© Government of India
Controller of Publication

ISSN 0579 - 4706

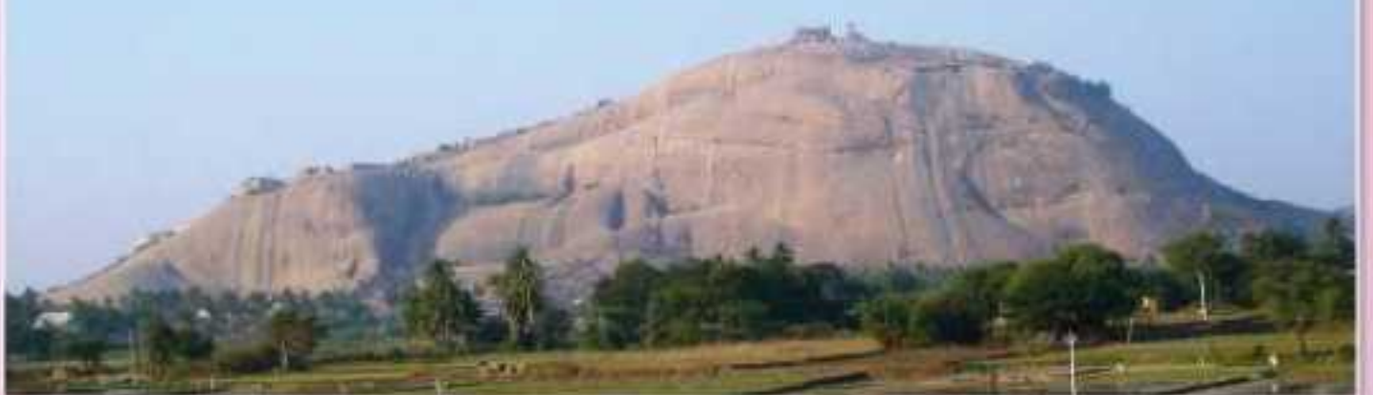
भारतीय भूवैज्ञानिक सर्वेक्षण
GEOLOGICAL SURVEY OF INDIA

तेलंगाणा का भूविज्ञान एवं खनिज संसाधन

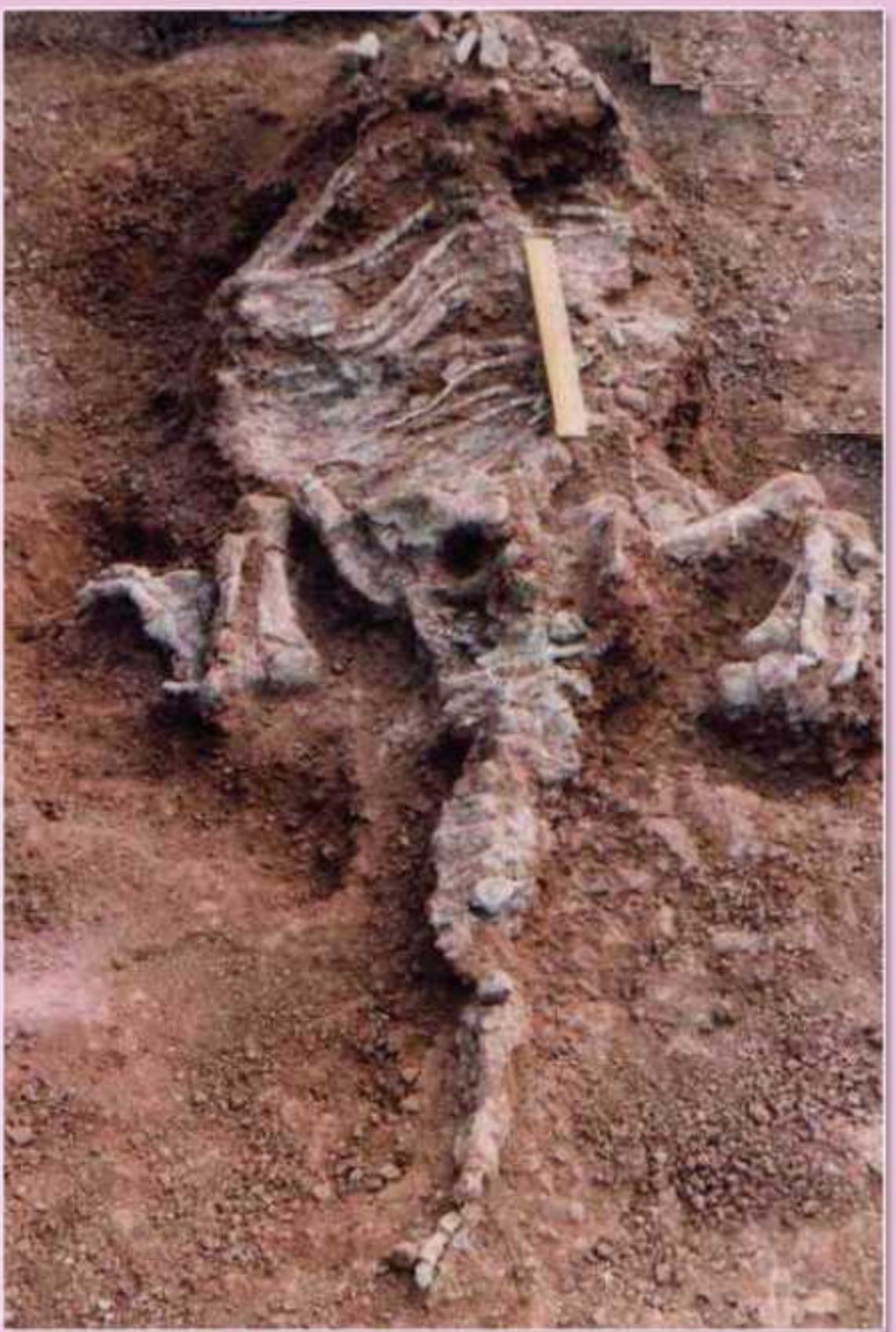
विविध प्रकाशन संख्या ३० भाग - VIII ए, प्रथम संस्करण

GEOLOGY AND MINERAL RESOURCES OF TELANGANA

MISCELLANEOUS PUBLICATION No. 30 PART - VIII A, First Edition



भारत सरकार के आदेश से प्रकाशित
Published by the order of the Government of India
2015



Rhynchosaurus skeleton (Photo by Palaeontology Division SR)

© Govt. of India
PGSI - 383
Controller of Publication 450-2014 (D.S.K. II)

भारतीय भूवैज्ञानिक सर्वेक्षण
GEOLOGICAL SURVEY OF INDIA

तेलंगाणा का भूविज्ञान एवं खनिज संसाधन

विविध प्रकाशन संख्या ३० भाग - VIII ए, प्रथम संस्करण

GEOLOGY AND MINERAL RESOURCES OF TELANGANA

MISCELLANEOUS PUBLICATION NO. 30 PART - VIII A, First Edition

भारत सरकार के आदेश से प्रकाशित
Published by the Order of the Government of India

2015

© Copyright Government of India, Geological Survey of India (2015)

First Edition: 2015

Compiled by

Kamatham Mahender Reddy
Director
and
R.M.Sundaram
Director

Manuscript Processed for printing by

S.Someswara Rao
Senior Geologist

K.Jagadishwar Babu
Senior Geologist

T.Vaideswaran
Superintending Geologist

Under the supervision of

G. Pratap Reddy
Director
Publication Division, SR, Hyderabad,

Under the guidance
of
M.S Jairam
Deputy Director General & HoD
GSI, Southern Region, Hyderabad

Published by
Director General
27, Jawaharlal Nehru Road
Geological Survey of India
Kolkata – 700016
2015

Price : **Inland :** ` 162/- **Foreign :** $ 6.5 / £ 4.25

Front cover : Granite Inselberg resembling the Whale Back at Bhongiri in Nalgonda District, Telangana *(Photo by Shri Kamatham Mahender Reddy, Director).*

Back page : Open cast mining of coal, Gautham Khani, Kothagudem, Khammam District. *(Photo by Dr. G. Samuel Sukumar, Supdt.Geologist).*

प्राक्कथन

विविध प्रकाशन श्रृंखला, 30 के प्रकाशनों के अंतर्गत भारतीय भूवैज्ञानिक सर्वेक्षण, भारत के राज्यों के भूविज्ञान और खनिज संसाधन पर संक्षिप्त सूचना प्रकाशित करता है। इस श्रृंखला के अंतर्गत तेलंगाणा राज्य का भूविज्ञान और खनिज संसाधन वर्तमान खंड, भाग VIII ए का भाग है। भारत के 29 राज्य के रूप में निर्मित तेलंगाणा राज्य का यह पहला खंड है जिसका उद्भव अविभाजित आंध्र प्रदेश से तेलंगाणा राज्य से हुआ है। वर्ष 1975 में इसका पहला संस्करण प्रकाशित हुआ था। बाद में वर्ष 2005 में इसका संशोधन किया गया।

देश के भूविज्ञान और खनिज संसाधनों के अन्वेषणों को सामने लाने हेतु भारतीय भूवैज्ञानिक सर्वेक्षण देश के कोने-कोने से अपनी क्रियाकलाप कार्यान्वित करता है और हितधारकों के लिए सामग्री प्रकाशित करता है। इस खंड में तेलंगाणा राज्य में किए गए कार्य को प्रतिबिम्बित किया गया है। 1:50,000 मानक पर क्रमबद्ध भूविज्ञान मानचित्रण की सामग्री पश्चात् चयनित क्षेत्रों में बड़े पैमाने पर विशेष विषयक मानचित्रण का कार्य लिया गया। इस राज्य से संबंधित फील्ड कार्य और प्रयोगशाला अनुसंधान अध्ययनों से एकत्रित डेटा विशेषतौर पर स्तरित शैल-विज्ञान में कुछ संशोधन इस राज्य के लिए सहायक रहा विशेषतौर पर प्रीकैम्ब्रियन भाग और विकासात्मक इतिहास को पुनःनिर्माण करने में सहायक रहा है।

खनिज संसाधनों को पता लगाने के लिए किए गए गवेषण परिणामस्वरूप कई खनिज निक्षेप सामने आए जैसे खंमम जिले के मायलाराम क्षेत्र में ताँबा निक्षेप, वारंगल और करीमनगर जिलों के बय्यारम क्षेत्र में लौह अयस्क, महबूबनगर और रंगारेड्डी जिलों में भीमा द्रोणी में चूनापत्थर निक्षेप, आदिलाबाद जिले के मेग्नीज उपस्थितियां, खंमम जिले के कोयला निक्षेप जिसे सिंगरेणी कोलेइरीज खनन कर रहा है। महबूबनगर जिले के नारायणपेट में किम्बरलाइट/लैंप्राइट की खोज एक विशेष महत्वपूर्ण स्था रखता है। जिसने इस क्षेत्र में हीरे की खोज हेतु आगे की अन्वेषण की प्रेरणा मिलेगी। नलगोंडा जिले में परमाणु खनिज निदेशालय (प्रभाग) ने महत्वपूर्ण यूरेनियम के निक्षेपों का पता लगाया है जो कि तेलंगाणा राज्य के खनिज संसाधनों में यह एक मूल्यांकित संकलन है।

1:2 मिलियन मान पर तेलंगाणा राज्य का भूविज्ञान और खनिज मानचित्रण, सहित यह प्रकाशन उद्यमियो, व्यवसायियों एवं विद्यार्थियों के लिए बहुत ही लाभदायक होगा।

दिनांक : 19-03-2015
कोलकाता [redacted]

(हरबंस सिंह)
महानिदेशक
भारतीय भूवैज्ञानिक सर्वेक्षण

FOREWORD

Geological Survey of India brings out Miscellaneous Publication series volume 30 providing concise information on the geology and mineral resources of the states of India. The present volume, ***Geology and Mineral Resources of Telangana,*** Part VIII A of the series, for the state of Telangana is the first edition of the newly formed 29th State of India, carved out from the state of Andhra Pradesh. The first volume published in 1975 was of the undivided state of Andhra Pradesh which was later revised in 2005.

Geological Survey of India in its quest of unraveling the geology and mineral resources of the country carries out its activities in every nook and corner of the country and publishes for the users. This volume reflects the work carried out by GSI in Telangana State. After completion of Systematic Geological Mapping on 1:50,000 scale, Specialized Thematic Mapping was taken up on larger scale in selected areas. The data accrued from field work and laboratory research studies pertaining to this state has helped in certain revisions in the stratigraphy, particularly in the Precambrian part and in reconstructing the evolutionary history.

The exploration work carried out in this region to find out mineral resources resulted in locating several mineral deposits such as the copper deposit in Mailaram, Khammam district, Iron ore in Bayyaram of Warangal and Karimnagar districts, Limestone deposits of Bhima basin in Mahaboobnagar and Ranga Reddy districts besides Manganese occurrences of Adilabad district, coal deposits of Khammam district which is being mined by Singareni Collieries. Discovery of Kimberlite/Lamproite Field in Narayanpet of Mahaboobnagar district is of considerable significance which gave impetus for further investigations for the search of diamonds. Significant Uranium deposit has been discovered in Nalgonda district by Atomic Minerals Division which is a value addition to the mineral resource of the state.

This publication along with the Geological and Mineral Map of Telangana on 1:2 million scale, will be of great use to entrepreneurs, professionals and students of geology.

Harbans Singh
Director General
Geological Survey of India

Date:19-03-2015
Kolkata

GEOLOGY AND MINERAL RESOURCES OF TELANGANA

CONTENTS

Page No.

I. INTRODUCTION 1
II. GEOLOGY 2
A) ARCHAEAN 3
Peninsular Gneissic Complex-I 4
Dharwar Craton 4
Khammam Schist Belt 4
Greenstone Belts 4
B) ARCHAEAN TO PALAEO-PROTEROZOIC 7
Peninsular Gneissic Complex-II 7
Karimnagar Granulites 7
Eastern Ghats Mobile Belt 7
Khondalite Group 8
Charnockite Group 8
Migmatites 9
Mafic Dykes 9
C) MESO TO NEO-PROTEROZOIC 9
Cuddapah Basin 9
Cuddapah Supergroup 9
Kurnool Group 10
Pakhal Basin 11
Pakhal Supergroup 11
Penganga Group 12
Sullavai Sandstone 12
Bhima Basin 12
Alkaline Rocks/ Kimberlites-Lamproites 12
Alkaline rocks 13
Kimberlites and Lamproites 13
Granites 13
D) LATE CARBONIFEROUS – EARLY CRETACEOUS 14
Gondwana Supergroup 14
Lower Gondwana Group 14
Upper Gondwana Group 15
E) LATE CRETACEOUS – EOCENE 16
Deccan Traps 16
F) QUATERNARY 16

III. STRUCTURE AND TECTONICS **18**
IV. GEOLOGICAL HISTORY **19**
V. FOSSIL OCCURRENCES **22**
VI. MINERAL BELTS **24**
VII. MINERAL RESOURCES **33**
Barytes 33
Basemetals (Copper, Lead And Zinc) 34
Building Stones 34
Chromite 35
Clays 35
Coal 36
Diamond 38
Dimension Stones 40
Dolomite 40
Fuller's Earth 41
Gem Minerals 41
Corundum 41
Garnet 41
Glass Sand/Quartz 41
Gold 42
Graphite 42
Iron Ore 42
Kyanite 43
Limestone 43
Manganese 44
Mica 45
Mineral Pigments 45
Molybdenite 45
Uranium 45
ANNEXURES :
I Major Occurrences / Deposits of Minerals 46-48
II Minor Occurrences / Deposits of Minerals 49-50
LOCALITY INDEX **51**
SELECTED BIBLIOGRAPHY/REFERENCES **55-56**
List of Abbreviations **59**
PLATE – Geological and Mineral Map of Telangana

GEOLOGY AND MINERAL RESOURCES OF TELANGANA

I. INTRODUCTION

Telangana is the 29th State of India which has come into existence from 2nd June, 2014. It has been carved out of Andhra Pradesh and has an areal extent of about 114,840 sq km lying between 16º 00' and 20º 00' North latitudes and 77º 00' and 82º 00' East longitudes. It is bounded by Maharashtra in the north Chattisgarh in the East, Karnataka in the west and Andhra Pradesh to the south. It is broadly divisible into two physiographic units namely i) Gondwana graben and (ii) the Deccan Plateau forming a wide expanse of flat to low-undulatory terrain of plains and small hills. It has a general altitude ranging between 200 m and 600 m with a gentle easterly slope. The Plateau region is dotted with hills of low to moderate height, some of which rising to more than 1000 m above MSL.

The Gondwana graben which exposes the entire Gondwana sequence having a trend of NW-SE direction, hosts one of the country's richest coal reserves. The major part of Deccan Plateau in the state characterised by the Eastern Dharwar Craton composed main the granite /gneissic variants of the Peninsular Gneissic Complex. The granites form the inselbergs, hills and lowlying mounds, where as the gneissic terran form the Pediplain-Pedimont. This Plateau is bordered in the west by Deccan basalts which, form the mesa, butte morphology.

The Godavari and the Krishna are the major rivers flowing through the State. Originating in the neighbouring States, these rivers enter Telangana and drain the Deccan Plateau and cut across the Eastern Ghats in Andhra Pradesh to debouch into the Bay of Bengal. Some the minor rivers drains in the state are Manjeera, Musi, Kinnersani, Manair and Munneru.

The State experiences tropical to semi-arid conditions with temperatures ranging between 42ºC and 48°C during summer and 8º C and 17ºC during winter. The average annual rainfall varies between 550 mm and 1500 mm. The rainfall is caused chiefly by the southwest monsoon between June and September.

II. GEOLOGY

The earliest geological account was given by Bruce Foote (1876) on Geology of parts of Bellary, Anantapur and Mahabubnagar and Kurnool and he described under Dharwar System. Mukherjee (1931) of Hyderabad Geological Survey reported Dharur and Gadwal Bands of Dharwar rocks. Mukherjee, et al., (1936) also accounted geology of eastern portion of Raichur, Nalgonda.

The area of Telangana State forms part of Southern Precambrian Tectonic Province or Southern Peninsular Shield and the shield elements are described under Dharwar Craton consisting of greenstone -granite suite with relative stability yielding relative older radiometric ages followed by intra cratonic basins (Cuddapah, Pakhal, Bhima and Godavari Graben comprising Gondwana sediments); and are bordered by Eastern Ghats Mobile Belt (EGMB) having highgrade granulites with younger thermal events. Dharwar Craton is divided into two tectonic Blocks with reference to its North-South trend. The Western Tectonic Block (WTB) covering major areas of Karnataka with two cycles of greenstones and geosyncline piles and the Eastern Tectonic Block (ETB) relatively narrow linear greenstone belts diapiric granites and the division is with respect to the N-S trending Closepet Batholith (Viswanatha and Ramakrishnan, (1976).

The craton is covered partly by the Phanerozoic Gondwana sediments along the NW-SE Godavari Rift/Graben, which is flanked on either side by the Proterozoic sedimentary sequences of Pakhal, Penganga and Sullavai basins. A small portion of the Proterozoic Bhima Basin extends into the State from Karnataka in the west. The late Mesozoic Deccan Trap cover of the central and western India has its extension marginally into the north-western part of the State. Isolated minor outcrops of the Cretaceous-Tertiary rocks and the Quaternary sediments are confined mostly to the Inland river basins of Krishna, Godavari and their major tributaries over a very narrow zone bordering them. Laterite and Bauxite of Tertiary age are formed in certain areas over the Deccan traps.

The Stratigraphic succession (Table-I, 2 & 3) and a brief account of the geology of Telangana is given below, in a chronological order. The Precambrian stratigraphy is worked out both in WTB and ETB on the modern lines as proposed by Anhaeusser et al., (1969).

TABLE – 1
GENERALIZED GEOLOGICAL SUCCESSION OF ARCHAEAN PALAEO-PROTEROZOIC ROCKS OF TELANGANA

Era	Supergroup	Group	Intrusive	Lithology
PALAEO-PROTEROZOIC TO ARCHAEAN	EASTERN GHAT (1850-1950 Ma)	MIGMATITE CHARNOCKITE KHONDALITE	MAFIC DYKES YOUNGER GRANITOIDS (2500 Ma)	Dolerite, gabbro and pyroxenite Granite, alkali feldspar granite, quartz syenite Grey to pink granite and granodiorite Closepet Granite Migmatitic Gneisses Pyroxene Granulites Calc Granulites Garnet Sillimanite Gneiss, Quartzite Graphite Gneiss

	PENINSULAR GNEISSIC COMPLEX	KARIMNAGAR GRANULITES (2550 Ma) Peninsular Gneiss-II (2550 -2600 Ma)		Migmatites (banded gneisses, garnetiferous quartzo feldspathic gneisses, hypersthene gneiss, quartzo-feldspathic granulites) Granite Gneiss,Granite, and it's variants with enclaves of Dharwars
ARCHAEAN	DHARWAR (2900 ma)	Ghanpur Yerraballi Peddavuru Gadwal Khammam		Amphibolite, hornblende schist, chlorite-actinolite schist, quartz-sericite/chlorite schist, biotite-chlorite schist, garnet-biotite schist, kyanite schist, banded ferruginous quartzite, metapyroxinite, metagabbro, meta-anorthoiste, serpentinite and talc-termolite schist (metamorphosed volcanogenic and sedimentary rocks), Chimalpahad gabbro anorthosite complex and other mafic-ultramafic rocks.
	PENINSULAR GNEISSIC COMPLEX	Peninsular Gneiss-I (3000 Ma)		Aplite, quartz vein, pegmatite granite, granodiorite, tonalite with enclaves of Sargurs.
		OLDER METAMORPHICS (SARGURS) (Seen as enclaves in PGC-I) (3300 Ma)		Garnet-biotite schist/gneisses, biotite-staurolite schist, kyanite-muscovite schist/ quartz, amphibolite± garnet and banded ferruginous quartzite.

A) ARCHAEAN

Smeeth M.F. (1916) outlined the Geological History of Mysore, described gniessic rocks under Peninsular Gniessic Complex encompassing basement gneiss corresponding to Peninsular Gneiss-I forming basement for schist belt rocks and younger intrusive gneiss and granites corresponding to Peninsular Gneiss-II of present account.

It includes the undifferentiated gneisses and gneissic granitoids and is considered older to the greenstone belts. Revision mapping carried out in Telangana has shown that the PGC comprises different suites of gneisses and intrusive granitoids, the latter predominating over the former. The gneisses are migmatitic, grey, fine to medium grained, banded to streaky. Tonalite, trondhjemite and minor proportion of granodiorite are the compositional variants within the gneisses of the Kukkalarugudem area. They are generally potash poor and exhibit distinct trondhjemitic trend on chemical variation diagrams. These gneisses were deformed and metamorphosed along with the associated greenstones.

Peninsular Gneissic Complex – I

It mainly comprises the granitic variants and gneisses which have resulted as a consequence of granitisation of the high grade metamorphics, termed as older metamorphics, equivalent of Sargurs. These high grade rocks were subjected to the process of granitisation in multiple phases resulting in variety of granites and gneisses. However the undigested parent rocks are seen in the form of enclaves and remnants within these grantoids. These are seen to the north of the Gondwana basin in Adilabad District, which have a geographical continuity into the Central India but are referred there as Bijapur Gneiss with enclaves of Bengpals.

Eastern Tectonic Block of Dharwar Craton

In Telangana the Cratonic part included in the ETB of the Precambrian segment is essentially a low grade metamorphic terrain exposing schistose rocks in the form of narrow and linear belts and varied types of granites and gneisses that separate the schist belts. These granitic rocks form bulk of the granite-greenstone belts in the State are known by the term of Peninsular Gneissic Complex (PGC). The schist belts, generally referred to as greenstone belts or supracrustals are metamorphosed to greenschist to amphibolite facies of rocks.

Khammam Schist Belt

Schistose rocks containing the amphibolite to green-schist facies mineral assemblages and displaying imprints of multiple phases of deformation and migmatisation is noticed in the Khammam Schist Belt located in the marginal zone between Craton and EGMB. These rocks have earlier been equated with the Sargur Group due to their similarity of composition and metamorphic grade with those in the type area in the western part of the Dharwar Craton in Karnataka. All the amphibolite- green schist facies rocks are equated with the low grade greenstone belts.

Unlike other greenstone belts like Gadwal and Peddavuru, there is no linear belt like configuration as regard to Khammam Schist Belt. Three generations of deformations of gneisses can be recognised. The slivers of meta-basic and meta-sedimentary supracrustal rocks located amidst the gneisses and spread over a linear zone in the area between Kothagudem-Chimalpahad in the north to Thiruvuru, Krishna District, AP in the south and Wyra-Tallada in the south in Khammam District is referred to as Khammam Schist Belt. The zone extends in an N-S to NNE-SSW over a strike length of 75 km with a width of 10 km. The various rock units in the belt are quartz-garnet-biotite schist, quartz-garnet-kyanite-muscovite schist, calc-silicate rocks, magnetite quartzite and quartzite with or without sillimanite representing meta-sediments and amphibolite/hornblende schist constituting meta-volcanics. Intrusion of granitoids and migmatisation of the schistose rocks resulted in the formation of biotite gneiss and hornblende gneiss which are sometimes garnet bearing. Amphibolite, quartzo-feldspathic gneiss and feldspathic quartz-mica schist also form part of the migmatite. The schists and gneisses were subjected to multiple phases of deformation and were intruded by pink granite, gabbro-anorthosite, ultramafics and the gabbro/dolerite dykes. The amphibolite grade schists and gneisses were retrograded along shears that are rich in chlorite and epidote.

Chimalpahad Gabbro-Anorthosite Complex

The Chimalpahad gabbro-anorthosite complex, occupying an area of about 200 sq km was syntectonically emplaced in the Khammam Schist Belt, southwest of Kothagudem in Khammam District. It is the biggest Archaean metamorphosed layered complex in India and is essentially a leucogabbro (gabbroic anorthosite and anorthositic gabbro) with subordinate anorthosite and gabbro components. These exhibit rhythmic layering and locally magmatic cross-bedding. The complex is intruded by amphibolite ± garnet, pink granite, lenses of ultramafic bodies ± chromite, mica pegmatite and quartz veins. Similar layered gabbro-anorthosite is also noticed near Sripuram.

