CHAPTER V

CHARNOCKITE SERIES

INTRODUCTION

The Charnockite Series of Tirunelveli is characterized by basic and acid members. Among them the acid type is the most abundant variety and it is mostly comprised of enderbite and its variants. Charnockite is not encountered and the ultrabasic component of the Charnockite Series is rare. The members of the Charnockite Series resemble the corresponding variants which occur in force in Tamilnadu. It is intended to describe and discuss in this chapter the field and petrological characteristics of the Charnockite Series of Tirunelveli.

The distribution of the components of the Charnockite Series of the thesis area is depicted in Fig.7.

FIELD CHARACTERISTICS

The ultrabasic member is represented by pyroxenite. It occurs as ultrabasic schlieren in the patches of
MAP SHOWING THE DISTRIBUTION OF THE CHARNOCKITE SERIES OF THE THESIS AREA

EXPLANATION

FIG 7

ARCOT GRANITES

PINK GRANITE, PEGMATITE, APLITE AND PINK GNEISSIC GRANITE

CHARNOCKITE SERIES

ENDERBITES

BASIC GRANULITES

MAGNETITE QUARTZITE

DHARWARS

CALC-GRANULITES

PELITIC AND SEMI PELITIC GNEISSES AND GARNETIFEROUS GRANITE GNEISSES

RIVER
basic members immersed in enderbite in the hill 4 miles west-south-west of Govindapperi and in the basic band occurring one mile south of Amallur. Sometimes it is present as lenticular patches in the basic member and their length varies from 3' to 6". They display granulitic texture and are dark grey in colour. They are essentially comprised of dark glistening grains of pyroxenes. Granular pale yellow plagioclase is rare in between the grains of pyroxenes.

The basic members occur as bands, patches and fragments in enderbites, as narrow bands amidst Dharware and as patches and fragments in pink granites.

The longest band occurs in Vallimalai situated 3 miles south-west of Govindapperi and it is immersed in enderbite. It is folded as an antiform. It is nearly six miles long and about one mile wide at the nose of the antiform. It is dark grey in colour and is composed of dark glistening grains of pyroxenes and plagioclase. In places, it is traversed by narrow veins of pink granite and quarts. Along their contacts the basic member carries hornblende in addition to pyroxenes. Another basic band about one and a half miles long and two furlongs wide occurs one mile south of Palayankottai
and it is surrounded by enderbites. It is essentially comprised of pyroxenes and plagioclase and displays a granular texture.

West of Karisalkulas a band three miles long and about 2 furlongs wide is encountered amidst pelites and pink granites. It is a fine-grained granular rock and carries granular dark hornblende besides dark glistering pyroxene and pale yellow feldspars.

About 2 miles west of Karisalkulas, narrow bands varying in length from 100' to 200' and in width from 6' to 40' occur intercalated with Dharwars and pink granite (Plate IV, Fig.1). They display shearing and are converted to plagioclase amphibolites. They are characterized by faint foliation owing to the presence of oriented prisms of hornblende.

About 2 miles west-north-west of Kalakkadu and one mile west of Neddiyapatti, basic granulite folded in the form of synform occurs immersed in pink granite. Along the axis of the fold it is highly sheared and carries spangles of biotite. It is characterized by gneissose texture owing to the directional orientation of prisms of hornblende. It carries along the contact of pink granite much amount of spangles of biotite. Away from
the contact of granite biotite sparingly occurs associated with hornblende.

Narrow bands of basic members are often encountered amidst granites around Singikulam. The bands are characterised by detached fragments separated by narrow veins of pink pegmatite (Plate IV, Fig. 2). They are comprised of plagioclase and hornblende with minor amount of biotite, quartz and microcline-perthite. Sometimes narrow bands of basic granulites occurring amidst Dharwar are traversed by veins of pink granites (Plate IV, Fig. 3) which are less than 6" in width. The narrow layers of basic members occurring intercalated with pink granite are characterised by plagioclase amphibolite. Marginal to pink granite the main band of basic member comprised essentially of pyroxenes, hornblende and plagioclase carries spangles of biotite.

Two miles west-north-west of Kalakkadu a narrow band of basic granulite occurs immersed in granite. It is sheared along the contact of granite and carries granular pink garnet.

Around Pattamadai a narrow band of basic member occurring in enderbite displays contamination along the contact with calcareous members. The contaminated component is fine-grained and dark grey in colour. It carries
dark glistening diopside, pale yellow feldspar and occasional grey granular scapolite. About one mile west of Ambasamudram a narrow band of basic member occurring in enderbite carries xenoliths of calcareous member. They are enriched in phlogopite and wollastonite. Pale grey plagioclase occurs associated with wollastonite and granular scapolite is rare.

Enderbite occurs as distinct masses south of Manjolai Estate, in Valli Malai, about 2 miles south-west of Govindapperi, in Pattankadu Malai, 2 miles north-north-west of Govindapperi and in the hillocks located north of Ambasamudram (Plate IV, Fig.5). It also characterises the Manjolai Mottai and the plains around Sermadevi, Pattamadai, Omanallur and Mallakulam. The plains of Tirunelveli and Palayankottai are also comprised of enderbite. It displays granular texture and is pale bluish grey in colour. It is usually fine-grained but in places, it is medium-grained and granular. It is essentially comprised of pale blue-grey quartz and pale yellowish grey oligoclase and antiperthite with minor amount of grey glistening hypersthene.

Two miles east of Makkadai a narrow band of enderbite occurring amidst Dharwars displays fine foliation owing to directional orientation of spangles of biotite.
One mile south of Kallidaikarioni enderbite occurs as a sill amidst garnetiferous biotite gneiss and it is about 6" thick and carries fragments of xenoliths which are finely granular and dark grey in colour. They are essentially comprised of dark glistening biotite, grey feldspars, and occasional pink garnet (Plate IV, Fig. 6).

South of Padmaneri enderbite occurs as narrow bands intercalated with Dharwars and displays minor folding and thickening along the nose of the minor antiform (Plate IV, Fig. 7).

About half a mile east of Karandaneri basic member occurs as bands and patchies in enderbite (Plate IV, Fig. 9). They show pinch and swell structure and sometimes they are drawn out as lenticular patchies separated by intervening layers of enderbite.

Around Jermadevi, north-west of Govindapperi and north-west of Padmaneri enderbite carries bands, patchies and fragments of basic granulite and sometimes along the contact of basic granulite it carries minute fragments of basic member of 1 mm in diameter and has the appearance of migmatis. The dark grey fragments are finely granular and are comprised of dark glistening pyroxenes and pale yellow andesine.
Near Omanallur, one mile south of Karisalkulam, and two miles south of Singampatti, garnetiferous enderbites are encountered and they have faintly banded appearance. Pale yellowish grey layers varying in width from half an inch to one-fourth of an inch alternate with narrow grey layers carrying streaks of pink garnet and spangles of biotite.

