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ORIGINAL ARTICLE

FIELD RELATIONSHIP OF DOLERITE DYKES IN AND AROUND GINGEE AREA VILLUPURAM DISTRICT, TAMILNADU, INDIA

***M. Kanimozhi and B. Selvaraj**

Department of Earth Sciences, Annamalai University, Annamalai nagar, Chidambaram-608002

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ABSTRACT

The formation of dyke is an integral feature of crustal evolution, which is interlinked with magmatic and deformational events which have occurred from the Archean times. Dykes serves as avenues for the transport of magma from mantle level to the upper crust. The study area forms the northern part of the Tamilnadu state, south India which falls under the Southern Granulitic Terrain (SGT) of Peninsular India. Southern Granulite Terrain has witnessed significant part of Precambrian mafic igneous activity in the form of episodic mafic dyke intrusion of the Palaeoproterozoic period. The study area has been cut across by the number of younger basic dykes which are generally fresh, massive and are of dolerites and gabbros. These dykes are, show variety of textural features. The geochemical studies of the black granites from the study area classified them under sub alkaline- tholeiitic basalts thus a co-genetic relationship between the samples can be established.

Keywords: Dolerite, SGT, dykes

1.INTRODUCTION

Younger basic intrusive of Gingee area (Villupuram district), Tamilnadu, South India are chiefly comprises of dolerite and gabbro which are emplaced in a criss crossing pattern in the entire district. They signify a significant phase of basic magmatism in the Southern Granulitic Terrain (SGT), which forms the Precambrian crust of the Southern Indian shield. Precambrian crust of the Earth consists of nine cratons, viz, regions in Asia and Indian subcontinent, Europe, Greenland, North America, South America, Africa, Australia and Antarctica. The Indian craton including Sri Lanka forms about 3% of the total area of Precambrian crust. The Indian Precambrian terrain include the Dravidian shield (the Western Dharwar craton, the Eastern Dharwar craton and the Southern Granulite Terrain) in the south, the Eastern Ghat mobile belt in the east, the Chotanagpur Singhbhum in the northeast and the Aravallis in the northwest (Goodwin, 1996). The oldest rocks of Indian craton lie in the Aravallis, the Singhbhum and the Dharwar regions (-3.4 Ga). Major events of orogeny occurred during 3.0 Ga and 2.5 Ga, in which the later marks a boundary for Archaean-Proterozoic ages. It is further characterized by high-grade metamorphism, which in turn has resulted in consolidation of South Indian Shield (Goodwin, 1996, Jayananda and Peucat, 1996).

Corresponding author*: ***M. Kanimozhi,* *Department of Earth Sciences, Annamalai University, Annamalai nagar, Chidambaram-608002*

The dyke rocks demarcate deciphered the recurring episodes of crustal extension during which large quantities of mafic magma were transported from the mantle to the crust. The emplacements of the dykes have been witnessed episodically, for about 4 billion years in the history of the Earth. The mafic dyke swarms have attracted the earth scientists because they represent the lithological component of the lithosphere which is being used as an important geochronological marker and their chemistry provides important evidence about the development of continental lithosphere (Tarney and Weaver, 1987).

Sugavanam et al., (1977) have attempted to correlate the dyke activity with the various deformational episodes in the northern part of Tamilnadu. According to them the emplacement of the Dolerite and quartz-gabbro dyke swarms predating to alkaline-carbonate complex have taken place post F2 deformation since the WNW-ESE dykes do not show any effect of migmatization but they are emplaced before F3 deformation as they are involved in N-S warping. They also noticed that both WNW-ESE and NE-SW/NS dyke are intensely sheared with profuse development of epidote. Murthy (1987) compiled the geological map of dyke swarms in India and it provides first geological account on the status of our knowledge on the mafic dykes in Southern Granulitic Terrain of India. Afnasseyev et al. (1964) reported the K-Ar age of about 1680 Ma, though the geochronological and isotopic work is lacking in this area.

Palaeomagnetic studies of Precambrian dykes were reported only in late eighties, which include Radhakrishna et al (1986) form north Kerala and Venkeatesan et al, (1987) from the parts of North Arcot , Tiruvannamalai and Salem districts of Tamil Nadu.

