CHAPTER I

INTRODUCTION TO SITTAMPUNDI COMPLEX

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1.1 INTRODUCTION

Much information on Archaean anorthosites have been recently published. The present author reviews the earlier works in the light of latest informations available. An attempt is made to give a complete data of the chromite bands in Sittampundi.

Ashwal (1988) attempted to give a simple unified theory for the formation of anorthosite. In Table I Ashwal and Burke (1987) gives the general characteristics of each type of anorthosite.
The various types are,

1. Archaean type
2. Proterozoic (Massive) type
3. Stratiform type
4. Oceanic type
   - a. Mid-oceanic ridge
   - b. Ophiolite
5. Intrusion type
   - a. Cognate
   - b. Xenolithic
6. Extra-terrestrial

The Sittampundi anorthosite is included under the Archaean type with an age of 2.7 to 3.75 Ga. The other example that is included along with Sittampundi is that of Bad Vermilion L.Ontario, Canada.

In Table II, some interesting facts about terrestrial anorthosite are given (Ashwal, 1988).

TABLE I ANORTHOSITE TYPES AND CHARACTERISTICS

Type	Texture	mol % An	Age (Ga)	Ore Deposits	Examples
Archaean	equant megacrysts upto 30 cm	75-90	2.7-3.75	Cr, Fe-Ti	Bad Vermilion L, Ont; Sittampundi, Indai
Proterozoic (Massif-Tupe)	laths upto 1m	40-65	1.0-1.7	Fe-Ti	Marcy, N.Y.; Nain, Labrador
Stratiform	Variable	50-80	0.1-2.7	Cr, Pt, Fe-Ti, V	Stillwater, Montana; Dufek, Antarctica
Oceanic (a) mid-oceanic ridge	adcynykate	68-75	0.0	-	Mid-Atlantic, Mid-Indian ridges
(b) ophiolite	adcumulate	78-82	0.44-0.04	-	Bay of Islands, Newfoundland
Inclusions	variable	variable	0.0-1.2	-	Gardar dikes, Greenland
(a) Cognate (b) xenolithic	variable	Variable	?	-	Beaver Bay diabase, Minnesota
Extraterrestrial	adcumulate	95-98	-4.4	?	Lunar crust

(After Ashwal 1988)

TABLE II ANORTHOSITE TRIVIA

Oldest :	3.75 Ga Manfred Complex, Yilgarn Block, Western Australia
Youngest :	0.00 Ga Mid-Atlantic, Mid-Indian, Mid-Cayman Ridges
Largest :	15,000 km Cunene massif, Angola
Most Published :	Sittampundi anorthosite(Archaean), India (Plag cor+liq)
Most Profitable :	Bushveld Layered Intrusion, South Africa (Pt, Cr, Fe, Ti, V)

(After Ashwal 1988)

Ashwal is of the opinion that there are 3 myths on anorthosite formations. They are,

1. There was a distinct anorthosite event in the late proterozoic.
2. Anorthosites are a major constituent of the lower crust.
3. Archaean anorthosites are metamorphosed equivalents of layered mafic intrusion.

Regarding myth 1, Ashwal states that if other anorthosite types are included (Refer Table 1), it may be stated that anorthosites have been produced, over the entire range of geological time (and is forming even today).

Regarding myths 2, he states that many high grade terrain such as new Quebec are anorthosite-free andrelative paucity of anorthosite among lower crustal nodule suites of kimberlites and alkali-basalts argues against an anorthosite lower curst. Therefore to suspect that anorthosite is any more abundant in the lower crust than it is on the Earth's surface has no valid reasons.

Regarding myth 3, Ashwal states that Archaean anorthosites are characterised by a distinctive features absent in the layered anorthosite intrusion. Further Archaean anorthosite are uniformly highly calcic(An 75-90) in comparison. Layered anorthosites have a variable An content from A

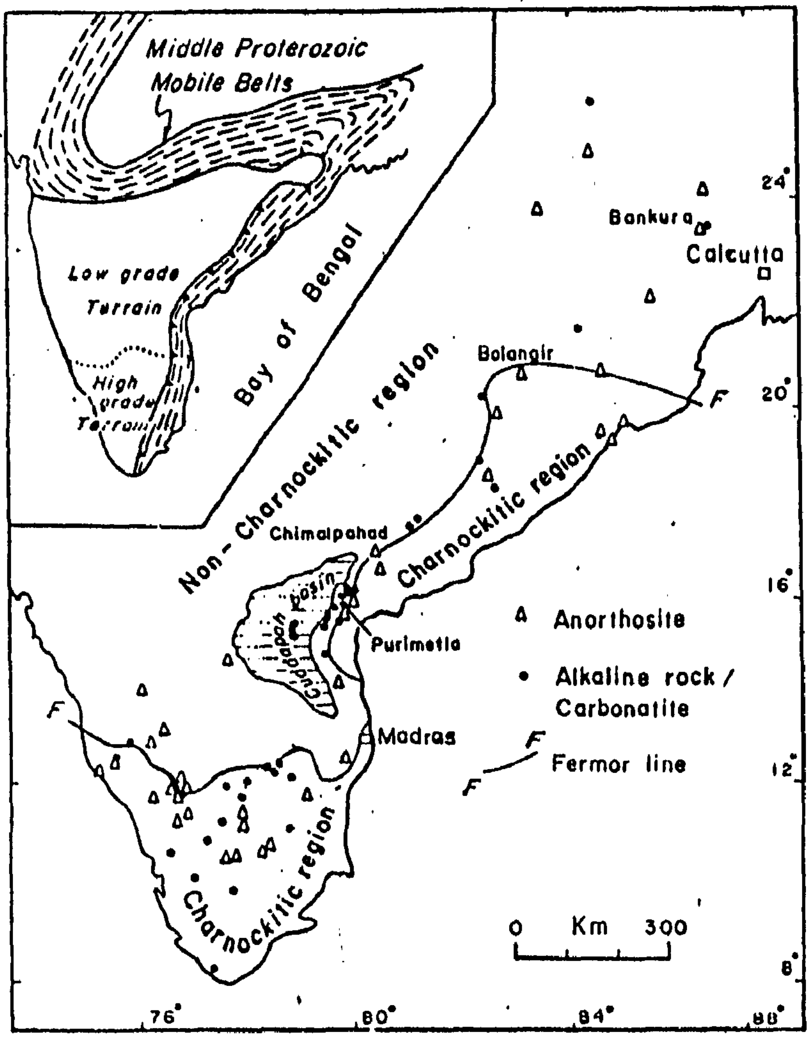


Fig.1

Alkaline rock occurrences in the precambrian Shield of Peninsular India

(after Leelanandam, 1988)

Anorthosite Alkaline rock occurrences in South India.

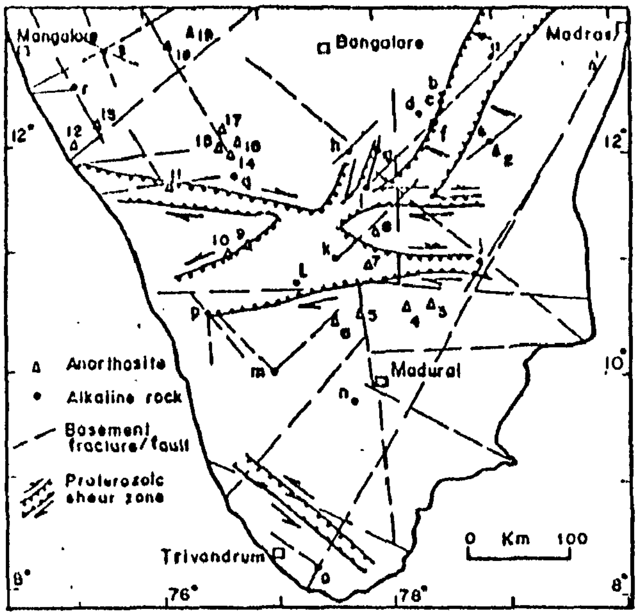


Fig.2

Anorthosites: 1.Chinglepet, 2.Mamandur, 3.Manapparai, 4.Kadavur, 5.Oddanchatram, 6.Palni, 7.Chinnadharapuram, 8.Sittampundi, 9.Togamalai, 10.Attapadi, 11.Kabbani, 12.Perinthatta, 13.Rettanjaripparambu, 14.Gundlupet, 15.Hullahalli, 16.Konkanhundi, 17.Sindhuvalli, 18.Holenarasipur, 19.Nuggihalli.
Alkaline rocks: a.Paravamalai, b.Elagiri, c.Koratti, d.Sampalpatti, e.Torapaddi, f.Sevattur, g.Piccili, h.Hogenkal, i.Pakkanadu, j.Ariyalur, k.Sivamalai, l.Kunduruubetta, m.Munnar, n.Kammam mottu, o.Puttetti, p.Mannapra, q.Sholayar, r.Sullia, s.Peralimala.

