

EXPLORATION & DEVELOPMENT



# Indian Minerals Yearbook 2012

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EXPLORATION & DEVELOPMENT

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## GOVERNMENT'S POLICY

The National Mineral Policy, 2008 for non-fuel and non-coal minerals introduced by the Government in replacement of the National Mineral Policy 1993 lay enormous thrust on the various aspects of mineral industry, such as regulation of minerals, role of State in mineral development, survey and exploration, database of mineral resources and tenements, strategy of mineral development, etc. Among other things, strong emphasis is laid on the following:

- \* To judiciously exploit and utilise the country's mineral potentialities, systematic regional and detailed exploration will be carried out using state-of-the-art techniques in a time bound manner. Zero-waste mining will be the national goal and mining technology will be upgraded to ensure exploration and utilisation of entire run-of-the-mine.
- \* To make regulatory environment conducive to private investment, procedures for grant of mineral concessions, such as Reconnaissance Permits, Prospecting Licences and Mining Leases shall be transparent and seamless with security of tenure guaranteed. Prospecting and mining shall be recognised as independent activities with transferability of concessions playing a key role in mineral development.
- \* To attract large investments and high technology, a new concession, namely, Large Area Prospecting Licence (LAPL) will be introduced. Duration of all concessions will be rationalised and areas of operations enlarged suitably within each State.
- \* IBM will maintain a digitised database comprising a Resource Inventory and a Tenement Registry. The Tenement Registry will give information of leasehold and freehold areas in terms of greenfield,

brownfield and relinquished areas, etc. Data filing will be rigorously applied and concession holders will be monitored. Lock-in arrangement will be assured and the data will be released to prospectors after integration.

- \* Prospecting being a high-risk venture, access to risk funds from capital markets will be facilitated.

This policy initiative is expected to encourage greater involvement of private sector in survey and exploration of minerals.

The High-Level Committee constituted by the Government of India which brought out the National Mineral Policy, 2008 has recommended amendments to the MMDR Act, 1957 with the purpose of providing necessary initiatives to attract investment and participation of private and public sectors in areas of exploration and exploitation of minerals. In a latest development, MMDR Bill, 2011 has been introduced in Lok Sabha on 12.12.2011, which has been referred to Standing Committee on Coal & Steel.

## ORGANISATIONS INVOLVED

GSI, AMD, DGMs of various states, public sector companies like NMDC, MECL, MOIL, etc. continued their efforts in respect of surveying, mapping and exploration of new deposits and re-assessment of old deposits/mines during 2011-12.

In oil sector, ONGC, OIL and a few joint ventures and private companies were engaged in exploration of on-shore and off-shore areas.

## IBM

IBM, as a facilitator to the Mineral Industry (a) provides technical consultancy services for conducting feasibility studies, environment impact assessments, environment management plans, etc; (b) carries out mining research project on need-based aspects of mining; (c) conducts

mineral beneficiation studies including mineralogical testing and chemical analysis and (d) prepares mineral maps.

During 2011-12, IBM prepared 60 multi-mineral leasehold maps with forest overlays on 1:50,000 scale in respect of Jammu & Kashmir, Himachal Pradesh, Haryana, West Bengal, NEER States, Kerala and Goa. Forest overlays are prepared in collaboration with Forest Survey of India.

During 2011-12, IBM conducted 65 ore dressing investigations, 49,139 chemical analysis, 2,408 mineralogical studies and one in-plant study.

Indian Bureau of Mines undertakes preparation of National Inventory of mineral resources on a quinquennial basis. Under this programme, implementation of UNFC system was adopted in 2002 replacing the earlier resource classification based on Indian system. Subsequently, NMI as on 1.4.2005 was updated. Updation of the NMI of mineral resources in respect of 70 minerals based on UNFC system as on 1.4.2010 has also been completed in March, 2012.

## GSI

GSI pursued its systematic geological mapping in 2011-12 and had completed 1,880 sq km large-scale mapping, 45.105 sq km detailed mapping and 63,097 m drilling as against preceding year's achievement of 2,425 sq km large-scale mapping, 32.215 sq km detailed mapping and 57,961 m drilling. Out of the total mappable areas of 3.146 million sq km of the country, 3.094 million sq km has been covered so far by systematic mapping bringing the total coverage to 98.34%.

## Reserves Established

Reserves/resources established in the course of mineral exploration during 2011-12 are furnished below:

i) About 5,611 million tonnes resources of coal in various coalfields of Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Odisha and West Bengal were estimated.

ii) In Rajasthan, a total resource of 13.67 million tonnes lignite were estimated.

iii) In Damurda South Block, Keonjhar district, Odisha, a total inferred manganese ore resource (333) of 1.15 million tonnes has been estimated at 20% Mn cut off and an additional 0.608 million tonnes of marginal grade (10-20% Mn) resource has also been estimated.

## Survey

### Marine Survey

GSI continued its offshore geoscientific studies both in Exclusive Economic Zone (EEZ) and Territorial Waters (TW) along the East and West Coasts of India. Surveys in the near-shore zones (0 m - 10 m isobaths) were carried out using hired small mechanical boats.

During 2011-12, a total of seventeen cruises were undertaken using three vessels.

The following marine geoscientific surveys were carried out during 2011-12 Field Season:

1. Six cruises aboard R.V. Samudra Manthan within EEZ conducted the following:
  - a) Multibeam bathymetric survey of the continental slope off Gopalpur-Kalingapatnam-Pudimadaka, Odisha-Andhra Pradesh coast (SM-218).
  - b) Study of the seabed morphology and magnetic anomaly pattern across the arc-trench gap of Great Nicobar Island (SM-219).
  - c) Monitoring of changes of Curie Isotherm around Barren Island and Multibeam bathymetric survey around Barren Island (SM-220).
  - d) Multibeam bathymetric survey to the east of Nicobar Islands on the Sewell Rise (SM-221).
  - e) Multibeam bathymetric survey of the continental slope off Pudimadaka-Godavari, Andhra Pradesh (SM-222).
  - f) Preliminary survey for phosphatic sediments off Okha, Gujarat (SM-223).

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2. Seven cruises aboard R.V.Samudra Kaustubh within the Territorial Waters (TW) off the east coast conducted:

a) Parametric (magnetic & seismic) survey within TW off north Andhra Pradesh coast (ST-215).

b) Placer mineral resource evaluation in the TW off north of Bhimunipatnam, Andhra Pradesh (ST-216).

c) Study of the seabed morphology in the outer continental shelf off Gopalpur-Chhatrapur, Odisha (ST-217).

d) Geotechnical surveys off Puri, Odisha (ST-8).

e) Parametric (magnetic) surveys between Puri and Kushabhadra river mouth off Odisha coast (ST-218A).

f) Multibeam bathymetry off Malud, Odisha (ST-219).

g) Mapping of sea-bed within TW off Point Calimere, Tamil Nadu (ST-220).

3. Four cruises aboard R.V. Samudra Shaudhikama within the TW off the West Coast conducted:

a) Parametric (magnetic) survey within TW off Gulf of Mannar (SD-235).

b) Mapping of the seabed, off Okha, Gujarat (SD-236).

c) Evaluation of relict sand body off Ponnani, Kerala (SD-239).

d) Parametric (seismic and magnetic) survey within TW off Kanyakumari-Thoothukudi Coast (SD-240).

### Airborne Survey

GSI pursued airborne geophysical surveys for generating database by employing magnetic and gamma ray spectrometric techniques. The surveys followed up by data processing, preparation of aerogeophysical maps and interpretations help in ground evaluation and add information to geological maps that would aid prospecting and exploration for minerals. The data

from the aerial surveys thus form an important backup for refining the geological understanding of an area, with focus on identification of favourable locales of mineralisation, crystal structure, etc.

Airborne survey operations over Chandrapur - Brahmapuri area, Maharashtra were started in December 2011 and continued till 16.01.2012. Airborne data along a total of 4,139 line km out of the total assigned target of 17,390 line km was acquired only at an average height of 150 m. On 16.01.2012 onwards the proposed survey work was at halt as the Twin Otter Aircraft VT-ELX was grounded due to major technical snag.

Since the acquisition and induction of TOASS, a total of 495,062 line km over an area of 294,045 sq km was covered by multi-sensor surveys involving magnetic, spectrometric, radiometric and electromagnetic methods till the field season 2010-12, in the following areas: Mamandur (Tamil Nadu), Aladahalli, Gadag, Wajrakarur-Vedavathi basin (Karnataka and Andhra Pradesh), Agartala-Silchar (for ONGC in Tripura and Assam), Ratnagiri (Maharashtra), Siliguri-Guwahati (for ONGC in West Bengal and Assam), Tosham-Singhana (Haryana and Rajasthan), Sukinda-Baripada (Odisha), Bundi-Bharatpur (Rajasthan), Agucha-Malpura-Chaksu (Rajasthan), Moradabad -Bareilly (for OIL in Uttar Pradesh), Gorakhpur-Muzaffarpur (for OIL in Uttar Pradesh and Bihar), Satyamangalam (Tamil Nadu), Hindoli (Rajasthan), Bhilwara (Rajasthan), Gangapur-Nasirabad (Rajasthan), Chhattisgarh basin (Chhattisgarh and Odisha), Betul-Chhindwara (Madhya Pradesh), Narayanpet-Raichur (Andhra Pradesh), Hungund-Mudhol (Karnataka), Lalitpur (Uttar Pradesh), Mahoba-Panna (Uttar Pradesh and Madhya Pradesh), Nalgonda-Mahbubnagar (Andhra Pradesh), Bengaluru-Penukonda (Karnataka and Andhra Pradesh), Mulbagal-Tambalpalle (Karnataka and Andhra Pradesh), Nagpur-Wardha valley area (Maharashtra), Baihar-Katru area (Madhya

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Pradesh and Chhattisgarh), Kanker area, Chhattisgarh, Mauranipur-Sarila area (Madhya Pradesh and Uttar Pradesh), Hosadurg-Vengurla area over Western off-shore and Chandrapur-Brahmapuri (Maharashtra).

Ground evaluation of aerogeophysical data is carried out with the help of aerial photos and imageries, mostly by detailed mapping, sampling, pitting and trenching, and wherever necessary, by drilling.

### MECL

The highlights of exploration carried out by MECL during 2011-12 are given below:

- i) The company has registered 296,301 m of drilling for various minerals namely coal, lignite, iron ore, rock phosphate and for atomic minerals on behalf of Atomic Mineral Directorate for Exploration & Research (AMDER), Hyderabad.
- ii) For coal & lignite, a total of 122,576 m of geophysical logging was carried out. Further, surface geophysical survey was also carried out, in which an area of 193 sq km was covered with 4826 nos of gravity stations.
- iii) A total of 125 sq km of geological mapping was done for different minerals in various parts of the country.
- iv) In laboratories, a total of 28,597 samples were analysed and 79,197 radicals were determined along with petrological studies on 211 nos of thin sections.
- v) A total of 27 exploration reports for geological investigations, geophysical, environmental & remote sensing studies were submitted for various minerals namely, coal, lignite, iron ore and rock phosphate.

vi) A total of 3,345 million tonnes of reserves were added to NMI. Mineralwise details of reserves established by MECL during 2011-12 are:

Coal	- 2296 million tonnes
Lignite	- 1043 million tonnes
Iron ore	- 4.23 million tonnes
Rock Phosphate-	1.26 million tonnes

### MINERALWISE EXPLORATION ACTIVITIES PETROLEUM AND NATURAL GAS

The Government of India has formulated a New Exploration Licensing Policy (NELP) to accelerate and expand exploration of oil and gas in the country. A total of 235 blocks have been awarded so far in eight rounds of NELP during 2000-2010. Exploration under NELP has shown positive results, in both inland and off-shore areas. With a view to accelerate further the pace of exploration, in the ninth round of NELP, 34 exploration blocks were offered and bids were received for 33 blocks.

### ONGC

Business Development and Joint Ventures Group of ONGC (BD & JV), in line with the ONGC's pursuit for Business Growth Plans has initiated several measures for achieving enhanced value chain integration in hydrocarbon business in the field of Petrochemicals, Power & Fertilizer.

ONGC continued its operations for exploration of oil and gas. Out of 26 identified sedimentary basins in on-shore and off-shore areas of the country, exploration was continued in Cambay Basin, Gujarat; Jaisalmer in Rajasthan; Upper Assam, Tripura, Mizoram in Assam-Arakan; Himalayan foothills, Himachal Pradesh; Vindhyan/Gondwana (Madhya Pradesh); Krishna-Godavari (Andhra Pradesh); Cauvery (Tamil Nadu); West Bengal and in East Coast and West Coast off-shore areas.