Half a mile north of Maragalkurichonchi contaminated enderbite occurs along the contact of silicaceous member and enderbite. It is dark grey in colour and carries dark glistening grains of diopside, pale grey feldspars and grey granular quartz.

In the enderbite one and a half miles north-east of Ambasamudram semipelitic members sometimes occur as xenoliths. They are white in colour and finely granular. They are essentially comprised of white feldspars, granular colourless quartz and occasional pink garnet.

One mile west of Maragalkurichonchi and one mile south of Kallidakurichonchi the pelitic xenoliths occur in enderbite (Plate IV, Fig.3). They are fine-grained and dark grey in colour. They are such garnished in biotite, pale grey feldspars and colourless quartz and carry occasional needles of sillimanite and granular pink garnet.
The lenticular patches vary in length from 3" to 2' and in width from 1 inch to one-fourth of an inch.

Sometimes, enderbite-pegmatite occurs as veins in enderbite. It is comprised of coarse grains of dark grey microcline-perthite and yellowish grey grains of quartz and oligoclase.

Along the axis of the major folds enderbites are highly sheared and carry lenticular patches of mylonites and ultramylonites which were designated as Trap Shotten gneisses by King and Poole (1865). They occur as dark compact lenses varying in length from 1" to 3" amidst the enderbites. Sometimes anastomosing stringers are sent in different directions from the lenticular patches of mylonites.

Three miles south of Palayankottai, and in Pattankadu Malai, Vallimalai and Manjolai Mottai, enderbite is intruded by pink granite (Plate IV, Fig.4). Along the contact of pink granite and enderbite fragments of varying sizes of enderbite occur in pink granite. North of Karendaneri, 2 feet wide band of granite cuts across enderbite (Plate IV, Fig.10). North of Sengiculam enderbite occurs as a band immersed in pink granite (Plate IV, Fig.11).
Adjacent to pink granite enderbite carries porphyroblasts of potash feldspar. Sometimes, porphyroblasts of plagioclase also occur associated with books of biotite. One mile east of Karandaneri enderbite carries porphyroblasts of plagioclase associated with biotite and pink garnet adjacent to pink granite.

Adjacent to masses and veins of pink granite, enderbite is invariably altered to dark grey granodiorite gneisses. One mile south of Jermadevi garnetiferous biotite enderbite shows a gradational passage to pale grey granite gneiss. It is coarse grained and carries pale grey microcline and grey quartz. Granular pink garnet and spangles of biotite occur in minor amount. In Manjolai mottai, enderbite is sheared along the contact with granite and is traversed by veins of pink granite and quartz. It is extensively altered to grey garnetiferous biotite granite gneiss. In places, grey gneisses are highly siliceous owing to the presence of quartz veins.

One mile south of Singikalam dark grey granodiorite gneiss shows gradational passage to pale greyish pink adamellite gneiss. It displays foliation owing to the presence of closely spaced axial plane cleavages.
Around Gopalasamudram dark grey acid gneiss occurs as xenoliths in pink granite. They are finely granular and are characterized by pale yellow feldspars, pale grey quartz and occasional granular pink garnet. In places, enderbite and dark grey acid gneisses display two sets of well-developed joints (Plate IV, Fig. 12).

**PETROGRAPHY**

**NOMENCLATURE:**

Holland (1900) grouped under the term Charnockite Series a number of rock types genetically related to charnockite. He classified the Charnockite Series into four divisions, namely, ultrabasic, basic, intermediate and acid divisions. Under the ultrabasic division he included pyroxenite and baihaitite. He designated the basic members as norites. Under the intermediate division he grouped the rocks carrying minerals present in both basic member and charnockite. Charnockite was included under acid division. Later, Willey (1937) added another variety to acid member and called it enderbite.
EXPLANATION TO PLATE IV

Fig. 1  Field photograph of narrow bands of basic members intercalated with Dharwars and pink granite, in the middle portion of Kolundamamalai in the western division.

Fig. 2  Field photograph of basic member occurring as boudins separated by narrow veins of pegmatite near Singikulam in the central portion of the central division.

Fig. 3  Field photograph showing basic member of Charnockite Series traversed by veins of pink granites at the base of Kolundamamalai.

Fig. 4  Field photograph showing enderbite traversed by veins of pink granite south of Palayankottai in the eastern division.

Fig. 5  Field photograph showing the occurrence of enderbite as distinct masses in Vallimalai located two miles north-north-west of Govindapperi in the central portion of the western division.

Fig. 6  Field photograph showing the occurrence of enderbite as sills in garnetiferous biotite gneiss one mile south of Kallidaikurichi.
Fig. 7 Field photograph of enderbite occurring as narrow bands in semipelites and showing thickening along the nose of the minor antiform, north of Pudmaneri in the eastern portion of the western division.

Fig. 8 Field photograph of pelitic xenoliths in enderbite one mile south of Kallidaikurichi in the western portion of the western division.

Fig. 9 Field photograph showing the occurrence of bands and patches of basic member in enderbite about half a mile west of Karandaneri in the south eastern portion of the central division.

Fig. 10 Field photograph showing enderbite cut across by granite, north of Karandaneri in the south eastern portion of the central division.

Fig. 11 Field photograph showing the band of enderbite immersed in pink granite, north of Singikulas in the central portion of the central division.

Fig. 12 Field photograph showing well developed vertical joints in the basic member of Charnockite Series half a mile south-west of Devanallur, south western portion of the central division.
In Tirunelveli, the ultrabasic member is represented sparingly by pyroxenite which carries in places sparingly pale grey plagioclase. The basic components are comprised of noritic and dioritic members. Along the contact of calcareous member, the basic member of Charnockite Series has absorbed material of sedimentary origin and has given rise to a rock of abnormal composition. Read (1921, p. 177) designated such rocks resulting from the assimilation of sedimentary material "Contaminated igneous rocks". Following Read, the basic member showing abnormal composition has been designated as contaminated basic granulite. The acid member is comprised of enderbite and its variants. Adjacent to pink granite, pegmatite and quartz veins the basic member is converted to plagioclase amphibolite and enderbite to dark grey acid gneisses.

ULTRABASIC DIVISION:

The ultrabasic member is pyroxenite. It is a medium-grained dark grey granular rock (A.117) characterised by dark glistening grains of pyroxene. Pale yellowish grey granular labradorite is rare.

