CONSOLIDATED THREE YEAR REPORT ON MINERAL EXPLORATION CARRIED OUT IN THE 1,542 SQ KM, HANGAL RP BLOCK, HAVERI, GADAG AND SHIMOGA DISTRICTS, KARNATAKA

1 INTRODUCTION

The Hangal block granted to Indophil Resources Exploration Services (India) Pvt. Ltd. (Indophil) on Reconnaissance Permit (RP), forms the southern part of the Dharwar-Shimoga belt in Haveri, Gadag and Shimoga districts. Haveri town is located on NH-4 in the eastern part of the RP and is the H. Q. of the districts, is an important commercial centre.

The block is accessible by National Highway connecting Bangalore and Pune between Haveri and Dharwar section of the National Highway. It is also well connected by the main Broad gauge Railway line connecting Bangalore and Pune between Haveri and Hubli section of South Western Railway.

1.1 DETAILS OF THE PERMIT

The RP application was submitted on 3rd April 2000 at the office of the Director, Department of Mines and Geology, Bangalore over 1,542 sq km, Hanagal block. The RP application was recommended by the Govt. of Karnataka for grant and due concurrence was given by the Govt. of India. The permit was granted on 23rd Oct.2002 and the RP Deed was executed on 17th Jan 2003 with the Govt. of Karnataka. Plan showing the location of Hanagal RP block is given in **Fig.1**.

On completion of the 2nd year, 50% of the granted area of 1,542 sq km was relinquished and 771 sq km area was retained for further exploration in the 3rd year. During the Reconnaissance exploration, 3 prospective blocks have been identified and applied for grant of PL in 3 PL blocks. Details are furnished in section 5.2 of this report.

2 LITERATURE AND MAP COMPILATION

2.1 GEOLOGICAL MAP

Extensive compilation of all the available literature on Dharwar-Shimoga schist belt and the previous work of Geological Survey of India (GSI), Dept. of Mines and Geology and other agencies was

completed in house. Indophil geologists compiled the geological map on 1:50,000 scale of the permit block from various published sources, mainly from the Records of GSI. Geological map also incorporates the information collected during reconnaissance field traverses carried out by company geologists and consultants. The geological map was compiled on GIS format by digitizing each one of the rock units on different layers and other data. The digitized version is taken to MapInfo environment for the final out put of the coloured version of the geological map of the RP block as presented in **Fig. 2**.

Indophil created a base map on the basis of topographic sheets 48 N/1, N/2, N/5, N/6 and N/9 for undertaking stream sediment geochemical sampling and for follow up detailed geological mapping on larger scale and geophysical surveys in promising prospects.

A comprehensive research of both published and unpublished work, regional and detailed mineral exploration programmes of GSI and other agencies, on the project was completed. An extensive bibliographical compilation of work on the geology and mineral resources in the area of interest was prepared.

All geographical locations including mapping, surface sampling, locations of old workings and other important land marks have been located by using modern GPS equipment. Total station survey was conducted for accurate contouring of prospects and locations of drillholes.

2.2 REMOTE SENSED STUDIES

Google Earth Image of the RP block was studied to find out linear structures important for search of gold mineralization in the area. The image is presented in **Fig.3**.

As there are restrictions on sale of aerial photographs to private exploration agencies, digital elevation model image of the R.P. area, was studied in place of aerial photographs. Digital elevation images (DEM) provide synoptic as well as three-dimensional view of topography. Thus, they can substitute for stereoscopic pairs of aerial photographs. It clearly brings out the BIF ridges amidst the low ground occupied by the greywacke. NW-SE trend of the rock formations and easterly dip are evident. Isoclinal folds with axial planes dipping easterly could be inferred NE of Ganajur and south of Tavargop. Digital elevation model image of the RP block is shown in **Fig.4**.

2.3 SCOPE OF THE REPORT

The report presents all the geological information on location geology, structure, mineralization and details of work carried out during the 3 year tenure of the permit. Report also includes description of the most gold bearing blocks discovered during the RP tenure and prospective gold bearing blocks discovered during the RP tenure and details of Prospecting Licences applied.

