CHAPTER – I

INTRODUCTION

1. USES OF CHROMITE :

Chromite is the only economic source of Chromium. It has a wide range of uses in metallurgical, chemical, refractory industries. The properties of chromium that makes it most versatile and indispensable are its resistance to corrosion, oxidation, wear and galling and enhancement of hardenability.

In metallurgical industry, chromite is used for manufacturing low-carbon and high-carbon ferro-chrome and charge chrome which in turn are used as additives in making stainless steels and special alloy steel. Hard lumpy chromite is used for producing high carbon ferro-chrome while friable ore and fines briquettes are used for low carbon ferrochrome. Both briquetted fines and lumpy ores are used in production of charge chrome.

For ferro-chrome Cr: Fe should be 2.8:1; Cr_2O_3=48% (min) and for charge chrome Cr : Fe should be 1.6 : 1; Cr_2O_3 = 44% (min.).

In chemical industry, chromite is used for production of sodium bichromate which is the source material for making various chromium-based chemicals. These chrome-chemicals are used in chromium plating, leather tanning, furniture and fixtures, vehicles, safety matches, as dyes in clothings, drilling muds and as catalysts and pigments. Ore with chromite to iron ratio 1:6 and a minimum 44% Cr_2O_3 is acceptable for chemical end-use. The most objectionable impurities are silica and lime.

In refractory industry, chromite is used as a refractory material because of its high melting point (1,700^o to 1,900^o C). Generally, refractories are made using magnesite and chromite together and depending on the chromite to dead-burnt magnesite (DBM) ratio, bricks are called chrome-mag bricks (50 to 55% chromite) and mag-chrome bricks (45 to 50% chromite). Dense chrome bricks containing 100% chromite are also manufactured. Chromite refractories used for lining of open hearth steel furnaces serve as neutral refractories. Recently, a technology has been developed in India to produce cosinters from magnesite and high grade chrome-ore fines (+55% Cr_2O_3) and the product is highly useful for making special quality refractory bricks. The refractory industry prefers hard lumpy ore containing low silica and low lime. In some refractory unit, high silica lumpy ore blended with low silica friable ore is used in the manufacture of ordinary types of refractory bricks. In refractory industry Cr_2O_3 should be a minimum of 40%.

In addition, chromite is also used in ceramic industry and electrode making industry.

2. WORLD RESOURCES AND PRODUCTION :

The huge deposits of South Africa, constituting more than 75% of known world resources, are now the major sources of chromite ore globally.

The important countries where considerable reserves of chromite ore are known and mined for production of ferro-chrome and charge-chrome etc. are Brazil, Republic of South Africa, Kazakhstan, India, Russia and Finland. Internationally, 79% consumption of chromite is

made in metallurgical industry, 13% in chemical industry and 8% in refractory industry, on an average. In the metallurgical industry, 60% is consumed for stainless steel production.

The world resources of chromite were assessed at 11 billion tonnes, as quoted in Mineral Commodity Summary, 1998 comprising about 3.6 billion tonnes of recoverable reserves and 7.5 billion tonnes of resource base whereas the world resources of chromite are assessed at 1.8 billion tonnes of metal content, ibidem, 2004 which are sufficient to meet the world demand for several decades. About 77% of the total world resources are located in South Africa, followed by Kazakhstan 6%. The other important countries possessing chromite resources are Zimbabwe, Finland, India, Brazil, Turkey, Albania, Russia, United States and Iran. The world resources of chromite and production of chromite are presented in the following tables.

Table – 1 : WORLD RESOURCES OF CHROMITE

(By principal countries) (in '000 tonnes)

Countries	Resource base (in excess of recoverable reserves) 1998	Resource base 2004
South Africa	550,0000	2,00,000
Kazakh Stan	32,0000	47,000
Zimbabwe	93,0000	-
Finland	12,0000	-
India *	17770 *	5,700 **
Brazil	23000	-
Turkey	20000	-
United States	10,000	7,000
Albania	6100	-
Iran	2400	-
Russia	46,0000	-
Other Countries	37000	11,00,000
World total	**750,0000**	**18,0000**

[Source : U.S.G.S. Mineral Commodity Summaries, 1998, 2004]

* Indian Mineral Year Book, 1998 (data as on 1.4.1995)
** Indian Mineral Year Book, 2004 (data as on 1.4.2004)

Table-II : WORLD PRODUCTION OF CHROMITE (By Principal Countries)

(in '000 tonnes)

Country	2001	2002	2003
Brazil	300	200	300
Finland	575	566	549
India	1549	3066	3199
Iran	-	-	-
Kazakhstan	2046	2370	2928
Russia	-	-	-

South Africa	5502	6439	7405
Turkey	455	326	229
Zimbabwe	723	726	666
Other countries	850	807	1124
World total	**12000**	**14500**	**16400**

[Source : IBM Year Book, 2004]

3. INDIA'S RESOURCES AND PRODUCTION :

1. Archean Greenstone Association

a. Sukinda and Nausahi in Orissa
b. Sinduvalli and Byrapur in Karnataka
c. Bhandara and Ratnagiri in Maharashtra
d. Roro and Jojohatu in Bihar
e. Ponda and Dudsagar in Goa.

2. Proterozoic Granulite Association

a. Kondapalli in Andhra Pradesh
b. Sittampudi complex in Tamilnadu.

3. Tertiary Ophiolite Association

Chromite occurrences of Manipur, Nagaland, Andaman and Nicobar Islands and Jammu & Kashmir.
[Important resource occurrences in India are shown in Plate – 1]

A. Resources :

Total recoverable reserves of chromite in the country as on 01.04.1995 were assessed at 86.23 million tonnes in which the shares of proved, probable and possible reserves are 30%, 36% and 34% respectively. Over 97% of the total recoverable reserves are found in Orissa State. Out of the total recoverable reserves of all grades about 34% is of Metallurgical grade and 29% is of charge Chrome grade. As per UNFC system, total resources of chromite in the country as on 1.4.2000 are 179 m.tons comprising 47 m.tons of insitu reserves (26%) and the remaining 132 m.tons of resources (74%). Category-wise, grade-wise and state-wise break up of recoverable reserves are given in following table.

Table-III : RECOVERABLE RESERVES OF CHROMITE

(In thousand tonnes)

State / Grade	Recoverable Reserves (as on 1.4.2000)		
	Proved	**Probable**	**Total**
Metallurgical (>48% Cr_2O_3)	8072	3464	11535
Refractory (>40% Cr_2O_3)	407	448	855
Charge Chrome (>44% Cr_2O_3)	14381	7057	21,439
Low	-	-	-

Beneficiable	5876	6923	12799
Others	-	-	-
Unclassified	17	19	35
Not known	-	-	-
BY STATES			
Andhra Pradesh	-	-	-
Bihar	-	-	-
Karnataka	523	648	1170
Maharashtra	2	0	2
Manipur	-	-	-
Orissa	28227	17263	45490
Tamilnadu	-	-	-
ALL INDIA	28752	17910	46,663

[Source : IBM Year Book, 2004]

B. Production :

Orissa continued to be the leading producing State of chromite, accounting for 99% of the total production in 2003-04. Production of chromite in Karnataka, Maharashtra accounts for the remaining 1% production.

The sector-wise, state-wise, district-wise production of chromite along with its market price is presented in the following table.

Table-IV : PRODUCTION OF CHROMITE 2003-04 (BY SECTOR AND BY STATE/DISTRICT)

Quantity in tonnes, Value in Rupees

State / District	Total Production (Tonnes / Value(Rs.)					
	2001 - 02		2002 - 03		2003 - 04	
India	**1548,900**	**2660411**	**3068631**	**4672625**	**2904809**	**4321241**
Public Sector	**321667**	**606163**	**704773**	**1304769**	**774482**	**1376446**
Private Sector	**1227223**	**2054248**	**2363858**	**3367856**	**2130327**	**2944795**
Karnataka	**17937**	**30880**	**19194**	**31436**	**12425**	**28961**
Hassan	**17937**	**30880**	**19194**	**31436**	**12425**	**28961**
Maharashtra	**32**	**53**	**27**	**50**	**5**	**21**
Bhandara	**32**	**53**	**27**	**50**	**5**	**21**
Orissa	**1530931**	**2629478**	**3049410**	**4641139**	**2892379**	**4292259**
Dhenkanal	**19360**	**38950**	**18141**	**43609**	**12700**	**35066**
Jajpur	**1443517**	**2492244**	**2960140**	**4488661**	**2819426**	**4154001**
Keonjhar	**68054**	**98284**	**71129**	**108869**	**60253**	**103192**

[Source : Indian Mineral Year Book, 2004.]

4. Marketable Grade :

The marketable grade for chromite deposits are determined as per the specification of the end uses viz. metallurgical, chemical etc. The Expert Group on classification of minerals with regard to their possible optimum use constituted by the erstwhile Department of mines of Govt. of India has recommended the following end use specification of chromite. (Reaffirmed in 1998)

Metallurgical :

(a)	High carbon ferrochrome	:	Cr_2O_3 :	48% (minimum)
			Cr : Fe:	2.8:1 (maximum)
(b)	Charge chrome	:	Cr_2O_3 :	44% (minimum)
			Cr : Fe :	1.6:1 (minimum)

Chromite containing 42% of Cr_2O_3 with Cr:Fe ratio of 1.4:1 are being used for production of charge chrome. The ore should be lumpy and friable ore can be used after agglomeration.

Refractory (Grade III)	Cr_2O_3	:	40% (minimum)
The ore should be lumpy.			
	Al_2O_3	:	14% (maximum)
	FeO	:	18% (maximum)
	SiO_2	:	<9%
	CaO	:	1% (maximum)
Chemical	Cr_2O_3	:	44% (minimum)
	FeO	:	20% (maximum)
	CaO	:	3% (maximum)
	MgO	:	14% (maximum)
	Al_2O_3	:	14% (maximum)
	SiO_2	:	7% (maximum)

Besides the above specifications, another grade system used for presenting the production of chromite is based on the percentage of Cr_2O_3 alone.

Grade-I	:	>47% of Cr_2O_3
Grade-II	:	40-47% Cr_2O_3
Grade-III	:	<40% Cr_2O_3

5. Market Price :

The market price of chromite ores in domestic market as per the grade for the year 2002-03 to 2004-05 (P) is presented in the following table.

