The Satnur-Halaguru area, described in the present investigation occupies, about 298 sq.km., lies partly in Bangalore and partly in Mandya districts of Mysore State and is located about 65 km. SW of Bangalore city. It is bounded by latitudes 12°12'30" and 12°30'30" and longitudes 77°10' E and 77°22'30" E.

Geologically, the area represents a deeply eroded part of Archaean terrain where some of the rocks, formed at great depths, under pyroxene-granulite subfacies metamorphic conditions, are exposed. It consists of a variety of rock types of diverse petrographic characters, degree of metamorphism, age and origin. The rocks of the area have been broadly classified in the present investigation into: charnockites, hypersthene-bearing rocks constituting an integral part of metasediments, orthopyroxene-bearing granitized basic dykes, basic granulites devoid of hypersthene, metasediments, gneisses and granites and dyke rocks.

The charnockites, though occasionally found as thin clots and patches even in the northern gneissic region, are only well developed in the southern region, especially in the south-east and south-western portions of the area. They are represented by a complete variety
ranging in composition from ultrabasic to acid of which the acid variety is predominant and the ultrabasic is scarcely developed. The predominant acidic variety forms elongated patches of variable size and always shows imperceptible gradation into the associated biotite- and hornblende gneisses. The basic members, with the exception of the south-eastern corner of the area where they form a fairly large massif, in all other parts occur as bands, ribbons, rafts, lenses and patches of variable sizes in the acidic members and also in gneisses. The contacts of the basic charnockite inclusions are either sharp or only show a narrow transition zone.

In most charnockites of the area hornblende or biotite occur as consistently as the characteristic mineral, hypersthene, and generally differ from those of the type area by their common distinct banding, foliated nature and lighter colour. The charnockite varieties, containing only the pyroxenes are of restricted occurrence, seldom occurring in patches of mappable sizes.

The ultrabasic charnockites of the Satnur-Halaguru area are generally rich in hornblende and are comparable with bahlaite described by Washington (1916) from the type area namely, Madras.
The basic charnockites comprise hornblende-diopside norite, diopside-hypersthene diorite; hornblende-diopside-hypersthene diorite and biotite-diopside-hypersthene diorite, of which the third type is the most common.

The intermediate charnockites show a large variation in their megascopic and microscopic characters. They vary in texture and mineral composition on one hand into the dioritic variety of basic charnockite and on the other into enderbitic variety of acid charnockite but those nearer to the latter variety namely, enderbitic acid charnockite, are the most common.

Among the acid members, enderbitic with abundant plagioclase is the most widely developed while charnockite proper (or birkramite), consisting of abundant K-felspar, is very much restricted in its occurrence. In both the types, biotite occurs as a common dark component in addition to the characteristic mineral hypersthene and only occasionally diopside, hornblende and garnet appear.

The mineral constituents of Satnur-Halaguru charnockites are mainly quartz, K-felspar, plagioclase, ortho- and clinopyroxenes, hornblende and biotite. The accessories are ore minerals (chiefly magnetite, ilmenite and pyrites), apatite and zircon. Garnet and olivine occur subordinately in some of the acidic and ultrabasic members, respectively.
Despite its variation in colour from typical blue to white, grey and yellow in the hand specimen, quartz always shows numerous small indeterminable randomly arranged acicular inclusions and undulose extinction.

K-felspar is dominantly microcline and only subordinately it is orthoclase perthite. It is found in abundance only in the less common charnockite proper or birkemite type, while in others it is either absent or present only in subordinate amounts.

Plagioclase ranges in composition from 58 to 22% An. and is usually fresh. Plagioclase with less than 35% An. present in the acid, intermediate and dioritic basic members is often antiperthitic. It is always untuned and occasionally shows oriented hair-, rod- and dust-like inclusions. It is commonly multiple twinned. Twinning is generally well developed in the plagioclase felspars of the basic members but in the intermediate and acid members it tends to be faint, patchy and distorted. The twinning laws are most frequently albite, not uncommonly manebach-al a and albite-al a and occasionally manebach and pericline. Carlsbad and albite-carlsbad twinning is characteristically absent.

The orthopyroxene of the charnockite is usually
strongly pleochroic and ranges from bronzite to ferrohypersthene in composition. Bronzite type is limited in its occurrence to a few of the ultrabasic varieties but the hypersthene and augite ferrohypersthene are found in all the members. There is no systematic variation in the composition of the orthopyroxenes with the variation in the basicity of the rocks.

Pale green non-pleochroic clinopyroxene is found in all the members of the charnockites, though less common or absent in the more acid members. It is of salite composition and its optical properties do not vary appreciably with the variation in the composition of the rocks.

Hornblende of the charnockites is chiefly a strongly pleochroic green-brown variety but dominantly brown and bluish types are found in some of the ultrabasic members. It is abundant in basic and ultrabasic members but is scarce or absent in the more acidic types.

Biotite is common in the acid and in some of the intermediate members. It is a strongly pleochroic brown variety.

Both hornblende and biotite show evidences of having been derived from pyroxenes.

