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Geochemistry Characterization of Alkaline Syenite from Pakkanadu Alkaline Carbonatite Complex, Ultramafic rocks from in Southern Granulite Terrain

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ABSTRACT

Pakkanadu alkaline Carbonatite Complex (PASC)occurs in Southern Granulite Terrain (SGT) contains many rock formations from mafic to ultramafic composition. Twenty samples were collected randomly to assess the textural characteristics and trace elemental concentration of the alkaline rocks from Pakkanadu complex, mafic rocks from the Chalk Hill Complex of SGT, Salem, India.The Photomicrograph study discloses the presence of felsic minerals (Alkali feldspar and Nepheline) and mafic minerals (Olivine and Pyroxene) in the collected examples. The petrography result shows that both crustal and mantle-derived rock compositions and their texture demonstrate their source. The elemental distribution in alkaline and mafic rock is controlled by the process of magma differentiation.

1. Introduction

Trace element data information can be utilized to demonstrate and interpret magmatic processes (Schiano et al.,1993;Walteret al.,1995;Costa et al.,2003). In situ determinationof Trace element in minerals has become progressively mainstream and numerous examinations have been distributed on basaltic systems (Jeffries et al.,1995;Benoit et al., 1996; Coogan et al., 2000; Thompson and Malpas 2000; Tiepolo et al., 2002), on ultramafic mantle rocks, and on stages applicable to mantlemelting (Coogan et al., 2000; Blundy and Dalton 2000; Gre`goire et al., 2000; Tiepolo et al., 2000). Investigations of Trace element apportioning and Trace element substance in more evolved silicic frameworks are less regular(Lemarchand et al., 1987;Wood and Trigila 2001), and particularly Trace element convergences of mineral stages inalkaline silicate plutonic rocks have just been examinedin a couple of cases (Larsen, L.M., 1979). The Southern Granulite Terrane is a collection of crustal blocks that were welded together at different times from Neoarchean to the most recent Neoproterozoic – Cambrian (Collins et al., 2007; Santosh et al., 2009). The Sothern Granulite Terrain is facilitating a wide assortment of unmetamorphosed and to a great extent undeformedalkaline magmatic suites including syenites, ultrapotassic rocks, carbonatites, lamproites also, shonkinitesoccurring as intrusives, lensoidal, dykes and fittings that are generally within or proximal to major paleo-stitch/shear zones or transcrustalfaults (Santosh and Drury 1988). In this southern segment of the Indian shield, there is an assortment of igneous bodies intruded after the Archean metamorphic evolution, these bodies are post-structural and have a wide range of composition, from moderately basic granitic lithology through ultramafic composition and more uncommon, more exotic bodies, for example, shonkinite, syenites, and nepheline syenites.An unusual occurrence of alkaline rocks in association with dunite and peridotite was first reported at Salem byRamanathan,S. (1954). In this examination, we analyze the Trace element substance of alkaline and mafic minerals from three related, however petrologicallydifferentalkaline to peralkalineigneous complex to research the partitioning behaviorof trace elements in characteristic in natural alkaline silicate melts.

Regional Geology

The southern granulite terrain in south India and represents a suture rift structure of Neoarchean to the latest Neoproterozoic – Cambrian age(Collins et al., 2007; Santosh et al., 2009). The Salem Block represents one of the major blocks in the northern domain of the SGT, closely to the south of the Archean Dharwar Craton. The basement of the block is considered to have formed during Neoarchean and was metamorphosed during early Paleoproterozoic at P-T conditions of 14–16 Kbar, and 850ºC) (Anderson et al., 2012;Clark et al., 2009).Charnockite is one of the rock types that cover the basement Chalk Hill Complex. It belongs to the Southern Granulite Complex (SGC) supergroup, the age of Archean (Santosh et al., 2009;Clarket al., 2009;Plavsa et al., 2012). Further, the granulite terrain exhibits two periods of high-grade metamorphism during the late Archean and late Neoproterozoic. Earlier,GradyGrady, C., (1971)has brought out several trending deep fault systems tapping the mantle in south India.The intrusive magmatic suites in the different blocks and the intervening shear/suture zones in the SGT can be broadly grouped into two: a mid-Neoproterozoic (Cryogenian) alkaline suite characterized by feldspathoidal syenites, pyroxenites, shonkinites, and carbonatites(Kumar et al., 1998;Miyazaki et al., 2003;Schleicher et al., 1998) and a late Neoproterozoic – Cambrian group of mostly A-type granites and rare syenites(Rajesh et al., 1996; Santosh and Drury 1988; Santosh et al., 2009). The Cryogenian alkaline magmatic suite is generally dispersed along the southern edge of the Dharwar Craton or the southern fringe of the Meso-

Neoarchean crustal squares welded to the craton and incorporates those of Angadimogar, Peralimala, Kamaneri, Sevattur, Sundamalai, Samalpatti, and Yelagiri.

