotite-granet schist, quartzo-fledspathic gneiss, metapelitic, marbles and quartzite, which overlie the high-grade gneisses [19, 20]. Mineral composition, texture and structures in these rocks indicate marine shelf depositonal environments [10]. High-grade meta-sediments near Abu Hamed have yielded Rb/ Srerrochron age of Ca. 0.0703 [20]. Quartzo-feldspathic gneiss from the Bayuda Desert has yielded and Nd model age of Ca. 100Ma [16]. These low age and isotopic ratios exclude along the crustal history of the original rock material prior to the amphibolites facies metamorphism. The high-grade meta-sediments and the Keraf gneiss are called by some authors the supra-crustal meta-sediments due to their mode of formation. [1, 20] believes that the high-grade meta-sediments belong to the high-grade gneisses and migmatites and they have been placed in their present stratigraphic level of younger tectonic activities.

2.3.3 Low-grade meta-sediments:

The low grade metamorphic rocks from an N-S trending belt that covers more than 60% of the total surface area of the Nubian Shield [1, 20-22]. They are tectonically emplaced over the high-grade rocks (both the gneisses and meta-sediments) of the Wadi Halfa Bayuda Terranees [21, 23]. The sediments are locally divided into a proximal western portion which is coarse immature and a distal eastern portion with fine-grained textures [21, 24]. The low-grade meta-sediments and high-grade supra-crustal rocks are believed by some authors to have the same age and tectonic history, but represent different levels within the Neoproterozoic crust in the area [20, 23].

2.3.4 Ophiolitic mélange rocks:

This is highly tectonics and serpentinized mafic-ultramafic allcothonous sequences scattered in Wadi Halfa, Bayuda and Gabgaba. They occur along the shear zones representing major tectonic features in the each as the Keraf Shear Zone, Atmur-Delgo suture and Dem El Tor shear zone [1, 19, 21, 23].

2.3.5 Volcano-sedimentary sequences:

These are occur in the eastern margin of the Gabgaba Terrance, the east and SE Bayuda Desert and in the vicinity of the Wadi Halfa area [1, 20-22]. In east Bayuda Desert these rocks occur as intermediate volcanic in a sedimentary matrix of tuffaceous-silicious composition [20]. In SE Bayuda Desert the volcano-sedimentary rocks include Rhyolite andesite and basal intercalated with volcano-clastic sedimentary units. Limited occurrences of marbles quartzites and Fe-rich cherts are associated with the volcanic material [6, 19]. Rocks form this sequence has yielded Rb/Sr errochron ages of 800 - 850Ma and 87Sr / 86Sr ratio of 0.70251 - 0.70299 [20]. [21] has argued that the volcano-sedimentary sequences in the SE Bayuda Desert could be correlated with arc-related assemblage in the Haya Terrane

of the Red Sea Hills. The argument is based on the structural trends, lithologicall and petroligical similarities. Limited occurrences of meta-volcanic and volcano-clastic material were reported from the Delogo area west of the Nile [12]. In the Wadi Halfa area successions of mafic-meta-volcanic intercalated with minor facies volcanic and clastic sediments were reported by, The volcanic material has yielded Rb/ Sr whole rock ages of 650-580Ma and 87Sr/ 86Sr ratio of 0.7025 - 0.7031 [10]. The data support the conclusion that the volcanic and the associated volcano-clstic texture material represent a juvenile addition to the crust without contribution from the older gneisses [25].

2.3.6 Molasse-type sediments:

These are slightly metamorphosed and weakly deformed sedimentary units reported in the Amaki area by [1, 6]. The Amaki sedimentary sequences occupy the uppermost stratigraphy portions among the basement units. Lithologies include conglomerate and sandstone with minor intercalations of chert, volcanic tuffs and limestone. This sequence is considered to represent molasse-type sedimentation of the last orogenic phase in the Nubian Shield [20].

2.3.7 Magmatic rocks:

These are the plutonic emplacements and the Cenozoic volcanic extrusion. The plutons have various dimensions, shapes and compositions. They are divided into Syn- and post-orogenic intrusion on the basis of emplacement time [11, 20, 26]. And the syn-orogenic intrusions are I-type foliated granitoids intruded during the period 800 - 550Ma ago. These rocks are mainly intruded in the high-grade gneisses. The post-orgenic intrusion is A-type pinkish granite scattered in Wadi Halfa, Bayuda and Gabgaba area as ring dykes, batholiths and small stocks. The rocks are not foliated and composed predominantly of quartz and alkali feldspars [26]. They have emplacement ages less than 550Ma [11, 16, 20]. Nd and Pb isotopic ratios of the Wadi Halfa post-orgenic A-type granite showed that the participation of older crust in the generation of the granite is very minor [13]. A similar conclusion reached for granite in the southern Bayuda Desert by [20]. Cenozoic Volcanic are reported in many localities within the Wadi Halfa and Bayuda Desert area [1, 6, 19]. They occur are flows and plugs of trachyte, basalt, tephrite, phonotephrite, latites and phonolites [19].

2.3.8 Phanerozoic sediments (youngest):

These are sedimentary outliers in the Wadi Halfa and Bayuda area. The rocks belong to the Nubian sandstone formation which is Mesozoic age [5, 27]. The major occurrences of the Phanerozoic sedimentary rocks are north of Wadi- Halfa and SW Bayuda Desert.

3. Details Geological Mapping of El-shereik Study Area:

The El Shereik study area is covered by metamorphic, meta-somatic, igneous rocks, and plugs. Taken more than 40 samples through six traverse, for classification and petrographic study, three of traverse towards N – S and other heading towards SW – NE and have found some samples within the quarries represented as economic rock such as Talc, Wollastonite, and Graphite in addition to the gold mining (all of them as traditional mining) which form strong economic add to raise the living conditions of the inhabitants of the region and arrivals, because there are quartz veins associated with graphite rocks, mica schist and soil brackets where there are reasonable quantities, as we found that rocks as container for gold element with a dipping less than 60o to the north-west, where there are quartz veins conformable range foliate those rocks sizes and different extensions, but the gold-containing component

is no parallel to the foliation bands in graphite and mica schist rocks. These rocks are distributed within a major westward plunging anticline and are overlain in most parts by superficial deposits. They have been listed as follows.

Superficial Deposits:-

- Aeolian deposits
- Fluvial deposits
- Collovial deposits

Igneous Rocks:-

- Dolerite and basaltic dykes.
- Rhyolite porphyry dykes.
- Quartz veins.
- Pegmatites.
- Diorite.

Metamorphic Rocks:-

- Migmatites
- Calc-silicates
- Wollastonite
- Talc schist
- Carbonaceous rocks (dolomitic marble)
- Amphibolites
- Graphitic schist
- Mica schist
- Quartzo-feldspathic schist
- Grey gneiss

