Preliminary Petrological Studies of Basement Rocks, Thar Coal Basin, Thar Parkar District, Sindh, Pakistan.

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ABSTRACT

The basement rocks encountered in exploratory bore holes drilled for exploration and evaluation of coal deposits in Thar Parkar district, Sindh Pakistan have formed the basis for present studies. The Thar coal field is located 50km from Mirpurkhas town in the southeast part of Sindh province. The basement complex was penetrated through eighteen boreholes at drill depth range from 112 to 279 meters. These rocks were identified in field as Pink and Grey Granites. The present studies are based on the samples of eight bore holes only i.e; TP-14 TP-2, TP-6, STP-6, TP-3, STP-5, SB-11and SB-26. The basement rocks are of Igneous as well as metamorphic origin. The Igneous rocks identified petrographically are Alkali-feldspar Granite, Granodiorite, Rhyollite, Rhyodacite and Aplite while that of metamorphic origin is Plagioclase Hornblende Gneiss. These rocks are termed as Thar Granitoids. The mineralogical data shows that feldspar are exsolved and present in the form of perthites and the presence of one feldspar (perthite) shows granites are hyperslvus.The chemical data plotted in various binary and ternary diagrams suggest that the Thar Granitoids are (1) in general peraluminous in nature (2) restricted to psuedoternary minimum at moderate water pressure.

INTRODUCTION

During coal exploration programme several bore holes were drilled primarily for the appraisal of coal deposit. The basement complex was penetrated through eighteen holes (Fasset & Durrani, 1974; Alam et.al., 1996 & 1998) at drill depths range from 112 to 279 meters.The present studies are based on the basement rocks core samples from eight bore holes only i.e; TP-14, TP-2, TP-3, TP-6, STP-6, TP-3, STP-5, SB-26 and SB-11 of Thar coal basin hereafter referred to as Thar Granitoids.The Thar coalfield is located in the Thar Desert, south east of Sindh province, Pakistan.it is 50 Km from Mirpurkhas town and co-ordinates $24^0 30^/$ N to $25^0 45^/$N (lattitudes) and $69^0 45^/$E to $71^0 00^/$ (logtitudes).

General Geology

The area is mainly covered by the thick sequence of recent sand dunes.. The genaralized picture of the stratigraphical units as encountered in drill holes are shown in Table 1.

TABLE-1 Stratigraphy of the area

Formation	Age	Lithology
Dune sand	Recent	Sand, salt and clay
	Unconformity	
Alluvial deposits	Sub-recent	Sandstone, siltstone, clay mottled
	Unconformity	
Bara Formation	Paleocene to Early Eocene	Claystone, shale, sandstone, coal, carboniferous claystone
	Unconformity	
Basement complex	Pre-Cambrian	Igneous and metamorphic rocks

PETROGRAPHY

The petrographic studies involve both mega- and microscopic studies. The petrographic studies are based on the core samples from eight bore holes only. In all 15 representative samples were selected. The rocks studied are identified as pink granite, grey granite, granodiorite, rhyolite, aplite, rhyodacite, and plagioclase hornblende gneiss .Selected samples of both pink and grey granites were also analyzed modally (Table 2).

Pink Granite

Pink granites were encountered in TP-2, SB-11, and SB-26. The texture of the rocks is in general medium to coarse grained, interlocked and hypidiomorphic granitic. However, the rock sample of SB 11/245M has hybridized texture i.e. it is partly coarse-grained hypidiomorphic granular and in part fine to coarse-grained inequigranular seriate texture (Plate l a). The sample of SB-26 shows moderate to intense fracturing and breaking of grains alongwith silicification(Plate 1b). The major minerals are perthites (predominantly string type with some microperthites)(Plate 1a & b), quartz (both as moocrystalline & polycrystalline grains) and antiperthites with chequer board Albite twinning) with minor secondary ferromagnesians (hornblende in SB-11 Plate 111b and fine aggregates of biotite, epidote, magnetite, rutile Plate III b) .The fine euhedral zircon grains are rarely present as accessory mineral. Magnetite subhedral fine disseminations are rarely present.

Grey Granite

There is no significant textural and mineralogical difference from the Pink Granite above defined. This rock is encountered in TP-3. The rock is fresh, interlocked, coarse-grained hypidiomorphic granular and medium grained. The minerals it consists of are quartz, perthite, and antiperthite with minor ferromagnesians(Plate IV b).

Granodiorite

The granodiorite was encountered in TP-6. The rock is dark yellowish orange, fine to medium hypidiomorphic. The rock is dominantly composed of quartz, plagioclase, K-feldspar and minor secondary ferromagnesian after hornblende. Fluorite colourless grains are rarely present (Plate VI a).

Rhyolite

Rhyolite was encountered in TP-2 as dykes within the Pink Granite (Fig. 5).The texture of the rock is medium to fine grained porphyritic. Quartz, microcline and plagioclase are present as phenocrysts. Groundmass is fine grained granular aggregates mainly consists of quartz, plagioclase, biotite with partial alteration to chlorite, silica and opaque grains Rutile with partial alteration to leucoxene is present as accessory mineral.

