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Anorthosite and Associated Rocks of Oddanchatram, Dindigul Anna District, Tamil Nadu.

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ABSTRACT
This Project report pertains to the study of Anorthosites and Associated rocks of Oddanchatram, Palani Taluk, Dindigul Anna District of Tamil nadu The area is comprised of interesting and rare rock types namely Anorthosite, Pyroxenite, Norite, Charnockite, Garnet-Sillimanitegneiss,migmatite, pink granite, pegmatite, aplite and minor occurrences of molybdenite and iron ores.The area under investigation, Oddanchatram is located on the northern slope of kodai hills (Palani Hills) which forms a part of western ghat range.It is represented in the portions of survey of India topographic sheets numbering 58 f/10, 58 F/11, 58 f/14 and 58 f/15 published in the year 1921. The area lies between North Latitude 10° 27' and 10° 32' and East Longitude 77° 40' and 77° 48'. The Total extent of the area is roughly 66 Sq.miles. The field work was conducted by using clinometer and Brunton compass. The area was traversed across and along foliation and strike directions in order to precisely demarcate the lithological boundaries and to note variations in structure, texture, and mineral characters. The structures of the study area is quite interesting with much contortion, folding, shearing, jointing and faulting which are normally anticipated in the Archaean terrain.

KEYWORDS: Anorthosite, Associated rocks, Oddanchatram, pyroxenite, Archaean terrain, charnockite.

I INTRODUCTION

1.1 Introduction

This Project report pertains to the study of anorthosites and associated rocks of oddanchatram, Palani Taluk, Dindigul Anna district of Tamil nadu. The area is comprised of interesting and rare rock types namely anorthosite, pyroxenite, norite, charnockite, garnet- sillimanitegneiss, migmatite, pink granite, pegmatite, aplite and minor occurrences of molybdenite and iron ores.

1.2 Location of the study area

The area under investigation, oddanchatram (Fig.1) is located on the northern slope of kodai hills (Palani Hills) which forms a part of western ghat range.It is represented in the portions of survey of India topographic sheets numbering 58 f/10, 58 F/11, 58 f/14 and 58 f/15 published in the year 1921. The area lies between North Latitude 10° 27' and 10° 32' and East Longitude 77° 40' and 77° 48'. The Total extent of the area is roughly 66 Sq.miles. Oddanchatram is 35 km west of Dindigul, Headquarter of newly formed Anna district and 35km east of Palani, the famous pilgrimage centre and one of the abodas of Lord Muruga. The study area is well connected by State Highways and numerous metalled and non-metalled roads. The area is also connected by Southern Railway metre gauge line running between Dindigul and Pollachi. Almost all the Villages around the study area are connected by network of cart tracks and footpaths.

1.3 Previous work

Vinayak (1960) Surveyed a part of the area and gave a good account of the Iithological association and paragenesis of Oddanchatram anorthosites. P.R.J .Naidu (1960) studied this area in detail and described the rocks as "anorthite gnesis" which occur as xeneliths.Narasimha Rao (1963, 1964) published a few papers peratining to the twin laws fo Plagiclase of anorthosites and their significance in the petrogenesis of the rock and also about the granitic rocks of the area.'De' (1969) suggested that it belonged to a belt of massive proterozoic, Adirandock type anorthosites.Saravanan and Lakshmi Narayanan (1972) discussed about the origin and development of garnet in the sheard contact zones of anorthosites basic granulites.Subsequently, Narasimha Rao (1974,1975) reported about the occurrece of " Block

structures "and hornfelsic xenoliths in the anorthosite. Windley and selvam (1975) made a comparative study of anorthosites of Tamilnadu and described them as deformed and isolated slices of anorthosite bearing Archaean mafic stratiform compex. Janardhan and Wiebe (1985) discussed the petrology and geochemistry of this area and mineralogical characters of oddachatram anorthosites are similar to that of proterozoic massif anorthosites.

1.4 Methods of study

The field work was conducted by using clinometer and Bruton compass. The area was traversed across and along foliation and strike directions in order to precisely demarcate the lithological boundaries and to note variations in structure, texture, and mieneral characters. A base map was prepared from Survey of India topographical sheets numbering 58 F/10, 58 f/11, 58 f/14 and 58 f/15 published in the year 1921. The portions of the above topographic sheets where suitably enlarged for convenient field geological mapping. The area is comprised of many hillocks of considerable heights namely kuzhandaivelappan hill (Δ1381), Ethilan malai (Δ 2000), vannan karadu, (Δ 1220), Anai karadu (Δ 1211), Ragaswami malai (Δ 1920),Veriyappur malai (Δ1723) etc., These hillocks are visible from any part of the investigated area and hence they were taken as reference points for locating a place. Structural features like strike and dip of the foliation, lineation, jointpattern, minor folds, slickensides, shear planes and contact relationships of various lithological units were systematically studied in the field. In each ΔΔΔand every locality, bearings were taken and specimen were collected and numbered serially. Textural, mineralogical , structural and other variations, were carefully noted. All the above observations and readings were plotted on the enlarged base map to show distinctly the relationship among the rock units. Interesting geological features were photographed and neatly sketched and detailed descriptions about them were noted down in the field note book. Thin sections were prepared from the hand specimens collected in the field. The petrography of the various rock types were studied in the laboratory by the examination of thin sections under the petrological microscope. optical characters like pleochroism extinction angle, 2V, of a few constituent minerals and anorthite content of plagioclase feldspars were determined.

