Ultrapotassic rocks from Carbonatite Complex of Tiruppattur, Tamil Nadu, India

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Abstract: *Ultrapotassic rock occurs volumetrically minor in the carbonatite complex of Tiruppattur (N12° 15-30' E78° 25'-30'), Tamil Nadu, India. The rock occurs as a small plug and dyke. It is composed of >40% normative foids against k-feldspars. However, no feldspathoids are seen in this rock. Field and petrographical features reveal that a discontinuous continental half graben rift zone (>3000x>200km) caused fragmented segments from Arunachal Pradesh to Tamil Nadu extending several tens of km depth below which numerous hairline fractures might have been developed up to mantle. Deep extension of such hairline fractures into mantle of shonkinite / phlogopite-pyroxenite might have been subjected a low degree of partial melting. The melt has been raised and filled in an intermittent magmatic chamber and has been resulted to continuous differentiation and fractionation leading to successive serial order of emplacements of co-magmatic alkali syenites and carbonatites in two adjacent Sevvattur basin and Jogipatti basin. In middle of continuous magmatic activities in serial order in Sevvattur basin, the Jogipatti basin might have been uplifted, rotated and shifted to series of continuous emplacements of potassic syenites in it. Shonkinite dyke occurs at contact between ultrabasic rock and granite gneiss. A large body of an arc like Mg-Al rich lamproite (phlogopite-pyroxenite) exposes in southwestern part of the basin. It has similar trace-element content to ultrapotassic rock which is enriched with lithophile elements, PGE, Au, Ag, Mo, Cu, Zn, Cr, Ni, Pb, REE, F, CO_2 and SO_3. Ultrapotassic rock is an exploration tool for several mineral deposits.*

Keywords: Ultrapotassic rock, melanite-microcline syenite, shonkinite, phlogopite-pyroxenite, lamproite.

1. INTRODUCTION

Ultrapotassic rock is classified when molar contents of bulk rock composition of $K_2O/Na_2O>3$ [1]. Wide spread global geochemical characterization weight percent of composition K_2O/Na_2O >1 is potassic rock and it exceeds over K_2O/Na_2O >2 is discriminated as ultrapotassic rock [2]. There exists vast geochemical difference by using these two factors [1, 2] for interpreting data (Tables 1, 2, 3 for the alkali complex of Tiruppattur). It is most intriguing and perplexing problem in solving petrogenesis of the rocks. Detailed structural tectonic and petrographical studies might have been shed light on tectonic setting of this complex. The data for ultrapotassic rock emplaced in Jogipatti basin is extremely high in molar content of $K_2O/Na_2O>3$ and wt% $K_2O/Na_2O>2$. It occurs in southwestern end of the area (Fig. 1- 4).

2. METHODOLOGY

Most wet-gravimetric chemical analyses of rock samples were carried out between 1967 and 1973 by the author for his Ph.D. work [3] in geochemical laboratory of the Presidency College, Chennai. Some were carried out by geochemists of geochemical laboratory, Moscow State University, Russia. Additional analyses were carried out in the geochemical laboratory in the Department of Geology and Mining, Chennai. Field and laboratory studies were carried out for the past 40 years. Rittmann's norms were calculated for these rocks [4] and included in these tables.

3. FIELD STUDIES

Figs.1 to 4 is prepared based on textural and mineralogical variation present in rock in the field. The ultrapotassic rock is very fine-grained white colored rock showing vitreous glossy texture. It was mined for building stone till 1970, latter mining was banned. It is found at contact between Mg-Al rich phlogopite-pyroxenite (lamproite) and garnet sanidine syenite. Vermiculite pockets are seen in ultramafic rock in Sevvattur and in Jogipatti basins. Field and petrographical studies reveal that alkali syenites associated with carbonatites are subjected to prolonged process co-magmatic differentiation, fractionation and sequential emplacements in serial order by tectonic setting in the two adjacent structural basins [5-9].

The Sevvattur basin is comprised with sequences of porphyritic oligoclase syenite which rimmed with massive fine-grained hornblende / augite syenites. In inner portion feldspar platelet of maximum size 10x8x1 cm is seen. It exhibits normal zoning (an_{28-24} ab_{72-76}) [3-9]. Such zoning is visible to naked eye. Cumulates of feldspars and mafic minerals show magmatic flow orientation. The grain size of mafic and feldsic minerals increases towards south. Further, hornblende has imperceptive gradation into augite enriched with sodium content. Thin veinlets of acmite-magnetite-quartz syenite are seen in syenite bodies. In this basin, younger syenites are found sequentially in inner portion.