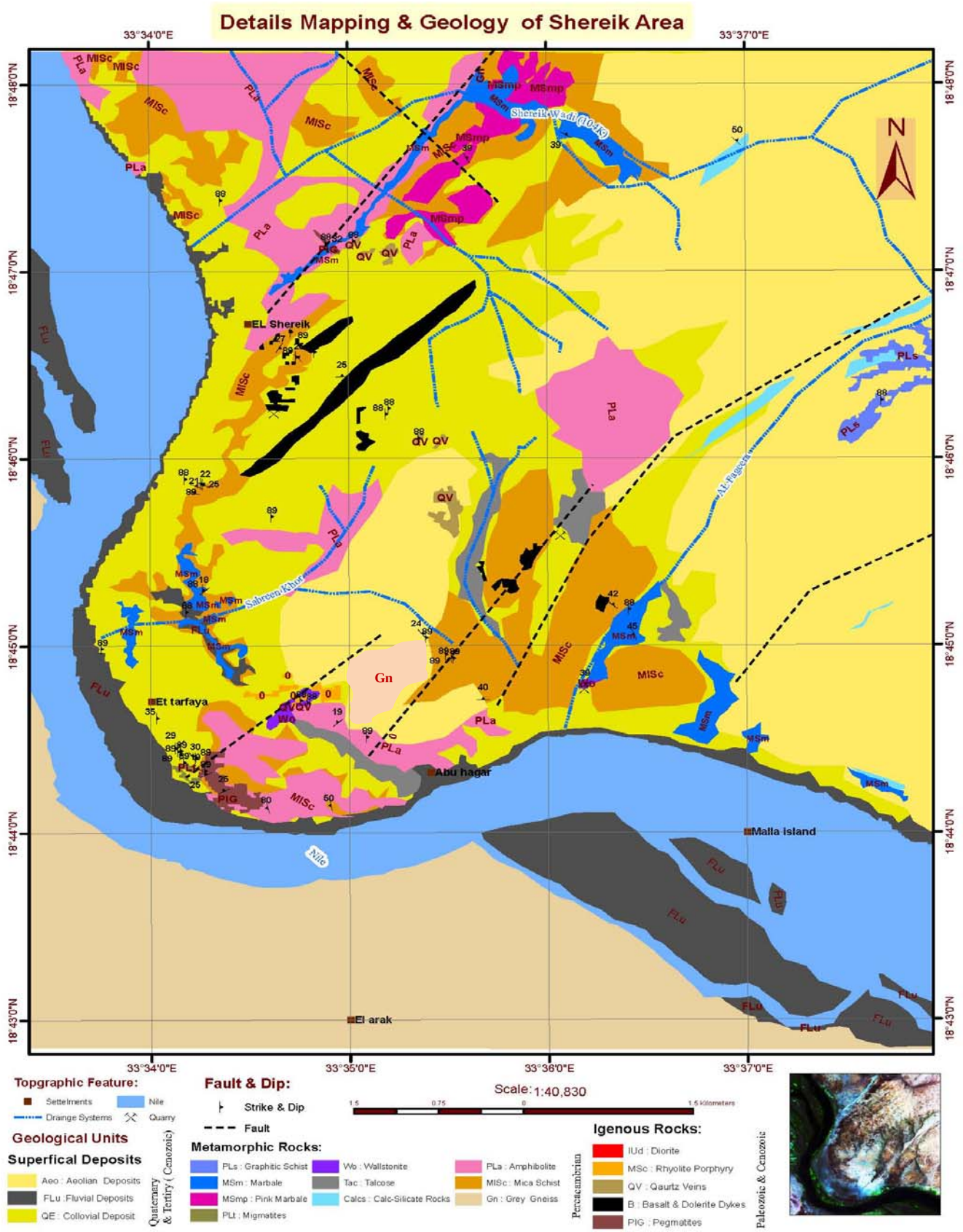


Fig 5. Detailed geological map of emphasizing structures of the El Shereik study area east Nile bank.

3.1 Metamorphic Rocks:

These rocks generally constitute more than 60% of the surveyed area and distributed over most of the western side. They formed most of the outcropping rocks around Shereik Town (Fig. 5). Their description has been done from oldest to youngest, although there are obvious unequivocal criteria to support this classification except the some structural not clear and these rocks are repeated laterally with the structures.

3.2. Grey Gneiss:-

These rocks are generally classified as para-gneisses or ortho- gneisses, its greyish and coarse texture formed under conditions of high-grade regional metamorphism. These rocks exposed to the southeast of the study area. Although it's coarse-grained but it's characterized by a weak layered or less regularly banded appearance due to the segregation of ferromagnesian minerals from quartzo-feldspathic minerals in discontinuous layers or lenticels. The dark minerals commonly include Biotite and or Horenblend, and less common pyroxene, Garnet is often present in minor amounts. This gneiss may be termed as ortho-gneiss which is derived from the metamorphism of an igneous rock as it has been suggested that it descended. The most prominent occurrence lies at the southeastern part of the study area. In spite of its pronounced layering, this rock closely resembles diorite in that it is coarsely crystalline brownish - grey rock on its weathered surfaces and greyish to whitish on its fresh surfaces. It's a rather homogeneous rock provided that it's not affected by metasomatic replacement or by the incorporation of the country rocks. Structurally, this rock is generally weakly foliated compared to other rocks in the study area like qaurtzo-feldspathic schist. It exhibits localized zones of intense shearing due to faulting or due to differential shearing during the deformation of the Keraf Shear Zone within the adjacent incompetent rock.

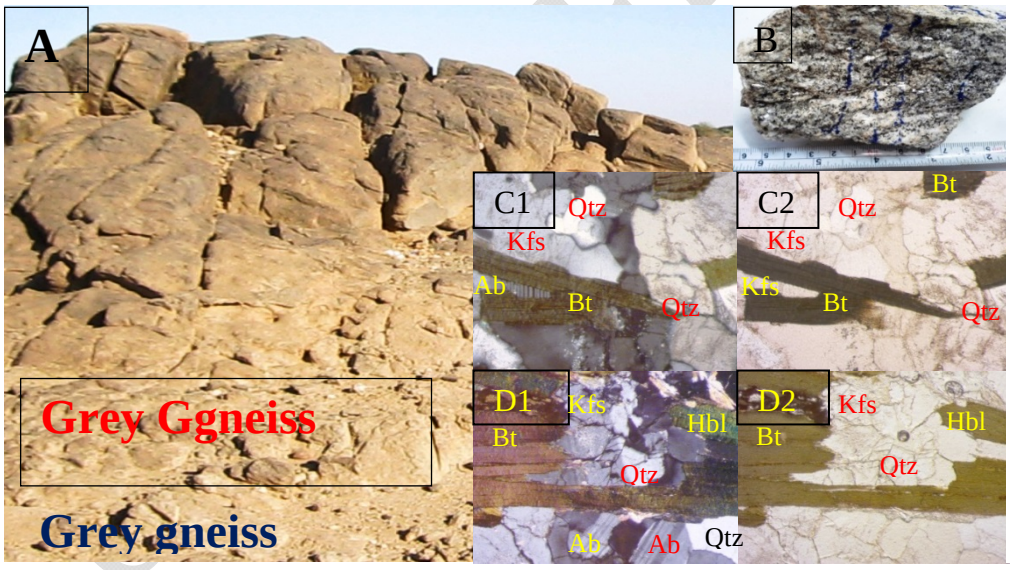


Plate (A) showing outcrop of grey gneiss with weak layering, plate (B) Displays a hand specimen of upper exposure of grey gneiss. But the Plates (C1, C2, D1 and D2) Photo-microscope of the mineral composition of grey-gneisses, it is weakly foliated and mainly consisting of quartz, plagioclase, k- feldspar, biotite and little hornblende. Picture (C1&D1) taken under cross Nicole (XPL) (C2 & D2) out-analyzing (PPL).

4.2.2Quartzo-feldspathic schist:

It's dark brown on weathered and its croup out at several locations concordant with dolomitic marble especially in the east of the Nile bank near the railway. It is laterally associated with quartzo-feldspathic gneiss and amphibolite schist especially at the far east of the study area. It differs from grey-gneiss and granitic gneiss, it's more strongly foliated, more fissile and it's characterized by the development of

closely cleavage with composed of quartz, k-feldspar, plagioclase, muscovite and biotite. Hornblende is present locally in significant amounts as well as garnet.

