IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 8, August 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

Petrogenesis and Geochemical Characteristics of Core Samples Gneieisses at Abu Rusheid Area, Southeastern Desert, Egypt.

Oraby[1], F. M., Mahmoud[1], M. A. M., El-Mezayen[2], A. M, and Shalan[1], A. S.

[1] Nuclear Materials Authority, Cairo, Egypt, B.O. Box: 530 El-Maadi.
[2]Faculty of science, El-Azhar University, Nasr city, Cairo, Egypt.

ABSTRACT

The present study was carried out to investigate the down core variation of the major and trace elements concentrations in core samples of the two boreholes (BH1 and BH2), at Abu Rushied area, South Eastern Desert, Egypt.

Lithologically, the studied core samples of BH1 are mainly quartz-hornblende schist, serpentinite, whitish gray granoblastic gneiss alternating with pinkish gray porphyroblastic gneiss with sharp contacts. While, the studied core samples of the BH2 are mainly whitish gray granoblastic gneiss, pink granoblastic gneiss, quartz-feldspar-biotite schist, quartz-hornblende-biotite schist, mica schist, talc carbonate, gray granoblastic gneiss with migmatite zone and finally whitish gray granoblastic gneiss.

Based on the major elements discrimination criteria to discriminate betweenorthogneiss and paragneiss; the pinkish gray porphyroblastic gneiss of BH1, pink granoblastic gneiss of BH2 and gray granoblastic gneiss with migmatite of BH2 are igneous origin, while whitish gray granoblastic gneiss of BH1 and BH2 is sedimentary origin. The mineralogical and chemical composition of the orthogneisses indicates that they are granodioritic to adamellitic and have compositions consistent with hydrous partial melting of a felsic source, suggesting subduction-related magmatism. Based on Si, Al and alkali contents the paragneisses, could be classified as metamorphosed arenite to greywacke. Sedimentation may have occurred in a back-arc basin setting with transitional deposition from shallow-marine to terrestrial environment.

The study of the trace elements in BH1 showing that some elements are increase with increasing depth such as Cr, Ba and V, but the most trace elements showinggeneral decrease with increase depth such as Ni, Zn, Zr, Pb, Sr, Rb, Ga, Y and Nb. The highest values of Zr, Y and Ba are related to porphyroblasticorthogneiss(Orthogneiss) at depth 50-55 m. In BH2, Sr, Ba and Cu showig general increase with increasing depth but Zn, Zr, Rb, Ga and Nb showing general decrease with increasing depth. On the other hand, Cr, Ni, Y and Pbare showing no change depth. Cr, Ni, Cu, Sr and Ga tend to enriched along the Ophiolite zone. The highest values of Ba are related to the lower and upper contacts of gray granoblastic granitic gneiss.

Keywords: Abu Rushied, Trace metals, Core samples, Orthogneiss, Paragneiss, calc-alkaline, granoblastic and Porphyroblastic.

INTRODUCTION

The first systematic project of geochemical exploration started in 1967 in the southern part of the Eastern Desert of Egypt by the United Nations Development Program in close collaboration with the Government of the Arab Republic of Egypt (UNDP Project), which was known as the Regional Planning of Aswan District Project. The project area comprise 80,000 km^2 in the Southeastern Desert of Egypt, bounded to the north by latitude 25^o, to the south by latitude 22^o, and extending from the Nile in the west to the Red Sea in the east. Then, it followed by the second project during 1969-1973 by the Egyptian Geological Survey in the southern part of the Eastern Desert and Aswan region. The results of 1365 geochemical samples from Abu Rushied area was estimated as a big deposit accounting for ore reserves of 13 thousand tons of Ta_2O_5 and 90 thousand tons of Nb_2O_5 in contents amounting to 0.02 and of 0.14 % respectively. The tantalum-niobium mineralization is associated with tin (up to 0.3%), lithium (Li_2O up to 1%), zirconium (up to 1%), uranium (up to 0.8%) and thorium (up to 1.43%) (Sabet et al., 1976f).

In the most time, many workers have used trace elements as genetic indicators for a wide variety of mineral deposits (Soliman et al., 1971, Sabet et al., 1976 a-h, Bralia et al., 1979, Kaneda et al., 1986 and Bajwah et al., 1987, Ibrahim et al., 2008).

Abu Rusheid area is considered as the extension of the Migif-Hafafit metamorphic complex (El-Ramly and Akaad, 1960; Hassan, 1964; El- Shazly and Hassan, 1972; Hashad and Hassan, 1959), which is highly tectonized and characterized by presence of several types of mineralization and alteration processes along time spans.TheMigif-Hafafit metamorphic complex represents one of three major domal structures in the Eastern Desert of Egypt (Fowler and Kalioubi, 2002).

Ibrahim et al., (2008) excludes the four shear zones, which intruded by lamprophyre dykes–bearing U-minerals, base metals and REEs and concerned mainly with the cataclastic rocks and the surrounding granitic rocks. The absolute contents of the trace elements are estimating over Wadi Abu Rusheid level (385m).

To explore the uranium mineralization and associated economic minerals at deeper levels a drilling bore holes was carried out by Diamond core drilling at Abu Rushied area.In this paper we reported the geochemical data of gneissic rocks which is a useful guide to constrain the former tectonic setting of the Abu Rusheid area.

RESULTS AND DISCUSSION

Geological setting

Surfacegeology

Abu Rusheid area is located at the Southern part of the Eastern Desert of Egypt, about 45 km to the Southwest of MarsaAlam city (Fig. 1a). It is bounded by Latitudes 24° 36′ 46" and 24° 37′56" N and Longitudes 34° 45′ 00" and 34° 45′ 30" E. Abu Rusheid-Sikait area is bordering to the major shear zone known as the Nugrus thrust fault (Greiling et al., 1988) or the Nugrus strike-slip fault (Fritz et al., 1996) and/or Sha'it–Nugrus shear zone (Fowler and Osman, 2009). Abu Rusheid area is characterized by low to moderate topography and highly tectonized rocks. It is located between a major thrust to the NE and a minor one to the SW. Geologic map of Abu Rusheidgneisses and surrounding rocks was prepared out based on the field relations and structural observations (Fig. 1b). The main rock units encountered in Abu Rushied area are grouped as follows; - (a) Gneissic rocks (b), Opiolitic mélange, (c) granitic rocks, (d) post-granitic dykes and veins. The gneissic rocks occur in the field down thrusted the ophiolitic mélange and foliated in ENE-WSW direction. The ophiolitic mélange, consisting of ultramafic rocks and layered metagabros set in metasedimentary matrix. The lithologic contacts with ophiolitic mélange are tectonized and well defined. The gneissic rocks occupy the core of the granitic pluton and cross cut by three shear zones; the first two zones extend NNW-SSE, while the third extends ENE-WSW. Gneissic rocks are characterized by containing mineralization as uranium and associated minerals.

