

# Current Status of Exploration and Resources of Gold in India: Review of Prospect-wise Resources Defined by MECL

B. P. RATURI\*, J. NARAYANA MOORTHY, SAURABH VIVEK and MD. INTAZAR ALAM

Mineral Exploration Corporation Limited, Nagpur, India

\*E-mail: bpraturi100@yahoo.in

**Abstract:** Mineral Exploration Corporation Limited (MECL) has brought to finality a number of gold prospects and Resources since 1980 in different parts of the country. Gold mineralisation occurs in diverse geological settings cutting across time scale with specific peaks. One such peak is the Neoproterozoic period when globally many gold deposits were formed in greenstone belts. Mesoproterozoic and Proterozoic Periods too are known for significant gold mineralisation. In India, gold mineralisation is found in the Archaean greenstone/schist belts, granitoids adjacent to greenstone belt, Proterozoic Fold Belts and in the Southern Granulite Terrain. Mineralisation of both primary and secondary types occur. Primary mineralisation is both syngenetic and epigenetic in nature. Primary mineralisation may develop in any rock type but metabasalt account for most production. Mineralisation occurs in diverse structural settings. Shear zones are the major control of mineralisation. Fold closures are also favourable locales for mineralisation. Mineralised zones occurring in greenschist to amphibolite facies metamorphic terrains are always marked by retrogression. Wall rock alteration and geochemical changes associated with mineralisation are indicative of hydrothermal activity.

Secondary mineralisation of lateritic and placer types also occurs in different parts of the country. In addition to primary mineralisation, secondary gold in laterites is common in the Southern Granulite Terrain. Detailed exploration by MECL has eventually led to delineation of gold Resources in Yerrappa-Gantalappa block, Ramagiri schist belt; Chigargunta and Old Bisanatham blocks in Kolar schist belt, Uti block in Hutti-Maski schist belt and Kunderkocha block in Gorumahisani –Badampahar belt. Uti block is under active mining by opencast method whereas mining in other blocks is suspended. Dona East block in Jonnagiri schist belt and Sangli and adjacent blocks in the Gadag schist belt are in the hands of private sector for further development. Pahardia and Parasi blocks in the Singhbhum Proterozoic Fold Belt have been successfully auctioned by the government to private investors. The paper presents the salient features of completed and ongoing investigations for gold by MECL in different geological terrains in the country. With vast experience in the field of exploration with updated infrastructure under a single umbrella, besides a team of professional geoscientists, MECL is fully equipped to offer integrated multi-disciplinary services for carrying out exploration for gold and other minerals within India and abroad.

**Keywords:** Gold Exploration, MECL, Dharwar Craton, Singhbhum Craton, Aravalli Fold belt.

## INTRODUCTION

Gold has attracted the mankind since time immemorial. In nature, it occurs as both primary and secondary types. Secondary occurrences are seen in laterite and as placers of alluvial and colluvial types. Primary gold mineralisation occurs in diverse geological setting and periods with different peaks. One such peak is the Archaean period when vast of the gold deposits were formed mainly in the Neoproterozoic greenstone belts. The adjoining granitoids also carry mineralisation. Mesoproterozoic greenstone belts/schist belts, Proterozoic Fold Belts/supracrustal belts are also potential sources for gold mineralisation. The mineralisation occurs in both volcanic and sedimentary rocks represented mainly by metabasalt,

metaandesite, metarhyolite, metaultramafite, metagreywacke, metaargillite, quartzite, banded iron formation (BIF) and Quartz Pebble Conglomerate (QPC). Mineralisation is most often confined to deformed and metamorphosed rocks characterized by distinct wall rock alteration and associated geochemical changes. Mineralisation is generally restricted to structural dilatant zones, exhibiting ductile to ductile-brittle shearing. Fold closures are also favourable sites for gold mineralisation more so in BIFs.