The southwestern Jogipatti basin is relatively younger, uplifted, rotated [10-20] and shifting with sequential emplacements co-magmatic series of rocks. A serial order of co-magmatic miarolitic riebeckite potassic pegmatite-aplite, scapolite-wollastonite aplite, garnet sanidine syenite, melanite-microcline ultrapotassic syenite and zircon syenite are seen. Riebeckite-richterite sovite, garnet sovite, beforsite, ferro-carbonatite, benstonite carbonatite, magnesite, barite and apatite-ilmenorutile veins are seen in Mg-Al rich lamproite. Ring dyke of carbonatite is seen emplaced amidst syenites at the center of the basin near Jogipatti village [3-5].

The syenites and carbonatites are enveloped by an arc of ultramafic rocks steeply plunging inwards inner sides of the basins. The ultramafic rocks include members of kimberlite, lamproite, phlogopite-pyroxenite, porphyritic-pyroxenite, cavernous pyroxenite, ilmenorutile-pyroxenite, peridotite and dunite [21-31]. Apatite-ilmenorutile veinlets 100x10x5 cm extending from 3 to 5 m length are found about 1 km SW of Onnakarai village. Ultramafic rocks have barite, benstonite and carbonatite veinlets. An arc like skarn is seen at the contact between alkali syenite and phlogopite-pyroxenite and numerous folded [22] ultra basic nodules varying in sizes from >1cm to >30cm are seen in the skarn rock Thin veins of calcite (>1mm width) alternatively is released from ultramafic rock . Over turned folded ultramafic nodule is comprised with ellipsoidal or spherical tightly folded dome and swelled basin. Native Cu, Ag, galena, bornite, sphalerite, phyrrhotite, pyrite, covellite, chalcocite, malachite, and azurite are seen on the broken surfaces of such nodules.

Coarse-grained garnet wollastonite syenite and fine-grained garnet bearing aplite are seen within syenite complex. In wollastonite rock, wollastonite and para-wollastonite syenite occur together [3]. Syenites vary in bulk chemical composition from potassic to ultrapotassic in Jogipatti basin. They are enriched with sanidine / anorthoclase and high temperature maximum microcline (ferrian feldspar) as essential minerals. The accessory minerals are zircon, magnetite, phlogopite, richterite, magnesioriebeckite, garnet, scapolite and wollastonite. Veins of garnet syenite in Sevvattur basin has lower K_2O/Na_2O content than garnet-sanidine syenite in Jogipatti basin. A small body of zircon syenite occurs 1 km SW of Samalpatti village is a potassic syenite having euhedral metamict zircon as essential accessory mineral and sanidine as essential mineral.

These two basins set amidst in Alangayam rift- zone spreading hundreds of km in NE-SW towards Arabian Sea on length and width of tens of km NW-SE [11]. The rift zone crosscuts a major Precambrian paleo-rift system extending >3000 km in length and >200 km width intersecting NE-SW and N-S rift zones extending to Cap Comorin [5, 10]. The deep narrow fracture might have been produced hairline fractures below faulted segments of several tens of meters down to the Earth to release pressure causing low degree of partial melting of mantle source. Shonkinite / phlogopite-pyroxenite might have been present at that mantle source as they occur in the field. The low degree of partial melt appears to be filled in an intermittent cavity large enough to be a magmatic chamber where the melt might have been differentiated and fractionated into different series of alkaline magma, periodically emplaced in sequential order in these basins. The reactivations of Precambrian rift system might have been continued by effusions of carbonatitic lava and ash flows and silicate perovskite directly from mantle source lying below 2000 km during Early Pleistocene in Tamil Nadu [13-20] and continual reactivations till Recent.

4. PETROGRAPHY AND GEOCHEMISTRY

Syenites having molar (K+Na/Al >1.2 exhibits agpaitic texture due to formation of early crystallization of feldsic minerals before the crystallization of melanocratic minerals [32]. The molar ratio (K+Na /Al < 1.2 is miaskitic rock in which mafic mineral crystallize earlier than feldspars.

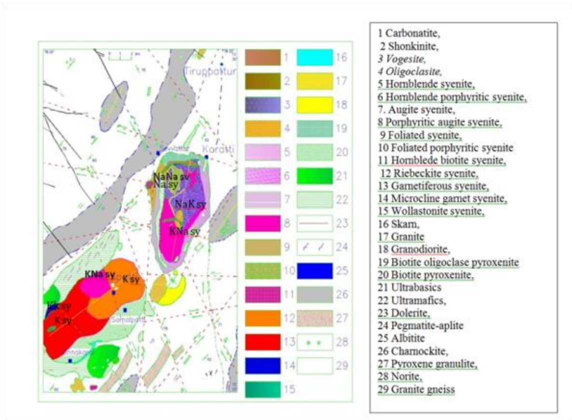


Fig. 1 Simplified geological map of carbonatite-alkaline complex, re-classified on the basis of bulk chemical composition. N-S trending ultrapotassic rock occurs in SW corner of the map [1, 2, 3].