(after Leelanandam, 1988)

An $_{50}$ An $_{80}$. From the above observations Ashwal proposes. a simple unificd theory that the anorthosite of plagioclase feldspars formed from mantle derived basaltic magmas. He believes that this simple statement can provide a provisional hypothesis applicable to all anorthosite types, both terrestrial and extra terrestrial.

In Figures 1 and 2 anorthosite and alkaline rocks from the deep crust of the Peninsular India are located. There are about 40 anorthosites and equivalent number of alkaline rock occurrences in the Precambrian Shield of Peninsular India and great majority of theme are virtually restricted the Eastern Ghat mobile belt, Which is comparable to the Grenvellen Provinces of Canada (Leelanandam et al, 1988).

Leelanandam et al (1988) is of the opinion that the Charnockitic (gneiss-granulite) region of Peninsular India is uplifted as a whole relative to the non-charnockitic (granite - greenstone) region and Fermor's line forms on abrupt discontinuity between contrasting geological terrains. The metamorphic discontinuity across the boundary between the Eastern ghats and the adjoining craton, suggest thrusting of the eastern terrain over the western terrain. Models invoking collision tectonics with attendant anomalous crustal thickening of the

Proterozoic mobile belt and with high thermal gradiants may explain the anorthosite genesis. The granulite terrains subsequently developed very low thermal gradiants and experienced alkaline magmatism (Leelanandam et al, 1988).

Morrison et al (1988) observes that all the Archaean terrain anorthosites are characterised by the presence of equant plagioclase megacrysts of homogeneous An content, typically greater than An_{80}. The volcanic and hypabyssal units occur in greenstone belts under generally associated with supra crustal. Dykes with megacrysts form large swarms cross-cutting both greenstone and granitegneiss terrains. However geochemical data suggest that the parent melt and the processes which generate the megacrysts and their host rocks are the same in all tectonic settings.

Crystallization Conditions

Crystallization conditions as explained by Morrison et al, (1988) the homogeneity typical of Archaean plagioclase megacrysts requires growth in a nearly isothermal enrichment. Crystallization takes place in mid to upper crustal level chambers. Individual megacrysts from large scale intrusives (eg. the Bad Vermilion lake mass) and from Metachewan dykes have smooth oscillations in An content from their cores to within a few hundred microns of their much more sodic rims. These oscillations suggest replenishment of the parent liquid during crystallization of the megacryst.

In addition rare earths abundances and range in slopes in dyke rocks vary greatly for approximately constant major elements composition. The rare earths are de-coupled from the major elements. This characteristics together with the indications of rejuvenation of the parent liquid shown by the mega-cryst An content is typical of magma replenishment during crystallization and the establishment of perched major element compositions in an otherwise evolving liquid. Most but not all of the incompatiable element de-coupling and enrichment observed in the dyke rocks can be accounted for through replenishment processes. However, replenishment processes cannot account for the range in slope and abundances observed between deflected dykes and those which highly enriched patterns.

At Bad Vermilion lake the anorthosite complexes is layered on a large scale as in Sittampundi. Individual units vary in mode, size frequency distributions of the megacrysts. Some units have distributions indicating sorting of megacryst during cumulate formations. Contacts between units which differ in degree of sorting are observable. Flow and sorting during cumulate formation appear to have been important. The density of the liquid is equal to that of the plagioclase at the temparature of crystallization (about 1200°C) consequently the megacrysts are neutrally buoyant in the liquid form which they crystallize. In addition, the large size of the megacryst suggests few and scattered nuclei during crystallization. The large scale cumulate suggest the presence of large periodically replenished magma chambers (Morrision et al, 1988).

A brief outline of the regional settings of anorthosites and petrogenetically related basalts are given by Phinney et al,(1988). According to them, the Archaean occurrence of megacrystic anorthosites and megacrystic basalts are as follows:

Megacrystic Anorthosites

1. Anorthosite to gabbroic cumulate crystal Segregations in, complexes associated with volcanic sequences typical of low to middle metamorphic grade greenstone belts.
2. Thick anorthositic to gabbroic sills that intrude the volcanic sequences typical of greenstone belts.
3. Anorthositic to gabbroic complexes associated with high grade metamorphic terrains containing marbles, quartzite, quartzofeldspathic gneisses and amphibolites.

Megacrystic Basalts

1. Flows, dykes and sills in volcanic sequences typical of greenstone belts.
2. Dyke swarms in stable cratonic areas forming parallel to sub-parallel patterns over hundreds of thousands of sq.km intruding both high grade granitic gneisses and low to middle grade supra crustal belts.

In conclusion, the megacrystic anorthosite and basalt can occur in a variety of geological settings (Phinney, 1988).

Effects of fluids at high grades

Several petrographic observations in high grade anorthositic complexes indicating the infiltration of substantial amount of fluid. recrystallized plagioclase ranging from strained patchy area to polycrystalline areas may occur as irregularly distributed zones, vein like stringers, or rims around relict cores. Generally these areas display elevated values of sodium and rare earth elements in the plagioclase. Inclusions of tiny amphibole needle are common in non-recrystallized plagioclase of upper greenschist and higher grade. Concentration of inclusion is highly variable even within a single crystal, many plagioclase crystals containing 10% or more by volume of these inclusions. Therefore, it is regarded that there must be flow of fluids

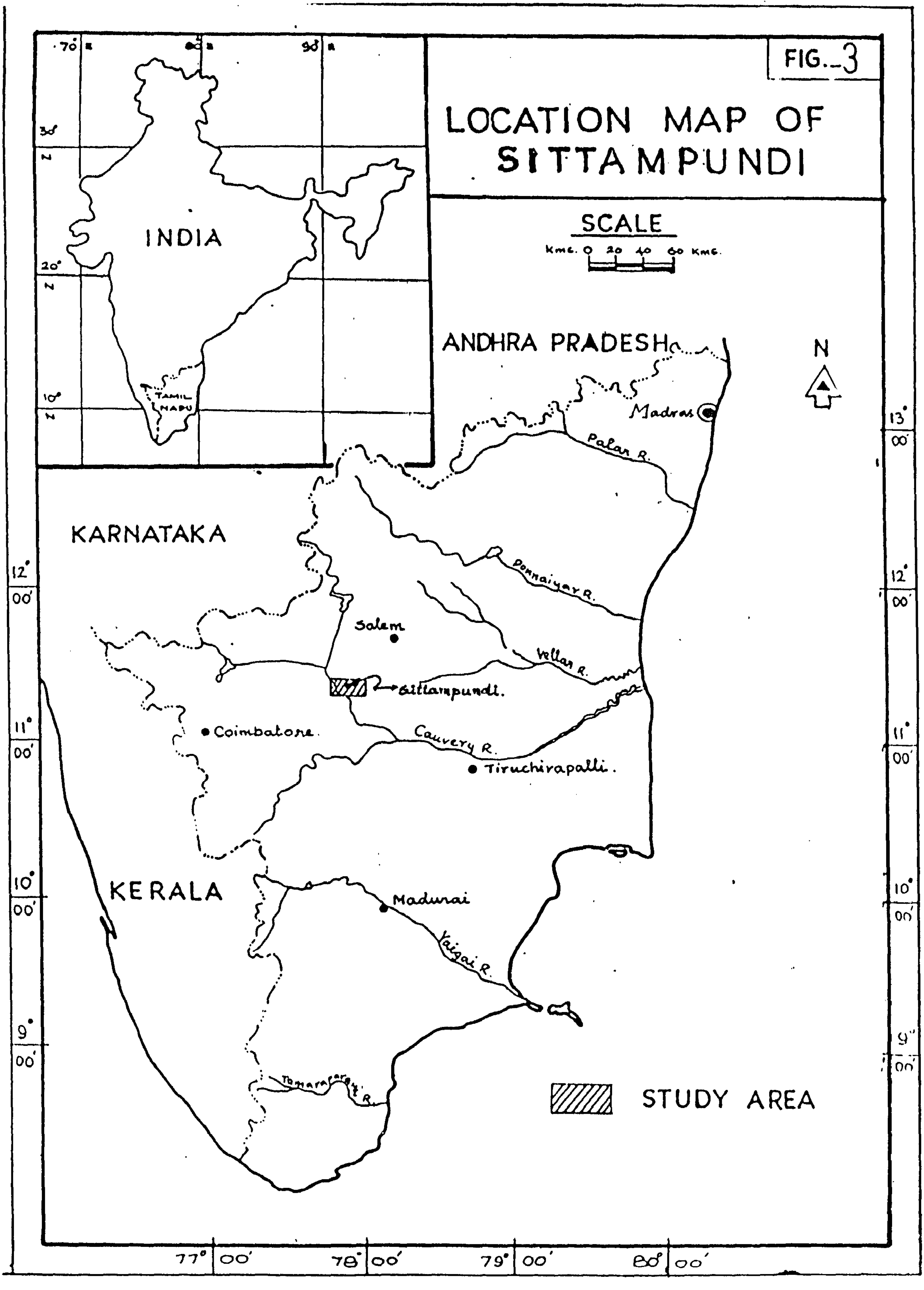


FIG. 3
LOCATION MAP OF SITTAMPUNDI
SCALE
Kms. 0 20 40 60 Kms.
N
INDIA
TAMIL NADU
70° E
80° E
90° E
30° N
20° N
10° N
ANDHRA PRADESH
KARNATAKA
KERALA
Madras
Palar R.
Ponnaiyar R.
Salem
Vellar R.
Sittampundi.
Coimbatore
Cauvery R.
Tiruchirapalli
Madurai
Vaigai R.
Tamaraparani R.
STUDY AREA
13° 00'
12° 00'
11° 00'
10° 00'
9° 00'
77° 00'
78° 00'
79° 00'
80° 00'