Until recently Geological Survey of India was doing regional exploration for gold and Mineral Exploration Corporation Limited (MECL) was engaged in detailed exploration of the promising prospects. The spurt in gold prices

prompted the MECL to diversify into detailed exploration for gold in the year 1980, especially to explore and extend the life of the world famous Kolar Gold Mines. Since then, MECL has been exploring the different geological domains in the country. The exploration domains included Archaean greenstone/schist belts and adjoining granitoids, Proterozoic Fold Belts and laterites in the Southern Granulite Terrain (SGT). The exploration has covered Kolar belt, Hutti-Maski belt, Ramagiri, Nuggihalli, Chitradurga, Dharwar and Gorumahisani greenstone/schist belts, Proterozoic Aravalli, Singhbhum and Sakoli Fold Belts; Archaean granitoids bordering Jonnagiri belt and Wayanad gold field within the SGT.

Detailed exploration involved topographical survey, geological mapping, geochemical sampling, close spaced drilling, mineral beneficiation, geotechnical and environmental studies with or without mine sampling and finally exploratory mine development. The main purpose of detailed exploration was to increase confidence level of Resource estimates as well as augmentation of the existing Resources. MECL's efforts in different geological domains are presented below for a synoptic appraisal.

#### **RAMAGIRI SCHIST BELT**

In this belt, detailed exploration was carried out in Chennabhavi block, Ramagiri South Shaft area, Yerrappa-Gantalappa block and Gantalappa block. The exploration in Yerrappa-Gantalappa block has delineated two lodes viz. the Yerrappa and Gantalappa lodes, over 300m and 200m strike length respectively with a lean zone of 200m in between. The rock types of the schist belt are hornblende schist and quartzites forming the base and the mineralised phyllite overlies them. The rocks are folded and metamorphosed. Gold mineralisation is associated with stringers and veinlets of quartz and quartz carbonate veins localised in phyllite. Besides, the gold mineralisation is associated with black quartz-carbonate rock occurring in the northern part of Yerrappa Block. Shear zones control the mineralisation. A total of nine ore shoots have been delineated ranging in strike length between 5m and 108m and an average width of 1.36m and average grade of 2.65 g/t Au. The ore shoots exhibit pinch and swell structure. The total ore Resources estimated up to a vertical column of 200m in different blocks is 0.602 Mt with an average grade of 2.40 g/t Au. Bharat Gold Mines Limited (BGML) has carried out mining till its closure in 2001.

#### **KOLAR SCHIST BELT**

This schist belt holds the world-famous Kolar Gold Field (KGF) which has produced over 800 tonnes of gold metal from different mines. MECL initiated gold exploration in the lease hold area of BGML and extended beyond the leasehold in

different prospective blocks. MECL has also carried out detailed exploration in the southern part of the belt in the following blocks.

#### **Chigargunta Prospect**

Located 27 km south of KGF the Chigargunta prospect extends over 4 km and is divided into six blocks namely Block-I, II, III, IV, V and Boundary Block from north to south. Mafic schists on west and felsic schists on east are the two major litho-units which have undergone amphibolite facies of metamorphism. Gold mineralisation occurs along shear zones in both mafic and felsic schists. Mineralisation in mafics as well as at the contact of mafics and felsics is designated as 'western mineralisation' while that in the felsic rocks 'eastern mineralisation'. Accordingly, each block is also divided in western and eastern sectors. Gold occurs in the eastern mineralisation mostly as, free milling type; whereas, it is both free milling and refractory types in western mineralisation. MECL carried out detailed exploration including underground mine level development, raising/winning and trial stopping and exploratory deep drilling over about 5 km strike length in both western and eastern mineralisation systems which eventually led BGML to undertake mining till closure in 2001. A total gold Resource of 2.916 Mt of ore was estimated at a grade of 5.14 g/t Au. Most of the ore shoots are wide and open even beyond the explored depth of 300 – 350m.