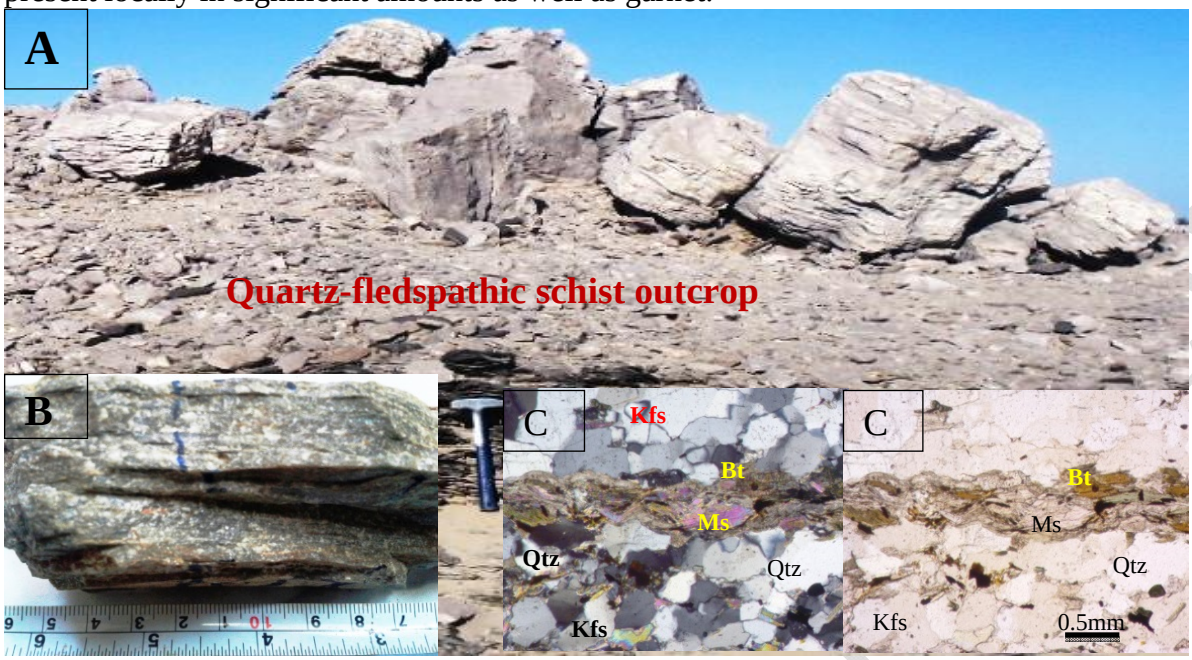


Plate (A) showing the outcrop of the quartzo-feldspathic schist. (B) Displays close up view of upper qaurtzo-fledspathic schist, while the plates (C1 & C2) are quartz-fledspathic schist, impure quartzite (C1) taken in cross Nicole and (C2) in plain polarizing light, it's fine grained texture with sutured boundaries, composed of quartz, feldspar muscovite, biotite and little calcite. Parallel to cleavage – fracture foliated. Its dynamic metamorphism of regional grano-blasts. Its typical orthogonal horn-felsic texture- grano-blasts rock. Cataclastically deformed by breakage, a shredding of mica (muscovite), its typical quartz- feldspar- mica schist (muscovite + biotite schist).

4.2.3 Garnet-amphibolite schist:

It's used this term when garnet porphyro-blasts are clearly discernible in the rock as in the east bank of the Nile and closely grey gneiss exposed of the study area. A few exposures were also observed in the area close to the marble bands on the southern portion. At those locations garnet-amphibolites schist is inter-banded with talc, wollastonite and mica schist (biotite–muscovite). However the predominance of garnet there could be attributed to the development of calc-silicate minerals due to the contact with marble rocks. It lies in the condition form rocks of the (garnet) epidotised-amphibolite facies, as a result of retrogressive of metamorphism, and its more intense conditions form rocks granular facies. This epidotised-amphibolite is typically represented by Hornblend, Epidote, Albite (in rocks of basic igneous composition). An increase in metamorphic intensity is marked by the disappearance of epitomized (garnet) and the formation of its more calcic plagioclase to give the assemblage diagnostic of amphibolite facise. It is formed in deeper parts of folded mountain belts as Mozambeag belt. This rocks its low-medium grade facies.

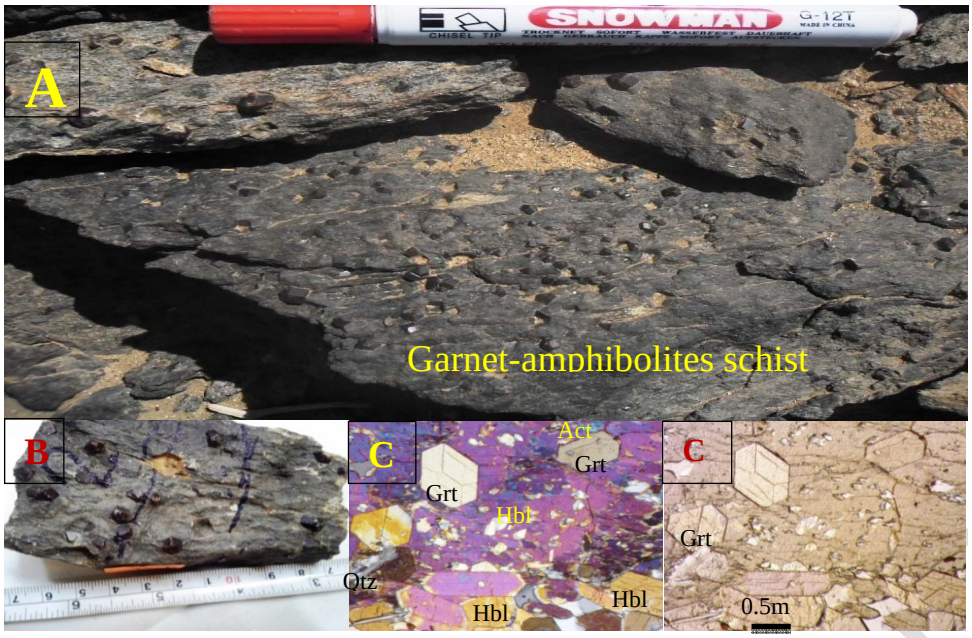


Plate (A) shows outcrop of garnet-amphibolites schist with impure garnet. (B) Showing a hand specimen of garnet amphibolites schist. But the plates (C1 & C2) showing photo-microscope of porphyro blasts of garnet amphibolites. It is medium to coarse crystalline rock, consisting of parallel alignment of hornblende, garnet and little quartz. Also explain garnet and acttinolite in (low relief). (A) Taken in cross Nicole under microscope and (B) in plain polarized light.

4.2.4 Mica schist:

These rocks its typical Biotite mica-schist which occurs mostly as pockets and lenses distributed several parts of the study area. The most important exposures which lie southeast, northwest and east of the study area. In most occurrences, it's associated with marble and composed of biotite, and quartz as well as Muscovite, and it's well foliated by the preferred orientation of flaky minerals Adjacent to the marble bands. Biotite schist becomes very coarse crystalline and the proportion of biotite amongst its constituents remarkably increases. These rocks consist of a mineral of the Mica group, which distributed in a variety of metamorphic and also can be found in igneous and sedimentary rocks. Biotite is black in hand-specimen, and has perfect basal cleavage.

Plate (A) Exposure of mica Schist, southwest portion of study area and plate (B) A hand- specimen of mica schist. But plates (C1 & C2) showing porphyro-blasts of garnet biotite-schist, medium to coarsely crystalline rock consisting of parallel alignment of biotite, quartz and garnet. The shearing along the zones of mica concentration – alteration, explain altered mica schist in sheared zone, which consist of quartz, biotite, altered garnet, plagioclase, talc predominant, a little hornblende and iron oxides. (C1) Taken under cross Nicole microscope and (C2) under a PPL.

4.2.5 Amphibolite:

These rocks are distributed over almost all of the area covered by the bedrock or the basement complex. It covers wide areas northeast, northwest and south portion of the east of the Nile bank. This rock is typically dark black in colour, well foliated by preferred orientation and in some location by garnet. This particularly discernible where the rock is affected by metasomatism. Amphibolite is frequently disturbed, as broken or cut by faults, such as over thrusts or by pegmatite dykes and quartz veins. Metasomatism is well pronounced within these rocks and it gave rise to the great compositional divert from these rocks. Structurally amphibolite is well foliated, by banding in some places, affected by tight folding into NE direction. Their attitude of foliation depends on their position in the major structure. It strikes generally in the northeast at the northwestern part, and towards to southwest along the southern part of the structure. It's strongly foliated metamorphic rock, dark to black color, consisting mainly of hornblende, plagioclase, biotite, almandine and garnet with little or no Quartz, and having crystallo-blastic texture. Amphibolite grades into garnetifrous hornblende-plagioclase gneiss as the content of quartz increases.