Rhyodacite

Rhyodacite was encountered in STP-5. The rocks are partially to completely altered, the alteration is more intense in the upper part with its textures completely obliterated. The samples from lower unaltered part exhibit glomeroporphyritic texture (Plate V a). The glomerocrysts are medium to coarse-grained quartz and plagioclase. The groundmass is partly glassy showing fluidal texture and partly fine aggregates of quartz and sericite. Irregular smoky grains of leucoxene are present in dissemination.

Aplite

Aplite was encountered in drill hole STP-6. The rock is brownish pink, medium grained allotriomorphic granular(Plate.Vb). The mineral constituents are quartz, perthite, antiperthite and minor ferromagnesian.

Plagioclase Hornblende Gneiss:

Plagioclase Hornblende Gneiss was encountered in TP-14. It is medium grained, banded with nematoblastic texture. The mineral constituents are plagioclase, K. feldspar, quartz and nematoblasts of hornblende and fine disseminations of magnetite.

Geochemistry

Analytical results of Thar Granitoids are shown in Table 2 CIPW norms have been calculated and are given in the Table 4. The differentiation Indices (Thornton and Tuttle, 1960) of Thar Granitoids, Alkali Feldspar Granites range from73.52 to 88.69, Granodiorite from 82.87 to 83.99 showing the compositions are well evolved.The chemical data of the Thar Granitoids is used to plot binary and ternary diagrams. All the diagrams show the close clustering. The plots of molecular normative An - Ab - Or composition (after Barker, 1979) in Fig. 3 shows that the Tp - 2 & Tp-3 are in the field of granites and the rocks of Tp-6 fall in the field of granodiorite. These are compatible to the petrography of the samples. The molar plot in the ternary system Al_2O_3 - (Na_2O + K_2O) - CaO (Fig. 4) is showing peraluminous character of the suites. The plots of normative percentages of quartz - orthoclase - albite of Thar Granitoids (both pink & grey) (Fig. 5) in triangular diagram after Tuttle & Bowen 1958 restricted to the region of pseudoternary minimum at a moderate water pressure.

Discussion

The present report is of preliminary nature based on petrological studies of very selective samples from eight bore holes of Thar coal basin. The rocks identified are pink and grey Granite, Granodiorite, Rhyollite, Rhyodacite, Aplite, and Plagioclase Hornblende Gneiss described as Thar Granitoids. The mineralogical data shows that feldspars are exsolved and present in the form of perthites and antiperthitic growths. The presence of one feldspar (perthite or exsolution) shows that the granites are hypersolvus. The C.I.P.W norms calculated on the basis of chemical composition of Thar Granitoids yield normative corundum indicating their peraluminous in character. This is confirmed by molar plot in the ternary system Al_2O_3 -(N_2O + K_2O) -CaO (Fig.4) The normative percentages of quartz -orthoclase - albite of Thar Granitoids plotted in triangular diagram (Tuttle & Bowen, 1958) (Fig.8) are restricted to the region of pseudoternary minimum at moderate water pressures except the samples from the contacts and altered ones. The mineralogical and chemical data and its interpretations on the basis of various binary and ternary phase diagrams suggest that the Thar Granitoids are magmatic rocks of peraluminous nature.

REFRENCES

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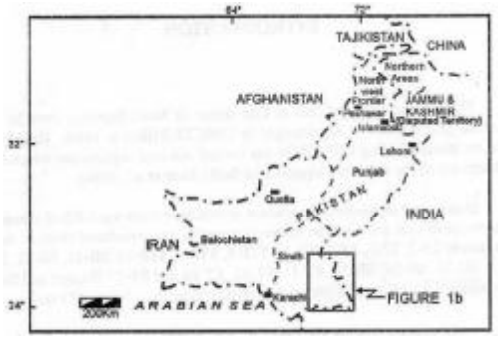

Fig.-1a: Location map of study area.

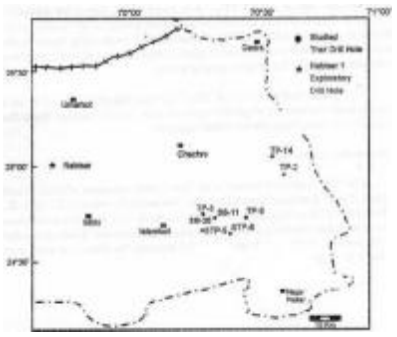

Fig. 1b: Locations of studied bore holes

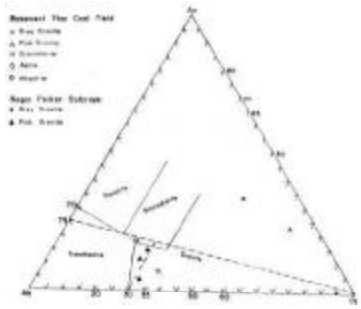

Fig.-3: The classification of granitic rocks according to their Molecular normative An-Ab-Or composition after Barker (1979). The original field of O' Conner is shown by broken line.