Greenstone Belts

The greenstone belts located in Telangana are part of the Eastern Tectonic Block of Dharwar Craton and are treated as time equivalents of the **Dharwar Supergroup** of the Western Block of the Dharwar Craton.

The Greenstone belts consisting mainly of meta-volcanics with minor proportion of meta-sediments command a special status by virtue of their mineral potential. A majority of them occur in the western and southwestern part of the State in the form of N-S to NNW-SSE trending sub-parallel belts amidst the gneisses and granites. The prominent belts include Gadwal, Peddavuru, Yerraballi and Ghanpur schist belts. Tholeiitic meta-basalt represented by chlorite-actinolite schist and amphibolite predominate over the acid volcanics. The meta-sediments include BIF, quartz-chlorite schist and minor proportion of calcareous rocks in association with chert.

i) Gadwal Schist Belt

Named after Gadwal town, the schist belt has a total length of about 85 km extending in a general NNW-SSE direction from Veldurti in Kurnool District in the south to Narayanpet in Mahbubnagar District in the north. Further south, it could not be traced because of Gani Kalva, Veldurti fault. The rocks of Gadwal schist Belt are described under Gadwal Group with lower Sangala Formation comprising metabasic volcanics with Pillow structures at places and Banded Iron Formation (BIF); followed by Ulindakonda Formation represented by Volcanic conglomerate/vent conglomerate/meta-rhyodacite/meta rhyolite with clasts of granite (trondhjomite) possible indicating shattered fragment of basement – thus sialic basement is inferred such is the roundedness it can be mistaken for sedimentary conglomerate but the matrix (acid volcanic) decided it to be vent or volcanic conglomerate. Rounding is due to fluidization processes. Recent studies enabled to trace NW-SE trending, intermeittently exposed schist band connecting Gadwal Belt with Raichur Belt. Thus defining a southerly plunging Regional Fold with NW-SE axial trace. Three phases of granite suite - Trondhjomite-Tonalite-Gneiss (TTG), Tonalite-Granodiorite-Monzogranite(TGM) and Monzogranite-Syenogranite(MS). While TTE is having similar deformational imprints like schist belt possibly indicating basement (?) and syn-tectonically intruded TGM and MS suite. Three phases of deformation – D_1 Penetrative deformation gave rise to NNW-SSE to NW-SE trending regional schistosity with attendant PT conditions of greenschist metamorphism. It resulted in F_1 mesoscopic neutral folds. The regional southerly plunging fold with Gadwal and Raichur representing arm of F_2 antiformal structure due to D_2 deformation and syn-tectonic emplacement of diapiric granite (TGM and MS suites) resulted in the development of aureole metamorphism as indicated by the development of anthophyllite, garnet, andalusite, silliminite and cordierite. The D_3 deformation through away the schist belt rocks into broad warps with E-W axial trace. Mafic dyke activity marks the youngest igneous activity cutting both granite greenstones but not overlying Cuddapah rocks. Later deformations are in the form of shears and faults and are seen occupied by quartz reef.

ii) Peddavuru Schist Belt

A linear NW-SE trending Peddavuru schist belt extends over a strike length of 30 km from Juvigudem in the north to Ethipothala in the south and depicts a hockey stick shaped belt. The lithounits in the 2 km wide belt are metabasalt pillowed allthrough, metarhyodacite, quartz-sercite schist and Banded Iron Formation (BIF). Banded and intensely deformed tonalite gneiss may be older basement gneiss occurs as discrete outcrops of small dimensions within granodiorite terrain close to the schist belt. TGM and MS suites show intrusive relationship with schist belt rocks. Dolerite dykes trending N-S and E-W cut across the schist belt. The schist belt rocks are showing three deformations - D_1 resulting F_1 mesoscopic isoclinal folds. The D_1 deformation with attendant development of penetrative regional NNW-SSE trending schistosity with attendant PT conditions of greenschist facies. The D_2 co-axial fold southerly plunging anti-formal fold with NW-SE axial trace with syn-tectonic emplacement of TGM and MS suites. The D_3 deformation through away the schist belt rocks into broad warps with E-W axial trace.

Archaean megacrystic anorthositic dyke is noticed on the left bank of Krishna river near Nagarjuna Sagar cutting schistose rocks of Peddavura schist Belt. The megacryst of plagioclase is of 10-15 cm in diameter and are analogous to football anorthosite of Quebec.

iii) Yerraballi Schist Belt

It is a 8x5 km belt trending N-S, exposed near Yerraballi in Karimnagar District. It comprises metabasalt, BIF and quartz-pebble conglomerate. It is engulfed by intrusive granitoids and bears the imprints of two phases of folding. The rocks are metamorphosed under PT conditions of greenschist facies.

iv) Ghanpur Schist Belt

Ghanpur schist belt in Warangal district is 16km long and 1km wide extending from Zafargarh 2km north of Ghanpur in NNW-SSE direction. It is characterised by banded iron formation, amphibolite, biotite schist with sulphide stains and encrustations.

There is a structural unanimity in all these belts resulting due to Dharwar Orogeny.

TABLE-2

GEOLOGICAL SUCCESSION OF MESO TO NEO-PROTEROZOIC ROCKS OF TELANGANA

Era	SG	Group	Formation	Super group	Group	Formation	Group			Intrusives
NEOPROTEROZOIC		CUDDAPAH BASIN		PAKHAL BASIN			BHIMA BASIN			
		KURNOOL	Narji limestone Banganapalle Quartzite			SULLAVAI SANDSTONE				
					Unconformity		Sedeam Subgroup	Shahbad	Lime-stone	
					PEN GANGA GROUP	Putnur Limestone Takkallapalli Arkose		Rabbanpalli	Sst. Congl Silt-stone	
MESOPROTEROZOIC	CUDDAPAH SUPERGROUP		Srisailam Quartzite	PAKHAL SUPERGROUP		ALBAKA SANDSTONE				Kimberlites and lamproites; granite, alkali feldspar granite; nepheline syenite, syenite, quartz syenite and other alkaline rocks; gabbro, gabbroic-anorthosite, pyroxenite, dunite and serpentinite (Kondapalli Complex); gabbro-norite, anorthosite and pyroxenite (Chimakurti Complex) (1800 - 2300 Ma)
			—Unconformity—			*Disconformity*				
		NALLA MALAI GROUP	Cumbum (Pullampet) Formation Barienkonda (Nagari) Quartizite		MULUG GROUP	Lakhavaram Shale Pattipalli Quartzite Enchecheruvu Formation Polavaram Formation Jakkaram Arkose				
			Disconformity			*Disconformity*				
		PAPA GHNI GROUP	Vempalle Formation Gulcheru Quartzite		MALLAM PALLI GROUP	Pandikunta (Karlai Shale) Gunjeda Dolomite (Bayyaram Quartzite) Bolapalli Formation				
——————Unconformity——————										
Gneisses, granitoids, schists and mafic dykes										

B) ARCHAEAN TO PALAEO-PROTEROZOIC

The Archaean Palaeo-Proterozoic boundary in Telangana is not well defined and the Precambrian terrain, exposing a variety of rocks, presents a complex geological history. These rocks occurring in different litho-tectonic domains have considerable overlap in time and space. The domain-wise description of the Precambrian rocks is given here, broadly following the chronological order to the extent possible.

Peninsular Gneissic Complex-II

The intrusive granitoids of the PGC-II are classified into two, an older group dominated by granodiorite and the younger potassic granite. The older granitoids are grey, massive to weakly foliated, medium to coarse grained and equigranular to porphyritic or megacrystic. They are locally well foliated and gneissic due to deformation and characterized by the presence of Mafic rich Micro granular Enclaves (MME) and synplutonic Mafic Magmatic Dykes (MMD). The composition varies from tonalite through granodiorite to adamellite (monzogranite). They represent typical calc-alkaline suite of granitoids and form large syntectonic plutonic bodies emplaced into the gneisses and the greenstone belts. They are closely associated with hornblendite - hornblende gabbro - diorite bodies and microgranitoid dykes and enclaves, which exhibit features indicative of magma mingling and/or mixing.

Based on the field relations, structural and textural characteristics and the types of enclaves present, the granitoids are grouped into three suites viz. Tonalite-Trondhjemite Granodiorite gneiss (TTG) suite, Tonalite-Granodiorite-Monzonite (TGM) suite and Monzonite-Syenogranite (MS) suite. TGM suite is the compositionally expanded suite ranging from tonalite at one end to granite at the other end through granodiorite. The TGM suite is syntectonic and the youngest MS suite is late to post tectonic in relation to regional deformation.

The younger granites include granite and alkali feldspar granite. They are intrusive into the greenstone belts, gneisses and the calc-alkaline granitoids and occupy major part of the state. They are massive, grey to pink, medium to coarse grained and equigranular to locally porphyritic.The gneisses, forming the oldest group among the granitic rocks within PGC-II, either occur in the form of linear belts parallel to the greenstone belts or occupy the core of some domal structures within the greenstone belts. The gneissic belts are separated from the greenstone belts by the intrusive granitoids. Here, the second group constituting calc-alkaline suite of granitoids occupies almost entire area between the different greenstone belts. Some of the domal granitoids within the greenstone belts, other than the domal gneisses, also belong to this group. In the north, the gneisses and calc-alkaline granitoids occur in the form of enclaves and outcrop-size remnants enclosed within the youngest group i.e., the granite - alkali feldspar granite which occupy large tracts. Here again, the calc-alkaline granitoids are predominant in the close vicinity of minor greenstone belts. These gneisses and granitoids have been classified on the basis of their mineral assemblage, colour and grain size.

Karimnagar Granulites

Outside the Eastern Ghat Mobile Belt (EGMB), the granulites also occur well within the craton in the form of large enclaves and linear bands amidst granitic rocks close to the NW-SE trending Godavari Rift/ Graben. They are spread over a linear zone that extends over a length of 200 km with an average width of 40 km in Karimnagar, Warangal and Khammam districts. The granulite facies rocks here include charnockite, enderbite, pyroxene granulite, sillimanite quartzite with or without garnet, diopside bearing quartzite and sapphirine granulite. These are collectively grouped under Karimnagar Granulites.

Eastern Ghats Mobile Belt

The Eastern Ghats Mobile Belt (EGMB) also referred to as the Eastern Ghat Granulite Belt, is a granulite terrain mainly made up of khondalite, quartzite, calc-granulite, pyroxene granulite and charnockite. The EGMB has a trend of NE-SW and extends from Brahmini River in Orissa, passes through the eastern parts of Telangana upto Ongole in Andhra Pradesh, for over 900 km. The belt skirts

the eastern fringes of Dharwar and Bastar cratons and the southern fringe of Singhbhum Craton. It has a maximum width of about 300 km, in Orissa which gradually tappers down to only a few km and terminates near Ongole in Andhra Pradesh. It stands as one of the classic examples of ultra-high temperature (UHT) metamorphic belts. Three broad longitudinal zonations have been made in EGMB namely, (i)The Eastern Migmatite Zone (EMZ) 40-100 km (ii)Central Khondalite Zone (CKZ) also 40-100 km wide and (iii) Western Charnockite Zone (WCZ) which is 20-30 km wide. The area occupied by the above suites (zones) within the EGMB is 45%, 25% and 30% respectively. The EGMB bears a tectonic 'Thrust' contact with the eastern margin of Dharwar and Bastar Cratons.

The EGMB hosts a number of minerals of economic importance such as manganese, graphite, tin-tungsten and apatite. Cainozoic lateritisation resulted in the well known and extensive bauxite cappings. Besides, pegmatites the rocks of EGMB are known for their gemstone potential, mostly sillimanite and chrysoberyl cat's eye. Many of the charnockite varieties and leptynites are being exploited as dimension stone granites. Radio-active mineralisation has been reported from the central part of EGMB, north of Polavaram.

The different rock types in the EGMB are tentatively classified into Khondalite Group and Charnockite Group, which constitute the Eastern Ghat Supergroup. As they are the most intensely deformed and metamorphosed among all the crustal rocks in the State, they have traditionally been considered oldest having Archaean ancestry. Of late, it is being realised that the prominent tectonic and metamorphic imprints in them and possibly some of the charnockites and migmatites are much younger (Meso to Neo-proterozoic).

Khondalite Group

The Khondalite Group consists of quartz - feldspar - garnet - sillimanite $\pm$ graphite schist/gneiss (khondalite), quartzite and calc-gneiss/calc-granulite, which represent the metamorphosed equivalents of the original argillaceous, arenaceous and calcareous sediments respectively. Quartzo-feldspathic gneiss with or without garnet, biotite, sillimanite, commonly referred to as leptynite/leptite, also forms a distinct litho-unit of this Group.

The rocks of the Khondalite Group, which constitute the dominant component of the Eastern Ghats, form continuous hill ranges in the Eastern Ghats proper and as isolated ridges, hills and mounds in the midst of migmatites at lower elevations and in the adjoining coastal plains. At places, graphite-rich khondalite grades into graphite schist/gneiss which locally constitutes small but workable graphite deposits in the Districts of Khammam.

Charnockite Group

The Charnockite Group includes i) pyroxene-granulite (basic charnockite) and ii) hypersthene bearing rocks of tonalite, granodiorite and granite composition (intermediate to acid charnockite). They are interbanded and co-folded with the khondalite and migmatite rocks on a regional scale.

The pyroxene granulite occurs as small lenticular bodies or linear bands parallel to the regional foliation within the intermediate and acid charnockites. Many of the pyroxene granulite bands are distinctly gabbro/noritic in composition. The intermediate and acid charnockites form large bodies associated with the khondalites. They can be classified into enderbite, mangerite, and charnockite based on the proportion of quartz, plagioclase feldspar and K-feldspar. Some charnockites contain feldspar megacrysts, which show crude orientation parallel to regional foliation. They appear to be syntectonic intrusives. Incipient charnockitization is also noticed in gneisses along the flanks of Kannegiri Massif.

About 200 sq km area of hilly terrain occurring to the south of Chimalpahad Gabbro-Anorthosite complex in Khammam District and consisting of high grade metamorphic rocks constitute the Kannegiri Granulite Complex. It falls in the marginal zone situated between the granite dominated Eastern Dharwar Craton in the west and the EGMB in the east. It is bounded by ENE-WSW trending shear zone in the nothern side with in the PGC and is mostly covered under soil in the southern side. The Kannegiri lithounits

consists of garnetiferous quartzo felspathic rocks and mafic granulites. Signatures of both Archaean and Proterozoic have been reported by various workers for the Kannegiri Granulites. The Kannegiri block is considered to represent a remnant of the thrusted block scrapped off during the course of evolution of EGMB.

Migmatites

Migmatisation of the khondalite, charnockite and pyroxene granulite gave rise to a variety of rock types. These include: 1) banded gneiss with alternating bands of khondalite and quartzo-feldspathic rock, 2) khondalite with feldspar porphyroblasts, 3) garnetiferous quartzo-feldspathic gneiss with pyroxene and/or sillimanite, 4) garnetiferous quartzo-feldspathic gneiss with relict patches of charnockite/ pyroxene granulite. The migmatites, predominantly occurring along the foothills and coastal plains, are associated with intrusive granitic rocks.

Mafic Dykes

The granite/gneiss-greenstone terrain of the Dharwar Craton in Telangana is intruded by mafic dyke swarms. They generally do not extend into the EGMB and are partly covered by the Cuddapah, Pakhal and Gondwana sediments and Deccan basalt. The distribution of these dykes is generally dense along the northern, western and southern margins of the Cuddapah Basin. The dykes exposed in the cratonic part extend over long distances in E-W, NW-SE, N-S and NE-SW directions.In the northern part of the State in Mahbubnagar, Ranga Reddy, Medak, Nalgonda, Khammam, Warangal, Karimnagar and Nizamabad Districts, dykes in all the above said four directions are of almost equal prominence.

Dolerite is the most common variety among the mafic dykes, gabbro and pyroxenite being locally present. These dykes are dark grey, dark greenish grey or black coloured. They are mainly tholeiites characterised by rich in silica, and low K_2O, Na_2O and MgO content. A few dykes located in Nalgonda District are alkali basalts. The dyke swarms in Khammam-Warangal-Karimnagar show lesser degree of crustal contamination as compared to other swarms.

As per the available isotopic data, most of the mafic dykes fall within the age range of 2200 Ma to 1700 Ma. Meso-Proterozoic and younger dykes are also present. Mechanism of emplacement of these dykes is dilatational via brittle crack filling, related to the periodic extensional tectonics that affected the Dharwar Craton.

The dykes traversing the granulite terrain within the cratonic part have clouded plagioclase feldspar which imparts an uniform dark grey colour to the rock. Such dykes are quarried for dimensional stones and traded as black granite. A number of quarries of good quality black granite exist in Karimnagar, Warangal and Khammam Districts.

C) MESO - TO NEO-PROTEROZOIC

Meso to Neo Proterozoic sedimentary rocks and associated volcanics unconformably overlie the Archaean gneisses, granitoids, schists and Proterozoic mafic dykes. They are distributed in well-defined sedimentary basins known as Cuddapah, Pakhal and Bhima. The crescent shaped Cuddapah Basin is almost entirely located in the residuary Andhra Pradesh except for small patches of it, which are exposed in the southern periphery of Telangana. The Pakhal and Bhima are exclusively within Telangana of which the Pakhal Basin developed along the Pranhita-Godavari Valley in the northern part of the State, comprises the rocks of Pakhal Supergroup, Penganga Group and Sullavai Sandstone. The Pakhal basin is the most significant one because of it's large extent and vast mineral potential. Bhima basin is exposed in the western part of the state over a smaller area whereas the major part of the basin falls within the adjoining Karnataka.

CUDDAPAH BASIN

Cuddapah Supergroup

The Cuddapah Supergroup of rocks are sub-divided into three groups and one Formation namely I) Papaghni Group ii) Chitravati Group iii) Nallamalai Group and iv) Srisailam Quartzite. In Telangana area, Papaghni and Nallamalai groups are exposed in parts of Nalgonda district.

i) Papaghni Group

The Papaghni Group named after the Papaghni River, which is a tributary to the Pennar in A.P., is exposed only along the western margin of the basin and is divided into two formations namely, (1) Gulcheru Quartzite and (2) Vempalle Formation.

The Gulcheru Quartzite is exposed at the southern periphery of the State occupying small areas, composed of quartzite conglomerate and grit with shale intercalations. The basal part of the formation is dominated by conglomerate in the north and quartzite in the south. The quartzite has a thickness of 60 m.

The Gulcheru Quartzite grades upward into the Vempalle Formation which is shallow occupying small areas at the southern periphery. It comprises grey, fine grained and flaggy dolomite, dolomitic limestone, purple shale, chert and quartzite, in that order of abundance. Algal structures are observed on weathered surface of the dolomite at places. Also contemporaneous igneous flows and tuffs having doleritic or basaltic composition and showing chilled margins have been found within the dolomite. At places, dolomite contains high-grade limestone and veins of barite.

ii) Nallamalai Group:

The Nallamalai Group derives its name from the Nallamalai hill range which occurs longitudinally in the middle of the Cuddapah Basin. The Group is subdivided into two formations namely 1) Bairenkonda Formation and 2) Cumbum Formation. Barenkonda is an arenaceous unit composed predominantly of quartzites and the Cumbum is argillaceous consisting of shale, slate and phyllite with thin bands of quartzite, limestone and dolomite.

iii) Srisailam Quartzite:

Srisailam Quartzite derives its name from the famous Srisailam Temple, located atop an imposing plateau, which is constituted exclusively of the quartzite. The unit in Nagarjunakonda is highly pitted and is due to the scooping out of pyrite crystals.

It is given an independent status in the stratigraphic sequence. The quartzite is interbedded with thin siltstone units and is usually thick bedded, dense and fine to medium grained. The siltstone is flaggy and contains frequent intercalations of shale.

Kurnool Group

The Cuddapah sediments in parts of the Kundair Valley and Palnad tract mostly in Andhra Pradesh are unconformably overlain by the Kurnool Group of rocks which comprise a 500 m thick succession of sandstone/quartzite, limestone and shale. The Kurnool Group is divided into six formations: 1) Banganapalle, 2) Narji, 3) Owk, 4) Paniam, 5) Koilkuntla and 6) Nandyal. However in Telangana the rocks belonging to Banganapalli and Narji formation occur along the southern periphery over small areas in parts of Mahabubnagar district.

The Banganapalle Formation is 10 to 50 m thick and consists of a thin bed of basal conglomerate followed upward by coarse grit and sandstone. Glauconitic sandstone is also found. The conglomerate essentially consists of pebbles of chert, quartz, jasper and quartzite. The basal conglomerate and gritty sandstone are a well-known source of diamond, since ancient times.

The Narji Formation includes the blue, grey, buff and fawn coloured limestones with intercalations of shale, quartzite and intraformational conglomerate breccias. The limestone is exposed along the southern boundary of the state the limestone is massive, extremely fine-grained and is high in lime and low in magnesia. The limestone is of cement grade.

Pakhal Basin

The Meso to Neo Proterozoic sediments of the Godavari Rift Valley are classified as Pakhal Supergroup, Penganga Group and Sullavai Sandstone. These sediments occur as two parallel NW-SE trending belts, with about 40 km wide stretch of the Gondwana sediments in between. The southwestern belt extends from south of Khammam in the southeast to Adilabad and beyond into Maharashtra in the northwest and the northeastern belt from a little north of Bhadrachalam in the southeast to a little beyond Chanda (Maharashtra) in the northwest. The overall length of the basin is about 350 km and the width is about 100 km including the intervening Gondwana sediments.

The Pakhal Basin is represented by 6000 m thick assemblage of arenaceous, argillaceous and carbonate (dolomite) sediments and is conspicuously devoid of limestones and igneous rocks in contrast to the Cuddapah Basin.

Pakhal Supergroup

The Pakhal Supergroup is divisible into i) Mallampalli Group, ii) Mulug Group and iii) Albaka Sandstone. The southwestern belt includes rock units of only Mallampalli and Mulug Groups and the northeastern belt those of the Mulug Group and Albaka Sandstone.

Mallampalli Group

The Mallampalli Group is further subdivided into three formations i.e. Bolapalli Formation, Gunjeda Dolomite (Bayyaram Quartzite) and Pandikunta Shale (Kalrai Shale) and attains a maximum thickness of about 825 m.

The Bolapalli Formation is dominantly arkosic with subordinate conglomerate, glauconitic sandstone, quartzite, chert breccia and dolomite. The Gunjeda Dolomite is predominantly a dolomite with interbeds of glauconitic arkose, shale and minor chert. The Bayyaram Quartzite, the stratigraphic equivalent of the Gunjeda Dolomite in the southeastern part of the basin, is dominantly an orthoquartzite, followed by ferruginous quartzite, shale, chert, conglomerate and clay. Haematitic iron ore is associated with this formation in Bayyaram and Mallampalli areas.

The Pandikunta Shale is predominantly shale with thin interbeds of dolomite, chert and sandstone, whereas the Karlai Shale is predominantly shale with interbeds of quartzite and occasional carbonaceous shale, siltstone, arkose and dolomite.

Mulug Group

The Mulug Group of the southwestern belt, which has a thickness of about 2830 m is subdivided into five formations: 1) Jakkaram Arkose, 2) Polaram Formation , 3) Enchencheruvu Formation, 4) Pattipalli Quartzite and 5) Laknavaram Shale.

The Jakkaram Arkose, Polaram Formation and Enchecheruvu Formation are together represented in the northeastern belt by Cherla Formation (290 m thick) which comprises an assorted assemblage of quartzite, arkose, dolomite, chert and limestone, the individual units being laterally impersistent. The stratigraphic equivalents of the Pattipalli Quartzite and Laknavaram Shale in the northwestern belt are designated respectively as Somandevara Quartzite (915 m thick) and Tippapuram Shale (1340 m thick).

The Jakkaram Arkose consists of arkose with variable proportions of chert, conglomerate, glauconitic sandstone, quartzite and shale. The Polaram Formation is essentially an assorted assemblage of silicified shale, chert, shale, carbonaceous dolomite and quartzite. The Enchencheruvu Formation is predominantly a flaggy argillaceous dolomite with interbeds of limestone, calc arenite, calcareous shale, shale and chert. The Pattipalli Quartzite is generally an orthoquartzite with subordinate amounts of ferruginous quartzite. The Laknavaram Shale consists of a thick sequence of shale with numerous interbeds of quartzite and subordinate ferruginous sandstone, feldspathic quartzite, siltstone and dolomite.

Albaka Sandstone

The Albaka Sandstone forms an imposing plateau rising to a height of around 500 m above ground level. It is represented by a sequence of alternating red, brown, green, grey and white sandstones with sporadic partings of shale and siltstone. Minor lenses of conglomerate and arkose occur in the basal part.

The Mallampalli and Mulug sediments display a progressive increase in their intensity of deformation and metamorphism towards southeast. In the extreme southeastern part of the basin in Yellandlapad and Mailaram areas, talc, actinolite or tremolite bearing marbles and phyllites with garnet, staurolite or andalusite are common. These marbles are very much sought after as decorative stones.

Radiometric dating of glauconite from the Jakkaram Arkose indicated ages of 1276 ± 30 Ma, 1188 ± 14 Ma and 1142 ± 37 Ma (Mathur,1982). The glauconite from the Pakhal sediments of Ramagundam area has given K-Ar age of 1330 ± 53 Ma (Vinogradov *et al*, 1964). From the study of stromatolitic forms in the dolomites, Chowdhuri

(1970) assigned a Middle Proterozoic age to the Pakhal Group. Based on this data and guided by gross lithological similarity and relative stratigraphic position, the Pakhal Supergroup is correlated with the Cuddapah Supergroup.

Penganga Group

The development of the Penganga Group is restricted to the area around Ramagundam and the Penganga River in Karimnagar and Adilabad districts. The main lithological difference between the Pakhal and the Penganga rocks is that the carbonate component in the former is represented by dolomite and in the latter by limestone. The contact of the Penganga sediments with the older Pakhal is all along a faulted one. The Penganga Group is considered to be a stratigraphic equivalent of the Kurnool Group. The Penganga Group is essentially an arkose-limestone sequence which is divisible broadly into two formations, namely (i) Takkallapalli Arkose and (ii) Putnur Limestone.