3 REGIONAL GEOLOGY OF THE RP BLOCK

The area covered by RP block forms a part of the Neoarchaean Dharwar-Shimoga deformed volcano-sedimentary basin. The major rock-types include a thick meta-sedimentary sequence of greywacke, argillite, banded iron formation and few narrow bands of meta volcanics, belonging to Chitradurga Group of Dharwar Supergroup. Greywacke is the dominant rock which is frequently interbanded with shale, phyllite, quartz-chlorite-sericite schist. Greywacke is deeply weathered in most parts of the RP block. The regional bedding and foliation trends of rock types vary from NW to WNW with steep dips towards northeast.

The meta greywackes are deeply weathered. A major zone of sulphidic, cherty BIF bands traversed by quartz and quartz-carbonate veins lies in the western part of the RP block. In the central and eastern portions of the Permit area the BIF bands are sparce and more isolated with smaller strike dimensions. BIF is sulphidic and gossanous with boxworks, intensely weathered with secondary oxides replacing original sulphides and iron oxide minerals.

3.1 STRUCTURE

The regional trend of bedding and foliation are more or less parallel and vary from NW to WNW with steep northwesterly dips. Structurally the rocks are deformed into isoclinal folds, some times folded folds with steeply dipping axial planes. These folds are defined by BIF bands which act as marker horizons. A number of NNW-NW trending shear zones are inferred to occur basin wide. Shearing must have brought about fracturing of the competent BIF bands and associated acid volcanics. These constitute pathways for the immunerable quartz and quartz-carbonate veins seen in the belt.

3.2 GOLD MINERALISATION IN THE RP BLOCK

It has been observed that the BIF interbedded with metagreywacke, especially the sulphidic banded iron formations intersected by quartz and quartz carbonate veins are auriferous. Sulphide mineralization in the form of disseminated pyrite, pyrrhotite and arsenopyrite are seen here and there

associated with BIF. Sulphides in most cases are completely altered into secondary iron oxides like goethite and limonite and one of the best criteria used for locating gold-bearing zones were the presence of boxworks, carbonate alteration, sericite alteration and quartz veining.

Search for BIF and sampling them for gold has been the basic approach for prospecting for gold in this RP block. There are number of parallel - sub parallel BIF bands having long strike lengths of the order of 8-16 km.

GSI has reported gold mineralization in several localities in the RP block viz., Karajgi, Kardigudda and Lakkikoppa. It has also carried out prospecting including drilling in some of the reported gold occurrences. But no where in the RP block GSI was able to locate ore-grade gold mineralization, where as Indophil has succeeded in finding a mineable gold deposit at Ganajur. Even at Karajgi, where GSI has done some drilling and abandoned the area as of poor grade, Indophil with limited drilling was able to define a 130m long open pittable, shallow level deposit. These prospects will be drilled further.

4 EXPLORATION BY INDOPHIL

4.1 EXPLORATION STRATEGY

Basic exploration strategy adopted was to cover the entire RP block by rapid stream sediment sampling. Normal stream sediment sampling coupled with panning for visual examination and counting of gold particles happens to be primary tool in gold exploration. However, in Shimoga schist belt the orientation stream sediment sampling did not help in leading to the source of gold mineralization. As a result the basic approach was modified and impetus was given to intensive rock-chip sampling using the criteria explained in section 3.3 above.

All the samples collected were analysed for Au and As and some were analysed for Cu, Pb, Zn, Fe and W. Anomalous rock-chip sample locations were further tested by channel or profile sampling to represent the full width of the outcrops or the suspected mineralized section to ascertain the insitu grades over the full width of the zone. This led to identification of 23 potential gold-bearing blocks. Gold mineralization in all these blocks is associated with quartz and quartz-carbonate veins in cherty sulphidic BIFs. Further intensive sampling together with geological mapping helped to define significant surface dimensions of prospects at a few localities highlighted in this report. Test drilling by RAB and RC techniques was carried out to confirm the mineralization and establish the depth persistence of gold mineralization and its grade.

4.2 DETAILS OF SAMPLING

Following table summarizes the details of sampling work carried out and quantum of ground geophysical survey and drilling carried out during the 3 year tenure of the permit.