II GEOMORPHOLOGY

2.1 Physiography and drainage

The area under investigation forms a northern slope of kodai hills (Palani hills) Which is an offshoot of western Ghats. The area is mainly an undulating, rugged terrain surrounded by a number of hillocks rising to about 1000 to 2000 feet from mean sea level. The south and South - Western part of the study area is occupied by the north-eastern portion of Kodai Hills. The northern and north-western part of the study area comprised of small hillocks namely Anaikaradu (Δ 1277), Kollankaradu (Δ 1262), Kurinchakaradu (Δ 1585), Vannankaradu (Δ1220), etc. on the western part of the study area prominent hillocks namely Ethilankaradu (Vettilaimalai Δ 2000), Thandiyan karadu (Δ1350), Kanavaimalai (Δ1300), Kuzhanthaivelappanmalai (Δ1381), etc. In the eastern and north eastern part of the study area there are two prominent hills namely Rangaswami Malai (Δ1920), and Veriyappur karadu (Δ 1793). The alignment of the above hillocks are generally NE-SW direction which is roughly parallel to the strike of the rock bodies(Figure.2.1 and 2.2).

The general drainage pattern of the area is dentritic in the plains and sub-parallel in the hillocks. The drainage is mainly controlled by geological structures.(Figure.2.3) Nanganji Ar is the only river that drains the area from south to north. The river originates from the northern part of Kodai Hills near the place Pachalur and flows towards north through sirumalai and Aiyulur hills in the name of parapalar. Near Vadakodu, a dam has been costructed across parapalar river. Further north, this river takes a steep fall of 120 feet. The it takes a surface run-off from Virupakshi in the name of Nanganji Ar. Further, it takes a north-eastern turn and finally joins with Amaravathi river.

Figure.2.1 Panoromic view of the western part of the study area as viewed from kuzhandaivelappanmalai (Δ 1381)

Figure.2.2 The water falls Thalaikuthi formed by the river parappalar. A set of joints are also seen on the fault plane.

2.2 Weather and climate

The climate of the study area is tropical mosoonal. The temperature of the hill range is different from that of the plains. Temperature ranges between 15°c to 38 °c on the lowland, while it is 10° to 18° on the hillocks. The summer season prevails during April and May. The strong wind from south-West prevails during june. Jully and August. Rainfall is scanty and the distribution of rainfall shows bimodal. The first mode is centred around August but the maximum rainfall occurs during north-east Monsoon around November. The hilly area, in addition, receives south-west Monsoon rain. Generally the climate of the study area is arid and that 50 to 60% of the total amount of rain falls during the rainy season. The rainfall varies from 50 to 75 cm in the plains while, it is as high as 150 to 200 cm in the hillocks. Variability of rainfall is about 20 to 30%, a characteristics of a semi-arid region. Aridity is common in the lowland once in 3 to 5 years. The Nanganji Ar is noted for its seasonal floods and the supply of water dwindles during hotter periods.

Figure 2.3 Drainage Map of Oddanchatram, Palani Taluk, Dindigul Anna District of Tamil nadu

2.3 Vegetation

Eventhough the hillocks, get higher rainfall comparatively, they lie on the leeward-side of the southern monsoon winds. Hence the vegetation on the northern slopes of these hillocks is dry type. The hillocks are clothed with dry monsoon forest. At some places, on the hillocks medicinal shrubs are noted as in the palani hills. The palani Hills are having much open forest type and more barren soil. Which is covered with coarse grasses while sheltered valleys are wooded. The vegetation of the plains comprises of scattered trees in the fields, avenue trees and shrubs mostly cactus and other nerophytic plants around hill range, all other peaks and heights have little vegetatio and they comprise of deciduous trees occasionally and throny plants and shrubs mostly. Slopes of palani range comprises of deciduous trees, like vegai, Vekkali, White and Red cerdars, Some teak and black wood. Gallnut trees are numerous. Lower and palani plateaus are more valuable and contain evergreen trees. The distribution of natural vegetation is governed by a complex of environmental factors including geology, soil, climate, ete. Natural vegetation is considerably being damaged by indiscriminate felling and burning. Hence, due afforestation and soil conservation measures should be taken up in the hill reserves to protect natural vegetation cover and to check crosion hazard.

2.4 Weathering

Anorthosites show evidences of greater of greater weathering in comparision to the adjacent country rocks like charnockite, gneiss and migmatite. Since anorthosites are composed mostly of felsic minerals, they are susceptible to easy weathering. Because of this reason, the anorthosites commonly occur in low-lying area surrounded by resistant country rocks like charnockite, gneiss and migmatite. Most of the cultivated lands are situated on the weathered soils of anorthosite. As anorthosite exposures are scarce on the surface, due to quick weathering, and subsequent erosion, most of the fresh samples of anorthosites were collected from well cuttings.(Figure 2.4) Basic granulites show mostly spheroidal weathering in a number of places resulting in onion like spheroidal boulder (Figure 2.5). These spheroidal boulders prominently displayed by the basic granulites were photographed in the field.