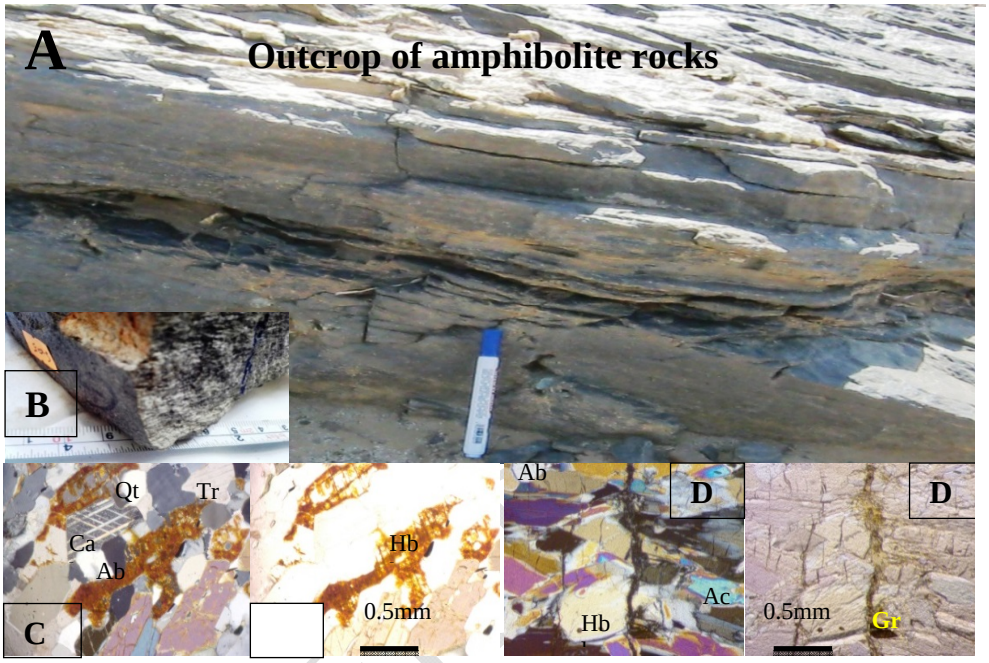


Plate (A) Showing outcrop of amphibolite in the south part of the study area. (B) A hand specimen of amphibolite. But the plates (C1, C2, D1 & D2) showing photo-microscope displays the strongly foliated amphibolite schist, with shaped minerals of hornblende, plagioclase, calcite, little (quartz and iron oxides). Also explained the minerals of tremolite, ferro-actinolite and garnet with Cata-clastic breakage granulation of mineral grains with micro-fracture a crossing the foliated. C1) Taken under cross Nicole microscope and (D1) under plain polarizing light.

4.2.6 Graphite schist (plumbago):

It's exposed as highly altered, foliated rock; consisted of quartz vein, which carried association's mineral gold. In general, it's a natural crystalline form of carbon, dimorphism. But is found here as schistose in an abandoned local mine in the eastern portion beside Al Fageera valley, also its exposed clearly along the Asphalt highway, where its highly deformed by thrust faults and is injected by quartz boudinage. This rock structures may be a big limb of tight upright folds. It's grey to black colour, fine grain texture and greasy to the touch. Its flakes disseminated through metamorphic rocks such as gneisses, marble, and schist. It's probable that graphite was derived from carbonaceous material of organic origin. Graphite is also called plumbago because for centuries it was confused with galena, a black sulphide of lead.

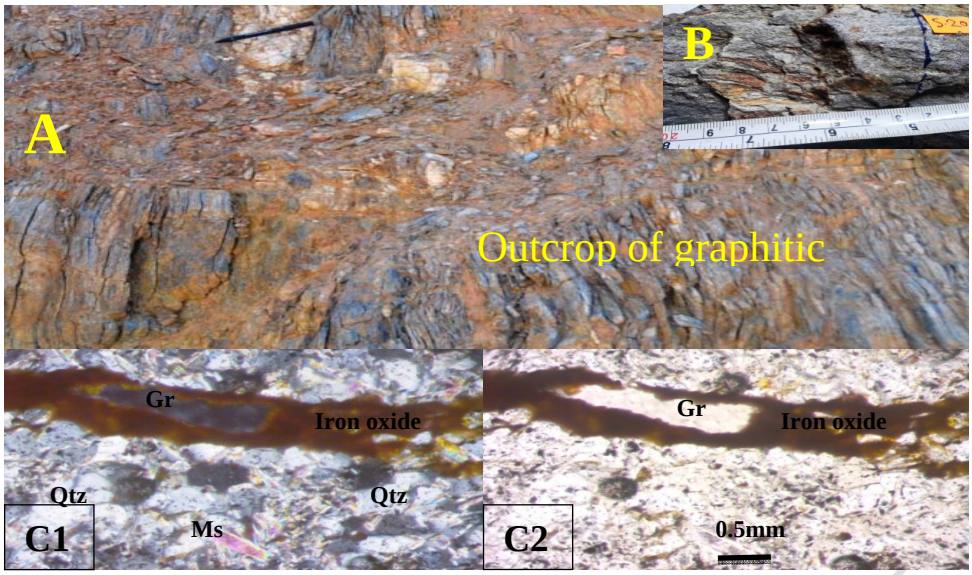


Plate (A) displays outcrop of graphitic schist. It is highly deformed with mullion and boudinage of quartz. (B) Shows a hand specimen of graphitic schist. (C1 & C2 photo micro scope) are showing a foliated of graphitic schist which consist of a graphite, muscovite, quartz and iron oxides (brownish) as micro fracture. (C1) Taken in cross Nicole microscope and (C2) in plain polarizing light.

4.2.7 Carbonaceous Rocks:

These rocks are exposed at several locations in the surveyed area, however, the most significant exposure that occupies southwestern part of the majority hinge on the fold. Marble at this location forms a huge mass massive as whitish and pinkish colour and it's coarsely crystalline. It's mainly dolomitic marble intercalated with coarsely crystalline biotite schist and differ than other outcrops of marble was observed north of the study area as well as south of El Shereik Town, eastern and central portion. These exposures, display spectacular folded patterns of mainly syn-formal structures with their axes plunging westwards. However marble at these locations differs from that of the main southern mass massive. It's fine in grain size and remarkably sheared and silicified, and it's never reacts with dilute hydrochloric acid because high content of magnesia, its typical dolomitic marble and it's not known that whether dolomitization took place during the digenetic processes or later during the metamorphic or metasomatic processes. In general this marble, fine to coarse grained consisting mainly of recrystallized Calcite or dolomite. It is metamorphosed limestone with full vary-colour greyish, whitish and pinkish, which results in the formation of minerals such as frostorite, can be used as Ornamental stone.

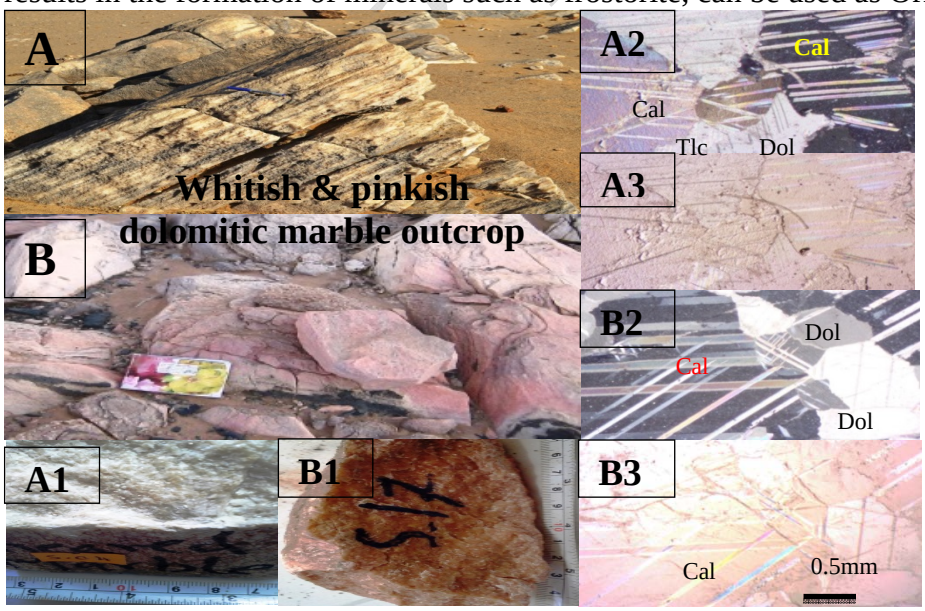


Plate (A & B) Shows outcrop of the whitish & pinkish dolomitic marble at the surveyed area. (A1 & B1) Explain a hand specimen of whitish & pinkish marble. Plates (A2, A3, B2, & B3) shows the sheared dolomitic & pinkish marble under microscope. Its coarsely crystalline rock consisting of parallel alignment of calcite, dolomite and little talc minerals. (A2 & B2) Taken under cross Nicole and (A3 & B3) under the plain polarizing light.