Sl. No.	Type of work	No. of samples
1.	Stream sediment samples	47
2.	Rock-chip samples	685
3.	Channel profile samples	1,025
4.	RAB drill samples	455
5.	RC drill samples	766
TOTAL		**2,978**
6.	Ground geophysical (magnetic) survey	**26.6 line km**

4.3 STREAM SEDIMENT SAMPLING

Stream sediment samples were collected from 47 sites and the samples were analysed for Au, As, Cu, Pb, Zn, Fe and W. As mentioned earlier the stream sediment sampling was not particularly useful in Shimoga schist belt and it did not help us in tracing the provenance of gold mineralization. No further stream sediment sampling was done. Location of stream sediment samples collected in the RP block is shown in **Fig. 5**. Analytical results are tabulated in **Table1.**

4.4 ROCK-CHIP SAMPLING

In the first stage of rock-chip sampling, random rock-chips from 368 spots were collected mainly from BIF outcrops spread over the entire RP area. This led to identification of anomalous gold near Lakkinkatti, Lakkikoppa, Shabal, Badamgatti, Ganajur-Karajgi-Karadigudda, Torur, Baragihalli and Savanur-Huralikoppa-Kurubar Mallur villages. The locations of rock-chip sampling are given in the **Figures 6, 7 and 9.**

Detailed rock-chip sampling programme was taken up in the prospective areas to further confirm and define gold minerlised zones and further random rock-chip sampling was continued in other parts of the RP block.

Rock-chip sampling and analysis confirmed significant gold mineralization in the Ganajur-Karajgi and Lakkikoppa-Hosur tracts. In addition mineralization was picked up in the banded ferruginous cherts exposed to the north and northeast of Torur, east of Shabal and south-southeast of Baragihalli. In these

areas several samples have analysed more than 1 g/t Au. Indicating gold mineralization of significance.

Rock-chip samples were collected from Savanur-Huralikoppa-Kurubar-Mallur area, where the geological setting is very similar to Ganajur-Karajgi area. However, in Savanur-Huralikoppa section only one sample gave + 1 g/t Au (7.66 g/t Au) and rest of the samples showed poor incidence. Most of the samples analysed around 0.3 g/t Au. It is believed that gold might have been stripped due to intense weathering of the outcrops and erosion, as evidenced by abundant cavities in the gossanised sulphidic BIF. The results suggest that the anomalous BIF zones needs to be tested deep down to examine the ground below the weathered and leached horizons.

In Kurubar Mallur area only one sample yielded 0.3 g/t and rest of the samples were characterized by poor gold values, suggesting much lower grade for mineralization in the BIFs.

Location of rock-chip samples collected in the RP block is shown in **Fig. 6.** Analytical results are given in **Table-2**. The rock-chip sampling programme helped in identifying potential gold bearing targets are listed below:

Sl. No	Block No	Name of the prospects
1	1	Ganajuru-Karajgi
2	3	Lakkikoppa-Hospet
3	4	Jakkinkatti
4	8	Sisivinal-Sirbadgi (Chillur Badni)
5	9	Kalyan
6	10	Badamgatti-Belgalpet
7	13	Hosur
8	14	Hotanhalli
9	15	Tavargop
10	18	Torur
11	22	Kanchi Neglur-Adur

4.5 CHANNEL / PROFILE SAMPLING

Encouraged by the analytical results of random rock-chip samples, channel / profile sampling was undertaken in some of the more important of the targets listed above. The targets are so chosen are: Ganajur-Karajgi, Badamgatti, Shabal, Jakkinkatti and Kalyan areas. Channels were cut across the trend of mineralization or the rock formations and systematic rock-chips, were recorded from the channels to collect representative samples from the channels. Map showing the channel / profile sampling locations are in **Figures 7, 8, 10 and 10a.**

4.5.1 Channel sampling profiles in the Ganajur- Karajgi tract:

This tract has been classified into 7 prospect blocks for purpose of systematic channel sampling. The prospects are: (1) Ganajur main (GMP), (2) Ganajur central (GCP), (3) Ganajur northwest (GNW), (4) Ganajur southeast (GSE), (5) Karajgi Hut (KHP), (6) Karajgi Main (KMP) and (7) Karajgi southeast (KSP) prospects. Channel sample profiles in these prospects are shown in **Fig. 7** and analyses of channel samples from these profiles are tabulated in **Table-3.** The analyses indicate a wide anomalous zone of 15 to 30m surface width of gold mineralization over a strike length of 500m in the Ganajur Main Prospect. A somewhat narrower (~8m) mineralized zone over a strike length of 250m is indicated in the Ganajur Southeast Prospect. An approximately 6 m wide mineralized zone, has been indicated in the Karajgi Main and Karajgi Southeast Prospects over strike lengths of 350m and 100m respectively. The grade of mineralization in these zones appears to be in the economically viable plus 2g/t range.