through the plagioclase in some manner to add sodium, iron, heavy rare earth elements and water.

1.2 Location

The area under investigation represented in Survey of India toposheet No.58 I/3, and I/4 and 58 E/15 and E/16 published in the year 1972. The area is located between latitude 11°14' and 11°12'30'' north and longitudes 77°52' and 77°57' east (Fig.3) Sittampundi is well connected by truck roads one leading from Tiruchengodu to Namakkal and other is Tiruchengodu to Paramathi Velur. The village can be reached by a metalled road from Nallur to Kabilarmalai, the area under investigation falls in Namakkal and Tiruchengodu taluks, Salem district, Tamil Nadu State.

1.3 General Statement and Review of previous literature

It was the well developed corundum crystals at Sittampundi that attracted by the attention of researchers nearly 200 years ago. Count de Bournon and Richard Chenew reported in the Philosophical transaction of the Royal Society of London in the year 1802 on the corundum bearing rocks with a new mineral (Indianite) occuring in the matrix of the rocks.

In 1843 a Newbold described the occurrence of corundum in Tiruchengodu taluk.

Middlemiss (1896) also described the corundum occurrence in Salem and Coimbatore districts.

Lacroix (1899) made a petrological chemical and mineralogical study on wernerite (scapolite of intermediate composition).

Iyer (1933) attributed the formation of these rocks due to fractional differentiation of a basic magma. He explained the origin of corundum as due to an over saturation of alumina with anorthite fraction.

Iyengar (1949) maped this areas with the economic aspects of the geology of Sittampundi complex with special emphasis on chromite deposits.

Krishnan (1953) presented a sketch map and analyses of chromite deposits of Namakkal and Tiruchengodu Taluks, Salem District.

Nehru (1955) has studied anorthosite-amphibole gneisses and associated rocks of Sittampundi and states that in Sittampundi one encounter a metamorphic facies in their association together of eclogites, amphibolites and anorthite-spinel rocks rather than gabbroic rocks and anorthosites. He did not give any explanation on the origin of chromite in the anorthite gneisses of this area.

A.P. Subramanian (1956) has done extensive work on the mineralogy of the rocks of Sittampundi and suggested the name Sittampundi complex. The

TABLE - III

GEOLOGICAL SETTING OF ANORTHOSITE-ECLOGITE-GABBRO COMPLEX

Stratigraphic Position	Rocks of the area
Closepet or Arcot granite.	Pink granites and pegmatites pyroxenite-websterite.
Peninsular gneiss	Biotite gneiss and migmatites.
Dharwar Group	Anorthosite-eclogite-gabbro complex. ultrabasics; Peridotites, saxonites and dunites; banded magnetite quartzite, crystalline limestone, amphibolites and hornblende schists.

(After Subramaniam, 1956)

Complex consists of a layered sequence of meta-anorthositic gneisses and eclogitic gabbors. The meta-anorthositic gneisses containing layers of chromitite and perknites were reported by him.

Subramaniam's views on Sittampundi complex

According to him, sittampundi Complex is a metamorphosed gravity stratified sheets. He argues that deformation and mineral reconstitution during two periods of Archaean orogeny, following primary crystallization from a basic magma, modified the paragenesis and mineralogy of these rocks with the development of new minerals such as hornblende anthophyllite, pyralmandites, epidote-clinozoisite, grossularite-garnet, porphyroblastic corundum (in part with calcite rims and chromite with unmixed rutile).

The geological setting of anorthosite-eclogite-gabbro complex as given by A.P. Subramanian (1956) is given Table III.

The diagramatic interpretation of the form and structure of the Sittampundi complex as given by A.P.Subramanian is shown in Fig.4, Fig.5, corundum crystals in anorthosite. Further, Subramanian has compared the vertical sequence of Sittampundi complex with that of Bushveld and Bay of Islands gravity-stratified sheets Table IV.

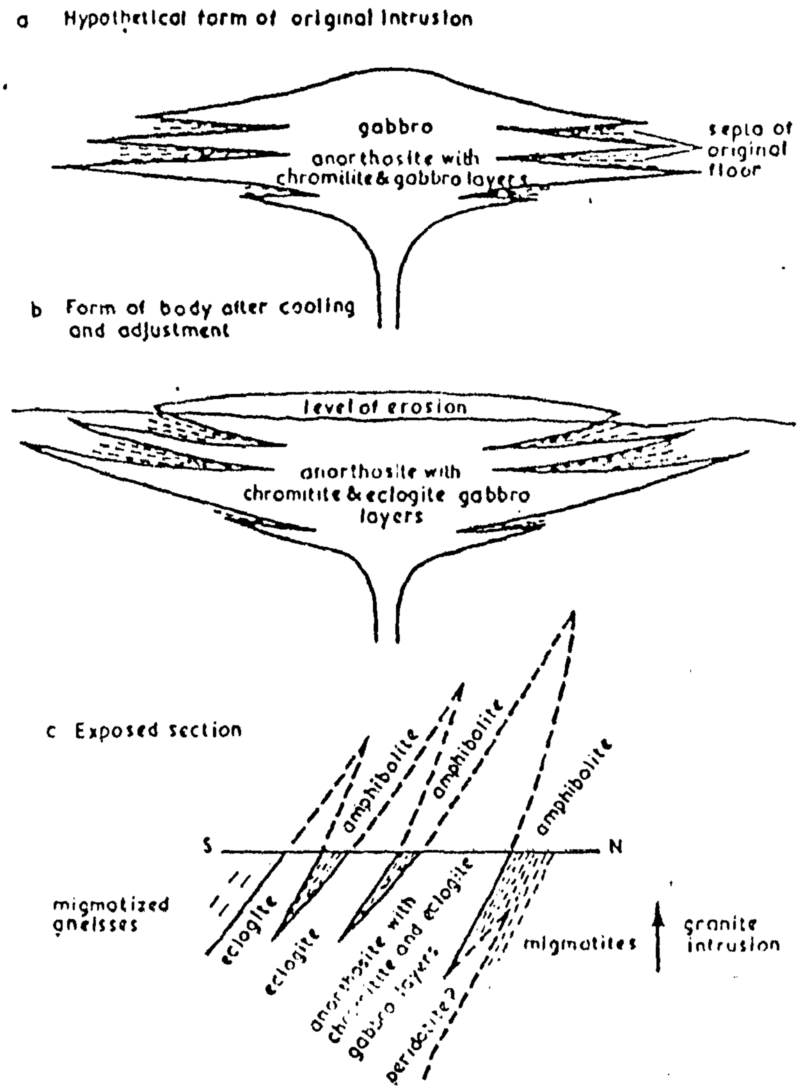


FIGURE 4.—DIAGRAMMATIC INTERPRETATION OF FORM AND STRUCTURE OF THE COMPLEX

a. Hypothetical form of original intrusion
b. Form of body after cooling and adjustment
c. Exposed section