2.MATERIAL AND METHODS

FIELD RELATION

Most of the Gingee area (Villupuram district) exhibits multi structural and polymetamorphic complexity. Various phases of deformation can be inferred from the high warping and contorted foliation trends with variable amount of dip. Except the dykes, all the lithounits are having well developed foliation. Major structural markers which can be found in the study area are thin magnetite quartzites, pyroxene granulites and pink granite. In the present study the detailed geological field study was carried out from the eastern and central part of the district where the dyke bodies are well exposed to the surface (Fig. 1).Trends of dykes can be broadly grouped into three set: Group – I Dykes having trends NW-SE, WNW-ESE and E-W, Group – II Dykes having trends NNW-SSE, N-S and NNE-SSW, Group –III Dykes having trends NE-SW.

Various geomorphic features, trends and structures of the exposed dyke bodies and its relation with the country rocks were recorded in detail in the field diary. Fresh exposures were studied for colour, texture and mineralogical composition of the rock. The dykes have a very sharp contact with the surrounding rock. At few places chilled margins too observed. They are hard, compact, massive and extends up to few hundred kilometers. They are fine to coarse grained and at places were mined out for dimensional stones

Fig:1(a) Photograph showing rock Hornblende Biotite GniessNear Thandavasamutheram

Fig.1 (b)The content between the Counbtry rock and Dyke Body At Sirukadambur

Fig: 1 (c) Dolerite Dyke rock ExhibitingSpheroidal weathering Near Kaspakaranai

Fig:1 (d) The Dolerite Bouldewrs of Dyke body near Agalur

3.RESULTS AND DISCUSSION

GEOCHEMICAL STUDIES

Ten dolerite dyke samples were analysed for major and trace element and REE concentration, using XRF and ICP-MS from GSI Bangalore. To obtain analytical precision and calibration of the instrument, the samples were simultaneously analysed with basalt (BEN) international geostandard (Govindaraju, 1989). Values obtained for Major, Trace and REE elements are within the permissible limits . On the TAS (Total Alkali Silica) diagram, all samples are falls in the basaltic andesite field

Major oxide data when plotted over Na_2O+K_2O+Fe_2O_3-MgO diagram indicate tholeiitic composition. All the samples are falling in the above trend line in tholeiitic field indicates enriched in K_2O, indicating moderate-K tholeiitic character. On the TAS (Total Alkali Silica) diagram, all samples are falls in the basaltic andesite field (Fig.3) and reveals to confirm the moderate enrichment of alkalis along with the silica saturation (Raju and Srivastava, 2009). For Villupuram dyke, the MgO and Mg# values from 4.24 to 6.4 and 23.32 to 32.05, respectively (Table 1). The villupuram dolerite dyke show lower (28.14), values of Mg# compared to the Dharmapuri dyke (34.87 to 63.19) (Jeyabalan et al., 2012).

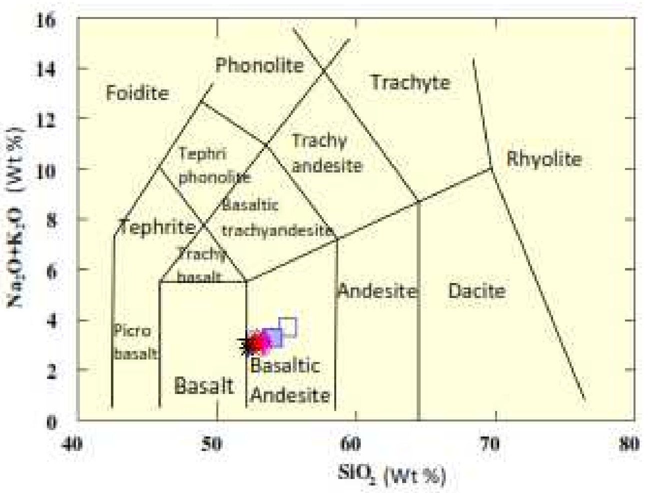

Fig.2.IUGS classification of volcanic rocks (LeMaitre, 1989). All dyke samples are basaltic andesite in composition.

The low MgO content accompanied by high SiO_2 values in case of black granites indicate that these magma types have undergone relatively high degree of Olivine fractionation.

Data plots over AFM diagram (Irvine Baragar, 1971) indicate tholeiitic nature of all dyke samples (Fig 3). Bivariate data plots MgO and other major oxides (Figs.), indicate that the Villupuram dolerite dykes negative correlated with MgO Vs K_2O, P_2O_5 and positive correlation with Al_2O_3, Fe_2O_3 and Na_2O. It is important to note that the Na2O content in these dykes is reatively high. However, K_2O is relatively low, showing fractionation of low-theleiites.

