**GEOLOGY OF AL-MAQATIRAH DISTRICT**

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**BY**

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**SUMMARY AND CONCLUSIONS**

The Al-Maqatirah area to be dealt with in the present work builds up the southwestern continuation of the Taiz basement block which is exposed as a NE-SW trending linear horst. It is confined between the arc terranes of the Arabian-Nubian Shield and the predominantly gneissic terranes of the Mozambique belt (**see Fig.2,Pohl,1984**).

Geological and petrographical evidences revealed that the studied horst structure consists mainly of an old metamorphosed gneiss sequence intruded by a Pan-African series of basic and acidic minor intrusions and dykes. The gneiss sequence is divided into two conformable divisions; each of which is intercalated and dissected by amphibolite, pegmatite and gneissic granite sheets reaching up to few kilometers long and several tens to hundreds meters thick; (1) The lower, high-grade metamorphic diatexite division is exposed in the southern half of the Al-Maqatirah area and is predominantly composed of granite gneisses together with minor proportions of anatectic granite and migmatized amphibolites, and (2) The upper medium- to high-grade metamorphic metatexite division which consists mainly of gneisses, amphibolites and metatexitic migmatites.

Both divisions are structurally and petrographically correlated with the infrastructural gneisses exposed in Al-Bayda terrane which have been studied by **Sakran (1993) and Windley et** **at.(1996)**. This correlation furtherly confirms the aforementioned suggestion that the studied gneisses of the Yemen basement represents a part from an old Pre-Pan-African metamorphosed rock unit which were reworked during the Pan-African event (**Krِner,** **1964**). Meanwhile, petrographical and mineralogical studies indicate that the amphibolite intercalations were derived from igneous as well as sedimentary protoliths, while the host gneisses are of sedimentary parentage. These protoliths were wholly laid down on a passive continental margin and were regionally metamorphosed (M1) under low to medium pressure and medium to high temperature conditions as inferred from (a) the presence of cordierite, andalusite, hornblende, sillimanite, staurolite and feldspars in the metamorphosed rock varieties of the upper division and (b) the wide-scale development of diatexites and anatectic granite sheets and lenses in the lower division as well as in the cores of the anticlinal areas of the upper division as well. The granite gneisses are represented mainly by granodiorite gneisses, tonalite gneisses and minor diorite gneisses. These varieties display large variation in their colour index or the relative distribution of the mafic and felsic minerals. This is, most probably, due to the variation of the progressive partial melting and/or the wide difference of the composition of the original protoliths of the metamorphosed rocks.

The partial melting of the gneisses or amphibolites can be easily discriminated into melanocratic and leucocratic bands or lenticles particularly within the metatexitic migmatites of the upper division. The mineral assemblages of leucosomes generally vary from trondhjemitic (consists mainly of plagioclase and quartz) to granitic (contain k-feldspar, plagioclase and quartz) composition while the mineral association of the paleosomes are generally similar to the equivalent gneisses which display the following petrographic characters: (a) the occasional presence of cordierite and restriction of garnet throughout the whole range of the medium-grade metamorphosed gneisses and even persist to the higher

temperature part characterizing the metatexitic migmatites, and (b) the rare existence of staurolite with cordierite. These petrographic observations run concordantly with the petrographic data recorded by **Winkler,(1976**) on cordierite-medium grade metapelitic zones. **Winkler,(1976**) interpreted the coexistence of cordierite and garnet depends on a function of the MgO/MgO+FeO ratio (0.5 to 0.6) i.e. with increasing this ratio the stability field of garnet is reduced and that of cordierite extends towards higher pressures. Also, the rare coexistence of staurolite and cordierite in mediumgrade metamorphosed gneisses is mainly due to the breaking down of staurolite in the presence of muscovite + quartz at pressures lower than about 5 Kb according to the following reaction:

staurolite + muscovite + quartz = Al2SiO5 + biotite + H2O

If muscovite is absent, as for instance in certain metagraywackes the above reaction cannot proceed. Therefore, staurolite may persist into high-grade rocks and eventually decompose according to the following reactions:

staurolite + quartz = Al2SiO5 + almandine + cordierite + H2O

staurolite + quartz = Al2SiO5 + almandine + H2O

The latter reaction has been investigated by Richardson (1968)

using a pure Fe-staurolite and noticed that it takes place at

temperatures a little below 700 Cْ and is only slightly pressure

dependent.