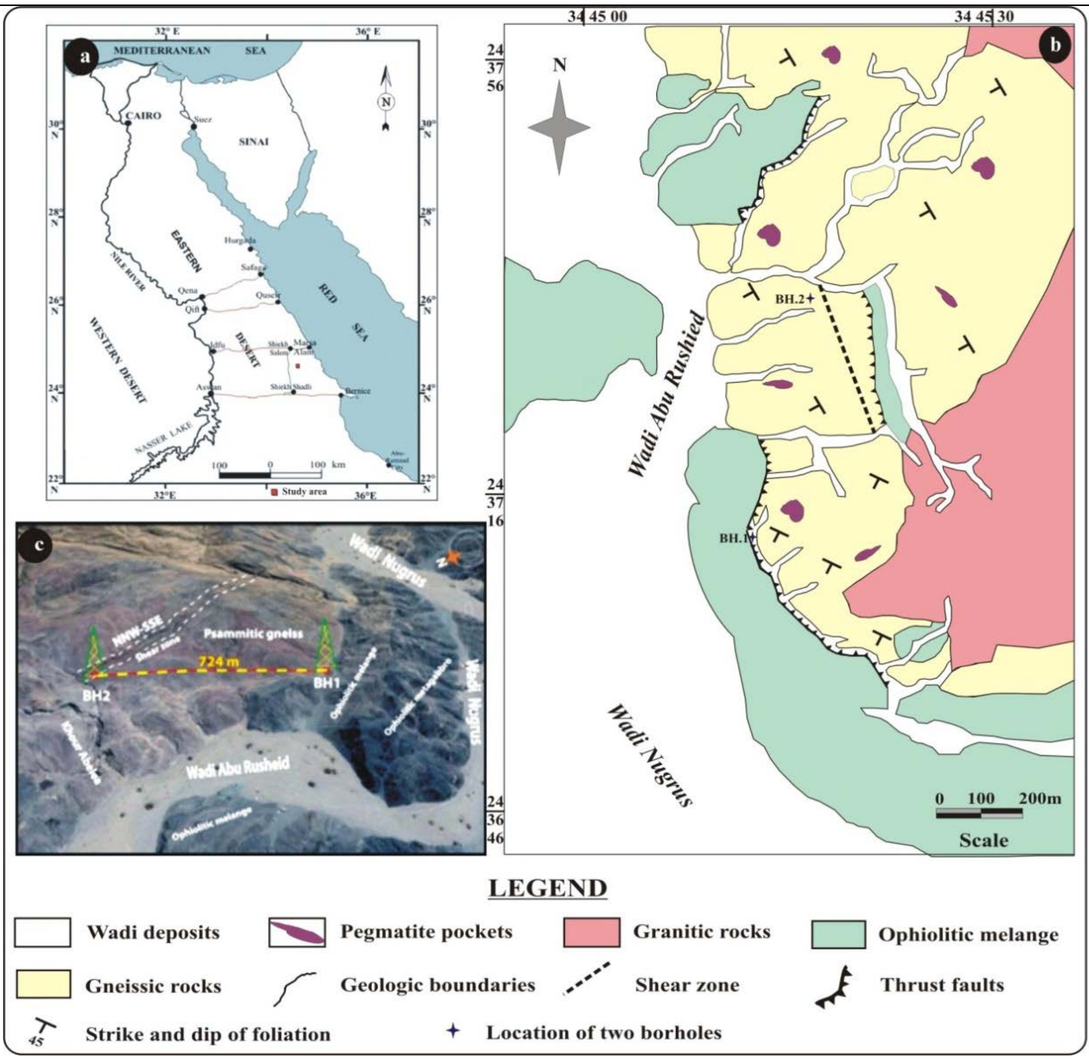

Fig. 1a:Location map, b) Geologic map of Abu Rushied area (modified after Ibrahim et. al., 2004) and c) Landsat image showing the location of the drilled two boreholes, at Abu Rusheid area, South Eastern Desert, Egypt.

Sub-surface geology

At the first phase of drilling to 54m (BH2) and the second phase of drilling to 70m (BH1), geophysical logging to a depth were completed and sample distributions were collected. The lithostrtigraphic sequence is constructed for the studied two boreholes (BH1 & BH2) in Abu Rushied area based on the morphological features and petrographical examination, (Fig. 2).

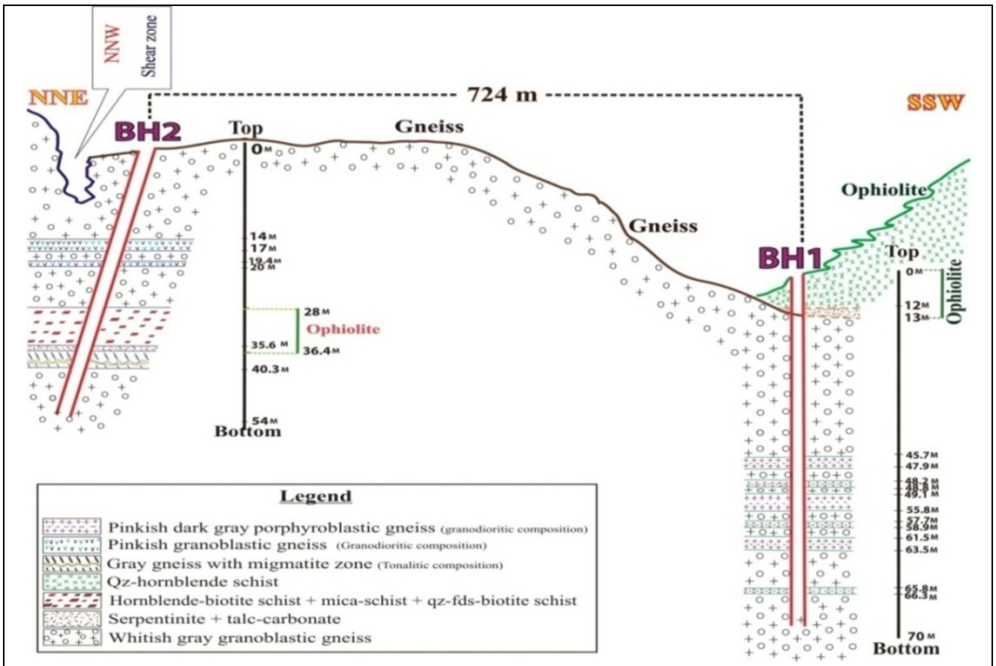

Fig.2: Schematic cross section showing the subsurface geology of the two drilled boreholes.

Borehole- 1 (BH1)

This borehole is vertical (90°); it had been drilled to about 70m depth from the topographic level. It is clear that the subsurface units are represented mainly from top to bottom by quartz-hornblende schist, serpentinite, whitish gray granoblastic gneiss alternating with pinkish gray porphyroblastic gneiss with sharp contact (Fig. 3a).

Borehole-2 (BH2)

Borehole-2 (BH2) was drilled to about 54 m depth from the topographic level with inclined dip 76^{o} towards the east direction. The main target for this borehole is to intersect the NNW shear zone at depth as well as to study the distribution of uranium mineralization and important economic minerals at deeper levels. The lithostrtigraphic sequence of studied borehole-2 are mainly comprised from top to bottom as whitish gray granoblastic gneiss alternating with pinkishgranoblastic gneiss (Fig. 3b), quartz-feldspar-biotite schist, quartz-hornblende-biotite schist, mica schist, talc carbonate (mélange rocks), an gray granoblastic gneiss with migmatite zone (Fig. 3c).

Accessory minerals are mostly represented by zircon, xenotime, apatite and secondary uranophane. Zircon is present aslong and short prismatic crystals of tetragonal system Some crystals are tectonized and present as anhedral crystals and others are enriched by radioelements; partially metamectized and surrounded by pleochroic halos (Fig. 3d). Xenotime occurs as yellowish brown to bluish color, taking stubby bipyramidal crystals with short prisms and noticeable elongate fractures resulted from the intersected perfect [010] cleavage, (Fig. 3e). Apatite is found as rare minute prismatic crystals included in perthite and quartz. Some visible secondary uranium mineralization

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 8, August 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

was recorded at depth 23-24m as amorphous yellow material associated with hematite filling the late-stage fractures, (Fig. 3f).