2.5 Soil types:

The black and red soils are the two major types found in the study area. The soil is classified into three units namely, black clayey, black loamy and the black sandy. These are confined to the western parts of the study area. More than 85% is red soil, in which red loamy ad red sandy and black

sandy soils contain gypsum and kankar in their subsoil. Mostly these soils are derived through weathering of anorthosites, charnockites and gneisses.Alluvium is confined in a narrow zone along Nanganji Ar. This acts as a good aquifer while weathered charnockite and gneisses are poor aquifers. Hence, shallow water bodies become dry during summer. Water level from the surface ranging from 3 to 20 mts. is a reflective factor for dry semi-arid climatic condition and the presence of poor aquifer in the study area. All the soils appear to have been developed mostly on similar geology and from one and the same parent material. Yet, differences in soil properties are seen which might be due to the differences in topography, drainage and mineralogical composition of the rock types.

Figure.2.4 Ptymatically folded mafic bands within anorthosites.

Fig.2.5 Spheroidal weathering displayed by basic granulites

III OUTLIE OF THE GEOLOGY OF THE STUDY AREA

3.1 Geological settings

Garnetiferous gneisses, basic granulites and migmatites are the oldest group of rocks whcih are presumably of Dharwarsia age, Metasediments(Calcareous,ferruginous ad pelitic)granite and pegmatite are associated with them. The anorthosite body forms a narrow and tabular sheet running parallal to the NE - SW foliation of the pre-existing granulitic rocks. The intrusive character of the anorthosite into the basic granulitic terrainis maifested in the field. In basic graulite is included as xenoliths, while in some other cases, the anorthosite intruded the basic granulite with sharp contact on either side. The area has been affected by poly-phases of deformation and metamorphism in which anorthosites and basic granulites are participated. In consequence of these deformation, new structural trends, mineral lineations, foliation and minor fold axes have been introduced locally in the area. Fracture zones have been developed and shearing along this plane, produce mylonite, cataclasitc fabric and slickensides in the rocks. There are also narrow zones principally in the directions of the newly imposed trends showing thorough recrystallisation and introduction of new minerals like garnet,sillimate,etc., in equilibrium with attended P-T conditions. There are certain contacts between anorthosites and basic granulites which exhibit the above said characters.

3.2 Geological Sequence

The stratigraphic sequence established by the present investigation is as follows:

Table 3.1Stratigraphic sequence

Stratigraphic Position	Rock Types
Recent	Black and red soil Alluvium Kankar
Arcot granite	Quartz veins Aplite Pegmatite Pink granite
Anorthesites	Garnetiferous anorthosite Pure anorthosite
Charnockites	Charnockite (acid and intermediate)
Peninsular gneiss	Proxenite Norite
Dharwars	Garnetiferous mica gnesis Garnet – sillimanite gnesis Migmatite Quartzite Magnetite quartzite

3.3 Rock types and their field relationships

The main rock types of the area are anorthosite and basic granulite of Archaean group. In addition to the above rocks, the terrain consists locally of charnockites, meta-sedimentary rocks and calc-silicates. The contact between the various rock

types in most of the places are inferential as the critical areas are under soil cover. The failed relationship of the various rock types of the area are described in the following order and not in the order and not in the order of stratigraphic sequence.

3.3.1 Anorthosite

The anorthosite covers roughly an area of about 12 Sq.miles. The main outcrops of the anorthosite are observed.(Figure. 3.1) in Δ 1223 hillock (Near Oddanchatram railway station). Kuzhanthaivelappan malai (Δ 1381), in Δ 1194 hill (half a mile South of Virupakshi), in Ehtilankaradu (Vettiaimalai Δ 2000), in Vannankaradu (Δ1220), in a ridge Kaveriammapatti, in the eastern slope of Anaikaradu (Δ 1277), in the Erraiya Kavundanpudur and Western foothill of Veriyappur karadu (Δ1793). The presence of the same rock in other places were observed in several well sections, In most of the above locations, the anorthosites are founded in a highly weathered condition. The anorhtosite rocks are partly covered by soil and Kankar cappings, which attain a maxium thickness of about 40 feet.

3.3.2 Charnockite

These rock types are found in the form of lenses, bands and patchy masses within gneisses. The charnockite rocks ar foliated and they can be observed on the weathered surfaces. The foliaton of the rock is due to the parallel arrangement of planer minerals. The mineral composition is variable due to migmatitic nature of the rock. In the charnockites xenoliths of basic granulites and quartz magnetite occur as bands. The main outcrops of charnockite of Pachalur: in the southern and eastern foothill of Rangeswamyamalai: in the northern and western flank of Kurichakaradu and in the hill 1507, one mile south of Chatrapatti.(Figure. 3.2)

3.3.3 Norites

Norites do mot occur widely in the study area. They are found only as lenses and intercaleted bands within bodies of anorthosite and charnockite. Number of norite bands are found on the western slope of Kuzhanthaivelappanmalai (Figure.2.6). These noritic bands are running in the NE direction and also extend upto Δ 1223 hillock. The noritic bands are found parallel to that of foliation planes of the country rock.