Table-V : MARKET PRICE OF CHROMITE ORES

(In Rupees per tonne)

Grade	Market	2002-03	2003-04	2004-05
Chips 46% Cr_2O_3	Ex-Byrapur Mine (Karnataka)	4350	4150	4300
Chips 44% Cr_2O_3	Ex-Byrapur Mine (Karnataka)	3400	3200	3400

Chips 28-30% Cr_2O_3	Ex-Byrapur Mine (Karnataka)	1015	1000	1100
Lump 56% Cr_2O_3 (low silica)	Ex-Kamarda Mine (Orissa)	3938	4332-4657	4857-4957
Lump 50% Cr_2O_3	Ex-Kamarda Mine (Orissa)	3150	3465-3725	3925-4025
Lump 42% Cr_2O_3	Ex-Kamarda Mine (Orissa)	2419	2661-2861	3061-3161
Lump 38% Cr_2O_3	Ex-Kamarda Mine (Orissa)	2125	2338-2526	2726-2826

CHAPTER – II

DEPOSITS OF ORISSA

INTRODUCTION

Major share (98.6%) of chromite resources in the country are located in Orissa. The chromite deposits occur in number of localities along NE-SW belt associated with ultramafic complexes of Sukinda, Baula-Nausahi and similar occurrences of ultramafic rocks at Bhalukasoni and Ramgiri. (Plate 2)

A. SUKINDA ULTRAMAFIC COMPLEX

Sukinda chromite alone contributes nearly 95% of total chromite reserves of the country. It has been explored by geological mapping, drilling, sampling in different phases.

a. Location :

Tahsil	:	Sukinda
District	:	Jajpur
Toposheet No.	:	73 G/16 & G/12

b. Quantum of Work Done :

The Sukinda ultramafic complex was explored in different phases comprising of work viz. geological mapping (1:2000 scale), drilling, pitting and trenching. A total of 29.799 square km area on 1:2000 scale was mapped. A total of 48,412.30 m was drilled in 518 boreholes. 12,511 core and trench samples were collected and 1,130.60 cu m pitting and trenching was done in total. As a result of this, a total of 145.022 million tonnes of chromite reserve of all grades have been established in Sukinda valley. The break up of phase wise quantum of work done by GSI is given below.

Phase-I

Geological mapping (1:2000)	:	20.179 sq km
Drilling (202 boreholes)	:	34,642.30 m
Pitting and trenching	:	1,130.60 cu m
Sampling	:	11,427 nos.

Phase-II

The Phase-II exploration programme in Gurjang block of Sukinda ultramafic complex commenced in 1980-81 and continued up to 1985. The work inputs are :

Geological mapping (1:2000)	:	3.75 sq km

Drilling (94 boreholes)	:	5,790 m
Sampling	:	688 nos.
Cumulative strike length	:	12.90 kms.

Phase-III

The Phase-III exploration for concealed chromite deposits in northern and eastern part of Sukinda ultramafic complex commenced in 1985. The inputs are:

Geological mapping (1:2000)	:	5.87 sq km
Drilling (142 boreholes)	:	7980 m
Sampling	:	401 nos.

c. Geological Set-up :

The Sukinda ultramafic field is confined to an east-west trending valley lying between the Daitari hill range in the north and Mahagiri range in the south. The ultramafic rocks of Sukinda valley are emplaced within a sedimentary sequence of Iron Ore Supergroup. These rocks of sedimentary sequence extended in an arcuate belt from the west of Daitari to Nausahi (a distance of 50 km) and beyond.

The following geological succession can be given :

- Soil and alluvium and laterite
- Dolerite dyke
- Granite and granophyre
- Metalava/Dolerite
- Chromiferous ultramafics in lopolithic structure (45 sq km)
- Conglomerate, grit and orthoquartzite with placer chromite underlain by banded magnetite chart, shale and phyllite with alternating sequence of lava at base.

d. Controls of Mineralisation :

The dunite members of ultramafic complex partially or fully altered to feebly schistose talc-serpentine mass, are the host rock for chromite ore seams showing a lithological control. Five major seams have been identified in Sukinda ultramafic complex. They are :

i) Lower Brown Ore seam
ii) Upper Brown Ore seam
iii) Sukrangi Ore seam
iv) Kamardah Ore seam
v) Grey Ore seam or Mahagiri Ore seam

All the ore seams are mostly friable and partly lumpy, except for the Mahagiri Ore seam which is lumpy and suitable for refractory use.

The five ore seams mentioned above are exposed discontinuously for a strike length of more than 7 kms with 1-40 m of width.

e. Dimensions of the Ore Body :

The repetition of dunite members and chromite ore seams has been attributed to rhythmic layering within ultramafic complex. One of the ore seams of Bhimtangar block has been

established for more than 7 km on the surface while others have strike extension from 200 m to 2 kms. Depth continuity is ascertained to be more than 250 m from the ground surface in 4 boreholes in Tisco area. Pinching and swelling of ore seams are normal.

Most of the area is covered with lateritic profile more than 50 m thick. Specks of chromite in laterite and association of secondary silica (chart) in close proximity are considered locally as the surface manifestations of chromite mineralisation in the northern limb of fold of Bhimtangar block. Besides, a lumpy chromite ore seam has been established in Gurjang area in the northern limb of folded structure by drilling. Mahagiri lumpy chromites are exposed for about 7 km in the southern limb of the fold in Bhimtangar block.

f. Mode of Formation and Age :

The chromite mineralisation is confined to ultramafic body which has intruded into the Precambrian metamorphites in the form of a lopolith. The Precambrian metamorphites are represented by gritty quartzite and metavolcanics. The intrusive has a width of 2 to 5 km and extends for a length of 20 km in an ENE-WSW direction from Kansa in the east to Maruabil and beyond on the west. The ultramafic body consists of Magnesite rich serpentinised dunite-peridotite with chromite bands and subordinate amount of pyroxenite devoid of chromite mineralisation. This ultramafic body is early magmatic intrusives into the Precambrian metamorphites. The dunite-peridotite members are highly serpentinised and intensely lateritised giving rise to a nickeliferous laterite profile of variable thickness.

The repetition of dunite members and chromite ore seams has been attributed to rhythmic layering within the ultramafic complex. The presence of scour/slump structures in the chromite horizons of the Sukinda belt is characteristic of gravity controlled magmatic layering. The ultramafic rocks are of Precambrian age.

g. Nature of Mineralisation :

Chromite occurs as persistent thick bands, seams, lenses within ultramafic complex. Six seams have been delineated with thickness varying from 10 to 50 m. These are friable in nature and described as brown ores. The first brown ore horizon (Seam-1) is perhaps the thickest seam in the world (40m). All the six seams are fairly thick and persistent both along the strike of the intrusive and with depth as observed in the quarry and borehole sections from Saruabil in the east to Bhimtangar in the west. Further west at Kalarangi, Kathpal and Maruabil, these chrome ore bodies do not exhibit any regular alignment, rather these are exposed in disjointed bands and lenses disrupted by the emplacement of younger granite.

The chromite deposit of Sukinda belt is mainly stratiform type and can be classified into the categories like lumpy ore, granular ore, friable ore, ferruginous ore, disseminated ore and banded ore.

h. Grade and Reserve :

Phase-I

Six distinct parallel chromite ore bodies are exposed disjointedly. The cumulative strike length of each band is 7 km with 1-40 m width.

The ore is generally friable except in Mahagiri band where it is mostly lumpy. The ore is mostly of charge chrome and metallurgical grade with +48% Cr_2O_3, 1-6% SiO_2, 5-8% C, 0.4% S and 0.3% P. Only upper weathered portions to a maximum thickness of 30 m may show 30-35% Cr_2O_3.

A summarised statement of blockwise, ore reserve is given below :

1. Bhimtangar (TISCO) : 93.29 m.t. (200-250 m depth)
2. Kaliapani (OMC) : 15.54 m.t. (200 m depth)
3. Sukrangi (OMC) : 7.60 m.t. (200 m depth)
4. Saruabil (M.L. Jain) : 8.86 m.t. (200 m depth)
5. Kamardah (S.C. Mohanty) : 2.22 m.t. (150 m depth)

127.51 million tonnes

Band/level wise quantum of work done and reserves estimated in Sukinda area are as follows :

Band/level	No. of boreholes	Meterage drilled	Reserves in million tonnes
Upper Brown Ore Seam	128	15,180.50 (upto 250 m)	77.03 (fine) 69.4%
Lower Brown Ore Seam	43	6,175.95 (upto 200 m)	16.17 (fine) 12.7%
Sukrangi Ore Seam	28	2,962.88 (upto 200 m)	7.60 (fine) 6%
Saruabil Ore Seam	29	3,706.45 (upto 200 m)	7.70 (fine) 6.1%
Kamardah Ore Seam	23	2,353.45 (upto 200 m)	2.22 (fine) 1.7%
Grey Ore Seam/ Mahagiri Ore Seam	31	4,184.45 (upto 200 m)	15.63(lumpy) 12.3%

Phase – II Reserve estimated : 14.20 million tonnes

The details of reserves of different grades with specifications are :

Metallurgical (>48% Cr_2O_3 with Cr:Fe >2.80)	Charge-chrome (42-48% Cr_2O_3 Cr:Fe >1.60)	Inferior (30-42% Cr_2O_3 Cr:Fe >1.00)	Total
4.18	4.94	5.08	14.20

Phase-III Reserves estimated : 3.312 million tonnes

The break-ups (in million tonnes) are :

Metallurgical	Charge-chrome	Inferior	Total
0.06	1.12	2.132	3.312

B. OTHER DEPOSITS/OCCURRENCES AROUND SUKINDA

1. Kathpal - Jajpur district :

The ultramafic body covers an area of 0.4 sq km with lenses of lumpy chromite within serpentinised dunite and unaltered orthopyroxenite. The chromiferous ultramafic body occurs as xenolith within granophyre in the WSW of main Sukinda valley. A total of 1.12 m.t. of lumpy chromite reserve has been established up to 60 m depth. The area is mined by Facor and OMC.

2. Birasal, - Dhenkanal district :

About 2.5 km NNE of Birasal, lenses of chromite ore body occur within altered serpentinised dunite. This altered ultramafic body also possibly occurs as a xenolith within the granophyre.

3. Maulabhanj Parbat - Dhenkanal district :

About 1.5 km SSE of Maulabhanj hill near Bhuban in Dhenkanal district, several lenses of lumpy chromite ore occurs within altered dunite alternating with bands of pyroxenite and secondary chart derived from leached ultramafics in a set up similar to that seen in Sukinda valley. Extension of such pockets are seen over more than 1 km.

4. Asurbandh - Dhenkanal district :

About 6 km ESE of Maulabhanj chromite, low grade chromite occurs as pockets associated with ultramafic bodies which have been extensively lateritised. Concentration of pockets of chromite is seen within chert bands.