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During 2011-12, ONGC acquired a total of 13,606 GLK/LK of 2D seismic data which included 2,535 GLK inland and 11,071 LK off-shore data. During the same period, 9,820 sq km of 3D seismic data was also acquired which included 2,314 sq km inland and 7,506 sq km off-shore areas. ONGC's 135 exploratory wells comprised 99 wells to a total depth of 243,580 m inland areas and 36 wells to a total depth of 132,790 in off-shore areas.

During 2011-12, ONGC reported 23 new hydrocarbons discoveries, namely, Pattharia (PTAA), G-354(GKAP), KH-31 (KHAV) and Gojalia-13 (GOAB) in Assam & Assam-Arakan basin; Viraj-58 (VJEP), North Kodi-461(NKPI), East Linch (LNBU), NK-472 and UBER-2 (UBAC) in Western offshore basin; Nohta-2 in Frontier basin; Hartoki-1(HOAB) in AAFB-Cachar basin; North Kovikalappal-3(NKKAA) and Periyakudi-1 (PDAA) in Cauvery Onland basin; AN-DWN-2002/I-C (ANDW-1) in Andaman Offshore basin; GS-70-1, Chandrika South-1 and KGOSNO41NAAL-1 in KG Offshore; MDW-13 in Mahanadi Offshore; Aliabet-3 (ABAF) in Gulf of Cambay basin; GSSO4NAA-1 in Saurashtra Offshore basin; GK-42-1 in Kutch Offshore basin and B-127E-1 and BH-67 in Mumbai Offshore basin. As a result of these exploratory efforts, ONGC accreted 84.13 million tonnes reserves during 2011-12, leading to 2,679.04 million tonnes ultimate reserves of oil and oil-equivalent gas (O+OEG) at the end of the year in areas under its operations.

### **OIL**

OIL owns a vast array of advanced computing systems to process and interpret geo-scientific data through integrated exploration applications such as Remote Sensing, Structural & Stratigraphic Interpretation, Seismic Attribute Analysis, Source Rock Evaluation, Biostratigraphy, Sequence Stratigraphy, Petrophysics, Basin Analysis, Techno-Economic Evaluation, etc.

Significant discoveries of oil/gas struck by OIL at various districts in Assam during 2011-12

are as below :

i) The Well Diroi 5 (Loc.MFH) located on the Dikcham structure in the Moran Extension area in the Dibrugarh district of Assam. The well was drilled to a depth of 4,600 meters within the basement to probe the hydrocarbon prospects within the Lakadong+Therria formation. The well was encountered a number of prospective sand ranges within the Lakadong+Therria formation, showing evidence of oil during testing. This discovery has opened up a new area for exploration in the Diroi area, especially in the Palaeocene-Lower Eocene formations.

ii) The Well Nahorkatiya 594 (Loc.CM) located in the Kharikatia structure in Chabua area in the Dibrugarh district of Assam. The well was drilled down to a depth of 3,905 meters within the basement to probe the hydrocarbon prospects within the Paleocene-Lower Eocene formations. The well has encountered a number of prospective sand ranges within Lakadong+ Therria formation and is currently producing gas from one of the tested sands. The discovery of gas in this well has opened up a new area for exploration in the Kharikatia area especially in the Paleocene-Lower Eocene formations.

iii) The Well Nahorkatiya 595 (Loc.NLC) located in Amgurigaon structure in the Dibrugarh district of Assam. The well was drilled down to a depth of 3,055 meters to probe the hydrocarbon prospects within the Barail formation and secondary prospects within the Tipam formation. The well was encountered oil bearing sand within Barail formation, which has been tested and two more possible oil bearing sands within the same formation. The discovery of oil within the Barail formation in this well has opened up a new area for exploration in Amgurigaon structure within the Nahorkatiya extension ML area.

iv) The Well Makum 41(Loc. HVI) located in the North-West Makum structure of the Makum-North Hapjan oil field area in the Tinsukia district of Assam. This well was drilled to a depth of

4,174 meters within the basement to probe the hydrocarbon prospects within the Barail and Tipam formations as primary target and Palaeocene-Lower Eocene formations as secondary target. On testing, the well produced oil from Barail formation. This discovery of oil in this well has opened up a new play for exploration/exploitation in the North-West Makum structure in the Hugrijan area.

v) The Well Makum 43(Loc. HVL) located in the West Makum structure in the Tinsukia district of Assam. The well was drilled to a depth of 3,060 meters within the Barail formation to probe the hydrocarbon prospects within the Barail and Tipam formations. The well has encountered one gas bearing sand within the Barail formation (tested) and two possible hydrocarbon bearing sands within the Tipam formation. The discovery of gas within the Barail formation in this well has opened up a new play for exploration/exploitation in the West Makum structure in the Hugrijan area.

vi) The Well Balimara-1(Loc. DGF) located in the Balimara structure in the Dibrugarh district of Assam. This well was drilled to a depth of 4,985 meters within the Kopili formation to probe the hydrocarbon prospects within the Tipam and Barail formations and additionally to probe hydrocarbon prospects within the Kopili formation in the southern part of the Upper Assam Basin near the Belt of Schuppen. The well produced oil on testing the Barail formation. Presence of oil within the Kopili formation was also established in this well for the first time in OIL's operational area in Assam which has opened up a new area for exploration in the region. The discovery of oil within the Barail formation in this well has opened up a new play for oil exploration/exploitation in the Balimara structure in the

Dumduma area.

vii) The Well Nahorkatiya 597 (Loc.HUM) located in the East Zaloni structure in the Tinsukia district of Assam was drilled to a depth of 1,989 meters within the Tipam formation to probe the hydrocarbon prospects within the Girujan formation. The well has encountered one gas bearing sand within the Girujan formation (tested) and a hydrocarbon possible gas bearing sand within the Upper Tipam formation. The discovery of gas within the Girujan formation in this well has opened up a new gas play for gas/oil exploration/exploitation in the East Zaloni structure in the Hugrijan area.

The physical achievements of exploration activities pursued by ONGC and OIL during 2011-12 are detailed in Table-1.

### **Reliance Industries Ltd (RIL)**

On February 21, 2011, RIL and British Petroleum (BP) announced their strategic alliance. Under the aegis of this alliance, BP took 30% participatory interest in 21 oil and gas production sharing contracts operated by RIL in India, including the KG-DG 6 block. It will focus on exploring, discovering and producing hydrocarbons in India's deep water blocks. In the D1-D3 gas fields, 22 wells have been drilled so far, of which 18 were producer wells. Of these, two wells were drilled during the year. RIL has declared the commerciality of discovery D-34 of KG-D6 and restated the proved reserves upward based on re-estimation. The RIL made a discovery in the first well drilled in CY-D6 block-well SA1-Discovery Dhirubhai 53 and also submitted a proposal for commerciality of 8 discoveries in CB-10 block and notified declaration of commerciality for D32 and D40 in NEC-25 block. RIL's domestic oil and gas portfolio consists of 17 exploration blocks excluding KG-D6, CBM, Panna-Mukta and Tapti.

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**Table – 1 : Exploration for Petroleum & Natural Gas by ONGC and OIL, 2011-12**

Agency/location/State	Drilling					
	Seismic Survey		Exploratory		Development	
	2D(GLKM)	3D(SQKM)	Wells	Meterage	Wells	Meterage
<b>ONGC: Total</b>	<b>13606</b>	<b>9820</b>	<b>135</b>	<b>376370</b>	<b>280</b>	<b>558690</b>
<b>Inland: Total</b>	<b>2535</b>	<b>2314</b>	<b>99</b>	<b>243580</b>	<b>238</b>	<b>445580</b>
Andhra Pradesh	–	128	10	37990	10	30050
Assam	121	218	18	53830	24	85030
Bihar	70	52	–	–	–	–
Gujarat	89	454	47	83650	188	296950
Himachal Pradesh	–	–	1	5270	–	–
Madhya Pradesh	129	–	2	7460	–	–
Mizoram	–	–	1	1970	–	–
Rajasthan	271	151	2	4540	–	–
Tamil Nadu	1110	243	8	26500	13	24560
Tripura	–	33	9	21370	3	8990
Uttar Pradesh	363	20	–	–	–	–
West Bengal	382	1015	1	1000	–	–
<b>Off-shore: Total</b>	<b>11071</b>	<b>7506</b>	<b>36</b>	<b>132790</b>	<b>42</b>	<b>113110</b>
East Coast Off-shore	11071	6634	17	78290	–	–
West Coast Off-shore	–	872	19	54500	42	113110
<b>OIL : Total*</b>	<b>1440</b>	<b>1838</b>	–	–	–	–
<b>Inland: Total</b>	<b>929</b>	<b>341</b>	–	–	–	–
Andhra Pradesh	–	73	–	–	–	–
Assam & Arunachal Pradesh	886	268	–	–	–	–
Mizoram	43	–	–	–	–	–
<b>Off-Shore Total</b>	<b>511</b>	<b>1497</b>	–	–	–	–
Andhra Pradesh	511	1497	–	–	–	–

\* During 2011-12, OIL carried out 127,994 m drilling in 38 wells in on-shore areas of Assam (36 wells - 124,828 m drilling) and Rajasthan (2 wells - 3,166 m drilling).



## COAL

The agencies engaged in exploration for coal during 2011-12 were mainly GSI, CMPDI, MECL and State Directorates of Geology & Mining.

## GSI

The GSI continued its operations for search and assessment of coal resources in the country through regional exploration in coalfields of Andhra Pradesh, Assam, Chhattisgarh, Madhya Pradesh, Maharashtra, Odisha and West Bengal. An additional resource of 5,610.83 million tonnes of coal have been assessed from the data generated from regional exploration during 2011-12.

In Andhra Pradesh, Reconnaissance stage (G-4) exploration by scout drilling was taken up during 2010-12 in Vutasamudram-Venkatapuram area, Southern sub-basin of Godavari Valley Coalfield, Khammam and West Godavari districts to explore and evaluate coal potentiality of Barakar and Lower Kamthi formations, already established in northern adjoining Narayanpuram-Pattayagudem and Sitanagaram areas and to decipher the structural and stratigraphic set up of the area. The uppermost coal/carbonaceous shale zone, viz., C zone of Lower Kamthi Formation containing 3 to 8 split sections varying in individual thickness from 0.60 m to 1.80 m and cumulative thickness from 3.14 m to 8.98 m was intersected in boreholes GVVK-1 and GVVK-3. The middle coal/carbonaceous shale zone, viz., B zone of Lower Kamthi Formation containing 12 split sections having individual thickness varying from 0.50 m to 1.45 m with cumulative thickness of 10.04 m was intersected between 379.25 m and 435.75 m depths in borehole GVVK-3. Prospecting stage (G-3) regional work for coal by drilling was taken up during 2010-12 in Bugga-Khammamtoogu sector, Southern Part of main basin of Godavari Valley Coalfield in Khammam district to explore and evaluate coal resource potentiality of Barakar coal seams already established in the adjoining Manuguru Mining Block located to the northeast. In GBK-2 a total of 12 nos of thin coal/carbonaceous shale seams/bands were intersected within Lower Kamthi Formation between 43.79 m and 187.35 m depths having individual thickness

varying from 0.55 m to 1.60 m with cumulative thickness of 9.48 m. The coal/carbonaceous shale zone recorded within Barakar Formation between 280.30 m and 481.37 m depths containing 4 split sections varying in individual thickness from 0.51 m to 1.25 m with cumulative thickness of 3.36 m.

In Assam, Prospecting stage (G-3) regional exploration was taken up during 2010-12 in Sukchar-Singrimari block, Singrimari Coalfield in Dhubri district at the border of Assam and Meghalaya to explore the behaviour and the northward extension of the coal bands established in adjacent area during 1985-88 and to establish the coal resource potentiality of the area. An area of 7.20 sq km, which is mostly under alluvium cover, was mapped to the north of the explored block (field season 1985-88). The area forms a part of the Precambrian Gneissic Complex comprising of migmatites, biotite gneiss, granite gneiss, porphyritic granite and Tertiary sedimentary rocks. Thinly laminated rocks characterised by greenish coloured shale, siltstone, sandy clay, light greenish coloured sandstone belonging to the Talchir Formation and Karharbari Formation comprising coarse grained, gritty to pebbly sandstone, medium to fine grained sandstone, siltstone light grey to black carbonaceous shale occur in Hallidayganj. These formations of the Gondwana Group overlie the Precambrian Gneissic Complex with an unconformity. Isolated occurrences of Lower Gondwana rocks exist in the extreme NW corner of the area. Carbonaceous shale horizons with coal stringers occur within gritty sandstone of the Karharbari Formation. A total meterage of 254.30 m was drilled in three boreholes. The first two boreholes were abandoned due to technical difficulties. The third borehole commenced in March 2012.