#### **Mallapakonda Prospect**

Located in the southern part of the belt Mallapakonda Prospect is composed of amphibolites, BIF and minor graphite sulphide schist. Gold mineralisation occurs in sulphidic BIF. Gold is mainly refractory type. Exploration by MECL has established gold resources of 0.773 Mt with average grade of 2.47 g/t of Au.

#### **Bisanatham Block**

The old Bisanatham Mine is located 8 km south of KGF mines. MECL reclaimed the mine and sampled the first four levels out of nine underground levels. The mine is developed on one major auriferous zone called 'Bisanatham Main lode' in which quartz, feldspar and hornblende are the major minerals. Calcite, epidote, zoisite and opaques are present in trace quantities. The host rock is schistose amphibolite which is sheared. The shear zone is parallel to schistosity and controls the mineralisation. Gold occurs as free milling type. Pyrrhotite, arsenopyrite and chalcopyrite are the associated sulphides. The total potential of the mine can be augmented by further reclamation and sampling of lower levels and extension of drives in promising sectors for exposing the full dimension of

the lodes. The Mineral Resources estimated over a strike length of 310 m and up to a depth of 160 m is 0.173 Mt of an average grade of 4.7 g/t Au. BGML has carried out mining in this block till its closure.

### HUTTI-MASKI SCHIST BELT

India's current mine production of gold comes from this belt. There are three working gold mines operated by M/s Hutti Gold Mines Ltd., a PSU owned by Govt of Karnataka. The prime producing mine is near Hutti village in Raichur district, Karnataka. The other two are at Uti and Hira Buddini located about 20km to the east, working as two satellite mines to the main Hutti mine. The belt has other gold prospects explored by GSI and two private Companies. MECL has carried out detailed exploration in the following blocks.

#### Buddini

This prospect lies near Maski, about 25 km south of Hutti Gold Mines. Gold mineralisation occurs in quartz reefs within carbonate bands amidst cherty chlorite schist. The mineralised zone is characterised by quartz, carbonate and sulphide association and the width varies from few centimetres to two metres. A total of five lodes have been identified, viz. E1 Lode, Mopla Lode, Main Lode, W-1 and W-2 Lodes; of which the Main and Mopla lodes are persistent. The Mopla lode is the most promising and is characterised by stringers and veinlets of quartz and ankerite traversing chlorite schist. Wall rock alteration is marked by sericitisation and chloritisation. The Main and Mopla lodes extend for 200 m along strike beyond the limits of old workings. Resource has been estimated for Mopla lode which stands at 0.21 Mt of ore with average grade of 2.16 g/t Au.

#### Wandalli

This block is located to the east of Hutti Gold Mines. The rocks are dominantly mafic volcanics represented by massive and schistose amphibolites with minor amount of felsic volcanics, carbon phyllite, chert and veins of granodiorite and quartz. The mineralised zones are predominantly confined to mafic volcanics represented by fine grained schistose amphibolite. The mineralised zones are parallel to sub parallel exhibiting pinch and swell structure along strike and dip. The beneficiation study reveals that gold has been recovered to the tune of 92.2% with tailing assay of 0.05ppm gold. The ore resource estimated up to a depth of 70 m is 0.46 Mt of an average grade of 2.76 g/t Au.

#### Uti

This block lies in the northeastern side of the belt and a

mine is being operated by M/s HGML. The host rock for mineralisation is mainly coarse-grained amphibolite. Other minor rock types in the block are felsic volcanics and carbon phyllite. Mineralised zones are defined as lodes characterised by wall rock alteration along a shear zone. Mineralisation is represented by intense silicification, feldspathisation associated with potash metasomatism and sulphidation. Gold is predominantly associated with arsenopyrite, pyrite and pyrrhotite. There are number of lodes in the block which were explored in detail by MECL. The most promising Lode-4 extends for 670m length and was explored up to a depth of 250m vertically. A total of 4.502 Mt of ore with an average width of 11.96 m and average grade of 2.5 g/t Au has been estimated. Lode-3 is persistent over 240m length and extends up to a depth of 175m. The Gold Resources of Lodes 3 and 2 combined has been estimated at 0.547 Mt of an average grade of 2.3 g/t Au with an average width of 7.63m. Lodes 5, 8 and 9 deserves further detailed exploration.