5. Ghotringa - Dhenkanal district :

North of the village along the western foot hills of quartzite hill, occurrences of chromite is reported in form of thin bands and layers within greenish quartzite. This occurrence is thought to be sedimentary type.

6. Kendragadia - Jajpur district :

Low grade chromite ore of irregular disposition is seen enclosed in silicified and lateritised ultramafic rocks occurring SW of Kathpal.

C. BAULA – NAUSAHI BELT :

Nausahi ultramafic complex covers a surface area of 5 sq km and a detached segment occurring at a distance of 50 km to the ENE of Sukinda area. Mining of chromite in Nausahi area started during 1942-43.

a. Location :

Tahsil	:	Anandpur
District	:	Keonjhar
Toposheet No.	:	73 K / 7

b. Quantum of Work (GSI) :

Large scale mapping (1:2000)	:	3.02 sq km
No. of boreholes	:	61
Meterage drilled	:	7672.05 m

No. of core samples analysed	:	1385
Pitting and Trenching	:	29.00 cu m

c. Geological Set up :

The Nausahi ultramafic field lies at the foot hills of the Baula hill range and appears to have a north south elongation, its southern limit is not yet clearly known.

The rocks of Nausahi sector include metasediments of the Iron Ore Super Group and ultramafics and basic intrusives. The ultramafic rocks include dunite, periodotite, harzburgite etc. These are intruded and surrounded on all sides by the mafic suite of rocks (gabbro and dolerite dykes) except in the northern part where a thick cover of laterite and alluvium exists.

Two phases of ultramafic intrusives have been identified in the area – the older dunite-chromitite phase and the younger peridotite-pyroxenite. Chromite occurs within the first phase of ultramafics.

A generalised geological sequence in the area is given as follows :

Soil alluvium laterite

Dolerite dyke

Granophyre and Granite

Gabbro with lenticular magnetite

Chromiferous ultramafics

Quartzite and quartz schist

d. Controls of Mineralisation :

The ultramafic complex of Nausahi area forms a roughly N-S running body represented by both fresh and weathered dunite, peridotite, pyroxenite and harzburzite intrusives engulfed by gabbro – anorthosite suite of rocks. Chromite occurs as podiform deposit genetically related to the older intrusive phase of ultramafics as mentioned above. Gravity induced primary layering in the older intrusive phase of ultramafics is the main control of the chromite mineralisation.

e. Dimension of Ore Body :

Ore bodies in Nausahi sector are spread over a strike length of 3 km in N-S direction. The width of individual band as revealed from borehole data, varies from 15 m to as thin as 10 cm. The Nausahi ores are inferior charge chrome grade. Iron and silica are higher than in Sukinda sector.

f. Mode of Formation and Age :

In Baula – Nausahi belt, chromite is confined to ultramafic complex represented by serpentinised dunite – peridotite which is late magmatic intrusive into the older metamorphites. The older Precambrian metamorphites consist of massive quartzite, ferruginous quartzite, quartz-sericite schist and metavolcanics. The ultramafic body to the west of village Nausahi, extends for about 3 km in a NNW-SSE direction from Phulijhorahuli down to the village Jauthabahali. It is a dyke like body having distinct intrusive relationship with the older quartzite and epidiorite forming hills to the north. The ultramafic body has a maximum width of about 1 km in the middle tapering gradually towards north and south and mainly consists of serpentinised dunite periodite in the core and subordinate amount of pyroxenite at the periphery.

The ultramafics are of Precambrian age.

g. Nature of Ore Mineralisation :

There are in general 3 lodes in north Baula block and 2 lodes in South Nausahi block occurring as disjointed bodies. The chromite bodies occurring in form of discontinuous bands and lenses, confined to the altered dunite / peridotite, are exposed in the central part of the mine. These bands have an average width of 5 meters. The chromite seams in the Baula-Nausahi area are thin, (3 to 10 m) small, mostly hard and lumpy, and persists for a depth of more than 100 m as observed in borehole intersections.

The chromite deposit is mainly stratiform type with categories like lumpy and granular ore, friable ore, ferruginous ore, banded ore, disseminated ore and magnetic ore. The magnetic chromite ore is found in Baula chromite mines of FACOR where both chromite and magnetite are so intimately mixed that poses problem for their separation.

h. Grade and Ore Reserve :

Reserve of 3.40 million tonnes of chromite of all grades have been estimated in Baula-Nausahi sector, the break up of which is as follows :

Lease-wise reserve :

Nausahi (IMFA)	:	2.47 m.t. up to 175 m depth
Bangur (OMC)	:	0.86 m.t.
Phuljhar (OMC)	:	0.07 m.t.

Grade-wise reserve for Baula and Nausahi only :

Non-metallurgical grade	:	1.887541 million tonnes
Metallurgical grade	:	0.149322 million tonnes
Charge-chrome grade	:	0.433988 million tonnes
Total of all grades with average 37.7% Cr_2O_3	:	2.470851 million tonnes

i. PGM association :

Recently a bouldery ore body of 500 m x 50 m containing PGM and continuing up to a depth of 100 m is revealed from the mine section. Magmatic sulphides occur in association with chromite lodes. A sulphidic concentrate sample from FACOR mine has yielded Pt. 1.55, Pd 9.98, Au 1.17 ppm and Ag 20 ppm. The PGM rich zones call for detailed investigation.

D. Bhalukasuni – Nilgiri Chromite :

a. Location :

Tehsil / Sub-division	:	Nilagiri
District	:	Balasore
Toposheet No.	:	73 K/11

Bhalukasuni is located at a distance of 8 km from the sub-divisional headquarters Nilgiri, which is connected with Shergarh on NH-5 (Kolkata-Chennai Highway) by State Highway. Bhalukasuni chromiferous ultramafic body is the only known occurrence of its kind, east of famous Nausahi chromite fields.

b. Quantum of Work :

(i) The work done by GSI :

Detailed mapping (1:2000)	:	2 sq km
Drilling	:	309.25 m (4 nos. of boreholes)
Pitting	:	9.0 cu m (2 shallow pits of 1.5 x 1.5 m x 2 m dimension)
Geophysical inputs	:	Gravity and magnetic surveys (Regional scale)

(ii) The work done by DMG, Orissa :

Geological mapping (1:10,000)	:	38 sq km
Drilling	:	400.74m (in 15 nos. of boreholes)
Pitting	:	11 nos. of pits were sunk

c. Geological Set-up :

Bhalukasuni chromiferous ultramafic body forms a small segment falling on the eastern extremity of 50 km long ENE-WSW running Nausahi – Nilgiri ultramafic belt, predominantly constituted of basic igneous rocks intruding into the pre-existing Iron Ore Super Group of rocks. The local stratigraphy of the area may be given as :-

	Soil and alluvium
	Laterite
Intrusives	Nilgiri Granite (2346 m. yrs.)
	Gabbro-Norite (magnetite bearing)
	Pyroxenite
	Serpentinite (chromiferous)
Iron Ore Super-group	Metachert – quartzite
Singhbhum Granite Complex	Tonalite – Granodiorite suite of Kaptipada (3275 m. yrs.)

d. Dimension of Ore Body :

From the drill hole data, a narrow zone of ultramafic rocks comprising serpentinised dunite, peridotite, pyroxenite interspersed with thin zones of gabbroic rocks has been encountered with cumulative thickness varying from 10.85 m to 11.75 m. This zone thins out westward and occurs as detached bodies. Small discrete pockets of chromite occur in the serpentinised dunite.

The DGM, Orissa identified two small lodes – a western lode having a dimension of 50 m x 3.5 m x 4.5 m and a very small eastern lode with a dimension of 5.5 m x 2 m x 3.3 m.

e. Control of Mineralisation :

Mineralisation is lithologically controlled with confinement of ore bodies to the serpentinised dunite and peridotite rocks.

f. Grade and Reserve :

The DGM, Orissa estimated a total reserve of the order of 1550 tonnes for both massive and spotted variety of chromite with Cr_2O_3 content from 25.77 to 54.76%.

g. Nature of Ore Mineralistion :

Small bodies of chromite occur associated with serpentinised ultramafic rocks seen as enclaves within gabbro-anorthosite and hornblende – granophyre suite of rocks. Chromite bodies are of podiform type resting on a plutonic mass of gabbroic rocks, occurring at a depth of 20 m from the surface.

E. Ramagiri Chromite

a. Location :

Tehsil	:	Jeypore
Sub-division	:	Jeypore
District	:	Koraput

Ramagiri can be approached from Jeypore, which is connected with NH No.43.

b. Quantum of Work (GSI) :

Geological mapping (1:63,360)	:	8 sq km
Detailed mapping (1:1,000)	:	0.057 sq km
Pitting	:	5 nos. (each 1.5m x 1.0m x 1.0m)

c. Geological Set-up :

The country rock is granite gneiss with thin bands and lenses of hornblende schist and chlorite-sericite-quartz schist. These lithounits form isolated outcrops in an otherwise soil covered area. Several chromiferous altered ultrabasics (at present an aggregate of talc and tremolite and/or talc-schist) are exposed occurring as intrusives into the country rocks.

d. Dimension of Ore Body :

These chromiferous bodies are not continuous in outcrops and are mostly patchy, bouldery type in soil covered area. Largest individual body exposed in a nala section has a dimension of 10 m x 4 m.

e. Nature of Ore Mineralisation :

Detailed mapping reveal that the chromite bearing altered ultrabasics occur as discontinuous patches over a length of 200 mtrs. in N-S direction. Chromite forms neither distinct bands nor pockets but is distributed throughout the altered ultrabasics as disseminated grains.

f. Control of Mineralisation :

Chromite mineralisation is lithologically controlled occurring as disseminated grains within altered ultrabasic rocks.

g. Grade :

5 channel samples collected from pits showed the following analytical results :

Cr_2O_3 - 24.07 to 27.49%

$Fe_{(t)}$ - 8.10 to 14.24%

CHAPTER – III

DEPOSITS OF JHARKHAND

INTRODUCTION

Chromite deposits of Jharkhand had a pioneering role in the early history of chromite exploitation in India. Small deposits of chromite ore are confined to the southern part of Singhbhum district in Jharkhand. Such deposits are exposed around Jojohatu, Hatgamariya, Keshargariya, Roroburu, Chitungburu, Kimsiburu, Kittaburu. Small occurrences of chromite are also found at Kusmita, Gurgaon, Tonto and Janoa-Ranjrakocha areas. Many of the deposits have been prospected by private parties but abandoned afterwards. The deposits are rather scattered and small and the grade is generally inferior (30-40% Cr_2O_3).