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They also contain low MgO. The amount of fractionation required to reach at a given MgO level is dependent upon the fractionating assemblages, which differs from suite to suite (Thirwall et al. 1994). In case of these dykes, presence of more or less similar MgO contents, pointing towards analogus fractionation of the parental magmas. Fe_2O_3 andTiO_2 display a negative relation with MgO suggesting accumulation of accessory Fe – Tioxides. (Fig.3). The concentrations of TiO_2, Y and Mg number act as monitors of fractional crystallization and Ba, Rb, K_2O and SiO_2 contents are normalization to allow for the fractional crystallization effects. The alkaline magma at relatively low pressures tends to evolve away from the low-pressure thermal divide, whereas sub-alkaline melt fractionates more toward SiO_2 enriched compositions. Therefore, variation in SiO_2 with respect to oxides and some selected trace elements would help to understand geochemical differences amongst these dykes. On SiO_2 Vs. major oxide diagram (Fig.4) the data plots show positive correlate with CaO and Na_2O and negative correlation with TiO_2, Al_2O_3, MgO and Fe_2O_3. In these dykes low concentration of Rb, Ba and V indicate that these are less crustal contaminated (Fig.4)

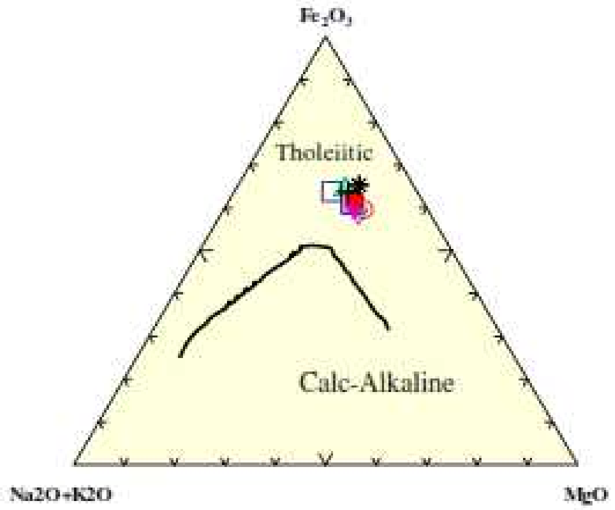

Fig.3 AFM diagram in term of alkalies (Na_2O+K_2O), Fe_2O_3 and K_2O. Solid line separates field of tholeiitic rocks from calc-alkaline rocks (Irvine and Baragar, 1971)

The Zr is a highly excluded high field strength element (Barker et al., 1983), increase constantly during fractionation of the olivine, pyroxene or plagioclase. Data plots (Fig) between Zr Vs. Nb, Y, Rb show negative correlation indicates high concentration of Zr and Sr show positive correlation it reveals that these dykes contain high concentration Sr.

The low MgO content in the Villupuram dolerite dykes is suggestive of their origin from an evolved magma type. Increase in the Al_2O_3 and Na_2O with rise in the SiO_2 contents signifying pyroxene and plagioclase fractionation. Presence of highly calcic-pyroxene in the dykes demonstrates relatively slow cooling of magma in a close system. Low values of Rb and Ba in Villupuram dykes confirm their low K-tholeiitic nature. Low Ti values for black granites representing less fractionation of Fe-Ti oxides.