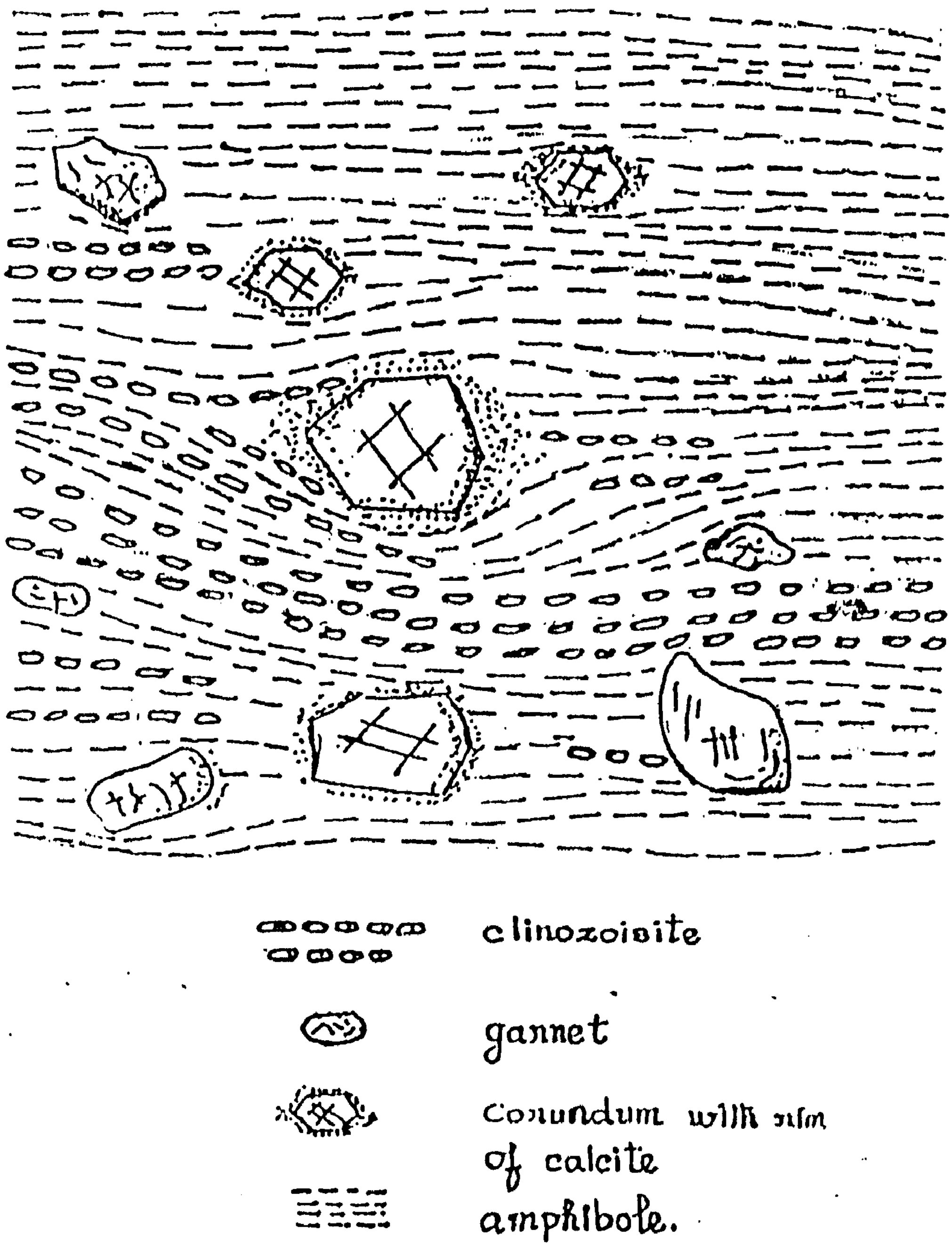


Figure 5. Showing corundum crystals in Meta-Anorthosite. (after Subramaniam, 1956)

TABLE IV

Comparitive vertical Sequence in some Gravity-Stratified Sheet Complexes.

Name	Bushveld	Bay of Islands		Sittampundi
Length	250 miles	65 miles		25 miles
Width	150 miles	10 miles		1½ miles
Thickness	2 to 3½ miles	7 miles		6000 feet
Age	Precambrian	Ordovican		Precambrian
	Acid rock(granite, granophyre, and felsite)	Roof volcanics		Top eroded
Upper Zone	Gabbro in part with interstitial granophyre Andesine anorthosite, diallagite etc. Feldspar An_{45-40}	Gabbro in part banded with some zones of troctolite olivine gabbro feldspathic dunite, etc., with only a little Pyroxenite	Upper zone	Eclogite gabbro seroes Feldspar An_{45-40} Orthopyroxene En Garnet Mg
Main zone	Nortie, labrodorite anorthosite, hypersthene diallagite, diallage hypersthenite, etc., with ilmenite-magnetite layers Feldspar An_{60-70}	Dunite, peridotite subordinate pyroxenite, contains zones of interbanded troctolite, gabbro pyroxenite,	Lower zone	
Critical Zone	Interbanded norite, diallage norite, bronzitite, harzburgite,			

TABLE IV Contd.

Critical zone	bytownite anorthosite, etc., with several chromite layers and a platinum horizon.	fledsparthic dunite, peridotite and gabbroic anorthosite	Anorthosite series with several layers of chromitite Feldspar An_{80-100} Also several thin layers of eclogite, garnet pyroxenite, and pronsitic pyropite Orthopyroxene En_{85}
Transition zone	Basic norite, bronzitie, bytownite anorthosite, minor chromite layers local sulfide lenses	Several chromite layers Basal group?	Garnet Mg_{50-55}
Chill zone	Basic norite, bronzitie, bytownite anorthosite Feldspar An_{72} Hypersthene En_{68}		Basal group hidden (?)
Mineralogical variation	Fledspar increasing in anorthite content downward. Pyroxene magnesian toward base	Bytownite to labradorite. Olivine Fa_7 to Fa_{20} Orthopyroxenes at the base and clinopyroxenes at top	Feldspar An_{45-100} Orthopyroxene En_{80-86} Garnet Mg_{45-80}

TABLE IV Contd.

Segregations dikes		Pyroxenite veins, gabbro pegmatite, feldspathic dunite, basalt prophyry, gabbro, granite	Websterite Pegmatite
Satelitic intrusions	Norite, quartz dolerite, locally pyroxenite, olivine bronzitie, etc.	Ultramafic rocks, gabbro and hornblende gabbro	Pyroxenite Websterite

(After Subramaniam, 1956)

After extensive mineralogical and petrological study he has summarised as follows:

1. The garnets of eclogitic rocks are pyralmandites which are characteristic of eclogites.
2. The garnet from anorthosite has a peculiar composition with high molecule of grossularite and a fair amount of pyralmandite molecule which according to Ramberg Indicates formation under a high pressure environment.
3. The plagioclase feldspars of the anorthositic rocks have a unique compositional range of An_{80} to An_{99} in anorthosites which represent the nearest approach in nature to synthetic anorthite.
4. The amphibole is the edenite in anorthosite andparagasite in chromitite.
5. The anthophyllite in anorthosite is rich in alumina(gedrite). Anthophyllites varying from magnesium to aluminium types are also present.
6. Cordierite from the rock interpreted as xenolith is a magnesium variety.
7. The clinozoisite in the anorthosite is generally low in epidote molecule.
8. The chromite in the chromitite is rich in the spinel molecule falling at the boundary of chromian spinel and aluminian chromite Table V.

TABLE - 5

COMPOSITION OF CHROMITE FROM CHROMITITE.

	Weight percent	Molecular ratio	3+	2+
Cr_2O_3	36.88	485	485	---
Al_2O_3	24.12	473	473	---
FeO	29.40	409*	86	319
MgO	7.22	179	---	179
MnO	0.68	10	---	10
CaO	0.77	14	---	14
TiO_2	0.36	4*	---	---
SiO_2	0.34	6	---	---
	99.77	--	1044	522

Formula according to Thayer's method:

$Cr_{47}\ Al_{45}Fe_8(Mg_{34}Fe_{61}Ca_3Mn_2)$

Or

$Cr_{47}Al_{45}(Mg_{34})$, (Fe^{3+} and Fe^{2+} obtained by difference)

Norm :

Chromite (Mg, Fe) Cr_2O_4	46.45
Spinel (Mg, Fe) $Al_2\ O_4$	45.31
Magnetite $Fe.Fe_2O_4$	8.24
Total	100.00

(After Subramaniam, 1956)

9. Corundum in these rocks is derived from the primary rocks during two periods of metamorphism, associated with the formation of garnet and clinozoisite-epidote.
10. The mineral transformation took place during two periods of Archaean metamorphism.
11. The bulk chemistry of the rocks agree with that of rocks from their stratiform sheets.

Much of the layering is considered primary and the chromitite horizon are thought to have been formed during a normal fractional crystallization of a basic magma under quiescent conditions, with recurring tubulence or pulsation of the magma within the chamber.

The eclogite series are interpreted as original mafic series of the complex. Subramanian suggests that they were transfered to eclogite, during the first period of regional metamorphism. The anorthosite rocks fall in the amphibolite facies, though they fall is generally restricted fields of the ACF diagram for cordierite- anthophyllite subfacies.

