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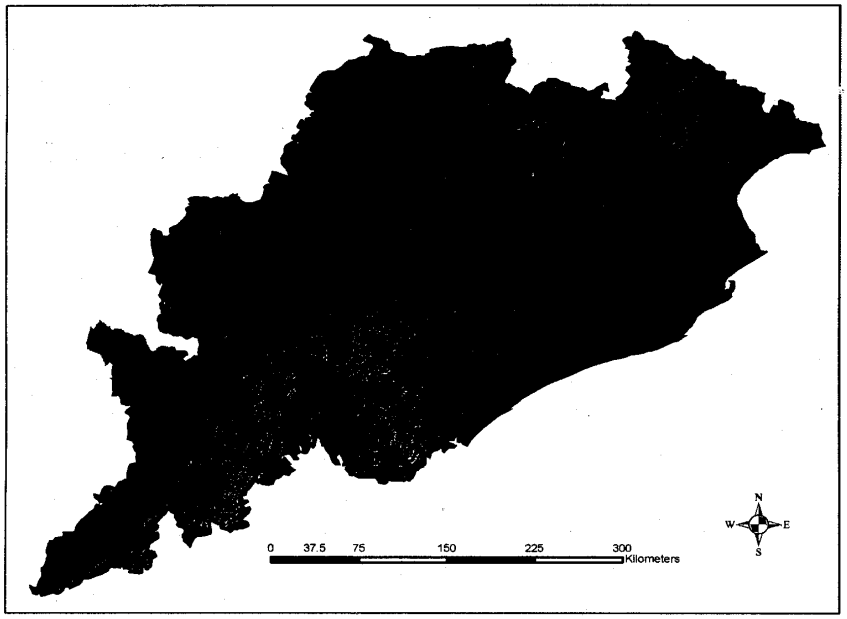
Closing Report on Reconnaissance Permit 7470/IV (GD) SM 6/2000 Orissa

Report for the period
16/02/05 to 15/08/07



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1. Reconnaissance Permit (RP) Status

The RP is 2000 km^2 in extent and was executed at Bhubaneswar on 15th February 2005. As per rule 7(i) (a) of MCR 1960, it is scheduled to be reduced by 50% on or before 14th February 2007. A total of 1000 sq km was relinquished on 20th July 2006 (Map 1) and the remaining 1000 Sq. Km is relinquished on 15th August 2007.

2. Geology and Geomorphology of the RP area

The Bhandara Craton is rectangular in shape and bounded by the Mahanadi Rift in NE, the Godavari Rift in SW, Narmada Rift to the NW, and the NE-SW trending Eastern Ghat Mobile Belt on the SE.

The Eastern Ghat Mobile Belt is juxtaposed with the Archean craton along a ductile thrust with a northwesterly thrust movement. This shear zone is characterized by south-easterly dipping mylonitic foliation and a down-dip stretching lineation (the L-S fabric of mylonites).

Geologically the RP area consists of the eastern margin of the Bhandara Craton with a complex lithological association of basic intrusive rocks, granitoids, supracrustal rocks and unmetamorphosed Late Proterozoic sediments in the east and the Eastern Ghat Mobile Belt in the further eastern side with high grade metamorphic rocks (Map 2).

Uncertainty and unavailability of precise age data of the rocks have resulted in varied interpretations and correlations attempted by different workers. A simplified stratigraphic succession of the Bhandara Craton is presented below. The Sukma and Bengpal metamorphic rocks are possibly the oldest Mesoarchaean sequences of this region. The relationship of the precursors of the trondhjemitic gneisses (3.56 Ga) with the Sukma and Bengpal sequence is debatable from being a probable intrusive to being basement.

The Sukma supracrustal rocks consists of high grade metamorphosed orthoquartzites, carbonates and pelites in association with prominent iron formations and subordinate mafic ultramafic rocks. The Bengpal Group overlies the Sukma metamorphics with an unconformity and consists of amygdular metabasalts and andalusite-chlorite schist which are overlain by conglomerate and quartzites.