Later on, during the subsequent Pan-African orogeny the metamorphosed rocks were dissected by Hudabah sinistral shear zone, 8 km wide, along which the metamorphosed rocks were variously sheared and cataclased and were transformed into protomylonites, mylonites, ultramylonites and minor phyllonites and cataclasites. The sinistral shear sense indicator is deduced from:(a) σ-type complexes, (b) **δ**-type complexes, (c) S-C and C-C̀ structures (**Figs. 72,73** ),and (d) the vergence of the minor folds exposed along both sides of the fault trace(**Figs. 80,82,83**),. The inferred shear sense indicator of the Hudabah shear generally concords with that of the strike-slip faults dissecting Al-Bayda island arc terrane (**Fig.1**).

The metamorphosed rock sequence are subsequently intruded, particularly along the Hudabah shear zone, by a series of basic to acidic minor complexes and dykes. The intrusive masses comprise Magzaaُ olivine gabbro, Hajir uralitized gabbro, Al-turbah uralitized hornblende gabbro, and Adim alkali granite(**Fig.6**). The dykes are abundant and include pegmatite, basalt, andesite and fine-to medium-grained granite dykes. The occurrence of the most of intrusive complexes along Hudabah shear zone may testify to their emplacement under sustaining NW-SE transpressive stresses associating Hudabah shear zone. Moreover the partial shearing of the intrusive masses indicate that the Hudabah shear was active over a long period of time or, at least, rejuvenated several times subsequent to the emplacement of the igneous bodies. Detailed mapping of the metamorphosed rocks reveal that they undergo strong evidences of polyphase of deformation in addition to two metamorphic events (M1&M2). Five deformational phases (D1- D5) with distinct overprinting relations were recognized. These deformation features are remarkably not restricted to the studied area but generally extended all over the Taiz basement block as well. Moreover, the deformational features of the D3 to D5 are generally localized in narrow zones. The sequential development of the five deformation phases can be summarized as follows:

**D1 deformational phase** characterize the Pre-Pan-African infrastructural gneiss sequence as it evolved during an orogenic cycle older than the Pan-African one. During the old orogeny the parent protoliths of the metamorphosed rock sequence (greywackes, siltstone, claystone, calcareous sandstone, impure marls and basic flows) were metamorphosed under high temperature and low to medium pressure conditions. This old regional metamorphism (M1) was associated with development of narrow zones of anatexites in the deeper parts and formation of medium pressure high temperature minerals such as cordierite, staurolite, andalusite, sillimanite, hornblende, plagioclase and

k-feldspar in the upper or shallow parts

The main fabrics formed during D1 deformation phase display pervasive natures such as continuous and spaced planar foliation (S1) and the associated L1 lineation. The associated L1 lineation structure is characterized by the development of elongate minerals such as hornblende, plagioclase and k-feldspar porphroblasts. Both S1 foliation and L1 lineation structures commonly run concordantly with the original

layering structure (S0) of the metamorphosed rock sequence. In addition, the D1 deformation phase is joined by the abundant development of intrafolial folds of different attitudes (F1) particularly in the upper division exposed in the northern part of the map area.

**D2 deformation phase** is generally existing everywhere in the studied area and is noticeably distinguished by the occurrence of mega- and mesoscopic F2 folds which resulted from folding of the relict bedding (S0), S1 foliation and L1 lineation structures. The folding leads to the development of S2 axial plane foliation and slaty cleavage and L2 lineation structures. The latter L2 lineation comprise fold-hinge and rod lineations. The D2 deformation features are generally trending NE-SW and are related to a regional stress acted across NW-SE direction.

**D3 deformation phase** is mainly related to a ENE-WSW regionalscale

strike-slip fault crossing the middle part of the study area. The fault was accompanied by strong mylonitization of the dissecting rocks, retrogressive metamorphism (M2), development of diagonal

R1 and R2 conjugate faults and large to minor scale folds and formation of high relief ridges. These structural features may testify that transpression is occurring along the fault zone, meaning that the sinistral strike-slip movement was accompanied by shortening across the Hudabah main fault.

**D4 deformation phase** is represented by severe subaerial

erosion of the Precambrian gneiss sequence followed by uplifting of

its diatexite and metatexite divisions to the surface, and finally followed by the unconformable deposition of thick sequences of Mesozoic sediments.

**D5 deformation phase** is expressed by a series of extensional fractures and high-angle normal faults which are wholly pertaining to brittle deformation. They are entirely postdating the deposition of the Phanerozoic sediments and took place during two subsequent periods. The faults of the early period trend NE-SW whereas those of the younger one strike NW-SE.