Fig. 3: Photomicrographs of core sample showing:-a) Sharp contact between porphyroblastic gneiss and granoblastic gneiss, b) Sharp contact between pinkish granoblastic gneiss and whitish gray granoblastic gneiss, c- Stromatic layering in migmatitic gray granoblastic gneiss, e- Violet flake of lepidolite and metmectized zircon f- Well-formed crystal of xenotime. d- Fracture filled by amorphous radioactive mineraland iron oxides.

Geochemistry

Methodology

A number of representative core samples were prepared for major and trace elements, from the two drilled boreholes. The chosen samples which represented the all varieties of gneisses were crushed and then powdered using agate mortar to avoid contamination. Thepowders of the crushed samples were subjected to chemical analysis using wet chemical technique of Shapiro and Brannock (1962) for major oxides and X-ray fluorescence technique (XRF) for trace elements at the Laboratories of the Egyptian Nuclear Materials Authority. The results of these chemical analyses are given in tables(1, 2, 3 & 4).

Table. 1: Major oxides of Abu Rushied subsurface gneisses of BH1, South eastern Desert.

RockType	Whitish gray granoblastic gneiss (BH1)										Pinkish-gray porphyroblastic gneiss (BH1)		
	Major oxides (wt %)												
S. No.	**13m**	**15m**	**17m**	**19m**	**21m**	**23m**	**26m**	**32m**	**38m**	**43m**	**48m**	**53m**	**63m**
SiO_2	74.89	73.78	77.50	76.85	72.28	70.33	72.58	71.29	72.1	71.78	68.10	68.32	69.69
Al_2O_3	12.44	11.51	10.28	10.55	11.86	11.91	12.23	10.7	11.1	10.23	13.03	12.39	15.86
Fe_2O_3*	3.03	1.68	1.28	1.92	3.67	5.19	3.34	3.99	6.1	6.1	5.42	6.2	3.19
TiO_2	1.07	1.01	1.1	1.05	1.43	1.03	1.03	1.32	1.34	1.40	1.09	1.1	0.40
CaO	1.12	2.80	0.67	1.2	1.63	1.11	0.78	1.17	1.4	2.8	2.8	2.8	3.03
MgO	0.63	0.98	0.97	0.8	0.74	0.59	0.74	0.32	2.1	1.7	1.00	1.00	1.06
MnO	0.40	0.55	1.1	0.98	1.2	0.34	1.1	0.66	1.02	0.45	0.59	1.09	0.90
Na_2O	4.46	3.81	3.88	3.77	3.95	4.09	4.44	4.66	2.12	2.7	3.37	2.73	4.33
K_2O	1.14	2.52	1.54	1.22	1.37	3.3	2.4	3.01	2.93	3.09	3.93	3.64	1.30
P_2O_5	0.35	0.69	0.55	0.11	0.79	1.32	0.84	0.65	0.10	0.06	0.14	0.12	0.12
L.O.I	0.7	1.05	1.28	0.84	1.19	1.06	0.67	0.95	0.71	0.34	1.32	1.78	0.36

Fe_2O_3*: Total iron as ferric iron oxide

Table. 2: Major oxides of Abu Rushied subsurface gneisses of BH2, South eastern Desert.

Rock Type	Whitish gray granoblastic gneiss (BH2)								Pinkish granoblastic gneiss (BH2)		Gray granoblastic gneiss with migmatite (BH2)		
	Major oxides (wt %)												
S. No.	**1m**	**5m**	**7m**	**13m**	**22m**	**44m**	**48m**	**52m**	**15m**	**17m**	**36m**	**39m**	**40m**
SiO_2	70.46	70.73	70.51	70.18	70.73	74.68	75.48	71.03	72.08	73.37	68.88	69.20	66.99
Al_2O_3	12.22	11.79	12.09	12.3	11.50	9.93	7.91	10.77	12.68	13.66	12.95	13.22	12.05
Fe_2O_3*	6.4	5.40	7.29	4.40	7.40	5.2	5.3	5.6	3.56	3.57	4.2	6.1	7.08
TiO2	1.24	1.12	1.83	1.22	0.74	1.45	1.6	1.01	0.97	0.38	1.4	1.07	1.04
CaO	2.8	2.4	1.40	2.80	2.8	1.4	1.4	2.8	2.30	2.61	4.2	3.8	4.14
MgO	1.00	1.3	1.10	2.00	1.00	1.00	1.3	1.5	1.22	0.76	1.09	1.2	2.39
MnO	0.50	0.54	1.12	0.99	1.3	0.39	1.2	0.68	1.04	0.50	0.60	1.2	0.92
Na_2O	2.22	2.7	2.03	3.03	2.43	2.43	2.7	3.03	4.05	3.19	3.2	3.16	2.99
K_2O	2.84	4.55	3.09	2.85	3.19	2.84	2.5	2.83	3.82	3.09	3.09	2.27	2.70
P_2O_5	0.10	0.1	0.06	0.06	0.04	0.06	0.16	0.08	0.02	0.12	0.16	0.08	0.39
L.O.I	0.46	0.97	0.88	0.99	0.39	1.09	0.78	0.74	0.32	0.13	0.70	0.49	0.32

Fe_2O_3*: Total iron as ferric iron oxide

Geochemistry of gneisses

The analyzed samples (Tables 1 & 2) show wide range of $SiO_2$and Fe_2O_3 reaching its highest in the whitish gray granoblastic gneiss at 22m depth, which is mainly ascribed to the plenty of fragments of opaque minerals may be iron oxides as confirmed by the petrographical investigations. The relative higher Fe values are due to both high content of sulphides and silicate minerals. The relative high content of Mn to form visible dendritic mangnease minerals in examined core samples. Na_2O_3 and K_2O contents in the pinkish granoblastic gneiss and pinkish gray porphyroblastic gneiss are high due to high modal percentage of feldspars and white mica. The high contents of Na_2O_3 and K_2O in some samples of whitish gray granoblastic gneiss of BH1 are due to the presence of pinkish fragments of feldspars support also their para-origin.

Generally, all the studied gneissic rocks in the two drilled boreholes can be classified as ortho- or para in their origin. Figure (4a) is a discrimination diagram (After Demant, 1992) to distinguish between magmatic and sedimentary origin of the gneissic rocks. The diagram shows that the cored porphyroblastic gneiss, pinkish granoblastic gneiss and gray granoblastic gneiss with migmatite zone fall in the orthogneissfield;while the most cored whitish gray granoblastic gneiss falls in the paragneiss field. According to the binary relation between SiO_2 vs. TiO_2 (Fig. 4b), which described by Tarney (1977), shows that all samples of porphyroblastic gneiss, pinkish granoblastic gneiss and gray granoblastic gneiss with migmatite zone fall within magmatic field except one sample of gray granoblastic gneiss with migmatite zone due to its high percentage of TiO_2 which is mainly ascribed to the interaction alongside ultramafic lithologie during metamorphism.