However, Ramakrishnan (1990) assigns Palaeoproterozoic ages (2.5Ga and 2.3Ga) for the Sukma metamorphics and Bengpal Group.

The Bailadila Group overlies the Bengpal Group with an unconformity and is composed of feldspathic quartzites, chloritic phyllite and banded iron formations.

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The Eastern Ghat Mobile Belt is recognised as an accreted terrain with high-grade metamorphic rocks. The major mappable units are mafic schists, quartz-feldspar-hypersthene granulites (charnockites), sillimanite-garnet-cordierite-sapphirine-schist and gneisses (metasediments locally known as khondalites) also the Calc-silicates, mafic granulites, leptynites (leucocratic quartz-feldspar-garnet gneiss), intrusions of anorthosite, gabbro, norite, dunite and serpentinite with chromite, and alkaline rocks. Most of these rock suites have been subjected to three or four deformational events and with a large number of shear zones cutting across them, and together comprise the Khariar-Angul Metapelite Complex of the Sukma Group.

Late Proterozoic detached basins containing unmetamorphosed sediments overlie the Archaean rocks of the Bhandara Craton. There are two major and six minor basins in the Craton. Two smaller basins, the Neogarh-Khariar (Nawapara-Kharihar) and the Ampani Basins are located slightly away from the RP area.

The Khariar Basin is composed of an alternating sequence of sandstones and shale and is equivalent to the Chandrapur Group of the Chhattisgarh Basin.

The Ampani Basin forms an outlier in the area south of the Khariar Basin and is composed principally of conglomerates, sandstones, siltstones, purple shales and calcareous intercalations. The rock association resembles the Chandrapur Group of the Chhattisgarh Basin and the Tirahgarh Formation of the Indravati Basin.

Simplified stratigraphic succession of the Bhandara Craton

Chhattisgarh Supergroup	**Un-metamorphosed Sediments**	**Upper Proterozoic**
~~	**Unconformity**	~~~
Basic Dykes	**Dolerites, Amphibolites**	
~~	**Unconformity**	~~~
Bailadila Group	**Banded Iron Formation, Phyllites with chert and local conglomerates**	**ca. 2.9-2.5 (Bandhopadhyay et al 1995). ca. 2.1 Ga (Ramkrishnan 1990)**
~~	**Unconformity**	~~~
Bengpal Group	**Amygdular metabasalt, andalusite schist and quartzite**	**ca. 2.9-3.5 (Bandhopadhyay et al 1995). 2.3 Ga (Ramkrishnan 1990)**
~~	**Unconformity**	~~~
Sukma (Group ?) metamorphic suite	**Sillimanite quartzite, cordierite anthophyllite rocks, Banded Iron Formation**	**ca. 2.9-3.5 (Bandhopadhyay et al 1995). ca. 2.5 Ga (Ramkrishnan 1990)**
~~	**Unconformity**	~~~
	Basement Gneiss (TTG)?	**3.56 (?): Zircons of tonalites by U-Pb method.**

The RP area is within the drainage basin of the Tel River, a tributary of the River Mahanadi (Map 3).The south western and south eastern corners of the RP comprise elevated pla-

teaus rising to over 700m.Below is a gently sloping plain falling from approximately 280m in the west, to 220m in the east. Isolated hills rise to over 600m above the plain.
The western plateau comprises sandstones of the Ampani Basin, whilst the plains are underlain by the metapelites of the Sukama Group.

The terrain is well dissected in the NE and Northern part and has poorly drained flat areas in the NW and central part of the RP.

3. Activity during the period (16/02/05 to 15/08/07)

Based on the initial geological analysis, it was decided that regional stream sampling would be an effective exploration technique to locate diamondiferous kimberlites. Reconnaissance stream samples were collected from suitable trap sites. In addition, an Airborne Hyperspectral scanner Survey (AHS) was flown over the RP area and the anomalies identified were followed up. Fixed wing geophysical magnetic and Frequency Domain EM surveys was also flown by Fugro over of the RP and Ground Geophysical surveys were also carried out to identify kimberlite pipes. Drilling of the targets was completed in the RP area but to date, no kimberlites have been found.