The Penganga Group in Adilabad district is represented by Pranahita Sandstone, Devalamari Limestone (equivalent to Chanda Limestone), Upper shale/siltstone (equvivalent to Sat nala Shale) and Upper dolomite. The Devalmari Limestone extending for a strike length of 3 km and width of about 300 m is of cement grade with CaO content ranging from 30% to 53%. The well known manganese ores identified in the Penganga Formatioin is found west of Ravalpalli, in a zone extending for 250m length and 3 to 5m width.

The Takkallapalli Arkose is a 400 m thick sequence of heavy arkose with interbeds and lenses of pebbly sandstone and conglomerate whose incidence is more in the basal part. Sporadic interbeds of shaly and micaceous sandstone are common throughout the thickness of the formation. The arkose is overlain by a 100 m thick sequence of **Putnur Limestone**, which is characterised by an overwhelming predominance of limestone and argillaceous limestone with interbeds of shale and manganiferous chert. The limestone is flaggy to thick-bedded, grey, dark-grey, buff and light pink and is mostly of cement grade with subordinate flux grade bands. The well known manganese ores of Adilabad District are hosted in this limestone.

Sullavai Sandstone

Sullavai Sandstone, the youngest unit of the Proterozoic sediments along the Godavari Valley is well developed along the southwestern belt and is exposed as a NW-SE trending linear belt for a length of about 110 km on either side of the Godavari River.

The sandstone has a maximum thickness of 900 m and contains variable proportions of red-brown mottled sandstone, arkose, conglomerate, glauconitic sandstone and shale, the sandstone being the most dominant member. Red and white bands and spotted nature of the sandstone render it attractive enough to be widely used as a decorative building stone.

Overlying the Albaka Sandstone of the northeastern belt occurs as 1375 m thick sequence of breccia and sandstone. Based on lithological similarity, this sequence is considered to be a stratigraphic equivalent of the Sullavai Sandstone.

Radiometric dating of glauconite from the Sullavai Sandstone indicated an age of 871 ± 21 Ma.

Bhima Basin

The major part of the Bhima Basin is in Karnataka State where the rock formations are classified as Bhima Group which is divided broadly into Sedam and Andole Subgroups. In Telangana only the Sedam Subgroup is exposed which consists of i) Rabanapalli Formation and ii) Shahbad Formation.

The Rabbanapalli Formation is well exposed all along the southern boundary of the Bhima Basin and attains a maximum thickness of 35 m to 50 m. It comprises basal conglomerate followed upward by a sandstone, siltstone, purple shale.

The Shahbad Formation, the thickest formation of the Bhima Group, is about 70 m thick and comprises limestone which is flaggy in the lower and upper parts and massive in the middle part. A major part of the limestone is of cement grade. The Shahbad Formation is extensively used, after polishing, for flooring of houses.

Alkaline Rocks / Kimberlites - Lamproites

Several intrusive igneous rocks of distinctive petrological and petrochemical attributes occur amidst the granulites, greenstone belts, gneisses and the Proterozoic sediments. These can be classified broadly into (i) alkaline rocks and (ii) kimberlites and lamproites.

Alkaline rocks

The Precambrian alkaline magmatism in the granulite terrain of southern Peninsular India is manifested by several alkaline plutons with variable rock associations and different silica-saturation levels. The alkaline magmatic activity is considered to be the latest intrusive phase in the EGMB.

A good number of nepheline syenite plutons occur in Telangana which are localised at the contact between EGMB and Dharwar Craton. Notable among them are Kunavaram nepheline syenite pluton in Khammam District. These nepheline syenite plutons, range in extent from 5 to 85 sq km.

The Kunavaram nepheline syenite Pluton has a strike length of 16 km with a width of 6 km has the distinction of being the largest of its kind in the peninsular India. The major part of the Pluton forms a part of the neighbouring state of Andhra Pradesh. It consists essentially of syenite and nepheline syenite, the latter being intrusive into the former. Rb-Sr dating (whole rock) of the syenite indicates an age of 1244 ± 55 Ma (Clark & Subba Rao, 1971). A carbonatite body is located near Tekulapalli in southern flanks of Kannegiri massif.

Kimberlites and Lamproites

Kimberlites and lamproites, the two major primary host rocks for diamond are found emplaced into the Archaean-Proterozoic rocks in the eastern part of Dharwar craton. The kimberlites are intrusive in to the granite-greenstone terrain within the craton whereas the lamproites occur close to the eastern margin of the craton. Due to their distinct geographic distribution, the kimberlite and lamproite bodies form two separate provinces namely, Deccan Kimberlite Province and Nallamalai Lamproite Province (Satyanarayana *et al*, 1996).

The Deccan Kimberlite Province consists of three fields (i) Wajrakarur Kimberlite Field (WKF) in Anantapur District of AP and (ii) Narayanpet Kimberlite Field (NKF) in Mahbubnagar District of Telangana which extends into Gulbarga District of Karnataka and (iii) Raichur Kimberlite field falling in Mahabubnagar District of Telangana and Raichur District of Karnataka. The kimberlites which occur as pipes and dykes are mostly in the age range 900-1100 Ma in the WKF (Crawford and Composton 1973; Paul, 1979) Basu and Tatsumato, 1979; Anil Kumar et al, 1993 and Chalapathi Rao et al 1996) and 1360 Ma age in NKF (Chalapathi Rao et al, 1996). These bodies are found emplaced mostly along the intersection of NE-SW and E-W fracture system. The 32 kimberlite bodies reported by GSI and 29 by De Beers in the Narayanpet Field, found in an area are spread over 60 km E-W and 25 km N-S and emplaced along the fractures trending NW-SE and E-W. Out of the 29 bodies, 16 are in Gurmatkal- Yadgiri area and 12 in Wadagera area between the confluence of the Bhima and Krishna rivers. The Raichur Kimberlite Field encompasses six pipes emplaced along WNW-ESE fracture system. Besides these 14 lamproite bodies are reported from near Ramadugu and Somavarigudem in Nalgonda District.

Granites

Within the late Archaean Palaeoproterozoic Granite Gneiss terrain, there are isolated bodies of younger granitoids (undifferentiated) which may range in age from Palaeoproterozoic to Neoproterozoic. Some of them are intrusive into the Mesoproterozoic Cuddapah Basin and occur within and close to the basin margin in the east.

The Precambrian rocks described above occupy major part of the State. They are covered by the Phanerozoic sedimentary sequence in well defined basins situated in the north and along the coast and Deccan Trap volcanics in the northwest. The stratigraphic sucession of Phanerozoic cover is given in Table-3.

TABLE-3
GEOLOGICAL SUCCESSION OF PHANEROZOIC ROCKS OF TELANGANA

ERA	AGE	SUPERGROUP	GROUP	FORMATION	LITHOLOGY
QUATERNARY	Holocene Pleistocene				Alluvium and soil Laterite and gravel
TERTIARY	Mio-pliocene Palaeocene Late Cretaceous	Deccan Traps	Sahyadri		Basaltic lava flows with intertrappean and infra-trappean beds
				Godavari Valley	
MESOZOIC	Late Cretaceous Early Cretaceous Jurassic Mid To Late Triassic	Gondwana Supergroup	Upper Gondwana Group	Chikiala Formation *Unconformity* Gangapur Formation Kota Formation Maleri Formation	
PALAEOZOIC	Late Permian To Early Triassic Permian Carboniferous To Permian		Lower Gondwana Group	Kamthi Formation Barren Measures Barakar Formation Talchir Formation	
Unconformity Precambrian basement					

D) LATE CARBONIFEROUS – EARLY CRETACEOUS

Gondwana Supergroup

Rocks of Gondwana Supergroup, spanning in age from the Late Carboniferous to Early Cretaceous and with about 3500 m in thickness are exposed along the Pranhita-Godavari valley as a 55 km wide NW-SE trending linear belt extending for a length of 350 km between Antargaon in the northwest and Sattupalle in the southeast. They are also exposed along the east coast in the Krishna-Godavari Basin and other isolated areas. The Gondwana sediments of the Godavari Valley are believed to have been deposited in alluvial environment and those along the coast in marine and fluvio-marine environments. Besides hosting rich coal deposits, the Gondwanas contain a rich variety of floral remains, based on which the Gondwana Supergroup is divided into two major Groups, namely the Lower Gondwana Group characterised by *Glossopteris* flora and the Upper Gondwana Group by *Ptilophyllum* flora. The approximate proportion of various rock assemblages in the Gondwana mounts to sandstone (60%), conglomerate (17%) and siltstone, clay, coal, limestone etc (23%).

Lower Gondwana Group

The lower Gondwana sequence which is well developed in the Godavari Valley comprises four formations, namely i) Talchir Formation, ii) Barakar Formation, iii) Barren Measures and iv) Kamthi Formation.

Talchir Formation

The Talchir Formation occurs as numerous small outcrops along the western margin of the Godavari Graben. They also form outliers over the Archaen-Proterozoic basement.

The Talchir Formation is 200 m to 370 m thick and is represented by boulder bed (2 m to 6m thick) at the base consisting of boulders, pebbles and granules of varied lithology, sparsely distributed in an unstratified brown to grey silty matrix. Associated with the boulder bed is a 10 m – 250 m thick rhythmite sequence of shale and siltstone which grades upward into a 50 m thick light green sandstone. Palynofossils represented by *Plicatipollennites, Callumispora* and *Parasaccites* indicate a Late Carboniferous to Early Permian age.

Barakar Formation

In the Pranhita-Godavari valley, the Barakar Formation is the main coal bearing unit and is exposed along the western margin and the southeastern part of Godavari Graben over an area of about 620 sq km. It is divisible into two member's viz. the Lower and Upper Members. The Lower Member is 50 m to 200 m thick and consists of pebbly sandstone and feldspathic sandstone, siltstone and occasional coal laminae. The Upper Member is 200 m to 260 m thick and is characterised by fining upward coal-bearing cyclothems whose number varies from 2 to 16. Litho-units present in each cyclothem grades from very coarse feldspathic sandstone at bottom to grey shale/ carbonaceous shale/coal at top. In each coal seam, there is an alternation of shale and coal layers. The rich spore/pollen assemblage, dominated by *Rhizamspora, Scheuringipollenites*, *Indotriradiates* and *Ibsporites* suggests an Early Permian age to the Barakar Formation.

Barren Measures Formation

A 60 to 800 m thick sequence made up of white to light yellow feldspathic sandstone, siltstone, grey shale with streaks of coal constitutes the Barren Measures. Its thickness is maximum in Bhimaram area (500 m) in the northwest and tapers down to less than 100 m towards southeast. At places, in the upper stratigraphic levels, the Barren Measures carries a few coal seams. The spore/pollen assemblage in this formation is characterised by the presence of Middle to Late-Permian forms viz. *Densipollenites Weylandites, Horriditriletes Osmundacidites etc.*

Kamthi Sandstone Formation

The sandstone, with a maximum thickness of 2700 m, occupies a major part of the Gondwana Basin, resting unconformably over the Talchir, Barakar or Barren Measures Formations and at places directly the Pakhals. The Kamthi includes a heterogeneous assemblage of a variety of sandstone with numerous interbeds of conglomerate and silty clay. In contrast to the Barakar Formation, this is relatively more ferruginous and gritty, and less feldspathic. It also contains thin coal seams and is well exposed along the Godavari River near Sondila village.

Chintalapudi Sandstone is the extension of the Kamthi Sandstone in the southern part. Its lower part comprises sandstone and grey shale with thin lenses and streaks of coal, and the upper part yellowish brown conglomeratic sandstone which is ferruginous and feldspathic.

Upper Gondwana Group

This Group is well exposed all along the main Gondwana Basin and comprises four formations namely I) Maleri Formation, ii) Kota Formation, iii) Gangapur Formation and iv) Chikiala Formation.

Maleri Formation

The Maleri Formation ranging upto a maximum of 250 m thickness comprises soft, red clays with lenses of fine to medium grained calcareous sandstone. In the northwestern part of the Godavari Valley, the formation is divisible into four Members, namely the Yerrapalli, Bheemavaram, Maleri and Dharmavaram. The formation is characterised by the amphibia: *Metaposaurus*, reptiles: *Rhynchosaurus, Phytosaurus* and *Aetosaur, fish Parasuchus, Ceratodus* and fossil tree trunks which suggest Middle to Late Triassic age.

Kota Formation

The Kota Formation measuring a maximum of 600 m in thickness is well exposed along the eastern bank of the Pranhita River at Kota in Karimnagar District and extends as far south as Cherla. It is represented largely by white, coarse to very coarse grained, pebbly sandstone with lenses of

conglomerate and silty clay and thick marker zones of limestone. The 40m long stretch of the Kota Formation between the Pranhita and Godavari Rivers is one of the richest fossil bearing areas. The fossils include, besides flora, a variety of fauna like fishes, estherid flying reptiles, dinosaurs and micro-mammals. In course of search and excavation for a dinosaur bones in Yamanpalli area, Adilabad district about 840 skeleton parts belonging to saurapud dinosaurs were collected and developed between 1974 and 1980. Further study revealed that this dinosaur belonged to a new genus and new species Kotasaurs *yamanpalliensis*. The Kota dinosaurs throws light on the time of separation of the Indian Peninsula from the rest of the Gondwana land, their occurrence in India is a positive proof that there were overland connections between the Peninsular India and other Gondwana continents during early Jurassic (160 million years old) times. The famous Kotasaurus dinosaur fossil is discovered by GSI and is named after this Formation. GSI has also recorded a fully preserved Rincopteris from this Formation.

Gangapur Formation

The Gangapur Formation ranging in thickness between 100 m and 250 m, is best developed around Gangapur-Ralapet area of Adilabad District. It consists of pebbly sandstone, argillaceous sandstone, siltstone, carbonaceous clay and claystone. The grey clay bands yielded a rich assemblage of well preserved pollen and spores which include Acquitriradites, Macrocachyidites, Coptospora, Frangospora etc. and indicate an Early Cretaceous age.

Chikiala Formation

The Chikiala Formation is exposed as a narrow elongated strip for nearly 110 km from Sironcha in the north to around Chandrupeta in the south. It comprises friable, coarse grained, brown, red and yellow coloured ferruginous sandstones with intercalations of conglomerate and clay. On stratigraphic considerations, this formation is assigned Late Cretaceous age.

E) LATE- CRETACEOUS - EOCENE

Deccan Traps

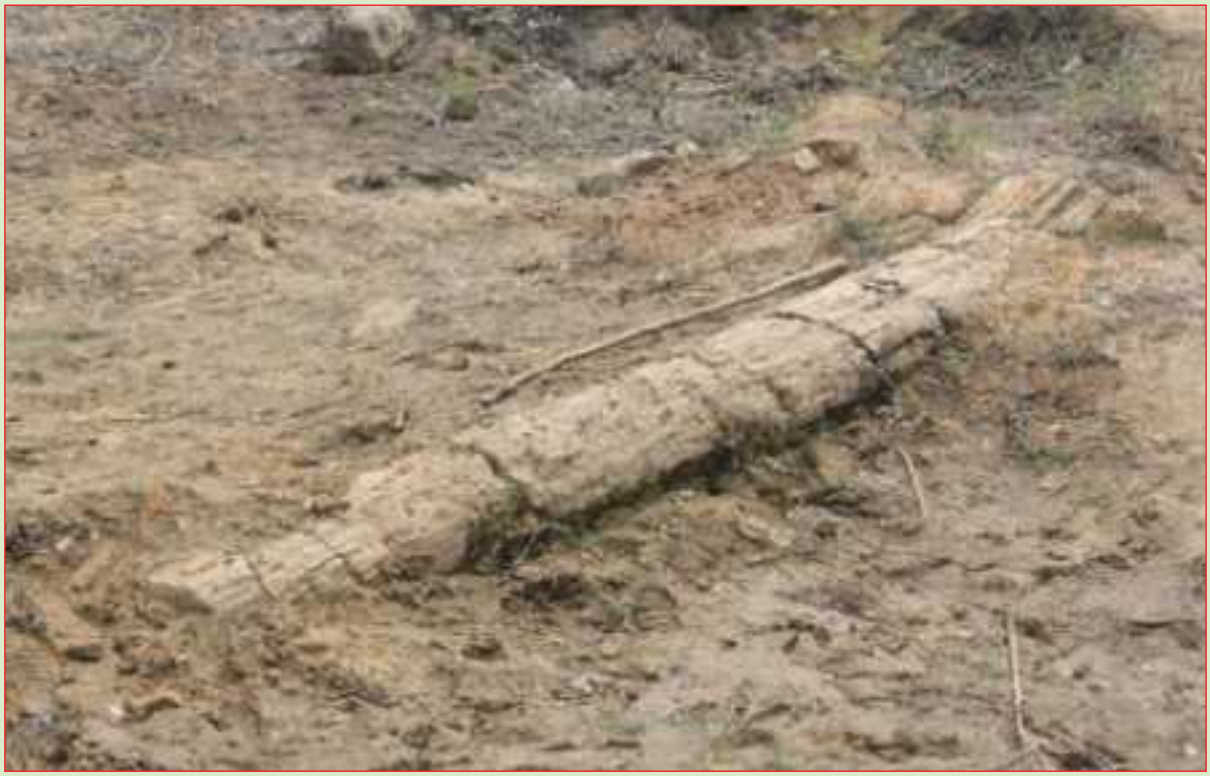
The Deccan Traps occupy an area of about 10,000 sq km in the northern and northwestern parts of the State covering mainly Adilabad, Nizamabad, Mahabubnagar and Ranga Reddy Districts. The trap rocks are sub-aerially emplaced horizontal to sub-horizontal basaltic lava flows. These are dark grey and greenish black. A total of seven trap flows of unweathered nature and another two which are completely lateritised are identified in the Tandur-Vikarabad-Pargi area of Ranga Reddy District. The individual flows range in thickness from less than a meter to as much as 50 m. In Medak District, the flows are of "Aa" type whereas in Nizamabad and Adilabad Districts they are of "Aa" "Pahohoe" and simple types. Basalts consists of pigeonite augite, andesine- labradorite, brown or green glass, microcrystalline silica, magnetite and rarely olivine.

Infra-trappean and inter-trappean sediments are associated with lavaflows and have an aggregate thickness of about 150 m. The infra-trappean sedimentary rocks comprising sandstone and limestone are exposed in parts of Adilabad, Nizamabad and Ranga Reddy Districts. Marine fossils such as *Turritella, Cardita (C.beaumonti), Rostellaria, Ostrea* and other genera of Late Cretaceous age are found in these infra-trappean beds.

Bulk samples from infra and inter-trappean beds at Naskal and Bacharam in Ranga Reddy District and Tirpol areas of Medak District yielded scores of mandibles, maxillae and isolated teeth and limb bones belonging to different orders of vertebrates. GSI has recorded the *prescence of Mollusc Physa sp. from intertrappeans near Shankarpalli*. The most important collection from Naskal includes a complete molar and a few fragments of Gondwanatherium, a truly endemic form of the Gondwana land.

F) QUATERNARY

The Quaternary sediments in Telangana are restricted to narrow linear zones bordering the inland river basins of Krishna,Godavari and their major tributaries in the form of flood plain deposits of fluvial origin. Volcanic ash (3m x 5m) has been recorded from a tributary of Kinnersani river near Kothagudem in Khammam district. It is a wind borned deposit correlated to Toba Volcanism of Sumatra Islands and dated to be 70,000 yrs B.P. It is 90% glass and acidic in composition.



The petrified wood trunk (5m x 13m) located along the Paloncha - Dammapeta Road, Khammam District, Telangana State. (Photo by : Palaeontology Division, SR)

Volcanic Ash (3m x 5m) occuring at Murreru River, a tributary of Kinnerasani River, near Gangaram Village, Kothagudem, Khammam District, Telangana State. (Photo by : Shri K. Premchand, Director)

III. STRUCTURE AND TECTONICS

Telangana comprises a mosaic of different geologic and tectonic provinces which are divided broadly into Eastern Dharwar Craton, Proterozoic Basins, Phanerozoic Gondwana Basin, Deccan Trap of the Cretaceous Tertiary and Quaternary cover of inland valleys. Each of these provinces is characterised by distinctive litho-assemblages, tectonic impress and metamorphic grades. While the craton, and the Proterozoic basins were affected by intense and polyphase deformation and variable degree of metamorphism under compressional/ tensional regimes, the other provinces were practically undeformed and unmetamorphosed. However, numerous faults/fractures of diverse trends and lengths traverse all the geologic provinces.

A brief account of the structure and tectonics in various geological provinces of the State is given below:

Eastern Dharwar Craton

The contact between the Dharwar Craton and the EGMB is a major thrust marked by contrasting lithologies, structural fabrics and metamorphic grade. The PGC, the dominant lithocomponent of the craton, is characterised by NNW-SSE Dharwarian trend. The greenstone belts occurring amidst the gneissic terrain as discrete linear to curvilinear belts display N-S and NNW-SSE trends with steep easterly or westerly dips. The contacts between the greenstone belts and cratonic gneisses are generally sheared.

The cratonic gneisses and the greenstone belts share a common deformational history and document the imprints of at least three deformations. The early F1 folds were preserved only mesoscopic scale as isoclinal / recline folds. Some of the lithological components of tonalite-trondhjemite suite could be syntectonic with this folding event. The second deformation, nearly coaxial with the first one, resulted in the formation of open upright folds that shaped the present configuration of the schist belts. The tonalite-granodiorite-monzogranite suite with typical calc-alkaline signatures and I-type characters probably represent syntectonic magmatism associated with this deformation, which was followed by late shears. The ductile shear zones, marked by mylonite development with subhorizontal lineation are mostly confined to the granite-greenstone contacts which greatly influenced the localisation of gold mineralisation. The third deformation was much less intense and is documented in the form of regional warps on E-W axis. The NW-SE trending Godavari Graben defines a Precambrian Crustal weakness activated in different geological times, it is a failed arm (/aulacogens) probably plume-generated tripple junctions of Precambrian tectonics and served as depository environment for Proterozoic and Gondwana sediments (Bruke & Dewey, 1973). DSS profile indicates gravity high shouldering on either side of the Graben (Subramanyam, 1980) and is supported by the distribution of Bhopalpatnam-Karimnagar granulites.

Proterozoic Basins

The Mesoproterozoic to Neoproterozoic sedimentary basins in the state include Pakhal-Penganga-Sullavai and Bhima.

The **Pakhal-Sullavai** sediments exposed along the Godavari Valley trend in a general NW-SE direction in conformity with the structural fabric of the Archaean basement and the regional trend of the valley, which is believed to be a graben. The intensity of deformation increases from northwest to southeast. Two periods of folding were inferred, the first giving rise to NW-SE trending folds which were later cross folded along E-W axis giving rise to northerly and southerly plunging folds. The Archaean-Pakhal contact along the northeastern margin is a pronounced fault all along whereas along the southwestern margin, it is partly depositional and partly faulted. The Pakhal-Sullavai contact in the area to the south of the Manair River is faulted in NW-SE trending fault, popularly known as Kadam River fault. Traversing the Pakhals of the Mailaram inlier is the NE-SW trending Mallavaram fault with Archaean granite thrust over the Pakhals.

IV. GEOLOGICAL HISTORY

Reconstruction of the evolutionary history of Telangana which is composed of cratonic, intracratonic and rift controlled sedimentary basins forming different tectonic provinces of Archaean-Proterozoic age with subsequent Phanerozoic and a narrow Quaternary cover bordering the inland rivers is beset with numerous problems and uncertainties. An attempt is made here to reconstruct the same with the help of available database.

The Archaean era (4500-2600 Ma) was undoubtedly marked by high geothermal gradients with relatively thin crust, perhaps of mafic composition that was ruptured around 3500 Ma releasing large amounts of tonalite-trondhjemite granites punctuated by emplacements of mafic-ultramafic volcanics all over the globe that eventually formed the nuclei of proto-continents referred to as cratons. The Indian Peninsular Shield is one such continent composed of a few cratonic nuclei-Dharwar, Bastar, Singhbhum and Aravalli. The continental crust in these nuclei was quite thick while in the intervening areas it was thin and weak - a factor that was responsible for later development of major structural features like rifts, ensialic basins and mobile belts, which became locales of extensive sedimentation and intense deformation and tectono-thermal events that collectively shaped the crustal architecture of the peninsular shield.

The ETB part of Dharwar Craton is composed dominantly of tonalitic to granodioritic gneisses with ages of 3000-2600 Ma commonly referred to as Peninsular Gneisses occupying about 40% of the area in the State. With intra-cratonic basins represented by sediments of Meso to Neo Proterozoic Cuddapah, Pakhal, Penganga, Kurnool, Palnad, Sullavai and Bhima sediments in the southeast, north and west and Deccan Traps in the northwest while they abut against the Godavari Graben (Pakhal and Gondwana) in the northeast and Eastern Ghats Mobile Belt in the east. In the south the gneisses merge with granulite terrain of Karnataka and Tamil Nadu.

The cratonic gneisses enclose a few widely separated, N-S trending, narrow and linear greenstone belts (schist belts) consisting of bimodal volcanics, chemogenic and clastic sediments that deposited in fault-bounded linear basins. These schist belts with a general greenschist facies metamorphic imprint have an age of around 2900-2700 Ma. The surrounding granite gneisses also have roughly comparable ages. It is believed that this Late Archaean ensemble formed in an environment similar to that of the present day convergent plate margins and accreted to the craton. The schist belts and cratonic gneisses were affected by three deformational events probably during 2600-2000 Ma during which the gneisses underwent amphibolite facies metamorphism accompanied by extensive migmatisation and potassic magmatism. On account of multi deformational events and subsequent erosion, the schist belts are preserved in synformal troughs in a vast expanse of granite gneisses and at many places they were completely engulfed by granites. The well exposed schist belts from north to south include Khammam, Yerraballi, Peddavuru, Ghanpur and Gadwal. The Khammam Schist Belt in the northeast represents the remnants of an originally single N-S trending schist belt that got dismembered during the development of the Eastern Ghats Mobile Belt and its subsequent deformation.