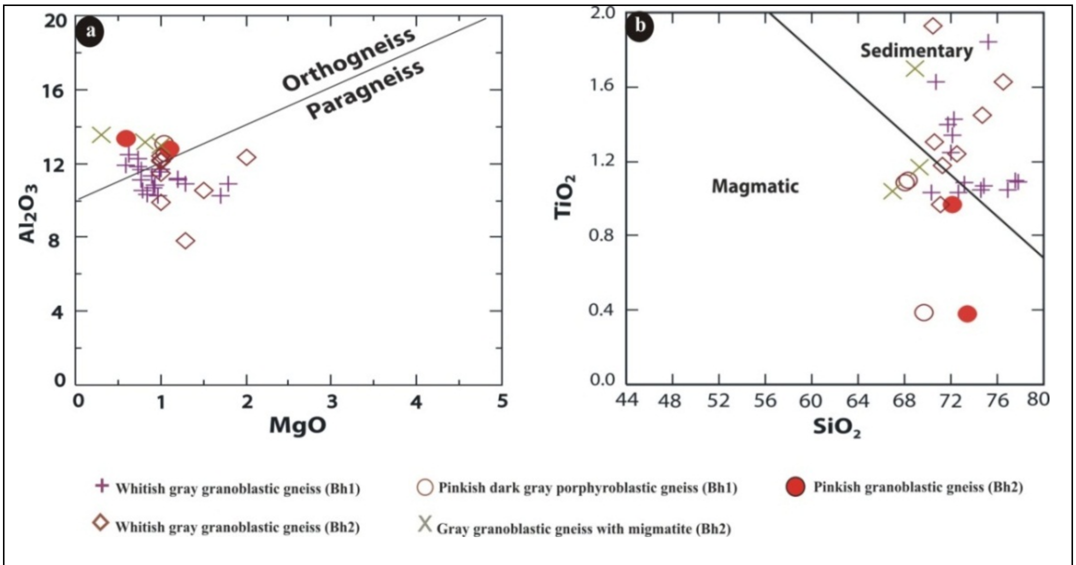

Fig. 4: Geochemical characteristics diagrams for the studied gneisses: a) Al_2O_3 vs.MgO discrimination diagram after Demant, (1992), b) SiO_2 vs. TiO_2 binary diagram (Tarney 1977).

Geochemistry of paragneiss

According to Wintsch and Kvale,(1994) diagram (Fig. 5a), most of the studied paragneisses fall within the lithic arenite and graywacke with some samples plot in the arkose to subarkose fields. Figure (5a) shows that the whitish gray granoblastic gneissic samples of the two boreholes are plotted within the graywacke field close to the arkose field. Sedimentation may have occurred in a back-arc basin setting with deposition of the greywacke in marine environment. Most of the whitish gray granoblastic gneiss samples are plotted in the lithic arenitefield reflecting deposition of materials of different sources in a fluvial to shallow-marine environment while some of whitish gray granoblastic gneiss samples are plotted in the arkose to subarkose fields may indicating a marked transition from sedimentation in shallow-marine environment to sedimentation in a terrestrial environment (Abd El-Naby, and Frisch, 2006).

The binary diagram after Garrels and Mackenzie, (1971) used to discriminate the protolith of the studied paragneiss, where the whitish gray granoblastic gneiss of the two boreholes plots in the greywacke field close to the arkose field (Fig. 5b).

Roser and Korsch, (1986) diagram illustrates the depositional environment of paragneiss(Fig. 5c). It suggests sedimentation in an active continental margin setting, with the exception of three samples which plot in the passive margin tectonic setting.

Bhatia (1983) suggested a diagram to discriminate between the different tectonic setting of the paragneiss rocks using the Fe_2O_3+MgO vs. Al_2O_3/Na_2O_3+CaO. On this diagram (Fig. 5d) the majority of samples lie at active continental margin field.

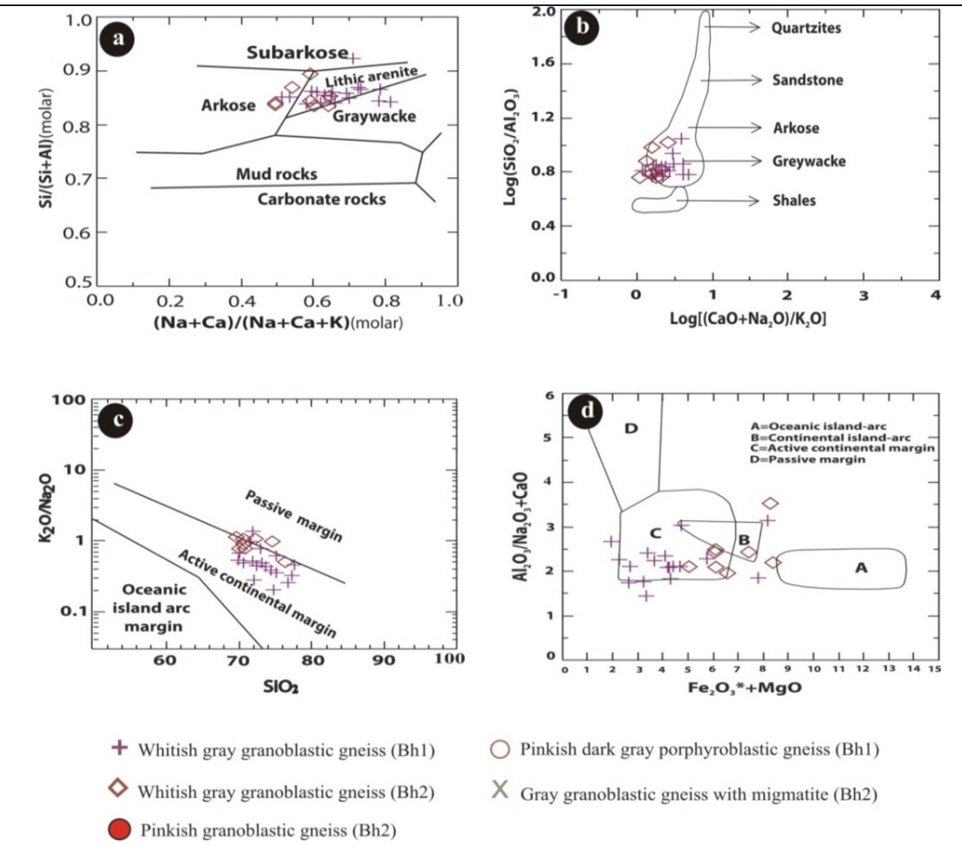

Fig. 5: Geochemical characteristics diagrams for the studied gneisses: a) Si/(Si + Al) vs. (Na + Ca)/(Na + Ca + K) (mole percent) plot for paragneissesafter (Wintsch and Kvale, 1994), b) Discrimination of the protoliths after (Garrels and Mackenzie, 1971), c) Diagram of log K_2O/Na_2O vs. SiO_2 (Roser and Korsch, 1986), d)Tectonic setting of the studied paragneisses after (Bhatia, 1983).

Geochemistry of orthogneiss (granitic gneisses)

Normative mineral composition of orthogneiss samples are plotted in Orthoclase (Or) – Albite (Ab) – Anorthite (An) diagram (Fig. 6a) after O'Connor, (1965). Most gneisses samples lie into the granodiorite field.

Many classifications of the igneous rocks were attempted by many authors depending on the different geochemical parameters. The calc-alkaline character of Abu Rusheid subsurface gneisses is indicated from the *AFM* ternary diagram defined by Petro et al. (1979). This diagram is commonly used to distinguish between tholeiitic and calc-alkaline differentiation trends in a magma series (Irvine and Baragar, 1971). It shows that all the examined samples plotted in calc-alkaline field (Fig.

6b). One sample of granoblastic gneiss with migmatite zone lies in tholeiitic field due to its high content of iron oxides which mainly ascribed to the interaction alongside ultramafic lithologies during metamorphism.

The A/NK vs. A/CNK binary diagram was constructed by Maniar and Piccoli (1989) to distinguish the different peraluminous, metaluminous and peralkaline magma types. The studied orthogneisses samples fall in the peraluminous field (Fig. 6c).

The possible magma source of the studied gneisses samples could be inferred from Figure (6d), established by Gerds et al., (2000).It shows that the gray granoblastic with migmatite and the porphyroblasticorthogneisses could be derived from partial melting of dacites-tonalite source that is found in deeper part of the crust of the Arabian Nubian Shield, whereas pinkish granoblasticorthogneiss was formed by partial melting of metagreywackes.