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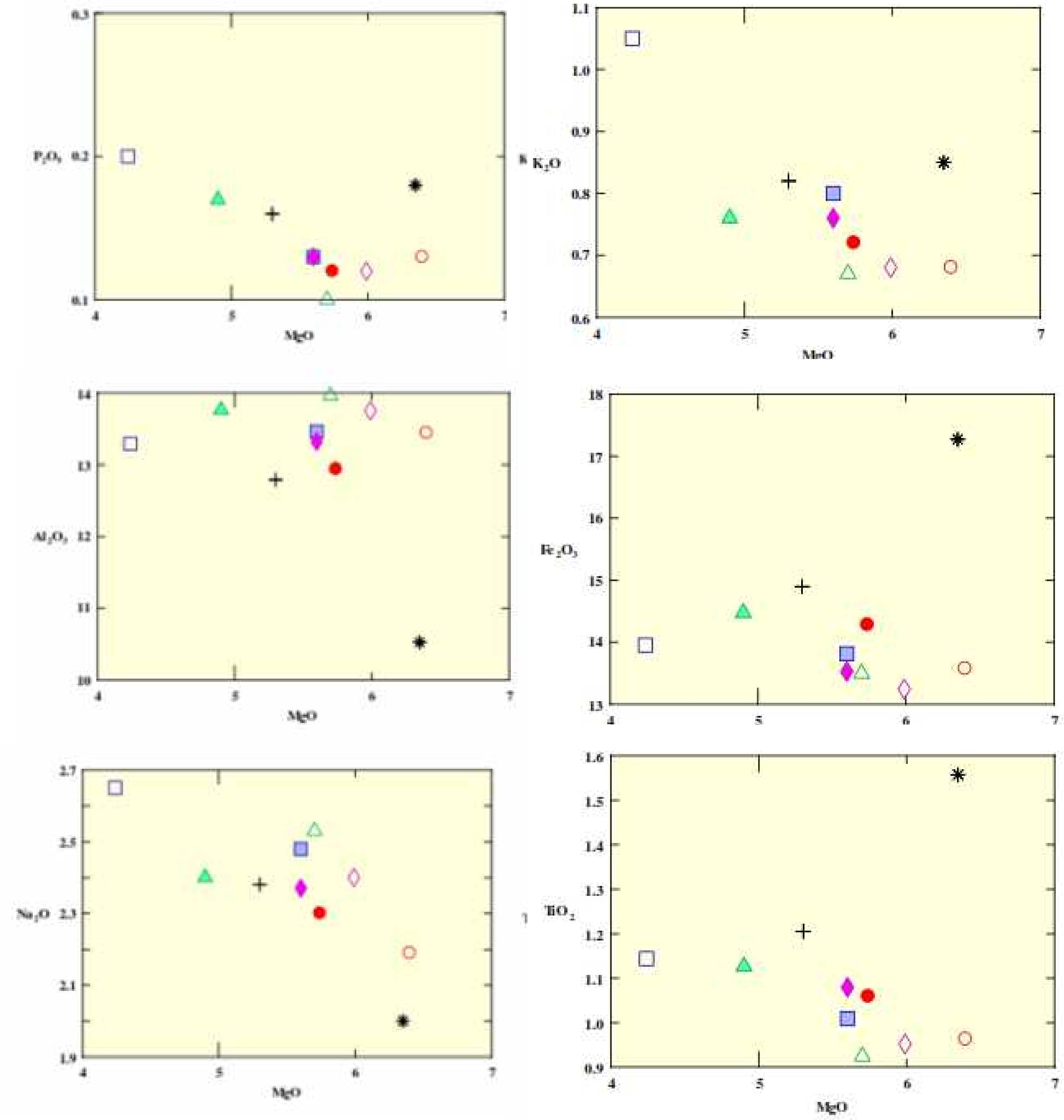