Study Area

The present study area falls between thealkaline rocks and ultramafic association of Pakkanadu and chalks hill complex occur northwest of Salem along which several alkaline intrusive suites are identified by rock assemblages in the South Indian Granulite Terrain(Santosh et al., 2002). They are fine to medium-grained rock predominantly made up of pink garnet and grass-green amphibole, pyroxene with a minor amount of feldspars and quartz.The charnockite body trends N-S direction and the direction of lineation or direction of elongation of mineral grains are in NW-SE 110°.

Result and discussion

Geological setting

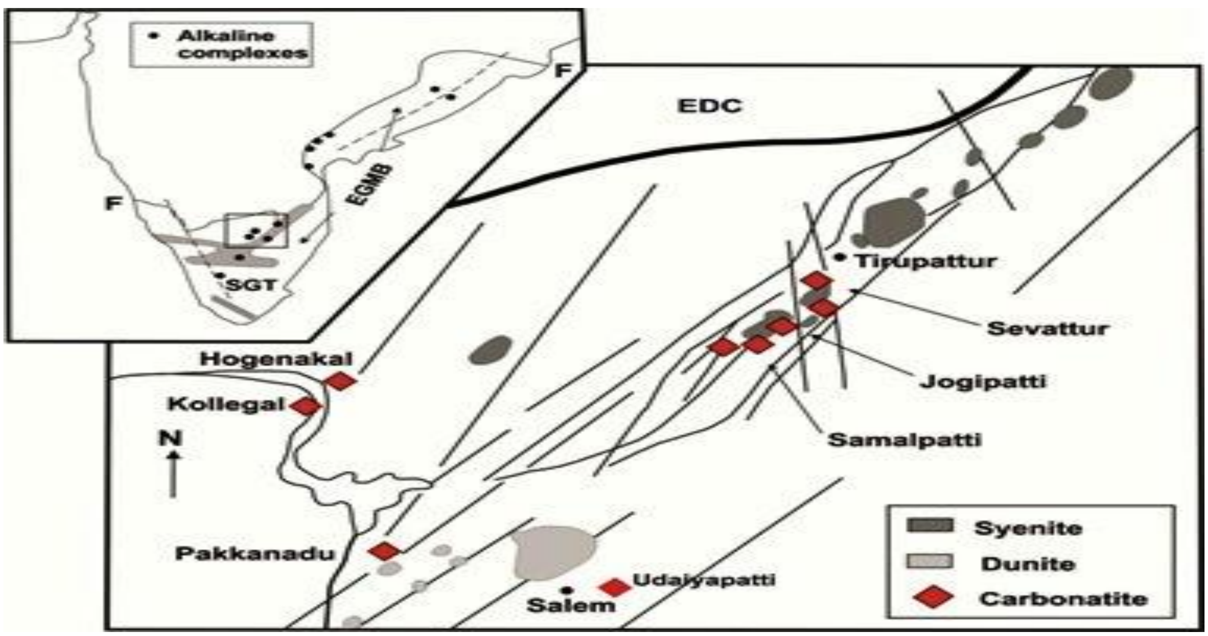


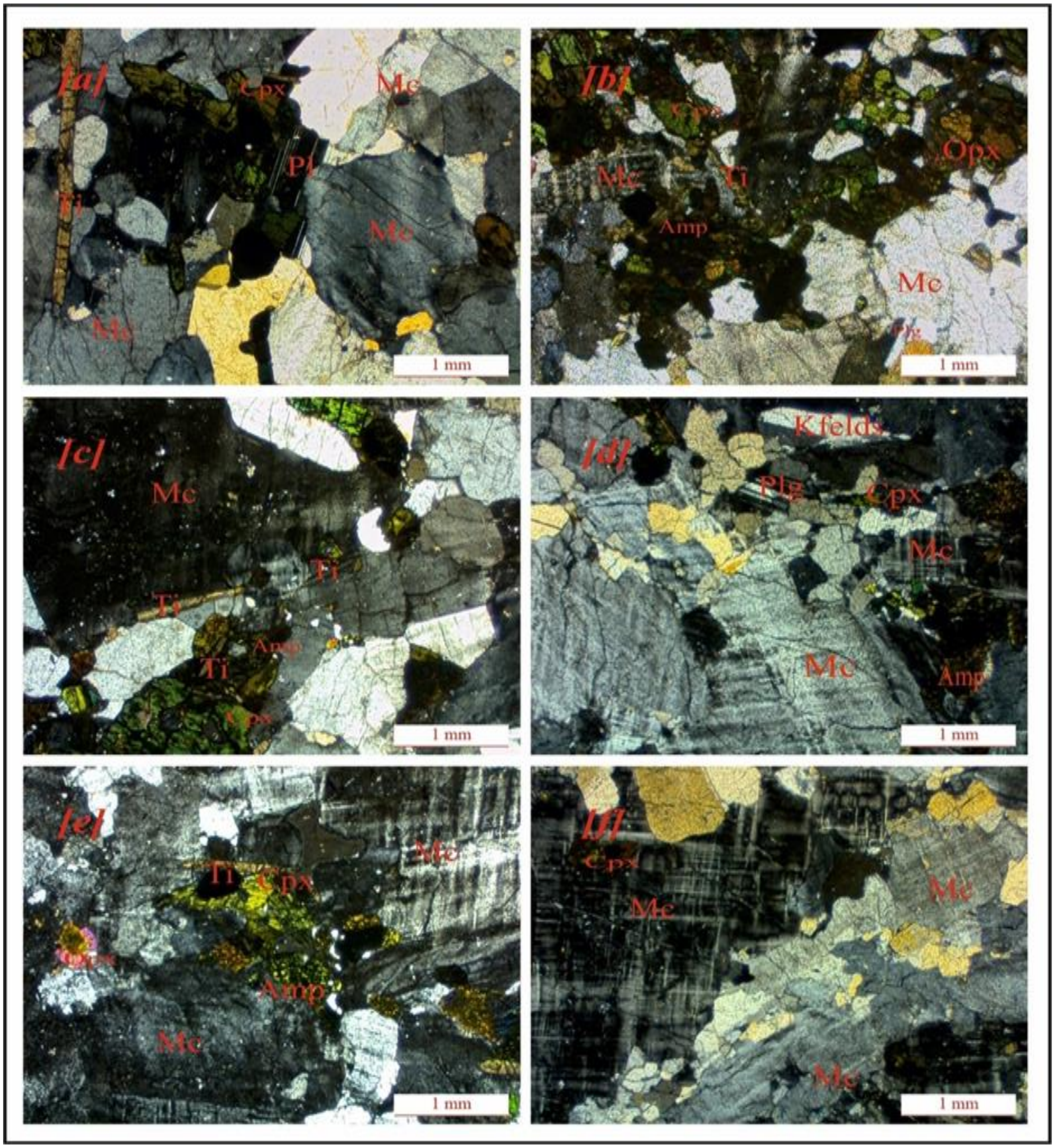
Figure. 1 Geological map of Fault Zone in south India showing Syenite-Carbonatite occurrences, (After Krishnamurthy P. 1988).

The present study investigates two representative alkaline magmatic complexes from the northern part of the southern granulite terrain; named as Pakkanadu alkaline complex.The Pakkanadu alkaline complex, syenite where intrude within the hornblende biotite gneiss of the Peninsular Gneissic Complex, which is an elevated body of NE trend (Fig.1).Syenite rock is mainly composed of medium to coarse-grained K- Feldspar, Clinopyroxene, Amphibole, and Plagioclase. Pegmatite vein intrudes along the syenite body, suggests the culmination of magmatic activity.The field settings and structural characteristics indicate these Syenite bodies to be of plutonic origin which was later intruded by dykes, suggestive of prolonged and pulsativetectono-thermal evolutionary history.The contact between the syenite and host rock is sharp and covered by thick soil occupied one sq. Km around. The smaller syenite pluton in Chindamaniyur and Semmandapatty located 13 km East of Kamaneri pluton exposed in N-S direction.