### CHITRADURGA SCHIST BELT

Dharwar Craton has been divided into East Dharwar Craton (EDC) and West Dharwar Craton (WDC). They are separated by a major N-S trending strike slip shear zone known as the Chitradurga Eastern Boundary Fault (CEBF) which coincides with the eastern margin of the Chitradurga schist belt. The Chitradurga belt is predominantly composed of metabasalts, felsic volcanics, metagreywacke-argillite, limestone, dolomite and BIF. Most of the gold Prospects are located in the vicinity of CEBF. MECL has carried out exploration in the following blocks.

#### Ajjanahalli East

Ajjanahalli East (Block-A) exposes gold mineralisation in BIF and associated meta basalt, meta-argillite and carbon phyllite. The mineralisation is structurally controlled, confined to a shear zone which has affected the BIF. Gold is found with sulphides as fine specks of less than 5 microns size and within the carbonate gangue as independent grains. This indicates that gold is both free milling and refractory types. Mineral beneficiation study indicated that a recovery of 90.6% gold is possible. A total of 11 lodes occur within Block-A. The Resource estimated over a strike length of 526m out of total strike length of 622 is 1.06 Mt with average grade of 2.39 g/t Au.

### DHARWAR-SHIMOGA SCHIST BELT

This Neoproterozoic schist belt occupies a major portion of the WDC and is dominantly composed of greywacke-argillite, metavolcanics and BIF. Deformed and sheared BIF hosts gold

mineralisation. MECL has investigated in detail a BIF-hosted gold prospect located at Chinmulgund village which had been discovered and sufficiently drilled by the GSI.

### **Chinmulgund**

The investigated area forms a part of the western limb of northerly plunging regional anticlinal structure defined by Banded Magnetite quartzite (BMQ) and associated quartz-chlorite-biotite-schist, argillite/greywacke traversed by quartz veins. Gold mineralisation is confined to BMQ which has an average width of 8.5m and covers a cumulative strike length of 3.5km. The major concentration of gold occurs along a fold closure in the NW part of Chinmulgund village. Gold mineralisation is associated with (i) Sulphide facies of BMQ and (ii) sulphides associated quartz-carbonate minerals. The sulphides occur along bedding planes at the contact of chert and magnetite layers. Important sulphide minerals are pyrrhotite, pyrite, arsenopyrite and occasionally chalcopyrite. Out of three major and one minor mineralized bands the Eastern Banded Magnetite is most promising. The ore Resource estimated over a strike length of 940m up to a depth of 150m (350mRL) is 1.36 Mt of an average grade of 4.51 g/t Au. The average thickness is 2.75m.

## **GADAG SCHIST BELT**

The Chitradurga schist belt north of the River Tungabhadra is known as Gadag schist belt. The rock types are mafic with minor felsic and intermediate volcanics, greywacke, carbonaceous and chlorite phyllite, interbedded with limestone, ferruginous chert, quartzite and conglomerate. The rocks are deformed and sheared attaining green schist to lower amphibolite facies of metamorphism. Gold mineralisation occurs in shear zones. There are distinct parallel to sub-parallel zones of mineralisation identified as Western, Middle, Eastern and Far-Eastern group. The Western and Middle group of mineralisation were taken up by MECL for detailed exploration. Prospects designated as Hosur Champion East, Hosur Champion West and Hosur sector fall within the Western Group. Mysore Mine and Sangli Mine blocks fall within the Middle Group. In the Western group the mineralisation is mainly confined to basaltic volcanic rocks while in the Middle group mineralisation occurs at the contact of metavolcanics and metasediments. Wall rock alteration associated with gold mineralization is represented by sericitisation, kaolinisation, silicification, carbonatisation and sulphidation. Gold is mostly free milling type. Beneficiation studies indicated 92 to 94% gold recovery. Detailed exploration by MECL in all the five blocks has established a total gold Resource of 2.81 Mt of ore with a grade varying from 2.07 to 3.70 g/t Au.