In chemical composition, expressed in terms of
main elements, charnockites are not exceptional rocks but may be interpreted as being members of the calc-alkaline series of plutonic rocks with a silica content ranging from 47% to 73%.

On the whole, the charnockite rocks of Satnur-Halaguru area are slightly low in alumina, which is never more than sufficient to satisfy the combined alkalies and lime; high in iron oxides, normally the ferrous oxide being greatly in excess of the ferric; fairly high in lime even in the most acid rocks and soda being always in excess of potash except in the charnockite proper.

The field characters of the charnockites like:
- the occurrence within the deeply eroded Archaean formations characterised as a whole by plutonic metamorphism, the absence of transgressive and intrusive relationships, the association with metasediments, occurrence as patches and inclusions and the general banded and foliated nature;
- the petrographic characters like: the remarkable freshness of minerals both in the specimens and in sections, irregular and rapid variation in the grain-size and proportion of minerals even within the limits of a small outcrop, the xenomorphic granular texture and constant absence of porphyritic texture, the rounded and embayed outlines of pyroxenes and felspars, the frequent occurrence of one
mineral as an inclusion in the other, evidences of strain like undulose extinction, peripheral granulation and bending and fracturing of twin and cleavage lamellae, the presence of myrmekitic borders to the Na-felspar grains and the occurrence of quartz of two generations; the mineralogical characters like: the microperthitic nature of Na-felspar, antiperthitic and unmixed nature of plagioclase and its patchy and distorted twinning on the albite, manebach-ala, pericline, albite-ala and manebach laws but never on carlsbad and albite-carlsbad laws, the strong pleochroism and the absence of regular variation in the composition of orthopyroxene with the variation in the basicity of the rocks and the occurrence of a clinopyroxene with almost the same composition in the different charnockite members clearly suggest that the charnockites, as they are seen at present, are definitely metamorphic rocks originally formed under pyroxene granulite sub-facies of regional metamorphism. Their chemical data is also not opposed to such an interpretation. The consistent occurrence of hornblende and biotite in addition to the characteristic mineral hypersthen in most of the Satur-Halaguru charnockites is due to their modification under amphibolite facies, subsequent to their formation under pyroxene granulite facies.

The hypersthen-bearing rocks constituting an
integral part of pelitic sediments are divided into: (1) quartz norite, (2) cordierite-hypersthen-ebiotite granulite, (3) leptynites and (4) biotite-hypersthen-quartz rocks. They strikingly differ in the field characters and in mineral and chemical composition from the charnockites of the area and afford evidences of having been formed by the metamorphism of appropriate aluminous sediments like the associated metasediments. Likewise, the garnetiferous hypersthen-bearing rock occurring in intimate association with the pyroxene-quartz-magnetite rock markedly differs from the charnockites of the area and affords evidence of having been formed by the metamorphism of appropriate ferruginous sediment.

The orthopyroxene-bearing basic dykes, which are comparable with the so called basic charnockite dykes (Jayaram 1962), comprise norite type containing hornblende-hypersthen and plagioclase (69 to 74% An.) and diorite types with hornblende, biotite, diopside, hypersthen and plagioclase (27 to 33% An.). In their mineral composition they resemble the basic charnockites of the area but in the field and petrographic details they notably differ from them. They are very much younger than the charnockites of the area and even the gneisses and granites,
and show evidences of having been formed by the consolidation of a basic magma.

Constituting an integral part of basic charnockite inclusions or representing distinctly separate inclusions, basic granulites devoid of hypersthene occur in the acid charnockites, gneisses and granites. On the basis of mineralogy these rocks have been classified into: plagioclase-diopside, plagioclase-diopside-hornblende, plagioclase-diopside-biotite, plagioclase-hornblende-granulite, hornblende rock and plagioclase-microcline-hornblende granulite. Of these the first three pyroxene bearing assemblages are considered to be the contemporaries of charnockites, while the rest are considered as the modification of the first two basic granulites or their basic charnockite equivalents under amphibolite facies conditions.

Similar to many of the charnockite localities of the world, in the Satnur-halaguru area also metasediments of various kinds occur intimately associated with charnockites. Based on the chemical composition, the various metasediments are divided into aluminous, calcareous, ferruginous and siliceous types. The aluminous metasediments are represented by gneisses containing sillimanite, cordierite, biotite and garnet; the calcareous metasediments by the calc-silicate granulites containing scapolite, hedenbergite,
diopside, garnet, plagioclase and quartz; the ferruginous metasediments by the pyroxene-quartz-magnetite rocks containing ferrohypersthene-sulite, hedenbergite, magnetite, quartz and garnet, and siliceous metasediments by the quartzites. Except for the interlocking of the mineral components of the rocks, the contacts between the metasediments and the enclosing charnockites and gneisses are sharp without any gradation. The metasediments appear to have played no role in charnockite formation. The textural and structural similarity between the charnockites and the metasediments and the occurrence of the isofacial mineral assemblages in the two, however, suggest the contemporaneous development of the two rock types under the same metamorphic conditions namely, pyroxene-granulite subfacies, of regional metamorphism.