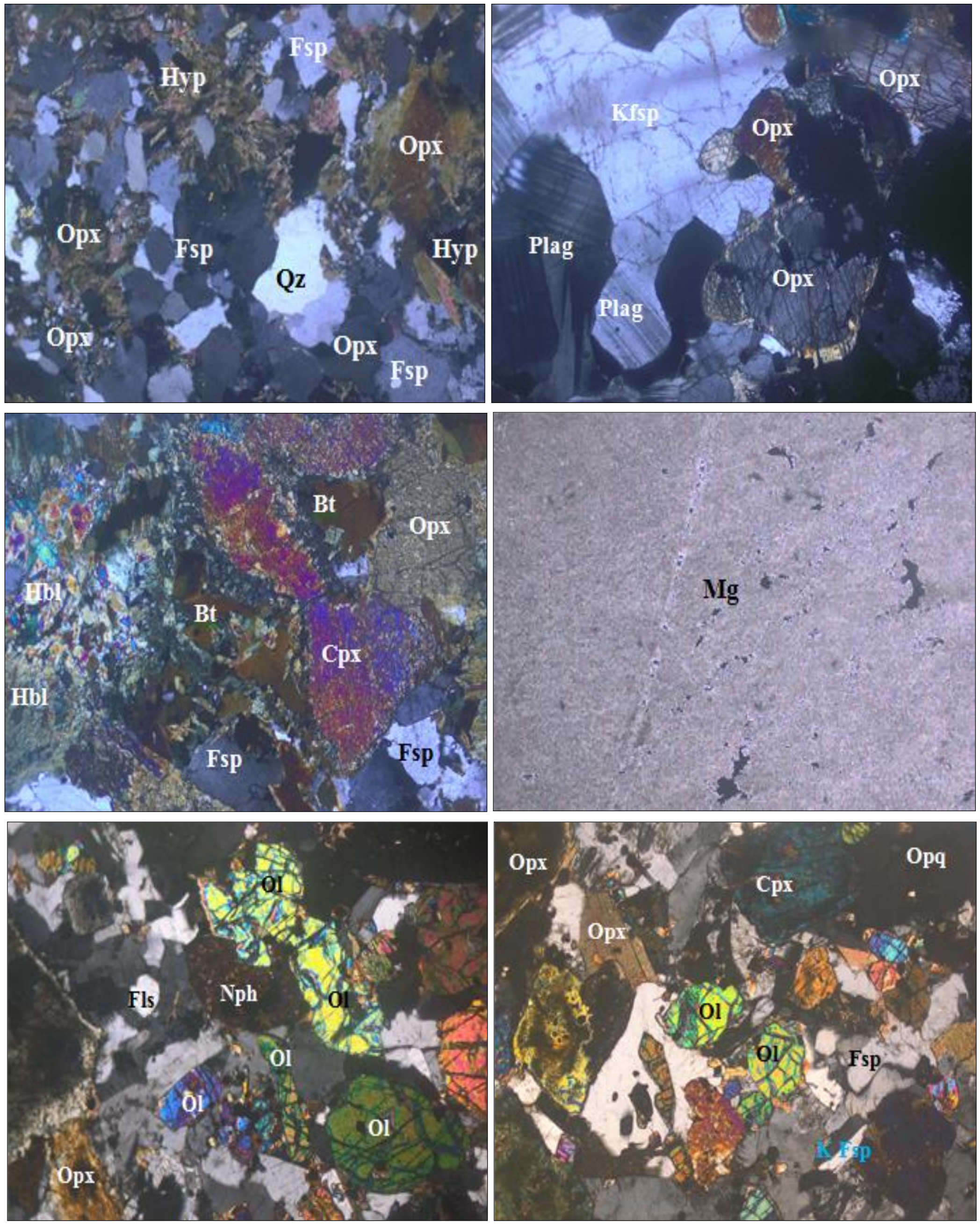
The Ultramafic rocks are chiefly composed of Dunite, clinopyroxene, olivine, orthopyroxene, nepheline, K- feldspar, which are found as intrusive within magnesite. Sharp contact of Magnesite veins intrude along the host rock of dark-colored Dunite are noticed, rock relation between them suggestive of probable magmatic origin. Gneisses from the study area appear alternative mafic and felsic layers at places and occur parallel to sub-parallel with the foliation. The porphyroblasts of garnets are occurring in different sizes surrounded by plagioclase, pyroxene, and amphibole. Fine to medium-grained, predominantly made up of pink garnet and grass green amphibole, pyroxene with a minor amount of feldspars and quartz.The intrusive alkaline rocks within the ultramafic rocks, as well as show relation on xenoliths of Dunite.Also been noticed coarse to medium-fine grained of pyroxene and feldspar crystals from the center towards the periphery of the intrusions.