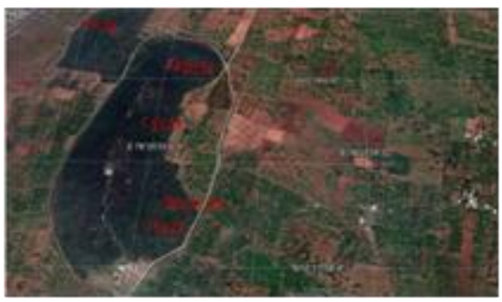


Fig.2 Field exposure of ultrapotassic rock is seen north of coarse-grained garnet syenite.

Fig. 3- Field exposure a) ultrabasic rock b) skarn rock carrying ultrabasic nodules c) A nodule.

Additional information on field and petrographical studies can be obtained on some publications [20-31]

Some alkali syenites (K+Na /Al < 1.2 too show agpaitic texture [32]. The environment of crystallization, open or closed magmatic crystallization, viscosity, volatile content and proportions of salic and mafic constituents play critical role in the formation of agpaitic mineralization. However, the above molar ratio is not the only criteria for agpaitic / miaskitic rock. Petrography, volatiles, F, Cl, solubility and geochemistry of rocks, considerably modify agpaitic index. Fluid inclusion studies in feldspars in syenites, calcite and apatite in carbonatites show that these minerals have CO_2, liquid CO_2 and saline waters [21] reduce agpaitic index of potassic rocks, producing agpaitic texture. Rocks occurring in Sevvattur basin (Table 1) and Jogipatti basin (Table 2a and 2b) show wide variation in agpaitic indices but with common co-magmatic differentiation trend. The early crystallization of feldsic mineral (agpaitic) before mafic minerals results textural changes. Most feldspar is surrounded by late formed melanocratic minerals [7, 32]. Rocks are soda rich in Sevvattur basin and potash rich in Jogipatti basin.

Fig. 5 shows positive linear trends of differentiation between ions of Al vs Si; Na vs Ca; and Ox^o vs (Na+K) where Ox^o is equal to $=Fe^3/(Fe^3+Fe^2+Mn)$. Negative correlations are seen in K vs Na ions and Foids vs K-feldspars. However, developments of foidal minerals are dominant only during early crystallization with positive linear variation in Sevvattur basin. K-feldspars in some rocks illustrate negative correlation in Jogipatti basin. Extreme silica deficiency in differentiated residual magma, consumes more k-feldspars and albite reducing weight proportion of k-feldspars and albite [4] by increasing of normative foids in rocks of Jogipatti basin. Progressive increases of Ox^o indicate, increase of water pressure at late magmatic differentiation in a closed magma chamber. Subsolidus (metastable) foidal minerals may be converted to equivalents of feldspars by increasing water pressure.

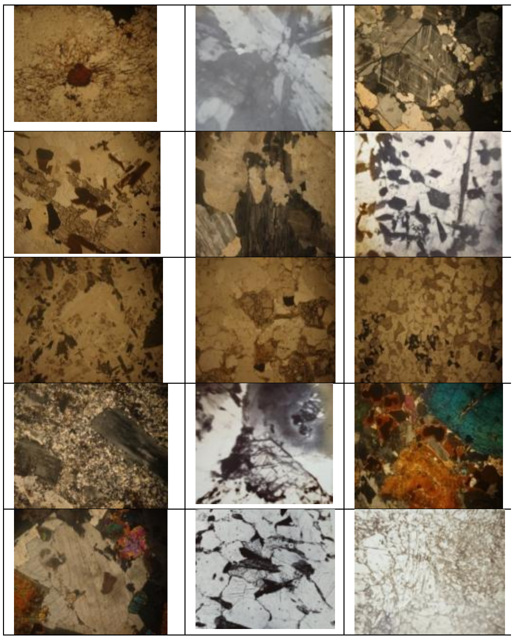


Fig.4- Microphotograph 1 to 6 represent rocks in Sevvattur basin and 7 to 15 represent in Jogipatti basin.