## **NUGGIHALLI SCHIST BELT**

This narrow schist belt is located in the middle of the WDC. The belt is dominantly composed of mafic and ultramafic rocks that are represented by serpentinites, metagabbro intercalated with seams of titaniferous magnetite, amphibolite and talk-chlorite-actinolite schists. MECL has carried out exploration in Kempinkote block lying at the southern tip of the Nuggihalli belt.

### **Kempinkote**

The dominant rock types in the block are amphibolite and ultramafic schist with their variants viz. quartz-chlorite-biotite schist, chlorite schist, amphibole gneiss, talc-chlorite schist, tremolite-actinolite schist and silicified amphibolite, etc. The rocks have undergone polyphase deformation and are sheared near the contact with Peninsular Gneiss. The mineralisation is lithologically as well as shear controlled and characterized by distinct wall rock alteration (silicification, biotitisation, chloritisation and sericitisation). The dominant sulphides in the mineralised zone are pyrite, pyrrhotite and minor amount of chalcopyrite. Gold is present in native state. There are six lodes in the block. The ore resource estimated over a strike length of 255 m is 1.385 Mt with average grade of 2.70 g/t Au.

## **JONNAGIRI SCHIST BELT**

In addition to the Archaean greenstone hosted mineralisation, gold of significant importance has been recorded from granitoids emplaced adjacent to greenstone belt. Dona East is one such block lying adjacent to Jonnagiri schist belt where MECL has carried out exploration.

### **Dona East**

Gold mineralisation is hosted in sheared granodiorite associated with significant wall rock alteration and minor sulphidation. Mineralization is structurally controlled epigenetic type. Gold is free milling type, generally occurs with sulphides and as visibles in quartz veins and stringers. MECL's Exploration led to Resource estimation of 7.77 Mt of ore with average grade of 2.04 g/t Au. The block was leased to a private firm for further development.

## **SINGHBHUM CRATON**

In Eastern India gold exploration was carried out in the Mesoarchaean Gorumahisani- Badampahar greenstone belt and Singhbhum Proterozoic Fold Belt.

### **Porojharna (Kunderkocha)**

In Porojharna block, gold mineralisation is confined to

**Table 1.** Summary of Gold Ore Resources defined by MECL in India

Sl. No.	Block	District	Resources (mt)	Grade (g/t)	Strike Length (m)	Vertical Depth (m)
1	Kolar Schist Belt, Chigargunta	Chittoor	2.916	5.14	500	300
2	Mallapakonda	Chittoor	0.773	2.47	110	170
3	Old Bisanatham	Chittoor	0.173	4.7	310	160
4	Ramagiri Schist Belt	Anantapur	0.602	2.40	750	200
5	Jonnagiri Schist Belt, Dona East	Kurnool	7.77	2.04	650	140
6	Gadag Schist Belt	Dharwar	3.345	2.580	720	250
7	Hutti-Maski Schist Belt	Raichur	5.728	2.500	435	175
8	Dharwar Schist Belt, Chinmulgund	Haveri	1.36	4.510	940	150
9	Chitradurga Schist Belt, Ajjanahalli East	Tumkur	1.06	2.39	526	280
10	Nuggihalli Schist belt, Kempinkote	Hassan	1.385	2.70	370	300
11	Waynad Gold Fields, Maruda	Mallapuram	1.07	2.86	200	120
12	Kunderkocha, Porjeharna	W. Singhbhum	0.007	13.11	125	60
13	Parasi	Ranchi	9.905	1.06	1406	170
14	Pahardia	W. Singhbhum	1.16	2.12	450	150
15	Bhukia East	Banswara	11.74	2.57	812	200