In Chhattisgarh, regional exploration under (G-2) stage initiated during 2009-10 and continued during this period was completed in Nawagaon block, Raigarh district, Mand-Raigarh Coalfield to establish the developmental pattern and continuity of the regional Barakar coal seams, already established in the Chainpur area in the west, Ongana-Potiya area in the north and Sithra-Kurekela sector in the southwest, and to assess

coal resources potentiality as well as to carry out appraisal of CBM content. Twelve regional (Seam I to XII in ascending order) and eleven local Barakar coal seams zones have been intersected between the depths of 11.96 m and 406.15 m. The important seams are Seam - I, IV, VI, VII and VIII with cumulative thickness of coal ranging from less than a meter to 20.44 m. Seam IV is the thickest seam and was intersected between the depths of 44.66 m and 283.48 m. Regional continuity of coal seams was established 10 km along strike and 12 km along down-dip direction. Regional exploration under G-2 stage was taken up during 2010-12 in Teram block, Raigarh district, Mand-Raigarh Coalfield to establish the developmental pattern and continuity of the regional Barakar coal seams intersected in already explored adjacent Kurumkela Block in the north-central part of Mand-Raigarh Coalfield and to evaluate additional coal resource in the area. In Barakar Formation, ten regional (Seam III to XII in ascending order) and few local coal seams with thickness ranging from less than a metre to 12.55 m (cumulative) were intersected between the depths of 132.90 m and 729.10 m. Of these, the important seams are Seam -V, VI, XI and XII. The thickest seam, Seam VI is banded in nature and its cumulative thickness ranges from 6.55 m to 12.55 m. During the period, regional continuity of coal seams was established 5 km along strike and 3.5 km along down-dip direction. Regional exploration under G-2 stage in Samarsingha block, Raigarh district, Mand-Raigarh Coalfield commenced during 2010-12 in order to establish the developmental pattern and continuity of the regional Barakar coal seams, already established in the Nawagaon Block in the north and Sithra-Kurekela area in the west, to assess coal resources potentiality and to carry out appraisal of CBM content. In Barakar Formation, thirteen nos of regional coal seams/zones (Seam I to XII in ascending order) with thickness ranging from less than a metre to 8.52 m (cumulative) were intersected between the depths of 56.20 m and 604.50 m. Amongst these, the important seams are Seam -I, VI, VII & XII. Regional exploration under G-2 stage was taken up during 2010-12 in Korja block, Hasdo - Arand Coalfield in Surguja district, to establish the developmental pattern and continuity of the

regional Barakar coal seams, established in previously explored Pendrakhi Block in the west, to assess coal resource potentiality of the area as well as to generate CBM baseline data. Four regional (Seam III to VI in ascending order) and four local (Seam L1 to L4 in ascending order) Barakar coal seams/zones have been intersected between depths of 65.83 m and 342.35 m. Coal Seam /Zone III, IV and V are considered to be significant because of their cumulative coal thickness which ranges from 2.57 m to 6.45 m. Regional exploration for coal (G-2) was carried out in Reonti (West) block, Tatapani – Ramkola Coalfield in Surguja district to establish the continuity of Barakar coal seams beneath the younger Raniganj and Barren Measures formations as well as to appraise its resource potentiality. Subsurface data revealed the presence of Raniganj, Barren Measures and Barakar formations. Six regional (I to VI in ascending order) and few local coal seams of Barakar Formation ranging in thickness from less than a metre to 66.66 m (cumulative) have been recorded between depths of 702.10 m and 880.00 m. Seams III to VI are important for their thickness and regional persistency. The seam nos IV and V are represented by several nos of split sections with the maximum cumulative thickness being 12.73 m (4.84 m clean coal) and 66.66 m (22.67 m clean coal), respectively. Exploration for coal by scout drilling in Vijaynagar-Giddha block, Tatapani - Ramkola Coalfield, Surguja district (G-2) commenced during 2010-12 in order to (a) to establish the structural disposition of the Lower Gondwana sequences, (b) to establish the continuity of Barakar coal seams beneath the cover of Barren Measures and Raniganj Formation, (c) to appraise the resource potentiality of Barakar coal seams and (d) to generate CBM Baseline Data. Thirteen regional (I to XIII in ascending order) and ten local Barakar coal seams/zones ranging in thickness from 0.50 m to 14.80 m were intersected between 22.55 m and 605.60 m depths. Seam II, III, IV, V, VI, VIII, XII & XIII are important for their thickness and regional persistency. Seam nos III (6.15 m to 14.80m), IV (3.40 m to 7.65 m) and V (0.60 m to 8.40 m) contain several split sections. During the period, regional continuity of coal seams was

established 4 km along strike and 1 km along down-dip direction.

In Madhya Pradesh, reconnaissance stage (G-4) exploration by scout drilling was taken up during 2010-12 in Saral (East) area, Singrauli Coalfield, Singrauli district to assess the coal development pattern and resource potentiality, establishing stratigraphic set up of the area and to generate CBM baseline data. Seven regional Barakar coal seams (I to VII in ascending order) ranging in thickness from 0.69 m to 3.78 m were intersected at relatively shallow depth between 229.20 m and 597.36 m. Out of these, Seam II, IV, VI & VII are relatively thicker (1.39 m to 3.78 m). Apart from these, two regional Raniganj coal seams (R-II and R-III) ranging in thickness from 0.78 m to 0.92 m were intersected at very shallow depths between 18.27 m and 62.03 m. The coal seams of Raniganj Formation are high rank low volatile bituminous coal. During the period, regional continuity of coal seams was established 5 km along strike and 1.5 km along down-dip direction. Spill over work was carried out in Hatta-Dudhmaniya area, Singrauli Coalfield in Singrauli district to assess the development pattern and resource potentiality of coal horizons in Raniganj and Barakar formations. Exploration for coal by scout drilling (G-4 stage) has revealed four regional Barakar coal seams (I to IV in ascending order) ranging in thickness from 1.36 m to 3.07 m in between depths of 542.19 m and 676.77 m. Seams II (2.80 m) and IV (3.07 m) are important for their thickness and regional persistency. Regional exploration under G-2 stage in Devanitola block, Sohagpur Coalfield, Shahdol district, was initiated in 2008-09 and continued during this period, for establishing developmental pattern of superior grade Barakar coal seams at shallow depth, to decipher major structural setup of the area, and to evaluate additional coal resources. Exploration in this block reveals occurrence of four regional seams (I to IV in ascending order) and two local seams (L1 and L2) within Barakar Formation varying in thickness from less than a metre to 8.20 m (cumulative) in the depth range from 156.85 m to 287.13 m. Seam III is the thickest (maximum cumulative thickness 8.20 m), composite in nature and characteristically shows two split sections.

The seam is very significant and is used as a key horizon for correlation purpose. During the period, regional continuity of coal seams was established 1.5 km along both strike and down-dip direction. Regional exploration under G-2 stage continued since 2009-10, was taken up in Amiliha block in Sohagpur Coalfield in Umariya district, to establish developmental pattern of superior grade Barakar coal seams at moderate depth, to decipher major structural set up of this area, to evaluate additional coal resources and to assess CBM potentiality. The area of exploration is covered mostly by Raniganj Formation associated with frequent basic intrusives (dolerite), and partly by Barren Measures occurring in southern and western parts. Four regional Barakar coal seams (I to IV in ascending order) ranging in thickness from less than a metre to 3.60 m have been intersected between 206.95 m and 370.15 m depths. Coal seams III and I are important for their thickness and regional persistency. During the period, regional continuity of coal seams was established 1.5 km along both strike and down-dip direction. Regional exploration under G-2 stage initiated during 2009-10, was continued in Pachri block, Sohagpur Coalfield in Shahdol district, to establish developmental pattern of superior grade Barakar coal seams at shallow depth, to decipher major structural set-up of the area and to evaluate additional coal resources. Exploration in Pachri Block revealed occurrences of four regional seams (I to IV in ascending order) and one local Barakar coal seam ranging in thickness from less than a metre to 3.35 m were intersected between 139.85 m and 309.00 m. Seam III is the thickest coal seam (1.05 m to 3.35 m) with two split sections and used as a key horizon for correlation of coal seams. Regional exploration under G-2 stage for coal in Maiki (North) block, Sohagpur Coalfield, Shahdol district, commenced in 2010-2012 in order to a) establish developmental pattern of superior grade Barakar coal seams at shallow depth; b) decipher major structural set-up of the area and c) evaluate additional coal resources. One dolerite body of around 90m thickness has intruded Barren Measures Formation. Exploration has revealed occurrences of four regional seams (I to IV in ascending order) and two local Barakar coal seams

(L1 and L2) ranging in thickness from less than a metre to 6.23 m between 389.40 m and 604.15 m depths. Seam no. III (3.05 m to 6.23 m) is the thickest with two split sections and is a key horizon for correlation of coal seams. Apart from these, six Raniganj coal seams/bands ranging in thickness from 0.50 m to 2.90 m were intersected at very shallow depths between 9.00 m to 62.65 m. Reconnaissance stage (G-4) exploration, was initiated in 2008-09 by scout drilling in Naurazabad (North) area, Johilla Coalfield in Umaria district, to delineate potential area of high rank superior grade coal, evaluation of additional coal resources, to decipher structural set up of the area and to assess CBM potentiality. The drilling continued during this period and indicated litho-assemblages akin to Barren Measures. Prospecting stage (G-3) regional exploration initiated during 2009-10 has been continuing in Payalidhana sector, Pench Valley Coalfield in Chhindwara district to establish the strike extension of Barakar coal seams below the Deccan Traps under favourable structural set up, already recorded in Bagbardiya sector to the southwest and Dhankasa area in the southeast, and to assess the coal resource potentiality of the area. Five regional Barakar coal seams (I to V in descending order) with individual seam thickness ranging from 0.55 m to 5.55 m were intersected between 296.70 m and 421.27 m depth. Seam II (3.40 m to 4.05 m), III (0.95 m to 5.55 m) and IV (1.90 m to 4.35 m) are important for their thickness and regional persistency. Coal can be categorised under 'High Volatile Bituminous B' to 'Medium Volatile Bituminous' rank. Prospecting stage (G-3) regional exploration under spillover drilling programme was carried out in the Bagbardiya sector, Pench Valley Coalfield in Chhindwara district to establish the strike continuity of Barakar coal seams encountered in Pathakhuri-Pipariya area in the west and Magrahi area in the east below the Deccan Traps under favourable structural set up and to assess the coal resource potentiality of the area. Five regional Barakar coal seams (I to V in descending order) ranging in thickness from 0.90 m to 3.20 m have been recorded between depths of 416.67 m and 440.41 m. Seam I (3.20 m), II (1.35 m) and IV (1.13 m) are

important for their thickness and regional persistency.

In Maharashtra, prospecting stage (G-3) regional exploration initiated during 2008-09 has been continuing in Dewala-Mangali block of Wardha Valley Coalfield in Yavatmal district to establish the strike continuity of Barakar coal seams, already recorded in Asthona-Kothurla-Mangli area in the northwest below the Deccan Traps under favourable structural set up and to assess the coal resource potentiality of the area. During this period, two boreholes were drilled and one coal seam of 0.60 m in thickness was intersected at 459.40 m depth in Barakar Formation.