The Late Archaean and Early Proterozoic (2600-2000 Ma) precisely, which represents a time of rigorous crustal growth and reworking of older Archaean lithosphere under conditions of high grade metamorphism, witnessed the development of the Karimnagar Granulite Belt This granulite belt which is located north of Karimnagar town was later subjected to the process of Granitisation was originally a part of the Dharwar-Bastar-Singbhum Cratons is constituted of a sequence of repetitively deformed high grade rocks referred to as charnockites and khondalites and their granitised equivalents which are predominantly seen as enclaves(restites) within the PGC. These rocks are of Archaean ancestry, at least in part, but affected and modified by younger tectono-thermal events including granitoid-charnockite intrusions and the granite melts generated

from two cycles of high grade metamorphism, one around 2600 Ma and other 1000 Ma.

The contact between the Cratonic gneisses in Telangana and the EGMB in AP is a major tectonic feature as borne out by many geological evidences. It is at places marked by gabbro-anorthosite and alkaline plutons of Middle Proterozoic age (1600-1000 Ma). This testifies that plate tectonics, normally considered to be in operation only during the last 200 Ma was operative in some primitive form even during the Proterozoic. Contemporary ideas on granulite belts-indicate that the EGMB most probably represents the lower crust of about 30 km depth that is exhumed to its present level by some form of thrusts tectonics associated with continent-continent collision or underplating of an oceanic plate.

The geological record for the period between 2600 Ma and 2000 Ma is poorly preserved or absent. This profound unconformity is universally known as the Great Eparchaean Unconformity. By around 2000 Ma, the Dharwar Craton and the EGMB in its primitive form were in existence and from the general structural trends observed in these crustal segments, it is deciphered that a general E-W compressive force was prevailing during this period. These forces and possibly some pre-existing major fractures in the craton led to the evolution of the intra-cratonic Cuddapah Basin in AP. Around the same time, the NW-SE trending Godavari Graben also came into being in which the Pakhal and Sullavai sediments in Telangana were laid down.

Following the intense dyke activity (1900 Ma-1700 Ma) involving dilational tectonics, sedimentation in Pakhal Basin commenced around 1700 Ma. In the Pakhal Basin, the early phase of deposition of sedimentation was accompanied by intermittent volcanic activity of basic, acid and barium rich phases. The strata were deposited all along the basin with the peripheral basement rocks forming high ground, which continued up to 1000 Ma when orogenic movements in the EGMB caused intense deformation of these rocks and also thrusted the intervening cratonic gneisses over them.

The Pakhal Basin was characterised by the absence of volcanism which is an unusual feature for a rift controlled basin. The Pakhals also were intensely deformed and transected by numerous fault systems, some of which are active even now. The Pakhal and Cuddapah Basins which are remarkably similar in several respects were probably connected during a substantial part of their evolution. In fact, the intervening area between the Pakhal and Cuddapah Basins exposes several discrete slivers of identical lithology all along a major fault/thrust which links the eastern margin of the Cuddapah Basin with the south-eastern margin of the Pakhal Basin.

During the Meso to Neo-Proterozoic time's crustal accretion was perhaps at its peak aided by extensional tectonics and high perturbed geotherms in the mantle. A manifestation of this is the widespread basic plutonism seen in the carton, mobile belt and, to some extent, in the Proterozoic basins. Kimberlite intrusions of Anantapur district in Andhra Pradesh and Mahbubnagar District of Telangana and lamproitic intrusions within the eastern half of the Cuddapah Basin mostly in Andhra Pradesh are related to this.

The post-Pakhal tectonic movements in the peninsula resulted in extensive folding, faulting and uplifting of the Proterozoic sediments in the southeastern part of the Pakhal Basin. This was followed by the evolution of the Sullavai and Bhima Basins during 900-600 Ma.

After the deposition of the Sullavais and Bhimas and their uplift, there was a great hiatus in the stratigraphic history of the area extending for about 300 million years. At the end of the Palaeozoic era, i.e., towards the Late- Carboniferous, Gondwana sedimentation commenced over the super-continent known as the Gondwana land comprising the present continents of Australia, India, Africa, South America and Antarctica. In Telangana the deposition of the Gondwana sediments was confined to the NW-SE trending faulted trough (Godavari Graben) along the Pranhita-Godavari Valley. Inland drainage discharged its sediments into this new basin, which extended from Asifabad in the northwest in Telangana to Eluru in A.P. in the southeast. The Gondwana sedimentation began with a glacial climate. The bulk of the strata,

deposited since the dessication of glacial conditions were laid down as a thick series of fluviatile and lacustrine sediments with intercalated plant remains which were ultimately converted into seams of coal.

By the end of early Cretaceous (150 Ma) India got separated from the Gondwana land and commenced its northward journey by opening and spreading of the Indian Ocean under the influence of plate tectonics as a result of which the Bay of Bengal was formed. The northward drift of India continued till its collision against the Eurasian plate around 65 Ma giving birth to the mighty Himalayas and triggering prolific outpourings though long narrow fissures of enormous volumes of lava that flowed as nearly horizontal sheets occupying large areas of western, central and southern India. These are basaltic in composition and are commonly known as the Deccan Traps which are seen in the area to the west and northwest of Hyderabad prior to and intermittently during the eruption of lavas, there came into being some streams and freshwater lakes in which fluviatile and lacustrine deposits like sandstone, marl and limestone were deposited. These are the "intratrapeans" and "intertrappeans". The association of fossil algae, *charophyte* and foraminifera with the intertrappeans near Rajahmundry represented estuarine conditions of deposition.

After the cessation of the volcanic activity, there was a lull in the geological history of the Indian Peninsula for a brief period. The lateritisation processes (chemical weathering), which commenced during the Tertiary period became vigorous during the Quaternary under the influence of intense monsoonal climate giving rise to laterite cappings in the upland region. There are evidences of uplift even during the Quaternary and the processes of physical and chemical weathering and deposition continue to operate and modify the present day physiography.

V. FOSSIL OCCURRENCES

The state of Telangana is endowed with many fossil occurrences. Various important stratigraphic horizons are represented in the Telangana state.

Stromatolites are reported to occur near Venkatapuram, in the Gunjeda Formation of Pakhal Basin in Khammam district. The Sromatolitic dolomite of the Mallampalli Group, Pakhal Supergroup varying from grey to pink is identified as *Colonella* in Bejjur mandal, Adilabad district.

The Trace fossil *Planolites* is reported from the Banaganpalli Quartzite occurring at the Northwestern fringes of Proterozoic Kurnool basin in the vicinity of Nagarjunsagar.

The Gondwana Basin spread over Khammam, Warangal, Karimnagar and Adilabad districts are reported to contain may vertebrates and invertebrates that are characteristic of Gondwanas. Noteworthy among them are the fossil wood from Kamthi Formation in Paloncha, Kothagudem area and the dinosaur bones of the Kota Formation, Adilabad district. The Karharbari flora represented by *Glossopteris* and *Gangamopteris* is known from Kamthi Formation in Manuguru area, Khammam District.

The fossilized skeleton of the dinosaur *Kotasaurus yamanpalliensis* occurring in the Kota Formation was discovered by GSI in Yamanapalli area of Adilabad district, which was studied, reconstructed and housed at Birla Science Museum, Hyderabad. An articulated skeleton of *Rhynchosaurus* was excavated from Maleri Formation near Kataram, Karimnagar disrict and is displayed in the museum of Geological Survey of India, Southern Region, Hyderabad.

The rocks of Maleri and Dharmaram Formations of Upper Triassic and the Kota Formation of Jurassic age containing abundant fauna and occur in Kakkepalli, Jilleda, Lingala, Metpalli, Naikampet, Kalvada and Chinna Inam areas in Pranhita-Godavari valley. Fossils of Dipnoi fishes namely *Ceratodus virapa, Ceratodus hunterrianus, Ceratodus hirlopeanus, Ceratodus negeshwari*; amphibian fossils of *Metaposaurs* (Upper Triassic) namely *Metaposaurus maleriensis*; reptilian fossils of Cynodonts namely Exaeretodon species, *Rhyncosaurus*, *Paradapedon huxleyi,* Phytosaurs *namely Parasuchus hislopi,* Pseudosuchians similar to *Typothorax;* Eosuchian namely *Malerisaurus robinsonae* and Coelurosaurs; invertebrates viz. a Uninoid namely *Tikia* sp. are present in the Maleri Formation. A portion of the palatine with teeth of *Rhyncosaur* sp. was recovered from lime pellet rock near Kushnepalli, Karimnagar.

Fossils of reptiles viz. Archosauria, Prosauropods, large Plateosaurid and small Theridontoxurid are present in Dharmaram Formation of Triassic age. Caudal vertebrae and chevrons closely related to *Kotasaurus* were found near Kurumapally village of Adilabad district.

The fauna from Kota Formation of Gondwanas includes fossils of fishes viz. Semionotidae, *Lepitodes deccanensis, Peradapedium egertoni, Tetragonolepis oldhami*; Pholiodophoridae namely *Pholodophorus kingii, Pholodophorus indicus;* Coelacanthidae namely *Indocoelocanthus robustus;* Hybodontid Sharks; reptiles viz. Sauropod dinosaur namely *Kotasaurus yemanpalliensis* and *Barapasaurus tagorei,* dinosaurian teeth belonging to Ornithischian dinosaurs (Fabrosauridae), three types of isolated teeth belonging to dinosaurs comparable to *Lesothosaurus*; flying reptiles viz. some fragmentary crocodilian remains, Dimorphodontida viz. Pterosaurs, two isolated teeth of Lower Jurassic Pterosaur namely *Campylognathoides indicus, Ramphorhynchus* and micromammals including Triconodonts, Symmetrodonts, Therian, Spalacotheriids and Nakunodon. Kota clay samples from Jakkepalli, Metpalli and Lingal, Adilabad district yielded Ostracodes and Gyrogonites namely *Praechara* sp. Incisors of early Mammals are also reported from Kota Formation. The invertebrates include a few fragmentary freshwater molluscan shells belonging to *Perreysia* sp.

Fragments of limb bone, rib bones and premaxillary tooth of a carnivore dinosaur; vertebrae of a turtle and a primitive reptile; fragmentary limb bone of a turtle; a portion of a mandible from Mesosuchian crocodyliformes, an isolated tooth of crocodyliformes; microvertebrates viz. Piscian isolated teeth, Pterosaur isolated teeth, Perciformes isolated teeth; invertebrates including shells of freshwater bivalves *Perreysia sp.;* other microfossils viz. Ostracodes belonging to Cypridacea, Darwinulacea and Cytheracea and Gyrogonites were recovered from the marly horizon underlying limestone of Kota formation, NE of Jakkepalli.

The Mesozoic Inter and Infra Trappean beds exposed around west of Hyderabad in parts of Ranga Reddy, Medak and Nizamabad districts are known to contain fossils such as micromammals, invertebrates namely *Physa sp, Unio sp.,* Charophytes namely *Peckichara varians, Platychara sp.*, *Microchara* and Ostracodes namely *Paracypretta jonesei, Cyprois sp*. Fragments of dinosaurs are also reported from these beds near Mudimiyala in Ranga Reddy district and Ada in Adilabad district. Mammalian fauna comprising tribosphenic Eutherian-Metatherian types and nontribospenic Gondwanatheriids and other microvertebrate faunas are reported from Naskal, Bacharam and adjoining areas. Cretaceous micromammals including isolated teeth and other dental remains of eutherian mammals represented by the genus *Deccanolestes* viz. tribosphenic molars from *Deccanolestes hispoli* and *Deccanolestes robustus,* hypsodont, rodent like molars of Gonwanatheriids namely *Gondwanatherium patagonium and Gondwanatherium rangapurensis.* Microverte brates known from Naskal include fishes namely *Igdabatis indicus, Picnodous sp, Stephanodus sp, Lepidotes sp, Apatedus striatus, Lepisoteus indica, Pycnodous lametae and Stephanodus lybycus*. *Sahnitherium*, crocodiles and fish ootoliths are recovered from intertrappean sediments near Rangapur, Medak district.

VI. MINERAL BELTS

COAL FIELDS

The Pranahita-Godavari Valley Coalfield defines a major NNW-SSE trending basin belt of Precambrian platform. This linear belt extends form north of Boregaon, Maharashtra in the north up to Eluru on the East Coast of Andhra Pradesh. It follows the course of Godavari and Pranahita rivers for over a length of about 470 km. Though there is a geological continuity of the Gondwana sediments from one extremity to the other, the sector for a length of about 350 km lying mostly in Telangana in usually referred to as the Pranahita-Godavari or Godavari Valley Coalfield, while the adjacent part in Maharashtra is designated as the Wardha Valley Coalfield.

The Godavari Valley Coalfield covers an area of about 17,000 sq km bounded latitudes 16°38' and 19°32' and longitudes 79°12' and 81°39'. The coalfield has an average width of 55 km, though there is a well defined constriction in the Paloncha-Kothagudem area where it is only 6 km.

The geomorphic setting of the coalfield is in a major graben flanked by Precambrian uplands. The Gondwana basin has a monotonous undulating topography and represents a peneplained surface.

The coalfield is drained by the rivers Godavari and Pranahita and their tributaries Wardha, Munner, Indravati, Sabari, Kinerasana and Telperu etc.

A. COAL BELTS

1. MERI PALLI – KAGHAZNAGAR COAL BELT

The Sirpur-Kaghaznagar in Adilabad district is the northern extremity of the NNW-SSE trending Godavari valley coal field. This belt extends between Kaghaznagar and Meripalli in Adilabad district. The coal bearing sequence is associated with the Barakar and lower Kamthi formations of early Cretaceous age. The thicknesses of the coal seams vary from 2 m – 6 m.

Exploration for coal in this belt is carried out by GSI, MECL and Singareni Colleries Company Ltd. (SCCL). The reserves are proved upto a depth of 600 m. The coal from this belt is non-metallurgical and therefore can be used in power generation, cement, fertilizers and railways.

2. DORLI-BELAMPALLI COAL BELT

An area of about 375 sq km in the Ramakrishnapur-Mandamari-Somagudem-Belampalli sector, located in the northern part of the Godavari Valley Coalfields of Andhra Pradesh was geologically mapped. A thick pile of Lower Gondwana rocks of the Talchir-, Barakar, Barren Measure, Lower Kamthi, Middle Kamthi, and Upper Kamthi Formations resting unconformably over a basement of Pre-cambrian rocks of the Sullavai and Pakhal Formations are met within the area. The Gondwana rocks of the Ramakrishnapur-Mandamari-Somagudem-Belampalli sector unconformably overlie Sullavai rocks in the southern part of the area and Sullavai and, Pakhal rocks in the northern part, and are homoclinally disposed with low to moderate dips. The strike trend of the Gondwana sediments varies between NW-SE to N-S, the mean trend being NNW-SSE. The dips are easterly at angles of up to 29°, the common range being 10 - 15°. Much higher dips and erratic strike trends are noticed in the vicinity of a few faults. The dips are generally much gentler in the northern part compared to the southern part. There is also considerable variation in strike and dip in different faulted blocks, due to variable throws along faults. The strike trend of the basement (Sullavai and Pakhals) is also similar to the strike trend of the Gondwanas, but the dips are much steeper, of the order of 15 to 50° with an average of about 25°, the basement-Gondwana contact being a distinct unconformity. Also evidences of folding are seen in the Pakhals and Sullavais at places. The dips in the basal part of the Upper Kamthis are sub-horizontal, to low, compared to the higher dips observed in the underlying Middle Kamthi and the overlying Upper Kamthi strata. The Middle-Upper Kamthi contact may, therefore, be an unconformity.The Lower Gondwana rocks are disposed in a homoclinal fashion with easterly dips and the Upper Kamthi Formtion,

the youngest rocks of the Lower Gondwana Group are overlain on the downdip side by rocks of the Yerrapalli and Bheemaram Formations of the Upper Gondwana Group.

3. SOMAGUDEM-INDARAM COAL BELT

Important coal blocks taken by GSI in this coal belt is Ramakrishnapuram-Mandamari block and Somagudem coal block.

In the ***Ramakrishnapuram-Mandamari*** coal block, an area of 130 sq km bounded by co-ordinates, latitude 18°45' to 18°52'30" and longitudes 79°28' to 79°35'15" has been mapped. A full sequence of the Lower Gondwana Group comprising Talchir Barakar, Barren Measure and Kamthi Formations are found here. The Precambrian Sullavai Formation forms the basement. Exploratory drilling has proved the presence of seven regionally persistent coal seams in Barakar and in the Lower part of the Kamthi Formations.

4. CHINNUR-CHANDRUPALLI COAL BELT

A full sequence of the Lower Gondwana formations comprising Talchir, Barakar, Barren Measure and Kamthi formations are exposed in the Chinnur area. The Precambrian Sullavai Group from the basement and the entire Gondwana sequence has been repeated due to set of faults and consequently the area of exploration has been divided into 'Eastern' and 'Western' sectors.

5. RAMAGUNDAM COAL BELT

Important coal blocks taken by GSI are Ramagundam and Khammampally blocks.

The ***Ramagundam block***: The exploration by drilling carried out so far by GSI has resulted in establishing coal reserves aggregating to about 1665 million tones.

In the ***Khammampally block***, regional exploration for coal in Khammampalli Area in the south-eastern extension of Ramagundem Mining Block was carried out and a total of 3639.00m of drilling was achieved in 11 boreholes. Compilation of the geological data such generated have led towards the identification of Barakar Formation, Barren Measures as well as Lower and Middle Members of Kamthi Formation; resting over Sullavai Formation/Gneisses with a faulted contact.

6. MULUG COAL BELT

Important coal blocks taken by GSI are (a) Satrajpally (b) Bhopalpally-Chelpur-Peddapur (c) Lakshmidevipet (d) Palampet-Venkatapur (e) Northern extension of Venkatapur (g) Govindraopet-Rangpur-Pasra.

The ***Satrajpally*** block located in the West-Central part of the NW-SE trending Godavari Valley Coalfield and covers an area of about 12 sq kms. An area of about 170 sq km in parts of Toposheet 56N/15 was covered in the ***Bhopalpalli-Chelpur*** area, district Warangal, situated in the central part of the Godavari Valley Coalfields. The area exposes rocks of the Lower Gondwana Group (Talchir-Barakar and Barren Measures Formations) resting unconformably over a Precambrian basement of Sullavai Formation, which consists of massive well-bedded, red quartzitic sandstones. The general strike of the Sullavai and Lower Gondwana rocks is NW-SE with low dips of upto 22° towards northeast. The average dips are of the order of 13 - 15°. The Lower Gondwana rocks of the area are affected by 6 major strike faults and two transverse faults and are repeated at least 4 times in the area. There are no outcrops of coal seams in the area. But eight correlatable coal seams and a few local seams have been identified on the basis of drill hole data.

Regional exploration for coal in ***Lakshmidevipet*** area of Godavari Valley Coalfield has been carried out covering an area of about 10 sq.km. It lies contiguously to the South East of Chelpur-Bhopalpally block. No significant coal seam has been intersected in the boreholes drilled in Lakshmidevipet area during the period.

The ***Pallampet-Venkatpur*** block covering an area of 50 sq km has been taken up. Around 50 boreholes were drilled with a total meterage of 17,461.05m showing two coal bearing horizons, one in Lower Kamthi and another in Barakar Formation

separated by 450-500mt thick barren zone. The area may be subdivided into three structural segments (i) Southern Barakar-Barren measures segment with max development of Kamthi coal seams,(ii) North-western segment with development of Kamthi coal seams and (iii) North-central Barren measure-Barakar segment with repeated strata. Six major strike faults with throw of 15m to 700m caused repetition and displacement of strata and equal number of transverse faults have also considerably displaced the rock strata. Coal seams are best developed in the southern structural segments where eight regionally persistent coal seams of Barakar Formation were proved over strike length of 12 km. The ***northern extension of the Venkatapur*** Block was taken for an area of 16 sq km in the Warangal district, Telangana

The ***Govindraopet-Rangapur-Pasra*** block was taken in TS 65 B/3 & 4 in the Warangal district, Telangana. Based on the pattern and type of the faulting, the area may be subdivided into three structural sectors viz. Sector-I in the south eastern part of the area with tilted segment and intraformational strike faults. Sector-II in the northwestern part of the area dominated by oblique faults causing distortion of strata. Sector-IIIA & III-B in the north and central part with strike normal faults in Supra Barakars.

7. KOYAGUDEM – ANISETHIPALLI – MANUBOTHULAGUDEM COAL BELT

Lingala-Koyagudem area under investigation forms the southeast continuity of Mulug belt of main Godavari Valley Coalfields, exposing Lower Gondwana Group of rocks from western margin to eastern margin in down dip direction. The Lower Gondwana sequence starts from Talchir formation which unconformably rests over metamorphic basement. Lower Coal Measures, (cf. Barakar Formation) Middle Measures (Barren Measures) and Upper, Coal Measures (cf. Kamthi/Raniganj Formation) are reported overlying Talchir Formation in ascending order. The western margin in this area shows boundary fault abutting Barakar Formation against metamorphic.

8. MANUGURU-CHERLA COAL BELT

Important coal blocks taken by GSI are (a) Cherla-Singavaram area (b) Manuguru-Bugga area (c) Bugga-Khammamtogu sector (d) Pagaderu (West) sector

The Manuguru-Bugga area, situated in the Khammam district Telangana lies between Latitudes. 17°55' and 17°59' N and Long ides 80°44" and 80°57'E. It is located along thenortheastern fringe of the Godavari basin of the Gondwana graben of the Godavari Valley coal fields and extends in an approximately ENE-WSW direction over a strike length of about 14 km. from the Godavari River on the east to near Bugga in the west. The Manuguru-Bugga area comprises a sequence of Lower Gondwana rocks viz. from bottom to top Talchir, Barakar, Barren Measure, Lower-Middle-and Upper Kamthi Formations resting unconformably on rocks of the Pakhal Formation of Precambrian age. The contact between the various Lower Gondwana Formations is conformable and gradational.

Bugga-Khammamtogu sector

The exploration revealed the presence of the litho-assemblages of Lower Kamthi, Barren Measures, Barakar, Talchir Formations and underlying metamorphic basement based on the subsurface data derived from the boreholes drilled in the study area. The general strike of the litho units recorded in the area is N55°E-S55°W with dips varying between 8°-12° northwesterly. The area has been affected by a number of normal step and transverse faults affecting the sediments of the area. The study reveals the occurrence by Lower Kamthi Formation characterised by yellowish brown, medium to coarse grained, at places gritty to pebbly, feldspathic cross bedded sandstone intercalated with grey shale, carbonaceous shale and interbanded coal seam zones.

Pagaderu (West) Sector

The exploration revealed the presence of the litho-assemblages of Lower Kamthi, Barren Measures, Barakar, Talchir Formations and

underlying metamorphic basement based on the subsurface data derived from the boreholes drilled in the study area. The general strike of the litho units recorded in the area is N70°E-S70°W with dips varying between 8°-12° northwesterly. The area has been affected by a number of normal step and transverse faults affecting the sediments of the area.

9. KOTHAGUDEM – PENGADAPA COAL BELT

In Kothagudem subbasin, GSI has taken following blocks (a) Erragunta (b) Dharmacherla-Abbugudem (c)Ramapuram (d)Ayenapalam (e) Kotahgudem-Pengadapa (f) Pennabally.

Erragunta block in the district of Khammam, Telangana is located in the southern part of the main basin. Two conglomerate horizons dipping towards each other, having an affinity to upper member of Kamthi formation have been mapped in the area. Most of the area is largely covered by sub-recent sediments. Conglomerate, pebbly sandstone and a number of clay horizons including variegated clay, Red brown clay, chocolate clay with rootlets (Palaeosol) and silicified sandstone have been intersected in the two boreholes, drilled in this area. No coal seams/zone-intersected in this area. The general strike of lithounits is NW-SE, in conformity with the regional strike of Godavari basin. Two conglomerate horizons along with other lithounits are running along NW-SE direction and are dipping towards each other i.e. eastern unit is dipping towards SW and western unit is dipping towards NE. The amount of dip is varying from 6° to 12° and near fault it is varying from 18° to 26°. Two conglomerate horizons are merging towards each other near Kottugudem village. This may be due to the dragging effect of a NW-SE running fault present between them, resulted in an apparent closure of two conglomerates.

The area is affected by numerous faults, major sets are (i) NW-SE ii) NE-SW. The NW- SE set are parallel to the formation boundary but NE-SW faults are cross faults. The faults have been picked from geocoded sheet (Imageries) and thereafter confirmed by field checks. The cross faults within the basin are parallel to the major faults within the basement running NE-SW. These faults are evidenced by the presence of slickensides, silicification, ferruginisation, dislocation of lithounits, quartz breccias, straight nala course and water seepage area. From field relation, it may be interpreted that for NW-SE fault, successive down thrown blocks are towards NE which resulted in a graben like structure in the central part of this part of sub basin.

Pennabally block: The Pennabally block is located in the Kothagudem sub basin. The Gondwana sequence in this area rest on a gneissic basement of Precambrian age. The sequence comprises a lithopile of Barakar, Barren Measure, Lower Kamthi and Middle Kamthi formations. The Gondwana sediments have a general strike of N 55º W – S 55º E with 10º-15º northeasterly dip. Regional exploration for in coal Penaballi block has indicated the presence of broadly four regionally persistent coal-carbonaceous shale zones in Barakar Formation. In addition, a number of coal seams belonging to both Barakar and Lower Kamthi formations have been intersected in boreholes. Thinning, splitting and facies variation of the seams/bands within coal seam zones are quite often and the correlation of Coal Seam Zones is difficult.

In the ***Kothagudem-Pengadapa*** block of GSI, drilling along with mapping of an area of about 135 sq. km. on scale 1:25,000 and about 15 sq km on scale 1:10,000 was done. A thick homoclinal sequence of Lower Gondwana rocks of the Talchir-Barakar-Barren Measures-Lower Kamthi and Middle Kamthi Formations resting unconformably on the Archaean Gneissic complex are met with in the area. The area is dissected by 25 gravity faults. In the northern part of the area 9 transverse to oblique faults appear to radiate from the Gautam Khani area. In addition 4 oblique to transverse faults hading east or southeast and one strike fault hading SW have also been inferred. In the southern part 5 faults trend more or less parallel to the strike and 5 are oblique to transverse. Most of the transverse faults have a southeasterly hade and two of them have throw of

over 200 m. - 250 m. Fault F25 along the northern margin of the area separates the 'Paloncha neck' area on the north from the Kothagudem basin on the south. There are no outcrops of coal seams in the area.