3.3.4 Proxenites

A the pyroxenite band occurs in a portion of the eastern flank of Ethilankaradu (Vettilaimalai) and Thandiyankaradu (Δ 1350). In this pyroxenite band a zone of sulphide mineralization of 150 m. long and 15 m which has been observed. Stringers of pyrrhotite and chalcopyrite are also found within this zone. Geological Survey of India has done a test pit sampling of estimating the reserves of sulphide ores.

Figure.3.1 Linear bands of norites within anorthosites on the western slope of kuzhandaivelappanmalai (Δ 1381)

Figure.3.2 Two directional joints in charnockite along Oddanchatram - pachalur Road.

3.3.5 Peninsular gneiss

The northwestern and southeastern parts of the study area is occupied by the Peninsular gneiss. It includes different members such as garnet-micagneiss, biotite gneiss and banded gneisses of migmatitic nature. They display excellent banded structure (Plate IV Fig.2) The foliation of the gneisses trend NE – SE in the northwestern portion an dips almost vertically. The extend however changes from NE-SW to E-W in some parts of the southeastern portion of the study area. These rocks carry lenses, streaks and veins of charnockite and norite.

3.3.6 Garnet –sillimanite-gnesis (Khondalite)

These rocks are encountered at Vannankaradu (Δ 1220) near Rangappanpudar. It forms a narrow to broad band of 100 to 500 feet thickness extending from Rangappanpudur to Thangachiammapatti where in attains a maximum thickness. The general trend of the khondalitic rocks is NE-SE. Good outcrops of these rocks are found as elongated ridges near kaveriammapatti and in Anaikardu near Erraiyakavundanpudur. Since these rocks are highly resistant to weathering they occur an elongated ridges when compared with the adjacent rock types.

3.3.7 Magnetite quartzite

Magnetite quartzite represents one of the oldest rock unites of the study area and is invariably seen all along the boundaries of basic granulite.

Magnetite and quartz are found as alternate thin bands. The thickness of the body varies from place to place. These rock types are found as very thin bands on the western flank of Ehtilan karadu (Δ 2000): on the western foothill of Anaikaradu (Δ 1277) and also on the western sideo of Veriyappurkaradu (Δ 1790)

3.3.8 Migmatite

Migmatites and granitic gneisses are observed in the northwestern corner of the area and extend towards south upto Chatrapatti. The hillock (Δ 1477) near Reddiyapatti is composed of biotite gneiss, hornblends-biotite gnesis and garnetiferous-mica gneiss. Hornblende-biotite gneiss and garnetiferous –mica gneiss. The general trend of these rocks is NE-SE and tures of N-S near Reddiyapatti. These rock types show minor movements along certain weak planes and such planes are mostly filled with pegmatitic veins. The occurrences of hornblende-biotite gneiss is also found along the road cutting between Oddanchatram and Vadakadu.

3.3.9 Pink granite

Pink granite is the last phase of major igneous activity of the study area. It pierces through the foliation planes of the country rocks namely charnockite,granitic gneisses and basic granulites. The trend of the pink granite of pre-existing rocks. The width of the pink granite varies from place to place. The average width being roughly about 30 feet. The typical exposure of the pink granite is observed in the southwestern part o Rangaswamimalai and extend towards NE direction through the entire peak of the same hillock. The above granitic intrusion, while extending from Rangaswamimalai towards S-W, it disappers along the low lying cultivated lands. Further, the same granitic intrusion reappears again on the northeastern part of palani hills along oddanchatram-pachalur road. Here, the grain size of the pink granite becomes finer and assumes aplitic character here and there.

3.3.10 Pegmatite and quartz vein

Minor occurrences of pegmatite and quartz veins are found traversing through anorthosite, basic granulites, charnockite and migmatites. A prominent occurrence of pegmatite and quartz veins is observed on the top of Rangaswamimalai where commercial exploitation of quartz and feldspar minerals is going on by private quarry owners.

3.4 Petrography

Thin sections were prepared from typical rock specimens. On the basis of thin section studies, the rock units were classified. The petrological and petrographic studies were useful as a feed back study for mapping the area. Carl zeiss petrological microscope was used for petrographic studies. A short account of the petrographical features of each rock types is discussed below.

3.4.1 Magnetite quartzites

This hard and compact rock is composed of alternate thin layers of quartz and magnetite. The magnetite is steel – grey in colour and is readly attrached by a magnet. In a few rock specimens, the thickness of the magnetite layering is greater than quarts. Under the microscope, the opaque magnetite is isotropic and occurs as elongated grains. Quartz is abundant and shows wavy extinction.It carries inclusions of elongated and irregular magnetite grains. Feebly pleochroic and pink coloured orthopyroxene is also observed in this rock. Modal percentage of magnetite varies between 10 to 30%.