silicified cherty phyllite of Iron Ore Series. The other associated rock types are sericite-graphite schist and phyllites. Mineralisation is found in smoky quartz veins. Exploration was carried out by drilling and sampling of an old underground mine. The ore Resource estimated over a strike length of 125 m up to a vertical depth of 60m is 0.007 Mt with an average grade of 13.11 g/t Au. Recently some amount of gold was produced by a private firm.

In the Singhbhum Proterozoic Fold Belt, lying between the Singhbhum Craton to the south and Chhotanagpur Gneissic Complex to the north, gold exploration was carried out by MECL in Parasi and Pahardia blocks.

### Parasi

Gold mineralisation in Parasi falls in the northern part of Sonapet valley. The area is occupied by Proterozoic metamorphosed rocks of Dalma Group represented by ferruginous quartzite, tremolite-actinolite-chlorite schist and quartz-feldspathic rock. The host rock for mineralisation is quartzose phyllite with or without schistose quartzite traversed by quartz and carbonate veins. The mineralisation is structurally controlled related to shearing. Gold is found as disseminations, specks, streaks and fracture fillings along shear planes in quartz-chlorite schist and in later quartz veins as well as within sulphides viz., arsenopyrite, pyrite and pyrrhotite in that order of abundance. Nine Lodes have been defined in the Parasi block each having different strike length and depth persistence. The strike persistence of the lodes ranges between 34m and 130m with an average width of 10.15m. The total ore Resources estimated over a strike length of 1,406 m and up to

a vertical column of 170m is 9.905 Mt with an average grade of 1.06 g/t Au. The block was auctioned for further development.

### Pahardia

The block falls within Chaibasa Group of Singhbhum Supergroup. The Chaibasa Group of rocks comprise mica schist which is often garnetiferous with numerous bands of amphibolite and quartzites. The rocks have undergone greenschist facies of metamorphism. Gold mineralisation is associated with silicified quartzites in calc-chlorite schists. The mineralisation exhibits wall rock alteration with sulphides as disseminations and specks. Magnetite occurs in the form of dissemination along the foliation planes. Gold is associated with quartz veins / silicified zones. The ore shoots plunge to southwest and extend over a strike length of 335 m in two separate patches. There are five lodes in the block having cumulative thickness of 14.65 m with an average assay of 1.57 g/t Au. The ore resource estimated over a strike length of 450 m is 1.16 Mt with an average grade of 2.12 g/t Au.

## ARAVALLI FOLD BELT

In Western India gold exploration was carried out in Bhukia area within Proterozoic Aravalli Fold Belt. Gold mineralisation occurs in Delwara Group of Aravalli Supergroup. There are a number of mineralised blocks in the Bhukia Gold Field. MECL has carried out detailed exploration in Bhukia East Block and the findings are presented below.

### **Bhukia East Block**

The rocks exposed in the Block are dolomitic marble, muscovite-biotite-quartz schist, keratophyre, quartzite and amphibolite / meta-pyroxenite. Pegmatites of variable shape and size intrude the above lithounits. The massive, semi massive to disseminated sulphide mineralisation comprises pyrrhotite, arsenopyrite, pyrite and chalcopyrite in the decreasing order of abundance. Veins and veinlets of sulphides fill fractures within the sheared/brecciated host rocks. The criss-crossing fractures/shears together gave rise to stock work pattern of mineralisation. Gold occurs as a native metal in arsenopyrite, loellingite and rarely within pyrrhotite. Gold also occurs in the alteration zones without sulphides and is of great economic significance. The total ore Resources estimated is 11.74 Mt with the average grade of 2.57 g/t Au. The lodes continue further towards depth.

