PART I

THE CHAPMANITES
CHAPTER II

NOMENCLATURE AND FIELD CHARACTERS

Introduction:

Hypersthene-granulites occurring south of Satnur were first noticed by Jayaram in 1901. In 1904, Smeth, who examined portions of the Biligirirangan hills (of which the present area forms the northern extension), found that the rocks were very similar to those described by Holland from the Nilgiri hills and used for the first time in Mysore the term "charnockite". The charnockites of Satnur-Halaguru area gained importance as a result of the recognition of their close association with hypersthene-bearing quartz-magnetite rocks and they have been described by Jayaram (1901, 1912 and 1917), Slater (1906).
Hum Kao (1927), Sadasiviah (1943), Naidu (1943b), Pichamuthu (1953, 1960, 1961 and 1965), Radhakrishna (1956) and Suryanarayana (1957 and 1960). These works have already been reviewed in Chapter I.

**Nomenclature**: 

In 1893, Holland suggested the name charnockite for a dark looking hypersthene-bearing acid rock, in honour of Job Charnock, the founder of Calcutta City, whose tombstone was made of this rock. He later (1907) defined charnockite as a quartz-felspar-hypersthene-iron ore rock and cautioned against the indiscriminate use of the term for any hypersthene granite in other petrographical provinces. An acid member of the charnockite series consisting of plagioclase (oligoclase or andesine), as the essential felspar, as distinct from charnockite in which the essential felspar is a microperthite, has been described by Tilley (1936) and given the name enderbite.

Under the term **"charnockite series"** Holland grouped together in one petrographic province a number of rock types genetically related to charnockite varying from charnockite to pyroxenite. For convenience of description he divided the series into four groups as acid, intermediate, basic and ultrabasic divisions. To describe
the rock types falling into each of these divisions, Holland employed the common names based on the mineral composition, such as pyroxenite, augite-norite, etc. with the exception of the acid variety to which the term charnockite was specifically employed.

With the lapse of time the original nomenclature of the charnockite series (Holland, 1900), has been modified to some extent (Washington, 1916; Gevers and Dunne, 1943; Quensel, 1951; Subramaniam, 1959; Wilson, 1959; Naidu, 1963) and this subject has been well discussed by Quensel (1951), Pichamuthu (1953) and others.

In this thesis the unqualified term "charnockites" is used as a group name for the whole assemblage of charnockite rocks and is synonymous with "charnockite series" of Holland. The terms ultrabasic charnockite, basic charnockite, intermediate charnockite and acid charnockite are employed respectively for the ultrabasic, basic intermediate and acid divisions. All these terms have been used without any genetic significance.

The rocks could have also been named as pyroxene-granulites or hypersthene-bearing rocks, as has been done by some investigators (e.g., Naidu, 1963) but much of the significance is lost by doing so. The author feels that
the term 'charnockite' is so firmly established both in the petrological literature and in common usage that no purpose is served by replacing it by the less significant terms like 'pyroxene-granulite' or 'hypersthene-bearing rocks'.

The charnockites of Satnur-Halaguru are characterised by the common occurrence of diopside and hydroxyl minerals, hornblende and biotite besides the characteristic mineral, rhombic pyroxene, and differ generally from those of the type area by their common distinct lighter colour and banding associated with foliation. There is such a close resemblance in the overall look between the more acid variety and intimately associated greasy grey biotite and hornblende-gneisses and between more basic charnockites and amphibolites that one finds it very difficult to demarcate them.

The charnockites of Satnur-Halaguru area range from acid to ultra-basic in composition. The acid charnockite is essentially an enderbite variety (Tilley, op. cit) and those resembling the charnockite proper (Holland, op.cit) or birkromite are rare. The most common basic charnockite of the area is dominantly hornblende-rich variety consisting mainly of hornblende, diopside, hypersthene and plagioclase (An. 26-58 %) resembling hornblende-
augite norite and hornblende-diopside-hypersthene diorite of the type area (Holland, 1900; Howie, 1955; Leelananda Rao, 1956). Following Howie (1955), basic charnockite has been divided into noritic and dioritic types depending upon whether the plagioclase is labradorite or andesine-oligoclase respectively.