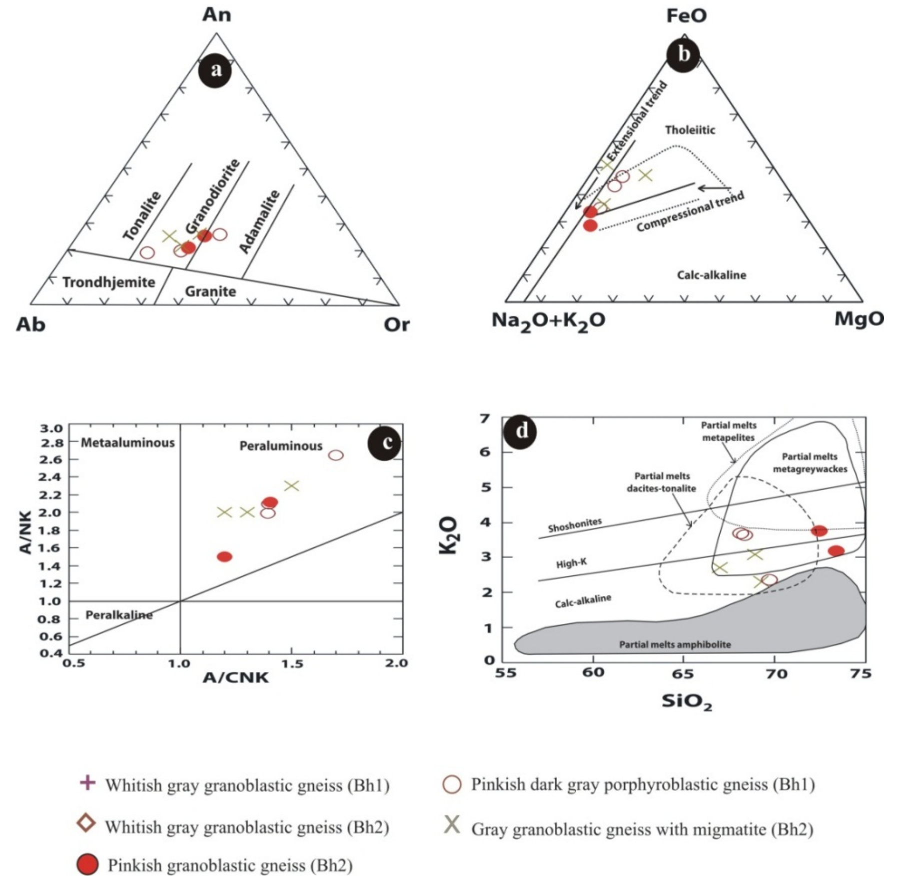

Fig. 6): Geochemical characteristics diagrams for the studied gneisses: a) Nomenclature of the orthogneisses judging from their normative mineral composition, after O'Connor, (1965), b) AFM ternary diagram for the after Petro et al. (1979), c) $Al_2O_3/Na_2O + K_2O$ vs. Al_2O_3 /Na_2O+K_2O+CaO discrimination binary diagram (Maniar and Piccoli, 1989), d) K_2O–SiO_2, field of partial melts of different rock sources after Gerds et al., (2000).

Geochemical distribution of trace elements in the studied two boreholes.

The studied paragneiss has moderate to high contents of lithophile and high field strength elements (HFSE) such as Rb, Ba, Sr, Zr, Y &Nb in addition to high contents of chalcophileelements

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 8, August 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

such as Cu, Zn and Pb.The porphyroblasticorthogneissof BH1 has moderate to high contents of compatible elements such as V, Cr, & Ni and high contents of lithophile and high field strength elements (HFSE) such as Rb, Ba, Sr, Zr, Y & Nb. The porphyroblasticorthogneisshas low contents of chalcophile elements such as Cu, Zn and Pb.

Table 3: Trace elements and their average values of the gneissic rocks along the BH1,South eastern Desert.

Lithology	Depth(m)	Cr	Ni	Cu	Zn	Zr	Rb	Y	Ba	Pb	Sr	Ga	V	Nb
Serpentinite	**-12**	907	1141	249	6360	15	43	2	218	579	2	417	18	2
Whitish gray Granoblasticparagneiss	**-13**	18	30	244	3749	1880	367	112	124	245	2914	209	3	87
	-14	17	5	95	1769	1351	715	81	74	369	2082	234	2	62
	-15	20	5	70	2623	1615	579	96	161	203	2510	126	5	75
	-16	14	3	72	4014	1165	249	69	85	52	1780	40	3	54
	-18	15	5	79	3249	1380	209	82	132	48	2119	17	5	64
	-19	15	3	103	3184	1537	698	92	58	109	2359	89	2	71
	-20	16	7	98	4060	1605	251	96	66	72	2487	56	4	75
	-21	12	2	55	4547	1706	194	101	88	45	2633	43	3	79
	-23	20	5	57	2683	1301	685	78	74	81	1971	59	2	60
	-24	18	5	88	3284	1215	558	73	80	84	1848	67	2	56
	-25	16	6	77	2311	1376	770	82	121	58	2124	46	4	64
	-26	17	5	84	7141	1389	686	83	61	33	2152	41	2	65
	-27	18	2	65	3679	1580	572	94	172	46	2433	36	5	73
	-29	23	6	104	3305	1509	297	90	454	59	2383	57	13	70
	-30	16	4	98	4568	1735	320	103	78	55	2713	55	4	80
	-31	15	2	77	3062	1257	356	75	87	44	1900	38	2	58
	-34	48	4	60	2751	1380	637	82	60	34	2120	25	3	64
	-35	40	14	33	2289	1468	623	87	49	34	2258	25	2	68
	-38	72	1	89	3685	1647	586	98	92	40	2582	39	3	77
	-40	74	3	143	3183	1038	531	62	82	33	1608	43	2	48
	-44	91	2	87	1381	976	394	58	241	34	1515	36	8	46
Porphyroblastic granitic gneiss	**-48**	47	6	70	806	627	634	37	851	31	930	25	22	29
	-53	46	1	81	279	2828	501	167	899	62	475	52	26	33
Whitish gray grano-blasticparagneiss	**-56**	62	6	157	2609	726	391	43	323	30	1111	27	9	34
	-60	76	3	250	6474	821	346	49	76	37	1264	40	5	38
P.G.G.*	**-63**	54	2	84	1182	1019	359	65	79	23	1549	16	2	72
W.G.G.**	**-68**	63	5	35	273	222	653	15	435	24	325	15	34	15
Average of W.G.G.		33	5	96	3328	1328	486	79	157	77	2049	61	5	62
Average of Porph.G.G.		49	3	78	756	1491	498	89	609	38	984	31	16	44

* **Porph.G.G.** = Porphyroblasticorthogneiss** **W.G.G.** = Whitish gray granoblasticparagneiss

The studied pinkish granoblastic gneiss of BH2 have a low contents of compatible elements such as V, Cr, & Ni and very high contents of lithophile and high field strength elements (HFSE) such as Rb, Sr, Zr, Y &Nb, Nb, but it has a high contents of chalcophile elements such as Cu, Zn and Pb. Gray granoblasticorthogneisswithmigmatite zone of BH2 has lowest contents of all trace elements along the gneisses of the BH2. From the study of the distribution and behavior of trace elements with depth in Abu-Rusheiddrillholes (Tables 3 & 4) and figures (7 & 8) it can be concluded that;

1- In BH1, some trace elements show general increasing with increasing depth such as Cr, Ba and V but the most trace elements show general decreasing with increasing depth such as Ni, Zn, Zr, Pb, Sr, Rb, Ga, Y and Nb. The highest values of Zr, Y and Ba are related to porphyroblastic gneiss

(Orthogneiss) at depths 50-55m where; a) Zircon occurs as aggregates or groups, b) Fluorite and Yttriam more enriched andc) Increase of Barite mineral along this zone.