In the ***Dharamcherla-abbugudem block*** work was carried out around Dhamaracherla (Lat: 17 22' 30" and Long:80 40' 00") Abbugudem (Lat:17 22' 46" and 80 40' 13") in the toposheet No.65 C/11 within the confines of Kothagudem sub-basin. In Dhamaracherla and Abbugudem areas, there are three major coal seams, one occurring in Lower member of Kamthi Formation and two in Barakar Formation.

10. YELLANDU COAL BELT

Yellandu outlier - an elliptical plunging asymmetrical synform detached by approximately 20 km from the western margin of the main Gondwana Basin Belt of Godavari Valley Coalfield was the birth place of coal mine in the Southern India way back in 1889. So far the mining activity was confined to the east of the central axis (faulted) of the basin to excavate power grade coal by mining mainly the Queen and King seams of Barakar Formation by underground working coupled with large open cast projects which came up during recent years.

Two coal measures were identified in the area associated respectively with Lower Member of Kamthi Formation and Barakar Formation. The intervening litho assemblage is predominantly coal famished barring sporadic occurrence of carbonaceous shale bands with coal laminae and designated as Barren Measures.

B. OTHER MINERAL BELTS

1. BAYYARAM IRON ORE BELT

The Bayyaram Iron-Ore Belt is situated in between Sripuram (17° 31' 20" : 80° 10' 00") in the south of Khammam district to Kottagudem (17° 54' 40" : 80° 33' 35") in the north of Warangal district of Telangana. The Iron-Ore Belt extends in a NNW-SSE direction over a strike length of 50 km along the western contact of Pakhals with the rocks of Khammam Group and Peninsular Gneissic Complex-II (PGC-II).

The major geological units exposed in the area are Khammam Group of Archaean age, Peninsular Gneissic Complex-II of Archaean to Palaeoproterozoic age and Pakhal Supergroup of Mesoproterozoic age sediments.

The Iron-ore is mainly occurring in two stratigraphic horizons. They are 1) The first horizon is in Khammam Group in the form of banded hematite magnetite quartzite, which is of low-grade iron-ore and 2. The second one is within the Gunjeda and Pandikunta Formations of Mallampalli Group of Pakhal Supergroup as detached lens shaped bodies of hematite, which is of high-grade iron ore. The hills lying west of the Archaean-Pakhal contact are mainly capped with steeply dipping banded hematite magnetite quartzite noticed at 1.25 km west of Utla (17° 47' 15" : 80° 02' 30"), 0.75 km north and 1 km south east of Vampu Tanda (17° 50' 00" : 80° 01' 15") and 1-2 km west and southeast of Gurimalla (17° 41' 30" : 80° 04' 00"). The banded rock contained fine alternating bands of quartz and iron oxides (mostly magnetite with little hematite). The iron amphiboles, viz., cummingtonite and grunerite are more commonly present. The mineral magnetite contains traces of titanium. These iron bands contain iron oxide (magnetite > hematite) only upto 1/3rd of the total rock and the remaining being mostly silica and silicate minerals. These rocks are low-grade iron ores with iron content ranging from 22% - 28%. Their reserves are estimated to be about 40 million tonnes.

Detached lens shaped bodies of haematite of all grades in Pakhals are seen exclusively confined to the peaks and hilltops in the area. This iron bearing Pakhal belt trends in a NNW-SSE direction over a strike length of 50 km extending from Sripuram in the south to Kottagudem in the north. The haematite lenses are occurring in association with quartzites of Gunjeda Formation and Quartzites and shale of Pandikunta Formation. The iron-ore bands are conformable to the country rock having a variable thickness of 3-15 m. But the thickness of iron-ore bands, as revealed from borehole data, ranges from 15 m – 40 m. The iron ore consists mainly of haematite with subordinate amount of limonite, jasper,

chert and some siderite too. The haematite is brownish red or steel grey in colour and massive in nature. Development of concretionary and botryoidal structures is noticed on a large scale when Ores are poor in iron content.

Of all the iron ore occurrences examined in the area, the Bayyaram iron-Ore is the thickest and is a high grade heamatite. In addition to the insitu ores, the float ore is found as boulders ranging from 2 to 9 inches in size down to a depth of 10 feet and over in the talus cover noticed at 1 km WNW and 4.5 km NNW of Motla Timmapuram (17° 41'15" : 80° 07' 05") and 0.5 km SW of Ramagundala (17° 38' 00" : 80° 08' 00"). The total insitu ore (8.7 m.t.) and float ore (2.3 m.t.) reserves of Pakhal belt are estimated to contain 11 m.t. of iron ore with 54% - 65% Fe of hematite of all grades. Sarma and Choudhary (1974), based on the drilling carried out in the upper iron-ore body of Bayyaram Gutta, estimated a reserve of 2.22 m.t. of iron-ore of < 55% grade, 0.71 m.t. of 55% - 60% grade and 0.34 m.t. of plus 60% grade. The SiO_2 ranges from 4% to 39%, Al_2O_3 from 0.2% to 5.4%, P- 0.03% and S < 0.1%.

The Pakhal iron-ores are thicker and richer in Bayyaram and gradually become thinner towards northwest. While the Khammam Group iron-ore is practically insignificant in the southern part but assumes massive proportions in the northwestern part of the area.

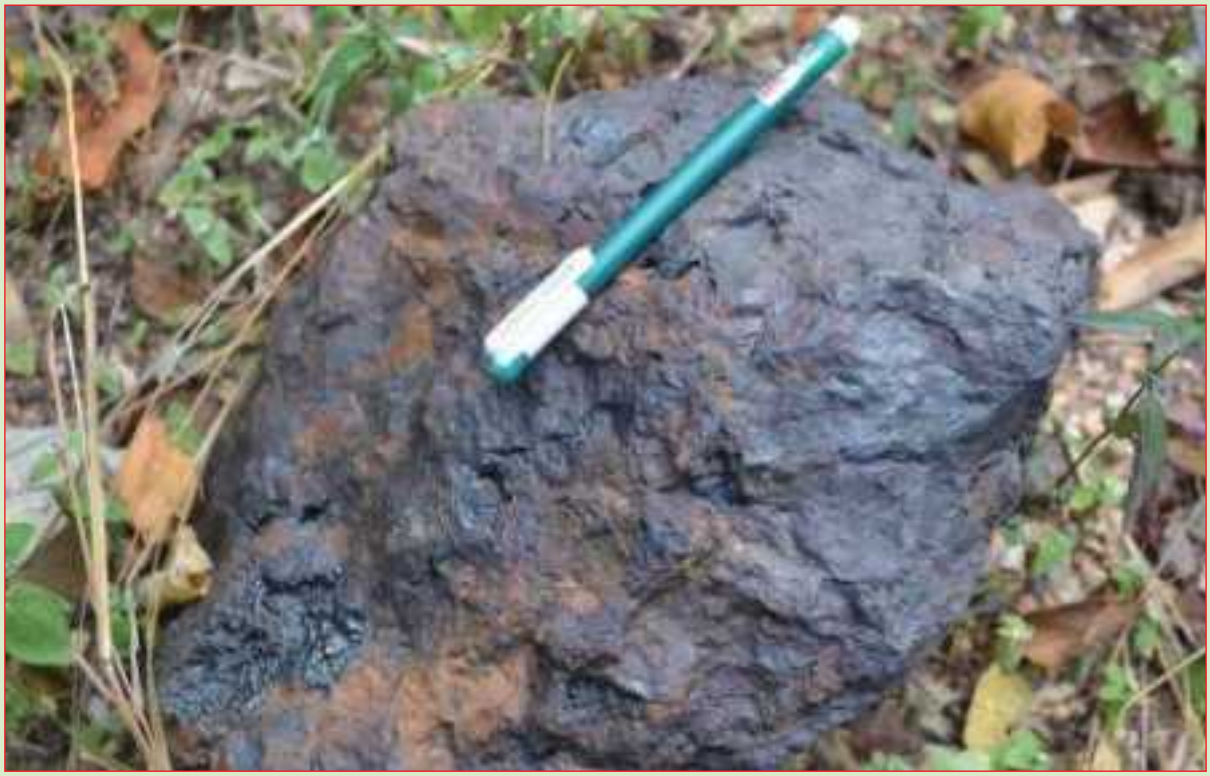
Small veins of barytes associated with the shale and quartzite of Pandikunta Formation are recorded at 1.5 km southeast of Nagaram (17° 32' 00" : 80° 31' 50") and 1.25 km NW of Regulagudem (17° 30' 20": 80° 13' 30"). The Ba SO_4 content varies from 96% - 99%. A total reserve of 2 lakh tonnes upto a depth of 15 m is estimated.

2. KONNAYAPALEM CHROMITE

The chromite deposits of Lingannapeta, Konnayapalem and Jannaram are situated in the northeastern part of Dharwar Craton in Khammam district of Telangana and are known for their float as well as a few in-situ chromite occurrences bounded by latitude 17°18'00" N and 17°22'30" N and longitude 80°24'E and 80°29'E in Survey of India toposheet no.65 C/7. Yenkur (17°19'30" :80°26'30") is the main biggest village in the area and all the chromite occurrences fall within a radius of five kilometres. Yenkur is connected to Tallada (12 km) in the south and Kothagudem (35 km) in the north by a tarmac road. The area forms a gently undulating terrain intervening the Eastern Ghats mobile belt and the Karnataka and the Bastar Cratons. Chimalpahad hill ranges on the north, Gabbagurti and Kannegiri hills in the south west and south east with intervening valleys. The central part of the area is nearly a peneplained with maximum and minimum elevations being are 632 m and 110 m above MSL respectively in the northeastern and southeastern part of the area. Boggugutta Vagu and Narsapu Vagu are the southerly flowing streams in the south and Tummala Vagu in the easterly flowing stream in the northeast of the area. Drainage pattern is mostly sub-parallel to rectilinear with minor ephemeral streams exhibitting a dendritic pattern.

The chromite occurrences in association with meta ultramafic rocks occur in isolated places in five blocks viz. Lingannapeta, Konnayapalem, Jannaram, Sriramagiri and Garla Vaddu (17°18'15":80°26'). These are distributed in an arcuate pattern from Jannaram in the southwest through Lingannapeta in the north to Garla Vaddu in the southeast. The Sriramagiri block is under lease-hold to Ferro Alloys Corporation (FACOR). Chromite deposits in Lingannapeta block, Konnayapalem block and Jannaram block have been explored by drilling. The chromite mineralisation is confined to the isolated ultramafic bodies towards south of the major gabbro-anorthosite complex. It occurs as lenses and pods of limited extent. They occur parallel to the structures of the enclosing rocks. Relatively large lenses of chromite were seen where ultramafics predominate over the associate suite of rocks. The chromite lenses vary in size from 9 to 40 m in length and 2 to 13 m in width. Besides these float ore occurs in Jannaram and Lingannapeta blocks wherein Chromite values range from 7.61% to 32.05%.

The ultramafic body of Lingannapeta block is the largest compared to other blocks. In this block,



Haematite, Bayyrarm Iron ore belt, west of Motlatimmapuram, Khammam district, Telangana
(Photo by Shri N. Nandhagopal, Senior Geologist)

Iron ore, South of Nilavancha, 65C/2, Bayyaram ,Warangal district, Telangana
(Photo by Shri N. Nandhagopal, Senior Geologist)

an insitu chromite lens is seen enclosed within the serpentinised dunite, pyroxenite and websterite. A borehole in this block has intersected a thick pile of ultramafic assemblage along with three chromite lenses. Amongst three blocks explored, the Lingannapeta block has the highest ore and proved to contain maximum chromite.

The Konnayapalem block is characterised by three layered ultramafic bodies of which two were intersected by drilling. The first ultramafic body occupies an area of 400 sq m (based on presence of float ore) while the second body is about 300 m southeast of the first one and hosts an in-situ chromite lens of 10 m x 2 m. In the Jannaram block the in-situ chromite lens is about 12.5 m x 2 m with very shallow depth persistence.

Ultramafic bodies in these areas are concealed under soil cover without adequate outcrops making difficult to understand their structure and morphology. Further, occurrence of float chromite as wellworn boulders, at places, in huge quantity remained migmatic with regard to its origin. The mafic - ultramafic units of the assemblage display inch scale layering which is persistent for a few hundreds of metres. In the thickened portions (sheaths) of the zone the layering is well pronounced, and the ultramafic units generally out number the mafic members. In addition to fairly large lenses of chromite intersected by drilling, the ultra mafic sheaths might contain lenses of limited dimension of the same size as that of the float some of which were released because of the deeply eroded nature of the terrain.

3. MANGANESE BELT, ADILABAD DISTRICT, TELANGANA

Manganese Ore Occurrences/ deposits of Adilabad are distributed in a 40 km linear belt from Gullughat 19°48' : 78°27' in the WNW to Mesala Khurd 19°40':76°45' in the ENE in Adilabad district of Telangana. Geologically, the area is occupied by granite and gneiss traversed by quartz/pegmatite veins belonging to Peninsular Gneissic Complex-II (PGC-II), arenite, argillite with interbedded carbonate sequence comprising of Penganga Group and basalt flows with infratrappearns of Deccan Trap. The Penganga Group non conformably overlies the PGC-II. The infratrappean conglomerate and sandstone separates the basalt flows of Deccan Trap from the underlying PGC-II and Penganga Group.Important deposits are located in the areas of Tamsi, Goatkur-Guda (19°46':78°29'35'') Pipparikunta (19°44'40"78°28'25"), Goatkur, Jamadapur (19°43' 48": 79°31'20"), Metguda-Kanpa (19°38'30" 78°39'50") and Mesala Khurd.

The manganese ore admixed with chert/jasper occurs associated with the middle part of Goatkur Limestone belonging to Penganga Group. The ore mineral assemblage comprising mainly oxides and hydroxides of manganese intercalated with jasper chert, is unmetamorphosed and unaltered retaining its original syngenetic characters. The ore minerals include wad, pyrolusite, manganite and minor psilomalene. The various types of manganese ores include i)banded, brownish black, dull, earthy, light and porous type with thin jasper/chert films forming the major proportion of the ore in all occurrences; (ii) black/brownish black, compact heavy ore with metallic lustre, devoid of banding occurs in association with the porous type eg. Goatkur-Guda, Tamsi and Pipparikunta areas; (iii) Steelgrey ore with metallic lustre in Pipparikunta mine and iv) Steel grey granular ore with metallic lustre in the form of thin minor veins traversing the above three types of ore in all the occurrences.

4. COPPER BELT, MAILARAM AREA, KHAMMAM DISTRICT

The area of Mailaram Copper belt bounded by North latitudes 17° 35' to 17° 50' and East longitudes 80° 30' to 80° 45' and falls in Khammam district of Telangana. Kothagudem, an important town, known for the mining activity is located to the south of the area. The Khammam-Yellandu-Bhadrachalam road passes through Sullanagar and Kottapalvoncha villages in the central part. The area comprises of rocks of Khammam Group and Chimalpahad gabbro Anorthosite Complex (CAC) of Archaean age, Peninsular Gneissic Complex-II (PGC-II) of Archaean to Palaeoproterozoic age, Pakhal Supergroup of Mesoproterozoic age and Gondwana Supergroup of early Permian to lower Triassic age.

The Pakhal sediments unconformably overlie schists and gneisses and the Gondwana sediments overlie Pakhal sediments or gneiss/schist and their contact is normal but faulted at places. The Khammam Group comprises of amphibolite, quartz-sericite schist, calc-silicate rock and banded magnetite quartzite (BMQ).

Copper occurs in the grey and blue quartz veins intruding the quartz-chlorite schist of the Khammam Group in the Mailaram area. The copper deposit in Mailaram Block consists of two ore shoots ,viz., the main and the central ore shoots and the northern ore lens, as 2 parallel lodes, the Hanging wall lode and the Footwall lode. The ore shoots are estimated to contain 8.45 lakh tonnes of copper ore upto a depth of 70 to 240 metres, along the plane of mineralisation. The mineralisation, besides Mailaram area, occurs in Bayar, Sarakkal and Venkatapuram areas.

5. NARAYANAPET KIMBERLITE BELT

Kimberlites were located by GSI around Maddur and Narayanpet areas in Mahabubnagar district, Telangana, The new field is referred to as Narayanpet Kimberlite Field (NKF) where kimberlite occurs in three clusters viz: Maddur, Narayanpet and Kotakonda and is located 200 km north of the Wajrakarur Kimberlite Field and extends 60 km E-W by 40 km N-S. The NKF is located in the northern part of the eastern Dharwar Craton. The rock types exposed are the Archaean migmatite gneisses and granites of Peninsular Gneissic Complex (PGC) with enclaves of supracrustal rocks.

Satellite imagery and Aerial photointerpretation reveals presence of well defined E-W and NW-SE trending faults and fractures. The foliation in migmatite gneiss trends NNW-SSE to NE-SW with steep dips on either side. In the Maddur-Kotakonda area, E-W trending major fractures and NE-SW trending minor tensional fractures are the controls for the emplacement of kimberlite. Maddur and Kotakonda clusters of kimberlites are associated with major E-W faults and resultant fractures developed due to reactivation of E-W fractures.

The Narayanpet field (NKF) contains 37 kimberlite pipes of which 16 pipes are shown in this mineral belt map. These were emplaced during Proterozoic, having age range of 1000-1300 my. The kimberlites of this field are small bodies except the Kotakonda and Vinjamur Kimberlites (KK-1 and KK-2) which are about 2 km in length with width varying from 20m to 100m. The outcrops are very few and sparse and are generally of 1 m x 2m in size.The kimberlites are oval, elliptical and linear in shape The morphological, textural and mineralogical characters of the pipe rock indicate that they are eroded to near root zone level. The kimberlites are usually weathered and altered with a thin layer of calcrete/ or covered by colluvium. However, a few of them are exposed. The rock is a hard compact, dark blue, porphyritic enclosing numerous xenoliths of country rocks. The characteristIc kimberlite minerals are olivlne, perovskite phlogopite,richterite, serpentine and carbonates along with xenocrysts of chromediopside. Chrome-spinel, picro-ilmenite are recorded in varying proportions in different pipes.

VI. MINERAL RESOURCES

Telangana is endowed with a variety of mineral deposits. Significant mineral deposits, namely, ferrous, non-ferrous and noble metals, precious & semi-precious stones, strategic and other industrial minerals are found in diverse geological formations ranging from Archaean to Proterozoic.

The Archaean high grade metamorphic rocks contains copper, barytes and gemstones; Dharwar Greenstones-gold and iron ore; Peninsular Gneisses-diamonds and precious & semi-precious stones and Eastern Ghats granulites – bauxite and dimension stones. The Proterozoic rocks, confined mostly to the intra-cratonic basins, contain basemetals, barytes, limestone, dolomite, diamonds, iron ores, magnesite, phosphorite and uranium. The late Palaeozoic- early Mesozoic rocks, referred to as Gondwanas contain coal deposits and clay.

The mineral deposits of national importance are limestone, barytes, coal, gold, diamond, dimension stones. The state has large reserves of different grades of limestone. Besides the cement grade limestone, significant reserves of BIF, SMS and high grade limestones are also found.

The coal bearing formations are confined to the Godavari Valley covering an area of 17,000 sq km in Telangana State occupying parts of Adilabad, Karimnagar, Warangal, Khammam and West Godavari districts and potential area for the coal is estimated to be about 11,000 sq km. Coal seams associated with the Barakar Formation are found in Ramagundam- Manuguru- Kothagudem-Yellandu sectors. The total reserves of coal estimated up to 1200 m depth are of the order of 22054.58 Mt (April, 2011).

Archaean greenstone belts, the major repositories of gold constitute the Dharwar Supergroup. They occur as linear, narrow and sub-parallel N-S to NNW-SSE trending schist belts amidst the Peninsular Gneissic Complex. These are Peddavuru, Yerrraballi, Gadwal and Ghanpur schist belts.

The state has the distinction of having produced many of the historically famous diamonds like the Koh-i-noor, the Great Mogul, the Hope and the Orloff which were recovered from gravels of river Krishna near Kolluru and Chandralapadu in A.P. Both primary and secondary source rocks of diamond occur in different parts of the state.

Telangana has immense potential for granite based dimensional stone industry. The Archaean-Proterozoic granite-gneiss terrain occupying more than 60% of the state, is a store-house of multicoloured rocks.

Manganese ore is mainly associated with Penganga beds in the Pakhal Basin.

The different economic minerals/rocks occurring in the state are described below in alphabetical order. Major occurrences / deposits of different minerals are listed in Annexure -I and minor occurrences are given in Annexure-II.

BARYTES

Barytes ($BaSO_4$) is one of the chief sources of barium. It contains 65% of BaO and occurs either as crystalline or massive. It can be easily identified by its high specific gravity. Snow white/white barytes is generally used in chemical and paint industry and to a minor extent in rubber, textile, paper, cardboard, leather, oil, cloth, linoleum, plastic and ceramic industries. The off-coloured barytes is used as drilling mud in oil well drilling.

The baryte deposits are classified into three main types: 1) vein and cavity filling, 2) bedded and 3) residual deposits. A majority of the deposits occur as veins or cavity fillings along fault zones. Barytes is known to occur in Khammam district. The occurrence is mostly associated with the Pakhal sediments.

Khammam District

The occurrences of barytes in this district are mostly confined to a narrow band of Pakhal sediments along a major NNW-SSE trending fault. The barytes occurs as lenses, stringers or veins ranging

in width from a few centimetres to 6 m. Maximum length of the veins is 300 m. The barytes is generally massive and often stained with iron oxides imparting brown to pink colours. The main occurrences are located at Rudramkota, Venkatayapalem, Gopalpur, Kodamur, Cheruvupuram and Pocharam. A cumulative reserve of about 0.5 Mt was estimated up to a depth of 15 m.

BASEMETALS (Copper, Lead and Zinc)

Under basemetals, copper, lead and zinc are described together because of their close association. The principal ores of copper are sulphides, carbonates and oxides. Some of the important copper minerals are chalcopyrite (Cu FeS_2), chalcocite (Cu_2S), bornite (Cu_5FeS_4), covellite (CuS), native copper (Cu), malachite {$CuCO_3Cu(OH)_2$}, azurite {$2CuCO_3Cu(OH)_2$} and cuprite (Cu_2O).

Lead is soft but a heavy metal, malleable and resistant to acids and is widely used in storage batteries, cables, sanitary fittings, chemical plants, making alloys and paints. Lead is closely associated with zinc and silver. The important minerals of lead are galena (PbS), cerussite ($PbCO_3$) and anglesite ($PbSO_4$) of which galena is very common.

The important zinc minerals are sphalerite (ZnS), smithsonite ($ZnCO_3$) and zincite (ZnO). Zinc is used in making brass alloy, collapsible soft tubes and pigments and for soldering and coating purposes.

Copper-lead-zinc mineralisation in Telangana is associated with the Archaean metamorphics and the Proterozoic Formations of Pakhal Supergroup. A number of basemetal occurrences are known but a majority are confined to Mailaram belt. Old workings are found at several locations in this belt. Multi-sensor airborne and integrated ground surveys carried out by the GSI followed by drilling had indicated a number of prospects in this area.

Khammam District

Copper mineralisation in this district is associated with quartz veins in quartz-chlorite schist and quartzite and dolomite interbeds in phyllite of the Pakhal Supergroup. The areas of copper mineralisation in this belt include those at Mailaram, Yellambailu, Banjar, Sarkal and Venkatapuram. Detailed investigation by the GSI indicated significant copper mineralisation in Mailaram and Venkatapuram areas.

In the **Mailaram deposit,** copper mineralisation associated with quartz veins is hosted by quartz-chlorite schist. The mineralised zone extends discontinuously over a strike length of 1.10 km in a NE –SW trending shear zone developed parallel to a major anticlinal axis. Chalcopyrite is the dominant mineral and occurs associated with chalcocite, covellite and pyrite. Based on detailed exploration, a reserve of 0.99 Mt of ore with 1.8% Cu was indicated down to a depth of 250 m. This prospect was subsequently developed by the Andhra Pradesh Mineral Development Corporation Ltd and mined for some time.

In the **Venkatapuram block,** located about 30 km east of Mailaram, copper mineralisation is in the form of sulphide bearing quartz veins traversing the Pakhal quartzite and dolomite. Chalcopyrite is the chief mineral which occurs as disseminations and stringers along with pyrite and pyrrhotite. The mineralisation is controlled by NE-SW trending shear zones. Two en echelon zones of copper mineralisation over a cumulative strike length of 300 m was established by drilling. The average grade of the ore varies between 1.27% and 1.58% Cu with widths ranging from 1.5 to 5.4 m.

Besides, aerogeophysical anomalies identified in the Pakhal dolomite and phyllite at Venkatapalem and Ragaboyingudem were tested by drilling, Pb+ Zn +Cu values recorded in general are poor.

BUILDING STONES

The Archaean gneisses, granitoids and quartzite having a wide distribution are extensively used as building stone. The dolerite dykes traversing the Archaean gneisses and granitoids, and the Deccan basalts are ideally suited as road metal. The flaggy limestone from the Bhima basin in Tandur-Malkapur-Ogipur-Bashirabad area in Ranga Reddy district and Kodangal in Mahbubnagar district yields good slabs (Shahbad stones) for flooring. The Sullavai sandstone near Chelvai in Warangal district, with spotted and ribboned appearance finds great demand for

decoration of buildings. The Pakhal dolomite near Manditog, Jestaipalle and Bethampudi near Yellandu in Khammam District are in fact recrystallised to marble of white, yellow and light pink hues making them attractive for flooring.

CHROMITE

Chromite ($FeCr_2O_4$) is the chief ore of chromium, which is widely used in metallurgical industry for making special steels/alloys. It is also used in refractory and chemical industry.

Minor deposits of chromite, known from Khammam, occur as veins and lenses associated with serpentinised ultrabasic rocks.

Khammam District

Several chromite occurrences are reported from Dendukuru, Gaurarам, Bhimavaram, Lingannapeta, Jannaram, Sriramagiri, Konayyapalem, Imamnagar, Enkuru and Kuntala. The chromite occurs mostly as either float or detrital ore and at some places *in situ*. The *in situ* occurrences are found as lenticular pockets in altered pyroxenite or ultramafite. A total resource of 0.187 Mt of chromite with 27.22 to 42.00% of Cr_2O_3, 27.34% SiO_2, 6.88 to 18.6% FeO and 8.5 to 12% Al_2O_3 was estimated upto a maximum depth of 40 m for the Jannaram, Lingannapeta and Konayyapalem areas. In addition to this, a likely resource of about 15,000 t of float ore is available (Sarma et al 1988). In Sriramagiri area, a relatively big lens of chromite with substantial reserve is under exploitation by the M/s Ferro Alloys Corporation Ltd.