In thin section, it displays a xenomorphic granular texture (Plate V, Fig. 1). It is essentially comprised of broad irregular plates and grains of
hypersthene and augite (Plate V, Fig. 1). Hypersthene is pleochroic from pink to pale green, the scheme being, \( X = \text{pink}, Y = \text{colourless}, Z = \text{pale green} \). In places, it displays (100) twin lamellae. \( 2V_x = 74^\circ; M_g = 1.690; M_x = 1.678 \). Augite is pale green in colour. A few plates display (100) twin lamellae. \( 2V_x = 59^\circ; M_a = 1.694; Z \wedge C = 44^\circ \). Hornblende sometimes occurs marginal to pyroxene. Magnetite and apatite are present as lumps marginal to pyroxenes. Labradorite is rare and its anorthite content is \( An_{70} \).

**BASIC DIVISION:**

BASIC division is comprised of hypersthene-augite-labradorite granulite, hornblende-hypersthene-augite-andesine granulite, biotite-hypersthene-augite-andesine granulite, garnetiferous hypersthene-augite-andesine granulite, contaminated basic member and plagioclase amphibolite.

**HYPERSTHENЕ-AUGITE-LАBRAДORITЕ GRANУLITЕ:**

Hypersthene-augite-labradorite granulite (A.113) is a dense granular greyish black rock comprised of dark glistening pyroxene and pale yellow feldspars.
In thin section it displays a xenomorphic granular texture. Labradorite occurs as anhedral plates and grains and shows twin lamellae. Its anorthite content is An$_{55}$. Augite is pale green in colour and sometimes displays (100) twin lamellae. It occurs as irregular prismatic plates and grains. Anhedral plates and grains of hypersthene are pleochroic from pink to pale green, the scheme being, X = pink; Y = colourless; Z = pale green. $2V_x = 56^\circ$; $N_g = 1.729$. Its inferred composition according to Deer, et al (1963) is En$_{45}$ - Fs$_{55}$. Lumps of magnetite are present marginal to pyroxene. Tattered grains of hornblende and flakes of biotite are rare.

HORNBLENDE-HYPERSTHENE-AUGITE-ANDESINE-GRANULITE

Hornblende-hypersthene-augite-andesine granulite (A.74) is a dark grey fine-grained granular rock with dark glistening grains of pyroxene and hornblende and pale yellow feldspars.

In thin slice it displays a granulitic texture. Anhedral plates and grains of andesine display in places reverse zoning. The anorthite content of the core is An$_{42}$ and that of the mantle is An$_{48}$. Sometimes it displays reverse zoning around different centres in a single plate. Hypersthene is pleochroic from pink to pale green.
$2\nu_x = 59^\circ$; $n_g = 1.707$. Its inferred composition following Deer, et al (1962) is $\text{An}_{50} \text{Fs}_{40}$. Augite is subordinate interstitial to hypersthene and shows alteration to hornblende. Hornblende occurs as prismatic plates and sometimes wraps around hypersthene. It is pleochroic from greenish brown to pale yellow, the scheme being, $X =$ pale yellow; $Y =$ yellowish green; $Z =$ greenish brown. $2\nu_x = 81^\circ$; $n_g = 1.669$; $Z \wedge C = 21^\circ$. Lumps of magnetite and apatite occur marginal to hypersthene and hornblende.

**BIOTITE-HYPERSTHENE-AUGITE-ANDESINE GRANULITE**

Biotite-hypersthene-augite-andesine granulite (A.122) is a fine-grained dark grey granular rock with dark glistening grains of pyroxene, spangles of biotite and pale yellowish grey feldspars.

Under the microscope, it shows a granular texture. Andesine occurs as irregular plates and grains and displays variation in anorthite content from $\text{An}_{46}$ to $\text{An}_{40}$. A few grains display undulate extinction owing to indistinct zoning. Irregular prismatic plates and grains of hypersthene are pleochroic from pale pink to colourless. In places, it displays (100) twin lamellae. Colourless augite is rare. Laths of biotite are pleochroic from brown to pale yellow. Lumps of apatite sometimes occur
in the plates of andesine. Magnetite is present as an accessory.

Garnetiferous-hypersthene-augite-andesine granulite:

Garnetiferous-hypersthene-augite-andesine granulite (A.209) is a dark grey, fine-grained, granular rock with dark glistening grains of pyroxene, pale yellow feldspars and occasional grains of pink garnet.

In thin section, it displays a granulitic texture. Andesine shows polysynthetic twinning lamellae and its anorthite content ranges from \( \text{An}_{44} \) to \( \text{An}_{38} \). Colourless plates of augite sometimes show \((100)\) twin lamellae. Hypersthene is feebly pleochroic from pale pink to colourless. \( 2V_\lambda = 54^\circ; N_\lambda = 1.724 \). Its inferred composition following Deer et al (1962) is \( \text{En}_{47} \text{Fs}_{53} \).

Garnet occurs as irregular grains (Plate V, Fig.2) and is pale pink in colour. Lumps of magnetite occur marginal to pyroxene and apatite is present as an accessory.

Contaminated basic member:

Contaminated basic member (A.89, A.252) is a fine- to medium- grained granular rock with glistening grains of diopside and pale yellow feldspars. Sometimes it (A.252) carries coppery red patches of phlogopite and pale grey wollastonite.
In thin slice (A.39) labradorite occurs as twinned plates and grains. Its anorthite content is An 70. Diopside is present as prismatic plates and grains (Plate V, Fig.3) and is pale green in colour. Sometimes, it occurs as blebs in the plates of labradorite.

$2V_g = 59^\circ$; $Z \wedge O = 42^\circ$; $N_m = 1.711$. Its inferred composition following Winchell (1951) is $Na_{45}Fe_{25}Mg_{32}$. Sphene occurs marginal to diopside and is slightly pleochroic from brown to pale brown. In places, diopside shows alteration to greenish brown hornblende. Sometimes laths of biotite pleochroic from dark brown to pale yellow are present marginal to hornblende. Section (A.252) carries patches enriched in phlogopite and wollastonite. Sphene occurs as lumps in the plates of wollastonite.

**PLAGIOCLASE AMPHIBOLITE:**

Plagioclase amphibolite (A.43, A.4) is a granular or finely foliated dark grey rock with dark glistening grains of hornblende, spangles of biotite and granular pale yellow feldspars.