### **Kappil and Maruda Blocks in Southern Granulite Terrain**

In Kappil Block, the host rocks are lateritized hornblende gneiss, charnockite and magnetite quartzite. In the laterite profile distribution of gold values is asymmetric which was confirmed by drilling. The overall results were not encouraging. The Maruda block was explored by drilling. The estimated total ore Resource is 1.07 Mt of 2.86 g/t Au grade.

### **OTHER AREAS**

In Central India, exploration was carried out in Kolari block within Proterozoic Sakoli Fold Belt. The result was not encouraging.

### **CONCLUSIONS**

MECL has played a pivotal role in the detailed exploration for gold in the country. On the basis of exploration findings gold production commenced in some of the blocks, but temporarily suspended. Currently mining is in progress in Uti block. Other blocks are under active consideration for investment decision. With vast experience in the field of exploration and upgraded infrastructure under a single umbrella, besides a professional team of in-house geologists, MECL is fully equipped to offer integrated multidisciplinary exploration for discovering and defining gold ore resources in India and abroad.

*Acknowledgements:* The authors record their sincere gratitude to the management of MECL for permission to publish the paper. Thanks are due to the geoscientists of MECL whose reports have formed the basis of this paper.

### **References**

- Geological Report on Detailed Exploration for Gold in South Kolar Schist Belt, Chittoor. Unpublished report of MECL, July 1994.
- Geological Report on Detailed Exploration for Gold in Mallapakonda, Chittoor. Unpublished report of MECL; May '81-Oct '83
- Geological Report on Detailed Exploration for Gold in Old Bisanatham, Chittoor. Unpublished report of MECL; May '87-Mar '89 (Phase-I) & Jul '89-Jun '90 (Phase-II).
- Geological Report on Detailed Exploration for Gold in Ramagiri Schist Belt, Anantapur. Unpublished report of MECL; Sep '89-Oct '90.
- Geological Report on Detailed Exploration for Gold in Jonnagiri Schist Belt (Dona East), Kurnool. Unpublished report of MECL; Aug '00-Feb '01(Phase-I) & Feb '01-Sept '02 (Phase-II).
- Geological Report on Detailed Exploration for Gold in Gadag Schist Belt, Dharwar. Unpublished report of MECL; Jun '87-Nov '88.
- Geological Report on Detailed Exploration for Gold in Hutti-Muski Schist Belt, Raichur. Unpublished report of MECL; Sep '89-Aug '94.
- Geological Report on Detailed Exploration for Gold in Shimoga schist belt, Chinmulgund, Haveri. Unpublished report of MECL; 'Feb '97-Jun '98 (Phase-I) & Nov '01-Sept '02 (Phase-II).
- Geological Report on Detailed Exploration for Gold in Chitradurga Schist Belt (Ajjanahalli East block), Tumkur. Unpublished report of MECL; Feb '13-July 16
- Geological Report on Detailed Exploration for Gold in Nuggihalli Schist belt (Kempinkote Block), Hassan. Unpublished report of MECL; Oct '03-Jan '05.
- Geological Report on Detailed Exploration for Gold in Waynad Gold Fields (Maruda-Nilambur), Mallapuram - Unpublished report of MECL; Dec '92 - Mar '94.
- Geological Report on Detailed Exploration for Gold in Kunderkocha (Pororjana block), West Singhbhum. Unpublished report of MECL; Oct '84-May '88.
- Geological Report on Detailed Exploration for Gold in Parasi Central block (Jun '07-Nov '09 and Jun '09-Feb '10); Parasi East block (Sept '13-Nov '14); Parasi West block. Unpublished Report of MECL, Mar '14-July15.
- Geological Report on Detailed Exploration for Gold in Pahardia, West Singhbhum. Unpublished report of MECL; Mar '13—Feb '15.
- Geological Report on Detailed Exploration for Gold in Bhukia East. Unpublished report of MECL; Jan '07-Oct '08.