The gneisses are the most widespread rock types of the area occupying a very large part of the central region. They are mainly biotite- and hornblende-bearing types with plagioclase as the dominant felspar. They bear an imperceptible gradational relationship with the intimately associated charnockites. All through their length and breadth they contain small relic patches of the charnockites which are in various stages of their transformation into the enclosing gneisses. Based on field and
petrological observations, it is opined that the gneisses of the area are the result of modification of charnockites by granitization and migmatization taking place under middle or low amphibolite facies conditions.

The typical granites of the area are pink non-porphyritic medium to fine-grained and coarse porphyritic types. They mainly occupy the north-eastern portion of the area and represent the southern extremity of the Closepet granite. They show conformable and gradational relationship with the gneisses. The felspar of the granites is dominantly microcline perthite which bears replacement relation with the associated minerals. The almost complete only absence of orthoclase and the presence of microcline suggests the granites to be synkinematic (Marmo 1956). The field, petrographic and mineralogical evidences indicate the formation of the granites by the granitization of the country rocks, which were none other than charnockites. The formation of gneisses and granites do not represent separate metamorphic episodes but indicate a chain of events in the evolution of the granitic rocks of the area by metamorphism and metasomatism. The formation of the granites marked the last major episode of the Archaean history of the area and their formation was not responsible
for the development of charnockites as postulated by Vredenborg (1918) and Rama Rao (1945).

One of the many interesting geological features of Satnur-Halaguru area is the occurrence of a large number and variety of dyke intrusives. They are broadly grouped into: (1) dolerites, (2) spessartites, (3) diorites and (4) alkaline dykes.

The dolerites are the most abundant of all the dyke intrusives. They are classified on the basis of texture and mineralogy into: (1) quartz-dolerites, (2) basaltic dykes, (3) olivine-bronzite dolerites, (4) poikilitic olivine-bronzite dolerites, (5) poikilitic dolerites and (6) augite-porphry, (7) meladiabases and (8) vitrophyric dolerites or hyalodiabases. All these varieties are genetically related to one another, having been derived from the differentiation of basic magma of calc-alkaline composition. The textural variation is, however, mainly the result of differences in the conditions of cooling.

Based on the nature of ferromagnesian minerals, spessartites are divided into diopside-spessartites, hornblende-diopside spessartites and hornblende-spessartites. They all possess the salient characters of lamprophyres.
They often show evidences of assimilation of country rocks suggesting that assimilation has played an important role in their derivation. The hornblende-spessartites sometimes show gradation into diorite porphyries suggesting their genetic relationship with those dykes.

The diorite porphyries are next in abundance only to dolerites. They essentially consist of plagioclase (oligoclase-andesine) and hornblende, both of which appear in two generations, although in variable proportions. They markedly vary in their grain-size, colour and look. There is gradation of these dykes on one hand into hornblende-spessartites and on the other to alkaline dykes through monzonite varieties suggesting a comagmatic relationship.

The alkaline dykes consist essentially of K-felspar (sanidine-orthoclase) and alkali pyroxene (augite-augite-augite). They vary in colour from brown to bluish grey and in texture from nonporphyritic to coarsely porphyritic. The porphyritic type comprises of sodalite- and 

The petrochemical study has shown that these are the products of consolidation of alkaline residuum derived from the differentiation of alkaline basic magma.
From field and petrological studies it is suggested that the meladiabases, vitrophyric dolerites, basaltic dykes and quartz-dolerites belong to the tholeiite magma series, while the olivine dolerites, spessartites, diorite porphyries and alkaline dykes belong to the alkaline olivine basalt magma series. The mineralogical and chemical individualities of the dykes belonging to different groups are believed to be the result of differentiation by fractional crystallisation of the primary basic magma.

The charnockites and the associated rocks of the Satnur-Halaguru area have features indicating deformation and show fairly well preserved megafabric elements like banding, foliation, folding (minor and major), lineation and jointing.

A very distinctive structural characteristic of Satnur-Halaguru area rocks is the general NNW trend and the predominant easterly dip of the various prominent planar structures like bedding, banding, foliation and basic schlieren.

The consistent parallelism of foliation to the bedding and banding, predominant easterly dip and repetition of beds, though not in such a regular order and sequence, are much suggestive of isoclinal folding of the rocks. This isoclinal folding appears to have taken place under
deep-seated conditions during the first pyroxene granulite facies metamorphism, that gave rise to various metasediments and charnockites of the area. The major and minor folds with an axial trace striking NWW are also the result of the deformation during this metamorphism though some of them may be relic structures.

The swing of NWW trending foliation to ENE and east near Palliya and 2.0 km NW of Satpur, is possibly connected with a later deformation. To this later period of deformation the minor folds whose axial traces strike almost ENE also belong. This later deformation appears to have taken place during the period of the breakdown of charnockites into diaphthoretic varieties.

The isotopic age determinations by the Rb-Sr methods have revealed that the charnockites are much older than the gneisses and granites of the area. This is also supported by field observation. The isotopic age data has further brought to light that the basic as well as the acid charnockites are essentially of the same age and so are the gneisses and granites. These new observations have thrown fresh light on the crystallines of Mysore State.

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