In Odisha, regional exploration under G-2 stage in Khariaparha block of Ib River Coalfield in Jharsuguda district, initiated in 2009-2010 has been continuing during 2010-12 with an objective to explore the possible continuity of regional coal seam/seam zones of Raniganj and Barakar formations towards northeast of already explored Kuraloi (A) North Block, to establish structural set up and stratigraphy of the area, to assess the coal resources potentiality of the area and to have preliminary appraisal of CBM potentiality. Five regional Barakar coal seam zones (Belpahar, Parkhani, Lajkura, Rampur and 1B in descending order) recorded between 20.97 m and 614.20 m depths. The Lajkura seam zone is the thickest having cumulative coal thickness of 59.36 m intersected at roof depth of 327.86 m. The maximum intersected cumulative thickness of Belpahar, Parkhani, Rampur and 1b coal seam zones are 26.69 m, 20.45 m, 57.37 m and 0.72 m, respectively, with multiple split sections. Continuation of coal seams has been established for about 2 km both along strike and dip direction. Gas desorption study of coal core samples has recorded a value of 0.14 cc/g. Regional exploration under G-2 stage in Grindola block, Ib River Coalfield, Jharsuguda district, commenced in 2010-12 with an objective to explore the possible continuity of regional coal seam/seam zones of Raniganj and Barakar formations encountered in already explored neighbouring Kuraloi (A) North block, to establish structural set up and stratigraphy and to assess

the coal resources potentiality of the area. In the first borehole, two Raniganj coal seam zones (R-I and R-II) and three regional Barakar coal seam zones (Belpahar, Parkhani and Lajkura from top to bottom) with cumulative coal thickness ranging from 11.41m to 26.59 m and 26.07 m, respectively, for Raniganj and Barakar formations have been recorded between 31.90 m and 514.20 m depths. Regional exploration for coal under G-2 stage in Similisaahi-Kunjabiharipur block, Talcher Coalfield in Angul district, continued in 2010-12 with an objective to explore the westward continuation of regional coal seams of Barakar Formation already intersected in the adjacent Jalatap block and to appraise the coal resource potentiality of the area. All the ten Barakar coal seams (II to XI in ascending order) were intersected in the depth range from 300.35 m to 601.89 m with cumulative coal thickness of individual seam zones varying from 0.55 m to 37.72 m. Continuity of regional coal seams for 6 km along strike and 2.5 km along dip direction has been established in the block. An additional indicated resource of about 1500 million tonnes of coal has been assessed for this block. Exploration for coal by scout drilling (G-4 stage) commenced during 2010-12 and continued during the period under review in Nuagaon North area, Talcher Coalfield in Angul district, to explore the down dip continuity of regional coal seams of Barakar and Karharbari formations, already explored in adjacent Nuagaon-Telisahi and Kudanali Northeast blocks and to assess coal resource potentiality of the area. Five Barakar and one Karharbari seam zones with cumulative thickness varying from 1.22 m to 36.15 m were intersected within the depth range of 70.06 m and 626.35 m. Continuity of coal seams was established for 6 km along strike and 3 km along dip direction. Regional exploration (G-3 stage) for coal was initiated in Korara-Danara sector, Talcher Coalfield in Angul district, during 2010-12 to establish the up-dip continuity of Karharbari coal seam at shallow to quarriable depth and to assess the coal potentiality of the area. The subsurface generated data indicates that the targeted Karharbari seam (Seam-I) has not

developed along the southwestern margin of the Talcher Gondwana Basin. Spill over drilling in Harichandanapur block, Talcher Coalfield, Angul district, has been continued in 2010-12 with an objective to establish the northward continuity of regional coal seam zones of Barakar and Karharbari formations, already intersected in adjacent Tribira block and to assess coal resource potentiality of the area. Barakar seam zones II & III were intersected in the last borehole (THC-4) in the depth range from 413.65 m to 471.05 m. Continuity of regional Barakar coal seams for 4 km along strike and 2.5 km along dip-direction was established. A total resource of 493.03 million tonnes of coal under indicated category within a depth of 600 m has been assessed in this block, out of which 214.78 million tonnes occur within 0-300 m depth. Baseline data generated for CBM in borehole no THC-4 indicates variation of in situ gas content from 0.06 cc/g to 0.26 cc/g.

In West Bengal, reconnaissance stage (G-4) regional exploration for coal initiated during 2009-10 by scout drilling in East of Bhabaniganj area, Raniganj Coalfield, Birbhum district continued during the reporting period to examine the extension of Barakar coal seams to the east of Nabasan and Binodpur-Bhabaniganj Blocks and to appraise the development pattern and regional persistence of the coal seams in the Barakar Formation. The area lies in the eastern adjacent part of Binodpur-Bhabaniganj Block and south of Kasta area in the Trans-Ajay part of Raniganj Coalfield. During the period under review, three boreholes were drilled in the area. In borehole RBB- 5, a 5.50 m thick coal seam (Salanpur-A seam) has been intersected at 391.30 m depth. Continuity of Barakar coal seams from the above-mentioned adjacent explored blocks was established. Reconnaissance stage (G-4) regional exploration by scout drilling was initiated during 2010-12 in South of Hingla River area in Raniganj Coalfield, Birbhum district to establish the development pattern and structural disposition of Barakar coal seams at depth under the cover of Barren Measures along with appraisal of the coal

resource potentiality and to establish strike-wise continuity of the regional Barakar coal seams already established in Nabasan and Binodpur-Bhabaniganj were drilled in the area. Development of Barakar coal seams, correlatable with Salanpur-A group with cumulative thickness varying from 0.70 m to 6.30 m were intersected in the depth range from 240.90 m to 480.40 m. Prospecting stage (G-3), regional exploration for Gondwana coal under the cover of Rajmahal Trap and Tertiary sedimentaries in Dhobbanpur sector, Birbhum coalfield in Birbhum district, initiated during 2009-10 with an objective to (a) establish continuity of coal bearing Barakar Formation to the south and east of Makhdumnagar and south of allotted CBM Blocks (BB-CBM-2005/III of DGM), (b) to examine the development pattern of coal seam and (c) generation of baseline data related to CBM, was continued in 2010-12. During the period drilling has been completed in four boreholes, viz, BDB-3 (part), BDB-4, BDB-5 (part) and BDB-6 (part). A maximum of 23 coal sections of Barakar Formation have been intersected between 429.55 m and 659.05 m depth. Thickness of the coal section ranges from 0.50 m to 4.75 m. Besides, two lignite seams of 1.20 m and 1.50 m thickness within Tertiary sediments have also been intersected at 169.10 m and 173.20 m depth in borehole No BDB-4. Maximum cumulative thickness of coal is 29.85 m recorded in borehole BDB-4 in the central part of the area. CBM desorption study of core samples collected from the coal seams has indicated a mere presence of desorbed gas (Q3) value of 0.10-0.15cc/g. Exploration by scout drilling (G-4 stage) in Gazipur area, south of Mahalla, Rajmahal Master Basin in Birbhum district, initiated during 2009-10 and was continued during 2010-12 to examine the extent of coal bearing Barakar and other Gondwana formations below the area of Tertiary sedimentaries and Rajmahal Trap, to apprise the coal development and CBM potentiality. Drilling has been completed in three boreholes, viz., BGZ-3 (part), BGZ-4 and BGZ-5 (part). The borehole BGZ-4 located in the southwestern part of the area has intersected 13 Barakar coal seams ranging in thickness from 0.60 m to 4.40 m in the depth range from 659.65 m to 797.20 m and having cumulative thickness of 22.81 m of coal. In borehole BGZ-3, six Barakar coal seams have been intersected

ranging in thickness from 0.50 m to 1.75 m between 554.10 m and 656.30 m depths. CBM desorption study of core samples collected from the coal seams indicate a desorbed gas (Q3) value of 0.104 cc/g to 0.256 cc/g. The last borehole BGZ-5 has recorded 159.30 m of Tertiaries and 201.60 m of Rajmahal Trap.

Additional resources estimated by GSI in various coalfields during 2011-12 are given in Table-2.

**Table – 2 : Additional Resources Estimated by GSI in Various Coalfields, 2010-12**

(In million tonnes)

State/Coalfield/Block	Additional resources
<b>Andhra Pradesh</b>	
(A) <b>Godavari Valley Coalfield</b>	
(i) Narayanapuram-Pattyagudem	98.86
<b>Chhattisgarh</b>	
(A) <b>Mand-Raigarh Coalfield</b>	
(i) Chainpur	654.26
(ii) Nayadih	362.40
(iii) Saraipali	331.10
(B) <b>Hasdo Arand Coalfield</b>	
(i) Parogia (West)	218.12
(C) <b>Tatapani-Ramkola Coalfield</b>	
(i) Reonti (West)	202.45
<b>Madhya Pradesh</b>	
(A) <b>Pench Valley Coalfield</b>	
(i) Bagbardiya	375.35
(B) <b>Singrauli Coalfield</b>	
(i) Hatta-Dudhmaniya	277.63
<b>Odisha</b>	
(A) <b>Talcher Coalfield</b>	
(i) Kudanali North-East	991.05
(ii) Harichandanapur	493.03
(B) <b>Ib-River Coalfield</b>	
(i) Piplimal-Khairkuni	1054.10
<b>West Bengal</b>	
(A) <b>Birbhum Coalfield</b>	
(i) Makhdumnagar	338.28
(B) <b>Raniganj Coalfield</b>	
(i) Binodpur-Bhabaniganj	214.20
<b>Total</b>	<b>5610.83</b>

**CMPDI**

CMPDI continued its coal exploration activities in 2011-12, mainly in CIL and Non-CIL/Captive Mining Blocks. Exploration in CIL blocks was taken up to cater to the project planning/production support needs of subsidiaries of CIL whereas exploration in Non-CIL/Captive Mining Blocks was undertaken to facilitate allotment of coal blocks to prospective entrepreneurs for captive mining. A total of 100 to 111 drills were deployed in 2011-12, out of which 55 were departmental drills.

CMPDI deployed its departmental resources for exploration of CIL/Non-CIL/Promotional blocks, whereas State Governments of Madhya Pradesh and Odisha deployed resources in CIL blocks only. Besides, four other contractual agencies have also deployed its own resources for detailed drilling/exploration in CIL/Non-CIL blocks.

In 2011-12, CMPDI and its contractual agencies took up exploratory drilling in 90 blocks/

mines spread over 21 coalfields in six states. These coalfields with no of blocks/mines are: Raniganj (9), Jharia (5), West Bokaro (2), Ramgarh (1), South Karanpura (3), Patharkhera (1), Pench-Kanhan (2), Kamptee (4), Nand-Bander (3), Wardha Valley (12), Singrauli (3), Sohagpur (8), Mand Raigarh (14), Tatapani-Ramkola (2), Johilla (1), Korba (3), Hasdo-Arand (1), Bistrampur (1), Talcher (10), Ib Valley (4) and Sonhat (1). Out of 90 blocks/mines, 24 were Non-CIL/Captive blocks, 01 consultancy block and 65 CIL blocks/mines. Departmental drills of CMPDI took up exploratory drilling in 58 blocks/mines whereas contractual agencies drilled in 32 blocks/mines.

A total of 4.98 lakh m of exploratory drilling was carried out by CMPDI in 2011-12 through departmental resources (2.73 lakh m) and outsourcing (2.25 lakh m) to State Governments/MECL/Tendering (CIL/Non-CIL blocks). Details of exploratory drilling carried out by CMPDI in 2011-12 are given in Table - 3.

**Table – 3 : Exploratory Drilling by CMPDI (Departmental and Outsourcing) in 2011-12**

Sl. No.	Agency	Target (m)	Exploratory drilling achieved (m)	Achieved (%)
1.	Departmental	250,000	273,018	109
2.	Outsourcing			
	i) State Govts	5,000	6,815	136
	ii) MECL (MoU)	83,000	96,207	116
	iii) Tendering (CIL Blocks)	12,000	17,605	147
	iv) Tendering (Non-CIL Blocks)	100,000	104,779	105
	<b>Total</b>	<b>450,000</b>	<b>498,424</b>	<b>111</b>

**Singareni Collieries Company Ltd (SCCL)**

During 2011-12, SCCL carried out detailed exploration in Godavari Valley coalfield, Andhra Pradesh. A total of 100,325 m drilling was achieved against a target of 112,600 m and coal reserves of the order of 390.24 million tonnes were proved in 2011-12. The total

proved geological reserves of Godavari Valley Coalfield are placed at 9,877.68 million tonnes as on 1.4.2012.

**State Directorates**

The details of exploration for coal carried out by the State Directorate of Geology & Mining of various states during 2011-12 are given in Table-4.

EXPLORATION & DEVELOPMENT

**Table – 4 : Exploration for Coal by Various State Directorates of Geology & Mining, 2011-12**

State/ District	Location	Geological mapping		Drilling		Remarks
		Area (sq km)	Scale	Boreholes	Meterage	
<b>Chhattisgarh</b>						
Korba	Saila block,	-	1:50,000	06	1797.20	Geological reserves remain at 51.15 million tonnes as previous year.
	Saila Pali area	-	1:4,000			
Raigarh	Dhaurabhata block, Gare Sector - 1A,	-	1:50,000	02	498.35	Total 14 million tonnes of C to G grades coal were assessed.
Surguja	Gotan-Birjupali area	300 0.48	1:50,000 1:4,000	-	-	Survey work with collection of 25 nos of samples have been done.
-do-	Saidu area	440 0.80	1:50,000 1:4,000	-	-	Total 20 nos of samples have been collected.
<b>Odisha</b>						
Angul	ALB blocks Talcher Coalfield	-	-	09	1151.90	Thickness of coal is varying from 4.05 m to 20.21 m in three split sections.
-do-	Arakhpal block Talcher Coalfield	-	-	06	1157.65	Thickness of coal Seam-II varies from 38.48 m to 44.75 m.
Jharsuguda	Madhupur block	-	-	11	2205.00	Five split sections of the Lajkura Ib Valley Coalfield seam which is only workable coal seam in this block have been established with thickness of split sections varying from 1.70 m to 15.60 m.