At Sittampundi the following sequence of events is envisaged by Subramanian (1956).

1. Emplacement of basic magma in Dharwar sediments during a period of quiescence. Fractional crystallization and gravitative differentiation with formation of a layered complex.

2. Metamorphism and regional migmatization with consequent chemical and mineralogical transformations in the rocks of the complex.
3. Elevation of the complex to the level of erosion with retrograde changes in eclogites.
4. Forceful intrusion of younger granite domes up the complex, tilting it on its edge. Considerable mineralogical changes, induced by mineralisers from the granite with consequent formation of epidote, garnet and corundum.

Naidu's view on Sittampundi Complex

Working on the layered complex in Sittampundi, Naidu (1960 and '63) regards the whole series as composed of igneous, sedimentary and migmatitic rocks of the Dharwarian, Peninsular and Charnockitic periods, domed up by the alaskite intrusion of the Closepet-granite period. From the study of garnets and amphiboles, he concludes that the rocks belong to three different geological periods. He further explains that the garnet bearing rocks are not at all eclogites and the mineral assemblages of the anorthite bearing gneisses denote them to be metamorphosed marly and pelitic sediments. He was influenced to a very great extent by the presence of calcsilicate minerals such as anorthite, horn blende, diopside, epidote, scapolite and grossular garnet.

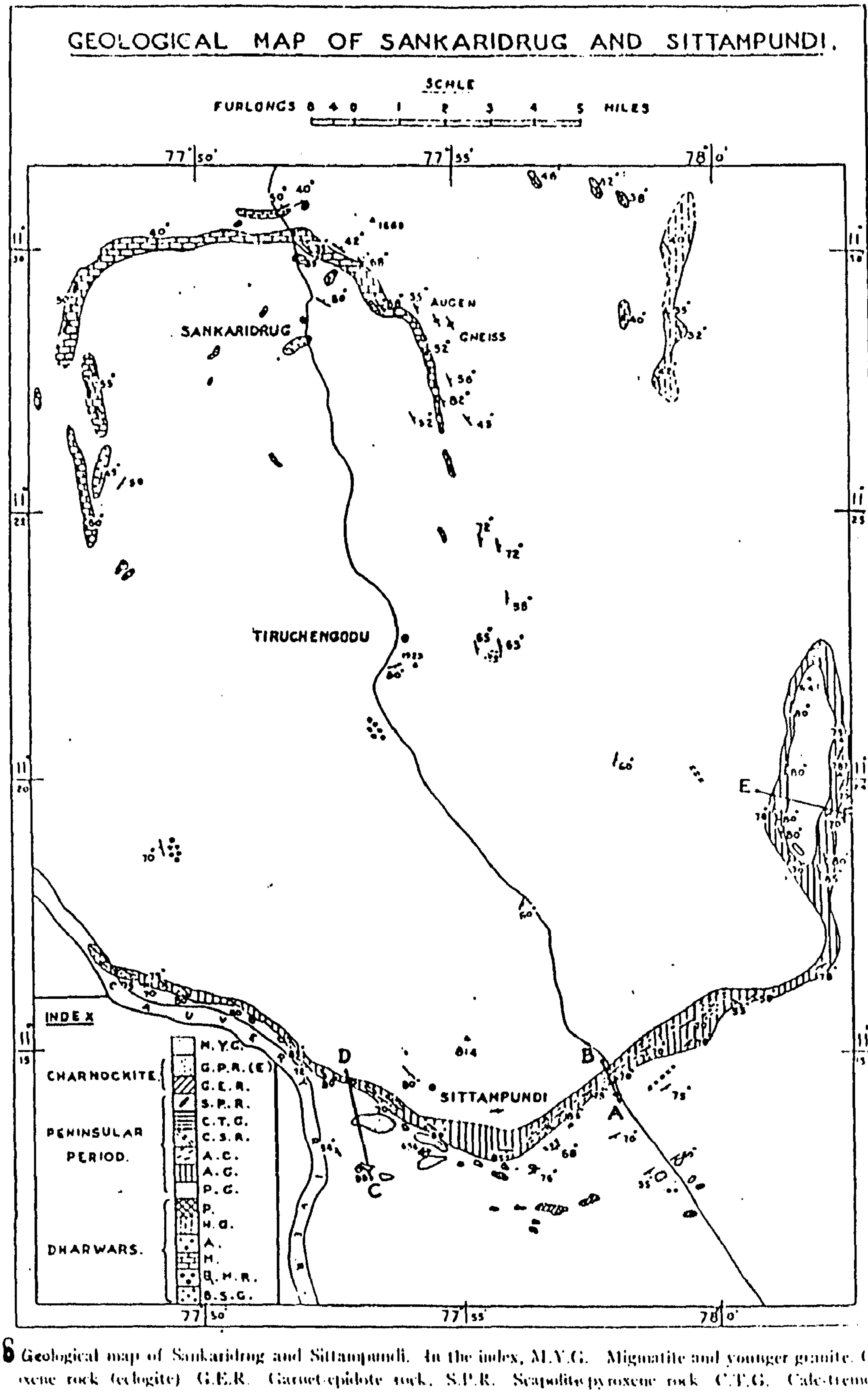


FIG. 6 Geological map of Sankaridrug and Sittampundi. In the index, M.Y.G. Migmatite and younger granite. G.P.R.(E) Garnet p[illegible]xene rock (eclogite) G.E.R. Garnet-epidote rock. S.P.R. Scapolite pyroxene rock C.T.G. Calc-tremolite gneiss C.S.R. [illegible]le silicate rock. A.C. Amphibolite with chromite A.G. Anorthite gneiss. P.G. Peninsular gneiss (not mapped separately from younger granite). P. Peridotite. H.G. Hornblende gneiss. A Amphibolite. M Marble Q.M.R. Quartz magnetite rock. B.S.G. Biotite sillimanite gneiss. AB, CD and EF are sections along the anorthite gneiss band.

(after P.R.J. Naidu, 1963.)

The geological map of Sankaridurg and Sittampundi as mapped by Naidu (1963) is given in (Fig.6). Based on his mapping he argues that there is no amphibolite bordering the anorthite-gneiss on either side, much less sarrounding all the rock types of the area as has been mapped by Subramanian (1956). Regarding corundum and chromite occurrence he points out, "Corundum and chromite mines occur in the middle of anorthite-gneiss band while chromite Occurs on either side of section AB, corundum is confined to the nose, the chromite is confined to the amphibolite-gneiss. The amphibole is a pale blue amphibole (characteristic of the major parts of anorthite-gneiss), chromite is segregated from the wall to the centre and the amphibolite lenses do not extent downwards. There are druses in chromite mines, showing layers of chromite, calcite and muscovite mica probably chromite was introduced from the dunites and peridotites occuring immediate to the south of the nose of the anorthite-gneiss band. The corundum mines are traversed by pegmatite, corundum occurs in well formed crystals and also as disseminated grains in the anorthite-gneiss".

Petrography, mineralogy and chemical analysis on garnet and amphiboles made Naidu (1963) to conclude that the garnets are almandinic in rocks associated with iron ores, pyropic in basic charnockite and grossularitic in anorthite-gneisses and the amphiboles are common hornblende in Peninsular gneisses and hastingsitic in basic charnockite and a highly aluminus-calcaiferous amphiboles in anorthite-gneisses.

From the above account, he concluded the rocks of Sittampundi complex belong to three different geological periods namely the Dharwars, the Charnockite series and the Peninsular gneisses and that it cannot be connected together by crystallisation differentiation processes.

According to Naidu the anorthite-gneiss consists of the following mineral assemblages:

(1). Anorthite-anthophyllite-amphibole(pale-blue, highly aluminous and calciferous)...Hornblende hornfels facies.

(2). Anorthite-greenish-blue-amphibole(of the type of the Peninsular gneiss)-biotite..Hornblende hornfels facies.

(3) Anorthite-grossularite-fassaite...Hornblende hornfels facies.

(4) Anorthite-corundum-spinel ... Sanidinite facies without sanidine (Turner and Verhoogen, 1960).

(5) Anorthite-Corundum-calcite..Pyroxene hornfels facies.

(6) Anorthite-epidote-diopside-calcite..Alamandine amphibolite facies,

(7) Anorthite-epidote-hornblende (pale-blue).. Almandine amphibolite facies.