Under the microscope it shows a granular texture (Plate V, Fig.4). Andesine occurs as irregular grains and its anorthite content varies from An 38 to An 32.
Prismatic plates and grains of hornblende are pleochroic from greenish brown to pale yellow. 2V<sub>g</sub> = 82°; Z = 0°; N<sub>a</sub> = 1.670. Lumps of magnetite are present in the plates of hornblende. Laths of biotite occur marginal to hornblende and are pleochroic from yellowish brown to golden yellow. Granular sphene is pale brown in colour and occurs marginal to hornblende. Sometimes, andesine shows alteration to calcite. Prisms of apatite are present as an accessory. In places, quartz occurs as veins interstitial to andesine and microcline-perthite is rarely associated with quartz vein.

**ACID DIVISION:**

The acid division is characterized by migmatic enderbite, enderbite, garnetiferous biotite enderbite, contaminated enderbite, mylonitic enderbite and enderbite pegmatite. In places, enderbite carries xenoliths of country rocks. Along the contacts with pink granite enderbite is reduced to dark grey acid granulites and gneisses.

**MIGMATITIC ENDERBITE:**

Migmatic enderbite (A.31) is a fine-grained granular rock and carries dark grey clots. The fine-
grained dark grey granular material is comprised of granular blue grey quartz, pale yellow feldspar, and dark bluish grey grains of hypersthene. The dark grey clots are essentially characterised by clusters of pale yellowish grey plagioclase associated with dark grey hypersthene and splinters of biotite.

Under the microscope, it shows a patchy texture owing to the presence of clusters of anhedral grains of andesine and prismatic grains of hypersthene amidst plates and grains of quartz, andesine and antiperthite. The anorthite content of andesine which comprises the patches is An$_{38}$. The broad plates and irregular grains of andesine associated with quartz display variation in anorthite content from An$_{35}$ to An$_{32}$. Plates of antiperthite also display a similar variation in anorthite content. Irregular plates and grains of quartz carry dusty inclusions and display undulose extinction. Hypersthene occurs associated with clusters of andesine and is pleochroic from pink to pale green. Hypersthene associated with plates of quartz and laths of biotite is feebly pleochroic from pale pink to colourless. Magnetite and apatite are present as accessories.

**EMEBRITE**

Enderbite (A.135) is a pale bluish grey medium-
to fine-grained granular rock comprised of pale bluish grey quartz, pale yellowish grey feldspars and dark glistening hypersthene.

In thin section, it shows a xenomorphic granular texture owing to the presence of plates and grains of quartz and feldspars. Quartz carries dusty inclusions and displays wavy extinction. Feldspars are represented by antiperthite and andesine. Antiperthite occurs as broad irregular plates and its anorthite content varies from An$_{33}$ to An$_{35}$. Andesine is present as irregular plates and grains and ranges in anorthite content from An$_{36}$ to An$_{32}$. Irregular prismatic plates of hypersthene is pleochroic from pale pink to colourless. 2V$_x$ = 55°; $N_g$ = 1.732. Sometimes, it shows (100) twin lamellae. Lumps of magnetite, prisms of apatite and granular siron occur as accessories.

**GARNETIFEROUS BIOTITE ENDORBITE:**

Garnetiferous biotite endorbite (A.12) is a banded rock with pale yellowish grey layers alternating with grey ones. The pale yellowish grey layers are comprised of pale yellowish grey plagioclase and grey quartz. The grey layers carry pale yellow feldspars, pale grey quartz, dark glistening hypersthene, spangles of biotite and granular pink garnet. Sometimes, it is devoid of banding and occurs as a dark grey granular rock (A.80).
In thin section it is essentially comprised of irregular plates and grains of andesine, with minor amount of hypersthene (Plate V, Fig. 5). Andesine and antiperthite are invariably twinned and their anorthite content varies from An$_{35}$ to An$_{30}$. Prismatic plates of hypersthene are pleochroic from pink to greyish green. Granular garnet is pink in colour and occurs marginal to hypersthene. Drops of deep green spinel are sometimes present in garnet. Biotite occurs marginal to hypersthene and garnet is reddish brown in colour. Magnetite and apatite are present as accessories.

**CONTAMINATED ENDERBITE:**

Contaminated enderbite (A. 149, A. 149) is a fine-grained dark grey granular rock with dark glistening grains of diopside, grey quartz and pale yellowish grey andesine.

Under the microscope, it shows a xenomorphic granular texture. Andesine and antiperthite display variation in anorthite content from An$_{48}$ to An$_{40}$. Quartz occurs as irregular plates and grains interstitial to plagioclase. Diopside occurs as colourless grains and sometimes shows alteration to yellowish green hornblende. Lumps of sphene occur interstitial to andesine (Plate V, Fig. 6) and in
the plates of andesine.

**MYLONITIC ENDERBITE:**

Mylonitic enderbite (A. 166) is a dense dark grey rock and carries lenticular aphanitic patches of mylonite. Under the microscope, it is highly crushed and carries lenticular plates and grains of quartz, andesine, occasional antiperthite and hypersthenes. Andesine displays bent twin lamellae and shows undulose extinction. Quartz occurs as elongate plates and grains and invariably displays wavy extinction. Hypersthenes is traversed by cracks and carries dusty inclusions. It is colourless and non-pleochroic. Biotite displays bent cleavages and carries dusty magnetite along the cleavages. The mylonitic patches are seen to be comprised of dusty greyish black matrix, which flows around elongate grains of quartz and andesine.

**ENDERBITE PEGMATITE:**

Enderbite pegmatite (A. 112) is a coarse-grained dark grey rock characterized by coarse crystals of microcline-perthite and medium-grained granular pale grey feldspar and grey quartz.
In thin slice microcline-perthite occurs as irregular plates and carries inclusions of irregular grains of oligoclase and antiperthite. Myrmekite is present along their contacts. Quartz occurs as broad plates and irregular grains and carries dusty inclusions. Granular siron and prisms of apatite occur as accessories.

**Xenoliths in Enderbite:**

Sometimes, xenolith of semipelite is present as granular patches which are white in colour. They are comprised of grains of white feldspars, colourless quartz and spangles of biotite.

In thin slice (A.51) microcline-perthite carrying spindles and stringers of sodaclase occur interstitial to irregular grains of quartz. Myrmekite occurs along the contact of antiperthite and perthite. Sometimes, irregular plates of antiperthite carry highly turbid grains of oligoclase. Laths of biotite are pleochroic from orange brown to pale orange yellow. Granular siron and apatite are present as accessories.

In places, xenolith of pelitic member (A.51) occurs as clots, and narrow patches in enderbite. The clots and patches are essentially comprised of coarse
plates of biotite, coarse grains of garnet, pale yellowish grey feldspars, grey quartzs and occasional needles of sillimanite.