The ultrabasic variety of the area is also usually rich in hornblende and corresponds to basaltic of the type area described by Washington (1916).
**Mode of occurrence**

The predominant acid variety (including acid variety proper and the acid intermediate type) forms elongated patches of variable sizes and always shows imperceptible gradation into the intimately associated biotite and hornblende gneisses. The basic members (comprising the basic charnockite proper, ultrabasic charnockite and basic intermediate type) with the exception of those of the SE corner of the area, where they form fairly large massif, occur commonly as bands, ribbons, lenses and patches of variable sizes and shapes in the acid members and also in the gneisses and very rarely in granite (Figs. 1 to 4, Plate IV. Figs. A to D and Plate V. Figs. A to C). The contacts of the basic charnockite inclusions with the enclosing acid charnockite and other rocks are either sharp or show narrow transition zones. None of the members shows characters of intrusion.

**Field distribution and relation**

The distribution of charnockite outcrops of mappable sizes is shown in the geological map (Map VI). Though found occasionally as thin clots and patches even in the northern gneissic region these rocks are well developed in the southern region, especially in the south-west
and south-eastern portions of the area. Of the different varieties, the acid charnockite of enderbite type combined with the acid intermediate variety is distributed over large area accounting for about 28% (60 sq.km.) of the total area occupied by the charnockites. Basic charnockite is next in abundance accounting for a total of about 13 sq.km. (12% of the total area of charnockite). Ultrabasic variety is the least developed of all the varieties and occupies a negligible area.

A. Ultrabasic charnockite:

Ultrabasic charnockite is very much restricted in its occurrence. It is found quite often as a variant of the basic charnockite occurring in association with the pyroxene-quartz-magnetite rock; for example in the hill .2092', and Sw of the hill .3250'. Less commonly, it occurs as small lensoid inclusions (Plate IV. Fig. a) in acid charnockite (e.g., in the hill .2736' and western slope of the hill .2213') and as a small patch in the large basic charnockite massif located on the SE corner, 1.5 km. NE of Makalanda.

When the ultrabasic and basic charnockites occur in association, there is always observed an imperceptible gradation between the two. In contrast to this, the
contacts of the ultrabasic inclusions occurring in the acid charnockite for all practical purposes are sharp. But at the marginal portions of these inclusions there is often the appearance of felspar (plagioclase) in notable amounts and the rock thus acquires more, the characters of basic charnockite. Not uncommonly, the marginal portions of the inclusions become extremely hornblende acquiring more the characters of hornblendite. Occasionally biotite occurs in notable proportion in the marginal portions.

B. Basic charnockite

(i) Large outcrop in the SE corner of the area:

The only large outcrop of the basic charnockite is located in the SE corner of the area enclosed within the quartzite bed of the pitching syncline. The exposure is continuous and consists of a series of flat topped low mounds which are covered with piled up tors of slabby and rectangular blocks of variable sizes. The outcrop has a maximum width of 1.8 km. in the E-W direction and a length of 4 km. in the N-S direction. It consists of a large proportion of dioritic basic charnockite with hornblende-diopside-hypersthene-plagioclase (An 42-46%) interbanded on all scales with other dioritic assemblages (viz., hornblende-diopside-plagioclase, hornblende-hyper-
and noritic types (vis., hornblende-diopside-hypersthene-plagioclase (An 50-55 %), diopside-hypersthene-plagioclase (An 50-52 %) and hornblende-hypersthene-plagioclase (An 50-55 %). The megascopically visible banding of the rock is however essentially due to the concentration of dark green to greenish black hornblende-rich layers alternating with those of the slightly finer grained lighter coloured hornblende-poor or hornblende-free bands. All along the western border of the massif (see Map VI), there is the development of the intermediate and to a lesser extent the acid charnockites. The intermediate and acid charnockites of this outcrop unlike those in the rest of the outcrops are finer grained and resemble very much the associated basic charnockite and show imperceptible gradation into them. In the northern part of the outcrop there are metasedimentary intercalations of variable sizes, (a few centimetres to 6-8 metres), shapes (e.g., ribbon, lens, raft, pod-like and irregular) and composition (vis., aluminous, calcareous, ferruginous and siliceous) whose margins, bedding and foliation are always parallel to the banding and foliation of the charnockite. A close study of the contacts between the metasediments and charnockite reveals that for all practical
purpose they are sharp and exhibit little or no evidence of interaction between them. The basic chamockite is traversed occasionally, by white quartzos-felspathic and coarse grained dark green diopside-and hornblende-rich veins. These veins are usually less than 1/2 to 2 cm. in width and run parallel to the foliation and banding of the chamockites.

(ii) Small basic chamockite inclusions:

The common occurrences of basic chamockite are, however, in the form of bands, ribbons, rafts, lenses, pods, knots and irregular patches of variable sizes (Figs. 1 to 4, Plate IV, Figs. B, C & D and Plate V, Figs. A, B & D) in the acid and intermediate chamockites, less commonly in gneisses and scarcely in granites. Such occurrences are best seen in the acid and intermediate chamockites exposed in the following places: (1) North of the hill .2213", (2) around the hill .1944", (3) along the Shimsha river course from Dodamahalli to the south, (4) in the hill .2049" and (5) in the low mound .2143" — all found in the S. portion of the area — (6) between the hills .2225" and .2792", (7) SE of Duntur and (8) on the eastern outskirts of Baiknashali. The basic chamockite inclusions in gneisses are best developed in the quarries of the eastern foot of Kabbalurga (.3550"),
about 1 km. to the west of Kunthru, and in the north­
eastern foot of Bhimankandi betta (3469'). Basic char­
nockite bands of mappable sizes are found: (1) on the
western bank of Shimsha river at its southern end, (2) in
the hill 1944' and to its west and south-west, (3) in the
hill 2213' and on its south, (4) in the northern out­
skirts of Dodamahalli, (5) in the northern slopes of the
hill 2955', south of Kempaigudandoddi, and (6) on the
north of the hill 2537', 1.6 km. SW of Duhalli — all
these are shown in the appended geological map (map Vi).
The basic charnockite is also found in association with
many of the bands of pyroxene-quarts-magnetite rocks of
the southern region, particularly with those bands located
on the west of Halaguru, northern foot of the hill 3250'
and on the northern slopes of the hill 2537'.

The basic charnockite inclusions occurring in
both acid charnockites and gneisses, exhibit just the
same type of field features. They are mostly hornblende­
bearing, schistose types and invariably elongated with
their length lying parallel to the gneissosity and folia­
tion of enclosing acid charnockites and gneisses. The
inclusions are sometimes closely jointed contrasting with
the poor jointing of the enclosing rocks and the joint
planes of the former generally and abruptly against the
latter. The margins of the inclusions are generally smooth and lack tongue or apophyses-like penetration into the enclosing rocks. There is always the interlocking of the components of the two rocks (viz., basic inclusions and the enclosing acid rocks). Except for this interlocking of the components, the contacts of inclusions at any one place look generally sharp and if transition were to exist it is seen usually over a narrow zone. However, passage of acid charnockites into basic members through intermediate members becomes evident when observations over a large area are combined. At the marginal portions of the inclusions besides the increase in the proportion of the felspar, hornblende becomes abundant, sometimes biotite appears in notable amounts, and the rock acquires the characters of plagioclase- and biotite-plagioclase amphibolite. This feature is well seen in the basic charnockite inclusions occurring in the quarries located on the eastern foot of Kabaldurga and 0.3 km N of Halасс- halli. This transformation of basic charnockite into amphibolite is connected with the breakdown of the former under middle or low amphibolite facies conditions subsequent to its formation.