3.4.2 Migmatite

According to Mehnert (1968) " A migmatite is a megascopically composite rock consisting two or more petrographically different parts, one of which is the country rock which is generally plutonic appearance." The above definition excellently applies to the migmatites of the study area. The parent rocks (Placement) involved in the formation of migmatites are charnockites and gneisses. The intruding rocks (neosome) responsible for migmatization are mostly pink, granites, pegmatites and aplites (Figure.3.3) by virtue of thorough migmatization between palaeosome and neosome, rocks of mixed erigin exhibiting of variety of textures are extensively developed. In the field, these rocks are predominantly nonhomogenous and variable in texture and appearance. Development of ptymatic folds, xenolithic inclusions of palaeosome, brecciated and layered nature of the rocks are some of the field structures observed in the migmatites. The rocks showing the above structural features were mapped as one lithological unit in the enclosed geological map (Figure.3.4)

Figure.3.3 A typical exposure of migmatite showing xenoliths of melanocratic palaeosome and leucocratic neosome.

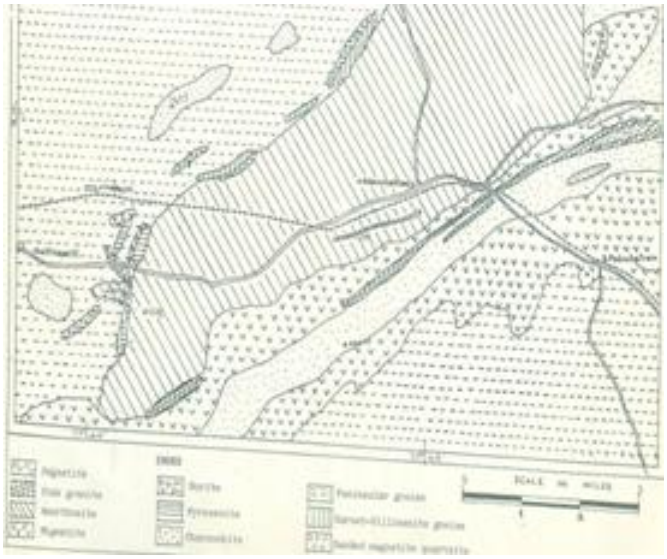

Figure.3.4 Geological Map of Oddanchatram, Palani Taluk, Dindigul Anna District of Tamil nadu

3.4.3 Garnet-sillimanite-Gneiss: (Khondalite)

It is a tough rock, composed of needles of sillimanite, seales of biotite, potash fieldspar, pink coloured garnet, Occasionally, graphite and magnetite are also present, In a few specimens presence of orhtopyroxene is also noted. Green spinel is rarely seen. Silky luature and prismatic habit are the typical characters for sillimanite.

Under the microscope, sillimanite occurs as aggregate needles with transverse cracks and occasional cleavages. The needles are not properly distributed and their orientation is irregular. Sillimanite is colourless and often occurs along with quartz. Spinel is green is colour and is isotropic under the microscope. Sillimanite needles show high relief and irregular cracks. Biotite shows plechroism from yellow to brown and occurs as scales.Feldspars are orthoclase and oligoclase in composition. Magnetite is black in colour and isotropie.

3.4.4 Peninsular gneiss

These rock types are repreented in the study area by garnetiferous mica gneiss.(Figure.3.5)The mineral components of this rock are quartz, feldspar, biotite,hornblende and iron ore. The percentage of mafics varies from section to section. Quartz grains are elongated and occur as aggregate and show wavy extinction. Potash feldspars are represented by Orthoclane. The plagioclase is oligoclass in composition and it shows polysythetic twinning. Biotite si plechric from yellow to brown. Hornblende is green in colour and shows prismatic elevages and low extinction angle ranging from 16° to 21°.Garnet is anhedral in shape with numerous cracks and shows isotropic character. Modal percentage of mieral components of this rock are as follows: Quartz – 29%, K-feldspar – 26%,Plagioclase – 20%, Garnet – 10%, Hornblende – 7% Garnet – 6%, and Iron orea – 2%.

Figure.3.5 Peninsular gnesis showing excellent banded structure – oddanchatram to Pachalur road

3.4.5 Charnockite

Variants of charnockite are represented in the field in the form of norite, pyroxenite and acid charnockite. These three rocks altogether form as most prevalent country rock in the field. Norites are distributed in the field in the form of lenses and intercalated bands within the anorthosite masses. Norite is melanocratic, equigranular and medium grained. In thin section it shows labradorite, diopside, hypersthene and hornblende. Vermicular intergrowth of prismatic grains of pyroxene within plagioclases are occasionally noted. Pyroxene shows alteration to hornblende. Apatite, garnet and magnetite are the accessories. The palgioclasses are sodic labradorite with polysynthetic twinning. Orthopyroxene (hypersthene) is feebly pleochroic from colourless to pink. Orthopyroxene shows prismatic cleavages and straight extinction. Noritic rocks are regarded as basic variety of charnockite series.Pyroxenite is a hard, compact and melanocratic rock with well developed prismatic cleavages which are megascopically visible. Under the microscope, the rock shows the presence of both ortho and clinopyrexenes. Orthopyroxene is represented by hypersthene which shows perfect prismatic cleavages, feeble pleochroism and straight extinction. Clinopyroxene is represented by augite, which shows perfect prismatic cleavages. Colourless and inclined extinction ranging from 45 – 45°. Pyroxenite is regarded as ulterbasic variety of charnockite.