A. JOJOHATU – ROROBURU BELT

a. Location :

District	:	West Singhbhum
Tehsil	:	Saraikella
Village	:	Jojohatu
Toposheet No.	:	73 F/10, F/11

Jojohatu lies about 25 km to the west of Chaibasa, the district headquarters of Singhbhum. The nearest rail-head is Chaibasa on the S.E. railway and this is connected to Tatanagar (distance about 80 km).

b. Geological Set-up :

The Jojohatu ultramafic body is spread in three blocks with a cumulative length of 8 km in N-S direction and over a width of 3 km. These blocks are named successively from North to South as Kimsiburu, Kittaburu and Roroburu-Chitungburu. The ultrabasic rocks with which chromite is associated is intrusive into the rocks of Iron Ore Super Group represented in the area by shale, phyllite, slate, quartzite, chert, dolomitic limestone and altered basic lava. Coarse to medium grained granophyre in several small outcrops occurring in close proximity to the ultrabasic body is younger in age to this. Lateritisation of the ultrabasic rocks is a common feature. A tentative sequence of the rock types observed in the area can be constructed as follows :-

	Laterite
	Quartz veins
	Altered dolerite and gabbro (metadolerite and metagabbro)
	Granophyre
Ultrabasic rocks	Dunite-saxonite-pyroxenite largely serpentinised but with some enstatite.
Iron Ore Super Group	Shale, phyllite, slate, quartzite, hematite quartzite, dolomitic limestone and altered basic lava.

The ultrabasic rocks though present at the ground level, form most of the hills of the area rising up to 650 meters above mean sea level. Due to extensive serpentinisation, the original mineral constituents of the ultrabasic rocks is largely obliterated. The contact of ultrabasic rocks with the rocks of the Iron Ore Super Group, wherever visible is marked by gradual steatitisation of the latter leading to the development of talc schist.

c. Control of Mineralisation :

The chromite deposits at Roro, is confined to a shear zone which has been overfolded with a gentle plunge towards the south. On the western slope of Karkatakuti, at Tattibera, chromite mineralisation is confined to a shear zone along the axis of a plunging anticline which has been cross folded, explaining the arcuate disposition of the mineralised zone. Deposits of Chitung hill, Kittaburu, Kimsiburu follow the same pattern. At Jumbliuli, 1 km NE of Jojohatu a vein of chromite is associated with a shear zone trending in N 40^o W-S 40^o E direction. There are several zones of shearing in the ultrabasic rocks, along which chromite lodes are associated, thus showing an overall structural control for the chromite mineralisation in the area.

d. Dimension of the Ore Body :

Four mineralised bodies were identified by pitting and trenching. The dimension of ore bodies are as follows :

(i) At Jumbliuli, a thin chromite vein occurring in a sheared and altered ultrabasic rock was traced for over 300 m with the thickness varying from 22 cm to 26 cm.

(ii) The Tilaisud deposit appears to be the continuation of the Roro chromite lode, which after being affected by a fault at Bechambara takes a turn and runs towards Tilaisud. The details of the dimension are not available.

(iii) In Barbasa – Karkatakuti area, a mineralised shear zone containing pods and lenses of chromite was found on the western slope of the Karkatakuti hill. These lenses can be traced over a stretch of 150 m and have a maximum width of 23 cm.

(iv) In the pit at Rutapi, massive chromite in a serpentine matrix occurs in talcose phyllites. The vein has a variable thickness and is irregular in behaviour.

e. Ore Characteristics / Nature of Mineralisation:

Chromite lodes occur as segregations, veins and lenses, associated with shear zones and are traceable for some distance as at Roro, Chitung, Karkatakuti and Southern Kimsiburu. Concentration of chromite is also seen as bands, stringers, pods or disseminations and also as sacks. Such occurrences are very irregular. Thin bands and veins either thin out or pinch out frequently or they are faulted, at places.

f. Mode of Formation :

Chromite mineralisation has the nature of magmatic segregtion, remobilized veins and also of eluvial placers such as chromite rich talus.

g. Grade and Reserve :

The analysis of some of the chromite samples collected from all the prospecting pits in the area viz. Jumbliuli (near Jojohatu), Tilaisud, Karkatakuti (near Jojohatu) are quite encouraging, Cr_2O_3 ranging from 46% to as high as 51.6% and FeO from 16.46% to 21.23%. The chromite is of refractory grade. Chromite from Rutapi and partly from Roro, Tilaisud area are of poor grade.

An estimate of reserve has been made on the basis of the study of the lodes in the working mines and also in the accessible abandoned mines. The average thickness of chromite bodies is taken to be 22 cm and the extension of ore body in depth is taken as 30 m. The probable reserves of different areas are as follows :

1. Roro area : (two lodes of chromite) : 40,130 tonnes
2. Jojohatu (Karkatakuti-Bangamunda area) : 40,125 tonnes
3. Chitung area - 8,025 tonnes
4. Southern Kimsiburu - 10,030 tonnes

Total reserves - 98,000 tonnes (approx.)

The reserves obtained are tentative as the workable bodies likely to extend even beyond the depth of 30 m. Some of the areas like Jumbliuli, Tilaisud etc. where prospecting was done are yet to be proved by exploratory drilling.

B. KIMSIBURU CHROMITE

The Jojohatu ultramafic body is spread in 3 blocks with a cumulative length of 8 km in N-S direction and for a width of 3 km. Kimsiburu forms the northern most block of this ultramafic body.

a. Quantum of Work (GSI) :

Drilling : 476.88m in 8 boreholes

b. Geological Set-up :

The Geological set up in the area is same as that described for Jojohatu – Roroburu ultramafic belt. The chromite mineralisation is associated with lenticular concordant bodies of serpentinised ultramafic rocks intrusive into the phyllites of Iron Ore Super Group and later folded along NW-SE axis.

c. Dimension of the ore Body :

There are two bodies of chromite mineralisation in the area. The dimensions are as follows.

Lode No. -1	Strike length	-	300 metres
	Average Thickness	-	34.6 cm
	Depth extension	-	75 metres
Lode No. -2	Strike length	-	80 metres
	Average Thickness	-	21 cm
	Depth extension	-	50 metres

d. Ore Characteristics :

The ore body is pocketlike in nature and it pinches off both along the strike and dip. Chromite is coarsely crystalline with interstitial serpentine and often interbanded with serpentine.

e. Grade and Reserve :

The analysis of 5 core samples has shown Cr_2O_3 content varying from 41.58 % to 49.90%. The bulk of the ore body is of metallurgical grade and the rest is of refractory grade.

The reserve is calculated from the ore dimensions and taking the specific gravity of chromite into consideration.

Lode No. 1	-	31,446 tonnes
Lode No. 2	-	3,260 tonnes
Total	-	**34,706 tonnes**

A total reserve of 34,706 tonnes was determined.

C. RANJRAKOCHA – JANOA DEPOSITS

a. Location :

District	-	Singhbhum
Village	-	Ranjrakocha, Janoa
Toposheet Nos.	-	73 F/6 and F/10

b. Geological Set-up :

The ultramafic rocks with which chromite is associated are intrusive into the rocks of the Iron Ore Super Group represented by the Chaibasa Group. The Chaibasa Group of rocks are represented by phyllites, chlorite schist, feldspathic quartz schist and quartzite. These rocks are folded and show a gentle plunge towards the north. The ultramafic rocks containing chromite mineralisation have intruded along the axes of these folds. Gabbros and dolerites are the later intrusives into these rocks, the quartz veins being the last. The tentative sequence of the rocks found in the area is as follows :

		Alluvium
		Quartz vein
		Gabbro (altered)
Ultrabasic rocks	-	Dunite and saxonite containing pockets of talc and talc schist
		Sheared conglomerate – local and impersistent
Chaibasa Group	-	Quartzite and chert
		Phyllite, chlorite schist
		Feldspathic quartz schist and quartzite

Due to widespread steatitisation and serpentinisation of the ultrabasic rocks, the nature of the original mineral constituents has been almost completely obliterated. The contact of the ultramafic rocks with the rocks of Chaibasa Group wherever visible is marked by gradual steatitisation of the former leading to the development of talc-schist. The major lithounits are cross-folded, and a number of faults and shear zones have developed.

c. Quantum of Work done by GSI

(i) 1963-64

Geological mapping (1:31,680) based on airphoto interpretation	:	35.32 sq km
Detailed Mapping (1:1200)	:	0.35 sq km
Pitting and Trenching	:	A number of prospecting pits were dug

(ii) 1970 - 71

Detailed Mapping (1:2000)	:	0.35 sq km
Large Scale Mapping (1:31,680)	:	3.00 sq km
Pitting and Trenching	:	221.0 cu m.

d. Control of Mineralistion :

The ultramafic rocks containing chromite mineralisation have intruded along the axes of folds formed by the rocks belonging to Chaibasa Group. These folds show a gentle plunge towards north. There are a number of shear planes within the ultramafic rocks along which the chromite mineralisation has taken place. On the Rakingora hill, three shear zones are seen and these coincide with the axes of the folds. As observed in the area north of Janoa, chromite mineralisation is mainly confined to a shear zone along the synclinal axis; mineralisation in the two flanks being subsidiary. Thus, the chromite mineralisation in the area is structurally controlled.

e. Dimension of the Ore Body :

Three chromite lodes have been found in Rakingora hill to the north of Ranjrakocha village. These lodes can be traced for a distance varying from 100 m to about 0.5 km. The thickness of chromite veins and lenses vary from 20 cm to 25 cm.

About 150 m west of the Rakingora occurrence, another mineralised shear zone contains a chromite vein of about 20 cm. thickness. The vein is acutely folded and is traced for about 150 m. Another prospecting pit in the area north of Janoa revealed a 20 cm. thick chromite vein.

f. Mode of Formation :

Chromite of three generations have been observed in the ultramafic rocks. Euhedral chromite which occurs within both olivine and enstatite seems to have crystallised before the silicates. It possibly belongs to the early magmatic period of crystallisation. Chromite of this generation is of minor importance and constitutes one to two per cent of the ore.

g. Ore Characteristics/Nature of Ore Minerals :

In Rakingora hill, chromite occurs as segregations, veins, lenses and is associated with shear zones, which are traceable for some distance. Concentration of chromite are also seen as bands, stringers, pods or disseminations. Such occurrences are very irregular. Thin bands and veins pinch out frequently or they are faulted. Shear planes containing mineralisation are also disturbed by occasional faults and slips.

h. Grade and Reserve :

The analysis of chromite samples collected from the prospecting pits in Ranjrakocha, Janoa and Rakingora hill area shows Cr_2O_3% from 31.48 to 38.55. However, two of the samples collected near Janoa analyse Cr_2O_3 over 48%.