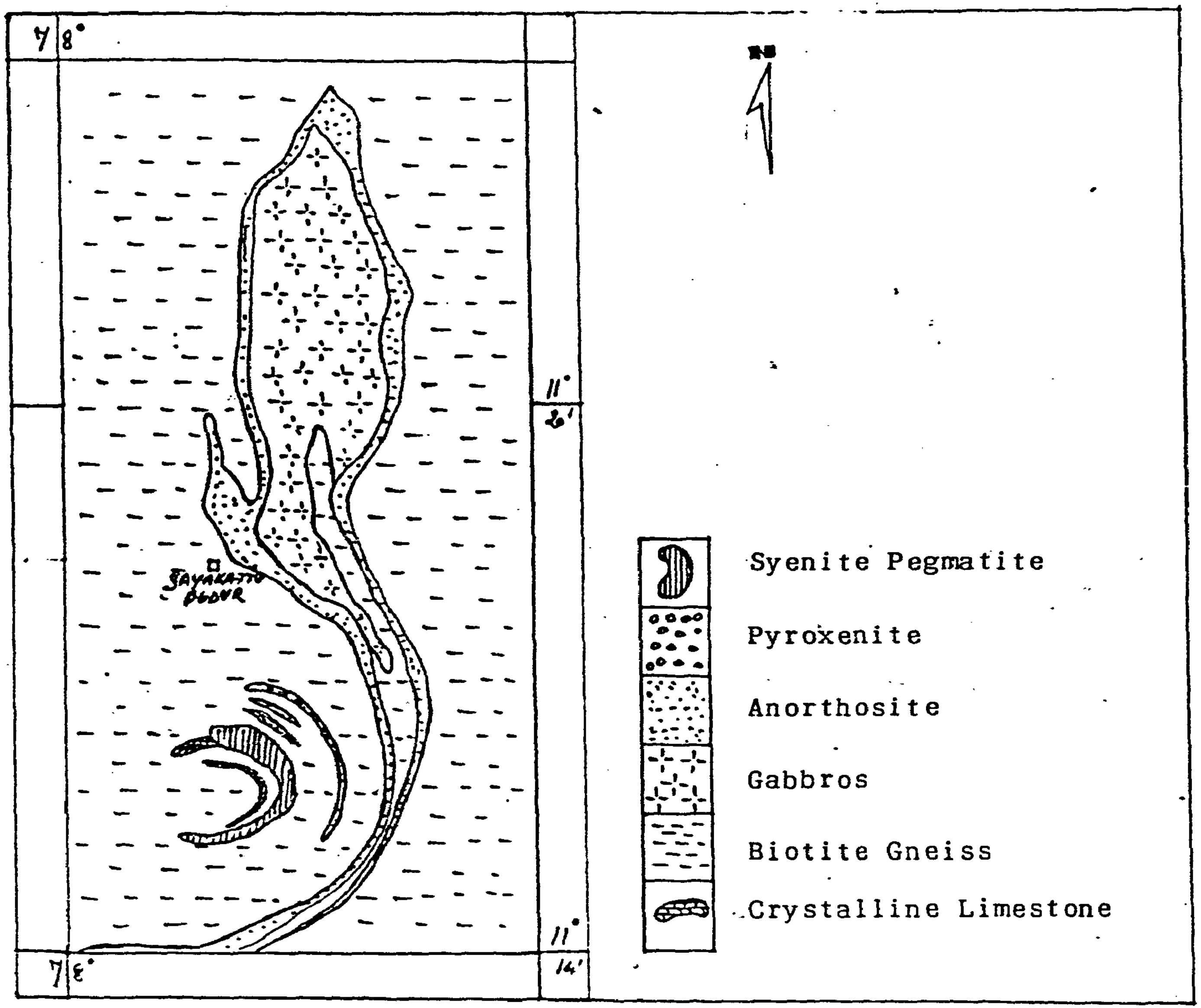
1.4 Recent studies

Ramadurai, Sankaran, Selvan and Windley presented the stratigraphic and structure of Sittampundi complex at Tamil Nadu in India in the year 1975. They found certain descriptions in the geological map of Sittampundi prepared by Subramanian. According to them most complex is occupied by anorthosite **sensu sticto** with less than 10% mafic mineral, which contain many thin **relict** layered and lenses of variety of rocks such as chromitite, garnetpyroxene rocks (Sittampundi eclogite), gabbro with or without garnet, hornblendite green mica rock (fuchsite?), peridotite, anthophyllite rock and diopsitite. Though these rocks do not appear to have sufficient regular distribution to enable a stratigraphy to be erected, the presence of chromitite forms a stratigraphic marker.

The stratigraphic recognised by them in the NE of the area is given below:

	Max. width (metre)
Top Clinozoisite anorthosite	150
Hornblende anorthosite	75
Gabbro (with 100 m long inclusion of pyroxenite)	750
	975

FIG. 7



(after Ramadurai, 1969)

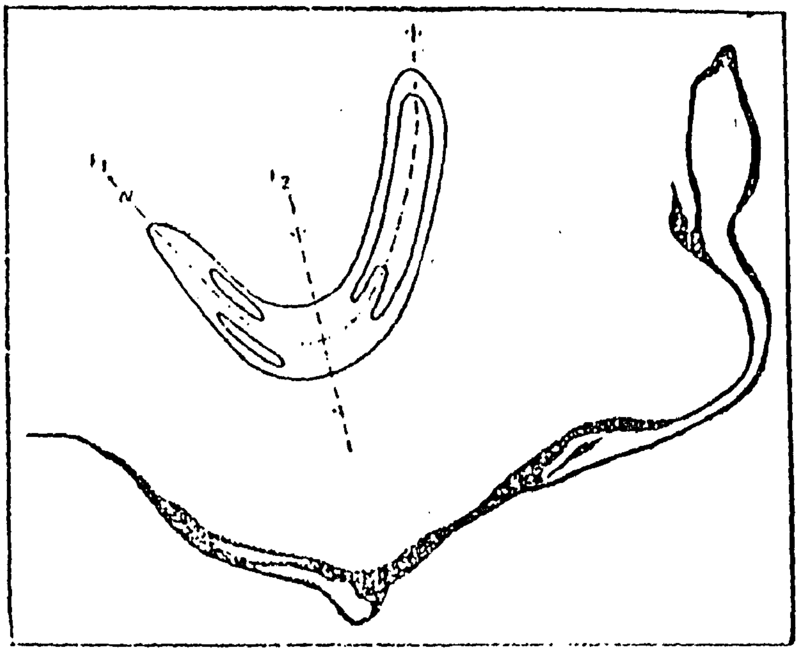


FIGURE. 8 .SHOWS FOLD INTERFERENCE PATTERN (after Ramadurai, et al, 1975).

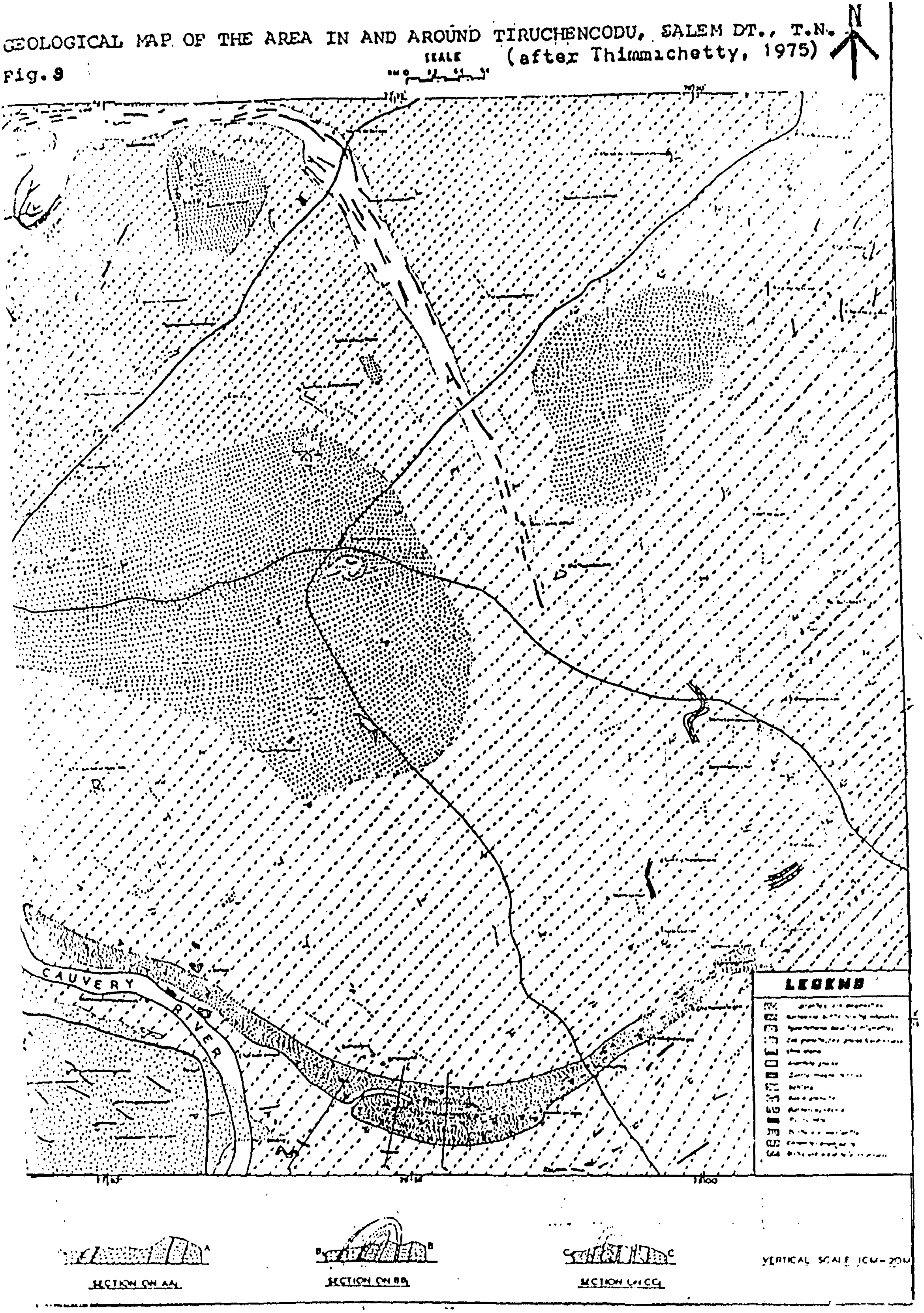
Chromite seams in the anorthosites reach six metres in width and can be followed semi-continuously for two kms (Ramadurai et al, 1975). Several interesting mineral assemblages occur in the anorthosite close to the chromitite viz.., corundum-sillimanite, staurolite-sapphirine, kyanite and sillimanite-corundum-gedrite-sapphirine (Janardhanan and Leake, 1974). An isoclinal antiform found in the north east of the study area is shown in (Fig.7).