The important mineral of acid and intermediate charnockite group of rock is hypersthene. Generally, these rocks are dark coloured and hence it is difficult to distinguish the acid variety from the intermediate variety in the hand specimen. Under the microscopel, the acid variety is composed of quartz, K-feldspar, sodic plagioclase, hypersthene and iron ore. The intermediate variety is made up of andesine plagioclase, orthopyroxene, augite and iron ores with or without Quartz. Subparallel arrangement of mafics is seen in both the varieties. The optical properties of hypersthene in the acid

variety are as follows:ZΔC = 2-5°, Pleochroic scheme; X = Pink., Z = light green. In the intermediate variety, the optical properties of hypersthene is similar to acid variety. Modal percentage of acid Charnockite is as follows: Quartz = 35%, K-feldspar = 40%, Plagioclase = 19% Hypersthene = 4%, other accessories = 2%, Modal percentage of intermediate charnockite is as follows: Quratz 10 %, K-feldspar =5%, Plagioclase = 40%, Clio and orthopyroxenes = 40% and other accessories = 5%

3.4.6 Pink granite, pegmatite, aplite and quartz veins

In hand specimen, pink granite is pink coloured and shows crude gneissosity owing to the planar parallelism of mafic minerals. Quartz is seen to have lineated in hand specimen. Under the microscope, perthitic intergrowth between quartz and microline is observed. The grains are coarse and irregular, Graphic texture is also common. The study area is travered by the intrusion of pergmatities, aplites and quartz veins. The intrusion of these acidic rocks favour the distintegration and feldspathization of pre-existing rocks. Pegmatites are extraordinarily coarse grained and pink coloured due to the abundant presence of orthoclase feldspar. Under the microscope pegmatite shows coarse grained and graphic texture between quartz and microline. Mafic minerals are mostly muscovite. Accessory minerals present in the pegmatite are apatite, beryl and sphene. Aplite is fine grained, equigranular and pink coloured rock. In hand specima, and under microscope. It contains the same minerals as in pegmatite under the microscope, aplite shows holocrystalling and allotrimorphic texture. Intergrowth texture is also common. Mafic minerals are not common. Quartz veins are found traversing the county rocks of the study area in almost all the directions. The quartz veins contain garnet in places and are also sometimes associated with coarse hornblende crystals.

IV STRUCTURAL FEATURES OF THE STUDY AREA

4.1 Introduction

The structures of the study area is quite interesting with much contortion, folding, shearing,jointing and faulting which are normally anticipated in the Archaean terrain. The various structural elements delineated and interpreted throw light on the fact that the various lithological units have been involved in a sequence of a few intrusive, metamorphic and deformational episodes. Generally, the rocks are characterised by a foliated structure to which all joints and other structure are geometrically related. The strike of the formations in the area under investigation varies from N 40° E to N80°E. The anorthosites are generally massive and devoid of any foliation. However, along the eastern and western margins, a crude foliation is developed in these rocks, as revealed by the linear disposition of the mafic constituents.

4.2 Folds:

The inconsistences observed in the foliation direction of the various rock types of the area prompted the author to make a few trips to some parts of the area. Based on these observations , a few remarks of general nature applicable to whole region are made here. All these data reveal the existence of a major isoclinal fold, perhapa overturned. The trend of the axial plane is NNE-SSE and is in conformity with the regional strike of the area. Infact, the various congruous foarces occurring within the domain of the major fold have been of immense value in fixing up the axial plane of the latter. After assessing the shapes and symmetry of such small scale at different positions occurring within the major fold area and also the profile pattern of the fold as viewed from it axis, the direction of the fold axis has been determined. The location of the axial plane by such graphical method is further confirmed in the field by the presence of such characteristic features as diallational structures like Boudinage,pinching and swelling.

4.3 Minor Folds

In some Places, anorthosites show extreme contortion and ptygmatic folds (Figure.4.1) A careful study of the various minor folds, their amplitude and wavelengths has been taken in order to evaluate as far as possible, the sequence of the fold them. Accordingly, several folds with amplitudes to a few cms to several metres have been identified in the area.

4.4 Joints:

Two directional jointing is well developed in basic granuilte and charnockite of the study area (Figure.4.2.) The strike joints trending NE-SW dip at vertical angles generally towards NW while the oblique joints striking NE-SE are almost vertical, sometimes showing steep dips towards S-W. The anorthosites are conspicuously unaffected by jointing. Horizontal joints are commonly noted in the charnockitses.

4.5 Shear Zones:

The eastern and western margins of the anorthosite masses appear to be zones of shearing and deformation. This is evidenced by

i) Extreme crushing, granulation and strike variation in the basic granulites along the western flank of Rangaswamimalai and in quartzite and in garnet – sillimanite gneiss in Vannankaradu

ii) Prolific development of garnets along the sheared contact zone of anorthosite – basic granultie. Shear planes are seen developing along the fold axial planes of minor folds. Two sets of shears are prominent in the area and they trend N 45°E and 35° W of which the former is older and the latter is observed dislocating the former in the field.

Figure.4.1 Extreme shearing folding contortion and layering in migmatites.

Figure 4.2 Displacement of pegmatite vein due to shearing movements.