1. Albitite shows expansion cracks around Na-pyrochlore, 2. Sheath growth of oligoclase from a common centre is seen in oligoclasite 3. Quartz bearing oligoclase syenite has complex twinning lamellae in oligoclase 4. Porphyritic oligoclase plates carrying small grains of mafics in hornblende-biotite speckled syenite 5. Porphyric platelet of oligoclase (10x5x1 cm) carries inclusions of euhedral oligoclase grown at different orientations and directions indicate prolonged magmatic crystallization. The mottled augite grain is rimmed by sodium augite. 6. Euhedral prisms and needles are seen in K-rich katophorite in matrix of oligoclase exhibiting panidiomorphic texture. 7. Phenocryst of anorthoclase shows more than one generation of feldspars surrounded by phlogopite and magnesioriebeckite. 8. Grossular-andradite garnet develops at the intergranular boundaries of plates of sanidine. Wollastonite prism is a common accessory mineral. 9. Granular melanite (>1mm), phlogopite flakes and magnetite are developed at interstitial spaces around inequigranular platelets of maximum microcline. It is an ultrapotassic syenite. 10. Large phenocryst of normally zoned oligoclase in fine-grained matrix of an aplite shows poikilitic texture. 11 A large flake of phlogopite carrying a metamict zircon producing radioactive haloes from core to periphery. Euhedral olivine, aegirine-augite and sanidine are essential minerals in shonkinite. 12. Shonkinite shows panidiomorphic texture. Growth zones are seen at peripheries of augite and amphibole. Development of very fine-grained sanidine (second generation) is seen at the intergranular boundaries of mafic minerals in shonkinite. 13. Interpenetration twin of sanidine is filled with cloudy-dusts of iron oxides in shonkinite 14. Flakes of phlogopite and iron oxides (nioborutile) are seen along intergranular spaces of pyroxene grains in a

pyroxenite. 15. Development of large inequigranular grains of pyroxenes produce a porphyritic texture in pyroxenite [20-31].

Table 1 Wet-gravimetric analyses of some rocks present in Sevvattur basin.

Sevvattur	1	2	3	4	5	6	723	1122	463	461	458	476	43	110	733
SiO2	63.05	63.54	61.26	62.22	59.99	62.68	48.35	50.28	64.24	60.87	54.37	58.16	61.25	62.22	53.07
Al2O3	22.39	22.27	20.91	20.98	20.87	19.41	12.97	23.25	14.74	14.09	5.3	17.98	20.76	20.98	13.03
Fe2O3	0.43	0.74	0.89	1.14	0.74	1.17	3.78	5.54	2.84	0.32	19.84	2.88	1.78	1.14	4.28
FeO	0.28	0.27	0.53	0.28	0.28	0.13	3.26	2.96	2.02	2.62	1.95	2.7	0.28	0.28	5.09
MnO								0.36	0.83	0.4	0.52				
MgO							2.68	3.82	1.13	2.51	0.98	1.87	0.01	0.01	3.75
CaO	0.67	0.75	1.1	1.44	1	0.93	12.91	5.6	4.93	4.14	2.5	5.98	1.98	1.44	11.75
Na2O	8.55	8.55	4.67	4.54	4.86	9.07	3.54	2.08	3.34	8	11.75	3.69	10.62	4.54	4
K2O	4	2.86	8.84	9.07	8.66	3.15	5	1.8	0.62	2.57	0.8	4.7	0.65	9.07	3.93
TiO2							0.75	0.9	0.62	0.2	1.5	0.65	0.01	0.01	0.69
P2O5							1.06	0.6	0.52	1.81	0.36	0.82	0.01	0.01	0.48
K2O/Na2Owt%	0.47	0.33	1.89	2.00	1.78	0.35	1.41	0.87	0.19	0.32	0.07	1.27	0.06	2.00	0.98
K2O/Na2O mol	2.73	1.95	11.05	11.66	10.40	2.03	8.25	5.05	1.08	1.88	0.40	7.44	0.36	11.66	5.74
cc										1.32					
ap							2.42	1.35	1.13	3.81	0.74	1.79			1.26
il							1.09	1.42	0.95	0.33	2.17	0.89			0.99
mt	0.21	0.22	0.35	0.44	0.45	0.8	1.51	1.23	0.83	0.94	0.91	1.12	0.43	0.61	1.93
sil	4.33	5.98	2.08	1.59	2.7				1.07						
ol	0.43	0.75	0.66	0.82	0.45	1.53	11.25						1.46	0.61	14.36
hy								23.23	9.77		2.74	10.18			
ac										5.74	56.1				
ns										1.27	3.93				
wo						0.68	22.73					2.24	1.08		19.37
or/san	44.01	21.86	55.78	52.91	52	80.45	44.56	15.48	2.32	26.20	4.45	47.99	87.15	83.98	39.3
pl	43.96	69.41	37.18	39.95	37.66	4.2	3.81	46.45	56.38	55.65	25.2	31.99		11.44	16.84
ne	7.06	1.78	3.94	4.29	6.75	5.97	12.64						9.87	3.37	4.95
lc						6.36									
ks															
qz								10.84	17.53	4.74	3.76	3.9			

Table 1 represents chemical compositions of rocks in Sevvattur basin.