Details of channel sampling are presented in **Fig. 7** and data given in **Table-3**.

4.5.2 Jakkinkatti and Kalyan areas

Locations of the channel sampling, are shown in **Fig. 8** and analyses of samples from the profiles are given in **Table-4.** Analytical results were not encouraging. In the Jakkinkatti area, only along one profile, channel samples analyzing more than 2 ppm Au were noted in a 2 m wide zone. In the Kalyan area, the highest value noted is 105ppm in a one metre wide zone in Channel KC-3.

4.5.3 Lakkikoppa, Badamgatti and Shabal prospects

This tract extends from Shabal in the NW to Badamgatti in the SE via, Lakkikoppa prospect, the latter explored by GSI. Channel sampling profiles in these two areas, are shown in **Fig. 10a** and analyses of the channel samples are tabulated in the **Table-5.** Perusal of the analytical data shows that in the Badamgatti block, greater than 1 ppm gold bearing samples have been met with in sampling profiles BPT-2 and 3. These two profiles are in the northern most part of the Badamgatti block, immediately southeast of Lakkikoppa prospect. A 5m wide mineralized zone with samples analyzing on an average 3.5 ppm Au, was observed in BPT-2. A One metre wide zone with the sample analyzing 1.45 ppm Au was observed in BPT-3. None of the channel profiles further southeast revealed mineralization with gold values greater than 1ppm. SPC-2 and SPT-3 channels in the Shabal block to the northwest of Lakkikoppa prospect picked up the mineralized zone to the northwest. A one metre wide mineralized zone with samples analyzing 2.74 ppm Au was met with in SPT-3. In SPC-2 channel sampling profile,

a 2 metre wide zone with samples analyzing more than 2 ppm Au were observed. Channel sampling in the Badamgatti and Shabal areas suggests that the Lakkikoppa prospect, beyond what is already defined, has limited strike extension towards NW and SE.

4.5.4 Savanur-Huralikoppa prospect

12 channel samples were collected in channels cut across the mineralized BIF-Greywacke horizon south of Savanur-Huralikoppa region. The first channel T-1 did not reveal any significant mineralization, whereas channel T-2 showed a 2 m wide zone with 2 samples analysing 4.28 and 4.86 ppm Au. Further exploration is warranted in the prospect. Analytical results of the channel samples are given in **Table-6.**

4.6 GROUND GEOPHYSICAL SURVEY

Following the channel (rock-chip) sampling, ground magnetic survey was carried out in the soil covered region between, Ganajur Main Prospect and further SE. The ground magnetic survey map is presented in **Fig.11**. This survey was not helpful in identifying mag anomalous zones presumably due to intense oxidation of iron bearing magnetic minerals in the BIFs of the area.

4.7 EXPLORATORY DRILLING

Reconnaissance drilling programme was undertaken comprising of both RAB and RC drilling to test the encouraging results obtained during rock-chip and channel profile sampling in Ganajur, Karajgi and Lakkikoppa prospects. A total of **1,915 m** of drilling spread over Ganajur, Karajgi and Lakkikoppa prospects was completed during the RP tenure. A total of 1,221 samples were drawn from the borehole cuttings and analysed for gold, arsenic etc. Boreholes confirmed that the mineralization is confined to BIF and the depth persistence. The analytical data of drillholes is given in **Table-8 in the CD attached**.