4.6 Fault

The presence of the major zones of the shear noticed in the area appear to be oblique strikeslip fault. The fault zones are indicated in the study area by the presence of slickensides and fault gauge. The trends of the faults vary from N25^0 to N 45^0 E. These faults have affected anorthosites also. Evidences for the strike-slip fault are seen in the strike course of the shear zones, having steep angles of dip and crushing of the rocks in the vicinity and in the existence of small bent parallel faults. The actual faulty plane is situated in the stream course of Nanganji Ar.

4.7 Structural analysis and sequence of fold systems in the area:

The area of planar clements such as foliation planes, compositional planes and fold axial planes were recorded, Linear elements measured include oriented minerals, minor fold axes, and lensoid bodies.

4.7.1 F1-Fold phases:

The earliest recongnizable deformation noticed in this area belongs to F1 fold phases. The hinges of these folds are defined by aggregate of mafic minerals and their preservation and indentity is due to the offering of resistance to later migmatization. Type isoclinals flexural force are recognized in such granular rock type like basic granulite also with fold axial plane sub-parallel to its foliation.

The linear elements characteristically associated with F1 folding of the strong mineral lineations (L1) exhibited by the oriented hornblende crystals in the basic granulite and internal foliation. The original direction of fold axis can no longer been determined with any degree of certainity in the area, as a they are immensely affected by later fold phases.

4.7.2 F2-Fold Phases:

This is by far the dominating structural fabric seen in this area. Early folding subsequent to F1 is indicated by the presence of isoclinal folds. The fabrics are representative from regional scale to hand specimen and even micro section reveral oriented arrangement of constituent minerals.

The major fault system which immediately followed the fold systems F2. From the trend, it is clear that the deformative forces that brought about the F2 fold system is responsible to bring about the major linear structure (L2) observed in this area are also due to these deformative forces.

The analysis of structural data clearly indicate the intrusion of the anorthsistic rock in the area during these deformative episodes. The fault planes and fold axis F2 of these deformative forces are in cofirmity with the trend of anorthositc body in the study area.

V ANORTHOSITES OF ODDANCHATRAM

5.1 Review on Anorthosites

The name " Anorthosite" was proposed by sterry Hunt in the year 1862, for a felsic rock, essentially composed of andesine – labradorite plagioclases the rock was referred to as Labradorfels, Labradosite or Hypersthene rocks, before the name anorthosite was given to this rock. Anorthosite is defined as a rock consisting of 90% or more plagioclase feldspar, Gabbroic, Noritic or Troctolitic anorthosite contains 10-22% mafic minerals.

Two principal types of anorthosites are distinguished based on field occurrences.

1. Layered anorthosited instratified complexes of Igneous rocks.
   Eg:- Stillwater igneous complex,Montana,U.S.A sittampundi complex of Tamilnadu.
2. Large massif type anorthosite.
   Eg:- Domical Adirandock massif, New York,

U.S.A ., Irregular massif of Lake St.John Quebec.

Among the massif type anorthosites, two varieties are dinstinguished based on the composition of Plagioclase and iron-ititanium oxides. The labradorite type is characterized by plagioclase in the range An 68-45% and titaniferous magnetite. The "andesine-type is marked by the plagioclase range An 48-25% antiperthite and hemo-ilmenite.Important mafic minerals that constitute the anorthosite are orhto and clino-pyroxens,olivine is usually present in troctolite varieties. Ores may be present as inclusions. Garnet is always found as marginal metamorphic facies. Hornblende and biotite are retrograde mafic products. Though more than a hundred massif type anorhtosite bodies have been reported throughout the world with their field set-up, no general consensus on the petrogenesis of anorthosites and its relationship with orhtopyroxene bearing rocks have been arrived.

5.2 Characteristic features of oddanchatram anorhosites:

The anorthosite body is a tabular sheet of six miles long and 2 miles wide and it elongation is almost parallel to the foliation planes of the country rock. This anorthosite pluton occurs within th extensive granulite facies terrain of South India. It occupies in a low-lying elliptical area surrounded by resistant country rocks like gneisses and migmatites. The contact relationships are excellently exposed at many locations along the boundary (Plate VI.Fig.1). Anorthosite body carries inclusions of older rocks like norite,pyroxenite and gneisses.Occassionally it show foliated appearance whenever mafic contents are present in considerable amount. No metamorphic aureole is observed around the body of anorthosite.

Garnets are developed along the sheared marginal contacts of anorthosited and basic garnulites. Cataclastic fabric is also prevalent in the anorthosite body. Secondary twinning and marginal crushing around perphyroblasts of plagioclase feldspars are common features. The plagioclase feldspars constitute more than 90%of the rock and the compositional range is between 45 – 60% An.Saussurititsation is incipient along the deformed palgioclases. The common mafic mineral present in the anorthosite is green hornblende, and pyroxene is generally absent. Pyroxene shows alteration ot hornblende.Biotite in always been secondary after hornblende. The mafic bands within the bodies of Anorthosite shows, in certain places, contorted foldings as is common in migmatitic terrain.This indicates the possibility of intrusion of anorthositic magma into the earlier nortic rocks. The anorthosites shows a colour variation and tend to be darker and brownish yellow in colour in the proximity of contact zone while its colour becomes lighter farther away from such contact zone.