3.1 Pre-field Operations

Purchased toposheets (on 1:50,000 scale) for the license area from the Survey of India and converted them into digital form.

Studied the Landsat, TM data and produced digital images. The field vehicles were mobilised along with laptop computers and other field equipment to the working area.

Forest and wild life reserve areas were avoided while planning for samples.

3.2. Reconnaissance Sampling

A total of 467 reconnaissance samples (353 stream samples and 114 loam samples) were collected from the RP

Stream samples comprised 75 litres of unscreened material, collected from natural heavy mineral trap sites and field screened to –2.0mm.

Loam samples comprise 30 litres of residual soil collected from flat surface areas

Reconnaissance sample localities and information are shown in Map 4 and Table 1.

The samples were processed at De Beers heavy mineral treatment plant in Bangalore, and the concentrates were scanned in the Bangalore Mineralogical Lab, India.

3.3 Reconnaissance Sampling Results

Results were received for all of the reconnaissance samples in the RP area and 233 samples reported positive with respect to kimberlitic indicator minerals. A total of 4461 spinels, 5 garnets, and 4 ilmenites were reported (Map 5 and Table 2).

3.4 Follow Up Sampling

A total of 10 follow up samples were collected from the western part of the RP area (Map 6 and Table 3). The samples were processed at De Beers heavy mineral treatment plant in Bangalore, and the concentrates were scanned in the Bangalore Mineralogical Lab, India.

3.5 Follow Up Sampling Results

The results of all the Follow up samples were received and 9 samples were reported positive with respect to kimberlitic indicator minerals. A total of 144 spinels were recovered from the follow up samples. No garnets, ilmenites or clinopyroxenes were recovered (Map 7 and Table 4).

3.6 Rock Sampling

A total 16 rock samples were collected (Map 8 and Table 5) and proved un related rocks.

3.7 Airborne Hyperspectral Scanner Survey

An airborne survey utilizing De Beers's proprietary Hyper Spectral Scanner was completed during March 2005 (Map 9). The system works by measuring reflectance of narrow wavelength bands of sunlight reflected from the Earth's surface. Different minerals (as well as other materials) absorb different wavelengths of light to varying degrees. The Airborne Hyperspectral Scanner Survey system is sensitive enough to actually distinguish some specific types of minerals by the absorption of certain wavelengths of light detected. In the search for kimberlites, the system is configured to look for the presence of magnesium-rich clay minerals, derived from the weathering of ultramafic rocks. There were 120 anomalies selected for field follow-up (Map 10).

Follow up of the survey involved field visits of anomalies and identification of the causative lithological units to conclude whether the source of the anomaly is kimberlitic or not. All the 120 anomalies were visited (Table 6 and Map 11). Samples were collected from surface material for PIMA (Portable Infra-Red Mineral Analyses) to confirm the causative material. There are no kimberlitic rocks noticed in any of the 120 anomalies.

Detailed sheets of Airborne Hyper spectral scanner survey anomalies followed up are attached as Appendix 1.

3.8 Airborne Geophysical Survey

An Airborne Magnetic and Time Domain Electromagnetic survey was carried out over the RP area. The results were processed and interpreted. Based on the response, a total of 87anomalies (Aero Magnetic- 36 and Aero Electromagnetic-51) were identified and they were followed up with ground geophysical surveys wherever necessary. (Map12).

3.9 Ground Geophysical Survey

3.9.1 Ground Electromagnetic Survey

Thirty five anomalies were followed up with ground frequency domain EM survey using GEM-2 (Table 7 and Map 13), covering a total of 583 line kilometres.

Detailed sheets of EM anomalies followed up with ground survey are attached as Appendix- 2

3.9.2 Ground Magnetic Survey

Eighty four anomalies were followed up with ground magnetic survey using a Proton precision magnetometer (Table 8 and Map14) covering a total of 2019 line kilometres.