In thin slice, they are comprised of broad plates and grains of fibrous perthite, anhedral plates and grains of quartz, porphyroblasts of pink garnet with stumpy prisms of sillimanite, rounded grains of quartz and laths of biotite. Sometimes, stumpy prisms of sillimanite are immersed in the plates of quartz and fibrous perthite. Granular sericite and apatite are rare.

**DARK GREY ACID GRANULITSES AND GNEISSES:**

Dark grey acid granulites and gneisses occur between enderbite and pink granite. They are dark grey to pinkish grey in colour and are characterized by granodioritic, adamellite and granitic members.

**DARK GREY GRANODIORITE:**

Dark grey granodiorite (A.14) is a dark grey granular rock characterized by pale yellowish grey feldspar, grey quartzs and spangles of biotite.

In thin section, it displays a xenomorphic granular texture. Broad irregular plates and anhedral grains
of oligoclase shows twinning lamellae and the anorthite content varies from An$_{30}$ to An$_{26}$. Antiperthite is subordinate and is present interstitial to oligoclase (Plate V, Fig.7). Its anorthite content is An$_{32}$. Microcline-perthite is very subordinate and myrmekite sometimes occurs along the contacts of oligoclase and microcline-perthite. Quartz occurs as elongate plates and grains interstitial to feldspars and shows undulose extinction. Laths of biotite are pleochroic from brown to straw yellow. Lumps of magnetite and apatite are present marginal to biotite. Zircon occurs as an accessory. In places, the dark grey granodiorite gneiss is crushed and displays a gneissose texture. In thin slice it shows a mortar texture.

**DARK GREY ADAMELLITE:**

Dark grey adamellite (A.111, A.168) is a dark grey finely foliated rock characterized by pale yellowish grey feldspars, grey quartz and glistening flakes of biotite.

In thin section, it is more or less similar to dark grey granodiorite gneiss but carries equal amount of oligoclase and microcline perthite. Antiperthite is subordinate. Myrmekite sometimes occurs along the contact of
oligoclase and microcline-perthite (Plate V, Fig.9). Quartz occurs as irregular plates and grains interstitial to feldspars and shows undulose extinction. Laths of biotite are pleochroic from brown to pale yellow. Granular sillimanite and slender prisms of apatite are present as accessories. Sometimes, it displays a gneissose texture.

DARK GREY GRANITE :

Dark grey granite (A.231) is a medium-grained granular rock comprised of pale yellowish grey feldspars, grey quartz and dark glistening flakes of biotite.

In thin section, it displays a xenomorphic granular texture. Microcline-perthite is present as broad plates and anhedral grains. Irregular grains and plates of quartz occur interstitial to perthite and carry trails of dusty inclusions. Oligoclase is subordinate and the anorthite content is \( \text{An}_{24} \). Myrmekite is rare. Laths of biotite are pleochroic from brown to straw yellow. Granular magnetite occurs marginal to biotite. Apatite and sillimanite are present as accessories.

The modes of the components of the members of Charnockite Series are listed in Table V.
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**Total**

1. **A.117** Pyroxenite. Location: Four miles south west of Govindappuri.
2. **A.113** Hypersthene-augite-labradorite granulite. Location: One mile west of Badhipatty.
3. **A.74** Hornblende-pyroxene-plagioclase granulite. Location: One mile south of Palayankottai.
4. **A.205** Garnet-pyroxene-plagioclase granulite. Location: Two miles west north west of Kalakkadu.
5. **A.89** Contaminated basic granulite. Location: Around Pattanamattai.
7. **A.4** Biotite-hornblende-plagioclase-microcline granulite. Location: Two miles west of Karisalkulam.
8. **A.135** Enderbite. Location: 2 miles south west of Govindappuri.
10. **A.14** Dark gray granodiorite gneiss. Location: One mile south of Singikulam.
11. **A.168** Dark gray adamellite. Location: Around Gopalsamudram.
12. **A.231** Dark gray granite gneiss. Location: One mile south of Veramadvi.
EXPLANATION TO PLATE V

Fig. 1  Photo-micrograph of pyroxenite (A.117) showing broad prisms of hypersthene and plates of clinopyroxene and lumps of magnetite. X Nicols. X 20.

Fig. 2  Photo-micrograph of garnet-hypersthene-augite andesine granulite (A.205) showing twinned plates of plagioclase, clusters of pyroxene and dark patches of garnet. X Nicols. X 20.

Fig. 3  Photo-micrograph of contaminated basic member (A.252) showing prismatic prisms and grains of diopside associated with plates of labradorite. X Nicols. X 20.

Fig. 4  Photo-micrograph of plagioclase amphibolite (A.4) showing twinned plates of andesine and prisms of hornblende, dark lumps of magnetite occur marginal to hornblende. X Nicols. X 20.

Fig. 5  Photo-micrograph of garnetiferous biotite enderbit (A.12) showing elongate prisms of hypersthene, laths of biotite, dark grain of garnet with inclusions of quartz, twinned grains of andesine and granular quartz. X nicols. X 20.

Fig. 6  Photomicrograph of contaminated enderbit (A.149) showing plates of antiperthite, grains of andesine, granular quartz and sphene in the center with irregular grains of diopside. X Nicols. X 20.

Fig. 7  Photomicrograph of biotite granodiorite gneiss (A.121) showing laths of biotite, grains of plagioclase, plates of antiperthite and granular quartz. X Nicols. X 20.

Fig. 8  Photo-micrograph of Adamellite gneiss (A.228) showing plates of migmakite occurring interstitial to antiperthite and microcline-perthite and associated with granular quartz. X Nicols. X 20.
PETROCHEMISTRY

Some fresh specimens of ultrabasic, basic and acid components of Charnockite Series were chemically analysed and their chemical analyses are presented in Table VI together with their norms.

Inspection of the analyses shows that the Charnockite Series is comprised of wide range of rocks ranging in composition from gabbro to granodiorite.

Though in essential respects there is an agreement with the members of the Charnockite Series and some magmatic rocks, the basic and acid components of the Charnockite Series are characterised by some deviations to suggest that they were formed from different magmas. For instance, the iron content of the basic member ($Fe : Fe+Mg = 67.88\%$) is high and the lime content is low. The acid member is characterised by higher ($Fe : Fe+Mg$) ratio (upto $90.05\%$). This deviation may be ascribed to the presence of ferrohypersthene in enderbite and rarity of clinopyroxene in them.

