CHAPTER 1

INTRODUCTION

Gabal Sufra and its environ is an interesting site to study the complicated basement rocks and their tectonic setting in the South Eastern Desert. It has been affected by the Pan-African tectono-thermal event (Kenndy, 1964) in a period from 950-450 Ma (Kröner, 1984 & Shackleton, 1986). According to previous literatures, this area is the type locality for some rock units referred to the Egyptian basement geology as the Shaitian granite.

1.1- Location and accessibility of the area.

Gabal Sufra area is located in the South Eastern Desert of Egypt on the Umm Qubur and Umm Rashid topographic sheets (Nos. NG 36 C6a and NG 36 C6c). This area covers about 720 km^2 of the crystalline basement rocks and is bounded by latitudes 24^o 33' 00" -24^o 50' 00" N and longitudes 34^o 02' 00" – 34^o 15' 00"E (Fig. 1. 1). The present area is named after the conspicuous mountain of Gabal Sufra, and reached starting from Idfu toward Marsa Alam along asphaltic road toward the East until the Barramiya after 110 km, the narrow and rough track about 60 km. toward the south, through Wadi Mullha, Wadi Hammash to reach the area (a total of 170 km from Idfu).

Another road starting from Marsa Alam toward the West until Sheikh Salm area (sign 40 km), then 30 km through Sheikh El Shazly road until through Wadi Barda, Wadi Gerf then Wadi Shait to reach the area.