4.2.8 Talc Schist:-

Theses rock exposed as several band contacts with marble, one of them extended more 1km, and it's very clear in an abandoned or quarry civil mine in the north and south east of the study area. It's a very soft rock, foliated, and whitish to grey-white in colour and wavy appear, and it found as coarse crystal foliated, fibrous and granular masses as an alteration product of Magnesium silicates, because its formed by metasomatism in impure dolomitic marbles as it found now parallel to dolomitic rocks. And its compact massive rock composed mainly of Talc. This rock can also be found in various colours, in addition to this type, as greenish or brownish and can be easily carved sometime namely in Steatite Talc. It is low-grade metamorphic rock.

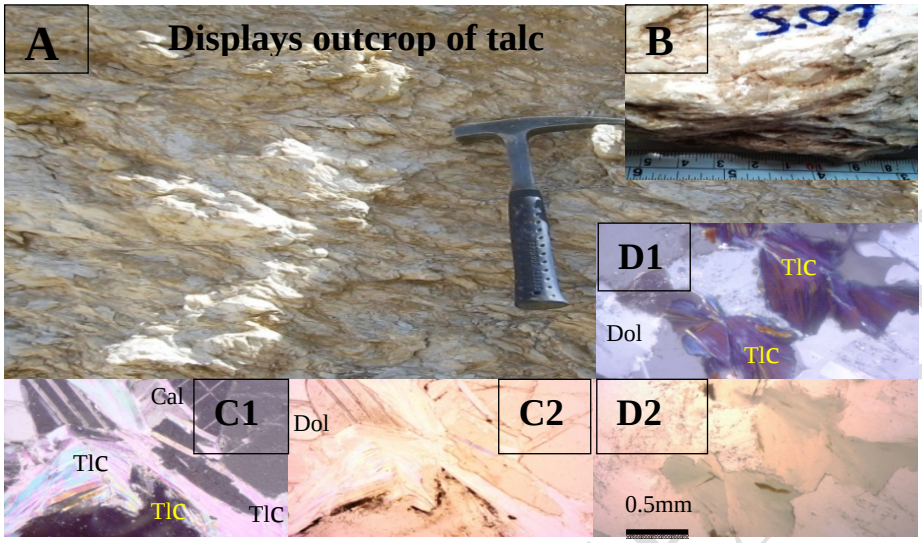


Plate (A) shows an exposure abandoned or quarry talc' schist into local mine in central of the study area. (B) Shows a hand specimen of talc. (C1, C2, D1 & D2) Showing the photos microscope of talc schist which composed minerals of talc, calcite and dolomite. (C1 & D1) taken under the cross Nicole microscope, but (C2 & D2) under plain polarizing light.

4.2.9 Wollastonite:-

This rock is exposed as abandoned or quarry local mine, which found in contact with dolomitic marble in the southeast portion of the study area. Its typical triclinic silicate mineral, composed of Casio2, its occurring as whitish to greyish-white colour, radiating coarsely crystalline masses. It's typical of contact-metamorphic calcareous rocks, and also occurs in low-pressure regional metamorphic rocks.

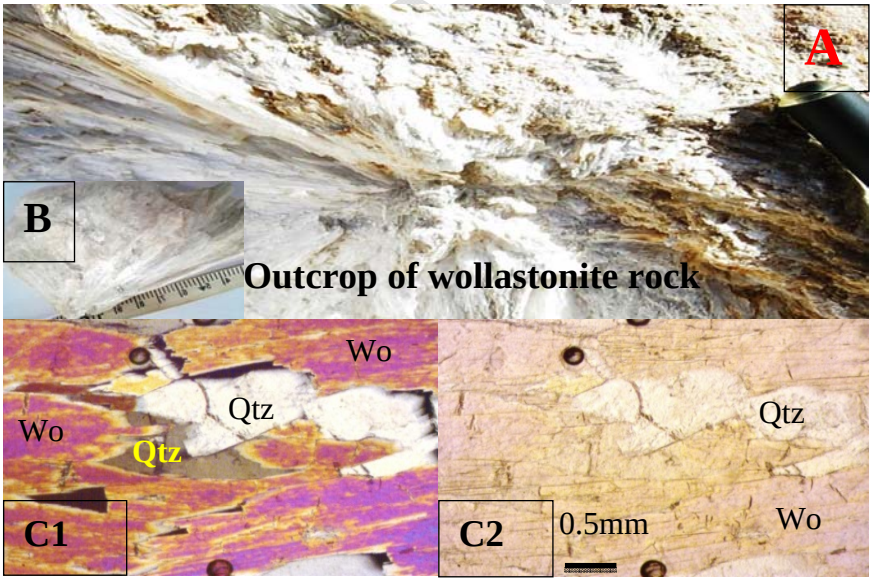


Plate (A Explains wollastonite rock into a local quarry south mapped area. (B) Showing a hand specimen of wollastonite rock. (C1 & C2) explained the photo-microscope of wollastonite skarn, rocks, radiated shape, mainly consisting of wollastonite and little quartz. (C1) Taken in cross Nicole and (C2) in the plain polarizing light.

4.2.10 Calc-silicate (calc-flint**) Rocks:-**

It's a type of metamorphic rock which appear as massive compact, very hard, fine to medium texture exposed in the eastern and northeast part of the study area, found in different colour from reddish-brownish to whitish and makes up of calcium and silicon are the dominant constituents, and which is derived from quartz -bearing dolomites and limestone, or from carbonate rock metasomatized by siliceous solutions from abutting granitic intrusions. These rocks consisting mainly of minerals, calcite, talc and quartz with weakly foliated texture. Also, maybe this rock is produced by the thermal metamorphism of impure limestone and silica as well as calcite. It is highly deformed and characterized by different types of micro folds and fault.

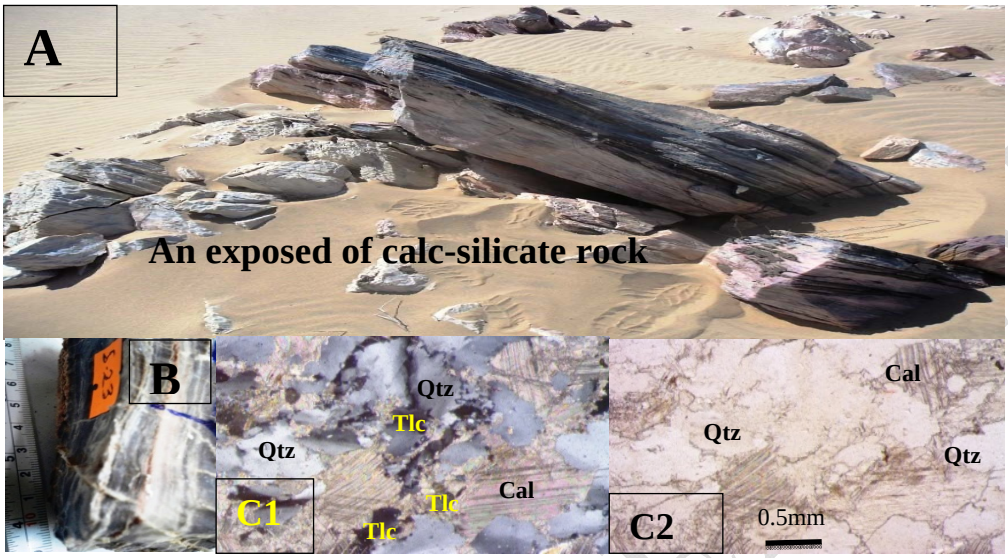


Plate (A) Showing an exposed of calc-silicate rock in east part of the study area. (B) displayed a hand specimen of calc-silicate. (C1 & C2) explained photo-microscope of calc-silicate rock, which is consisting of calcite, talc and quartz with weakly foliated texture. (C1) Taken under cross Nicole (C2) taken in plain polarized light.