Table 2 Wet-gravimetric analyses of syenites in Jogipatti basin

Jogipatti	54	110	77	12	13	14	15	219	36	3	340	349	85	541	360
SiO2	58.92	53.43	54.25	51.94	54.60	62.69	64.72	55.02	51.75	38.09	61.82	58.98	63.75	64.01	59.78
Al2O3	19.14	19.31	22.99	22.27	23.21	20.15	19.05	18.75	19.67	5.17	16.90	16.20	13.01	15.44	18.27
Fe2O3	1.89	5.94	2.83	3.53	4.05	0.21	0.00	2.17	3.26	1.05	0.61	2.51	1.98	2.44	1.32
FeO	0.56	0.28	0.56	0.41	0.55	0.14	0.00	0.36	0.08	14.10	0.34	2.72	0.65	0.25	1.14
MnO				0.14	0.16			0.03	0.10	0.18	0.02	0.12		0.40	0.07
MgO								1.24	0.58	14.18	0.49	2.22	2.59	1.62	1.21
CaO	1.20	7.58	2.12	4.50	5.70		0.19	4.47	3.65	15.52	2.06	5.15	0.89	0.21	5.61
Na2O	1.09	2.35	2.44	0.92	1.93	1.43	1.04	3.31	0.21	0.23	0.27	6.75	5.21	4.04	5.40
K2O	14.68	7.72	12.05	13.54	8.84	15.06	14.36	10.32	14.60	3.44	16.80	3.48	9.98	9.15	6.78
TiO2								0.28	0.64	1.66	0.09	0.56	0.10	0.14	0.20
P2O5									0.13	3.69		0.17	0.40	0.22	0.17
K2O/Na2Owt%	13.47	3.29	4.94	14.72	4.58	10.53	13.81	3.12	69.52	14.96	62.22	0.52	1.92	2.26	1.26
K2O/Na2O mol	7.86	1.92	2.88	8.59	2.67	6.15	8.06	1.82	40.59	8.73	36.33	0.30	1.12	1.32	0.73
cc															
ap									0.32	7.65		0.28	0.87	0.28	0.27
il								0.46	1.03	3.85	0.11	0.77	0.11	0.22	0.33
mt	0.73	0.61	0.96	1.14	1.13	0.11		0.63	0.9	1.93	0.28	1.43	0.7	0.84	0.65
sil			3.39		0.11	2.43	2.43								3.26
ol	3.21	0.61	2.2	2.57	3.43	0.28		4.12		57.98	1.02	7.7			4.02
hy														4.39	
ac										3.74	1.59		4.33	4.72	
ns											0.17		8.55	0.17	
wo				2.29				6.18			4.2	8.36	0.65		10.54
or/san	75.23	86.98	62.6	30.21	53.95	91.21	95.42	68.92	83.28	12.94	87.63	42.79	69.03	85.21	72.66
pl	8.39	11.44	5.48	16.99	35.9			3.61				35.04			
ne	5.91	3.37	13.39	5.15	5.57	5.97		16.08	1.35			3.63			8.26
lc	6.53		11.98	41.65					13.12	11.89	4.99				
ks															
qz							2.15						7.2	4.16	

Table 2 chemical analyses of rocks in Jogipatti basin.

Table 3 *Wet-gravimetric analyses of syenites in Jogipatti basin*

Jogipatti	361	318	319	572	39	78	79	86	561	736	990	7
SiO2	56.84	52.92	41.26	44.84	52.28	51.94	54.60	62.69	49.20	52.40	3.24	63.64
Al2O3	15.69	12.98	3.65	11.35	19.59	22.27	23.21	20.15	7.61	12.26	0.94	21.76
Fe2O3	2.37	5.31	10.18	12.14	2.82	3.53	4.05	0.21	6.40	2.99	2.30	0.31
FeO	3.02	1.80	8.26	0.50	1.73	0.41	0.55	0.14	5.58	6.75	0.41	0.17
MnO	0.17	0.11	0.29	0.40	0.13	0.14	0.16		0.36	0.02		0.44
MgO	1.73	3.21	9.67	0.70	0.25	0.01	0.01	0.01	10.43	6.01	1.06	0.78
CaO	7.73	6.18	20.18	19.01	5.15	4.50	5.70	0.01	10.03	8.48	48.43	12.32
Na2O	3.24	2.03	0.41	3.95	0.14	0.92	1.93	1.43	3.44	3.11	2.30	0.13
K2O	6.96	11.76	1.20	4.98	17.16	13.54	8.84	15.06	4.29	4.26	0.50	0.04
TiO2	0.50	1.09	1.48	0.40	0.56	0.01	0.01	0.01	0.76	0.99	0.20	
P2O5	0.47	0.46	0.73	1.20	0.13	0.01	0.01	0.01	0.82	1.53	1.48	
K2O/Na2Owt%	2.15	5.79	2.93	1.26	122.57	14.72	4.58	10.53	1.25	1.37	0.22	0.35
K2O/Na2O mol	1.25	3.38	1.71	0.74	71.56	8.59	2.67	6.15	0.73	0.80	0.13	0.20
	361	318	319	572	39	78	79	86	561	736	990	7
cc											85.16	
ap	1.07	0.88	1.61	2.58	0.28				1.78	3.19	2.88	
il	0.68	1.54	2.27	0.57	0.78				1.12	1.3	0.31	0.1
mt	0.96	1.76	2.15	2.75	1.34	1.2	0.68	0.11	2.57	1.3	0.26	0.1
sil							0.11	2.48				
ol	7.94	10.52	38.64	10.26	3.01	2.63	4.21	0.28	26.21	8.87		1.09
hy										17.53		
ac		10.35		2.29					11.82		5.55	
ns		2.31						2.03			3.08	
wo	11.04	11.01	39	35.64	9.37	2.29			17.74	9.63		0.1
or/san	63.27	28.63	11.6	7.45	6.25	32.97	65.32	91.2	34.58	40.75		
pl	13.92		4.55		1.39	14.17	21.81	1.86		17.42		85.19
ne	1.13	0.83	0.18	20.11	0.84	5.14	7.86	2.03	4.18		1.08	13.4
lc		32.16		18.34	76.74	41.6						
ks											1.69	
qz												