Location Map

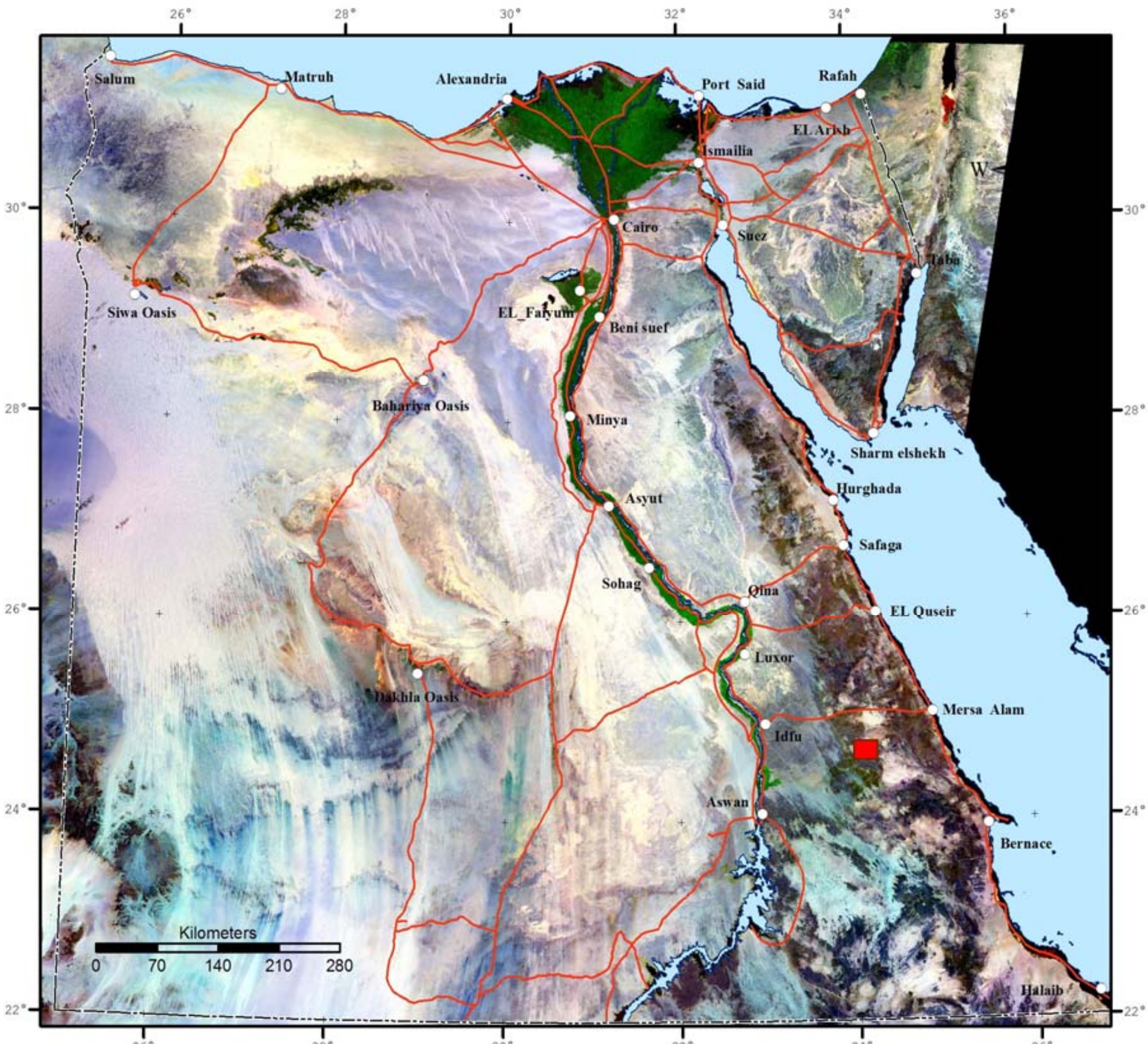

Fig 1.1: Location map of the study area.

1.2- Physiography (climate and topography)

The study area lies in an arid-semiarid region where rainfall is rare. Water resources are represented by two water wells named; Bir Umm Qubur and Bir El Murayr (Fig. 1.2).

The area is characterized by moderate to low relief with a number of high landmarks and peaks. It is drained by a number of wadies. These wadies are covered by alluvium of wind blown sand and other residual surfacial deposits which most probably related to Pleistocene and Quaternary age (Recent deposits).They including Wadi Hammash, Wadi Shait, Wadi Umm Hagalig, Wadi Umm Tundob (Fig. 1.3), Wadi El Humor, Wadi Umm Murghad runs east and Wadi Abu Tarda, Wadi El Amiriyah run southeast. The small gullies of Wadi Umm Ara East and Umm Ara West runs to the north

The main mountains within the mapped area are including Gabal Sufra, Gabal Abu Sidri, Gabal Umm Hagalig, Gabal El Humor and Gabal Hammash.

The drainage pattern in the area comprises denderitic and trellis pattern. The denderitic pattern is represented by Wadi Shait, while the trellis drainage pattern is represented by Wadi Hammash (Fig. 1.4).

1.3 Previous work of the study area and its environs

The area is included within Hammash-Sekit district map, of EGSMA scale 1: 100,000.

Puplished works on the area under consideration is scanty. Early studies on such rocks embracing the present area include Hume (1935), Schurmann (1953) and others.

Fig. (1.2): Bir Umm El Qubur at Wadi Shait.

Fig. (1.3): Wadi Umm Tundop surrounded by hills and mountains (Looking S).