Fig. 8 is the Harker's variation diagram displaying the variation of constituents with increase in silica. There is increase of soda and potash and
**TABLE VI**

**CHEMICAL ANALYSES OF ULTRABASIC, BASIC AND ACID COMPONENTS OF CHARNOKITE SERIES OF THE THESIS AREA TOGETHER WITH THEIR NORMS**

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<td>47.69</td>
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<td>1.13</td>
<td>1.16</td>
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Total: 99.89  100.09  100.26  100.17  99.91  99.93  100.31  100.28

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FIG. 8 MARKER'S VARIATION DIAGRAM OF THE HORNROYITE SERIES OF THE THESIS AREA.
decrease of magnesia and lime from the ultrabasic to acid end.

In order to know the role of more refractive elements in the evolution of Charnockite Series of Tirunelveli, the values of Mg"\textsuperscript{2+}, Fe"\textsuperscript{3+}Fe"\textsuperscript{2+}" and Na'+K' have been plotted in the triangular variation diagram and the plots are shown in Fig.9. The scattering of points in the figure suggests that the basic and acid members were not derived from the same source.

Fig.9, is Ca"-Mg"-Na'+K' trilinear variation diagram. It shows similar scattering of points of the Charnockite Series of the thesis area.

Some believe that assimilation might have played a part in the formation of Charnockite Series. Bowen (1928, p.213) and Read (1921) do not rule out the possibility of formation of norite owing to the assimilation of slates by basic magma. The presence of orthopyroxene in the members the Charnockite Series has been ascribed to the absorption of argillaceous strata by Evans (1921, p.133). Role of assimilation of sediments in the evolution of Charnockite Series has been emphasised by Rama Rao (1940), Gevers and Dunne (1943), Barth (1945), Prider (1945) and Foldervaart and Backstorm (1949).
Fig 9: Variation diagram of the members of the charnockite series of the thesis area.

- Plagioclase granite
- Basic granite
- Basic granulite
- Migmatite enderbite
- Enderbite, or garnetiferous biotite enderbite
- Pyroxene
- Hornblende-pyroxene
- Plagioclase-granulite
- Biotite-pyroxene
- Plagioclase-granulite
- Garnet-pyroxene
- Plagioclase-granulite (contaminated)
- Basic granulite
- Migmatite enderbite
- Enderbite, or garnetiferous biotite enderbite

Fig 10: Variation diagram of the members of the charnockite series of the thesis area.

- Pyroxene
- Hornblende-pyroxene
- Plagioclase-granulite
- Biotite-pyroxene
- Plagioclase-granulite
- Garnet-pyroxene
- Plagioclase-granulite
- Contaminated basic granulite
- Migmatitic enderbite
- Enderbite
- Garnetiferous biotite enderbite
- Enderbite
of xenoliths of pelites and semipelites in the members of the Charnockite Series of Tirunelveli leads to the enquiry of the possible role of synektis of sediments in the evolution of Charnockite Series. To decipher this possibility, the atoms of different constituents of ultrabasic member, basic member, enderbite, and sillimanite gneiss were plotted as a variation diagram on the silicon basis (Fig. 11). It suggests there is a gradual increase of K', Na' and Al'' and decrease of Fe', Ca', Mg' and Ti' from the ultrabasic member to enderbite, but the continuity is disturbed from enderbite to sillimanite gneiss. This is not in favour of the probable evolution of Charnockite Series due to the synektis of pelites and basic magma. There are no indications at the surface to suggest that deep seated assimilation of pelites by basic magma and its differentiation might have taken place to give rise to enderbites. Very low amount of corundum in the norms of enderbites is not in accordance with their synektic evolution.

The plots of the ACP values of the minerals of the Charnockite Series are shown in Fig. 12 which is the ACP diagram of granulite facies for rocks with excess of silica. The plots lie in the field of hypersthene-diopside-anortosite garnet. This suggests that enderbite
FIG 11. THE VARIATION DIAGRAM OF THE ATOMIC PROPORTIONS OF THE ULTRABASIC, BASIC MEMBER, ENDERBITE AND GARNETIFEROUS BIOTITE-SILLIMANITE GNEISS PLOTTED ON THE SILICON BASIS
was emplaced under granulite facies conditions.

In order to know the chemical variation displayed by plagioclase amphibolites of the thesis area, they have been chemically analysed and their chemical analyses and norms are listed in Table VII. The analyses of basic members of Charmockite Series and their norms are shown in the table for comparison.

Inspection of the analyses suggests a progressive increase in silica, soda and potash and gradual decrease in magnesia, ferrous iron and lime from the basic components of Charmockite Series to plagioclase amphibolites. The variation displayed by them match favourably with the general trend of crystallisation - differentiation of basic magma (Jowen 1930, p.70).

To trace the variation displayed by alumina, magnesia, iron, lime and alkalies with increase in silica, the Niggli variation diagram has been constructed for the basic members of Charmockite Series and plagioclase amphibolites and it is shown in Fig.13.

The figure suggests the sympathetic behaviour of Al and alk to each other and their increase in trend
with the increase in silica. $f_m$ and $o$ display a slight decrease with increase in $s_i$. vans and Leake (1960, p.354) ascribed the decreasing trend of $f_m$ with increase in $s_i$ to magmatic differentiation.

To decipher the individual behaviour of soda and potash, $k$-$ag$ values of basic member of Charnockite Series and plagioclase amphibolites were plotted in the corresponding diagram of Lassen and peak and the plots are shown in Fig.14. The $k$, $ag$ values of the basic members and plagioclase amphibolites display a reciprocal relationship to each other. This suggests that they belong to the Pacific Suite.

Much discussion has taken place regarding the chemical difference between amphibolites evolved from sedimentary rocks and lenticular ones. Engel and Engel (1951), Lepadu-Dargues (1953), Rockelmann and Poldervaart (1957) and Wilcox and Poldervaart (1959) have discussed this problem.

In order to know the source rocks of the plagioclase amphibolites of Tirunelveli, the $o$ values were plotted against $ag$ in the Miggli variation diagram following Leake (1963, p.1194) and they are shown in Fig.15. The plots of the basic members and plagioclase amphibolites of the
thesis area do not display a trend parallel to the line joining mixture of clay and dolomite.

In order to trace the variation shown by $mg\cdot o\cdot (al\cdot alk)$, trilinear variation diagram of Miggli suggested by Leake (1963, p. 1196) has been prepared and it is shown in Fig. 16. The trend of the plots of the basic members of Charnockite Series and plagioclase amphibolites of Tirunelveli suggests an igneous source.