## LIGNITE

GSI, MECL, DMG, Rajasthan and GMDC conducted investigation for lignite during 2011-12.

## GSI

GSI continued exploration for lignite in the East Coast lignite fields of Tamil Nadu and at the Tertiary sequence in Palana and Nagaur basins, Rajasthan to identify and assess lignite potentiality.

The search for lignite resources has been accorded priority in the states of Tamil Nadu and Rajasthan which are devoid of any coal deposit.

In Tamil Nadu, Prospecting stage (G-3) exploration for lignite in Bogalur East sector, Ramnad sub-basin, Ramanathapuram district, initiated in field season 2007-08 under promotional scheme was continued to delineate lignite bearing areas and to assess the resource potentiality of the area was completed in March, 2012. Two regionally persistent lignite seams, viz., Seam-I of maximum thickness of 12 m and Seam-II of maximum thickness of 3.80 m were intersected between 350.50 m and 443.50 m depths. The seams are of "Lignite A" grade. Investigation established the lignite potentiality over an area of 50 sq km in

this sector. Prospecting stage (G-3) exploration for lignite in Uttarakosamangai block, Ramnad sub-basin, Ramanathapuram district commenced on 20.02.2012. It includes delineation of lignite bearing areas and assessment of the resource potentiality.

In Rajasthan, Reconnaissance stage (G-4) exploration for lignite by scout drilling was conducted in Phalki North area in the Nagaur South sub-basin in Nagaur district to locate the lignite bearing blocks and to establish the stratigraphic set up in the Nagaur South sub-basin. GP survey in the area indicated a significant residual gravity low extending for a strike length of 2.4 km in N-S direction. A maximum of four lignite sections varying in thickness from 0.50 m to 2.48 m were intersected between 68.75 m and 262.25 m depths. Maximum cumulative thickness of lignite seam is 5.0 m and the grade belongs to lignite "B" category. Item was scheduled to be completed in June, 2012.

## State Directorates

Particulars of exploration carried out by State Directorate of Mines & Geology, Rajasthan during 2011-12 are given in Table-5.



EXPLORATION & DEVELOPMENT

**Table – 5 : Exploration for Lignite by State DMG and State Undertaking, 2011-12**

Agency/State/ District/ Location	Mapping		Drilling		Sampling (No.)	Result
	Area (sq km)	Scale	No. of boreholes	Meterage		
<b>DMG, Rajasthan</b>						
<b>Bikaner</b>						
Surpura	105	1:50,000	-	-	-	Lignite was not encountered and project is discontinued.
Kenya-ki-Basti	200	1:50,000	02	210	50	About 0.57 million tonnes of geological reserves of lignitic shale on the basis of visual estimation of core has been done.
<b>GMDC, Gujarat</b>						
<b>Bharuch</b>						
Amod	-	-	22	2,200	30	Drilling carried out for confirmation of lithology.
<b>Bhavnagar</b>						
Tagadi	-	-	10	1,491	60	Total 89.56 million tonnes of geological reserves (111) of lignite have been estimated in Block-A.
<b>Kutch</b>						
Panandhro	-	1:5,000	-	-	-	Balance reserves of lignite is approximately 9.70 million tonnes.
Lakhpat & Punharajpur	-	-	-	-	400	Total 50 million tonnes of lignite resources were estimated.
<b>Surat</b>						
Tadkeshwar	-	1:5,000	29	2,274	-	Total 24 nos of lignite samples were analysed.
	-	1:3,000				

## GMDC

GMDC carried out exploration for lignite in its Amod, Panandhro, Lakhpat and Tadkeshwar lignite mines. Particulars of exploration carried out by GMDC are given in Table-6.

## NON-FERROUS METALS

### BASE METALS

GSI, HZL, and DMG, Rajasthan conducted investigations for copper, lead and zinc ores in different parts of the country during 2011-12.

### GSI

The details of exploration activities carried out by GSI during 2011-12 are given in Table-6.

### HZL

Advanced mineral exploration technologies, viz, Heliborne Magnetic and Electro-Magnetic (VTEM), high resolution ground magnetic and gravity surveys, Deep Earth Imaging (Titan), GPS enabled field (XRF) Geochemical surveys in conjunction with other data acquisition and integration systems are being deployed to

systematically explore all exploration properties. To increase the effectiveness and provide more options with geophysical surveying, a SMARTem was deployed during the year. A total of 94,950 m of core and non-core drilling was completed at various exploration sites throughout the mines and tenements. A hole of 1,545 m was drilled at Rajpura Dariba which is the deepest ever at any base metal exploration project in India. The exploration activities have yielded the gross addition of 27.1 million tonnes to reserves and resources, prior to a depletion of 8.04 million tonnes in 2011-12. The contained zinc-lead metal has increased by 1.2 million tonnes, prior to a depletion of 0.83 million tonnes during the same period.

### State Directorate

During 2011-12, DMG, Rajasthan carried out prospecting for base metal around Jotripipal and Piruka villages, Dhaulpur district by mapping 1 : 10,000 - 10 sq km 1:2,000 - 01 sq km with 46 nos geochemical sampling and 14 nos spot sampling. Lead mineralisation is found at various locations in the area.

EXPLORATION & DEVELOPMENT

**Table - 6 : Exploration for Base Metals by GSI, 2011-12**

State/District	Name of block	Details of exploration	Results
<b>Gujarat</b> <b>COPPER</b>			
Banaskantha	Amlimal area	Geophysical survey, sampling and geochemical analysis	<p>Reconnaissance stage investigation (G-4) was taken up during 2010-12 in South Delhi Fold Belt in Amlimal area with an objective to search for copper and associated precious metals in the rocks of South Delhi Fold Belt between Ambaji and Deri polymetallic deposits. Indications of mineralisation in the Amlimal area is recorded in the form of malachite and azurite stains, specks and stringers of pyrite with occasional chalcopyrite in the cherty quartzite and amphibolite. Detail mapping have delineated various types of litho-units varying from meta-sedimentary calc-silicate bands to meta-volcanic rocks of amphibolite and meta-rhyolite and their variants along with plutonic quartz-syenite and quartz veins. Four shear zones are marked with limonitisation and mineralisation in the form of pyrite and chalcopyrite disseminations, encrustations of malachite and azurite as exposed in old pits. Development of gossan with various shades of limonitisation and box work is observed at places in Block-A and B, showing indications of mineralisation. A skarn zone was observed at the contact of calc-silicate, which comprises quartz-epidote-garnet rock, which is associated with an old pit with malachite mineralisation in the Block-C. The geophysical anomaly comprising SP, IP and magnetic established by ground surveys are corroborated by the shear zones in the area. Sampling was done keeping in mind the geophysical anomaly axes of the area. The copper values range from &lt;15 ppm to 2.38 % with 7 samples having values more than 0.1%. The Cu values are high in old pit samples of quartz-mica schist (Block-A) and calc-silicates of Block-C. The lead values range from &lt;25 ppm to 0.41% with 5 samples of gossan rock of Block-B and calc-silicate of Block-C having values more than 0.1%. Concentration of zinc, in the analysed samples ranges from &lt;10 ppm to 0.12%. Only one sample is showing Zn value more than 0.1%, which is from gossan sample of Block-B. The nickel values range from &lt;15 ppm to 92 ppm and that of cobalt values range from &lt;15 ppm to 580 ppm, which are comparatively higher in amphibolite samples. The silver values are &lt;5 ppm and gold values are &lt;0.05 ppm for all the samples from the three blocks. On the basis of sum of the geological, geochemical and geophysical data, it is recommended that test exploration drilling should be done in all the three blocks, along the shear zones, to reveal potentiality of the occurrence at depth.</p> <p style="text-align: right;">(Contd.)</p>

EXPLORATION & DEVELOPMENT

Table - 6 ( Contd.)

State/District	Name of block	Details of exploration	Results
<b>Haryana</b>			
<b>COPPER</b>			
Mahendragarh	West of Bakrija village	Geochemical analysis	Prospecting stage investigation (G-3) was taken up during 2010-12 in North Delhi Fold Belt in the unexplored parts of west of Bakrija, with an aim to delineate the host rock for copper mineralisation and to assess the potential of copper mineralisation to the west of Bakrija. The analytical of the core samples received has not indicated encouraging copper value.
<b>Jammu &amp; Kashmir</b>			
<b>LEAD- ZINC</b>			
Baramulla	Buniyar area	Mapping and sampling	Reconnaissance stage investigation (G-4) was carried out during 2010-12 in Buniyar area to reassess the nature and extent of Pb-Zn and other associated mineralisation in the area. Mapping along with systematic bed rock sampling in Banali area and traverse mapping in Buniyar and its adjoining areas helped in delineation of a 50 m wide mineralised zone within phyllitic sequence of Tirkanjan and Baren formations of Dogra Group in Banali area. Galena mineralisation is recorded in the form of small disseminations, stringers and veinlets besides minute chunks at places. Mineralisation is mostly confined within quartz-sericite veins and quartz veins traversing phyllites of both the formations. The galena bearing quartz-sericite veins and quartz veins are impersistent in their occurrence and do not continue laterally due to pinching and swelling nature. The samples collected during the course of the investigation have been submitted for chemical analyses and results were awaited.
Reasi	Bakkal-Serasandhu-Khairikot area	Geochemical analysis	Reconnaissance stage investigation (G-4) initiated during 2009-10 was continued during 2010-12 in Reasi inlier in Bakkal-Serasandhu-Khairikot area to reassess the potentiality of Pb-Zn mineralisation and other associated metals. The lithounits exposed in the area belongs to Trikuta Formation and Khairikot Formation of Sirban Group of Proterozoic age. The contact between these formations is unconformable which is represented by brecciated quartzite/chert-breccia. Surface indications of sulphide mineralisation have been noticed in the form of ferrugenisation/limonitisation, old workings, gossans and slag pieces. A total of 18 old workings have been noticed in the area of investigation. The old workings are primarily located within contact zone confined between uppermost part of dolomitic horizon of Trikuta Formation and the lowermost part of brecciated quartzite/chert-breccia of Khairikot Formation. Galena mineralisation occurs in the form of minor disseminations, lenses and veinlets as recorded SW of Serasandhu and Balada areas.

(Contd.)

EXPLORATION & DEVELOPMENT

Table - 6 ( Contd.)

State/District	Name of block	Details of exploration	Results
<p><b>Maharashtra</b> COPPER Chandrapur</p>	<p>Nai-Dilli-Dighori and Lal-Heti Dugula</p>	<p>Sampling and geochemical analysis</p>	<p>The analytical results of 145 samples have been received so far. Out of these, 5 samples have shown anomalous value of Pb up to 0.99% and 10 samples have yielded Zn value up to 3.14%. One sample shows anomalous value for Mn up to 899 ppm. In western extension of the area, in Sangar-Manju-Gai section light grey, massive dolomite of Trikuta Formation shows galena chunks in association with chalcopyrite and stains of azurite. In southern extension, in Anji-Nangla area, specks of chalcopyrite in grayish black to black shale within stroma-tolitic dolomite of Trikuta Formation have been observed. In Hiralakot-Rahotkot area, six old workings were noticed in limestone of Trikuta Formation, south of Chiralakot village, which showed chunks/veins of galena and sphalerite. In Khairikot area, one prominent old working having 5 m diameter is recorded at the contact of dolomite and brecciated quartzite/chert breccia. Big size chunks of galena were noticed in the roof part and walls of old workings.</p> <p>Reconnaissance stage investigation (G-4) was taken up during 2010-12 in the area between Nai-Dilli-Dighori and Lal Heti Dugula to establish northern strike continuity of Thanewasana copper and associated basemetal mineralisation. The area is occupied by gneiss and charnockite in the southern part &amp; granite in the northern part that is traversed by NW-SE trending quartz-barite-chlorite veins. Mineralisation is noticed in the form of specks, blebs and disseminations of sulphides in the quartz-chlorite veins in the shear zone. Soil sampling was carried out in grid pattern in all the blocks, viz., Dugula, Nai Dilli and Phutana. Analytical results of 26 bedrock samples from Dugula and Nai Dilli blocks show copper values from 10 ppm to 1500 ppm. 22 nos of PTS samples from Dugula block show Cu values from 10 ppm to 80 ppm and 44 nos of PTS samples from Nai Dilli block show Cu values from 10 ppm to 2200 ppm. Cu values in 94 soil samples from Dugula and Nai Dilli areas range between 10 ppm to 1975 ppm. Ore microscopic study reveals the presence of chalcopyrite, pyrite data and covellite in quartz-chlorite veins and also inclusion of chalcopyrite found within magnetite. Different Cu ore phases like chalcopyrite, bornite, chalcocite as well as Au and Ag phase have been identified in SEM-EDX study.</p>
<p><b>Meghalaya</b> BASE METAL East Garo Hills</p>	<p>Simsang Diwa village</p>	<p>Delineation of sulphide mineralised zones</p>	<p>Reconnaissance stage investigation (G-4) was carried out during 2010-12 near Simsang Diwa village to assess base metal potential in the area. During mapping different varieties of granites, viz., porphyritic granites and homophanous granites were delineated. Lamprophyre dykes are exposed near Simsang Diwa. Three major dioritic intrusions are recorded in the area between Simsang Diwa and Gambil. Near Simsang Diwa a shear quartz vein trending North-South with about 3 m width is exposed which contains pyrite grains. No significant sulphide mineralised zone could be delineated in the area so far.</p>

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EXPLORATION & DEVELOPMENT

Table - 6 ( Contd.)