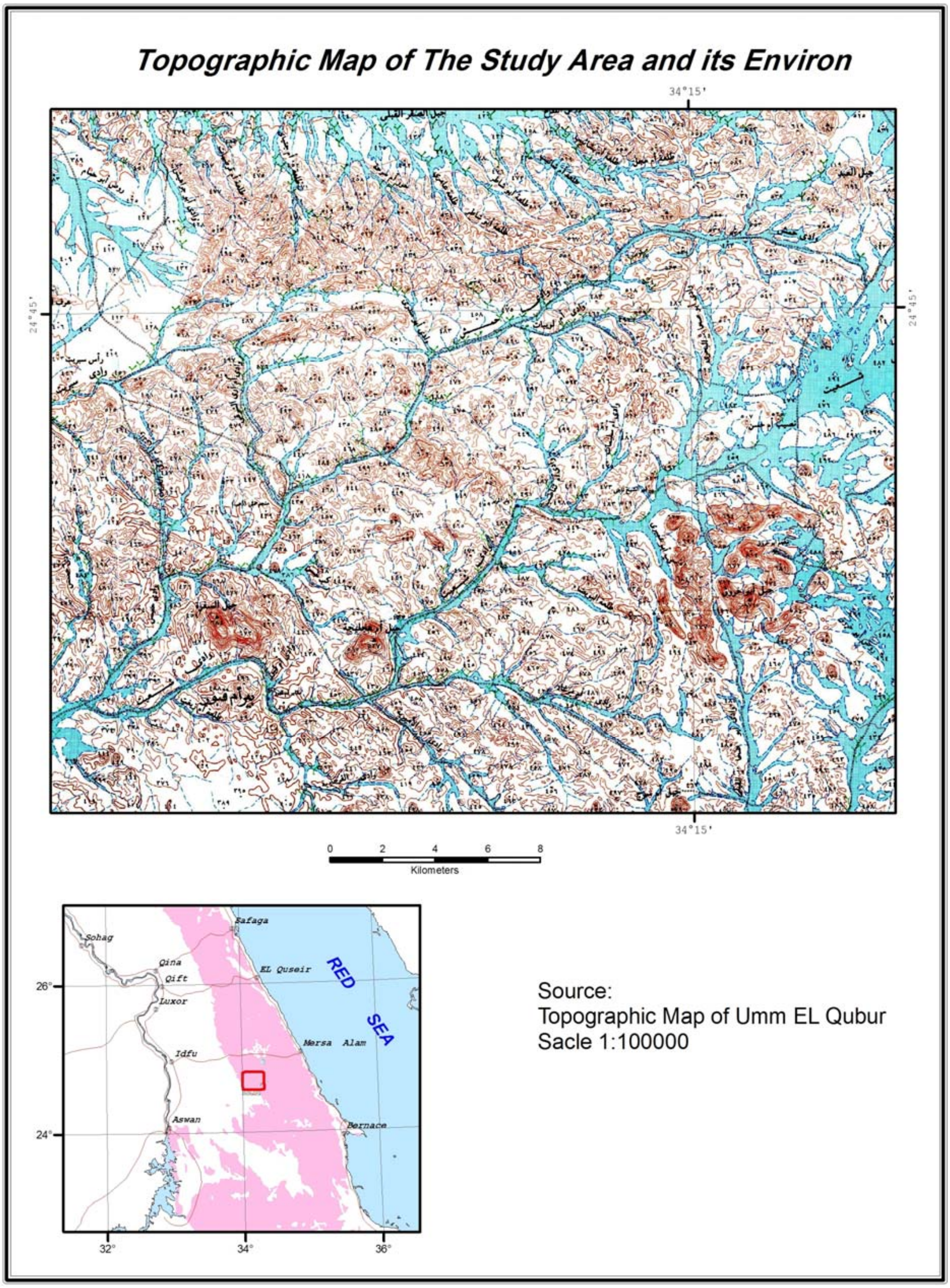

Fig 1.4: Topographic map of the study area.

Hume (1935) considered the Shaitian granites as old granites representing the most acid type of a Metarchaean succession or granite cycle.

Hume (1937) divided the gold mining areas into several groups. One of these groups is the south central portion of the eastern Desert which includes Barramiya mine. Dungash-Samut - Hammash group and other centers between latitudes 24º and 25º N. He (op. cit.) gives an account on the Hammash gold mine shafts and noted Ball's remarks regarding the presence of chalcopyrite, iron sulphide and copper in the gold workings.

Schurmann (1953) placed the Shaitian granites as a new subdivision in the Hume classification of the Egyptian basement and named them Shaitian granite representing an old period of plutonic activity prior to the late-Precambrian sedimentaries separating the Metarchaean from Epiarchaean.