Fresh specimens of dark grey granodiorite, and granite of the thesis area were chemically analysed and their chemical analyses are shown together with their norms in Table VIII. The chemical analyses of enderbite and its norms are also listed in the Table for comparison.

Inspection of the analyses reveals that from enderbite to dark grey granite there is progressive decrease in FeO and Na$_2$O and increase in K$_2$O. SiO$_2$ shows a progressive decrease from enderbite to dark grey granodiorite and thereafter it shows a slight increase in dark grey granite. MgO initially shows an increase from enderbite to dark grey granodiorite and thereafter it displays a gradual decrease from dark grey granodiorite to dark grey granite. Similar behavior is displayed by CaO and Al$_2$O$_3$. There is a considerable decrease in Na$_2$O/K$_2$O ratio from
### TABLE VIII

**Chemical Analyses of Dark Grey Granodiorite and Granite Gneiss of the Thesis Area and the Analysis of Enderbite Reproduced from Table VI**

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<th>Constituents</th>
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<td>74.58</td>
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<td>$\text{TiO}_2$</td>
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<td>0.11</td>
<td>0.76</td>
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<td>$\text{Al}_2\text{O}_3$</td>
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<td>12.18</td>
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<td>1.56</td>
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<td>Na$_2$O</td>
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<td>$\text{H}_2\text{O}^+$</td>
<td>0.98</td>
<td>0.97</td>
<td>0.64</td>
</tr>
<tr>
<td>$\text{H}_2\text{O}^-$</td>
<td>0.24</td>
<td>0.16</td>
<td>0.26</td>
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**Total**

|       | 100.29 | 100.13 | 100.31 |

---

**NORMS**

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<tr>
<td>w</td>
<td>23.94</td>
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<tr>
<td>or</td>
<td>12.83</td>
<td>26.58</td>
<td>9.35</td>
</tr>
<tr>
<td>ab</td>
<td>31.69</td>
<td>23.92</td>
<td>33.47</td>
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<tr>
<td>an</td>
<td>14.73</td>
<td>5.50</td>
<td>7.36</td>
</tr>
<tr>
<td>e</td>
<td>1.01</td>
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<tr>
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</tr>
<tr>
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<tr>
<td>mt</td>
<td>1.71</td>
<td>1.59</td>
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<td>2.09</td>
<td>0.21</td>
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<tr>
<td>ap</td>
<td>0.02</td>
<td>0.02</td>
<td>0.14</td>
</tr>
</tbody>
</table>

---

1. **A.14** Dark grey granodiorite gneiss.  
   Locality: One mile south of Singixalam.  
   Analyst: P. Arumachalam.

2. **A.231** Dark grey granite gneiss.  
   Locality: One mile south of Sermadovi.  
   Analyst: P. Arumachalam.

3. **A.135** Enderbite.  
   Locality: 2 miles south west of Govindapperi.  
   Analyst: P. Arumachalam.
enderbite to dark grey granite and this suggests the probable evolution of dark grey granite from enderbite by gain of potash, owing to the intrusion of pink granite into enderbite of the thesis area. There is a slight increase in MgO from enderbite to dark grey granodiorite. This suggests that a small amount of MgO has been introduced to form more biotite in dark grey granodiorite. This is in accordance with the observation of Cheng (1942, p. 124).

Fig. 17 is the variation diagram prepared by plotting SiO₂ against other constituents. It suggests that from enderbite to dark grey granodiorite there is a slight fall in SiO₂ and thereafter it shows a slight increase in dark grey granite. FeO and Na₂O show a gradational decrease from enderbite to dark grey granite. MgO shows an initial increase from enderbite to dark grey granodiorite and thereafter it shows a gradual decrease. Similar behaviour is displayed by CaO and Al₂O₃. K₂O displays a progressive increase from enderbite to dark grey granite.

PETROGENESIS

It is intended to describe in this section of this chapter the field, mineralogical and petrological
characteristics that have a bearing on the origin of the members of the Charnockite Series of the thesis area.

FIELD CHARACTERISTICS

Enderbite occurs as huge masses in Vallimalai, in Pattankadu Malai and south of Manjolai mottai. West of Tirunelveli veins of enderbite cut across the semi-pelites and garnetiferous granite gneisses. North of Ambasamudram, west of Marugalkurichoni and in Vallimalai enderbite carries xenoliths of country rocks. Along the contact of calcareous members both basic member and enderbite of Charnockite Series display contamination.

The development of stumpy prisms of sillimanite in the pelitic members and porphyroblasts of microcline-perthite and pink garnet in the semi-pelite along the contact of enderbite suggest that contact metamorphism was of a higher degree. These field characteristics are in favour of an igneous origin for the members of the Charnockite Series. This is in accordance with the observation of Holland (1900, p.212).

The basic members are very subordinate and enderbite is the most abundant member of the Charnockite
Series in the thesis area. This is not in favour of the derivation of enderbite from a basic magma owing to fractional-crystallisation differentiation.

The members of the Charnockite Series display folding and they have undergone regressive changes along the contact of pink granite. Usually enderbites are converted to dark grey acid granulites and gneisses adjacent to pink granite. In places, the Charnockite Series displays shearing and carries mylonite and ultramylonite. These suggest that the Charnockite Series was subjected to tectonic disturbance after its formation.

MINERALOGICAL EVIDENCE:

The basic members of Charnockite Series and enderbites carry plagioclase feldspars. Labradorite and basic andesine are encountered in the basic members. Acid andesine and antiperthite are present in moderate amount in enderbite. Sometimes, the plagioclase feldspars of the members of the Charnockite Series display reverse zoning. Barth (1952, p.26) observes that metamorphic rocks are characterized by plagioclase that display reverse zoning. Hills (1936, p.135) ascribes reverse zoning displayed by plagioclase feldspars to sudden release of pressure during
crystallisation. In the thesis area sometimes a single plate of plagioclase displays reverse zoning along different centres. Therefore, the reverse zoning displayed by plagioclase feldspars of the members of the Charnockite Series of Tirunelveli may be attributed to chemical readjustment due to metamorphism that characterise the emplacement of pink granites.

*Antiperthite occurs in enderbites.* Tilley (1936, p.315) and Howie (1955, p.744) ascribe the presence of antiperthite in enderbite to its high temperature of crystallisation.