CLAYS

Clays are hydrous aluminium, magnesium and iron silicates show wide variations in their chemical composition. Kaolinite, montmorillonite and illite constitute different clay minerals. The properties significant for utilisation of clay are plasticity, refractiveness, grain strength, dry strength, drying, firing shrinkage, vitrification range and fired colour. Clays are used in the manufacture of cement, refractories, ceramics, pigments, paper, paint, plastic, rubber, pesticide, fertiliser, linoleum, tiles, stoneware pipe and pottery. Some clays, like bentonite, are used as drilling mud. Based on the physico-chemical and mineralogical properties and their use in different industries, clays are classified as pottery clay, fire clay, ball clay, structural clay, porcelain clay, foundry clay, refractory clay, ceramic clay, white-ware clay and bleaching clay.

Clay deposits are found at many localities in diverse geological set-ups. The clays are associated mostly with Archaean gneisses, Proterozoic Pakhal sediments, Gondwana and Tertiary rocks.

Adilabad District

Pottery clay occurs at Chanaka, Rallapet, Pachagaon, Kallerala and Buttermal. The clay is associated with the Maleri Sandstone of the Upper Gondwanas. A reserve of about 5 Mt was estimated for the Pachagaon deposit which has an average of 22 to 25% Al_2O_3, 1.17 to 2.80% FeO and about 2% alkalies.

Hyderabad and Ranga Reddy Districts

White clays, derived mainly from the Deccan Traps (basalts) and granite, occur at several localities. The clays, after washing can be used in the manufacture of porcelain, pottery and in bleaching industry and also as drilling mud. Major clay deposits are at Srirangapur (18 Mt), Rudravaram (3.25 Mt), Timsanipappli (10 Mt), (7.5 Mt) and Alipur (11.5 Mt) .Other significant occurrences are reported from Vikarabad and Golconda.

Medak District

Clay beds, 2 to 3 m thick, dull coloured occur close to the Deccan Traps in Shekapur area occurring below 2 to 4 m thick laterite cover. The clay, after washing, can be used in chemical, porcelain and paper industry.

Nalgonda District

Kaolinised clay associated with limestone and shale of the Kurnool Group, is found at Chintriyal on the northern bank of Krishna River. It is used in the textile, paper, fertiliser and pesticide industries. A reserve of about 81,200 tonnes was estimated.

COAL

Telangana has the distinction of being the only major coal producing state in south India. Coal is associated with the Gondwana formations spread over 17,000 sq km area along NNW-SSE trending Godavari Valley extending between Sirpur in the north (Telangana) and Eluru in the south(AP) over a length of 350 km. The belt has a maximum width of 65 km and a minimum of 6 km covering parts of Adilabad, Karimnagar, Warangal, Khammam districts.

The coal bearing sequence is associated with the Barakar and Lower Kamthi (Raniganj Formation) formations of the early Cretaceous age in the intracontinental Godavari belt and Late Cretaceous sequence in the Krishna-Godavari coastal belt. The total thickness of the Gondwana sediments is more than 2900 m as recorded in an ONGC borehole at Aswaraopeta in Khammam District. The thickness of the coal seams varies from 2 to 6 m and occasionally upto 20 to 25 m.

Exploration for coal in the Godavari Valley is being carried out by GSI, MECL and Singareni Collieries Company Ltd (SCCL). Total reserves of the coal estimated upto April 2011, are of the order of 22054.58 Mt upto a depth of 1200 m and proved reserves are about 9287.95 Mt upto 600 m depth.

Coal from the Godavari Valley is non-metallurgical and hence is mostly used in power generation, cement, fertilizers and railways.

In the SW part of Kondapuram (Manuguru coal belt) of the Bugga-Khammamtogu sector within the main basin of Godavari valley coalfield, Khammam district, Telangana a tentative coal resource of 12.76 million tonnes has been assessed over an area of 4.260 Sq Km within the depth range of 0.00 to 1200 m under indicated category for thick seam and an additional resource of 38.09 million tonne coal is tentatively assessed from the thin seam under 'Indicated' category. The total coal resource assessed for the thick and thin seams in Bugga-Khammamtogu sector assessed to be 50.85 million tonnes.

In the NW part of Kondapuram (Manuguru mining belt) in Pagaderu West sector within main basin of Godavari valley coalfield, Khammam district, Telangana, a coal resource of 47.19 million tonnes has been tentatively assessed over an area of 6 Sq Km under indicated category for thick seam (Seam thickness Beside an resource of additional 141.73 million tonne coal for thin seam under 'Indicated' category has also been tentatively assessed. Thus, the total coal resource including thick and thin seams in Pagaderu West sector assessed to be 188.92 million tonnes (approx).

Adilabad District

Working coal mines are at Golet, Bellampalli, Indaram, Ramakrishnapur, Mandamari and Chinnur. Besides, significant deposits are found at Budharam, Samagudem and Srirampur Sarangapalli. The total reserves of coal for all the above mentioned areas are of the order of 1176 Mt (proved 517 Mt + probable 659 Mt.)

Karimnagar District

The reserves of coal in Ramagundam are 621 Mt of proved category and 61 Mt of probable category. The Ramagundam area has many collieries.

Khammam District

Major mines in the district are at Kothagudem, Yellandu and important coal seams occur at Madharam. Anisettipalli, Cherla, Pengadapa, Ayyanapalem, Koyagudem, Mailaram, Sattupalli and Mulkalapalli. The total reserve for all the areas is of the order of 875 Mt (proved 512 Mt probable 363 M.t).

Minor occurrences of coal are reported from the area around Narayanapuram-Pattayagudem area in the Southern sub-basin of Godavari valley coal field, Khammam district. Three regionally correlatable coal seams are reported, one within Barakar formation and the other two within lower Kamthi formation. The individual clean coal band varies in thickness from 0.30m to 1.48m.

A coal resource of 98.86 million tonnes considering thick coal seams/bands (1.20m and above thickness) under 'Inferred' ungraded category was estimated upto the depth of 1200m. Out of this resource, 4.96 million tonnes, 34.77 million tonnes

Kondapuram open cast coal mines, Khammam district, Telangana
(Photo by Shri S. Ananda Murthy, Director)

Exposure of coal seam within Sathupally coal mines of SCCL.
(Photo by Shri S. Ananda Murthy, Director)

and 59.13 million tonnes belong to 'Inferred' category in the depth ranges of 0m - 300m, 300m -600m and 600m - 1200m respectively. Besides this, additional 254.49 million tones of coal resource has also been estimated under same 'Inferred' ungraded category for thin coal bands (considering >0.50m and <1.20m thickness) in the area.

Warangal District

Coal deposits at Bhopalapalli are being mined. Besides, significant deposits occur in Lingala, Satrajpalli, Chelpur, Peddapaur, Govindaraopeta–Oasra and Palampet – Venkatapur areas. The total reserves for all these areas are 1881 Mt (Proved 28 Mt and probable 1853 Mt). Total reserves of coal (Coal Wing News, 2004) are 8091.10 Mt (Proved), 6092.43 Mt (Indicated) and 2513.73 Mt (Inferred) reserves totalling to 16697.26 Million Tonnes.

DIAMOND

Diamond, an allotriomorphic form of carbon, is the hardest of all the known minerals. Gem diamonds are used for ornaments and the off coloured diamonds in lepidary and other industry.

The primary source rocks for diamond, namely, kimberlite and lamproite of Late Proterozoic age are found in Narayanpet Kimberlite Field in Mahbubnagar District and Raichur Kimberlite Field in Raichur (Karnataka) and Mahbubnagar districts.

Mahbubnagar District

The gravels of the Krishna River occurring at Bollaram, Amaragiri and Somasila were reported to have been worked in the past for diamond. Old workings are also found in the Banganapalle conglomerate at Maddimadugu.

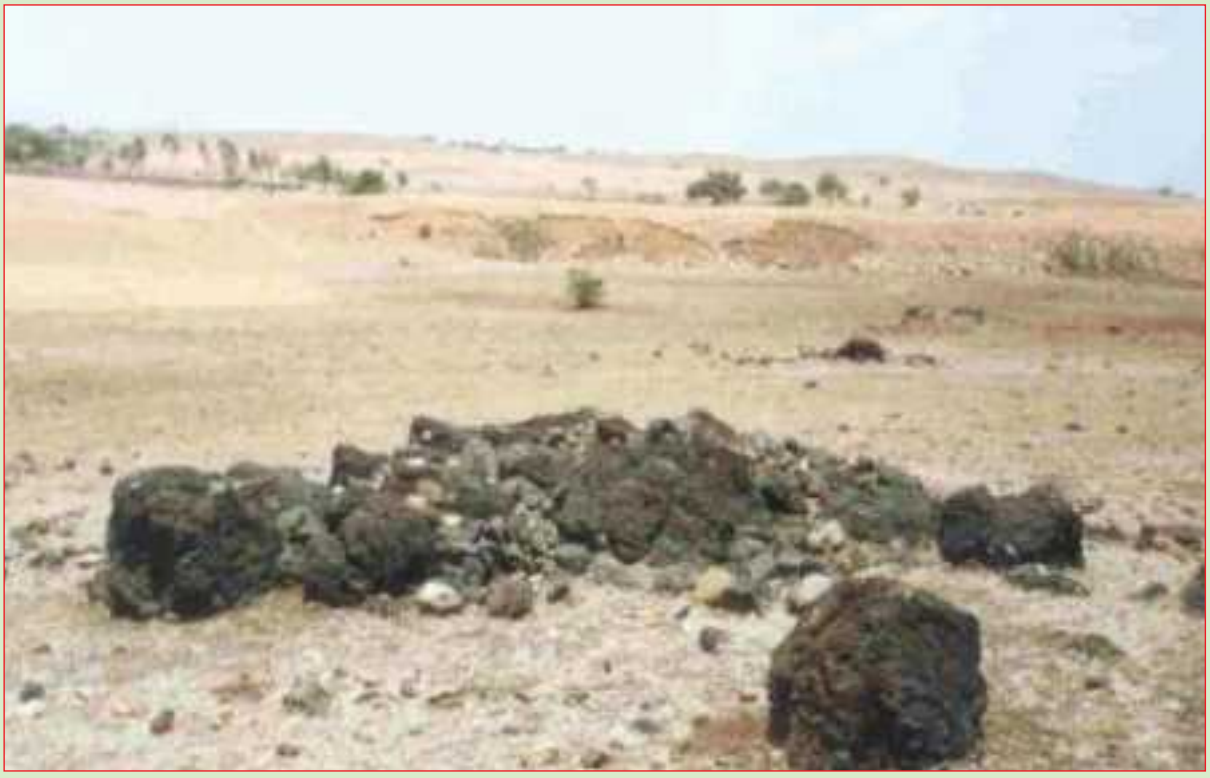
The Narayanpet Kimberlite Field (NKF) has E-W trend with 32 bodies discovered by GSI and 29 by De Beers. Of the 29 bodies, 16 are in Gurmatkal-Yadgiri area and 12 in Wadagera area between the confluence of the Bhima and Krishna rivers. Bulk sample testing by GSI of 13 kimberlite bodies from Maddur-Narayanapet-Gurmakal area did not yield any diamond whereas; the surface samples from the Wadegara kimberlites are reported to contain diamonds. The Kotakonda kimberlite body (KK-1 & KK-2) is the largest recorded so far over a length of 1.5 km and width ranging between 50 and 100 m.

Four kimberlite bodies are reported from Chagapuram and Maldakal area CGK-1, CGK-2, CGK-3 & CGK-4 which is a part of the Tungabhadra Kimberlite Field. CGK-3 is located about 2.5 km southeast of Maldakal with surface manifestation of about 650m x 200m with NW-SE longer axis, While CGK-4 kimberlite is located about one km northwest of Penchukalapadu with surface manifestation of about 150m x 100m. In Siddanapalli area located west of Gadwal in Mahabubnagar district three kimberlites, SK-1, SK-2 and SK-3 were discovered by GSI. These kimberlites are known as Siddanapalli cluster forming part of Raichur kimberlite Field.

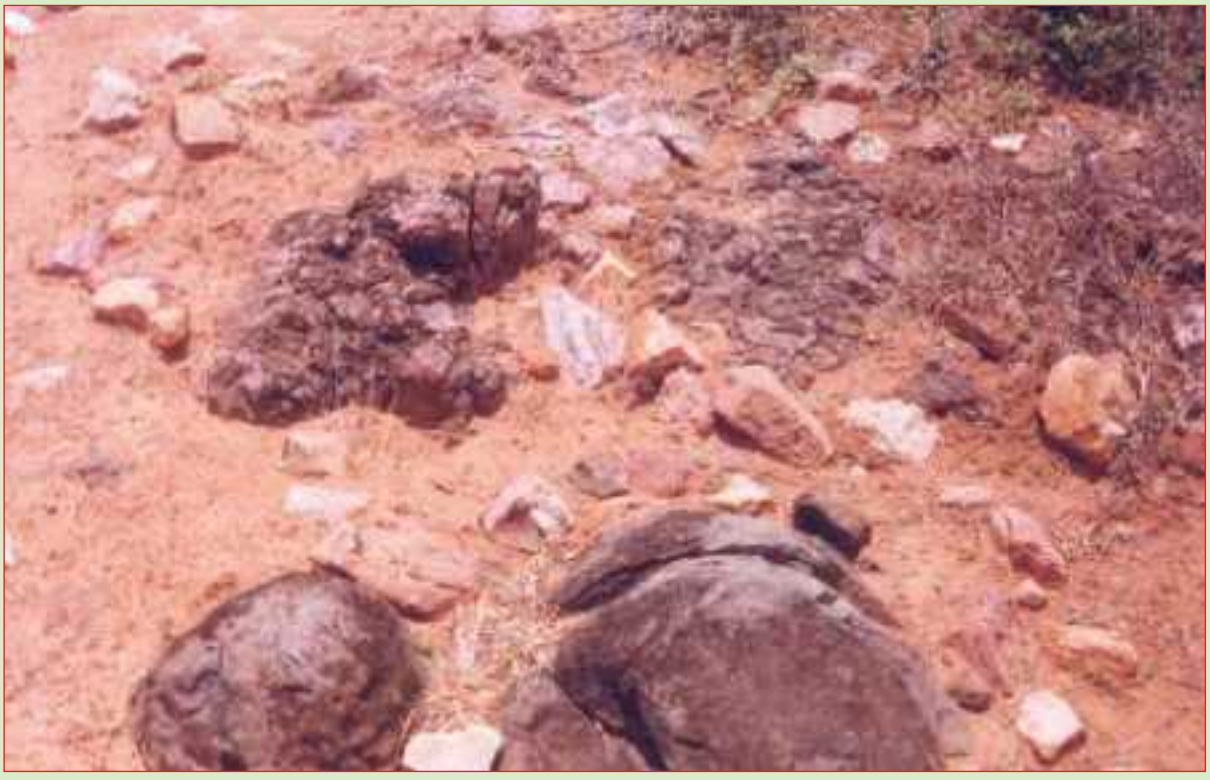
Nalgonda District

A total number of 14 thin lamproite dykes occurring in an area of 26 sq km, emplaced along NW-SE trending fractures into the granite terrain on the northern periphery of the Cuddapah Basin, have been reported to occur as two clusters around Ramadugu (11) and Somavarigudem (3). These lamproite are fine grained, compact and greenish grey in color and consists of well rounded macro crysts of olivine (carbonated and serpentinised) and phenocrysts of pyroxene and amphibole (chloritised and carbonated) set in a fine groundmass rich in carbonate, serpentine, phlogopite and perovskite.

Recently 12 lamproites are reported about 1 km west of Vattikod village and one lamproite dyke 1.5 km west of Maripalli village in Pulavayi block. In general, these lamproites are emplaced along WNW-ESE to NW-SE trending fractures and in one location are emplaced along side dolerite dyke. The lamproites vary in width from a few centimeters to several meters and extend over a length of tens of meters. Megascopically the lamproites are greenish grey to dark grey in colour; fine grained, altered and chloritized with relatively high in specific gravity than the surrounding rocks. In general these rocks are poor in xenocrystic minerals and are predominantly mica rich or mica poor. Thin section studies revealed that the mica rich lamproites are composed of phlogopite-diopside in a fine grained ground mass and the mica



Hardebanke variant of Siddanpalle kimberlite (SK-1), Mahabubnagar District, Telangana
(Photo by Dr. S. Ravi, Supdt. Geologist)



Field photograph of Ramadugu Lamproites, Nalgonda District,Telangana
(Photo by Dr. S. Ravi, Supdt. Geologist)

poor lamproite comprises leucite-diposide and phlogopite.

DIMENSION STONES

The State has immense potential for granite based dimension stone industry. The Archaean-Proterozoic gneiss-granite terrain together with dolerite dyke swarms and ultramafics, occupying more than 60% area of the state, is a veritable store-house of wide array of multicoloured rocks which are ideally suitable for use as panels, floorings, facades, table tops and in the construction of monuments and memorials. Gneisses, granites, porphyritic granites, basic dykes and gabbro, suitable as dimension stones are widely distributed.

Khammam District

Black Granite (dolerite) at Mallemadugu suitable for monuments is being mined. Paradiso variety (pink granite) and Kashmir White (leptynite) are available at Mettuguda and Ayyavarigudem.

Khammam district is also known for colourful marbles. Different varieties occurring in the district are white, grey-streak, mottled yellowish and pink found at Manditog, Pubali, Tekkaligudem and Jastaipalli. These marbles associated with the metamorphosed Gunjeda Dolomite of Pakhal Basin located close to Archaean basement are being mined locally.

Nalgonda District

A number of Black Granite (dolerite) quarries are known at several places in Kodad, Kattangur, Velligundu, Nuthanakal, Kathepaly, Nakrekal and Munnigal mandals of the district. Recovery of good size blocks is poor.

District-wise Resource position of DSG in A.P.

District	Total resources in Million Cu.m.
Khammam	0.02
Medak	2.15
Nalgonda	0.12
Total	**2.39**

Warangal District

Several commercial grade granite, black granite, pink granite and aplite, spotted sandstones occur at number of places in parts of Warangal district.

Type	Locality
Pyroxenite	Chityal 56O/10
Black granite (dolerite)	Gurtur 56 O/10
	Vippalapalli 56 O/13
	Mundrai 56 O/13
	Daulatanagar 56O/13
	Ayodhyapur 56O/13
	Surpalli 56O/11
	Nirad 56O/14
Pink granite	Aminabad 56O/13
Black granite	Kakarwad 56O/16
Spotted sandstone	Mangigad 57M/7
	Marrigudem 57M/7
	Doggigudem 57M/7
	Bhimaram 57M/8
	Dharmaraopet 57 M/8
Red clays	Sirpur Kagaznagar 57M/14
	Dharmaram 57M/14

DOLOMITE

Uses of dolomite ($MgCO_3$) are chiefly in metallurgical, refractory, steel and chemical industries. Thick dolomite bands associated with the rocks of Pakhal Supergroup are spread over large areas in the Pakhal basin. Significant deposits are found in Khammam.

Khammam District

In Madharam area, 3.50 Mt of SMS grade and 39 Mt of flux grade, were estimated up to a depth of 43.50 m. Occurrences of magnesian limestone, dolomite, limestone and magnestie are recorded between Raghunathapalem and Vemulanarava and about 88 Mt up to a depth of 6 m was inferred in this area.

White, grey streaked and mottled varieties of marble are known from Manditog, Nizampet, Jestapalle and Bethampudi areas. A reserve of about 25 Mt in Monditog area, 50 Mt in Pubali area, 12

Mt in Takalagudem, 111 Mt in Nizampet and 0.2 Mt in Jestapalle has been inferred.

FULLER'S EARTH

The soft light grey, blue or brown clay which is waxy in appearance has a soapy feel is known as fuller's earth. It is hydrous silicate of aluminium with varying amounts of magnesium, calcium, sodium and iron. Clays has a natural property of absorbing greasy matter thus finds its use in a number of industries as detergents, mineral and vegetable oil. Minor quantities are also used in making paints, soaps and refractories.

Hyderabad and Ranga Reddy Districts

Fuller's earth generally associated with infra-Trappean beds, is reported from Rudrawaram, Timsanipalli, Marepalli and Alipur. In these localities, the fuller's earth occurs as a gritty calcareous clay and the beds vary in thickness between 0.6 and 2 m. An inferred reserve of about 22.5 Mt was estimated for all these localities. Minor occurrences are also reported from Jadapalli and Godamaguda.

GEM MINERALS

Corundum

Corundum (Al_2O_3) is used mostly as an abrasive. Precious and semi-precious varieties are valued as gemstones. It occurs associated with ultrabasic or syenitic rocks in parts of Khammam district. All these occurrences are minor in nature. Besides, corundum bearing fuchsite schists are reported from Konampalle and corundum syenitic rocks from Shibavi-Hanumareddipalle. Semi-precious ruby corundum is found in ultrabasic rocks at Gobbugurti in Khammam District.

GARNET

Garnet is a group name consisting of isomorphous series of grossularite, pyrope, almandine, spessartite, andradite and uvarovite. Besides its use as an abrasive, finely powdered garnet is also used for surfacing plate glass, serpentine and marble, and also in the ornamental stone industry. Clear and transparent varieties with lustre are used as semi-precious stones. Significant concentration of garnet is found in the schist belt rocks in Khammam district.

Khammam District

Abundant garnet from garnet-kyanite mica schist is reported from Garibpet and Yellandu. Here the rocks are very friable and thus the garnet crystals can be easily separated. The crystals are deep pink, brownish red and attain a size of up to 2 cm. The total reserves estimated in the area are about 31 Mt with the garnet content in the rock varying from 11% to 19%. Porphyroblasts of garnet are also reported from hornblende granite in the southeast of Yellandu.

GLASS SAND/QUARTZ

Silica sand, normally used in manufacture of different grades of glass is generally known as glass sand. The chief specification for glass sand is the grain size which should usually be –20 mesh. Quartz veins suitable for glass industry have been reported from different parts of the state.

Hyderabad and Ranga Reddy Districts

Large reserves of quartz in the form of veins and reefs occur at Kukatpalli, Timmapur, Malayakatta, Mughalgidde, Durgi, Gadisingapur, Shamshabad and Bolaram. The quartz reefs are massive and highly jointed and are generally coated with iron oxide. They contain about 98.08% SiO_2 and 0.79% FeO. The reefs are generally a few kilometres long and 2 to 6 m thick.

Khammam District

Vein quartz suitable for use in the glass industry is reported from Tadlapalle and Gumpena. An inferred reserve of about 38 Mt was estimated from these two areas.

Mahbubnagar District

White quartz veins, suitable for glass manufacture are reported from Shadnagar, Chitampallim Elakotta, Gurugunta, Tirumalapur, Chowlapalle, Annaram and Vithal. These quartz veins, about a kilometre long and up to 90m wide, analyse 99.07% to 99.53% SiO2 and 0.072% to 0.148% FeO. A cumulative inferred reserve of about 1.0 Mt was estimated from these areas.

GOLD

Gold is a precious metal used mainly in international bullion for money transaction, making jewellery and to a lesser extent in electronic industry and medicine. The greenstone belts (Dharwar) occurring in the western part of the state bordering Karnataka host the gold mineralisation. The important greenstone belt in the state is Gadwal Schist Belt. Gold occurs as native metal or associated with the sulphides in the meta-basic and acidic volcanics, BIF, quartzite and granitoids. Ancient mining activity is evidenced at several places in the form of workings, pounding marks and crushed dupes of quartz.

Mahbubnagar District

In the NNW-SSE trending Gadwal Schist Belt, anomalous gold values with silver, arsenic and tungsten are found in pegmatites and quartz veins emplaced in metabasalt in Atkur and Dharur areas. Gold values ranging from 25 ppb to 165 ppb is reported from Patharchad & Chandragadda areas of the Gadwal Schist Belt.

GRAPHITE

Graphite is a soft crystalline form of carbon. It is used in the manufacture of crucibles, lubricants, paints, pencil lead, foundry facings, dynamos, brushes and electrodes and dry batteries. Its properties such as thermal conductivity and chemical inertness make graphite suitable in many industries. Graphite plates are also used in the nuclear reactors.

Graphite occurs as pockets, lenses, veins and disseminations more commonly with graphite schist/ gneiss and less commonly with quartzite of the Khondalite Group. Graphite associated with schists is generally amorphous whereas that associated with pegmatites and quartz veins is flaky.

Khammam District

Graphite is reported from several places in Khammam district and is generally amorphous with low fixed carbon (F.C) content.

Occurrences of graphite are reported from Ipalapadu, Sigurmamidi, Gopannaduem, Kantlum, Kavadiguntla, Gundlamadugu, Balapalle, Chintamreddipadu, Sidharam, Kunkulgoyapaka, Rachakonda, Maredupude, Ipparu, Chintakonda, Siddakaram, Mandulapad, Jidiguppa, Kaltanuru Chokkanapalle, Ravigudem and Chintakonda. Here also, graphite occurs as specks, streaks and small lenses in the garnetiferous gneiss, biotite-garnet schists and thin quartzite bands within khondalite. In general, the graphite bearing zones are lenticular and analyse 44% to 60% F.C. and 32% to 48% ash.

IRON ORE

Iron ores in the state are associated with the Dharwar and Pakhal Supergroups. Some lateritic ores of limited extent also occur associated with Gondwanas and Deccan Traps. The iron ore deposits can be classified as (1) lode or vein deposits, (2) bedded deposits, (3) detrital ore deposits and (4) lateritic deposits.The resource position obtained from the unpublished reports of GSI, is given as under.

Adilabad District

Low grade banded haematite quartzite associated with the Dharwar sediments account for about 17.41 Mt of reserve with 33.10% to 43% Fe in this district. The reserve available is 7.03 Mt at Chityal, 0.5 Mt at Kalleda, 0.38 Mt at Dustarabad and 5 Mt at Rebanapalle.