Moustafa and Abdalla (1957) carried out the first scholarly research on the Hammash copper deposits and found that the mineralized quartz veins occur in three main locations in the area namely the copper deposit of Umm Hagalig, the copper deposit at Umm Humor and the copper mineralization at Hammash gold mine.

Moustufa and Hilmy (1958) made a further contribution to the geology and mineralogy of the three main Hammash copper deposits. Their study comprised mainly mineralogical and paragenetic work on the ore as well as comparative study of other copper deposits of Egypt.

El-Ramly and Akaad (1960) proposed the term old grey granite for these rocks (Shaitian granite) to differentiate them from the younger red granites.

Higazy and El-Ramly (1960) recorded the Potassium-Argon ages of some rocks from the Eastern Desert of Egypt including Shaitian granite which gave the age of 590 Ma.

Moustafa and Akaad (1962) gave as elaborate description of the geology of Hammash-Sufra district. They reported that this district include the following major units beginning with the oldest. First a group of low grade metasedimentary inclnding schists, phyllonites, mudstones and metasedimentary amphibolites occur in the southeast and are associated with a body of serpentinite. The metasediments are intruded by coarse gneissose sheared granite known as the Shaitian granite. An elongated belt of opidiorite rocks originally of gabbroid nature traverses the metasediments. Then followed by extensive volcanics in the NE, that belong to the old volcanics of Dokhan type. A group of younger granite was then intruded mainly in the NW and central parts of the area which is mainly associated with minor acidic dykes and in part mineralized quartz veins. Finally, a group of alkaline volcanics occur as plugs and sheets cutting the older basement rocks and belong to the main alkaline volcanic suite of the neighboring region of Wadi Shait and Wadi Natash. They (op.cit.) also noted that an outstanding event of considerable shearing prior to the extrusion of the old volcanics affecting the metasediments and epidiorites and to a much greater degree of Shaitian granite.

Akaad and Mustafa (1963) considered the Shaitian granite as cataclastic gneisses with mylonitic varieties of granodiorite origin.

Hashad et al. (1972) gave Rb/Sr isochron age of 870 m.y for the Shaitian granites and postulated that this age does not represent the age of emplacement but apparently the age of granitization or Sr-homogenization processes.

Ivanove et al. (1972) showed that Hammash area as a whole is made up of different volcanics representing a wide range of composition, intruded by subvolcanic bodies of granodiorite porphyry. They (op.cit.) reported that at Umm Hagalig a zone of intensive propylitization, sericitization, kaolinitization and silicification occurs within the granodiorite porphyry. A number of quartz veins with malachite cut the granodiorite porphyry and were excavated in the past. At Wadi Ara East and Wadi Ara West, quartz- sericite - pyrite chalcopyrite as well as the presence of gossans and zones of hydrothermal alterations up to 500 m. long and 100 m wide within the andesite and granodiorite porphyry.

El Gaby (1975) classified the Egyptian granites into; a) syn-orogenic granitoids comprising the Shaitian and grey granites as well as a slightly later phase of porphyritic granite represented by the Aswan granite, and b) younger-granites which include the late to post-orogenic pink and red granites, the last phase of which commonly possess peralkaline tendencies.

El Gaby and El Aref (1977) studied the Shaitian granite of SED of Egypt and distinguished that the Shaitian granite intruded into the older metavolcanics and metagabbro-diorite complex, and it is equivalent to the grey granites (El Ramly and Akaad, 1960) or to the syn-orogenic plutonites (El-Shazly, 1964).

Stern (1981) divided the metavolcanics (MV) outcropping in the area between Lat. 25^{o} 30' and 26^{o} 30' in the Eastern Desert (ED) of Egypt into the older metavolcanics (OMV) comprising a thick succession of pillowed metabasalts and associated with ophiolitic metagabbros and serpentinites and the younger metavolcanics (YMV) comprising andesitic volcanic sequence and overlying and interfingered with immature sediments.