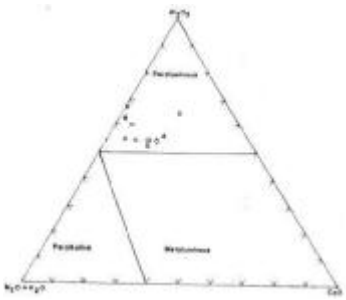

Fig.-4: Molar plots of Thar granitoid on ternary system after Power, 1983.

TABLE 2 -: Chemical composition of Thar Basement rocks: Grey Granite (GG), Pink Granite (PG), Granodiorite (Gr), Rhyolite (Rh), Aplite (Ap) and Metamorphic rocks (Mt).

Sample Number	TP-3/ *207.1	TP-3/ 206.77	TP-3/ 206.7	TP-2/ 189.7	TP-2/ 190.92	SB-26/ 225.55	SB-11/ 245.0	TP-6/ 146.88	TP-6/ 145.69	TP-2/ 196.36	STP-6/ 111.14	TP-14/279.27
Rock type	GG	GG	GG	PG	PG	PG	PG	Gr	Gr	Rh	Ap	Mt
SiO_2	71.88	71.80	70.58	66.92	68.85	71.48	58.30	71.84	70.74	70.64	68.92	56.15
Al_2O_3	16.73	18.42	16.35	18.23	17.02	17.15	24.58	17.15	17.71	18.85	18.36	18.80
Fe2O3	0.62	2.56	1.61	1.71	2.93	1.04	2.00	1.04	0.49	1.74	2.48	1.98
FeO	1.58	0.14	1.29	1.58	0.07	0.39	1.72	0.39	0.21	0.21	0.32	5.52
CaO	0.84	BDL	BDL	1.68	0.84	2.38	3.90	2.38	BDL	0.30	1.96	8.03
MgO	0.40	0.40	0.20	0.60	0.20	BDL	0.60	BDL	2.20	0.20	BDL	3.22
Na_2O	3.59	2.02	1.85	5.00	4.95	4.51	5.96	4.51	4.82	5.22	3.22	3.88
K_2O	3.12	3.20	4.20	3.22	3.50	2.40	0.99	2.40	1.81	1.30	3.12	0.60
MnO_2	0.56	0.10	0.31	0.95	0.31	0.49	1.20	0.49	0.66	0.12	0.65	1.42
TiO_2	0.24	0.12	0.20	0.32	0.09	0.20	0.58	0.02	0.11	0.06	0.22	0.30
P_2O_5	0.07	0.05	0.06	0.08	0.24	0.04	0.35	0.04	0.03	0.21	0.05	0.10
H_2O+	0.65	1.10	3.24	0.56	1.20	0.39	1.60	0.39	0.70	1.20	1.24	1.20
H_20-	0.40	1.20	0.40	0.30	0.30	0.12	0.30	0.12	0.20	0.02	0.20	0.90
ppm												
Pb	5	5	5	6	6	4	7	4	6	6	7	7
Cr	1050	425	900	825	1020	750	750	750	1150	790	1120	390
Ni	395	450	525	375	475	335	560	335	450	470	500	620
Co	390	385	590	310	420	375	480	375	460	460	530	625
Li	2	9	6	6	4	2	3	2	6	5	2	3

Table 3: Modal analysis of rocks from theThar Granitoids:				
	Gray Granite	Pink Granite	Granodio reit	Aplite
Quartz	37.40	40.35	34.19	44.08
Perthite	32.53	45.62	-	29.32
K-feldspar	-	-	15.21	-
Antiperthite	25.70	9.30	-	20.39
Rim Albite	2.13	0.67	-	1.51
Plagioclase	-	-	45.80	
Biotite	-	-	-	0.16
Chlorite		-	3.04	-
Epidote	0.41	0.12	-	0.22
Fluorite		0.89	1.76	
Quartz intergrowth	0.83	-	-	3.65
Carbonate	0.3	-	-	-
Vein silica	0.28	0.03	-	-
Magnetite	1.10	2.14	-	0.67

Table 4: CIPW Norms of Pink & Grey granites from Thar Basement .		
Minerals	**Grey Granite Aver. n*=3**	**Pink Granite Aver. n=4**
	42.44	25.86
Qtz	1.24	10.53
An	21.43	24.43
Ab	21.26	27.88
Or	9.02	6.04
C	0.72	0.78
Hm	0.81	2.16
Mt	0.16	0.28
Ill	0.05	0.47
Ap	1.76	1.42
Hy	0.34	0.13
En		
Fs		

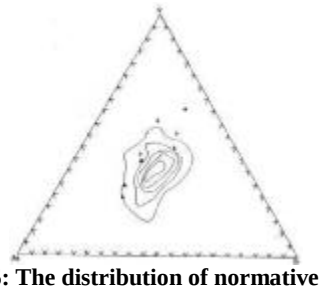

Fig.-5: The distribution of normative Quartz, Albite and Orthoclase in Plutonic rocks (after Bowen & Tuttle, 1958).