Karimnagar District

Haematite ore occurs associated with BIF of the Dharwar Supergroup. A reserve of 15 Mt of low grade ore (35% to 40% Fe) in Chandoli area and 0.67 Mt with 60% Fe in Yerrabali area was estimated.

Khammam District

The iron ore deposits occur associated with the Dharwar and Pakhal sediments. Low grade magnetite ore associated with the Dharwar iron formation occur near Utla Mathwada, Usarakapalle and Kucherla Bodu. A probable reserve of 59 Mt with 22% to 35% Fe was estimated in this area.

The haematite ore deposits associated with the Pakhals at Bayyaram were estimated to contain 11 Mt of iron ore with 54% to 65% Fe. A part of the deposit has already been exploited with remaining

resource of 24 Mt. Besides these two areas, a number of iron ore occurrences are reported from Motla Timmapuram, Irsulapuram and ErrammaGutta.

Warangal District

The Dharwar banded haematite quartzite near Yerrabali in Karimnagar District extends into Warangal district. A reserve of 6.7 Mt of iron ore with 33% to 66% Fe was estimated for this deposit. A band of haematite quartzite, associated with the Pakhal sediments near the southern end of the Pakhal tank bund was estimated to contain 0.85 Mt of low-grade ore.

KYANITE

Kyanite (Al_2O_3 SiO_2) is usually found as disseminated crystals in schist, gneiss and quartzite. It also occurs as coarsely recrystallised segregations and pockets in pegmatites and quartz veins.

On heating to around 1100^{o}C-1600^{o}C kyanite decomposes to form mullite (3 Al_2O_3 2SiO_2) which is the chief constituent of alumina-silica refractories as it is a very stable refractory and does not undergo chemical change or shrinkage upto 1800^{o}C. Kyanite is very widely used in the manufacture of refractories, spark plugs and other types of electrical porcelain products. The specifications for the refractory grade kyanite are a minimum of 54% Al_2O_3, and maximum of 15% Fe_2O_3.

Khammam District

Occurrences of kyanite are reported from Garibpeta and Kakerla. The garnet-kyanite-mica schist exposed on the hillock (1133) is a good source of kyanite, which can be easily separated as the rock is highly friable. The kyanite occurs as long bladed crystals of marine blue colour measuring upto 4 x 1 cm. The Al_2O_3 content is 65.83% while the SiO_2 is 34.17% for the samples analysed. The inferred reserves are around 48 Mt.

LIMESTONE

Limestone is the chief raw material in cement industry. It is also used as flux in metallurgical industry. High-grade limestones are used in chemical, alkaline, sugar, paper, glass and leather tanning industry.

The state is endowed with extensive deposits of limestone ranging in age from Archaean to Tertiary. Significant deposits of cement and flux grade limestones are confined to the Late Proterozoic, Putnur Limestone (Penganga Group) in the Pakhal Basin and Shahbad Formation (Sedam Sub-group) in the Bhima Basin. These formations are spread over in the districts of Mahbubnagar, Nalgonda, Adilabad, Karimnagar and Ranga Reddy. Minor deposits occur in Archaean, Gondwana and inter-trappean (Deccan Traps) formations in parts of Khammam district.

District-wise and major deposit/area-wise resources of limestone are shown in (Annexure -I).

Adilabad District

Deposits of cement grade limestone occur associated with the Penganga Group in Adilabad, Mancherial and Bellampalli. In Adilabad, cement grade limestone is located along the southern bank of the Penganga River and 32 km east and north of Adilabad town. CCI carried out detailed exploration in the area. Limestone resources available in Jamadapur, Bhimsari-Mallapur and Dantampalli have been identified. In Bellampalli, large deposits of limestone are reported in Tandur between Tolendi and Muraliguda by the DMG, Andhra Pradesh. A detailed estimate of the limestone deposits was done in Mancherial area by M/s ACC Ltd.

Flux grade limestone deposits occur in the Ara R.F. The limestone is being used by the Sirpur Paper Mills Limited.

Karimnagar District

Deposits of cement grade limestone associated with the Putnur Limestone of the Penganga Group are found in Putnur, Muknur and Narella areas. Besides, flux grade limestone is reported from Valkurti.

Mahbubnagar District

The Narji Limestone is exposed in Alampur area. CCI investigated for cement grade limestone in the area.

Nalgonda District

Flux grade and cement grade limestone deposits associated with the Narji Limestone occur in the southern parts of the district. Important areas are Wazirabad, Mahankaligudem, Raghunathapalem and Yepal Madhavaram.

Ranga Reddy District

Limestone of the Shahabad Formation is exposed in the western parts of the district. Good quality cement grade limestone is available in Tandur area. Limestone quarried from Masanpalli and Gangavaram is used in the local mini-cement plants.

MANGANESE

Pyrolusite (MnO_2), psilomelane [$MnO(OH)_2$], manganite ($Mn_2O_3H_2O$) and rhodochrosite ($MnCO_3$) are the chief minerals of manganese. Manganese is used chiefly in the manufacture of ferro-alloys, dry cells and also as a purifying agent in de-oxidising, de-sulphurising and de-carbonising steel. In addition to these, manganese is used in colouring glasses, paint, oil and varnish industry. Manganese sulphate and acetate are also used as fertilisers to some extent.

The manganese occurrences in the state are associated mainly with the Penganga Group in the Pakhal Basin. Economically significant deposits are found in Adilabad district. Several minor occurrences of manganese ore are known from other districts also which includes occurrence of low grade ores near Ratampet and Kandali in Nizamabad district.

Adilabad District

Manganese ore occurs as thin lenses in association with chert and jasper of the Penganga Group of sediments at Jamadpur, Goatkuri-Guda, Pitasikunta, Gaulishat, Tamsi, Jamdapur, Metguda-Kumpa. A total reserve of about 1.85 Mt (as on 2010) with manganese content of around 25%-40% is estimated for all these areas taken together. The phosphorous content of the ore is generally low (<0.06%).

District-wise and major deposit/area-wise resources of limestone

District	Location	Resources (million tonnes)		Grade
		Proved/Indicated	Inferred	
Adilabad	Jamadapur	10.62	-	Cement
	Bhimsari	35.56	-	-do-
	Dantampalli	5.40	-	-do-
	Bellampalli	-	3400	-do-
	Mancherial	25.00	600	-do-
	Ara	-	50	flux
Karimnagar	Putnur	-	87	-do-
	Narella	-	157	-do-
Mahabubnagar	Alampur	46	-	Cement
	Kasturapalle	-	5	-do-
Nalgonda	Wazirabad	-	2700	-do-
	Mahankaligudedm	-	108	-do-
	Raghunathapalem	-	11	Flux
	Yepal Madhavaram	-	119	-do-
Ranga Reddy	Tandur	154	-	Cement
	Kasturapalle	-	5.27	-do-

Minor occurrences are reported from Prakasam, Nizamabad, Cuddapah and Kurnool.

MICA

It is a complex silicate of potassium, aluminium and magnesium with minor quantities of lithium, vanadium and chromium. The common varieties of mica are muscovite, biotite, phlogopite, lepidolite, zinnwaldite and vermiculite. However, muscovite and to some extent phlogopite and vermiculite only find use in industry. In commercial terminology mica denotes only muscovite.

Muscovite finds its use in making of a variety of appliances like condensers, dynamos, motors, telephones, spark plugs, radio valves, insulators, stove windows, screens, protective spectacles, fire proof paints, boiler laggings, decorative tiles and wallpaper. However, the discovery of synthetic mica resulted in progressive decline of the mica industry, world over.

Karimnagar District

Muscovite bearing pegmatites traversing the granitic rocks carry mica books upto 20 cm across and are known from Desaipeta, Vagulapuram and Lingampet.

Khammam District

Occurrences of mica are observed in pegmatites traversing mica schists of the Khammam Schist Belt and hornblende gneiss near Gosavidu, Kannuru, Vavilala and Kallum and other localities in Yellandu and Madhira taluks.

MINERAL PIGMENTS

Mineral pigments are derived chiefly from ocherous substances and find wide application in paint, plaster, mortar cement, linoleum, rubber and other industries. Besides, yellow and red ochres, other materials like haematite and magnetite are also commercially used as pigments.

Adilabad District

The ferruginous clay bands containing dispersed haematite are used locally as pigments. Mining of ochres in small quantities is reported from Zazurlagutta.

Ranga Reddy District

Red and yellow ochre deposits occur in Pirampalli, Timmareddipalli, Ekamamidi Plulnadi, Komapalli, Arkatala and Yelachal within the Deccan Trap country. A reserve of about 50,000 tonne of red ochre and 10,000 tonne of yellow ochre were assessed for all the above areas.

MOLYBDENITE

Molybdenite (MoS_2), the most important ore of molybdenum, is used in making special steels, electrical industry and in manufacture of certain inks and glazes. It occurs as disseminations in pegmatites and quartz veins and as stringers and segregations at the contact of pegmatite and granite.

Karimnagar District

Molybdenite is reported from pegmatites and as stringers is granite in a 39 km long and 13 km wide belt extending from Antakpet to Machapuram. It has been reported from Kundenpalli, Basavapur, Maijampalli, Kochanapalli and Mustalpur. Polymetallic molybdenum sulphide mineralisation is also reported from Yellamala.

Medak District

Molybdenum mineralisation of Karimnagar District extends into Medak District and is reported from Nalgonda, Elgandal and Sunigram and also from Katkaur. A total reserve of 1.16 Mt was estimated for the two districts (by IBM).

URANIUM

Uranium is used in the atomic and nuclear plants. The chief ore of uranium is uraninite (pitchblende) which is an oxide of uranium (U_3O_8). Uranium mineralisation is reported from Granites of the Peninsular Gneissic Complex in Nalgonda district.

Radioactive mineralisation of U-Th has been reported for the first time from this district by the Atomic Minerals Division.

Nalgonda District

Significant concentration of uranium (upto 0.55 U_3O_8) was reported by AMD in the Granites of the PGC in Lambapur-Chitrial area, Nalgonda district.

ANNEXURE – I
MAJOR MINERAL OCCURRENCES / DEPOSITS

Mineral	District	Location	Geological Setup	Grade	Reserve	District wise resources as on 01.04.2010 (By IBM)	Remarks
Baryte	Khammam	Rudramakota (17° 15' : 80° 12')- Gopalpur (17° 15' : 80° 12') - Pocharam (17° 29' : 80° 13') area	Baryte occurs as lenses, stringers or veins and mostly confined to Pakhal sediments. A no. of occurrences are seen.	Massive type baryte veins 300 x 6 m.	Cumulative reserve is 1.8 Mt upto a depth of 15 m.	2.69 Mt	
Chromite	Khammam	Jonnaram (17° 18' : 80° 24'), Sriramgiri (17° 20' : 80° 24'), Konayyapalem (17° 18' : 80° 19'), Lingannapeta (17° 20' : 80° 21')	Chromite occurs as pockets/ lenses in altered pyroxenites or ultramafites as a number of occurrences.	Sriramgiri has substantial reserves. Jannaram, Lingannapeta, Konayyapalem area has 26.28 – 47 % $Cr_2 O_3$.	——	186,000 tonnes	Intermittant exploitation by private companies.
Clays	Adilabad	Pachagaon (19° 18' : 79° 29')		$Al_2 O_3$, 22 – 25%, Alkalies 2%, FeO 1.17 to 2.80 %	240,000 tonnes	8.96 Mt	Pottery clays
	Rangareddy	Vikarabad (17° 20' : 77° 49') - Rudravaram (17 22;77 39) area	Derived from Deccan basalt and granites	Low grade	About 22 Mt	0.65 Mt	Pottery porcelain type. China clay
Coal	Adilabad	Golet (19° 14': 79° 22'), Bellampalli (19° 02' : 79° 29'), Chinnur (18° 51' : 79° 48') sector.	Coal bearing Gondwana formations.		Total-1176 Mt.Proved 517 Mt Probable 659 Mt.		

	Karimnagar	Ramagundam (18° 46': 79° 27').	- do -		Total-682 Mt Proved 621 Mt, Probable 61 Mt.		
	Khammam	Yellandu (17° 48' : 80° 41'), Kottagudem (17° 32' : 80° 38'), Manuguru (17° 57' : 80° 50'), Sattupalli (17° 13' : 80° 48').	- do -		Proved 4956 MtProbable 1620 Mt Possible 4020 Mt.Total reserves upto 1200m depth-10,596 Mt (as on 2006)		—
	Warangal	Chilpur (18° 25' : 79° 54'), Lingala (18° 22' : 79° 41'), Oasra (18° 12' : 80° 10')	- do -		1881 Mt Proved 28 Mt Probable 1853 Mt		—
Base metals	Khammam	Mailaram (17° 43' : 80° 37'), Venkatapuram (17° 45' : 80° 46')	Copper mineralisation associated with quartz chlorite schist (Sargur) and quartzite-dolomite interbands in the phyllites (of Pakhal) Supergrpoups.	Mailaram-mineralised zone is 1.10 km long.upto 250 m depth	Probable 0.81 Mt. Possible 120.70 Mt	0.66 Mt	Developed by APMDC
Diamond	Mahabub-nagar, Gulbarga (Karnataka)	Narayanpet (16° 45' : 77° 30'), Maddur (16° 51' : 77° 36' 40"), Kotakonda (16° 45' 25" : 77° 39' 10")	Kimberlites occur as dykes and pipes emplaced into granites and gneisses.	33 kimberlite bodies in 60 x 25 km area (7 in Karnataka area)			—

Dolomite	Khammam	Madharam (17° 31' : 80° 14'), Raghunatha-palem (17° 18' : 80° 12'), Vemulanarva (16° 59': 80° 17').	Dolomites associated with Pakhal Group of sediments.	SMS grade 3.5 Mt; Flux grade 39 Mt upto 44 m depth; 88 Mt upto 6 m depth.	—	181.85 Mt	
Iron ore	Adilabad	Chittial (19° 04' : 78° 48'), Rebanapalle (18° 57' : 79° 07')	Magnetite associated with Dharwar sediments	17.41 Mt – 33.1 – 43% Fe			
	Khammam	Utla Matruda (17° 45' : 80° 02'), Bayyaram (17° 35' : 80° 06')	Magnetite is associated with Dharwars; Haematite with Pakhals	59 Mt ; 22-35% Fe 11 Mt ; 54-65% Fe		25.94 Mt	
Limestone	Adilabad	Bellampalli (19° 02' : 79° 29') area Ara Reserve Forest	Penganga Group	3,400 Mt inferred (cement grade) 50 Mt anticipated (flux grade)		873.16 Mt	
	Karimnagar	Putnur	Penganga Group	87 Mt - inferred (cement grade) 150 Mt - possible (cement grade)		26.35 Mt	

ANNEXURE – II
MINOR OCCURRENCES OF MINERALS / DEPOSITS

S.No.	Mineral	Location	Coordinates	Remarks
1	Asbestos	**Mahabubnagar district**		Chrysotile
		Somasila	16°02':78°20'	asbestos
2	Barytes	**Mahabubnagar district**		Occurs as fissures
		Bolaram	16°04':78°26'	filling in the biotite chlorite schist
3	Clays	**Hyderabad & Ranga Reddy districts**		White clays
		Rudravaram	17°22':77°39'	
		Timsanipalle	17°21':77°39'	
		Marepalli	17°20':77°42'	
		Alipur	17°19':77°48'	
		Vikarabad	17°20':77°49'	
4	Corundum	**Khammam district**		
		Yerracheruvupalle	17°24':79°02'	Associated with mica schists
		Polichettipalli	17°29':79°02'	-do-
		Gubbagurti	17°17':80°22'	Semiprecious variety
		Kunavaram	17°34':80°15'	-do-
		Rangapur	17°26':81°10'	-do-
		Nalgonda district		
		Peddagudem	16°46':79°16'	
		Timmapur	16°48':79°16'	
		Lingampalli	17°51':78°56'	
5	Diamond	**Mahabubnagar district**		
		Bolaram	16°04':78°26'	Krishna gravels
		Ammaragiri	16°03':78°23'	
		Somsila	16°02':78°20'	
		Maddimadugu	16°18':79°08'	
6	Feldspar	**Khammam district**		
		Raghavapuram	17°27':80°35'	

		Mahabunagar district		
		Basanapalle	16°48':78°38'	
		Kotakonda	16°45':77°39'	
		Charakonda	16°42':78°45'	
		Achampeta	16°19':78°50'	
		Kalvakurti	16°40':78°29'	
		Nalgonda district		
		Nindamanur	16°49':79°22'	
		Damaracherla	17°36':81°04'	
		Devarakonda	17°42':78°55'	
7	Glass sand / Quartz	**Medak district**		
		Andole	17°47':78°04'	
		Papannapet	18°02':78°05'	
		Narsapur	17°44':78°17'	
		Sadashivpet	17°03':77°37'	
		Sangareddi	17°38':78°05'	

LOCALITY INDEX

Locality	Latitude	Longitude	T.S.No.	District
Alipur	18 14 00	78 56 00	56J/16	RangaReddy
Annaram	18 54 00	79 56 00	56N/3	Mahbubnagar
Aspaka	17 23 30	81 06 40	65G/3	Khammam
Bacharam	17 18 40	77 49 00	56G/15	RangaReddy
Basavapur	18 07 00	79 04 00	56N/4	Karimnagar
Bayyaram	17 35 00	80 06 00	65C/2	Khammam
Bellampalli	19 02 00	79 29 00	56M/8	Adilabad
Bethampudi	17 34 00	80 27 00	65C/6	Khammam
Bhadrachalam	17 07 00	80 09 00	65C/4	Khammam
Bhiknur	18 10 00	78 02 35	56J/4	Nizamabad
Bhudaram	18 55 00	79 43 00	56N/9	Adilabad
Bolaram	17 18 10	77 41 00	56G/12	RangaReddy
Chagapuram	16 02 03	77 50 40	56 H/16	Mahbubnagar
Chanda	19 43 00	78 33 00	56 I/10	Adilabad
Chandoli	15 24 35	77 36 00	57E/7	Karimnagar
Chelpur	18 25 00	79 54 00	56N/15	Warangal
Cherla	17 31 00	80 17 00	65C/6	Khammam
Cherlapalli	18 46 30	79 09 10	56N/1	Karimnagar
Cheruvupuram	17 31 00	80 10 00	65C/NW	Khammam
Chimalpad	17 27 00	80 25 00	65C/7	Khammam
Chinnur	18 51 00	79 48 00	56N/13	Adilabad
Chintakonda	17 19 00	81 21 00	65G/7	Khammam
Chityal	19 04 00	78 48 00	56I/16	Adilabad
Dameracherla	17 36 30	81 04 00	56P/9	Nalgonda
Dendukur	16 53 10	80 24 10	65D/5	Khammam
Desaipeta	18 42 30	78 45 30	56J/14	Karimnagar
Devarakonda	16 42 30	78 55 30	56L/14	Nalgonda
Dharwar	19 26 00	79 08 00	56M/3	Adilabad
Dustarabad	19 05 00	78 52 00	56I/16	Adilabad
Elgandal	18 26 00	79 03 00	56N/3	Karimnagar
Gangapur	19 16 00	79 16 00	56M/7	Adilabad
Garibpet	17 29 00	80 39 00	57M/5	Khammam
Gaulghat	19 48 00	78 27 00	56I/5	Adilabad
Goatkuri-Guda	19 44 00	78 30 00	56I/6	Adilabad
Godamaguda	17 17 00	77 52 00	56G/15	RangaReddy

Godkel	18 32 16	78 25 45	56J/6	Nizamabad
Golet	19 14 00	79 22 00	56M/8	Adilabad
Gopalpur	17 15 00	80 12 00	65C/SW	Khammam
Gosavidu	16 56 00	80 29 00	65D/5	Khammam
Govindaraopeta	18 12 00	80 08 00	65B/4	Warangal
Gundlamadugu	17 25 05	81 17 00	65G/3	Khammam
Gurmatkal	16 47 30	77 23 30	56H/5	Mahbubnagar
Imamnagaram	17 21 40	80 27 30	65C/7	Khammam
Indaram	18 49 00	79 32 00	56N/9	Adilabad
Jadapalli	17 17 00	77 51 00	56G/15	RangaReddy
Jamatpur	19 46 00	78 29 00	56I/5	Adilabad
Jamdapur	19 43 00	78 32 00	56I/10	Adilabad
Jannaram	17 18 00	80 24 00	65C/7	Khammam
Jestapalle	17 24 00	80 16 00	67G/7	Khammam
Jidiguppa	17 30 00	81 21 00	65G/6	Khammam
Kallerala	19 20 00	79 30 00	56M/7	Adilabad
Kalluru	17 52 00	80 33 00	65C/9	Khammam
Kalthanuru Chokkampalle	17 29 30	81 17 30	65G/7	Khammam
Kamareddi	18 25 00	78 22 00	56J/7	Nizamabad
Kannuru	17 00 00	80 34 00	65C/12	Khammam
Kantlam	17 20 30	81 16 00	65G/7	Khammam
Katkaur	18 03 00	79 14 00	56N/4	Karimnagar
Kavadiguntla	17 22 15	81 15 50	65G/7	Khammam
Khammam	17 02 00	80 01 00	65C/4	Khammam
Kochanapalli	18 07 00	79 10 00	56N/4	Karimnagar
Kodamur	17 11 00	80 13 00	65C/SW	Khammam
Komavaram	18 43 00	80 02 00	65B/2	Karimnagar
Komasamudram	18 44 00	78 31 00	56J/10	Nizamabad
Kompalli	17 30 00	78 25 00	56K/6	RangaReddy
Konayyapalem	17 17 00	80 19 00	65C/7	Khammam
Kondapalle	16 37 00	80 36 00	56H/15	Mahbubnagar
Kondapur	18 20 45	78 40 37	56J/11	Nizamabad
Kota	18 55 00	79 59 00	56N/13	Adilabad
Kotakonda	16 45 25	77 39 10	56H/9	Mahbubnagar
Kothagudem	17 32 00	80 38 00	65C/10	Khammam
Koyagudem	17 35 14	80 30 26	56N/16	Khammam
Kukatpalli	17 29 00	78 27 00	56K/7	RangaReddy

Kukkalagudur	18 46 30	79 18 40	56N/5	Karimnagar
Kundanapalli	18 02 00	79 10 00	56N/4	Karimnagar
Kunkulgoyapaka	17 26 50	81 20 00	65G/7	Khammam
Kuntala	17 35 00	80 20 28	65C/6	Khammam
Kuprayal	18 22 00	78 21 30	65J/7	Nizamabad
Lakshmipuram	17 05 00	80 16 00	65C/SW	Khammam
Lingala	18 22 00	79 41 00	56N/11	Warangal
Lingampalli	17 51 00	78 56 00	56K/13	Nalgonda
Lingampet	18 35 00	78 29 30	56J/6	Nizamabad
Lingannapeta	17 20 00	80 21 00	65C/7	Khammam
Machapuram	18 17 00	78 54 00	56J/15	Karimnagar
Madaram	18 35 00	80 00 15	65B/2	Khammam
Madhira	16 55 00	80 22 00	65D/5	Khammam
Maijampalle	18 08 00	79 08 00	56N/4	Karimnagar
Mailaram	17 43 00	80 37 00	65C/10	Khammam
Manditog	17 38 00	80 20 00	65C/6	Khammam
Muknur	17 43 00	81 23 00	65G/6	Karimnagar
Osra	18 12 00	80 10 00	65B/4	Warangal
Pachagaon	19 18 00	79 29 00	56M/7	Adilabad
Pengadapa	17 28 00	80 40 00	65C/11	Khammam
Pocharam	17 29 00	80 13 00	65C/3	Khammam
Pubali	17 37 30	80 57 00	65C/6	Khammam
Raghunathapalem	17 18 00	80 12 00	65C/SW	Nalgonda
Ramagundam	18 46 00	79 27 00	56N/5	Karimnagar
Ravigudam	17 38 30	81 17 30	65G/6	Khammam
Rudravaram	15 45 00	78 05 30	57I/1	RangaReddy
Sattupalli	17 13 00	80 48 00	65C/16	Khammam
Sidharam	17 28 00	81 20 40	65G/7	Khammam
Sigurumamidi	17 29 00	81 18 30	65G/7	Khammam
Sriramgiri	17 20 00	80 24 00	65C/7	Khammam
Wazirabad	16 41 30	79 39 45	56P/10	Nalgonda
Yellandu	18 48 00	79 41 00	56N/9	Adilabad
Yerraballi	16 45 30	79 21 45	56P/5	Nalgonda

REFERENCES

AJIT KUMAR REDDY, T., SRIDHAR. M., RAVI.S, CHAKRAVARTHI,V. and BALACHANDRUDU, V., 2001. Report on the search for kimberlites/ lamproites in parts of Krishna, Khammam and Nalgonda Districts, Andhra Pradesh. (GSI unpublished progress report 1999-2000 & 2000-2001).

AIJAZ AKHTAR, R., MEHROTRA, 1988-89. Geology in parts of Warangal and Nalgonda Districts of Andhra Pradesh.(GSI unpublished progress report).

ANANTHARAMAN, S., SARMA DAS, D.C., and VENUGOPAL RAO, CH., 1997. Report on the Palaeontological Studies for the search of Micromammals in the Infra and Intertrappean Horizons of Andhra Pradesh. (GSI unpublished progress report 1993-94, 1994-95).

ANANTHARAMAN, S., and SARMA DAS, D.C., 1999. Report on the Palaeontological Studies for the search of Micromammals in the Infra and Intertrappean Horizons of Andhra Pradesh.(GSI unpublished progress report 1996-97).

ANANTHARAMAN, S., and SARMA DAS, D.C., 1998. Report on the Palaeontological Studies for the search of Micromammals in the Infra and Intertrappean Horizons of Andhra Pradesh.(GSI unpublished progress report 1995-96).

ANANTHARAMAN, S., 2004. Descriptive Palaeontological Studies of Micromammals in the Infra and Intertrappean Horizons of Andhra Pradesh. (GSI unpublished progress report 2002-03).

ANHAEUSSER, C.R., MASON, R., VILJOEN, M.J. and VILJOEN, R.P., 1969. A Reappraisal of some aspects of Precambrian Shield Geology, Bull.Geol.Soc.Amer. Vol.80 pp. 2175-200.

ANIL KUMAR, 1993. Rb-Sr. ages of Proterozoic kimberlites of India, evidence for contemporaneous emplacement. Precambrian Research, 227-237.