Hussein et al. (1982) proposed a genetic classification of the Egyptian granites and granitoids into three groups each has its own characteristics. The first group or G_{I}-granite comprises subduction related calc-alkaline granitoids formed by partial fusion of the mantle wedge with little or no crustal melt contribution. The second group or G_{II}-granites are collision related formed by the partial melting of a thickened crust due to folding and thrusting at plate boundaries, probably with some addition from the mantle. The third group or G_{III}-granites are intraplate, anorogenic granites formed by melting of pre-existing crustal rocks, and related to hot spots and incipient rifting.

El Ramly et al. (1983) prepared geological and structural maps for the area between Wadi Nugrus in the east and Wadi Shait in the northwest to document the complex igneous, metamorphic and structural evolution during Pan-African orogeny, which started at an intermediate crustal level and ended at the present upper crustal level.

Greiling (1987) studied the lithology, geochemistry and tectonic setting of the gneisses of SED of Egypt, and concluded that lithologically, the gneisses of Wadi Hafafit and Betan comprise a succession of metaplutonic rocks composed of serpentinites, gabbros/diorites, tonalites, granodiorites and two phases of granites with subordinate metavolcanics and metasediments. Whereas, in the gneissic succession a first event of foliation, deformation and medium grade metamorphism can be distinguished from the subsequent shearing/thrusting, this led to the tectonic transport of the low grade sequences over the gneisses. Tectonically, the gneisses obviously represent parts of calc-alkaline suites.

El Gaby et al. (1988) considered "Shaitian granite" as belong to the Pre-Pan-African rocks, which are deformed and mylonitized during the Pan-African orogeny. Whereas, the intermediate metavolcanics and their tuffs and associated volcanogenic greywackes belong to the island arc stage in which these metavolcanics are series of weakly metamorphosed volcanics essentially composed of andesites, dacites and pyroclastics of comparable composition, and the basalts and rhyodacites are subordinate.

Greiling et al. (1988a) studied the SED of Egypt and concluded that; it is made up of basal medium-grade gneisses including shelf facies metasediments, low-grade successions of ophiolitic mélange, calc-alkaline igneous rocks and related metasediments.

Rashwan (1988) carried out a comprehensive study on the geology of the northern Hafafit dome and showed that, the intrusive and structural relations within the gneisses domain revealed the following succession with the youngest on top.

- Gneissic tonalite and granodiorite.
- Psammitic gneisses probably derived from continental sources.
- Biotite schists interlayered with and overlain by the psammitic gneisses.
- Foliated metagabbros, essentially pertaining to an old oceanic crust.
- Ultramafic rocks of ophiolitic affinity.

Hilmy and Osman (1989) studied specifically the opaque minerals associated with gold in Hammash gold mine; they reported that pyrite, chalcopyrite and gold occur in quartz veins in granitic rocks and as scattered and disseminated impregnations in shear zones of highly altered metavolcanics.

El Kalioubi and El Ramly (1991) studied the origin and tectonic setup of the "granite" suite at Wadi Shait in the ED of Egypt and concluded that, the Shaitian granite represents a part of an old immature ensimatic island-arc. These rocks have more sodic than potassic and metaluminous in nature and exhibit calc-alkaline geochemical behavior.

El-Mahallawi (1995) studied the rare earth elements geochemistry and petrogenesis of the Shaitian granitoid rocks in the Wadi Shait and concluded that, the REE characteristics of the Shaitian granitoid rocks and associated metagabbro-diorite complex suggest two magma sources, one flat chondritic of mantle origin, and the second is LREE enriched of calc-alkaline crustal affinity.

Hassanen and El-Sayed (1997) studied the petrogenesis and tectonic environment of Hammash Dokhan Volcanics in South Eastern Desert and concluded that, the rock types are basalts, basaltic-andesites and andesites characterized by calc-alkaline affinity with noticeable enrichments in the LIL elements such as Sr, K, Rb and Ba relative to the HFS elements (e.g. Zr, Ti, P and Y). The chemical features indicated that Hammash Dokhan Volcanics strongly resemble the calc-alkaline volcanic arc magmatism with involvement of subcontinental lithosphere in magma genesis, whereas the fractional crystallization is the main process responsible for the formation of these rocks.