The orthopyroxenes present in the basic and acid members of the Charnockite Series were chemically analysed in order to know their composition and their analyses are listed in Table IX. Their formulae recalc-culated on the basis of 6 oxygen atoms and their composition in terms of their end members are also shown in the table. The basic member is comprised of orthopyroxene of composition En 40.52% and the endbite carries orthopyroxene of composition En 48.11%. The compositions of orthopyroxene in basic and acid members are not similar to those that belong to a differentiation series. Therefore, the basic and acid members might have formed from
TABLE IX

CHEMICAL ANALYSES OF THE OPHIOLITES FROM BASIC AND ACID MEMBERS OF THE CHARNOCKITE SERIES

<table>
<thead>
<tr>
<th>Constituents</th>
<th>1</th>
<th>2</th>
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<tbody>
<tr>
<td>SiO₂</td>
<td>49.98</td>
<td>49.31</td>
</tr>
<tr>
<td>TiO₂</td>
<td>0.29</td>
<td>0.18</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>3.97</td>
<td>2.12</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.71</td>
<td>0.97</td>
</tr>
<tr>
<td>FeO</td>
<td>26.89</td>
<td>32.10</td>
</tr>
<tr>
<td>MnO</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>MgO</td>
<td>16.99</td>
<td>13.61</td>
</tr>
<tr>
<td>CaO</td>
<td>0.43</td>
<td>1.18</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>K₂O</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>H₂O⁺</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>H₂O⁻</td>
<td>0.12</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Total 99.85  99.92

DISTRIBUTION OF IONS ON THE BASIS OF 6 (O) ATOMS

<table>
<thead>
<tr>
<th>Al</th>
<th>1.8931</th>
<th>1.9399</th>
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<tbody>
<tr>
<td>Al</td>
<td>0.1069</td>
<td>0.0601</td>
</tr>
<tr>
<td>Al</td>
<td>0.0761</td>
<td>0.0352</td>
</tr>
<tr>
<td>Ti</td>
<td>0.0082</td>
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<tr>
<td>Fe³⁺</td>
<td>0.0200</td>
<td>0.0288</td>
</tr>
<tr>
<td>Fe²⁺</td>
<td>0.8515</td>
<td>1.0557</td>
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<tr>
<td>Na</td>
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<td>0.0113</td>
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<tr>
<td>Mg</td>
<td>0.9386</td>
<td>0.7975</td>
</tr>
<tr>
<td>Ca</td>
<td>0.0175</td>
<td>0.0496</td>
</tr>
<tr>
<td>Na</td>
<td>0.0059</td>
<td>0.0046</td>
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</table>


different sources. This is in accordance with the observations of Howie and Subramaniam (1957, p. 594).

The occurrence of hornblende and biotite marginal to pyroxene in the members of the Charnockite Series and the gradational passage of enderbite to dark grey acid granulites and gneisses suggest the regressive changes suffered by the members of Charnockite Series owing to the emplacement of pink granite.

PETROGRAPHICAL EVIDENCE:

The ultrabasic member occurs as an ultrabasic schlieren in the basic types and it is comprised of hypersthene enriched in enstatite molecule and augite. Basic labradorite is rare. The basic members carry acid labradorite or basic andesine, hypersthene and augite. In the hornblende- and biotite-bearing components of the basic member ferronhypersthene is encountered together with basic andesine. This petrographical variation is similar to some of the basic rocks that have differentiated from a basic magma. The contamination displayed by the basic member along the contact with calcO-granulite suggests that the basic magma was involved in the formation of the basic members of the Charnockite Series of Pirunelveli.
Enderbites carry xenoliths of older rocks. Some of the xenoliths display hornfelsic texture. Under the microscope the minerals of the xenoliths have the tendency to occur as patches amidst the plates of quartz, andesine and antiperthite of enderbite. Sillimanite occurs as stumpy prisms. The migmatitic variant of enderbite carries minerals present in the basic members of Charnockite Series and they occur as clusters interstitial to quartz, andesine and antiperthite which comprise the enderbite. These suggest that the emplacement of enderbite was later than the Dharwar and basic members of the Charnockite Series. The presence of contaminated enderbite along the contact of enderbite and calc-granulite suggests that acid magma was involved in the formation of enderbite.

PETROCHEMICAL EVIDENCE:

The members of Charnockite Series display scattering of points in trilinear variation diagrams (Figs. 9 and 10). This suggests that the basic and acid members were derived from two independent sources.

In Fig. 11, there is a break in the continuity of variation of constituents from enderbite to sillimanite gneiss. In the norms of enderbites there is paucity of
cerundum. These are not in favour of syntectic evolution of enderbite from basic magma.

The plagioclase amphibolites display a chemical trend similar to basic igneous rocks.

CONCLUSION:

The basic components of the Charnockite Series of Tirunelveli suggest their probable formation owing to the differentiation of a basic magma that perhaps intruded as sills into the country rocks.

The abundance of enderbite and the paucity of occurrence of basic members are not in favour of the derivation of enderbite owing to the differentiation of basic magma. The presence of dry minerals like hypersthene and augite may be attributed to the consolidation of enderbitic magma under granulite facies conditions. Rakola (1952, p.168) observes that the attendant physical conditions and concentration of the components control the mineral composition of a rock. Therefore, he suggests that the same mineral assemblages may result by crystallisation of magmas as well as by metamorphic recrystallisation in the solid state.
The granular texture possessed by the members of the Charnockite Series, the irregular outline of pyroxenes in the acid member, the freshness of the minerals and the occurrence of antiperthite in enderbite have been ascribed to plutonic metamorphism by Howie (1935, p. 763-766). Similar views were expressed by Stillwell (1918, p. 194), Tyrrell (1926, p. 317), Groves (1933, p. 198), Mookolde (1940, p. 51), Vermor (1943, p. 99) and Turner (1943, p. 103).

The granulitic texture displayed by the members of Charnockite Series has been attributed by Holland (1900, p. 154), to the disturbance of magma during consolidation. The freshness of minerals may equally be attributed to plutonic crystallisation. Tilley (1936, p. 315) ascribes the presence of antiperthite in enderbite to its high temperature of formation. The embayed outlines of hypersthene may also result due to strewing of hypersthene in the magma.

The field, mineralogical, and petrological evidences displayed by the members of Charnockite Series suggest that they are plutonic igneous rocks and not metamorphosed sediments as expressed by Grosoa (1941) and Muthuswamy (1951, 1953). This is in agreement with the
opinions expressed by Holland (1900), Tyrrell (1926), Adams (1929), Tilley (1936), Hoekolds (1940), Hulfrey (1946), Wilson (1947), Addington (1948) and Askola (1952).

After their consolidation, the Charnockite Series was subjected to tectonic disturbance owing to the emplacement of pink granite. Therefore, it displays regressive changes. In places, basic members were converted to plagioclase amphibolites and enderbites to dark grey acid granulites and gneisses.