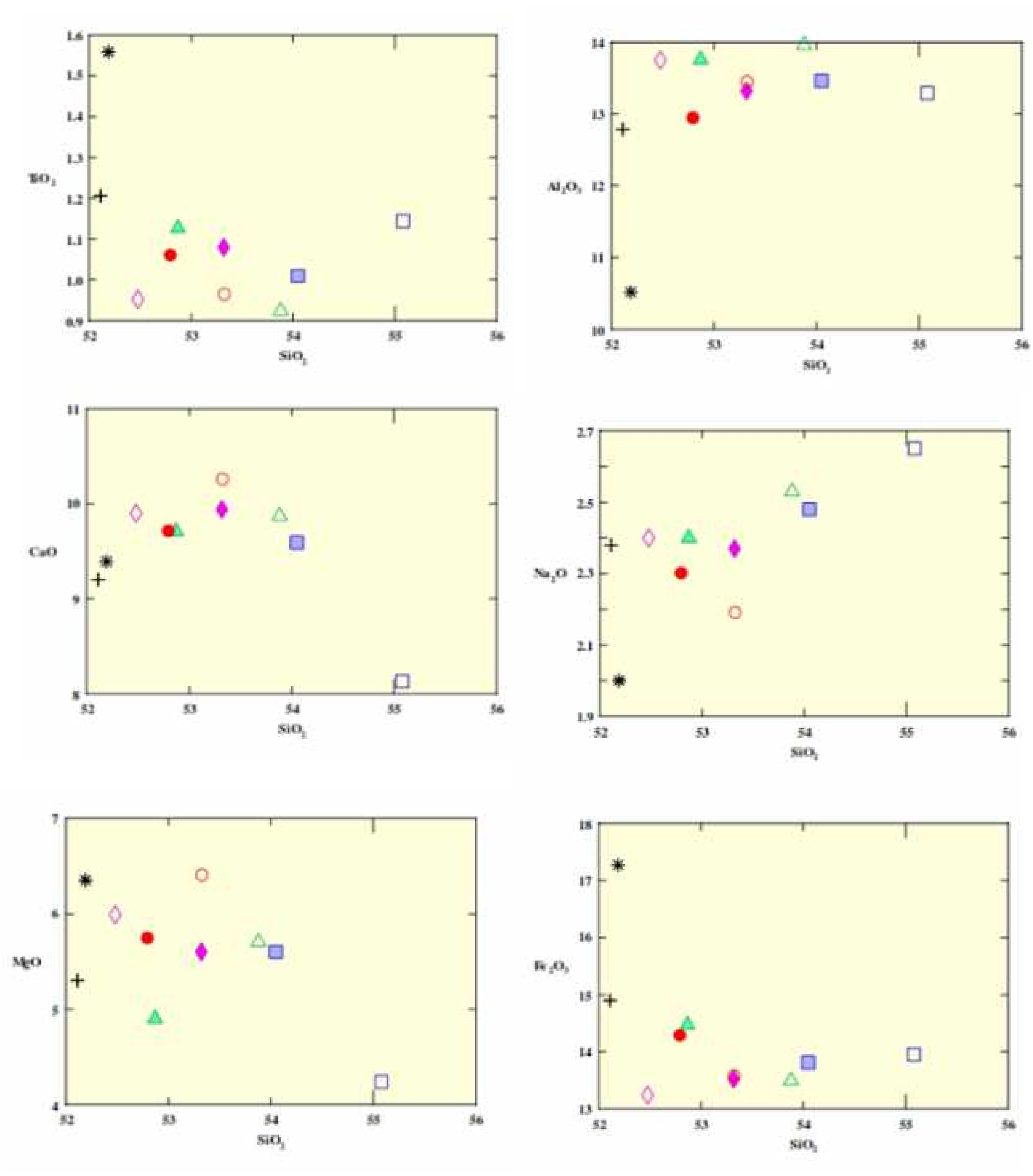
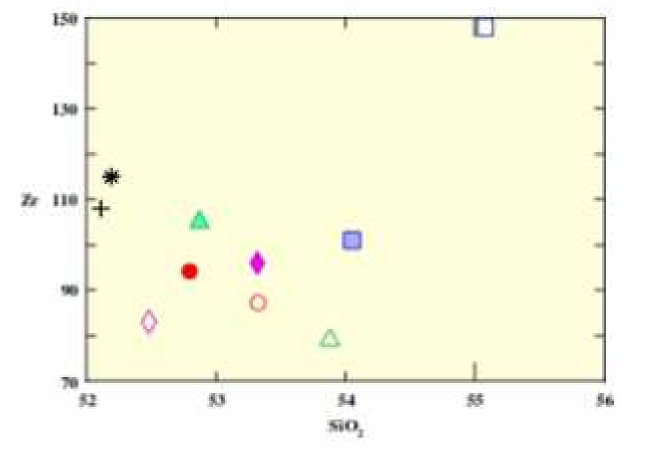
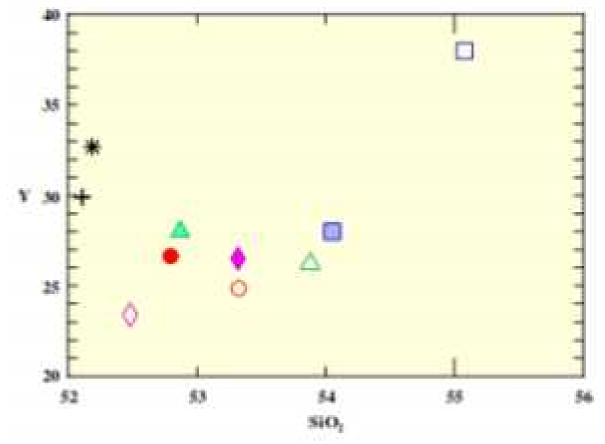