State/District	Name of block	Details of exploration	Results
<b>Rajasthan</b> BASE METAL Alwar	Khera block Mundiyawas- Khera area	Mapping, sampling, drilling and geochemical analysis	<p>Reconnaissance stage investigation (G-4) was taken up during 2010-12 in North Delhi Fold Belt in Khera block, Mundiyawas-Khera area to evaluate potential of copper and precious metal mineralisation. The block is located nearly 5 km SSW of Tehsil headquarters Thanaghazi in Alwar district and forms a part of the Alwar basin of North Delhi Fold Belt comprising rocks belonging to the Thanagazi Formation of the Ajabgarh Group of the Delhi Supergroup. The rock types exposed in the Khera Block are calcareous interbanded sequence of cherty quartzite and bands of scapolite biotite rock/ felsic volcanics, dolomitic marble with amphiboles, cherty quartzite and carbon phyllite. Surface indications of mineralisation are manifested by malachite stains, presence of old workings and occasionally fresh specks of sulphides like bornite, chalcopryrite and pyrite are observed. On the basis of mapping and sampling three such zones of mineralisation, which extend for about 300 m with an average width of 10 m - 30 m on the surface has been delineated. Channel sampling of the mineralised zones was carried out across the general strike of the lithosequence along three profiles (cross sections CS-1 to CS-3) and analytical results indicated encouraging basemetal and associated precious metals. Four scout boreholes were drilled to test the presence of sub-surface copper and associated precious metal mineralisation in this block. All the four boreholes intersected sulphide mineralisation, which has been established over a strike length of over 600 m in KBH - 1 to KBH - 4. Mineralisation mostly occurs in the form of disseminations, streaks, stringers, veinlets and fractured filled chalcopryrite, pyrrhotite, pyrite and rare specks of bornite and covellite, besides veins and specks within thin quartz and carbonate veins. The first borehole KBH-I intersected a 108.10 m thick mineralised zone with 0.29% Cu and associated silver and gold. It is a first time report of 108.10 m thick Cu mineralisation from the Alwar Basin of the North Delhi Fold Belt which includes a number of lodes aggregating to 77.65 m of 0.35% Cu (at 0.2% cut-off) and 33.8 m of 0.65% Cu (at 0.5% cut-off). Drilling in borehole KBH-2, along the strike also intersected similar type of sulphide mineralisation (190 m) with 0.2-0.5 % Cu (V.E.). The part analytical results of borehole KBH-2 indicate a no. of lodes of 110.60 m x 0.36% Cu (at 0.2% cut-off) and 41.50 m x 0.57% Cu (at 0.5% cut-off). Borehole KBH-3 is located to intersect the southern continuity of copper mineralisation of KBH-1 and borehole KBH-4 is located to intersect the northern continuity of the thick copper mineralisation of KBH-2, which also intersected similar type of sulphide mineralisation. However, the concentration of mineralisation is less as compared to borehole KBH-1 &amp; KBH-2.</p> <p style="text-align: right;">(Contd.)</p>

EXPLORATION & DEVELOPMENT

Table - 6 ( Contd.)

State/District	Name of block	Details of exploration	Results
Bhilwara	Karoi-Rajpura area, Pur-Banera belt	Sampling and geochemical analysis	Reconnaissance stage investigation (G-4) initiated in 2009-10, was continued in Pur-Banera belt in Karoi-Rajpura area to assess the basemetal potential of the area. Chemical analysis of 100 nos. of bedrock samples received so far indicates copper content varying from 19 ppm to 0.57%. The plotting of copper content in grid samples reveals extension of the Cu zone for further 150 m in continuation of delineated Cu anomaly during field season 2009-10 (80 m to 130 m wide copper zone with an average 0.34% copper content over a strike length of 300 m). Beside the bedrock samples, a total of 44 nos of channels/groove samples along lines (KR-5 to KR-9) has been collected. Results of channel KR-5 indicated copper content varying from 0.22% to 0.67% with an average of 0.45%. Electron Probe Micro Analysis (EPMA) studies indicate that the dominant sulphide phases are bornite and chalcopyrite with rare galena.
-do-	Salampura block, Pur-Banera belt	Drilling and geochemical analysis	Prospecting stage investigation (G-3) was taken up during 2010-12 in Pur-Banera Belt in the northern part of the Salampura Block to assess the basemetal potential between Pur-Dariba copper prospect and Gurla basemetal prospect. The item was taken up as a follow up action of geochemical survey (field season 2004-05). Mineralisation in this block is associated with garnet-biotite-sericite schist, magnetite bearing calcareous schist, which is intimately associated with Banded Magnetite Quartzite (BMQ) and calc-silicate. The area exposes quartzite, garnet-biotite-sericite schist in the south eastern part and garnet-biotite schist/calc-silicate rock/ amphibole marble in the north western part while the central part is characterised by predominantly inter banded sequence of garnet biotite schist/calc-silicate with minor band of BMQ. A total of five bore holes numbered SBH-7 to SBH-11 were drilled. The borehole SBH-7 intersected mineralised zones at various depth i.e. from 115.20 m to 117.50 m (2.30 m X 1.8% Zn & 0.3% Pb) and from 171.05 m to 172.94 m (1.89 m X 1.89% Pb+Zn). The borehole SBH-8 intersected lean mineralised zone (Pb-Zn) of 50 cm and also high stray values. The borehole no SBH-9, 10 and 11 intersected poor and lean mineralisation. The ore microscopic study reveals the association of pyrite, pyrrhotite, sphalerite, galena, magnetite and chalcopyrite. The EPMA

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Table - 6 ( Contd.)

State/District	Name of block	Details of exploration	Results
Bhilwara	Rampuriya and Gadariyakhera, Pur-Banera Belt	Mapping, petrography, EPMA study, etc.	<p>study help in identify the presence of bismuth mineral phase named "Eclarite" [Pb<sub>9</sub>(Cu, Fe) B<sub>12</sub>S<sub>28</sub>]. However, the core samples of SBH-7 analysed bismuth content less than 50 ppm and Fe % less than 20% which are economically not significant values.</p> <p>Reconnaissance stage investigation (G-4) initiated during 2009-10 was continued in Pur-Banera Belt between Rampuriya and Gadariyakhera villages to identify the target areas for basemetal and gold mineralisation by ground evaluation of airborne geophysical anomalies through integrated geological and geochemical surveys. In the area aerogeophysical anomaly map shows a chain of AEM anomalies ranging from 1-6 channel that define the presence of good conductor in association with significant magnetic signature over the proposed gap area. The rocks exposed in the area belong to the Rewara Formation of Pur-Banera Group of Bhilwara Supergroup and is of Lower Proterozoic age. Detailed geological mapping revealed magnetite-amphibole-garnet quartz-mica schist (MAGQMS), garnet quartz mica schist (GQMS), 1-2 m thick band of BIF in discontinuous pattern and a thin band of meta basalt, meta rhyolite and quartz vein with kyanite. Thin/polish section study indicated that the rock contains magnetite, sphalerite, galena, and few gold grains as major ore minerals. Garnet, quartz and amphibole represent gangue minerals. The base metal mineralisation is restricted to the BIF band. EPMA study was carried out and identified the different mineral phases, like Pb-Mn phase, Mn-Zn phase and Mn-Pb-Zn-Fe phase. Kintoreite [PbFe<sub>3</sub>(3+PO<sub>4</sub>)<sub>2</sub>(OH,H<sub>2</sub>O)<sub>6</sub>], Hydrohetaerolite [Zn<sub>2</sub>Mn<sub>3</sub>O<sub>8</sub>H<sub>2</sub>O], Coronadite [Pb(Mn<sup>4+</sup>,Mn<sup>2+</sup>)<sub>2</sub>O<sub>16</sub>], Groutite [Mn<sup>3+</sup>O(OH)], Pyrolusite (Mn<sup>4+</sup>O<sub>2</sub>), Monazite [(Ce, La, Y,Th)PO<sub>4</sub>] and Galena. Assay results of soil samples indicates, lead in the ranges from 25 ppm to 791 ppm while concentration of other element like Cu, Ni, Co, As, Mo, Ag is insignificant. Gold values of significance were noticed in 14 soil samples, which range from 0.1 ppm to 0.24 ppm. Analytical result of few trench sample indicated Zn value ranging from 0.03% to 1.31% and Pb value from 0.02% to 0.79% over a width ranging from 5 m to 12 m. A single value of old (0.1 ppm) has also been recorded in one sample of 1m width in Trench-12. On the basis of analytical result two significant anomalous zones for Pb and Zn has been indicated. Anomalous value of Tungsten (W) ranging from 56.88 ppm to 106 ppm was recorded. The high values of W are recorded for the first time in Pur-Banera Belt.</p>

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Table - 6 ( Contd.)

State/District	Name of block	Details of exploration	Results
Bhilwara	Kamalpura and Devpura blocks	Mapping, geochemical analysis, etc.	<p>Reconnaissance stage investigation (G-4) was taken up during 2010-12 in Pur-Banera Belt in Kamalpura Block between already explored Banera Reserve Forest Block and Devpura Block for integrated re-evaluation of multisensor aerogeophysical anomalies to identify target areas for basemetal mineralisation. Kamalpura Block forms a gap area between the explored prospects i.e., Devpura in south and Banera reserve forest in North and forms a part of Pur-Banera belt. Kamalpura Block occupies the northern end of Pur-Banera Belt and is 5 km south of Banera town. Detailed geological mapping has revealed sequence comprising calc-silicates, garnetiferous quartz-mica schist, quartz-mica schist, Banded Iron Formation (BIF), impure marble and quartzite. Evidences of mineralisation have been recorded in the garnetiferous mica schist and calc gneisses in the form of malachite stains and highly gossanised BIF bands. Two bands of BIF have been recorded. The first BIF band having a strike length of 200 m with varying width from 0.5 to 4.0 m occurs within garnetiferous mica schist and second BIF band having a strike length of 70 m and 3.5 m width at the contact of garnetiferous mica schist and impure marble. Under microscope, BIF shows alternate layer of quartz, magnetite and sphalerite. The minerals identified under EPMA study of BIF samples are: Galena, Chalcocite, Bornite, Bismuth, Monazite [(Ce, La, Y, Th) PO<sub>4</sub>] and Zircon. Geochemical samples chemical results have indicated the Cu values for soil samples ranging from 44 to 523 ppm and for bedrock samples from &lt;5 to 0.28%. On the basis of bedrock samples, a mineralised zone over a strike length of 350 m has been established in the garnetiferous mica schist. Some geochemical samples were also taken from BIF bands and the chemical result of these samples show Zn value up 950 ppm. Significant concentration of Tungsten value has also been reported from soil samples (ranging up to 152 ppm) for the first time in Pur-Banera Belt and a zone of 200 m x 100 m has been delineated.</p>

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EXPLORATION & DEVELOPMENT

Table - 6 ( Contd.)