Petrography

Commonly the rocks from the Pakkanadu alkaline complex contain alkali feldspar mainly orthoclase and microcline, pyroxene, amphibole with opaque. Sphene, apatite, quartz, zircon are the common accessory minerals. Microcline is the most dominant member of the alkaline complex. Under the microscope, Microcline grains are characterized by medium to coarse-grained, equigranular, colorless, non-pleochroic, low relief, and often exhibithypidiomorphic texture. Some of the albite and orthoclase rich K- feldspar crystals show concentric zoning. Microcline grains are shown Crosshatched twinning character. Simple twinning in orthoclase present in some of these samples.Clinopyroxenepresent and magnetite included as opaque mineral Pyroxene shows alteration. Medium grained alkali feldspar with clinopyroxene and biotite present major amounts, titanite present in accessory. Kamaneri samples show Biotization along the alkali feldspar grain boundary. Clinopyroxene inclusion in alkali feldspar along with coarse-grained subhedral clinopyroxene is identified(Fig 2 a-f).Collected Ultramaficrock samples are sectioned to study the mineralogy of the different rocks from the Chalk Hill Complex (CHC). Dunite, Charnockite, Granulite, Hornblende Biotite Gneiss, Magnesite, Shonkinite are the major rocks formed in this study area. These rocks show distinctive petrographic properties due to different origin. Dunite rocks mainly composed of olivine mineral shows holocrystalline nature with internal fractures has replaced by serpentine minerals and small proportions of pyroxene minerals are also present in this rock. Peridotites are coarse-grained rock mainly consisting of olivine and pyroxene minerals that show high relief with biotite, besides the rock has opaque minerals with minor amphibole. Dunite rock which is entirely formed by olivine mineral with holocrystalline allotriomorphic texture and peridotite rock of holocrystalline nature of olivine and pyroxene minerals. Generally, the sections all are texturally phaneritic (except mineral magnesite) holocrystalline, coarse-grained, and porpyroblastic texture (Fig 3).



Microphotographs 2(a-e) showinggrains of Amphibole is two sets of cleavage, highrelief, brown in color, greenish-brown to dark green pleochroism with contact twinning.**f.** Coarse-grained microcline is cross-hatched twinning



Microphotograph 3 showing **A** charnockite by its mineral assemblages of orthopyroxene, feldspar, quartz, and hypersthene which is holocrystalline nature with anhedral minerals. **B.** shows granulite rock which has holocrystalline nature, subhedral crystals of major feldspar with orthopyroxene mineral. **C.** section shows hornblende biotite and pyroxene with a little number of feldspar minerals which has foliations, namely, the section is hornblende biotite gneiss.**D.** shows magnesite mineral which is cryptocrystalline nature. **E & F.**shows the section of shonkinite rock from the chalk hill complex which has feldspar, olivine, and nepheline, and pyroxene mineral assemblage of holocrystalline nature.

Fe, Mn, and Trace element geochemistry

Alkaline syenite carbonatite complex

The trace element concentration is representing alkaline and mafic rock Table 1. The geochemical distribution plots of the alkaline and mafic rocks are plotted and shown in (Fig. 4).The geochemicaldistribution of alkaline rock in Ferromagnesian and transitional elements shows moderate patterns due to the lack of mafic minerals. A moderate pattern of Pb suggests the presence of K-feldspar, depletion of Fe, Ni, Cr, Cu suggest mafic mineral in pyroxene and amphibole. Chemically ultramafic rocks vary from intermediate to basic compositions and are classified as melanocratic color index rock type (Fig. 4).The Ferromagnesian and transitional (FTEs) trace element concentration will vary with rock type. From the analyzed data, the trace element concentration of mafic rocks are in increasing order of Fe>Mn>Cr>Ni>Zn>Co>Pb>Cu. The higher concentration of iron present in the olivine or pyroxene is incorporated in magnetite, shows predominant mafic affinity also confirmed from the petrographic analysis. Moreover, the higher concentration of Chromium and Nickel shows mafic to ultramafic affinity.