In general, the percentage of iron is high. Two of the samples from Ranjrakocha show high magnesia. Some of these chromite bodies can be used in the manufacture of refractories if the grade is improved by beneficiation. The chromite from Janoa is of metallurgical grade.

An estimate of probable reserve of chromite lodes as revealed from the prospecting pits have been made in Janoa – Rakingora area. The average thickness of chromite veins is taken as 20 cm and the extension of ore body in depth is taken to be 30 m. Depending on the strike length

of outcrop the reserve of the lodes are as follows :

Lode No.1 (Raja Khadan)	:	9,600 tonnes
Lode No.2 (Rakingora area)	:	3,600 tonnes
Lode No.3 (Janoa area)	:	2,400 tonnes
Total	:	**15,600 tonnes**

The reserves obtained are tentative as the veins can possibly be worked to a depth of more than 30 m. A definite figure of reserve can be estimated after drilling.

D. CHROMITE IN BICHABURU – KUSMITA – GURGAON AREAS

a. Location :

District	-	Singhbhum
Village	-	Kusmita
Toposheet	-	73 F/16

The area is served by the State Highway No.33 and is about 48 km south of Chaibasa.

b. Quantum of Work (GSI) :

Geological mapping (1 : 63,360)	:	Data not available
Detailese mapping	:	Data not available
Pitting and trenching	:	A few prospecting pits and trenches were dug.

c. Geological Set-up :

The ultramafic rock with associated chromite is occurring as intrusive into the rocks of the Chaibasa Group of Iron Ore Super Group. Chaibasa Group consists predominantly of hornblende schist, amphibolite and an occasional quartzite band. These rocks have been invaded by granite on regional scale with widespread granitisation and magmatisation of the country rock. The ultramafics have been traversed by tongues and apophyses of this granite. The granite has been traversed by two series of dolerite dykes and an occasional gabbro. The sequence of the rock types exposed in the area is :

	Laterite
	Quartz veins
	Dolerite and gabbro (with minor peridotite)
	Granite
	Ultramafic rock with chromite
Iron Ore Super Group	Hornblende schist, amphibolite and minor metaquartzite

d. Control of Mineralisation :

The rocks of the area have been affected by three generations of fold. The ultramafics and the associated chromite have been emplaced as small detached bodies along the axis of F_2 folds in NNW-SSE direction. The veins of chromite are aligned along the crest of the same fold. The mineralistion appears to be controlled by shears along NNW-SSE direction.

e. Dimension of the Ore Body :

(i)	Gurgaon	-	Strike length	:	80 m
			Thickness	:	2 m
			Depth extension	:	10 m
(ii)	Kusmita	-	Strike length	:	200 m
			Average thickness	:	2.5 m
			Depth extension	:	10 m
(iii)	Bichaburu	-	Strike length	:	30 m
			Thickness	:	7 m
			Depth extension	:	30 m

The depth extension of ore body has been taken after allowing for a reduction of depth of 25 m in Kusmita and 20 m in Gurgaon area, as the chromite ore up to such depth has been removed by mining.

f. Mode of Formation :

The ultramafics have been emplaced as small detached bodies along the axis of F_2 folds. Chromite ores seem to be an early magmatic differentiate from same magma,

g. Ore Characteristics / Nature of Ore Mineralisation :

Chromite ore bodies occur within ultramafic rocks as small plug like bodies and as discrete lenses and veins. These veins pinch off both along the strike and dip.

h. Grade and Reserve :

The grade of chromite is slightly inferior with Cr_2O_3 varying from 39.55% to 43.68%. The ore is amenable to washing with 68% recovery.

The reserve of chromite in Gurgaon, Kusmita and Bichaburu area was estimated taking the dimension of ore bodies and specific gravity of chromite into consideration.

Gurgaon area	-	6,400 tonnes
Kusmita area	-	20,000 tonnes
Bichaburu area	-	12,000 tonnes
Total	-	**38,400 tonnes**

Thus a total reserve of 38,400 tonnes was estimated.

E. Chromite of Tonto Area :

a. Location :

District	:	Singhbhum
Village	:	Tonto
Toposheet No.	:	73 F/11

The area lies about 24 km west of Jhinkpani, which is situated on the National Highway No.33, about 17 km south of Chaibasa, the district headquarter of Singhbhum.

b. Quantum of Work (GSI) :

(i)	Geological mapping (1:31,680) (based on aerial photographs)	:	40 sq km
(ii)	Detailed Mapping (1:1000)	:	0.40 sq km
(iii)	Pitting and Trenching	:	A few prospecting pits were sunk.

c. Geological Set-up :

The ultramafic rocks along with associated chromite occur as intrusive into the rocks of Iron Ore Super Group. Iron Ore Super Group of rocks consists of yellow, grey and purple shale, phyllite, quartzite, feldspathic quartzite, chert and altered basic lava. The ultramafic rock is highly altered due to extensive steatitisation. Vein quartz occurs in rocks of the Iron Ore Group.

Lateritisation of the ultramafics and other rocks is very common in the area. The tentative sequence of the rock types in the area is as follows :

	Laterite
	Quartz veins
	Ultramafic rocks including talc schist and talc rock
Iron Ore Super Group -	Quartzite including feldspathic quartzite and chert, yellow and purple shale, phyllite and altered lava.

d. Dimension of ore Body :

1. Hendeburu area :

Length	:	200 m
Thickness	:	0.2 m
Assumed workable depth extension	:	15 m

2. Hartahatu area :

Length	:	100 m
Thickness	:	0.25 m
Depth extension	:	30 m

e. Ore Characteristics :

The ore bodies in the area are in the form of veins, lenses and sacs with maximum thickness of 20 to 25 cm. The area is highly disturbed and the ore bodies are found to be discontinuous. The lenses and sacs tend to pinch out frequently both along the strike and along the dip.

f. Grade and Reserve :

The grade of chromite ore in Tonto area is poor and can be used only by blending with some better grade ore.

Reserve of chromite was estimated by taking the dimension of the ore body and specific gravity of chromite.

Hendeburu area - 2,400 tonnes

Hartahatu area	-	3,000 tonnes
Total	-	**5,400 tonnes**

The reserves estimated are tentative as the ore body can be worked to greater depth particularly in the Hartahatu area.

CHAPTER – IV

DEPOSITS OF MAHARASHTRA

INTRODUCTION

Bhandara – Nagpur, Sindhudurg and Chandrapur are three important chromite producing belts of Maharashtra. Chromite occurs as lenses, segregated pockets, veins, stringers and disseminations within the altered ultramafics mostly serpentinite bodies. Grades of ore varies from 30% to 42% Cr_2O_3.

1. BHANDARA – NAGPUR BELT

A. PAUNI OCCURRENCES :

a. Location :

Locality - Pauni
District - Bhandara
Toposheet No. - 55 P/9

Chromite deposits are located at about 2 km N and NW of Pauni, an important township on the Nagpur – Bhandara road via Umrer.

b. Quantum of Work (GSI) :

Geological mapping (1:3,000) : 1.6 sq km

c. Geological Set-up :

Chromite mineralisation is associated with highly altered and sheared ultramafic rocks represented by dunite, steatitised serpentinites which occur as interstratified layers within tightly folded Sakoli metasediments. The Sakoli metasediments are represented by phyllites, quartzites, gneisses, amphibolites etc. and these are subsequently intruded by granites. The ultramafics which occur as parallel bands and lenses are silicified, the silicification being intense along the margins. The ultramafics are noticed in similar horizons covering extensive areas intermittently exposed over a length of 40 km between Pauni (55 P / 9) in the east and Kharsingi (55 P / 6) in the west and are considered to have been emplaced along axes of folds of Sakoli metasediments. The stratigraphic sequence of lithounits are given below :

Recent and sub-Recent	:	Alluvium and lateritic grit
Vindhyan	:	Shales, sandstones and conglomerates
Archaean-post Sakoli (Archaean)	:	Chromite bearing ultramafic suite of rocks intruded by granites
Sakoli series (Archaean)	:	Interbanded phyllites, quarzites, gneisses and amphibolites

d. Control of Mineralisation :

The chromite occurs as concordant pods and thin layers in steatitised serpentinite emplaced along the synclinal axes of folds in the Sakoli meta-sediments. Though the ore bodies

lie roughly parallel to the foliation of the country rocks with their long axes parallel to the lineation, they do not show conspicuous flow structures. The concordant pods of chromite appear to have been shredded apart due to later folding and subsequent granite intrusions.

e. Mode of Formation and Age :

The chromite minerals formed and started separating in the early magmatic period of crystallisation and these were inferred to have been carried up as solid masses, during emplacement of its host ultramafic rocks.

f. Ore Characteristics / Nature of Ore Mineralisation :

Chromite occurs as concordant pods and thin layers within dunite and steatitised serpentinites emplaced in folded Sakoli metasediments. The contact between the chromite lode and the serpentinites is sharp and much of the chromite is surrounded by thin margins of yellowish green serpentinite which grades outwards into dark green to greenish black serpentinites.

g. Reserve and Grade :

A reserve of 0.48 million tonnes of ore with 52% Cr_2O_3 (beneficiated) is estimated up to a depth of 15 metres.

B. TAKA OCCURRENCES :

a. Location :

District	:	Nagpur
Taluk	:	Bhiwapur
Village	:	Taka
Toposheet No.	:	55 P/6

b. Quantum of Work :

DGM, Maharashtra (1973-74, 1977-78)

Geological mapping (1:63,360)	:	Not available
Detailed mapping (1:2,000)	:	2.40 sq km
Drilling	:	987.02 m in 14 boreholes
Trenching	:	1893 cu m in 64 trenches

GSI (1961-63, 1998-2000)

Large scale mapping (1:25,000)	:	100 sq km
Detailed mapping (1:2000)	:	1.62 sq km
Drilling	:	2006.65 in 19 boreholes
Pitting and Trenching	:	134 cu m
Sampling	:	225 nos. cores samples 26 nos. trench samples

c. Geological Set-up :

The area is covered by Archaeon metasediments comprising quartzite, schists and granite gneisses, which are intruded by granites and ultramafics. Chromite is confined to the altered ultramafic rocks (Birbirite). The birbirite bodies are in conformity with the general trend of foliation in gneisses and amphibolites.