State/District	Name of block	Details of exploration	Results
Jaipur	Dholpura area	Geochemical analysis	<p>Reconnaissance stage investigation (G-4) initiated during 2009-10 was continued in North Delhi Fold Belt in Dholpura area to assess the extent and potential of basemetal and associated gold mineralisation in the Raialo Group of rocks in Dholpura area. The lithology of the area is characterised by the presence of impure dolomite marble, banded-haematite-quartzite often brecciated, quartzite and chlorite muscovite schist association and granite gneiss of the 'Pre-Delhi' age. Ground evaluation of the 3 sets of lineaments delineated by photogeological studies has not indicated any significant association of base metal mineralisation in the area. Analytical results of bedrock samples collected from all the lithounits of the mapped area indicated Cu 5 ppm to 1202 ppm, Zn &lt;5 ppm to 755 ppm, Pb &lt;25 ppm to 133 ppm, Ni &lt;15 ppm to 140 ppm, Co &lt;15 ppm to 255 ppm, Ag &lt;5 ppm and Au &lt;0.05 ppm. Higher concentration of copper (&gt;200 ppm) is found associated with brecciated BHQ and only three samples from the pit with sporadic malachite stains in the dolomite rock noticed near Dholpura village has indicated &gt;1000 ppm Cu. The bedrock samples from the brecciated BHQ and ferruginised zones have indicated Fe content up to 33.30%. The analytical results of the channel samples carried out across the general strike of the litho-sequence in Dholpura and Shyampura area have indicated Cu values ranging from 29 ppm to 1766 ppm, Zn 7 ppm to 250ppm, Pb &lt;25 ppm to 54 ppm, Ni &lt;15 ppm to 54 ppm, Co &lt;15 ppm to 66 ppm, Ag &lt;5 ppm and Au &lt;0.05 ppm with Fe content varying from 0.3% to maximum 36.92% Fe. It is inferred based on the geochemical results and geological set up that the area around Dholpura-Shyampura is not encouraging for basemetal mineralisation.</p>
Sikar	Mahawa block	Geochemical analysis and mapping	<p>Prospecting stage investigation (G-3) was taken up during 2010-12 in North Delhi Fold Belt in Mahawa Block in Sikar district to assess the depth continuity of basemetal mineralisation within the Kushalgarh Formation on the western flank of the Kundla ki Dhani - Baniwala ki Dhani, Dokan Copper Belt. The Mahawa block is located within the western limb of a regional F2 fold plunging moderately towards SSW known as Mahawa synform. The rocks belonging to the Ajabgarh Group occupy the core of this synform and the limbs are occupied by quartzites belonging to the Alwar Group of the Delhi Supergroup. Six boreholes have been drilled and all the boreholes have intersected sulphide mineralisation confined to the axial trace of the Mahawa synform. Drilling established sulphide mineralisation over a strike length of over 1000 m in MBH-7 to MBH-12. Mineralisation mostly occurs in the form of fine disseminations and streaks with occasional stringers, veins and fracture filling of pyrite, chalcopyrite, bornite, covellite, galena and specularite. The width of sulphide zone varies from 1 m to 20 m. The chemical analytical results indicate a lean 2.0 m copper zone with 0.15% Cu in borehole MBH-7. In bore-hole MBH - 8 the analytical results received so far indicate two copper zones, viz, 4.80 m x 0.36% Cu and</p> <p>(Contd.)</p>

EXPLORATION & DEVELOPMENT

Table - 6 ( Contd.)

State/District/	Name of block	Details of exploration	Results
			2.10 m x 0.35% Cu besides 1.0 m x 0.36% Pb. In bore hold MBH-9 the chemical analytical results indicate a copper zone of 18.60 m x 0.30% Cu besides two zones of lead, viz, 2.0 m x 0.31% Pb and 2.10 m x 0.27% Pb.
Sikar	Mahawa east block	Geochemical analysis and mapping	Reconnaissance stage investigation (G-4) was taken up during 2010-12 in North Delhi Fold Belt to assess extent and potential of copper mineralisation in the Mahawa East Block located on the western flank of the Kundla ki Dhani - Baniwala ki Dhani - Dokan copper belt. The Mahawa East Block is located within the eastern limb of a regional F2 fold plunging moderately towards SSW known as Mahawa synform. The block is mostly under soil cover and exposes 50 m-75 m wide dolomitic marble intercalated with calc-quartz biotite schist, amphibole marble, carbon schist, calc-silicate rock and quartzite belonging to the Kushalgarh Formation of the Ajabgarh Group of the Delhi Supergroup. No surface evidences of mineralisation are recorded from the exposed part except for the ferruginised zone exposed in the northern part of the mapped area and along the western fringe of the dolomitic marble intercalated with calc-silicate, biotite schist, quartzite and amphibole marble. A total of 150 channel samples of channel MECH-1 to MECH-5 have been submitted to Chemical laboratory and the analytical results of 50 channel samples of MECH-1 indicated poor values for copper. The chemical analytical results of rest of the channel samples are awaited. Few test pits were dug in the soil covered part of the area and bedrock samples were collected to test the presence of sulphide mineralisation, if any. Geological mapping around Patan has indicated a carbon phyllite band with an average width 30 m and it marks the contact between the dolomitic marble and the quartzite ridge in the southern part. Two different thick pegmatite veins (trending in different directions) have been demarcated. No surface evidences of mineralisation are recorded from the western part of the mapped area except for few sporadic occurrence of feeble malachite staining. Channel samples were collected from the malachite stained amphibole bearing dolomite and banded semipelite.
Sikar	West of Nanagwas	Delineation of mineralised zones	Reconnaissance stage investigation (G-4) was taken up during 2010-12 in North Delhi Fold Belt in the west of Nanagwas area, to delineate the zones of basemetal mineralisation and associated precious metals. The lithounits exposed in the area are garnet-mica schist, biotite schist, amphibole marble, biotite marble, scapolite amphibole marble, dolomitic marble, seapolite bearing biotite schist, semipelite and scapolite-tremolite marble belonging to the Kushalgarh Formation of the Ajabgarh Group of the Delhi Supergroup, a part of the Nim ka Thana copper belt of North Delhi Fold Belt. Surface indications of mineralisation are manifested in the form of malachite stains and specks of unaltered sulphides of pyrite, bornite in amphibole marble and in thin quartz veins within amphibole marble. Besides, siliceous vein within the mineralised zone also contains fresh sulphides. Two mineralised zones (MZ-I &MZ-II)

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EXPLORATION & DEVELOPMENT

Table - 6 ( Contd.)

State/District/	Name of block	Details of exploration	Results
			have been delineated on surface indications in scapolite bearing amphibole marble. The strike length of mineralised zones is about 550 m and 900 m with the average width is about 25 m, and 10 m, respectively. The chemical analytical results of channel samples indicated copper values ranging from 31 ppm to 0.68%. Out of 151 channel samples, 85 channel samples give >0.20% Cu value.
Sikar	Dariba North block	Delineation of mineralised zones	<p>Reconnaissance stage investigation (G-4) was taken up during 2010-12 in North Delhi Fold Belt in Dariba North Block and in Dariba-Toda area to delineate the zones of basemetal mineralisation and associated precious metals in Dariba-Baleshwar area. The Dariba North Block area exposes calcareous rock packages belonging to the Kushalgarh Formation of the Ajabgarh Group of the Delhi Supergroup. The Ajabgarh rocks of the area are bounded by the Alwar quartzite on both eastern and western margin forming the high ridges. Surface indication of sulphide mineralisation is manifested in the form of presence of malachite stains and few specks of fresh sulphides in amphibole marble and dolomitic marble. Out of 150 channel samples collected analytical results of 75 nos are received so far indicate Cu values between 9 ppm and 700 ppm. In the Dariba-Toda area the rocks exposed belong to the Alwar and Ajabgarh Group of the Delhi Supergroup. The massive quartzite belongs to the Alwar Group while the Ajabgarh Group is mainly dominated by calcareous and argillaceous packages. Surface evidence of sulphide mineralisation is manifested in the form of malachite staining mostly in the calcareous lithounit. Near Palaswala-ki-Dhani malachite staining is observed hosted in dolomitic marble interbanded with amphibole marble. It is observed that the mineralisation is mainly hosted in calcareous package of Kushalgarh Formation of the Ajabgarh Group. During mapping on the basis of presence of foliation parallel pervasive malachite staining in dolomitic marble interbanded with siliceous band, two mineralised zones have been delineated on surface. Zone-I is about 850 m in strike length with average width of 30 to 35 m. This zone is exposed in east of Palaswala-ki Dhani and extends towards south in the western part of the study area. Zone-II is demarcated around Kalpala-ki-Dhani and is about 350 m in strike length with an average width of 10 to 15 m. This zone is exposed in the eastern part of the study area. 103 nos of channel samples and 50 nos of bed rock samples were collected across the mineralised zones.</p>

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EXPLORATION & DEVELOPMENT

Table - 6 ( Concl.d.)

State/District/	Name of block	Details of exploration	Results
Tonk	Between Janula-Danota	Mapping sampling, geochemical analysis, etc.	Reconnaissance stage investigation (G-4) was taken up during 2010-12 in Mangalwar Supergroup between Janula-Danota in Agucha-Malpura-Chaksu flown belt for ground evaluation of airborne geophysical anomalies by detailed geological mapping and systematic geochemical sampling to identify target areas for basemetal mineralisation. The Janula-Danota block is located near Rajwas village and about 9 km southwest of Newai, district Tonk, Rajasthan. Major lithounits present in the area are quartz-muscovite-biotite schist along with thin bands of migmatite and gneisses, pegmatite, quartz-epidote and quartz tourmaline veins. Petrographic studies revealed extreme alteration in the form of calcretisation of lithologies: altered amphibodata -lite, quartz-muscovite-biotite schist and gneiss. The geochemical assay results (Cu, Pb, Zn, Ni, Co, and Ag only) of soil samples received so far has not indicated encouraging values. The assay values of Cu ranges from 7 to 21 ppm and Zn from 26 to 48 ppm whereas Pb values are <50 ppm.
Sikkim BASE METAL West Sikkim	Chakung-Jugdum area	Geochemical analysis	Reconnaissance stage investigation (G-4) was carried out during 2010-12 in Lesser Himalayan zone in Chakung-Jugdum area covering parts of West district, to assess the basemetal and gold potentiality of the area. Sulphide mineralisation in the area is associated with Gorubathan and Buxa formations. In Gorubathan Formation, the mineralisation is recorded within remobilised quartz veins traversing greenish/greenish gray phyllite unit. Sulphide minerals are mainly pyrite and chalcopyrite, which occur as fine dissemination within the quartz veins. In Buxa Formation, mineralisation occurs in the form of malachite stains in the lower unit, which consists of phyllite and thinly bedded quartzite. Near the contact of Rangit Pebble Bed, profuse malachite stains are recorded. The groove samples from Arubote road section indicated copper values from 95 ppm to 25000 ppm. Three samples out of thirty samples show copper values of 1500 ppm. The Pb, Zn and Co show positive correlation with copper. The Pb values vary from 49 to 530 ppm, Zn values from 24 ppm to 880 ppm. One sample collected from Jugdum old Adit show a value of 90 ppb gold.

## Bauxite

### GSI

In Gujarat, reconnaissance stage investigation (G-4) was carried out during 2010-12 to search for titaniferous bauxite and to study its mineralogy in the area around Ukheda, Daban, and Wamoti Nani and Khanpur of Kachchh district. The area comprises mainly Mesozoic and Tertiary sedimentaries and the basic effusives and intrusives. In the bauxite-laterite belt kaolinitisation, lateritisation and bauxitisation were observed together at most of the places. The bauxite is pisolitic and its size varies from 1m to 2 cm in diameter. The width of bauxite is ranging between 1m to 3.5 m as observed in different river cuts and mine sections. Bauxite of Kachchh area contains four major oxides, viz.,  $Al_2O_3$ ,  $SiO_2$ ,  $Fe_2O_3$  and  $TiO_2$  and was formed due to lateritisation of silicate rock (basalt). The titanium bearing minerals like ilmenite, leucosene, rutile, anatase, etc. are enriched in the lower part of the bauxite due to its high resistance to weathering and low mobility. Samples along/across such identified zones/layers have been collected for analysis of  $Al_2O_3$ ,  $SiO_2$ ,  $Fe_2O_3$  and  $TiO_2$  and for Ga (gallium) and V (vanadium). According to the available XRF analysis report, the percentage of  $Al_2O_3$  and  $TiO_2$  varies between 16.09% to 64.45% and 1.34% to 5.14%, respectively, in Wamoti Nani and Wamoti Moti.