On the other hand, there are two trace elements do not show general increase or decrease with increasing depth such as Y and Cu.

In BH2, Sr, Ba and Cu show general increasing with increasing depth but Zn, Zr, Rb,Ga and Nb show general decreasing with increasing depth. On the other hand, Cr, Ni, Y andPb do not show general increasing or decreasing with depth. Cr, Ni, Cu, Sr and Ga tend to enriched along the Ophiolite zone. The highest values of Ba are related to the lower and upper contacts of gray granoblastic gneiss.

The trace elements values of BH2 are more than that of BH1.

Table 4: Trace elements and their average values of the different rocks along BH2, South eastern Desert.

Lithology	Depth(m)	Cr	Ni	Cu	Zn	Zr	Rb	Y	Ba	Pb	Sr	Ga	V	Nb
Whitish gray granoblastic paragneiss	-1	55	9	8	254	4921	1149	161	70	326	9	60	n.d	1479
	-3	45	10	10	262	3663	1020	313	73	266	4	80	n.d	1038
	-4	40	10	10	139	2675	854	114	57	78	10	79	n.d	761
	-5	29	25	13	971	4065	1343	287	61	560	9	88	n.d	1626
	-7	32	8	12	4627	3545	907	250	61	125	3	69	n.d	1309
	-8	35	12	4	2620	3099	960	275	50	26	11	75	n.d	3797
	-11	35	11	27	3680	4394	1096	237	63	20	6	81	n.d	1560
	-12	4	40	3	339	1200	85	320	223	46	12	96	n.d	980
	-14	29	13	17	2746	3240	1110	279	58	820	5	69	n.d	1153
Pink granoblastic granitic gneiss	-15	32	10	53	1734	4774	1306	298	67	188	4	77	n.d	1985
	-16	29	9	42	1074	5099	1085	231	57	520	8	79	n.d	1662
	-17	30	8	48	1097	4312	1042	451	48	630	9	77	n.d	1698
Whitish gray Granoblastic paragneiss	-18	33	9	10	3973	2905	838	149	52	230	3	83	n.d	1296
	-20	48	9	21	456	3633	1003	150	63	400	6	69	n.d	1144
	-21	3	33	44	128	950	83	310	525	308	4	66	n.d	755
	-22	6	45	33	953	855	74	275	196	450	8	13	n.d	520
	-23	31	8	35	3122	3183	536	167	51	49	8	72	n.d	987
	-24	42	26	27	2505	3700	448	134	55	101	9	34	n.d	1129
	-26	33	10	33	1617	796	394	273	58	75	24	70	n.d	369
	-27	27	9	23	2215	819	474	119	60	120	18	89	n.d	309
Schists+talc carbonate	-29	23	7	18	1062	460	268	249	61	45	9	73	n.d	76
	-30	33	15	48	111	333	433	192	52	241	8	73	n.d	63
	-32	47	10	104	1945	256	270	191	66	410	13	27	n.d	23
	-33	25	8	55	9	223	42	241	444	86	10	88	n.d	32
	-34	26	5	19	136	56	156	99	541	33	62	124	8	36
	-35	137	276	187	122	74	74	127	61	98	76	29	5	22
	-36	222	422	204	22	18	44	305	2295	245	24	67	n.d	12
Gray granoblastic Orthogneiss with migmatite	-37	28	10	52	264	2214	389	313	146	210	22	47	2	306
	-38	36	10	27	588	1430	434	173	66	320	15	48	n.d	239
	-39	36	8	16	546	953	337	154	94	145	14	49	2	190
	-40	31	9	28	739	862	211	222	42	356	16	76	n.d	175
Whitish gray Granoblastic paragneiss	-41	30	6	22	489	229	407	101	241	256	53	28	6	710
	-42	11	25	45	78	750	62	210	2389	47	36	89	n.d	860
	-43	23	9	31	213	1113	78	277	34	66	23	93	n.d	115
	-45	31	16	13	2036	612	351	155	418	350	52	36	n.d	205
	-46	3	33	26	42	850	61	212	837	46	22	75	n.d	740
	-48	31	10	26	243	557	471	198	114	254	29	53	2	175
	-51	31	8	55	231	296	309	99	243	145	52	37	4	820
	-53	37	10	26	567	2361	324	257	161	750	42	43	3	467
	-54	4	45	30	36	320	48	65	1947	250	35	10	n.d	756
Average of W.G.G.*		28	17	23	2283	2105	557	207	314	237	19	63	n.d	1171
Average of P.G.G.**		30	9	47	1301	4728	1144	326	57	446	7	77	n.d	1781
Average of G.G.G.M.***		33	9	31	534	1365	343	215	87	258	16	55	n.d	227

W.G.G. =** Whitish gray granoblasticparagneiss*P.G.G. =** Pink granoblastic granitic gneiss
*****G.G.G.M. =** Gray granoblasticorthogneisswithmigmatite