4.2.11 Migmatites:

These rocks are widespread in the surveyed area. It is obvious that most of the rock units in the area and affected by some degree of metasomatism which their discrimination and hence their mapping very difficult. The major exposures of metasomatic rocks were observed in the Al Tarafi village where intense injection of pegmatite dykes, quartz veins and stringers acted as leucosome, lead to the development of a wide region of metasomatic rocks. These rocks vary significantly in texture, appearance and in composition as metasomatic replacement, which refers to a rather heterogeneous process. They are well foliated by preferred orientation as well as by the well pronounced migmatitic layering. Typical migmatitic structures such as pinch and swell structures are frequently observed in the study area. Its highly complex rock that is generally an intimate mixture of apparently igneous material of granitic composition and high-grade metamorphic rock; it is characterized by a banded or veined appearance. The principal theories of this migmatite granitic material which introduced from magma (injection gneiss) or it may be formed from through the action of fluids permeating the host rock (Granitization) or formed by partial melting (Anatexis) under very high temperature and pressures. This rock was found in the suggesting area of Al Shereik dam set project.

Photo shows the migmatite body east Nile bank (Tarafy village).

4.3 Igneous Bodies and Dykes:

4.2.12 Diorite:-

This rock exposed as grey-dark colour, coarse-grained, with a composition between that of granite and basalt. It occurs as large intrusions, dykes in the east portion of the study area. This rock often forms above a convergent plate boundary where an oceanic plate subducts beneath a continental plate, because partial melting of the oceanic plate produces a basaltic magma that rises and intrudes the granitic rock of the continental plate. There, the basaltic magma mixes with granitic magmas or melts granitic rock as it ascends through the continental plate. This produces a melt that is intermediate in composition between basalt and granite. Diorite can be formed if this type of melt crystallizes below the surface, typical like this type. And it's composed of sodium-rich plagioclase (andesine & oligoclase) with lesser amounts of hornblende and biotite and very little quartz. This makes diorite a coarse-grained rock with a contrasting mix of black and white mineral grains. Typical as "salt and pepper" appearance as a clue to the identification of diorite.

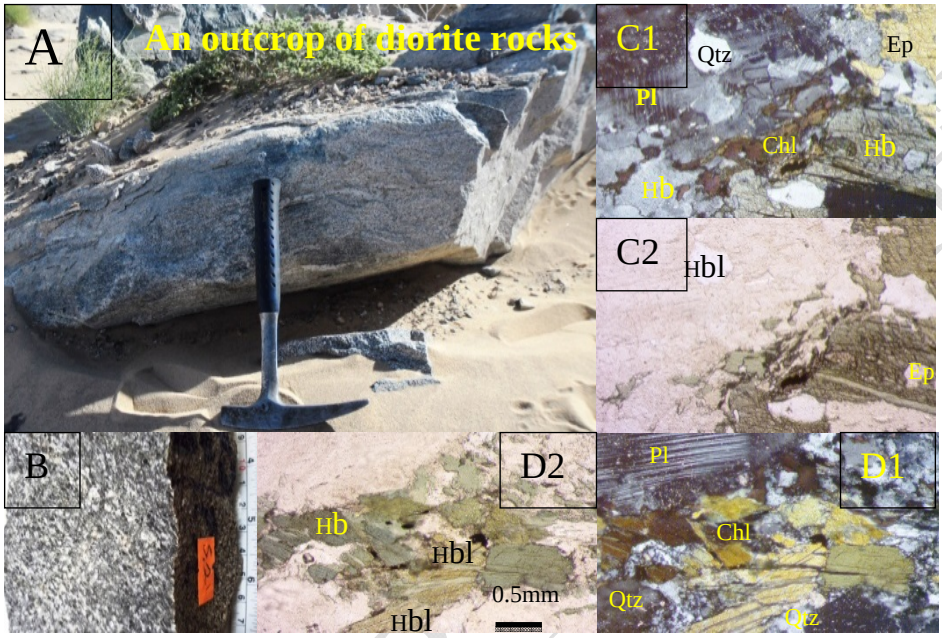


Plate (A) showing an outcrop of diorite rocks east portion of the study area. (B) Shows a hand specimen of diorite rocks. (C1, C2, D1, & D2) displayed a cata-clastic texture of diorite rock, with kinking of twining, (C1 & C2) taken under cross Nicole and (C2 &D2) under plane polarized light. Undulates extinction of quartz granulation of minerals pyroxene. These plates showing the minerals of hornblende, chlorite, epidote, quartz and plagioclase. It is typical cata-clastic diorite with the shredding of chlorite and hornblende.

4.3.1 Pegmatite Dykes:

These rocks wide distributed in the study area. It has ranged in size between more 8cm to over seven meters in thickness and more than 1Km longer, with vary in colour, texture, composition and included older deformed greyish pegmatite and younger pinkish pegmatite. Their range in form between huge irregularly shaped mass, linear bodies as dykes to thin veins or stringers. In composition these rocks range between pegmatite consisting of quartz and k-feldspars only to pegmatite with complex composition consisting of quartz, k-feldspar, plagioclase, muscovite, tourmaline of black and light colour as well and biotite, that is greyish pegmatite type. Their texture also varies very much between very coarsely crystalline formed of mega-crysts to medium grained. The greyish pegmatite is slightly too strongly sheared giving rise locally to gneissose texture. In any case theses pegmatite in general a very coarse grained igneous rock with grain size larger (1 to more than 2cm), typically like that found around the margins of large, deep seated plutonic, often extending from the pluton itself into the surrounding country rocks. It's included small veins, lenticular and pod shape. Some of them have internal zonation of fabric, with simple composition, comprising mainly of quartz and potassium feldspar, with lesser amount of Muscovite and tourmaline. These pegmatite represent as a volatile-rich, late stage in the crystallization of a magma.

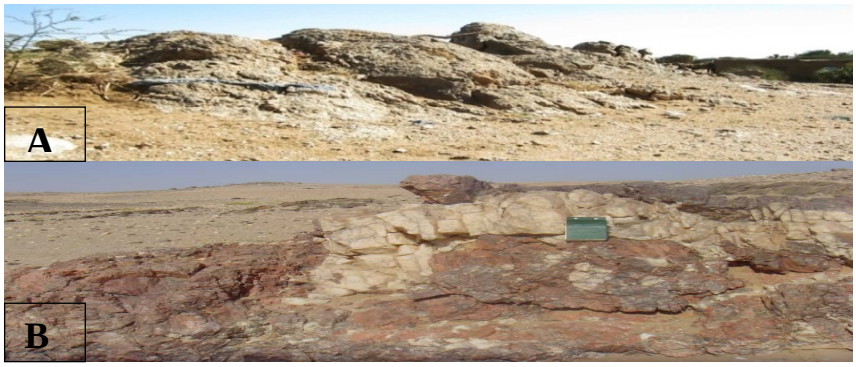
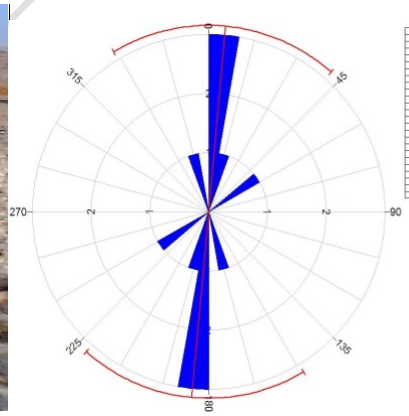


Plate (A) displayed a greyish pegmatite dyke exposed.
(B) Displayed the Pinkish pegmatite dyke, both two dyke exposed close to the Nile bank at the study area.