5.3 Mineralogy and mode of occurrence:

The anorhtosites of Oddanchatram consist of 95% plagioclase with little hornblende and iron ores. It is coarse grained and often porphyritic with variable colours ranging from grey, pink,purple and occasionally brown. The play of colours of plagioclase feldspar under sunlight is a characteristic feature. In thin section, the rock is hypidimorphic granular and shows conspicuously the protoclasitc effects like granulation, bending and wedging of plagioclase and undulose extinction, the plagioclase is almost invariably twinned. It shows alteration to calcite and chlorite. Pyroxene is generally absent and the usual mafic constituent is hornblende.However, thin sections of specimens from the proximity of enclosed norite bands show the presence of orhto and clinopyroxenes in minor amounts. Hypersthene anhedra are also found intergrown within plagioclase feldspars, the pyroxenes shows alteration along the periphery, cracks and cleavages to biotite, hornblende and chlorite Garnet occurs embedded in anorhtosites as ovoids and almond-shaped grains. There are occurrences of garnet grains rimmed by a thin zone of mafices of half millimeter width. The removal of these garnets, due to weathering, imparts a pitted appearance to the host rocks. The garnet has a tendency to be developed along the deformed narrow zones.magnetite grains occurring in anorthosites show a linear disposition. Magnetite occasionally includes grains of hypersthene. Biotite has been formed at the contacts of ore and plagioclase.

With regard to the mode of occurrence anorthosite body forms a narrow and tubular sheet running parallel to the NE-SE foliation planes of the pre-exiting granulitic rocks.The intrusive character of the anorthosite in the rocks granulite is manifested in the field. In some cases, the basic granulite is included as xenoliths while in some other cases,the anorthosite intruded the basic granulite with sharp contacts on either side (Plate VI,Fig.1).

5.1 petrography

Based on field and laboratory evidences, oddanchatram anorthosites can be broadly classified into two divisions:

1. Pure anorthosites and
2. Garnetiferous anorthosites.

5.2 Pure anorthosites:

This is the most predominating type in the study area. It is coarse grained, somewhat porphyritic with plagioclase of variable colours ranging from grey, pink, purple, and brown. It consist of 95% plagioclase with little hornblende and frequently shows play of colours. Under thin section, the rock is hypidiomorphic granular and shows protoclastic effects like crushing, granulation, bending and wedging of twin lamellae of plagioclase feldspar. The anorthite content of plagioclase feldspar ranges from An 45-An 65. the plagioclase is almost invariably twinned. it shows alteration to calcite . It shows alteration to calcite and chlorite. Pyroxene is generally absent and the usual mafic mineral is hornblende. Prismatic grains of hypersthenes are found intergrown within plagioclase feldspars. The clino and orthopyroxenes show alteration to hornblende, biotite and chlorite.

This rock type is free from garnet. However, some thin sections show the presence of euhedral garnet, crystals which are irregularly distributed. An interesting feature is that these garnet crystals have developed a mafic rim around their margin. The plagioclase, feldspars show occasional zoning in both twinned and untwined crystals. Magnetite grains also show a linear disposition.

5.3 Garnetiferous anorthosites:

This variety of anorthosite is distinguished from pure anorthosites by the characteristic presence of garnet. In the outcrops minute grains of garnets can be observed. In hand specimens, the rock is dark coloured, equigranular and medium grained.

This rock is found to consists of about 75% plagioclase (An 65-An 75), 23% garnet and the rest are green hornblende, magnetite and sphene. Under thin section, the rock is hypidiomorphic granular. Plagioclase is both twinned and untwined. It shows alteration to scapolite. Garnet occurs as anhedral grains in the interstitial spaces between plagioclase crystals. There is an intergrowth formed between hypersthenes and plagioclase.

Fig.1 A sharp contact between leucocratic anorthosites and melanocratic basic granulites.

VI SUMMARY AND CONCLUSION

Oddanchatram is situated in the North Eastern side of Kodai Hills and surrounded by Ranaswamimalai, Veriyappurkaradu, Anaikaradu, Vannnankaradu, Thandiyankaradu, Ehthilankaradu and Kuzhanthaivelappanmalai, only one small river, Nanganji Ar,is flowing in the study area occupying faulty zones. The lithological variations within the study area is highly significant. Attempt has been made to decipher the various lithological units particularly anorthsite and eits releationships with other rock types. A detailed geological investigation including field mapping, thin section study under petrological microscope and determination of anorthite content have been undertaken to throw light on the characterstic features of oddanchatram anorthosite. Gemorphologically, the area is highly rugged and undulating topography, Physiography,drainage, weather,climate,vegetation, weathering and soil types are discussed. The geology of oddanchatram and description of the various rock units present in the area under investigation are covered. Detailed petrographic study was undertaken with the help of thin sections prepared from rock samples collected from the study area. The results of the study are presented. The structure of the area under investigation is very interesting with much folding, shearing and faulting normally anticipated in the archaean terrain. Inferences from field observation about folds are discussed. A review on anorthosites of oddanchatram has been presented. Its mineralogy, made of occurrence and petrography have also been discussed. Views of earlier workers on oddanchatram anorthosite are also presented. The author further opines that comeparative study of various anorthosites from anorthositic complexes occurring within the same orogenic belt or different orogenic belts of peninsular India may ultimately yield valuable clues on the genesis of the massif anorthositic rocks of Oddanchatram.

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