Detailed sheets of Magnetic anomalies followed up with ground survey are attached as Appendix 3 .

3.9.3 Ground Gravity Survey

Fifty three anomalies were followed up with ground gravity survey using CG-5 gravimeter (Table 9), covering a total of 981 line kilometres.

Detailed sheets of gravity anomalies followed up with ground survey are attached as Appendix 4.

3.10 Drilling

A total of 2913 meters in 92 holes were drilled to test the geophysical anomalies and Airborne Hyper spectral anomalies (Table 10 and Map 15).

Detailed sheets of borehole logs are attached as Appendix 5.

4. Interpretation

Based on the results received for various techniques used in exploration of this RP, the western portion has been identified as having the most potential for the discovery of a diamond bearing body (Fig 1 – 10). However further exploration work in this area did not result

in the discovery of kimberlites or related rocks and hence the whole of this RP was relinquished (Map 1).

5. Personnel

Name	Designation	Education
K.V.Suryanarayana Rao	Project Manager	M.Sc.Tech-Applied Geology
Krishna Pande	Staff Geologist	M.Sc. – Applied Geology
Chandan kumar	Staff Geologist	M.Sc. – Applied Geology
K.V.Praveen Kumar	Staff Geologist	M.Tech-Remote Sensing
Prashant Laharia	Geologist (on contract)	M.Sc Tech Geology
Sukhbinder Sharma	Geologist (on contract)	M.Sc Geology
Sudipta Sarkar	Geologist (on contract)	M.Sc. Tech-Geology
Rekha K.R.	Kimberlitic Mineral Analyst	M.Sc Geology
Shobha N.	Kimberlitic Mineral Analyst	M.Sc. Geology
Sanjay Deogiri	IT Manager	B.Sc. Electronics, MCSE
Rina David	SHE Officer	Graduate
Girish Menon	Security Adviser	Grade 12
Gajanana Naik	Treatment Plant Supervisor	Graduate
R.Shrinivasalu	Field Assistant	Grade 10
Venu Kumar	Field Driver	Grade 12
A.Channaiah	Field Driver	Grade 10
Rajanna	Field Driver(on contract)	Grade 10

Labour
Labourers were employed on a daily basis from local towns and villages to help with the field work.

6. Training

De Beers maintains high operating standards including safety and environmental awareness. To this end, training is an integral part of career development with the organization. The following is a short summary of training completed during reporting period.

All Earth scientists, field assistants and field drivers attended a training program on Crisis Management to deal emergency situation related to safety and security in the field.

An HIV/AIDS awareness programme was conducted for the entire field based staff.

The drivers attended a training course on Defensive Driving and Road Safety conducted by the Automobile Association of Southern India.

All field drivers attended training on vehicle maintenance conducted by Mahindra & Mahindra.

Earth Scientists attended training on new mineral classification scheme.

All field geologists attended a training program on First Aid conducted by International SOS.

Earth scientists attended a programme on Arc SDE and Arc GIS to hone their skills in Database management.

Earth Scientists also attended a programme on Datamine solutions which will enable them to effectively organize data from drilling programmes.

A brief introductory lecture on basic geology was given to field drivers and field assistants. Earth Scientists attended a programme on XSIMS database management.

Earth Scientist completed a sort time assignment for drilling and petrology training in Canada and South Africa.

7. Expenditure

Total expenditure of Rs. 94, 416,166 has been incurred for the Reconnaissance Permit to date. The expenditure was incurred as follows:

Capital expenditure: Rs. 4,902,769

Revenue expenditure: Rs. 89,513,397

8. References

Bandyopadhyay, B. K. Roy A. jain A. K. 1995: Structure and Tectonics of a part of the Central Indian Shield: In Continental crust of north-western and central India. Sinha Roy S, Gupta K. R. (Eds) Geol Soc India, Mem 31, 433-468.

Ramakrishnan M 1990, Crustal development in southern Bastar, Central Indian Craton. In Precambrian of central India Geol, Surv, India Spl Publ. No 28 44-66

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