Not infrequently, the basic inclusions are traversed by white to light grey quartzofeldspathic veins and
occasionally by coarse-grained hornblende- and biotite-rich pegmatite veins (similar to those noticed in large basic charnockite massif occurring in NE corner of the area, described earlier) which are generally less than 1 to 2 centimetres across and persist for less than 1 to 3 metres in length. The latter variety (i.e., hornblende- and diopside-rich veins) is essentially restricted to the basic inclusions while the former (i.e., quartzofelspathic veins) may sometimes continue into the enclosing acid rocks without any change in the course. But nowhere are the microcline-rich pinkish and greyish quartzofelspathic veins traversing the acid rocks seen continuing into the basic inclusions. The veins generally run parallel to the strike of the inclusions. At places the vein material is thrown into small folds, the axial planes of which are either parallel or almost perpendicular to the strike of the inclusion, but elsewhere (e.g., Kabbaldurga quarry) they are highly contorted and exhibit no regularity.

The basic charnockite bands located to the north of the furlongstone 7/55 on the Bangalore-Mysore road and in the northern vicinity of Dodanahalli consist of numerous closely spaced relatively thicker parallel ribbons of whitish quartzofelspathic material. The ribbons are mm-


usually 1 to 8 cm thick and persist sometimes for over 4 to 5 metres along their strike. The parallel arrangement of the quartzofelspathic veins in some sections of these exposures is so perfect as to resemble perfectly bedded rock (Plate V, Fig.3). These as well as the previously described common thinner less persistent veins show interlocking of their components with those of host rock and but for this interlocking of components the contacts are sharp.

C. Intermediate and acid charnockites:

Fairly large and continuous exposures of acid charnockites are found in the SW and SE portions of the area. In the SW portion they are best developed (i) in the low northerly striking elongated chain of mounds (.2136') SW of Banasamudra, (ii) around the hill .1994', 1.6 km. SE of Banasamudra, (iii) around the hill .2213', 1.3 km. SE of Dodamahalli, (iv) as discontinuous outcrops along the Shimsha river course from Dodamahalli to the southwestern end of the area; (v) around the hill .2049', 1 km. NW of Chillaupura, and (vi) in the hill .2143', 1.4 km. N of Halaguru. There are quarries of various sizes scattered in most of these outcrops and those situated in the hills .2136', .2049' and .2143' provide exce-
lent opportunity for studying the field relation, petrographic feature and structural characters.

In the SE corner of the area there are good exposures of well banded acid charnockite in association with the intermediate charnockite. Almost the whole of the hill .2711' and most part of .2755', .2957' and .2792' of the Basavanabetta hill ranges are made up of these rocks. Good outcrops are also seen near Nakalanda, further east of the hills referred to above and on either side of the western limb of the quartzite bed of the pitchine syncline found in the southeastern part of the area. A small but interesting exposure of acid charnockite is found around Murlethima and oddi, about 3 km. SW of Satmur and about 1 km. SW. of Kemmala.

In the central part of the southern region which is occupied mostly by gneisses, the acid charnockite patches of variable sizes and shapes occur scattered more commonly on the northern slopes and foot of Basavanabetta hill ranges.