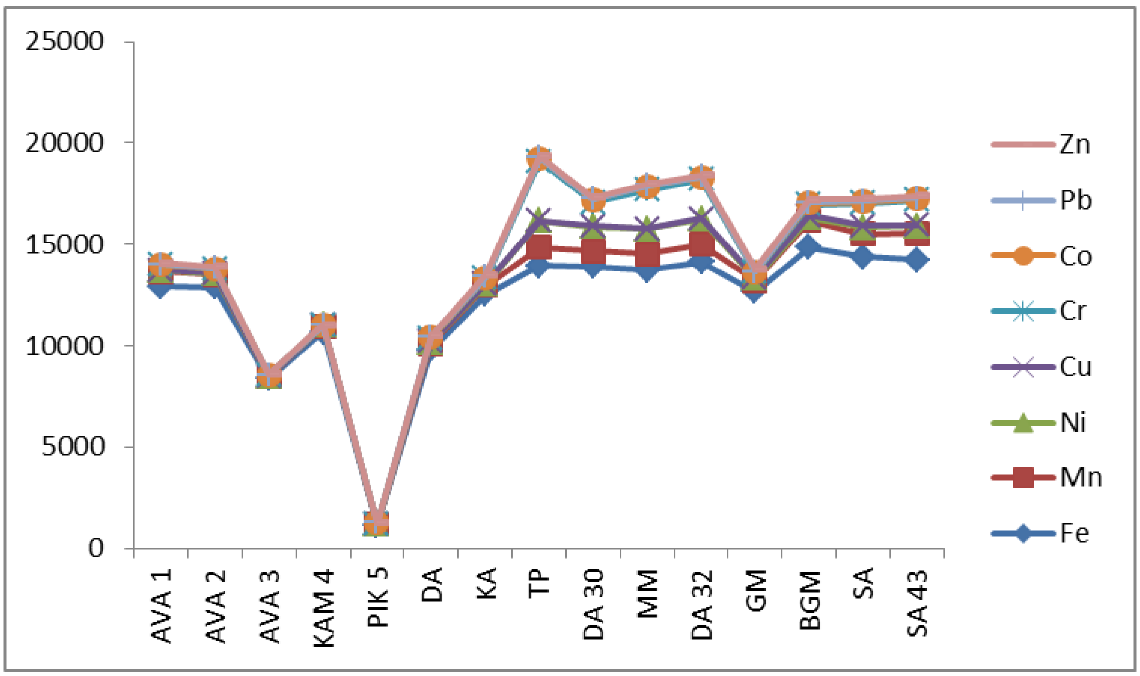


Figure 4. Trace elements concentration diagrams of alkali and ultramafic rock.

Table 1. Trace elements concentration (ppm) of alkaline and ultramafic rocks.

S.No	Sample	Fe	Mn	Ni	Cu	Cr	Co	Pb	Zn
1	AVA 1	12939	723	51.7	12.1	243.3	34.7	14.4	65.4

2	AVA 2	12889	621	45.3	20.9	213.3	29.8	20.4	69.6
3	AVA 3	8392	57	11.2	1.4	117	5.1	0.6	9.3
4	KAM 4	10676	309	11.3	1.1	23.9	2.3	0.3	8.2
5	PIK 5	1163	41	14	0.5	34.9	3.3	0.1	3.4
6	DA	9798	301	68.1	51.5	161.9	35.3	36.3	62.4
7	KA	12523	436	85.2	18.8	252.3	42.5	44.2	98.4
8	TP	13964	890	1299.2	15.4	2945.2	127.6	40.7	82.9
9	DA 30	13912	764	1205.2	15.6	1194.2	119.3	45.4	54.7
10	MM	13718	806	1230.9	15.7	1932.7	155.4	40.1	66.9
11	DA 32	14128	882	1238.4	11.6	1943	121.6	37.8	70.5
12	GM	12675	537	118	51.8	224.8	39.6	27	116
13	BGM	14841	1308	152.9	122.8	556.1	66.5	15.2	155.4
14	SA	14376	1134	315.4	85	1120.2	66	31.6	110.7
15	SA 43	14254	1296	361.6	36.3	1234	74.5	37.8	98

Conclusion

The petrological and geochemistry studies of mafic rocks incorporate Petrogenesis and the cooling history of magma. The ferromagnesian and transitional trace element data indicate the magma type and source whether the rock is felsic or mafic, to suggest magma derivation from a Subcontinental lithospheric mantle source with Ultramafic affinity. The elemental distribution is controlled by the process of magmatic differentiation. Alkaline magmas may have distinctly different styles of emplacement.

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