A generalised stratigraphic sequence in the area is as follows :

Recent to Sub-recent	Soil/Alluvium
Upper Cretaceous to Lower Eocene	Deccan basalt
---------- Unconformity ----------	
Cretaceous	Lameta beds of clays, cherts, siliceous limestone and sandstone
---------- Unconformity ----------	
Permo-Carboniferous	Sandstone and shale (Kamthi)
	--------Unconformity ----------
	Sandstone and shales, coal seams (Barakars)
	Sandstone and shales (Talchirs)
---------- Unconformity ----------	
Archaean (Sakoli Gr.)	Aplites, pegmatites and quartz veins, ultramafic rocks, granite gneisses
	Amphibolites and schists, quartzites, brecciated quartzites and banded magnetite quartzites (BMQ)

d. Control of Mineralisation :

The chromite mineralisation is mainly concentrated in the altered ultramafics (birbirites) as disseminated and lensoid bodies, indicating a lithological control of mineralisation.

e. Ore Characteristics/Nature of Ore Mineralisation:

Chromite occurs as concordant pods and lenses within the altered ultramafic rocks.

f. Dimensin of Ore Body :

The exploration carried out by DGM, Maharashtra in Taka-Ballarpur areas reveals the following facts.

The ultramafic zone with the associated chromite mineralisation extends from Chincholi hill in the west through Ballarpur-Taka village up to Dhamangaon and Pitechua villages in the east for about 5.5 km in length and has a width of 1.4 km. The frequency of rich chromite bearing ultramafics is more between Taka and Ballarpur villages. Detailed exploration work carried out in the area revealed six apparently disconnected pods and lenses of chromite. The dimension of these bodies are as follows :

Body No.1

No. of chromite bands	-	2
Strike length	-	20 to 30 m
Thickness	-	0.2 to 1.6 m
Depth extension	-	10 to 16 m

Body No.2

No. of chromite bands	-	14
Strike length	-	100 m
Thickness/Width	-	0.25 to 3 m
Depth extension	-	40 m

Body No.3

No. of chromite bands	-	4
Strike length	-	16 to 44 m
Width	-	0.20 to 3.50 m
Depth persistence	-	8.00 to 16.00 m

Body No.4

No. of chromite bands	-	3
Strike length	-	16 to 24 m
Width	-	0.45 to 1.20 m
Depth persistence	-	12.00 to 22.00 m

Body No.5

No. of chromite bands	-	2
Strike length	-	68 m
Average Width	-	1.57 m
Depth persistence	-	25 m

Body No.6

No. of chromite bands	-	3
Strike length	-	8 to 40 m
Width	-	0.20 to 4.8 m
Depth persistence	-	60 m

g. Reserve and Grade :

The reserve and grade of chromite in Taka-Ballarpur area estimated by DGM, Maharashtra are presented in following table.

Body No.	Insitu reserves in tonnes	Recoverable reserves in tonnes	Grade	
			Cr_2O_3%	FeO%
1	1700	1190	23.50	11.32
2	31960	22370	35.28	14.12
3	4440	3110	28.62	16.11
4	1390	970	30.75	17.00
5	5200	3640	30.19	11.24
6	10890	7620	28.30	14.54
Total	**55580**	**38900**	-	-

Thus, the total in situ reserves and recoverable reserves in Taka-Ballarpur area are in the order of 55580 tonnes and 38,900 tonnes respectively. The Cr_2O_3 and FeO content ranges from 23.50 to 35.28% and 11.24 to 17.00% respectively.

2. CHANDRAPUR BELT

A. BALLARPUR OCCURRENCES

a. Location :

Locality	-	Ballarpur
Tahasil	-	Warora (New Chimur)
District	-	Chandrapur
Toposheet No.	-	55 P/6

b. Quantum of Work (DGM, Maharashtra **) :**

Drilling	-	374.29 m in 6 boreholes
Trenching	-	582.00 cu m in 17 trenches

c. Geological Set-up :

This is westward extension of Taka chromite zone. The geology of the area has been mentioned in the description of Taka occurrences.

d. Dimension of Ore Body :

The dimension of 6 nos. of chromite bodies in this area has been mentioned in the description for Taka occurrences.

e. Reserve and Grade :

The reserve and grade of chromite in Taka-Ballarpur area has been mentioned in Taka occurrences.

B. DHAMANGAON – PUYARDAND OCCURRENCES

a. Location:

Locality	-	Dhamangaon – Puyardand
Tahsil	-	Umrer and New Chimur
District	-	Nagpur and Chandrapur
Toposheet No.	-	56 P/6

b. Quantum of Work (DGM, Maharashtra **):**

	Dhamangaon area	**Puyardand area**
Geological mapping (1:63,360)	-	95 sq km
Detailed mapping (1:1000)	1.20 sq km	
Trenching	910 cu m	
Drilling	645.11 m (in 11 boreholes)	

c. Geological set-up :

These occurrences are the southern extension of Taka area. Chromite occurs in altered ultramafic in a set up similar to that seen in Taka.

d. Dimension of Ore Body :

Chromite bands vary in thickness from 0.25 m to 1.00 m.

e. Reserve and Grade :

Dhamangaon – Puyardand area is devoid of any significant mineralisation. Maximum Cr_2O_3 in the ore is 45%.

C. PITECHUVA OCCURRENCES

a. Location :

Locality	-	Pitechuva
Tahsil	-	New Chimur
District	-	Chandrapur

QUANTUM OF WORK (DGM, Maharashtra**) :**

Geological mapping (1:63,360)	-	27 sq km
Detailed mapping (1:1000)	-	0.36 sq km
Trenching	-	686 cu m
Drilling	-	578.80 m (in 10 boreholes)

c. Geological Set-up :

Chromite occurs as lenses, veins within altered ultrabasic rocks in a set-up similar to that seen in Taka, Ballarpur and Puyardand area.

d. Dimension of Ore Body :

Length	:	30 m
Width	:	0.4 m to 0.8 m
Depth	:	0.28 m

c. Reserve and Grade :

This is a small deposit and the recoverable reserves are of the order of 660 tonnes with Cr_2O_3 content ranging from 22.81 to 35.15%.

3. SINDHUDURG BELT

In this belt, chromite deposits of Kankauli area are located in three different places near Kankauli, Janoli and Vagda within a distance of 2 km from Kankauli town. Gosaviwadi chromite occurrence form another deposit in this belt.

A. KANKAULI – JANOLI – VAGDA OCCURRENCES :

a. Location :

District	-	Sindhudurg
Tahsil	-	Kankauli
Toposheet No.	-	47 H/11

Kankauli, an important town in the area is situated on the Bombay – Konkan Goa Highway. Kolhapur is the nearest railway station and is about 130 km away from Kankauli. Kankauli chromite deposit is located at about 2 km NE of Kankauli town, Janoli deposit is at 100 m NW of Kankauli deposit. Vagda deposit is situated 1.6 km south of Kankauli town.

b. Quantum of Work GSI (1959-60) :

Geological mapping (1:63,360)	-	10 sq miles
Detailed mapping (1:1200)	-	All occurrence points

DGM, Maharashtra (1971-74)

Geological mapping (1:15,840)	-	100 sq km
Detailed mapping (1:1250 & 1:2500)	-	2.70 sq km
Pitting and Trenching	-	70 cu m
Drilling	-	1600.10 m (in 45 boreholes) Kankauli area – 35 boreholes Vagda area – 8 boreholes Janoli area – 2 boreholes

c. Geological Set-up :

Regionally, the Archaean rocks are represented by Dharwarian metasediments, metabasites, granite gneisses and acidic as well as mafic and ultramafic intrusive rocks. These are unconformably overlain by the Kaladgi sediments of Precambrian age which in turn are covered by extensive sheets of Deccan trap lava flow. Large area of the region is covered by laterite and lateritic soil.

The stratigraphic sequence in the area is presented as follows :

Soil and lateritic soil	Recent and sub-recent
Laterite	Post Eocene to Recent
Deccan traps (basalts)	Upper Cretaceous to Lower Eocene
---------- Unconformity ----------	
Conglomerates, grits, Quartzites, shales, sandstone etc.	Kaladgis (Precambrian)
---------- Unconformity ----------	
Acid intrusions	Granites, pegmatites and quartz veins
Basic intrusions	Dolerite and gabbro
Ultrabasic intrusions	Dunite, picrite, serpentinite etc.
Granite	Gneisses, hornblende schist, biotite schist, amphibolites, banded hematite quartzite

The regional trend of foliation of Archaean rocks varies from NNW-SSE to NW-SE with steep dips of 60^{o} to 80^{o} mostly towards west.

d. Control of Mineralisation :

In Kankauli – Janoli area, chromite occurs in a few discontinuous outcrops spread over a distance of about 525 m, enclosed in ultramafic rocks, mainly dunite which is altered at places to serpentinite schist, talc schist and tremolite schist. This ultramafic body with the included chromite trends in WNW-ESE direction which is discordant with the regional trend of foliation in the country rocks. This indicates that the ultramafic body occurs as a dyke.

In Vagda area, there are two exposures of ultramafic bodies trending in NW-SE direction, intruding the country rocks of hornblende schist.

e. Dimension of the Ore Body :

The chromite ore bodies are exposed at five places in Kankauali – Janoli area and at three places in Vagda area. The dimension of these bodies are as follows (GSI, 1959-60).

Area	Band No.	Length(m) x Width (m)
Kankauali – Janoli	1	137.0 x 7.6
	2	6.0 x 4.5
	3	9.0 x 2.4
	4	24.0 x 3.0
	5	12.0 x 2.4
Vagda	1	30.5 x 6.0
	2	45.7 x 6.0
	3	18.0 x 1.5

Subsequent work by DGM, Maharashtra (1971-74) indicated three fairly well developed bands in Kankauli area. Those are Southern band 150 m x 3-10 m x 50 m (depth). Middle band 170 m x 1-5m x 40 m (depth) and Northern band 40 m x 0.1 – 4m x 20 m (depth).

f. Mode of Formation and Age :

The ore microscopic study of chromite and ultramafic rock samples from the area indicate that the formation by the late magmatic processes involving residual liquid accumulation and injection appears to be favourably applicable to these chromite deposits.

The ultramafic rocks and associated chromite are of Archaean age.

g. Nature of Ore Mineralisation :

Chromite forms steeply dipping bands in ultramafic rocks and its metamorphosed derivatives such as serpentine-talc-tremolite schist etc. The ore microscopic studies indicate that chromite occurs in small lenticular segregation and dissemination in serpentine ground mass. It forms thin lines branching randomly and there is no preferred orientation of chromite and other rocks minerals.

h. Reserve and Grade :

The total estimated reserves of chromite in Kankauli and Vagda areas as estimated by GSI (1959-60) are of the order of about 71,300 tonnes with an assumed depth persistence of about 30 m. The Cr_2O_3 content varies from 32 to 38 percent. Iron varies from 12 to 18 percent.