Lenses, bands, pods, knots, ribbons and irregular patches of acid charnockite varying in size from about a centimetre to a metre across, are sometimes met within the gneisses of the northern region. An excellent example of this type of occurrence is seen in a number of places
in the Kabbaldurga-Bhimankand hill ranges, particularly in the quarry on the 36 foot hill of Kabbaldurga (Figs. 6 to 9 & Plate VI, Fig. 8), around the place where the natural arch is located, on the northern slopes of the hill .3469', southern slopes of .2808', along the prominent valley that passes in between the hills .2808' and .3458' and on the southern as well as on the northern foot of the hill .3458' in the gneisses exposed north of the hill .2782' (1 km. NW of Satmar) and in the quarries 0.5 km. to the west of Kunthru (Fig. 8).
Description of various charnockite exposures:

(1) The low mound 21°43', 2.4 km. north of Halaguru

Rama Rao (1927) in his "notes on the geological features of the Maddur-Malvalli region with special reference to rocks of charnockite affinities" has given an account of this exposure. According to him this exposure provides good evidence for his view that the acid and intermediate charnockites are formed by the interaction of older noritic rocks with the Closepet granite injections. This exposure consists mainly of rudely foliated, coarse-grained greasy grey acid charnockite which grades imperceptibly on one hand into almost massive or only very rudely foliated greasy bluish grey or brownish grey rock with a typical charnockite look and on the other to a distinctly foliated light grey to almost whitish biotite-gneiss. These rocks consist of basic charnockite inclusions of variable shapes which are medium to fine-grained and vary in size from a small clot to patches 3 to 4 metres in width. The basic inclusions of this exposure, contrary to most other exposures, are at times more irregular in their outline. The contacts between these basic inclusions and the enclosing acid charnockite are generally sharp but at places they show gradational contacts with narrow transitionary zones. The charnockite
often shows pink or greyish pink coarse microcline-rich pegmatite veins which run generally parallel to the foliation. The basic inclusions also show quartz-felspathic veins but these are grey to white in colour and contain plagioclase as the essential felspar as distinct from the quartz-felspathic veins in acid charnockite in which the microcline is the essential felspar.

(ii) The exposures on the western bank of the river Shimsha, west of Kadhali, north of furlong stone 7/55, on the Bangalore-Mysore road (south of the hill 2213') and SE of Satnur, comprising the hills 2755', 2957' and 2792'.

In all these three exposures charnockites show a similar field relationship. The acid charnockite, which is the dominant rock in these outcrops, is greasy grey, and well banded, (Plate V.Fig. D) looks more like grey biotite and hornblende gneiss and shows imperceptible gradation to the basic charnockite. In fact it is hardly possible to demarcate the two. The basic charnockite inclusions which are commonly stretched parallel to the foliation are quite numerous. Inter-banding of acid and basic charnockites can be seen on all scales with the individual bands varying from a few centimetres to about 3 decimetres. The contacts between the host
acid charnockite and the basic charnockite inclusions are generally sharp but at places gradual transition of one to the other by felspathisation is clearly seen. The rocks show numerous coarse to fine-grained quartzofelspathic veins with or without hypersthene. Disposition of these veins, generally parallel to the foliation and banding of the charnockites, accentuates the banded appearance of the rock.

(iii) The hill 2049', 1 km. NW of Chillapura:

The charnockite exposed in this hill is a perfectly banded variety (Plate VI, Fig. A). The banding is very prominently seen in some of the quarries situated in this hill. The rock owing to its overall light grey colour and distinct banded nature looks more like hornblende gneiss. The banding is due to the presence of fine to medium grained hornblende- and biotite-rich intermediate to basic charnockite layers alternating with those of the greasy yellow grey or brownish acid charnockite and whitish to light grey quartzofelspathic layers completely devoid of hypersthene, comparable to quartz-felsspar rich layers of hornblende and biotite gneisses of the area. The basic inclusions (mostly of basic charnockite) are markedly stretched and elongated and show invariably diffused margin. In this exposure also there are
whitish to light grey coarse pegmatite veins, similar to those noted in the exposures described earlier, which commonly run parallel to the banding, and thus accentuating the banding of the charnockite. The banding of the charnockite together with its quartzofelspathic veins is often thrown into folds (Plate XXXIV, Fig. 3 in Chapter XIII of this thesis) a few centimetres to one or two decimetres across, with the axial plane trending generally parallel to strike of the rock.