The geological map of Sittampundi complex prepared by Ramadurai et al, indicates a major departure form that of Subramaniam (1956) who suggested that the anorthosite was bordered on both sides by continuous amphibolite layers. Following Naidu (1960) Ramadurai et al (1975) emphasize the fact that these amphibolites an absent and the anorthosite is every where bordered by quartzofeldspathic hornblende-biotite gneisses.

Regarding the structure, Ramadurai et al point to two major deformation episodes that affected the complex giving rise to the present fold interference pattern(Fig. 8). The first deformation episode was responsible for the broad arcuate curvature of the Sittampundi, thus resulting in an open fold that plunges deeply to the south.

GEOLOGICAL MAP OF THE AREA IN AND AROUND TIRUCHENCODU, SALEM DT., T.N. (after Thimmichetty, 1975)

Fig. 9



Thimmichetty (1975) dealing on the geology and mineralogy of the area in and around Tiruchengodu Taluk, Salem District has mapped the Sittampundi complex area in order to find out the occurrence and distribution of garnet in meta-anorthosite series (Fig. 9).

He concludes that while the garnets of anorthite-gneiss and skarn rock are grossular rich and andradite rich respectively. The garnet of garnet-pyroxene rocks and basic granulites are pyropic and almandinic. The first two garnets indicate the composition of the sediments in which they were formed. The later two granulite facies are under the granulite-eclogite transitional facies.

The petrochemistry of the meta-anorthositic gabbro and garnetiferous granulites of the Sittampundi complex has been studied by Janardhanan and Leake (1975). Chemical analysis for major and trace elements of 21 meta-anorthositic hornblende gabbros, 9 mafic rocks mostly garnetiferous granulites and 15 country rocks and xenoliths are presented. The igneous origin of the complex is confirmed by the general influnence in Si and alk with fall of mg (Fig. 10); pronounced positive correlation of chromium and nickel with mg (Fig. 11); c against mg and Sr and mg against oxidation ratio (Fig. 12).

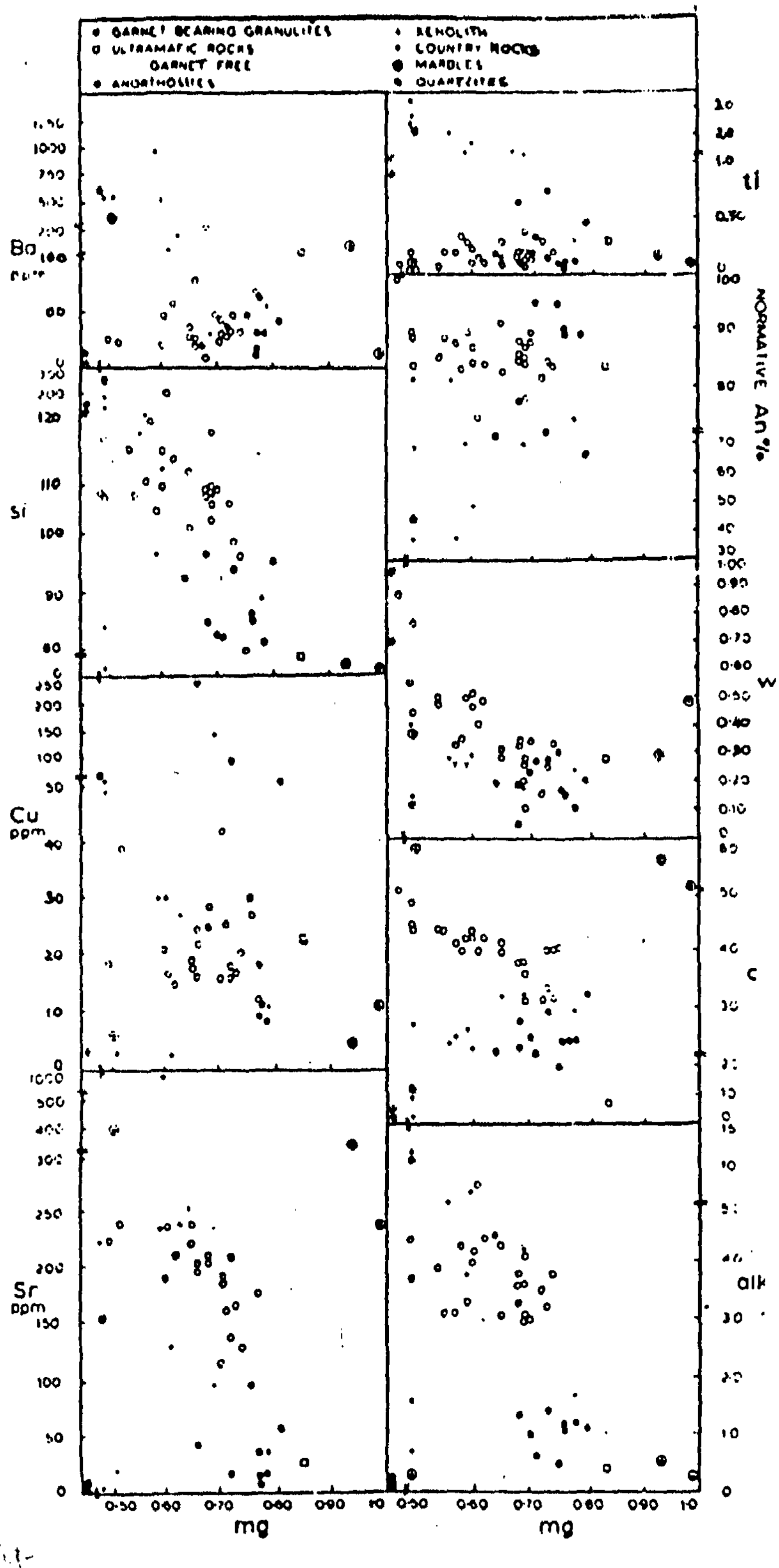


Figure 10 . Plots of Niggli mg against Ba ppm, Cu ppm, Sr ppm, Niggli Si, ti, w (=oxidation ratio), c and alk and also against normative An% for Sittampundi rocks. Samples analysed by Subramaniam (1956). (after Janardhanan et al, 1975).