4.3.2 Quartz Veins:

These rocks are widely distributed in the surveyed area, especially in the central part, has a huge quartz vein because of their high resistance to weathering and relatively form high ridges over the surrounding geology. Quartz veins are oriented towards many directions as shown in rose diagram; however, they are most commonly oriented towards NNE and NW. Their size ranges between a few centimetres to more 3m in width and several hundred meters in length. Its emplacement possibly accompanied the late hydrothermal stage of the granitic magma injection, elsewhere NE and central surveyed area have significant amounts of gold were produced by gold hounds during the past few years until present. Outcrops of quartz veins disintegrate into angular rubble which is in turn highly resistant to weathering that caused them to cover a wide area, especially in the east and central part with finding a few crystalline quartz which as crystalline silica as commonly hexagonal prisms, colourless and transparent, near to the Nile bank. It's. It is one of the commonest rock-forming minerals and is an essential constituent of acid igneous rocks, for example granite rocks. Its occurs pegmatite and in hydrothermal veins in association with ore minerals.



Statistical Summary	
Calculation Method	Frequency
Class Interval	15.0 Degrees
Azimuth Filtering	Quadrilateral
Data Type	Bidirectional
Rotation Amount	0.0 Degrees
Population	12
Total Length of All Lineations	12
Maximum Bin Population	3
Mean Bin Population	1
Standard Deviation of Bin Population	0.73
Maximum Bin Population (%)	25.0
Mean Bin Population (%)	8.3
Standard Deviation of Bin Population (%)	6.1
Maximum Bin Length	3.0
Mean Bin Length	1.0
Standard Deviation of Bin Lengths	0.82
Maximum Bin Length (%)	25.0
Mean Bin Length (%)	8.3
Standard Deviation of Bin Lengths (%)	6.8
Vector Mean	5.3 Degrees
	185.30 Degrees
Confidence Interval	32.1 Degrees
	(95 Percent)
Rotate	0.0

Photo explains quartz vein outcrop possibly mineralized bearing black manganese oxides. On t other side rose diagram shown the general direction of quartz vein in the study area.

4.3.3 Rhyolite Porphyry Dykes:

These rocks are exposed along the southern part of the surveyed area, it forms arranged as swarms linear dykes, and they are continued across the Nile to the western side. This rock forms an outstanding feature in that area for its unique lights brownish to red colour and its uniform thickness and composition. This rock is dark reddish brown on its weathered surfaces and purplish red on its fresh surfaces and its porphyritic texture. It is formed of reddish potash feldspar and quartz as well as little amount of fine to microcrystalline quartz. Their size ranges between a few centimetres to several 3m in width and from several hundred kilometres to more than 3km in length. Structurally, high deformed and brecciated.

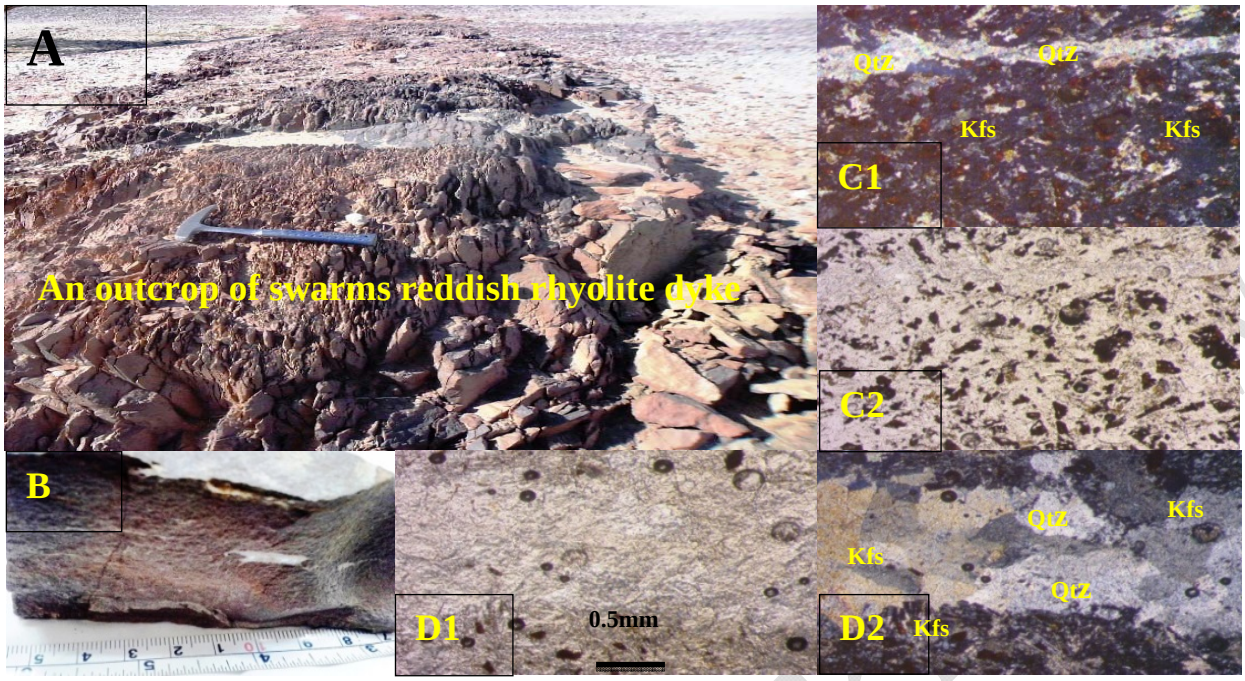


Plate (A) shows an outcrop of swarms reddish Rhyolite dyke in southern areas. (B) Displayed a hand specimen of reddish porphyritic Rhyolite dyke. (C1, C2, D1 & D2) explained the photo-microscope of non- flow texture Rhyolite and typically porphyritic, with phenol-crysts of quartz and potassium feldspar in a glassy to microcrystalline groundmass. There are small vein-let filled with micro-crypto-crystalline silica. (C1 & D1)Taken under cross Nicole micro-scope and (C2 & D2) taken under the plane polarized light.

4.3.4 Trachy-basalt and Dolerite Dykes:

An outcrop of brownish black, Trachy-basalt rock is exposed in the area just northwest of the study area as high hill ridges as well as the Basaltic exposure there forms a relatively high hill over the surroundings comprising most probably an eroded volcanic plug. A few basaltic dykes are present in the north and northeast of the surveyed area in the form of a parallel swarm of dykes oriented in N-NW. And some dolerite dykes were emplaced along normal fault zones (migmatite fault) between Al Shereik and Al Tarafi village. The basaltic rock is a dark colour, finely crystalline, consisting of plagioclase, augite and a little amount of Olivine in the form of small phenocrysts. Dolerite dykes are apparently amongst all other rocks in the area and crosses most of them, it's less than 1m in the wide and more 1km length. In general Trachy-basalt is an extrusive rock which a composition, basic to intermediate between trachyte and basalt. Both calcic plagioclase and alkali feldspar are present, as well as augite, olivine and Leucite or analcime may be minor constituents. Sometime can be compared with latite is the potassic variety of Trachy-andesite. But the dolerite is a medium grained intrusive igneous rock of basaltic-composition, composed essentially of clino–pyroxene-augite, plagioclase usually (labradorite) and Fe-Ti oxides, commonly showing ophitic textures. The name of the principal minor mineral may be added olivine dolerite and can also be compared with diabase, which is a synonym for dolerite.