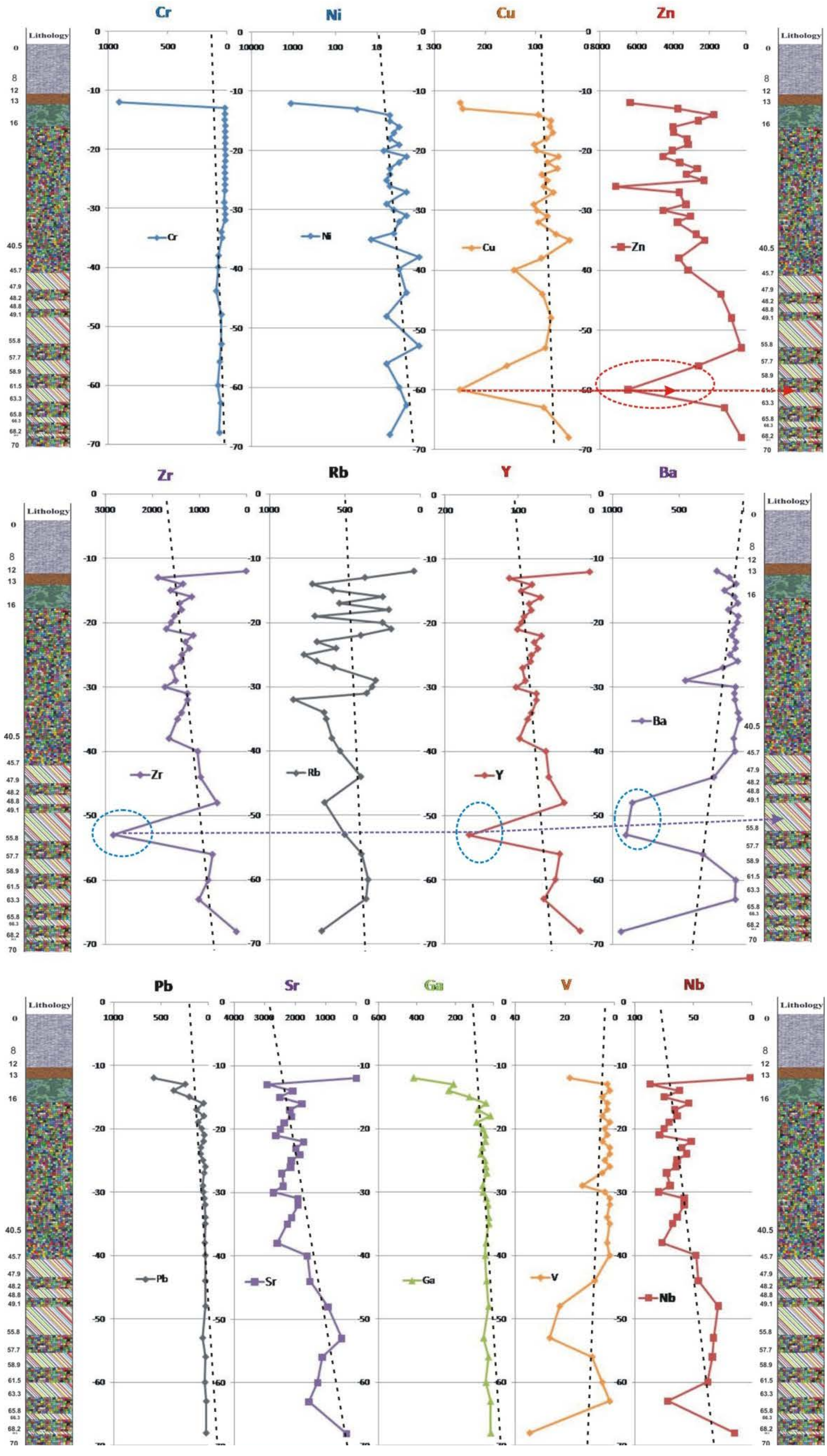

Fig. 7: Trace elements (ppm) Vs. depth of BH1 at Abu-Rusheidarea, South eastern Desert.

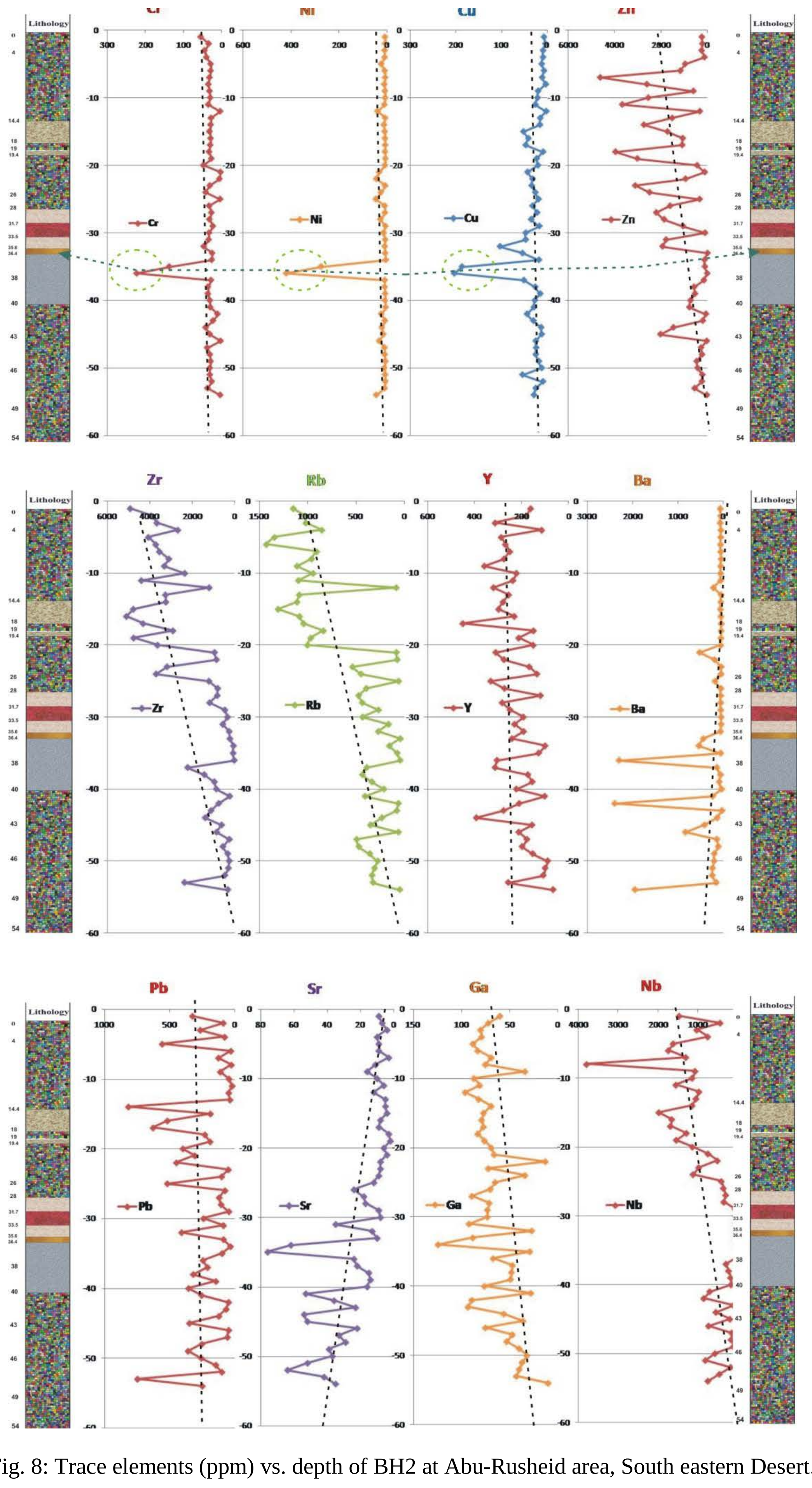

Fig. 8: Trace elements (ppm) vs. depth of BH2 at Abu-Rusheid area, South eastern Desert.

CONCLUSION

1) The underlying units in BH1 are represented mainly by whitish gray granoblastic gneiss alternating after 46m depth with pinkish gray porphyroblastic gneiss with sharp contacts.
2) The core samples of the BH2 are mainly comprised of whitish gray granoblastic gneiss, pink granoblastic gneiss, quartz-feldspar-biotite schist, quartz-hornblende-biotite schist, mica schist, talc carbonate (represent another deformed mélange body), gray granoblastic gneiss with migmatite zone and finally whitish gray granoblastic gneiss.
3) The metamorphic sequence most likely represents a sequence of pelites and psammites, intruded by megacrystic granitoid injections from external sources then metamorphosed to an amphibolites-granulite facies assemblage.
4) Petrographically, the metmectized zircon, Well-formed crystals of xenotime, radioactive minerals and iron oxides filled the fracture and fissures are found in the whole studied core samples.
5) The whole-samples geochemical signature of the paragneisses and orthogneisses showing that lower SiO_2, Na_2O and K_2O accompanied by higher TiO_2, Fe_2O_3, MgO,MnO, Al_2O_3 and CaO.
6) The geochemical data of the studied gneisses along the boreholes suggested that thepinkish gray porphyroblastic gneiss of BH1,pink granoblastic gneiss of BH2 and gray granoblastic gneiss with migmatite of BH2 show igneous origin, whereas whitish gray granoblastic gneiss of BH1 and BH2 show sedimentary origin. Also, the geochemical data of the paragneisses suggested different sedimentary protolithes ranging from lithic arenite to graywacke which metamorphosed later to paragneisses.
7) The geochemical data of the orthogneisses indicate that their protoliths are calc-alkaline, peraluminous, I-type, and generated in subduction-related environment.Most of orthogneissesare calc-alkaline in composition which supports their derivation from a crustal source by fractional crystallization.
8) The distribution and behavior of trace elements with depth revealed that the core samples characterized by higher contents of Rb, Ba, Sr, Zr, Y, Nb, Cu, Zn and Pb.