Table 3 Additional chemical analyses fir the rocks in Jogipatti basin.

Yagi has explained geological setting of magmatic differentiation trend of both quartz bearing alkali syenites in association with silica-undersaturated syenites existing together in field [33].

Fig. 6 shows that potassic and ultrapotassic rocks belong to lamproite to Roman Igneous Province [2]. CaO vs SiO_2 represent rocks in Group I. It is related to continental rifting followed by hairline fractures extending to mantle source causing low degree of partial melting of lamproite normally producing alkaline Group I. Ultrapotassic rocks are derived from deep seated mantle source having lower CaO and higher SiO_2. The range of silica contents may be due to partial melting at variable depth. Fractures and hairline fractures by continental rifting / divergent plate margin would have been produced Group I rocks. Group II rocks have low SiO_2 and high CaO content [2]. Group III occur in orogenic belts / Island arc / subducted slabs in which higher degree of partial melting producing calc alkaline series. Such type of partial melting may have been produced Group III rocks [2]. Crystallization of olivine, pyroxene, acmite, amphibole, biotite (phlogopite), magnetite, carbonates and sulphates, silica is added to residual magma. In addition to this increasing degree of oxidation ferric iron and alkalis are added to end stages of magmatic crystallization [33].

Mg and Al rich lamproite has essential constituents of tschermakite molecule, jadeite and phlogopite. During uplift tschermakite molecule or jadeite break down into silica undersaturated metastable plagioclase (anorthite albite solid solution series).

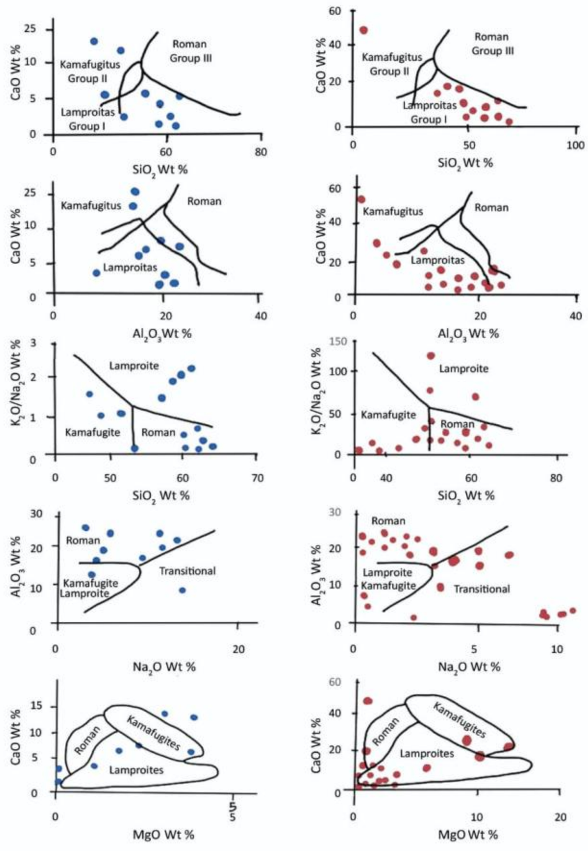


Fig. 6- Tectonic setting of alkali rocks in Sevvattur and Jogipatti basins.

Tschermak's molecule is an important end member in pyroxene group in which Al dominates in M1 and T sites. Al content of pyroxene decreases during decreasing PTX condition..