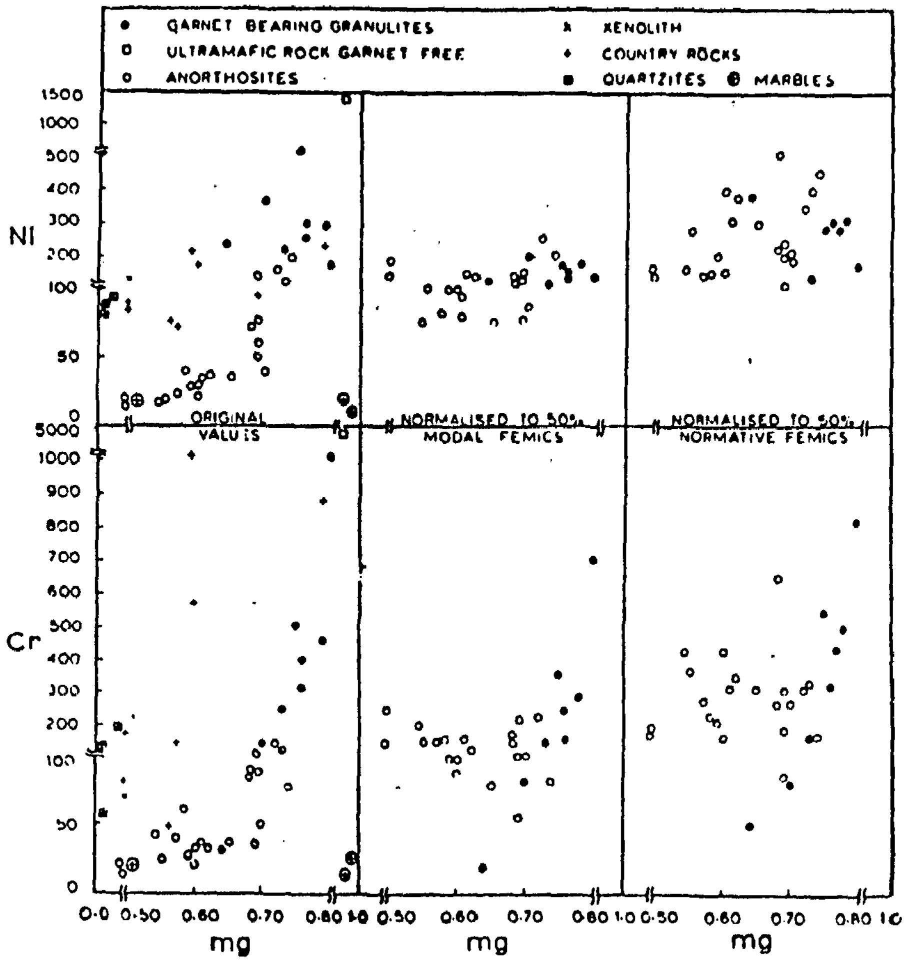


Figure:11 , Plots of Niggli mg against Ni and Cr contents in ppm showing the effect of normalising the Cr and Ni to allow for the differing proportions of mafic minerals in different anorthosite and granulite samples. (after Janardhanan and Leake, 1975).

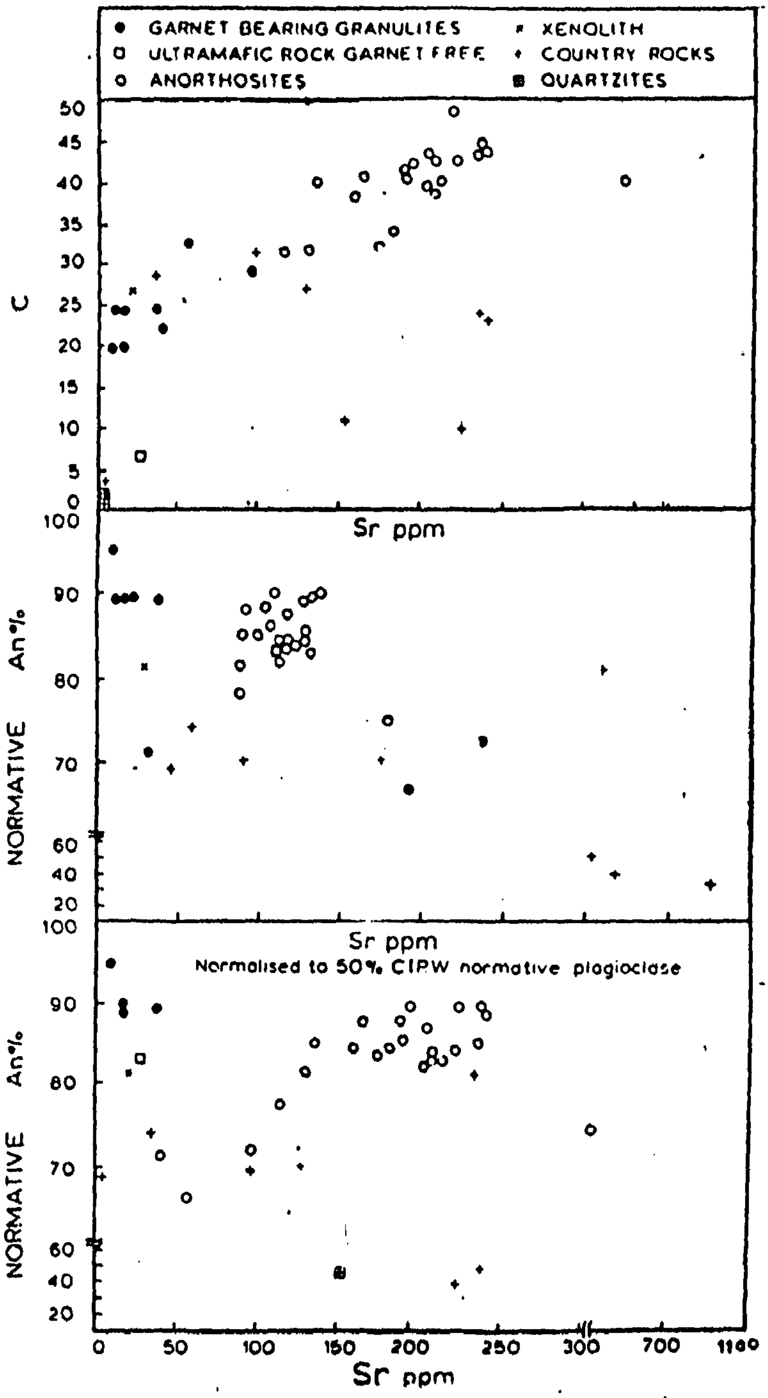


Figure 12. Plots of Sr ppm against Niggli c and normative An% also Sr, normalised to 50% normative plagioclase plotted against normative An% (after Janardhanan and Leake, 1975).

The granulites and meta-anorthositic rocks give congruent and therefore consanguinous igneous trends of variation suggesting they crystallised from one magma being the mafic and felsic portions separated by variable crystal settling. The meta-magmatic country rock especially the amphibolites are not part of the same suite.

Janardhanan and Leake (1975) point to the importance of normalising critical trace element contents (e.g. Cr, Ni and Sr) to constant mafic or felsic mineral percentage to allow for the widely differing abundances obtained from felsic rich and mafic rich rocks. This procedure allows igneous trends of variation to be much more critically appraised and in the present rock leads to the suggestion that some of the chromium in the meta-anorthositic rock was originally present as chromite a view in accordance with the occurrence of chromite rich layers in the intrusion.

Though a study on the hornblende in the meta-anorthositic rock was undertaken, Janardhanan and Leake (1975) state that it is difficult to distinguish whether it is recrystallised from primary igneous hornblende or derived by metamorphism of pyroxene, olivine and plagioclase.

Selvan (1980) is of the opinion that in the Sittampundi complex the metamorphism is subsequent and much later to the crystallized history of the Sittampundi complex.

Sabanayagam (1986) has investigated an anorthosite rocks of Sittampundi complex with special reference to garnet distribution. He has mapped the area in detail and found that the geological map prepared by Ramadurai et al (1975), very closely agreed with the observations by the author. However, Sabanayagam classified 5 lithological units namely,

1. Meta-sediments consisting of quartz magnetite rocks and calcite marble.
2. Garnetiferous granulite
3. Pyroxene bearing granulite
4. Meta anorthositic gabbros consisting of plagioclase hornblende rock garnetiferous plagioclase rock.
5. Peninsular gneiss and younger granite.

Mallik (1989) found indirect clue for the probable concentration of platinum group of elements (PGE) in layered mafic-ultramafic igneous complexes of Sittampundi. The platinum group of elements (PGE) in Sittampundi complex is present as dissemination of palladium-platinum-nickel sulphide in chromitite layers and are mainly connected with the axial plane schistocity of F_2 fold. Chromite sample away from the hinge of F_2, are practically devoid of PGE. It is inferred that F_2 deformation is responsible for small scale dissemination of PGE by remobilization and recrystallization.

1.5 Aims of Study

In the light of recent investigations on the genesis of anorthosites the author reviews the earlier work on anorthosite complex at Sittampundi with special reference to chromite bearing zones and his observations on chromite ores of Sittampundi complex.

1.6 Methods of Study

The review on previous literature brings out diverse opinion on the formation of anorthosite at Sittampundi, it is proposed to study an anorthosite complex under the light of latest informations available and intensive field work study supported by field photographs.