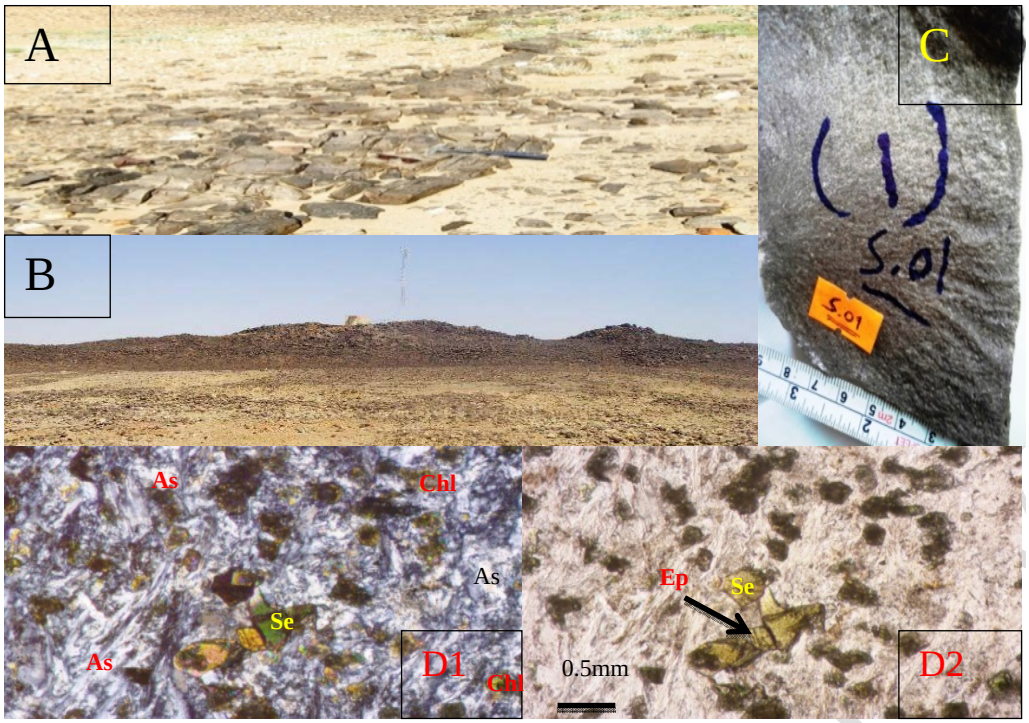


Plate (A) Explained the exposed of basalt dyke. (B) Shows the Trachy- basalt exposures dyke, both of them lies near to Al Shereik village. (C) Displayed a hand specimen of Trachy-basalt. (D1 & D2) displayed photo-microscope of Trachy-basalt, its highly altered, consisting of clay minerals (biotite) sercite, k-fiedspar (sanidine), chlorite, epidote, calcite, and little iron oxides with showing ophitic textures at the ground mass.

4.4 Superficial Deposits:

The superficial deposits are classified genetically into three types as the following, collovial, fluvial and Aeolian deposits.

4.4.1 Collovial Deposits:

This type comprises the most predominant type of superficial deposits in the study area. They are distributed in the area lying east of the railway track which passes along the east of the River Nile bank. These deposits consist of angular boulder, cobbles and granules at the slopes of hills or as talus sheets that cover the gently sloping areas around hills or ridges of quartz veins or dykes. Some of them may be used as a gemstone. It's found in different colours, amethyst, purple to blue-violet, rose, pink, orange-brown, smoky, pale yellow to deep-brown.

Plate (A) Shows an exposed of collovial deposit which spread in the hole study area. (B) Explains human activities for gold in Sabreen valley, as placer deposit. (C) Explains natural barriers such as ridges and hillocks in the eastern portion of the study area, its calc-silicate exposed. (D) Shows sand dune with ripple marks east portion near the highway Street of the surveyed area.

4.4.2 Fluvial Deposits:

On the other hand, comprise those deposits that were transported by water to their recent position. They include raised and reworked river terraces, wadi or Khor alluvium and recent Nile terraces. Fluvial deposits cover the area close to the Nile channel as well as along the seasonal Khors, Raised ancient terraces are present southeast of the study area. These were eroded by wind action, leaving some gravel patches on the upper surfaces [28]. A suspected abandoned channel of the Nile runs east of the present Nile course and is marked by the presence of the black Nile silt under the recent collovial cover or talus. The dark recent Nile silt covers a long stretch of land along both banks of the Nile and the adjacent farmlands where it is mixed partly by Aeolian sand. Fluvial deposits of the main wadies also form a significant proportion and are distinguished by their lighter colour from the rest of the superficial deposits. This is attributed to the presence of sand over silt which forms the bulk of the Nile deposit as recent sediment.

4.4.3 Aeolian deposits:

These deposits are present on the eastern bank of Nile especially behind natural barriers such as ridges, hillocks and the farmlands terraces. They are also present as isolated sand dunes in several topographic depressions in the eastern part of the investigated area. Aeolian sands and sand sheets are also present in many locations in the area lying west of the Nile. They are mixed and form as a significant proportion of the raised Nile silt that constitute the farm land in the studied area.

6.1 Conclusion

This effort represents an academic study and technology has been on my own expense under the supervision of the Graduate School of International University of Africa. It is scare to study the details of geological rock units and linked by the regional tectonic in the region, which is in the El Shereik area, River Nile State, Sudan. This area exposed to different types of metamorphic, igneous, and recent sedimentary rocks. These rocks found in an accumulated and crammed locally, it's exactly affected by movement as a result of various thrust faults. The previous studies, at study area, just focusing on regional, and their holes explored included, undifferentiated gneiss group: granitic, gneisses, migmatites, amphibolite, mica schist, marble, sand dunes, they are outcrop and non-outcrop or as a meta-sediments, mica-schist and a little of gneiss exposure are represented as basement rocks which widespread in the region as a part of regional geological Fig: (3). But this detailed research we found more different types of rock facies and various geological ages spread through basement rocks, but they are few compared to the basement rocks in different outcrops, and classified as follows: Igneous rocks: represented of Rhyolite, pegmatite, diorite, dolerite and Trachy-basalt, addition of metamorphic rocks, which is the most common spread in the region and includes the basement rocks mentioned above, which represented in gneisses, calc-silicate, as high-grad and dolomitic marble, wollastonite, mica schist, quartzo-feldspathic-schit and amphibolite as medium-grad rock, beside talc-schist, and graphitic schist are low-grad and the recent sedimentary rocks as residual and movable of gravel, which covers most of the study area. Most of these rocks are influenced structurally by thrusting faults, oblique faults, normal and semi-circular faults which appears as ductile and brittle deformation may be represented in Keraf Suture. These rocks extend and spread to the outside of the limits of the study area and most of them oriented parallel with Keraf Suture SE - NW region and a few of them are oriented E-W, This is maybe due of the collusion region represents at a contact boundary between Keraf Suture and Dem El Tor Suture Bayuda Terrance. Rocks of talc-schist, wollastonite and graphitic schist, represent very suitable quantities for the purpose of mining, as they are stretched several hundreds of meters and are also detectable and easy to transport as a result of the rail and highway escapes, besides mining of the gold element at present. Studies conducted in the region of Dem El Tor Shear Zone, its oldest age (isotopic signatures of the Bayuda later cooling from 590 to 550 Ma) occurred before Neoproterozoic than study area related to Keraf Shear Zone which youngest (Neoproterozoic time Pb isotope of ages dating, of KSZ curst formed -730–710Ma and that orogenic activity ended by -565Ma), because it has the first deformation of the folding of pre-Keraf Shear Zone proportion to the presence of folding in the west and east of the Nile zone, according to the border between Bayuda Terrance and Nubian Arabian Shield as suggest study. This is an indication that the deformation of Dem El Tor shear zone

already spread to the east of the Nile zone to the study area before Keraf sheer zone which younger age and it can be said that the rhyolites and pegmatite dykes which gives the name of Dem El Tor and their according of Dem El Tor Shear Zone which oldest age, compare with Keraf Shear Zone, represent clear evidence over geological periods despite its modernity, which extends in the direction of SSW to NNE conclusive the Nile zone and influenced by sheered breccia in east side of study area where the sheared of Keraf Shear Zone. The results of the present studies of various synthetic measurements of the rocks suggest that the curve of the River Nile zone in the Al Shereik study area, maybe it's a neutral folds as a result collision of Keraf Shear Zone out against of Dem El Tor Shear Zone as older. And also the River Nile, which is more modern than the deformed rocks, maybe it flows in the zone of collision between Keraf and Dem El Tor, and possibly the curves of Nile here are controlled by oblique faults and neutral folding which formed by deformation of Keraf Sheer Zone.

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