Low Pressure = High Pressure

Olivine = Hypersthene +Quartz

Anorthite = Tschermakite molecule +Quartz

Albite = Jadeite + Quartz

Nepheline + Albite = 2 Jadeite

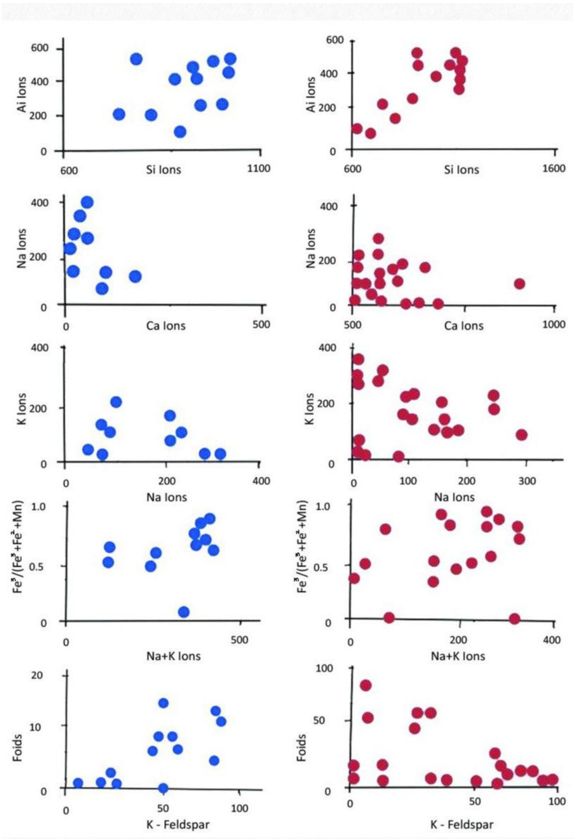
Anorthite = Tschermakite mol. +Quartz

4Anorthite+6Hypersthene= Tst +2Quartz

4Acmite+6Hypersthene+2Quartz= 2Riebeckite

Leucite+Kalsilite+3 Olivine = 2 phlogopite

These reactions move high pressure to low pressure with inherent temperature from right hand side to left hand side [4]. Low degree of partial melting of source rock or rapid rate of fracturing would have been also leading such reactions. Sillimanite content in saturated norm in ultramafic rock is increased volume content of biotite, spinel, cordierite, corundum and garnet at high PT conditions. At low pressure, metastable



Sevvattur basin Jogipatti basin

Fig. 5- Magmatic differentiation trends for the rocks in Sevvattur and Jogipatti basins.

tschermakite transforms into plagioclase by absorbing quartz from melt. Plagioclase has a solid solution between anorthite and albite. Break down of tschermakite molecules into anorthite might be produced calc alkaline series while jadeite into alkaline series during course of differentiation [21].

Carbonate enriched carbonatites have high LREE, Zr, Nb, Ba and Sr but they have poor contents of base metals. On the other hand hybrid carbonatites rich in melanocratic minerals are enriched with such base metals (Table-4). Ultramafic nodule (497) in skarn rock is relatively enriched with base metals of V, Cu, Zn, Co, Cr, Ni and Pb. Similar is true for lamproite, shonkinite and ultrapotassic rocks (Table 4). The skarn rock and its ultramafic nodule are appeared to be mantle derived metasomatic rock and it is found at the contact between syenite and ultramafic rock. About 10x10x10 cm galena is found in albitite bearing aplite and monazite of 6x4x3 cm is seen in pegmatite adjacent to skarn rock. Thin veins 100x3 cm magnetite bearing fluidal ferro-carbonatite and breccias [22] intersect the skarn rock are seen in one or two places in the skarn rock.. Fluidity of ferro-carbonatite is increased at late magmatic or hydrothermal stages.

5. DISCUSSION

Tectonic setting of igneous rocks is products of partial melting in the upper mantle, subducted oceanic crust, or lower continental crust. Individual igneous suites may be produced exclusively by one such process or may be represented product of more than one operating in concert. Tectonic uplift, magmatic emplacement ultramafic xenoliths incorporated in magma or during upward movements from mantle to crust may be caused changes in PTX leading to subsolidus high or low pressure phase transformation. The low PTX might have been one of the causes for crustal evolution from mantle source. Alumina or alkali concentration in ultramafic rock in mantle, leads to two different trends of subsolidus differentiates at different PTX condition as calc-alkaline and alkaline series. Volatile pressure locally affects by fluid inclusion / bubble is played critical role in mineral phase differentiation at mantle source. No more adequate experiment or field evidence is available to prove that rocks in these basins are differentiated products from subsolidus mantle source.