(iv) The charnockite S. of Duntur and E. of Naikanhalli:

The charnockite of these two exposures looks very similar. It is dominantly acid, rudely banded type exhibiting rapid variation in the mineral composition. There are basic inclusions of various sizes and shapes distributed throughout the exposure without any regularity. Both the host acid charnockite and the basic inclusions are traversed by light coloured quartzofelspathic veins, the regularity in the arrangement of which accentuates the banding of the rock. The banding of the charnockite thrown at places into small open folds, less than 0.5 metre across, whose axes are mostly parallel to the average strike of the banding and pitch at low angles to the north and south. A distinct feature of this exposure is the occurrence of thick patches of fine-grained
more massive pale purple or white quartzofelspathic rock. The latter rock, which looks more or less similar to the discoloured charnockite portions observed in the Habbal quarry could however be identified only in the portions opened by the quarries as these look just like the associated acid charnockite on the weathered dark surface. The contact between the charnockite and quartzofelspathic rock usually consists of a thin transition zone and the latter rock appears to have been formed by the breakdown of the former. At places coarse porphyroblasts of felspar sometimes reaching a size 2 cm. (long) x 2 cm. (width) x 3/4 to 1 cm. (thick), varying in colour from dark grey (in the charnockite portion) to light grey and light yellowish or pinkish grey (in the lighter coloured quartzofelspathic portions) occur. The distribution of these porphyroblasts is not uniform and are rather local in their development.

(v) The exposure around Murlethimmandoddi, 3 km. S.W. of Satnur:

The Murlethimmandoddi exposure runs discontinuously for about 14 km. in the N-S direction. It consists dominantly of light greasy grey banded and foliated coarse-grained acid charnockite carrying quite often lensoid, ribbon and raft-like inclusions of basic charnockite.
There are elongated patches of light grey to whitish quartzofeldspathic rocks devoid of hypersthene which show imperceptible gradation to the acidic charnockite. Besides, in places coarse pink pegmatitic and granitic veins (2 cm. to 1/2 metre thick) traverse the rock generally along the foliation and these are especially well developed on the northern vicinity of Murlethimandoddi. These pinkish veins like the grey and whitish ones noted in the other exposures, exhibit interlocking of the components with the acid charnockite.

(vi) The exposure 1 km. SW of Kemmalu:

An interesting exposure of a narrow band of strongly foliated acid charnockite is found further north of the preceding Murlethimandoddi exposure, 1 km. SW of Kemmalu. Here the charnockite is in direct contact with a light coloured semipelitic gneiss consisting of garnet, cordierite and sillimanite and with leptynite (garnetiferous quartzofeldspathic rock), but there is no evidence of gradual passage from one to the other. The pinkish gneiss occurring by the side of the acid charnockite band, shows some interesting features. It often consists of small irregular patches of acid charnockite which are in various stages of conversion into gneiss (Figs. 11 and 12). In the initial stages of transformation the grain-
size is reduced, the colour is bleached to pale grey or yellow and the pyroxene has notably altered into biotite. With the advancement of transformation the rock becomes more and more foliated, the pyroxene is completely replaced by biotite and the rock ultimately grades on to biotite-gneiss. A similar type of transformation of acid charnockite into gneiss has also been observed in the quarries of Kabbaldurga, the descriptions of which are given in the following section.
(vii) The gneiss quarry on the SE foot of Kabbaldur ga
(1.3500') 5 km. NW of Satnur:

This exposure has been described by Kishamuthu
(1960, 1961, 1965). It provides interesting and important
field relationships between the acid charnockite and the
biotite- and hornblende gneisses. It consists mainly of
well banded light grey biotite- and hornblende-gneisses
with patches of basic rocks (both charnockitic and non-
charnockitic) hornblende- and biotite-bearing acid char-
nockite of variable sizes and shapes. The basic inclusions
show at places diffused contacts with the enclosing
gneisses and are hardly demarcated from the amphibolite
into which they imperceptibly grade. The acid charnockite
inclusions look distinct due to their greasy grey or
brownish green colour and are massive and coarse grained
in texture. They vary in their size from a tiny knot to
patches 1 to 2 decimetres across and occur in the form of
pods, lenses, veins and irregular patches (Figs. 6 to 8
and Plate VI. Fig. B). The margins of these inclusions
unlike those of basic ones are irregular and much diffu-
sed. The inclusions are either massive or rudely folia-
ted (especially near the margins). When they are massive,
the foliation of the gneisses abruptly ends at the border
of the inclusions and so also the pegmatitic and aplitic
veins which traverse so extensively the gneisses. When
the inclusions are foliated, it will be in continuation
and conformity with the bending and foliation of the en-
closing gneiss. At places the gneiss itself is seen as
tiny clots and knots enclosed in the charnockite inclu-
sions. These clots and knots of gneiss probably repre-
sent the pools of granitizing solutions during the break-
ing down and conversion of charnockite into gneiss. The
progressive transformation of charnockite into gneiss
is associated with the gradual fading of the typical
greasy grey and brownish green colour of the charnockite
to light grey through yellowish grey and with the reduc-
tion in the grain-size and increase in the degree of
foliation and banding. Similar type of relation between
acid charnockite and biotite- and hornblende gneisses is
seen in places in Bhimankandi betta and in the gneiss
quarries to the west of Kunthra.
Salient field characters of Sarur-Halaguru charnockites:

(1) The charnockites of the area range in composition from acid to ultrabasic.

(2) They invariably contain hydroxyl minerals hornblende and/or biotite in addition to the characteristic mineral hypersthene and when compared to the type area charnockites, these are lighter in colour and show commonly distinct banding and foliation.

(3) Charnockites decrease in their abundance from south to north of the area. The larger mappable patches of charnockites are essentially confined to the southern portion. Only occasionally small clots, pods, knots and patches of these are observed in the northern region largely occupied by gneisses.

(4) None of the members of the charnockites exhibits characters of an intrusion.

(5) The acid charnockite occurs as patches ranging from less than 2-3 cms. to those over 0.5 to 3 km. in width and are generally elongated parallel to the regional trend and their borders are never sharply defined.

(6) With the exception of the SE corner of the area where it forms a fairly large massif, the basic charnockite occurs as bands, ribbons, rafts, lenses, pods, knots
and irregular patches, varying in width from less than one or two centimetres to tens of metres and over 3/4 to 1 km, in length in the acidic charnockites and gneisses.

(7) The acid charnockite grades imperceptibly on one hand to intimately associated hornblende- and biotite gneisses and on the other to the intermediate charnockite. The passage of one to the other is so imperceptible that it is difficult to demarcate each other and is seen in all scales. There is also gradual passage of acid variety into basic and ultrabasic charnockites through intermediate charnockite but this appears evident only when observations made over a large area are combined, for at any one particular point the contacts between acid and basic or ultrabasic charnockites appear sharp or consist at the most a narrow transitional zone.

(8) There is also gradation of acidic charnockite into leptynite (garnetiferous quartzofelspathic rock) through garnetiferous acid charnockite. Like that of hornblende- and biotite-gneiss formation the leptynite formation from acid charnockite is also related to the breakdown of charnockite under almandine amphibolite facies conditions subsequent to its formation.

(9) The basic charnockites grade imperceptibly on one
hand to the ultrabasic charnockite and on the other to diopside-hornblende-plagioclase granulite and to amphibolite with which they are so commonly associated. The ultrabasic charnockite grade into rocks consisting almost completely of hornblende (vis., hornblendite).

(10) Except for the intimate association, similarity in structure and texture and occurrence in both the mineral assemblages indicating their formation under identical metamorphic conditions, the charnockites and metasediments do not generally show evidences of interaction and gradational relationship between them.

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