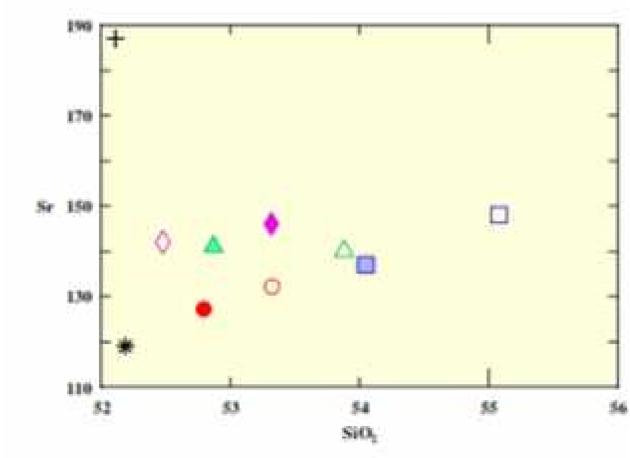
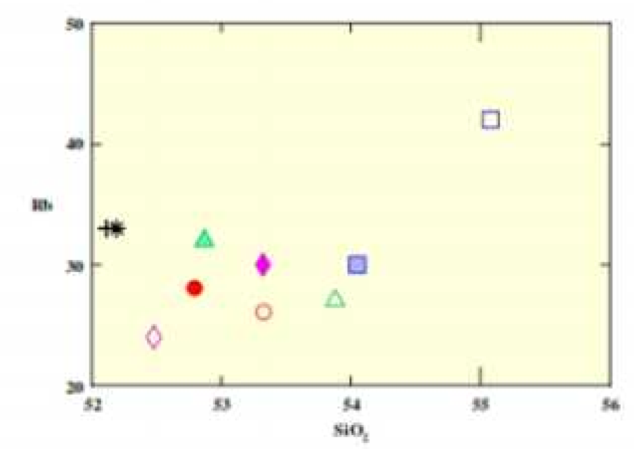