6. CONCLUSION

By this study it is inferred that different tectonic settings are formed under different environmental conditions of plate tectonic movements [34[. But all have related with faulted segments extending to several tens of km down to the Earth. The depth and degree of partial melting, PTX, rate of wide-opening of fracture, rate of ascending of melt, intermittent filling in a cavity, de-gassing effect,

Table 4. Trace elements distribution in carbonatites and associated alkaline rocks

Trace elenents distribution in carbonatite complex																	
		Ba	Sr	Nb	Zr	La	Ce	Nd	Y	Th	U	V	Cu	Zn	Cr	Ni	Co
carb	sub21	nd	5225	nd	5180	2690	2930	1900	45	140	nd	450					
sevbef	sub22	3570	9700	220	nd	350	1500	450	90	10	110	ns					
sevank	sub23	nd	4250	635	40	280	1860	570	130	30	40	nd					
jogsov	sub24	35	300	nd	10	25	40	10	nd	10	10	10					
garigai	sub25	220	350	nd	20	15	30	nd	nd	10	10	10					
onna	sub26	1159	7795	60	50	290	760	240	105	10	25	40					
sy	sub11	nd	270	740	120	200	650	430	200	50	10		20	20	15		
sy	sub12	2780	1120	15	120	60	nd	30	10	nd	nd		25	104	15		
sy	sub13	nd	955	35	260	70	120	45	30	15	10		20	50	25		
Pxsev	sub1		375		12	10	10	10	10			510					
pxsam	sub2		275		15	10	25	10	10			40					
mipx	sub3		900		30	80	180	50	35								
pxgari	sub4		217		20	10	10					90					
gn	sub32	2321	1424	60	155	55			25	10	10		45	70	10		
sy	sub33	1726	900	60	170	55			30	30	10		20	50	20		
sy	sub34	1945	1120	35	240	60			20	15	10		20	60	15		
ab jogi	sub35	220	30	180	350	20			10	250	100		10	15	35		
or jo	sub36		470		80	10	25	50	50		10		20	20	10		
shon	8	1000	2000		600				15			2000	1000	1000	1000	300	200
	R	600		60	30				10			200	8	100	2000	30	10
hybrid ca	319	200	200		10				8			100	100	100	8	20	30
hybrid ca	320	200			20							60	60	200	8	8	8
hybrid ca	321	2000	2000		8				8			60	30			8	8
Rieb carl	401	200	300	60	8				8			30	8	200	600	30	20
Rieb carl	402	600	100		20							6010	8		100	30	30
Rieb carl	490	100			10				8			10	8		30	10	10
Wo rock	491	300	300		8							60	300	100			8
Ultra nod	497	2000			10							300	100	300	100	60	30
Ultramaf	40	200	100		20				30			60	300	300	600	100	60
	201	3000	300	50	60				10			60	20	100		8	8
	203	6000	2000	100	50				60			100	8	200	100	30	20
hybrid ca	204		300		30				20			200	30	200	200	200	60
hybrid ca	206	600	600		60				60			100	100	100	600	100	60
oligo	219	1000	1000	60	100				10			300	60		30	10	10
J carb	318	4000	1000	20	60				60			100	100	100	200	30	30
Ap-mt ro	460	100	100		8							200	300	100	300	30	30
pyroxenit	789	300			400				10				100	60		60	60
Ultamafic	493		790			170	145	90	950			50			100	175	75
Ultra pot	39	475	2300			880	380	790	2630			315	280	670	320	375	560
Mel sov	990	120	4913		1115	250	165	123	733			78	73	110	73	73	160

Table 4 Trace elements (p.p.m.) in the rocks of carbonatite complex of Tiruppattur.

viscosity of melt, magmatic differentiation, heat-loss, rate of cooling and fractional crystallization of mineral species might have been widely varied from one tectonic setting to other. In the study area, continental rifting and fracturing might be the tectonic setting of the area. K_2O/Na_2O >1 in most of the rocks in Jogipatti basin might be due to deeper depth of low degree of partial melting subjected prolonged differentiation process. The Kolar gold-field, Cu-Pb-Zn deposit in Mamandur village and molybdenum deposit in Hurur-Utthangarai belt, are all located within 100 km distances from the ultrapotassic rock which is an exploration tool for these deposits. The rock is raw material for high grade ceramic products. It is used for cutting and polishing industry as high quality building slabs.

ACKNOWLEDGEMENT

Grateful thanks are due to Dr, V, Subramanian Ex. Additional Director, Department of Geology and Mining for his field guidance and moral support during my Ph.D. work at the Presidency College, Chennai-600005, between 1967 and 1973., The author thanks Dr. S. Saravanan and Mrs. Kasthuri Saravanan who maintained Salaparintha Guru-Shisya Parmpariya throughout entire research-period and developed his self thinking capacity.

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