As per the work of DGM, Maharashtra, the total insitu, recoverable reserves along with the grades of chromite are presented in the following table.

Area	Insitu Reserves in tonnes	Recoverable Reserves in tonnes	Cr_2O_3%	FeO%	Al_2O_3%
(A) Kankauli					
South Band	81132.00	56,792.40	31.04	22.05	12.63
Middle Band	49626.00	34,738.20	30.88	23.89	11.22

North Band	6590.00	4,613.00

	137348.00	96,143.60 (say 96,000 tonnes in total)	30.98 (Average)	23.02 (Average)	11.88 (Average)
(B) Vagda	7215.00	5,000 tonnes	34.21	25.27	15.17
(C) Janoli	1110.00	800 tonnes	-	-	-

Thus, total recoverable reserves of chromite in these areas is of the order of 101800 tonnes with the grade ranging from 30 to 34% of Cr_2O_3 and 22 to 28.5% of FeO.

B. GOSAVIWADI OCCURRENCES :

a. Location :

Locality - Gosaviwadi
District - Sindhudurg
Toposheet No. - 47 H/12

b. Geological Set-up :

Chromite occurs within altered, ultramafics (serpentinites and talc tremolite schist) associated with Precambrian hornblende schist.

c. Dimension of Ore Body :

The strike extension of the ore body is 30 m with 5 m of average width.

d. Reserve and Grade :

A reserve of 11,000 tonnes of ore with 39.07% Cr_2O_3 was estimated by the DGM, Maharashtra (1976-77). Subsequently the reserve figure has been revised as 0.102 million tonnes by DGM, Maharashtra (1991).

CHAPTER-V

DEPOSITS OF ANDHRA PRADESH

INTRODUCTION

In this state, the chromite deposits occur as lenses and pods of small dimension in two distinct geological environments (1) associated with the ultramafics of the metamorphosed, layered Chimalpad gabbro-anorthosite complex intrusive into the Archaean high grade schists and gneisses (Khammam district) and (2) as lenses and disseminations in pyroxenite emplaced within charnockite and quartzofeldspathic gneisses of the Easternghat Supergroup (Kondapalli, Krishna district). The chromite of Khammam district is of low grade with average Cr_2O_3 content less than 40%, the other oxides being within the permissible limits of refractory grades. The Kondapalli Chromite ore has high Cr_2O_3 content (upto 52%) as also high Fe_2O_3 (about 18-35%).

A. JANNARAM BLOCK

a. Location :

District	:	Khammam
Taluk	:	Wyra
Village	:	Jannaram
Toposheet No.	:	65 C/7

b. Quantum of Work Done :

Large scale mapping (1:25,000 scale)	-	50 sq km
Detailed mapping (1:2000 scale)	-	0.8 sq km
Pitting / trenching	-	50 cu m
Drilling	-	561.15 m (in 7 boreholes)
Sampling	-	10 nos.

c. Geological Set-up :

The Jannaram block consists of granitoids and gneisses of the Peninsular Gneissic Complex into which mafic-ultramafic-anorthositic intrusive bodies were emplaced. Anorthosite, gabbro / leucogabbro, pyroxenite, websterite and dunite constitute the lithounits of the ultramafic complex. The area is predominantly soil-covered, with an in situ lens of chromite occurring within the ultramafic units. All the litho assemblages of the intrusive complex exhibit conspicuous layering, but chromite occurs only as podiform lenses in places where the ultramafic units viz. dunite, pyroxenite, websterite form thickened sheaths within the layered sequence.

d. Control of Mineralisation :

Chromite mineralisation occurs in the form of pods/lenses within the thicker portions of the layered ultramafic-mafic assemblage, The chromite lenses are parallel to the layering and vary in size from a few centimeters by few centimeters and upto 12.5 mts x 2 mts. Though the

isomodal/cryptic/phase layering of the intrusion is present (observed only in drill hole intersections) chromite does not exhibit stratigraphic parallelism with the other units.

e. Dimension of the Ore Body :

A single in situ lense of chromite is exposed. It has a length of 12.5 mts. and a thickness of 2 mts. It is presumed to extend along dip, at least upto 6 mts.

f. Reserve and Grade :

The in situ lense accrues a reserve of 600 tonnes of chromite. Besides this, float chromite is present through out the block, which may yield about 500 tonnes (total 1100 tonnes).

The average grade of chromite is 39.26% Cr_2O_3, 13.53% SiO_2, 17.87% FeO, 10% Al_2O_3.

g. Ore Characteristics :

Chromite occurs as crystalline aggregates set in a matrix of olivine, talc, tremolite and pyroxenes. The ore is lumpy, hard, granular and black to steel grey.

h. PGM association :

Search for PGE may be attempted within the upper layered sequence.

B. KONAYYAPALEM BLOCK

a. Location :

District	-	Khammam
Taluk	-	Wyra
Village	-	Konayyapalem
Toposheet No.	-	65 C/7

b. Quantum of Work Done :

Detailed mapping (1:2000 scale)	-	0.6 sq km
Pitting and trenching	-	50 cu m (approx)
Drilling	-	295.90 m (in 2 boreholes)
Sampling	-	8 nos.

c. Geological Set-up :

The block is located about 6 km NE of Jannaram block. The area is completely soil covered, save a few outcrops of migmatitic gneiss, anorthosite, two lenses of chromite and ubiquitous float of chromite. The lenses of chromite are enclosed within talc-tremolite schist, and are located 400 m apart. The ultramafic-mafic assemblage occurs as enclaves in migmatites and gneisses. The trend of the layering is NW-SE with moderate to steep dips due SW. The mafic-ultramafic assemblage is folded on a NW-SE axis plunging at 55^o to 60^o SE (it could be likely that the emplacement is concomitant with the deformation of the migmatites and gneisses).

d. Control of Mineralisation :

Chromite occurs as pods and lenses of very limited strike extent as well as dip extension, enclosed within the talc tremolite schist, pyroxenite, dunite and websterite. The lenses are parallel to the layering. The mineralisation is restricted to thickened ultramafic layers only, although a thick pile of layered rocks occur.

e. Dimensions of the Ore Body :

An in situ lens of chromite measuring 9 m x 2 m with dip length is assumed to be about half of its length i.e. 4.5 m. is present. Occasional blind lenses of chromite were struck in the boreholes.

f. Reserves and Grade :

The in situ lens is expected to yield a reserve of 324 tonnes with 39.55% Cr_2O_3; 10.29% SiO_2; 18.69% FeO; 11.86% Al_2O_3.

g. Ore Characteristics :

The chromite is crystalline, granular, black to steel grey. The gangue minerals include talc, tremolite, serpentine and olivine/pyroxene.

C. LINGANNAPETA BLOCK

a. Location :

District	-	Khammam
Taluk	-	Wyra
Village	-	Lingannapeta
Toposheet No.	-	65 C/7

b. Quantum of Work Done :

Detailed mapping	-	0.5 sq km (1:2000) 1.25 sq km (1:5000)
Drilling	-	173 m (in 2 boreholes)
Sampling	-	20 nos.

c. Geological Set-up :

The block is situated about 4 km north of Konayyapalem block. Here an abandoned working for chromite exposes talc-tremolite schist, serpentinised pyroxenite/dunite and a lensoid occurrence of chromite. The vicinity of the working is strewn with ubiquitous float of chromite. Barring these features, the rest of the area is soil-covered. The topography forms a little elevated ground in relation to the neighbourhood. The strike of the banding/layering is NW-SE with steep (70^o-80^o) northeasterly dips.

d. Control of Mineralisation :

The chromite mineralisation is in the form of pods and lenses, enclosed within talc-tremolite schist, serpentinised dunite/pyroxenite. Borehole intersections in this block have established a huge thickness of ultramafic-mafic-anorthosite complex, showing distinct layering. Three seams of chromite were struck, enclosed within talc-tremolite schist.

e. Dimension of the Ore Body :

Three lenses of chromite were intersected by drilling in this block The following dimensions were assumed for these lenses.

Lens	1	:	80 m x 13m x 40m (depth extension)
Lens	2	:	10 m x 2.5 m x 5 m (depth extension)
Lens	3	:	10 m x 2.5 m x 5 m (depth extension)

f. Reserve and Grade :

Lens	1	:	0.16 million tonnes
Lens	2	:	500 tonnes
Lens	3	:	500 tonnes
Total Reserve		:	0.161 million tonnes

The average grade of the chromite ore is :

(All in %)

	Lens 1	Lens 2	Lens 3
Cr_2O_3	36.84	27.22	36.04
SiO_2	18.72	27.34	22.10
FeO	11.56	11.41	9.64
Al_2O_3	10.33	9.36	12.02
CaO	4.41	1.36	2.27
MgO	16.67	19.60	15.81

D. SRIRAMGIRI BLOCK

a. Location :

District	-	Khammam
Taluk	-	Wyra
Village	-	Sriramgiri
Toposheet No.	-	65 C/7

b. Quantum of Work Done :

Detailed mapping	-	Data not available

c. Geological Set-up :

The block is similar in geological set up to that of the Lingannapeta block. Here, an open cast mine of Ferro Alloys Corporation Ltd., Garividi, exposes the ultramafic litho-units of the intrusive complex, comprising serpentinised pyroxenite, dunite, talc-tremolite schist and chromite. This intrusive body has been emplaced into migmatites and gneisses of the Peninsular Gneissic Complex.

d. Controls of Mineralisation :

The chromite mineralisation occurs as parallel/concordant lenses within the ultramafics. Chromite occurs as thicker and more segregated lenses in this block which is due to the thick sack of ultramafic litho-units. The lenses have limited strike and depth extension.

e. Dimensions of the Ore Body :

The open cast mine, along with the chromite lenses, extends over a strike length of 150 m. The thickness of the individual lense varies from 1 m to 3 m but the entire zone in which chromite lenses are parallely disposed is about 10 m. The dip length is assumed to be around 75 m.

f. Reserves and Grade :

Total reserves (with tonnage factor of 4)	:	0.45 million tonnes
Chromite already mined out	:	0.09 million tonnes
Chromite available (probable category)	:	0.36 million tonnes

The average grade of the chromite is Cr_2O_3 – 38.12%, FeO-6.36%, CaO-2.52%, SiO_2 – 26.65%, Al_2O_3 – 11.16% and MgO-12.11%.