P2O5
MgO
K2O
MgO
Al2O3
MgO
Fe2O3
Na2O
MgO
TiO2
MgO


TiO2
SiO2
Al2O3
SiO2
CaO
SiO2
Na2O
SiO2
MgO
SiO2
Fe2O3
SiO2
52 53 54 55 56


Zr
150
130
110
90
70
52
53
54
55
56
SiO_2


Y
40
35
30
25
20
52
53
54
55
56
SiO_2


Sr
190
170
150
130
110
52
53
54
55
56
SiO_2


Rb
50
40
30
20
52
53
54
55
56
SiO_2

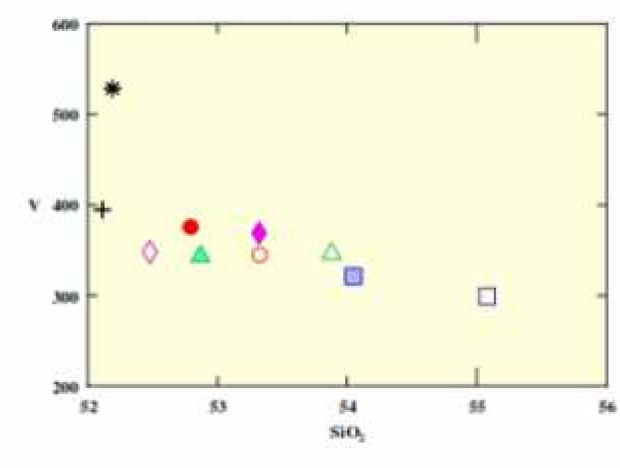

V
600
500
400
300
200
52
53
54
55
56
SiO_2

Table.1 Major oxide composition and Mg# of Gingee basic dykes

Sample	SiO_2	Al_2O_3	Fe_2O_3	MnO	Mgo	TiO_2	CaO	Na_2O	K_2O	P_2O_5	LOI	Total	Mg.No
G1	53.88	13.96	13.49	0.195	5.7	0.924	9.87	2.53	0.67	0.1	-0.38	100.9	29.70
G2	52.87	13.76	14.47	0.19	4.9	1.126	9.71	2.4	0.76	0.17	-0.49	99.87	25.30
G3	55.08	13.29	13.95	0.195	4.24	1.144	8.13	2.65	1.05	0.2	-0.41	99.53	23.31
G4	54.05	13.46	13.81	0.2	5.6	1.009	9.59	2.48	0.8	0.13	-0.44	100.7	28.85
G5	52.48	13.75	13.24	0.186	5.99	0.952	9.9	2.4	0.68	0.12	0.42	99.27	31.15
G6	53.32	13.32	13.52	0.185	5.6	1.079	9.94	2.37	0.76	0.13	0.36	100.6	29.29
G7	53.33	13.44	13.57	0.199	6.4	0.963	10.25	2.19	0.68	0.13	-0.53	100.6	32.05
G8	52.8	12.94	14.28	0.205	5.74	1.059	9.71	2.3	0.72	0.12	-0.46	99.42	28.67
G9	52.11	12.79	14.9	0.204	5.3	1.205	9.2	2.38	0.82	0.16	-0.6	98.46	26.24
G10	52.19	10.52	17.27	0.231	6.35	1.558	9.39	2	0.85	0.18	-0.71	99.82	26.88

Table 2.Trace element composition of Gingee black granites

Sample	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr	Y	Zr	Nb	Mo	Ag	In	Rb/Nb	Sn	Sb	Cs	Ba	Hf	Ta	W	Tl	Pb	Bi	Th	U
G1	41	1	346	40	44	70	130	100	18	1.5	5	27	140	26.2	79	2.9	2	0.5	0.1	9.31	1	0.2	0.8	207	2.1	0.21	0.5	0.09	5	0.1	2.03	0.71
G2	38	1	343	30	42	60	170	80	19	2.9	5	32	141	28	105	8.6	2	0.5	0.1	3.72	1	0.7	1.3	265	2.6	0.25	0.8	0.12	5	0.1	4.02	0.81
G3	37	1	299	20	41	50	170	100	20	2.7	5	42	148	38	148	8.4	2	0.5	0.1	5	2	0.2	1.6	326	3.5	0.35	0.9	0.15	5	0.1	4.72	1.12
G4	42	1	321	40	43	70	140	120	17	2.9	5	30	137	28	101	5.8	2	0.5	0.1	5.17	1	0.3	1.2	248	2.6	0.23	0.8	0.11	5	0.1	3.36	0.74
G5	40	1	348	120	42	90	150	70	17	2.5	5	24	142	23.4	83	5	2	0.5	0.1	4.8	1	0.2	0.9	224	2.1	0.22	0.7	0.1	5	0.1	2.57	0.91
G6	43	1	369	50	44	80	150	80	18	2.7	5	30	146	26.5	96	4.8	2	0.5	0.1	6.25	1	0.3	1.1	244	2.4	0.22	0.8	0.12	5	0.1	3.05	0.78
G7	43	1	344	140	44	100	150	80	16	2.8	5	26	132	24.8	87	5.7	2	0.5	0.1	4.56	1	0.3	1	219	2.1	0.36	0.8	0.09	5	0.1	2.67	1.77
G8	43	1	375	50	45	80	160	90	17	2.6	5	28	127	26.6	94	4.2	2	0.5	0.1	6.67	1	0.2	1.1	224	2.3	0.2	1	0.1	5	0.1	2.89	0.71
G9	43	1	395	60	45	70	180	100	18	2.6	5	33	187	29.9	108	4.6	2	0.5	0.1	7.17	1	0.2	1.2	258	2.7	0.23	1	0.12	5	0.1	3.07	0.87
G10	52	1	529	140	54	100	260	120	17	2.8	5	33	119	32.7	115	4.9	2	0.5	0.1	6.73	1	0.4	1.2	288	2.8	0.24	0.8	0.13	5	0.1	2.98	0.76

4.CONCLUSIONS

Villupuram dolerite dykes show increase in sub alkalis (K_2O+Na_2O) with increase in the SiO_2 content, indicate fractional crystallization. According to IUGS classification the study area dyke samples are falling within the basaltic andesite field. On SiO_2 Vs. major oxide diagram (Fig.4) the data plots show positive correlate with CaO and Na_2O and negative correlation with TiO_2, Al_2O_3, MgO and Fe_2O_3. In these dykes low concentration of Rb, Ba and V indicate that these are less crustal contaminated (Fig.5). Low values of Rb and Ba in studied samples confirm their low K-tholeiitic nature. Low Ti values for black granites representing less fractionation of Fe-Ti oxides

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