REFERENCES

Abd El-Naby, H., and Frisch, W., (2006): Geochemical constraints from the Hafafit Metamorphic Complex (HMC): evidence of Neoproterozoic back-arc basin development in the central Eastern Desert of Egypt. Journal of African Earth Science, 45, 173-186.

Bahatia, M. R., (1983): Plate tectonics and geochemical composition of sandstones. Jour. Geol., 91, 611-627.

Bajwah, Z. U., Seccombe, P. K. and Offler, R., (1987): Trace element distribution, Co : Ni ratios and genesis of the Big Cadia iron-copper deposit, new south Wales, Australia. Mineral Deposita, 22, 292-300.

Bralia, A., Sabatini, G. and Troja, F., (1979): A revaluation of the Co/Ni ratio in pyrite as geochemical tool in ore genesis problems. MineraliumDeposita, 14, 353-374.

Demant, M., (1992): Granites and rhyolites from the northwestern USA: temporal variation in magmatic processes and relations to tectonic setting. Trans. R. Soc. Edin., Earth Sci. 83, 51–64.

El-Ramly, M.F. and Akaad, M.K., (1960): The basement complex in the central E. D., Egypt. Between lat. 24º 30´ and 25º 40´ N. geol. Surv., Egypt, pp. 8- 35.

El-Shazly, E. M. and Hassan, M. A. (1972): Geology and radioactive mineralization at Wadi Sikait- Wadi El Gemal area. South Eastern Desert, Egypt. J. Geol. V. 2, 201 p.

Fowler, A. and El Kalioubi, B. (2002): The Migif-Hafafit gneissic complex of the Egyptian Eastern Desert: fold interference patterns involving multiply deformed sheath folds, Tectonophysics, 346: 247-275.

Fowler, A. and Osman, A. F. (2009): The Shait-Nugrus shear zone separating central and south Eastern Deserts, Egypt: A post-arc collision low-angle normal ductile shear zone, Journal of African Earth Sciences, 53: 16-32.

Fritz, H., Dallmeyer, R.D., Wallbrecher, E., Loizenbauer, J., Hoinkes, G., Neumayr, P., Khudeir, A.A., (2002): Neoproterozoic tectonothermal evolution of the central Eastern Desert of Egypt: a slow velocity tectonic process of core complex exhumation. Journal of African Earth Science, 34, 137–155.

Fritz, H., Wallbrecher, E., Khudeir, A. A., Abu El-Ela, F. F., and Dallmeyer, D. R., (1996): Formation of Neoproterozoic metamorphic core complexes during oblique convergence Eastern Desert, Egypt. J. African Earth Sci., 23, 311–329. from the Bauda Desert, Sudan., J. Afr. Earth Sci., vol. 3, p. 61-75.

Garrels, R. M. and Mackenzie, E. T. (1971): Evolution of sedimentry rocks: New York, W.W. Norton, 227p.

Gerdes, A., Wo¨rner, G., Henk, A., (2000): Post-collisional granite generation and HT-LP metamorphism by radiogenic heating: the Variscan South Bohemian Batholith. J. Geol. Soc. London 157, 577–587.

Greiling, R. O., Kr¨oner, A., El-Ramly, M. F., and Rashwan, A. A., (1988): Structural relations between the southern and central parts of the Eastern Desert of Egypt: details of a fold and thrusts belt. In: El-Gaby, S., Greiling, R. (Eds.), The Pan-African Belt of the NE Africa and Adjacent Areas. Tectonic Evolution and Economic Aspects.Freidr.Vieweg and Sohn, Braunschweig/Weisbaden, 121-145.

Hashad, A. H. and Hassan, M. A. (1959): Report on the prospection work carried out in Wadi El Gemal area, south Eastern Desert, Egypt. Internal Report, AEE, Cairo, UAR.

Hassan, M. A. (1964): Geology and petrographical studies of the radioactive minerals and rocks in Wadi Sikait-Wadi El Gemal area. Eastern Desert, U. A. R: M. Sc. Thesis faculty of science, Cairo Univ. 165p.

Ibrahim, M. E., Saleh, G. M, Amer, T., Mahmoud, F. O, Abu El Hassan, A. A., Ibrahim, I. H., Aly, M. A., Azab, M. S., Rashed, M. A., Khaleal, F. M. and Mahmoud, M. A., (2004): Uranium and associated rare metals potentialities of Abu Rusheid brecciated shear zone II, south Eastern Desert, Egypt (Internal report).

Ibrahim, M. E., Saleh, G. M, Amer, T., Mahmoud, F. O, Abu El Hassan, A. A., Ibrahim, I. H., Azab, M. S., Rashed, M. A., Khaleal, F. M. and Mahmoud, M. A. M. (2004): Geochemical Evaluation for Trace Elements Associated With Abu RusheidCataclastic Rocks, South Eastern Desert, Egypt (Internal report).

Irvine, T. N. and Baragar, W. R. A., (1971):A guide to the chemical classification of the common volcanic rocks. Can. Jour. Earth sci., vol. 8, 523-548.

Kandea, H., Shimazaki, H. and Lee, M.S., (1986): Mineralogy and geochemistry of the Au-Ag ore deposits of the South Korean Peninsula. Mineral Deposita, 21, 234-243.

Maniar, P.D., and Piccoli, P.M., (1989): Tectonic discrimination of granitiods. Geol. Soc. Am. Bull., 101, 635-643p.

O'Connor, J.T., (1965): A classification for quartz-rich igneous rocks based on feldspar ratios. U. S. Geol. Surv. Prof. Paper B525, 79–84.

Petro, W. L.; Vogel, T. A. and will band, J. T., (1979): Major element geochemistry of plutonic rocks suites from compressional and extensional plate boundaries, Chem.Geol.V.26, pp. 217-235

Roser, B.P., Korsch, R. J., (1986): Determination of tectonic setting of sandstone-mudstone suite using SiO_2 content and K_2O/Na_2O ratio. J. Geol. 94, 635–650.

Sabet, A. H., Tsogroev, V. B., Babourin, L. M. and Zharkov, V. M., (1976a): Mineralization of rare metal mineralization of apogranite type in the Central Eastern Desert of Egypt. Annals of the Geol. Surv.of Egypt, VI: 75-92.

Sabet, A. H., Tsogroev, V. B., Bordonosov, V. P., Shablovsky, R. G. and Kosa, M., (1976f): On the geologic structure, lows of localization and prospects of Abu Rusheid rare metals deposits. Annals of the Geol. Surv.of Egypt, VI: 181-190.

Sabet, A. H., Tsogrov, V. B., Bordonosov, V. P., Babourin, L. M., Zalata, A. A. and Francis, M. H., (1976h): On gold mineralization in the Eastern Desert of Egypt. Annals of the Geol. Sun. of Egypt, VI: 201- 212.

Shapiro, L. and Brannock, W. W., (1962): Rapid analysis of silicate, carbonate and phosphate rocks, U. S. Geol. Surv. Bull, 1144-A, 56p.

Soliman M., and Hassaan, M. M., (1971): Geochemical prospecting for lead and zinc in Gebel El Ruusas, Eastern Desert, Egypt, Geol. Rundschou, 60-3: 1285-1301.

Tarney, J. (1977): Petrology, mineralogy and geochemistry of the Falkland Plateau basement rocks, suite 300, Deep Sea Drilling Proect. Int. Rep. Deep Sea Drilling Project 36,893-921.

Wintsch, R.P., Kvale, C.M., (1994): Differential mobility of elements in burial diagenesis of siliciclastic rocks. J. Sediment. Res. A64, 349–361.