E. KONDAPALLI BLOCK

a. Location :

District	-	Krishna
Taluk	-	Vijayawada
Village	-	Kondapalli
Toposheet No.	-	65 D/10

b. Quntum of Work Done :

Reconnaissance mapping (1:25,000 scale)	-	35 sq km
Sampling	-	20 nos.

c. Geological Set-up :

Acid and intermediate charnockites are most common rock types in the Kondapalli area. The charnockites are associated with pyroxene granulites, magnetite-hypersthene-quartz granulite, garnetiferous quartzo-feldspathic gneisses and pink garnetiferous granite gneisses. Pegmatites and quartz veins are intrusive into all these rock types. Pyroxenites were emplaced into the charnockite, quartzo-feldspathic gneisses and pyroxene granulites.

The regional trend of the foliation is NNE-SSW to NW-SE with steep dips varying from 55^o to 80^o towards easterly direction.

d. Controls of Mineralisation :

Chromite occurs as lenses, bands, pockets and disseminations in steeply dipping and pitching lenticular bodies of pyroxenite. At places, thin chromite veinlets are seen on the walls of the chromite quarry occurring within intermediate charnockite, although the main chromite deposit is confined to the pyroxenite body.

e. Grade of the Ore :

The grade of the ore is Cr_2O_3 from 22.81 to 51.94%, SiO_2-0.05 to 8.30%, Fe_2O_3-17.94 to 38.94%, Al_2O_3-4.35 to 32.27%, CaO-1.65 to 2.10% and MgO from 6.80 to 20.66%.

f. Conclusion and Recommendation :

The chromite occurrences in nine localities of Kondapalli reveal that the ore occurs as irregular and impersistent lenses/bands and disseminations within the pyroxenite bodies.

The chromite is generally of poor quality, and even the ores containing high Cr_2O_3 content generally show high iron content, thus making them unsuitable for metallurgical purposes. These ores are, however, fit for use in the chemical industry.

CHAPTER – VI

DEPOSITS OF KARNATAKA

INTRODUCTION

Chromite occurs in the state in altered ultrabasic rocks (serpentinised peridotites) forming regular veins, lenses, and segregated pockets of various dimensions. Workable deposits of various grades and of varying extent are found in the districts of Mysore, Hassan, Chikmagalur and Shimoga. Of these, the deposits of Mysore and Hassan districts are most important from the commercial point of view.

There are several ultrabasic belts in the state, of which Nuggihalli schist belt, Hassan district and Sindhuvalli – Talur ultramafic belt of Mysore district are the most important. The major occurrences are in Byrapur, Bhaktarhalli, Jambur, Chikkonahalli, Tagadur etc.

A. NUGGIHALLI SCHIST BELT, HASSAN DISTRICT

a. Location :

District	-	Hassan
Taluk	-	Channarayapatna and Arsikere
Toposheet No.	-	57 C/8

b. Quantum of Work Done :

Geological mapping (1:15,800 scale)	-	12 sq km
Geological mapping (1:22,620 scale)	-	24 sq km
Photogeological study (1: 2,400 scale)	-	0.60 sq km
Geophysical survey	-	0.80 sq km
Sampling	-	80 ore samples
		95 soil samples

c. Geological Set-up :

The Nuggihalli schist belt extends for a strike length of 50 km in a NNW-SSE trend from near Arsikere in the north to Kempinkote in the south. This schist belt forming a prominent linear belt of medium to high grade schists belongs to Sargur Complex.

The schist belt consists of amphibolites and quartzites of Belgumba formation and meta-ultramafites (serpentinites), meta-peridotites, meta-pyroxenites, tremolite-actinolite-chlorite schists and dunite with bands of chromite and titano-magnetites, anorthosites and gabbro belonging to Bairapura ultramafites. The belt is enclosed by peninsular gneiss with basic dykes cutting across all the formations, and forms a narrow tightly folded synclinal structure. The regional strike of the schistose rocks is $N20^oW – S20^oE$ to N-S with a dip of 50^o to 60^o towards east. The axial plane schistosity (S_1) trends in $N30^oW – S30^oE$ direction.

d. Control of Mineralisation :

Mineralisation is lithologically controlled with chromite bodies being confined to serpentinites.

e. Dimension of the Ore Body :

The dimension of the ore bodies observed in different blocks are as follows

Name of the block	Dimension
Bhaktarhalli	23 m x 1.2 m
Chikkonahalli	16.5-432 m x 0.15-2.72 m
Tagadur	27.2 – 179 m x 0.53 – 2.58 m
Jambur	12.0 – 185 m x 0.3 – 1.21 m

f. Grade and Reserve :

The blockwise grade and reserve of chromite are as follows :

Name of the Block	Grade (in %)	Reserve (tonnes)	Estimated by
Bhaktarahalli	Cr_2O_3 36.40 Cr/Fe :: 1.5	1,250 (upto 30 m depth)	GSI
Chikkonahalli	Cr_2O_3 22.78-38.01 Cr/Fe :: 0.74 – 1.5	18,905 (upto 30 m depth)	GSI
Tagadur	Cr_2O_3 27.33-36.95 Cr/Fe :: 1.04-1.4	73,315 (upto 30 m depth)	GSI
Jambur	Cr_2O_3 33.19 – 49.09 Cr/Fe :: 1.2 – 1.98	19,645 (upto 30 m depth)	GSI
Bairapur	Cr_2O_3 46-48	686,630 (upto 197 m depth)	DGM, Karnataka

g. Ore Characteristics / Nature of Ore Mineralisation :

Chromite occurs as massive lenses of varying dimensions, linear disconnected bands and as veins within the serpentinites.

h. Recommendation :

On the basis of gravity surveys by GSI, two anomaly points – 'D' in Bhaktarahalli block and 'F' in Tagdur block, have been delineated and these points are suggested for further investigations by trenching and shallow systematic drilling.

B. SINDHUVALLI – TALUR BELT, MYSORE DISTRICT

a. Location :

District - Mysore
Village - Sindhuvalli, Talur, Dodkatur
Toposheet No. - 57 D/11, 57 D/12

b. Quantum of Work Done (GSI) :

Sindhuvalli and Dodkatur block	1.65 sq km
Geological mapping (1:1000)	655.0 m (in 8 boreholes)
Drilling	12 nos.
Trenching	221 (ore samples)
Sampling	

Talur block	0.21 sq km
Geological mapping (1:1000)	565.70 m (in 5 boreholes)
Drilling	95 (ore samples)
Sampling	

c. Geological Set-up :

The Sindhuvalli-Talur ultramafic belt extends from river Kabini in the south to the north of Mysore city. This belt of ultramafic rocks stand as detached linear mounds or low ridges amidst surrounding gneissic terrain. The gneissic terrain consists of hypersthene bearing gneisses, together with minor intercalations of hornblende pyroxene and hypersthene granulites. The general trend of foliation vary from N10^{o}W – S10^{o}E to N10^{o}E-S10^{o}W with very steep to vertical dips on either side.

The ultramafic rocks which have intruded the gneisses consists mainly of serpentinites, derived from the alteration of dunite, pyroxenite, hornblendite and steatite schists. There is a sharp contact between the serpentinites and the gneisses.

d. Control of Mineralisation :

The mineralisation is lithologically controlled with the chromite bodies being confined to serpentinites.

e. Dimension of the Ore Body :

Sindhuvalli – Dodkatur block : 130 m. X 0.18 – 0.75 m.

Talur block : 40 m. X 0.1 – 0.44 m.

f. Grade and Reserve :

The grade of chromite bodies in different blocks are as follows :

	Sindhuvalli block	**Dodkatur block**	**Talur block**
Cr_2O_3%	37.5 – 46.95	38.64	19.92 – 40.05
Fe/Cr	-	1 : 1.7	1 : 1.6

g. Ore Characteristics / Nature of Ore Mineralisation :

The chromite bodies are found as lenses and small bands within serpentinites ; the lenses are concordant in Sindhuvalli, Dodkatur area and discordant in Talur area and have limited strike extensions. The chromite grains are mostly anhedral, subrounded and often compact.

C. OTHER DEPOSITS

KALANGAVI (3 KM WSW OF HOSADURG R.S.), Chitradurga district,
Low grade disseminated chromite ore (below 31% Cr_2O_3) occurs with the ultramafics.

BANDE-BANUR-GAJEKATTE (1 KM FROM SIVANI R.S.), Kadur district
Low grade chromite ores (30% Cr_2O_3) as local disseminations occur within the ultramafics.

AMBLIKATTE – JHANDIMATTI – ANTARGANGE, Shimoga district

Sporadic ore concentrations in the expansive ultramafics, supporting some historical mining operations, have been reported.

CHAPTER – VII

DEPOSITS OF TAMILNADU

INTRODUCTION

Sheet like layered intrusion of anorthosite and pyroxenites are observed in the country rocks comprising Precambrian biotite gneisses. The commonest name given to this complex has been after the type area. The complex trending in ENE-WSW direction extends for a length of 40 km and for an average width of 400 m. The rocks of the area are further intruded by granites and pegmatites.

A. SALEM AREAS :

a. Location :

District	-	Salem
Taluk	-	Namkhal and Thiruchengoddu
Toposheet Nos.	-	58 E/15 & 16

c. Control of Mineralisation :

There are 4 to 5 chromite ore bands. These occurring in form of seams, are confined to pyroxenites. The pyroxenite is amphibolised to a large extent.

d. Dimension of the Ore Bodies :

The ore bands are 200 m to 2 km in length. The width is within 5 to 6 m.

e. Ore Characteristics / Nature of Ore Mineralisation :

Chromite occurs in forms of veins, lenses and pods.

f. Grade and Reserve :

The crude ore has 24-28% Cr_2O_3, 22-35% FeO, 24-30% Al_2O_3, 5-15% SiO_2 and traces of Hg. The beneficiated ore went up to 32-36% Cr_2O_3, 27-30% FeO and around 1% SiO_2 with alumina about the same as iron.

Reserves estimated by GSI stood at 0.22 million tonnes within 6 m from the surface.

B. CHALK HILLS AND KANJAMLAI AREAS

Small chromite deposits have been mined in dunite masses at both these places.

CHAPTER – VIII

DEPOSITS OF ARAKAN SUTURE LINE

Cretaceous – Eocene ophiolitic ultramafics in a broadly N-S trend along the Indo-Myanmar frontier viz. Arakan Yoma suture line down to the Andaman and Nicobar Islands, are studied for chromites and their incidences to form ore deposits in areas such as Nagalad, Manipur and the Andamans (near Port Blair at Chukergaon and also in Rutland).

CHAPTER – IX

DEPOSITS OF GOA

Large ultramafic pluton in Dudhsagar belt near Ponda has been recently confirmed to be chromiferous, though ore deposits are yet to be discovered in this Archaean greenstone association.