Youssef (2000) studied the petrography, geochemistry and isotopic characteristics of the northern part of the largest granitoid batholith in the Eastern desert, which covers some 2000 km^2 and lies south of Wadi El Gemal and Wadi Natash. It intrudes an ophiolitic mélange and the Migif-Hafafit gneisses in the north and Shadli metavolcanics in the south. Petrographically, the batholith is differentiated into several units mainly; monzogranite, granodiorite, tonalite and quartz diorite.Geochemically, these rocks are classified as calc-alkaline, metaluminous, I-type granitoids formed essentially in an island arc tectonic environment through magmatic differentiation processes envolving partial melting followed by fractional crystallization. Rb-Sr isotopic dating of the quartz diorite, granodiorite and monzogranite gave ages of 759 ± 85, 677 ± 51 and 612 ± 37Ma respectively. This time span covers a period starting from the time of formation of other older granitoids and extended to the early phases of the younger granite intrusions in the southeastern desert.

Abd El-Naby and Frisch (2006) studied the geochemical constraints from the Hafafit Metamorphic Complex (HMC) and the evidence of Neoproterozoic back-arc basin development in the CED of Egypt, and they concluded that, the HMC has two distinct metamorphic units; gneisses and amphibolites. The gneisses are subdivided on mineralogical grounds into granitic gneiss, biotite-gneiss, hornblende-gneiss and psammitic gneiss. Using major elements discrimination criteria to discriminate between orthogneiss and paragneiss, the granitic gneiss shows igneous origin, whereas biotite-gneiss, hornblende-gneiss and psammitic gneiss show sedimentary origin. The mineralogical and chemical compositions of the granitic gneisses indicate that they are tonalitic to trondhjemitic and have compositions consistent with hydrous partial melting of a mafic source, suggesting subduction-related magmatism. Based on Si, Al and alkali contents of paragneisses, the psammitic gneiss could be classified as metamorphosed lithic arenite, whereas biotite- and hornblende-gneisses are classified as metamorphosed greywacke. Sedimentation may have occurred in a back-arc basin setting with transitional deposition from shallow-marine to terrestrial environment. This sedimentation was probably occurred on a tholeiitic basaltic oceanic crust. While, the amphibolites are subdivided according to mineralogical basis into clinopyroxene-amphibolite, garnet-amphibolite and garnet-free massive amphibolite. Chemical data of amphibolites shows tholeiitic affinity, which suggests a back-arc geotectonic setting.

1.4 Scope and Methodology of the present study

The present work includes detailed field mapping, petrography, geochemistry and structural analysis and mineralization of the different rock types exposed in studied area at the South Eastern Desert of Egypt.

To fulfil this goal, the following activities were undertaken:

a- Standard geological field techniques and photogeology, interpretation of hard copy Landsat Thematic Mapper image (TM) (Fig. 1.5) of false colour were used to produce a base map for the field observations and a geological map at scale of 1:50,000.

b- Collection of two hindered and fifty hand specimens represent all varieties of the rock types. One hundred and fifty of these were sectioned and examined under the polarizing microscope. The petrographic studies and photomicrographs were carried out using a Nikon (Optiphot-Pol) polarizing microscope equipped with a full automatic photomicrograph attachment (Microflex AFX-II).

c- Bulk chemical analysis of 60 selected samples for their major and trace element contents. Chemical analysis was carried out at the Central Laboratories of the Egyptian Geological Survey. The data of the analyzed samples were computed and plotted using advanced geochemical software such as Minpet computer programs.

d- Structural studies through 200 structural measurements of planer and linear elements to construct a structural map and determine the different phases of deformation.