4.7.1 Ganajur Main Prospect

Both RAB and RC drilling was carried out in the prospect. 1005 m. was drilled and 272 samples were analysed to confirm the down dip persistence of gold values encountered during surface rock-chip and channel sampling. The mineralized zones were intersected between 14 m to 53m. The true width of mineralized zones varied from 9 to 26 m and the gold values range of 0.8 g/t Au to 19.25 g/t Au. Location of boreholes is shown in **Fig. 12** and the analytical data of all the boreholes are given in **Table-8 in the CD attached**. The cross sections of the drillholes are given in **Figures 13 (a) to (e).**

Drilling confirmed the persistence of significant gold mineralization over a strike length of 372 m, of an average width of 19 m. Drilling has confirmed the down dip continuity of mineralization upto 115 m. The gold ore resource is estimated at 1.533 million tonnes of an average grade of 3.79 g/t gold. About 5.8 tonnes of gold was estimated to be the metal content in the ore body. Mineralisation is open along both the strike and depth dimensions. The basis of this estimate of the ore reserve and the metal content is furnished in **Table-9.** The surface dimensions of the mineable ore body is given in **Fig. 12.**

These data indicate that Ganajur prospect can be develop into a open pittable mine to begin with. The full potentiality of the prospect will be evaluated by further close spaced and deeper drilling during the PL and ML stages.

4.7.2 Gangajur Central Prospect

Only one hole was drilled in this prospect. It gave a high value of 18 g/t for 4 m width of drill chips carrying visible gold **(Fig.16)**.

4.9 Lakkikoppa-Hosur prospect

GSI had explored this area but all details are in unpublished reports. Therefore, Indophil started it's own programme of exploration in the area. Surface rock-chip samples yielded several +1 g/t Au, with average values of 1.45 g/t Au to 3.5 g/t Au over 1 to 5 m width. Channel samples from GSI's old trenches have confirmed the rock-chip sampling results. Based on channel data, the strike length of the potential mineralized zone is estimated to be 500 m. Only one borehole could be drilled. The analytical results are given in **Table-12**. Though this borehole did not give good values and none of the samples analysed more than 1 g/t, the incidence of gold and widespread values in BIF, warrant further detailed exploration including additional drilling at the stage of PL. The possibility of establishing an open pit mine exists.

5 APPLICATIONS FOR PROSPECTING LICENCE

Exploration, by Indophil has been successful in identifying specific areas important for future development of gold mines in Haveri district. They are (1) Ganajur-Karajgi and (2) Lakkikoppa-Hosur. These prospects deserve to be explored in detail. Therefore, PL applications have been filed and the details are tabulated below: **Fig.17** shows the locations of the PL application blocks.

Name of the block	Area in sq km	Applied on
Ganajur-Karajgi	2.3	17.10.2003
Ganajur-extension	8	12.1.2005
Lakkikoppa	5	22.3.2005

6 ORE BENEFICIATION STUDIES

A 240 kg bulk of the ore from Ganajur prospect was sent to the Ore Dressing Laboratories of IBM at Bangalore conducting beneficiation tests. The sample was drawn from the DTH and RC drill-chips. Gold recoverability studies were carried out by the IBM at it's laboratories in Bangalore. Summary of the studies is as follows:

- The gold ore sample assayed 5.59 g/t Au, 4.0 g/t Ag, 5.06% S (T), 27.65% Fe_2O_3, 44.46% SiO_2, 4.2% Al_2O_3, 2.64% CaO and 1.78% MgO.

- Mineralogical studies revealed presence of free gold grains of 12 to 16 microns size, dispersed in silicate matrix. The ore contained about 8 to 10% pyrite and 2 to 3% arsenopyrite. Quartz was the

main gangue mineral present in the ore which constituted about 40 to 45%. Siderite was the next major mineral constituting about 25 to 30%.

- Electron Probe Micro Analysis (EPMA) revealed the presence of very fine native gold grains varying from 2 to 3 microns, occasionally upto 8 microns, occurring in pyrite and arsenopyrite. Also very fine grains of native gold of 2 to 3 microns size were noticed in silicates.

- Bottle roll cyanidation tests were carried out on the sample. Direct cyanidation of gold ore resulted in recovery of 78% of free gold. Residue after cyanide leaching assayed 1.23 g/t of Au. An additional recovery of 3.8% Au could be achieved on pre-oxidation of the residue after removal of free milling gold, followed by cyanidation. Results of the tests indicated that the residue loss was mainly due to the occurrence of Au as fine specks in silicates.

- The high content of recoverable free gold in the sulphidic-gold ore of Ganajur is an encouraging factor. The high head grade of the ore, presence of upto 78% free milling gold and high width of the ore body together indicate that Ganajur ore body is mineable by open pit methods.

- The full report of ore beneficiation studies received from the Indian Bureau of Mines is given in **Annexure-1**.

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