APPAVADHANULU, K., 1961-62. Report on the occurrence of garnet and kyanite near Garibpet, Khammam District, (GSI unpublished progress report).

APPAVADHANULU, K. and SUBRAHMANYAM, P., 1961-70 Final report of the detailed investigation for Copper ore in the Mailaram Copper Belt, Khammam district, A.P.

BASU, A.R. and TATSUMATO, M., 1979. Samarium-neodymium systematics in kimberlites and in the minerals of garnet lherzolite inclusions. Science. V.205, pp. 398-401.

BHATTACHARYA S.K., 1975. Stratigraphic and structural investigations of the Gadwal Schist Belt in Veldurti-Kurnool-Gadwal section in Kurnool and Mahbubnagar district, A.P., Misc. Publ., Geol. Surv. India, No.23, part 1, pp. 105-113.

BHATTACHARYA, S.K., 1977. Systematic geological mapping of Gadwal Schist Belt in Kurnool and Mahbubnagar districts, A.P. (GSI unpublished progress report. Composite report for F.S. 1969-71 and 1972-75).

BRUCE FOOTE, R., 1876. Note on the Geology of Parts of Bellary-Anantapur and Kurnool districts, Rec.GSI, Vol. pp.2

BURKE KEVIN. and DEWEY.J.F., 1973. Plume generated Triple Junctions: Key indicators in applying plate Tectonics to old rocks, Jour.Geo.Vol.81, pp.406-433.

CHALAPATI RAO., 1996. New Proterozoic K-Ar ages for some kimberlites and lamproites from the Cuddapah Basin and Dharwar Craton, South India. Evidence for non-contemporaneous emplacement. Precambrian Res, 79 (1996), pp. 363-369

CHOWDHURI, A., 1970. Precambrian Stromatolites in the Pranhita Godavari Valley, (South India), Pal. Geogra. Pal. Clim. Pal. Eco, V. 7, pp.309-340

CRAWFORD, A.R. and COMPOSTON, W., 1973. The age of Cuddapah and Kurnool Systems-South India. Jour. Geol. Soc. Australia. 19 (4) pp. 453- 464

DASH, C.R., and JAMWAL, C.S., 1986. Systematic Geological Mapping in parts of Medak and Nizamabad districts, Andhra Pradesh. (GSI unpublished progress report).

DASH, C.R., and THIRUVENGADAM, 1987. Systematic Geological Mapping in parts of Nizamabad district, Andhra Pradesh. (GSI unpublished progress report).

DAVID, J.S., SRIHARI, J., BASHA, S.M.J., BALACHANDRUDU, V. and NARAHARI, S.T., 1997- 98. Report on Specialised Thematic Mapping in Eastern Ghat Mobile belt, on the southern bank of Godavari River in parts of West Godavari and Khammam Districts, A.P. (GSI unpublished progress report).

DESHPANDE, M.L., 1970. Report on the diamond investigation in Krishna gravel areas and reconnaissance work in Srisailam and Pennar River. (GSI unpublished progress report).

DEEKSHITULU, M.N., 1959-60. Geology and coal reserves of Kothagudem, Tandur and Mulug areas in Godavari Valley Coal Field, Khammam, Adilabad, Karimnagar and Warangal districts, (GSI unpublished progress report).

DEEKSHITULU, M.N., 1961-62. Geology and Coal reserves of Kothagudem Tandur, and Mulug areas in Godavari valley Coal Field, Khammam, Adilabad, Karimnagar and Warangal District. (GSI unpublished progress report).

DEEKSHITULU, M.N., 1961-62. Geology of the Chilpur (Warangal district), Chinnur (Adilabad dist) and Pellajara (Karimnagar dist), Godavari valley Coal Field. (GSI unpublished progress report).

DURGA RAO, CH. and GOPAL REDDY, T., Specialised thematic mapping of granite – granulite terrain in Karimnagar District, Andhra Pradesh. (GSI unpublished progress report 2006-07).

FERMOR, L.L, 1936. An Attempt on the correlation of ancient schistose formations of Peninsular India, Mem.Geol.Mem.Geol.Surv.India, 70(1): 1-52; 70(2); 53-218.

GOPAL REDDY, T., and RAO, N.V., 1988-90. Geological study of granitoids in western part of Mahabunagar district, Andhra Pradesh. Report on Granite Project, part – A (GSI unpublished progress report).

GOPAL REDDY,T. and VISWANATHA RAO, N., 1990-91: Study of granites and related rocks in the southern part of Gadwal-Raichur Greenstone belts in parts of Mahabubnagar, Kurnool, Raichur districts, Andhra Pradesh and Karnataka. (GSI unpublished progress report).

GOVINDA RAO., M. SATHYANARAYANA, S.V., RAO, K.R.P., SIVAJI, K. and NAYAK, S.S., 1992. Diamond resources in Andhra Pradesh and their Potential- A Review. Workshop on Minerals and Mineral Based Industries in A.P.

HAMZAH ALI, 1951-52 and 1952-53. Report on Karimnagar district, Hyderabad State. (Hyderabad State Geological Survey report).

JOGA RAO, M., 1992. "Utilization of Clay in Andhra Pradesh". Workshop on Minerals and Mineral Based Industries in A.P.

KAILA, K L., ROY CHOWDHURY, K., REDDY, P R., KRISHNA VG., et. al. 1979. Continental Structure along Kavali-Udipi Profile in Indian peninsular Shield from deep Seismic sounding, Jour.Geol.Soc.India V.20, 11-307:33

KAZIMI S.M.K., Preliminary investigation for Gold and other associated elements in Ghanpur schist belt, Warangal District, Andhra Pradesh (P-I Stage). (GSI unpublished progress report 2007-08 & 2008-09).

KHURSHID MIRZHA, 1943. A brief outline of the Geological History of Hyderabad State with special reference to its mineral resources. Hyd. Geol. Survey, Bull. 2 pp. 69.

KING, W., 1872. Kadapah and Kurnool Formations, Mem. Geol. Surv. India. pp. 1-320.

KING, W., 1881. The geology of the Pranhita – Godavari valley. Mem. Geol. Surv. India. Vol. 18, 151-311

KITTU, N., 1967-68. Molybdenite investigation in parts of Karimnagar district. (GSI unpublished progress report).

LAKSHMINARAYANA, G., and BURHANUDDIN, MD., 1985-86. Systematic geological mapping of the Gondwana formations of Chandrugonda – Mulakalapalle – Amaravaram area, Godavari valley, Khammam district, Andhra Pradesh.

LAXMA REDDY, M., Preliminary investigation for Gold and other associated elements in the area North of Krishna River, Gadwal Schist belt, Mahaboobnagar and Kurnool Districts, Andhra Pradesh (P-I Stage). (GSI unpublished progress report 2009-10).

LAXMA REDDY.M. and CHARYULU, D.N., Preliminary investigation for Gold and other associated elements in the area North of Krishna River, Gadwal Schist belt, Mahaboobnagar, Andhra Pradesh (P-I Stage). (GSI unpublished progress report 2008-09).

MAHENDER REDDY, K ., RAHMATULLAH KHAN, 1988-89. Geology of the area around Narsampet and Warangal in Warangal district,Andhra Pradesh (GSI unpublished progress report)

MUKHERJEE, S.K., 1931. Geology of Western Portion of Mahabubnagar district, Jour.of Hyderabad Geology Survey, Vol.2

MUKHERJEE, S.K., Krishnamurthy, I.S., Mahadevan, C., 1936. Geology of Eastern Portion of Raichur with special reference to Granodiorite face of Dharwar Series of Rocks, Jour.of Hyderabad Geology Survey, Vol.2

MISCELLANEOUS PUBLICATION OF ANDHRA PRADESH (Undivided State) No.30, Part VIII Geological Survey of India (I edition – 1975; II edition – 2006)

MURALIDHARA RAO, K. and RAVINDRANATH, K., 1980. System Geological Mapping in parts of Mahabubnagar, Andhra Pradesh. (GSI unpublished progress report).

MUTHU, V.T., 1987-88. Report on the preliminary surveys for tin-tungsten, mineralisation in parts of East Godavari and Khammam districts, Andhra Pradesh. (GSI unpublished progress report).

MUTHU, V.T., 1988-89. Preliminary surveys for tin-tungsten mineralisation in parts of East Godavari, West Godavari, Khammam and Visakhapatnam districts, Andhra Pradesh.

NAGARAJA RAO, et. al. 1979. Geological and Mineralogical Map of Cuddapah Basin, 1,250,000 scale.

NAGARAJA RAO, B.K., RAJURKAR, S.T., RAMALINGASWAMY, G. and RAVINDRA BABU, B., 1987. Stratigraphy, Structure and Evolution of the Cuddapah Basin. Purana Basins of Peninsular India, Mem. 6, Geol. Soc. India. Bangalore, pp. 33-86.

NAGESWARA RAO, C., 1964-65. Investigation for flux grade limestone near Valkurti in Karimnagar district. (GSI unpublished progress report).

NARAYAN RAO, C., 1960-61. Exploration of the Angarajupalle Outliers of the Upper Gondwanas, Adilabad district. (GSI unpublished progress report).

NARAYANASWAMY, S., 1966. Tectonics of the Cuddapah Basin. Jour. Geol. Soc. India V. 7 pp. 33-50.

NARAYANASWAMY, S., 1975. Proposal for a charnockite-khondalite system in the Archaean shield of Peninsular India. Gol. Surv. Ind. Misc. Pub. Vol.23, pp. 1-16.

NARSIMHA RAO, CH. and KITTU, N., 1965-66. Investigation for Molybdenite in Karimnagar and Medak districts. (GSI unpublished progress report).

NATH, T.T., 2005. Report on Pal.Study of Vertebrate Fossil bearing Triassic and Jurassic Formations of parts of Pranhita-Godavari Valley, Andhra Pradesh. (GSI unpublished progress report 2002-03).

NATH, T.T., 2010. Report on the Early Jurassic Evolution of Vertebrates during the Upper Gondwana Period in the Pranhita-Godavari Valley, Andhra Pradesh (under the aegis of IGCP-506) (GSI unpublished progress report 2007-08 & 2008-09).

NATH, T.T., and SITARAMAIAH.Y., Interim Report on the Early Jurassic Evolution of Vertebrates during the Upper Gondwana Period in the Pranhita-Godavari Valley, Andhra Pradesh, (under the aegis of IGCP-506)- (GSI unpublished progress report 2007-08).

PAI.P.R., and ANANTHARAMAN.S., 1999. Report on the Laboratory Study Inter and Infratrappean Ostracodes and Charophytes of Andhra Pradesh. (GSI unpublished progress report 1997-98).

PATEL, S.N., Corridor mapping of the exposed canal sections in Mahaboobnagar, Warangal, Khammam, East Godavari and Srikakuklam Districts, Andhra Pradesh. (GSI unpublished progress report 2006-07).

PAUL, D.K., 1974. Isotopic Composition of Strontium in Indian Kimberlites Geochem. cosmochem. Acta, 43 PP. 389-394.

PRATAP REDDY, G. and RAMANAIDU., 1986-87. Systematic Geological Mapping in parts of Nizamabad and Karim Nagar districts, Andhra Pradesh. (GSI unpublished progress report).

RAGHUPRASAD RAO, K., BHASKAR RAO, K.S. and SATYANARAYANA, S.V., 1988-90. Assessment of diamond resources in known primary and secondary sources and search for hidden kimberlites in Andhra Pradesh. (GSI unpublished progress report).

RAGHUPRASAD RAO, K. and BHASKAR RAO, K.S., 1993-94. Report on the testing of the diamondiferous nature of Kotakonda kimberlite body, Mahbubnagar district. (GSI unpublished progress report).

RAJA RAO, C.S., 1982. Coal Resosurces of Tamil Nadu, Andhra Pradesh, Orissa and Maharashtra. Bull. Geol. Surv. Ind. Series-A, No. 45, Coal Fields of India, Vol. II.

RAJARAMAN, S. and DESHPANDE, M.L., 1976-68. Report on the preliminary investigation for diamonds in the Banganapalle Conglomerate and Thungabhadra-Krishna gravels in parts of Kurnool and Mahbubnagar districts. (GSI unpublished progress report).

RAJESHAM, T., BHASKARA RAO, Y.J. and MURTI, K.S., 1993. The Karimnagar granulite terrain – A new sapphirine bearing granulite province, South India. Jour. Geol. Soc. India, Vol.4 pp. 51-59.

RAJU, V.R., VIJAY KUMAR. and PRASAD, G.V.R. 1992. Geological and Mining aspects of limestone" Workshop on Minerals and Mineral Based Industries in Andhra Pradesh.

RAMAKRISHNAN, M., NANDA, J.K., and AUGUSTINE, P.F., 1994. Geological Evolution of the Eastern Ghats Mobile Belt, Workshop on Eastern Ghats Mobile Belt, Visakhapatnam, India, pp.3.

RAMAKRISHNAN, M., NANDA, J.K. and AUGUSTINE, P.F., 1998. Geological Evolution of the Proterozoic Eastern Ghats Mobile Belt. Geol. Surv. Sp. Pub. No.44, pp.1-21.

RAVI S., Search for kimberlites in Buthpur and Achampet block in Mahabubnagar District, Andhra Pradesh (P-I Stage). (GSI unpublished progress report 2008-09).

RAVI S., REDDY N.S., RAMAMURTHY, V. and SRINIVAS S., Detailed search fo kimberlites in Chagapuram sub-block in Mahabubnagar and Kurnool Districts, Andhra Pradesh (E-I Stage). (GSI unpublished progress report 2007-08).

RAVINDRABABU, B., CHAKRADHAR, M. and KHAN, M.M.A., 1992. "Resources potential of different grades of limestone". Workshop on Minerals and Mineral Based Industries in Andhra Pradesh.

REDDY, I.V. and REDDY, K.N., 1985-86. Report on the reconnaissance surveys for location of Tin-Tungsten mineralisation in parts of Khammam

district, Andhra Pradesh. (GSI unpublished progress report).

SARMA DAS.D.C., ANANTHARAMAN.S., VENUGOPAL RAO, CH. and DR.C.V.N.K. RAO, 1997. Report on the Palaeontological Studies for the search of Micromammals in the Infra and Intertrappean Horizons of Andhra Pradesh and Karnataka. (GSI unpublished progress report 1992-93).

SARMA,K.J., VISWANADHAM, K. and ANKANNA, V., 1986-88. A report on the investigation for Chromite in Jonnaram, Konayyapalem and Lingannapeta areas, Khammam District. (GSI unpublished progress report).

SARMA, K.J., 1990. Study of mafic dyke swarms of parts of Mahabubnagar and Rangareddy districts, A.P. (GSI unpublished progress report).

SARMA, T.D.K., 1992. "Slate deposits and slate polishing industries of Andhra Pradesh." Workshop on Minerals and Mineral Based Industries in AP.

SARVOTHAMAN, H. and GANESAN, V.,1984. Systematic Geological Mapping in Parts of Medak district. (GSI unpublished progress report).

SARVOTHAMAN.H., GANESAN, V. and CHANDRASEKHARAIAH, K.C., 1985. Systematic Geological Mapping in Parts of Medak district. (GSI unpublished progress report).

SARVOTHAMAN, H., SRINIVASAN, K.N. and SURESH.G., 1993-94. Classification of Granites in Parts of Nalgonda district. (GSI unpublished progress report).

SARVOTHAMAN, H., SRINIVASAN, K.N. and SURESH.G., 1994-95. Traverse Mapping in along the marginal zone between Khammam and Guntur districts of Andhra Pradesh. (GSI unpublished progress report).

SATYANARAYANA, S.V., et.al. 1997. Exploration of South Indian Diamond Province. An appraisal of investment opportunities "Indian Mining Summit, 1997".

SETTI, D.N., BADRINARAYANA, S. and APPAVADHANULU, K., 1969-70. Geology of Pakhals and associated rocks in parts of Khammam District. (GSI unpublished progress report).

SHAILENDRA DASHORA, B.M.SHAH, 1988-89. Geology of the area around Ghanpur and Kazipet in Warangal district of Andhra Pradesh. (GSI unpublished progress report)

SHARMA K.V.S., REDDY N.S., PAL N.K. and SATYANARAYANA G., Search for kimberlites in rajoli block in Mahabubnagar and Kurnool Districts, Andhra Pradesh (P-I Stage).(GSI unpublished progress report 2007-08).

SHIVAJI, K., 1987-88. Report on the investigation for diamonds in conglomerates at Banganpalle formation, Ramallakota, Karimnagar district. (GSI unpublished progress report)

SINGARAJU, V., and SHAH, B.M., 2001. Studies of volcanic ash beds of the inland valleys of Andhra Pradesh. (GSI Unpublished Prog. Rep. F.S. 1996-97).

SINHA, P.A., MUTHU, V.T. and PRAKASH, H.S.M., 1985-86. Reconnaissance surveys for phosphorites in parts of Papaghni and Chitravati Groups of Cuddapah Basin, A.P. (GSI unpublished progress report).

SINHA, P.A., MUTHU, V.T. and PRAKASH, H.S.M ., 1986-87. Reconnaissance surveys for phosphorite in parts of Papaghni and Chitravati Groups of Cuddapah Basin and in parts of Kurnool Basin, Andhra Pradesh.

SMEETH W.F., 1916, Outline of Geological History of Mysore, Mysore Gel.Dept. Bull.6, No.22

SOOD, H.K., and others 1978. New finds of phosphorite, Geol. Surv. India. News Vol. 9 pp. 4.

SOOD, N.K., 1980-81. Reconnaissance Surveys for Phosphorite in Cuddapah basin in Kurnool and Cuddapah District. (GSI unpublished progress report).

SREENIVASA RAO, T., 1980-81. Geology of some of the outliers and inliers of the upper Precambrian sedimentaries (Parkhal – Penganga – Sullavai) in Adilabad, Karimnagar and Khammam District, Andhra Pradesh. (GSI unpublished progress report)

SREENIVASA RAO, T., 1987. The Pakhal Basin – A perspective of Purana Basin of Peninsular India, Geol.Soc.Ind.Mem.6 00 161-187.

SRINIVASA RAO, K., SRINIVASA RAO, T., SILEKAR, V.S. and KAMESHWAR, D.R., 1977-78. Geology of parts of Narasampet and Mahbubabad Tahsils, Warangal district and Yellandlapad Tahsil, Khammam district, Andhra Pradesh. (GSI unpublished progress report)

SRINIVASAN, K.N. and GANESAN. V., 1986. Systematic Geological Mapping in Parts of Wyra and Kallur, Khammam district, Andhra Pradesh. (GSI unpublished progress report).

SRINIVASAN, K.N. and GANESAN. V., 1986. Systematic Geological Mapping in Parts of Patancheru and Ramachandrapuram, Medak district, Andhra Pradesh. (GSI unpublished progress report).

SRINIVASAN, K.N. and JAMWAL.C. S., 1987. Systematic Geological Mapping in Parts of Nizamabad district, Andhra Pradesh. (GSI unpublished progress report).

SRINIVASAN, K.N. and KRISTAPPA, 1989. Classification of Greenstones and Associated Granites of Jonnagiri and Peddavuru Schist Belts, Kurnool and Nalgonda districts, Andhra Pradesh. (GSI unpublished progress report).

SRINIVASAN, K.N. and NAGARAJA RAO, B.K., 1987-88. Classification of greenstones and associated granites of Gadwal Schist Belt. (GSI unpublished progress report - F.S. 1987-88).

SRINIVASAN, K.N. and ROOP KUMAR, D., 1991-93. NAGARAJA RAO, B.K., 1987. Classification of greenstones and associated granites of Gadwal Schist Belt. (GSI unpublished progress report - F.S. 1991-93).

SUBBA RAJU, M., 1978. Report advances on our knowledge of the Pakhal Supergroup with special reference to the central part of the Godavari Valley Rec. Geol. Surv.Ind. Vol.110 pp.2.

SUBRAMANYAM, C, 1983: An Overview of gravity anomalies. Precambrian Metamorphic terrains and their boundary relationships in the southern Indian shield in Precambrian of South India. Mem.Geol.Soc.India, V.4, pp-553-565

SUBRAMANYAM, P. and KRISHNAMURTHY, A. 1966-67 Geology and occurrences of Copper minerals in Venkatapuram- Kunavaram areas Burgampahad taluk, Khammam District. (GSI unpublished progress report).

SUBRAMANYAM, P. and SIVADAS, K.M. 1960-61 Geology and Copper deposits of Mailaram, Yellembailu area, Khammam District (GSI unpublished progress report).

SUBRATA SARKAR, Final report on exploration for coal by scout drilling in Narayapuram-Pattayyagudem area, Southern Sub-Basin of Godavari valley coal field, Khammam and West Godavari Distrits, Andhra Pradesh (G-4 Stage). (Progress Report: 2008-09 & 2009-10).

SURESH.G, SRINIVASAN.K. N AND RAO.N V, 1988-89: Study of Mafic Dykes Swarms of Nalgonda and Mahabubnagar district, Andhra Pradesh, International Seminar and Mafic Dykes Swarms, ISM, Dhanbad.

SWAMYNATH, J. and RAMAKRISHNAN.M., 1981. Early Precambrian Supracrustals of Southern Karnataka, GSI Memoir, Vol.112, pp. 1-351.

SWAMINATH, J., RAMAKRISHNAN, M. and VISWANATHA, M.N., 1976. Dharwar Stratigraphic Model and Karnataka Craton Evolution Rec.Geo.Sur.India, pp.107(2)/149-173.

SYAMALA RAO. and N.K.SOOD, 1983-84. Reconnaissance surveys for phosphorites in Pakhal Basin. (GSI unpublished progress report).

SYAMALARAO, A. and SINHA, P.A., 1988. Reconnaissance surveys for phosphorites in Yellandu area Pakhal basin, Khammam district, Andhra Pradesh. (GSI unpublished progress report).

VARAPRASAD RAO, C.J.R., 1963-63. A note an occurrences of dolomites and barytes in the Pocharam – Karepalli area, Yelandu taluk, Khammam district. (GSI unpublished progress report).

VENKATESWARA RAO, C.H. and BALACHANDRUDU, V., Investigation for iron ore in Bayyaram-Nilvancha-Sitanagar and surrounding areas, Khammam District, Andhra Pradesh (P-II Stage). (GSI unpublished progress report 2009-10).

VENKATAPPAIAH, A., 1992. "Coal resources of Andhra Pradesh and exploitation prospects". Workshop on Minerals and Mineral Based Industries in A.P.

VIJAYAM.B.E., 1969. Occurrence of Tuffisites in Pebble Dyke, Ulindakonda, Kurnool district, Andhra Pradesh, Geol.Soc.of India, Vol.5, pp.86-87.

VINOGRADOV, A., et.al. 1964. Geochronology of Indian Precambrian. 22nd Int. Geol. Cong. New-Delhi. pp. 550-567

VENUGOPAL RAO, CH., 1986. A Report on the Palaeontological Studies on the Inter-Trappean Sediments from Medak and Nizamabad districts, of Andhra Pradesh. (GSI unpublished progress report 1984-85).

VENUGOPAL RAO, CH., A Report on the Palaeontological Studies on the Inter-Trappean Sediments from Medak and Nizamabad districts, of Andhra Pradesh. (GSI unpublished progress report 1985-86).

YADAGIRI. P., 1982. Report on further studies on the Dinosaurian Fauna from Formation, Adilabad district, Andhra Pradesh. (GSI unpublished progress report 1978-79).

YADAGIRI. P., Osteological Studies of a Carnosaurian Dinosaur from Lower Jurassic Kota Formation, Andhra Pradesh. (GSI unpublished progress report 1981-82).

YADAGIRI, P., 1982. Studies on Fishes and Early Mammals from Kota Formation, Adilabad district, Andhra Pradesh. (GSI unpublished progress report 1979-81).

YADAGIRI, P., 1984. Examination and Excavation of Kota Maleri Beds of Adilabad district, Andhra Pradesh. (GSI unpublished progress report 1982-83).

YADAGIRI, P., VIJAYASARATHI, G. and NATH, T.T., 1996. Report on the study of Palaeozoic and Mesozoic Vertebrates from the Gondwana Sediments of Pranhita-Godavari Valley, Andhra Pradesh. (GSI unpublished progress report 1994-95).

LIST OF ABBREVIATIONS

ACC	- Andhra Cement Company
AMD	- Atomic Minerals Division
APMDC	- Andhra Pradesh Mining and Development Corporation
APPL	- Andhra Phosphates Pvt. Limited.
BF	- Blast Furnace grade
BGML	- Bharat Gold Mines Ltd.
CCI	- Cement Corporation of India Ltd.
DMG	- Directorate of Mines and Geology
FCI	- Fertilizer Corporation of India.
HZL	- Hindustan Zinc Limited
MECL	- Mineral Exploration Corporation Ltd.
NMDC	- National Mineral Development Corporation
ONGC	- Oil and Natural Gas Corporation
SAIL	- Steel Authority of India Ltd.
SMS	- Steel Melting Shop grade
Mt	- Million Tonnes

NOTES

NOTES

The Publication is available for sale from the office of the Director, Publication and Information Division, Geological Survey of India, 29, Jawaharlal Nehru Road, Kolkata-700 016 and from the following Regional offices of the Geological Survey of India.

Eastern Region	**:**	**Bhu-Bijnan Bhavan, Block-3, DK-6, Sector-II, Salt Lake City, Kolkata-700 091.**
Northern Region	**:**	**GSI Complex, Sector-I, Aligunj, Lucknow-220 020**
Southern Region	**:**	**GSI Complex, Bandlaguda, Hyderabad - 500 068.**
Central Region	**:**	**Block-A, 1st Floor, New Office Complex, Seminary Hills, Nagpur-440 006**
Western Region	**:**	**GSI Complex, 15-16, Jhalana Dungri, Jaipur - 302 004**
North Eastern Region	**:**	**Kumud Villa, Nongrim Hills, Shillong-793 003**
Delhi Office	**:**	**Pushpa Bhavan (2nd floor), A-Block, Madangir Road, New Delhi - 110 062.**

The Publication is also available for sale from the office of the Controller of Publications, Government of India, Civil Lines, New Delhi - 110 054.

Browse in for more information : www.portal.gsi.gov.in