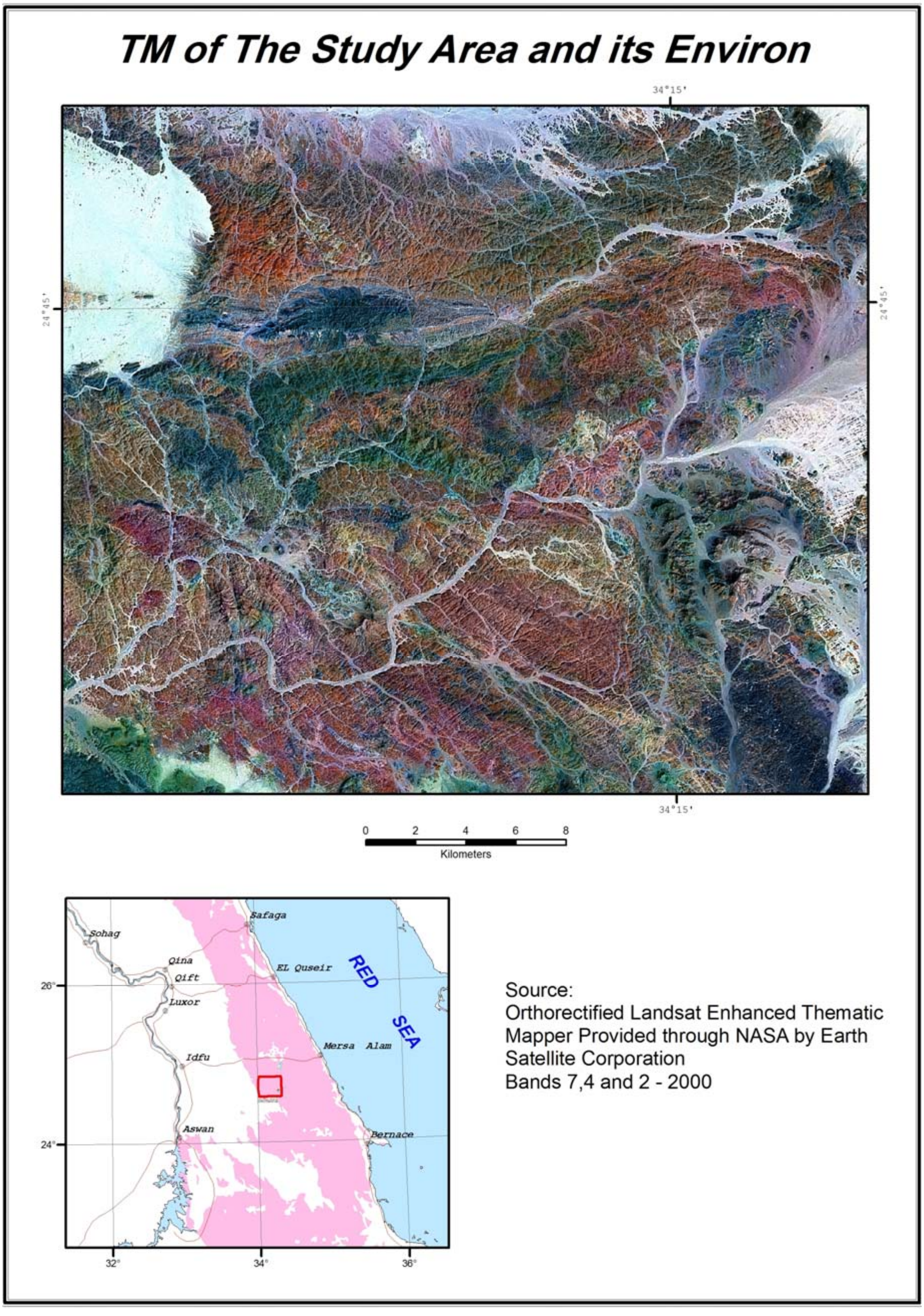

Fig 1.5: Landsat Thematic Mapper image (TM) of the study area.