In Madhya Pradesh, reconnaissance stage investigation (G-4) for bauxite was carried out in Tantar and Tainchi blocks, Dindori district, in collaboration with DGM, Madhya Pradesh. The basaltic flows of Deccan Trap capped by thick laterite cover account for the bauxite occurrence in the area. The investigation resulted in identification of bauxite ore in 5 (five) pockets over an area of 3.90 sq km. It occurs as impersistent lenses, pockets and irregular tabular bodies. Texturally, 2 types of ore [massive and pisolitic bauxite] are recorded. The pisolitic bauxite is richer in alumina content than the massive bauxite. The average thickness of bauxite as observed in area is 2.20 m. The analytical results of grab and channel samples of bauxite/aluminous laterite (Lateritic bauxite) shows average value of  $Al_2O_3$  48.3%,  $SiO_2$  3.07%,  $Fe_2O_3$  12.18 % and  $P_2O_5$  0.16%. The  $Al_2O_3$  content is more than 50% in pisolitic bauxite in the Silpiri (Tiklukheru) area. Pisolitic bauxite is richer in alumina content in comparison to massive bauxite and overall grade of this bauxite can be categorised under "Metallurgical Grade -II".

In Maharashtra, reconnaissance stage investigation (G-4) was taken up during 2010-12 in Sindhudurg belt in the lateritic terrain adjoining either sides of Voghotan river in parts of Ratnagiri and Sindhudurg districts to search for bauxite potential. In the study area of Konkan, the occurrence of laterites is controlled by ENE-WSW trending lineaments presently drained by Vaghotan river in the south and Kodavli river in the north. With the objective of locating the Bauxite rich zones within the laterites, sampling was carried out in areas with thick laterite cover from NE of Hathivale to Sagve and Vijaydurg in the SW. Profile sampling has been carried out in Hativale and Arekarwadi areas where bauxite enrichment is seen at depths. The upper zones are ferruginous in nature. Area SE of Hativale and areas around Nanarwadi show bauxitic nature at shallow levels. Sampling has been done in the intervening areas of explored blocks and to the south of Vaghotan river.

### State Directorates

During 2011-12, Directorate of Geology & Mining, Chhattisgarh conducted exploration for bauxite in Darai area, Kabirdham district (Mapping on 1:50,000 and 1:4,000 scales in 104 sq km and 2.408 sq km, respectively; 72 cu m pitting; 812.70 m drilling in 85 boreholes; 633 sample collections and estimation of 3.25 lakh tonnes of bauxite) and in Dandkeshra area, Mainpat plateau, Surguja district (Mapping on 1:50,000 and 1:4,000 scales in 215 sq km and 2.72 sq km areas, respectively; 58 cu m pitting; 1142.35 m drilling in 112 boreholes; 592 nos of sample collection and estimation of 4 lakh tonnes of metal grade bauxite).

During 2011-12, Directorate of Geology, Odisha carried out exploration for bauxite around Lingapadar and Gopalpur areas, Kalahandi district. Exploration include 1:25,000-51 sq km/ 1:2,000-1.2 sq km mapping, 03 nos of trenching and collection of 406 channel/grab/trench samples in Lingapadar areas and 1:25,000-70 sq km/ 1:2,000-1.25 sq km mapping, 02 nos. pitting, 04 nos. trenching and collection of 410 channel and grab samples around Gopalpur area. Six bauxite bearing plateaux have been identified north of Gopalpur. Similarly, around Maligan, Dongari and Janigurha areas, Koraput district exploration for bauxite include : 1:25,000-54 sq km mapping, 03 nos of pitting and collection of 111 channel/grab/pit and rock samples. Four bauxite bearing plateaux have been located around Dumuriguda, Talanaranga and Gararhamunda areas.

**NALCO**

During 2011-12, NALCO carried out exploration for bauxite in Panchpatmali mines, Koraput district, Odisha by pre-production drilling on 25 m x 25 m grids in North Block, Part-I areas for total of 8460.44 m in 346 boreholes with collection of 8,460 samples. Total 15 million tonnes of bauxite resources were estimated.

**Chhattisgarh Mineral Development Corporation Ltd (CMDC)**

During 2011-12, CMDC has conducted exploration for bauxite in Barima (Mainpat) mines in Surguja district by geophysical mapping in 135 ha; comprising 210 nos chemical analysis and 1135.50 m core drilling in 88 boreholes.

**FERROUS MINERALS****CHROMITE****GSI**

In Andhra Pradesh, reconnaissance stage investigation (G-4) was taken up during 2010-12 in Eastern Ghat Supergroup in the area between Kondapalli and Gangineni area in Krishna and Khammam districts to assess the potential of the area for chromite mineralisation. The rock types encountered in Kondapalli and surrounding areas are pyroxene granulite and charnockite with enclaves of pyroxenite. In the area to the north of Koduru village, a mappable pyroxenite body, which is 28 m in length and 17 m in width, is delineated and it shows chromite mineralisation. The chromite mineralisation occurs as lenses, bands, pockets and disseminations within steeply dipping lenticular bodies of pyroxenite. Chromiferous pyroxenite bodies are small in size and exposed as discontinuous bands having maximum dimensions 25 m in length and 17 m in width. In situ chromite mineralisation was recorded in all old chromite opencast quarries present in the area. The distribution of chromite is highly variable and irregular in the pyroxenite. The chromite ore is massive in character, black in colour with sub-metallic to metallic luster. It shows granular texture with high specific gravity. At places stringers of chromite with 5 cm in length and 1 cm in width are observed within charnockite unit. The analyses of 24 nos of chromite bearing bedrock samples generated from old workings varying in length from 30 m to 75 m and width of 0.5 m to 2.5 m around Kondapalli village indicated Cr<sub>2</sub>O<sub>3</sub> value ranging from 20.82% to 43.04%. EPMA

study of pyroxenite and chromitite reveals presence of Cr<sub>2</sub>O<sub>3</sub> in a range of 30% with higher percentage of FeO and MgO. Also, EPMA studies of two chromite samples show presence of PGE grains of Rb & Os (Rubidium & Osmium). Monazite grains are also present within the Chromitite. These monazites are mainly cerium (Ce) rich with very less concentration of lead (Pb). Analysis of 191 chromite bedrock samples assayed Cr% values ranging from 6.66% to 29.44%. Analytical results of 7 chromite samples for PGE indicate values Pt 30 ppb, Pd 65 ppb, Ir 15 ppb, Ru 185 ppb and Rh 135 ppb.

In Odisha, reconnaissance stage (G-4) investigation was carried out during 2010-12 for chromite to the south of Raibola - Kanheipal, Dhenkanal district to locate chromite bodies in the transition zone of Eastern Ghat Mobile Belt and Iron Ore Supergroup of rocks lying south of Sukinda Ultramafic Complex. In bedrock samples of serpentinite and gabbro, PGE value in six samples ranging from 64 ppb to 114 ppb. Test drilling in Tangeria area intersected a 1.10 m thick chromite band associated with ultramafic rock in one BH TBH-2 between depths 60.90 m and 62.00 m. In BH TBH-1 and TBH-4 disseminations of chromite within ultramafic could be intersected. Since the sub-surface probe did not yield any encouraging result, scout drilling was discontinued. However, Pt + Pd value in chromiferous serpentinite and pyroxenite in core samples of BH TBH-1 varies from 118 ppb to 198 ppb and 107 ppb to 642 ppb, respectively.

**State Directorate**

During 2011-12, Directorate of Geology, Odisha carried exploration for chromite in Kandhara and Kankadabad areas, Dhenkanal district by geological mapping over 104 sq km area, large scale mapping on 1:2,000 scale in 0.125 sq km area, 64 nos of pitting and collection of 72 rock and soil samples. Three ultramafic bands were located. In Quarry No.2, Talangi chromite mines of M/s IDCOL, Jajpur district, 42.5 m drilling in one borehole with collection of 86 core samples has been carried out. To assess the low grade chromite (with threshold value + 10% Cr<sub>2</sub>O<sub>3</sub>) and nickel (with 0.6% of nickel), an overburden dump of Talangi chromite mines of M/s IDICOL was grided in 20 m x 20 m interval, delineated by geological mapping on 1:1,000 scale in 0.0054 sq km area, 11 nos of pitting and collection

of 170 samples. Pit samples were collected from each grid intersection and seven channels were given along the eastern and southern face of the dump to study the vertical profile and chromite incidence.

## IRON ORE GSI

In Jharkhand, reconnaissance stage (G-4) investigation was carried out for iron ore around Silpunji-Kantoria block, West Singhbhum district during 2010-12 in collaboration with DGM, Jharkhand to assess iron and manganese ore potentiality of the block. The mapped area forms part of core area of the synclinorium and the eastern limb of the Jamda-Koira synclinorium of the Iron Ore Group of rocks. It comprises upper shale formation with interbands of BHJ intraformational conglomerates, quartzite, ferruginous brecciated cherty quartzite which is overlain by cover sediments of Kolhan Group represented by a sequence of ferruginous sandstone, feldspathic sandstone and capped by laterites, at places. The iron ore in the area is derived mainly from the lateritic iron ore. A few iron enriched bands associated with BHJ has been delineated among them the two bands located around Kantoria, Hesapi and south of Param Baljori are the most prominent. The band in the west of Hesapi has a strike continuity of a more than a kilometre and is most promising. Analytical results of 7 samples from this band revealed FeT% between 50% to 55% and 2 samples showed FeT% >55%. Analytical results received hitherto for laterites have indicated Fe value up to 41.50% and Mn value up to 21.55%. Lateritic iron ore typically occupies the contour heights between 460 m and 500 m on the top and slopes of the hillocks. Manganese mineralisation occurs as layers and lenses of various shapes and sizes within the Upper Shale Formation of Upper Bonai Group. Mineralogically, it consists of pyrolusite and cryptomelane.

In Karnataka, reconnaissance stage investigation (G-4) was initiated during 2010-12 in selected freehold areas in Kenkeri, Melanahalli, Guruyapura, Kempanahalli, Dasudi, Kandikere Blocks and adjacent areas in Hosadurga Taluk, Chitradurga district for preliminary assessment of the iron ore occurrences in parts of Chitradurga schist belt as a follow up of decisions taken in SGPB of Karnataka and CGPB meetings. Large

scale mapping in Melanahalli and Guruyapura Blocks has brought out three bands of BIF. The analytical results of trench samples (value of 55.01% Fe) obtained near a fold closure indicated a structural control for the ore mineralisation. Bedrock samples have analysed values ranging from 20.11 to 46.91 wt % Fe. The width of BIF band at Purada Mata hill range from 10 to 15 m and at south of dolomitic stone hill it is 35 m. In Kandikere block a 15 to 20 m wide band of BHQ has been delineated.

In Odisha, prospecting stage (G-3) investigation was carried out in Sagasahi East block, Sundargarh district during 2010-12, for assessment of iron ore potential in the northern contiguous area of already explored Ghoraburhani -Sagasahi block. The investigation was aimed to examine the downdip continuity of the ore bodies already intersected in the adjoining Ghoraburhani block by drilling vertical boreholes on 200 m x 200 m grid up to depths varying from 70.40 m to 100.10 m. The cumulative thickness of ore bodies intersected at 55% Fe cut off varies from 2.0 m to 90 m and has an average iron content varying from 61.77% to 64.97%. The item will be continued in the next field season 2012-13. Prospecting stage (G-3) investigation was carried out in Damurda - Champuasahi area, Kendujhar district during 2010-12 for assessment of low grade iron ore bodies associated with BHJ and ferruginous laterite in the area. Detailed mapping in the northern part of Damurda ridge has brought out discontinuous linear iron ore bodies exposed in old quarry/pit sections. On the surface, the iron ore bodies are covered by ferruginous laterite of 1 m- 5 m thickness. The iron ore-bearing zone continues further north towards Bolani. The iron ore is mainly laminated and lateritic type. The maximum length of the ore bodies is about 160 m with a thickness of 2 m - 5 m. The exploration in Damurda block has indicated a moderate to low potentiality of iron ore mineralisation over a strike length of 2.2 km with 20.7 m average width and an average grade of 55.56% Fe. Reconnaissance stage (G-4) investigation was carried out around Chamakpur-Nayagarh area, Kendujhar district as an additional item for delineating detrital iron ore bodies in the eastern and southern margins of Horseshoe basin. Stratigraphically detrital iron ore bodies belong to the basal conglomerate horizon of the Kolhan Group and rest unconformably over granite and gritty quartzite. Detrital iron ore bodies are composed of clasts of

hematite, jasper, beryl, quartz and rock fragments of approximately, 1 cm to 16 cm size ranges. The population of iron bearing clasts (hematite with massive, hard and soft laminated BHF) range from 35% to 65% by volume within the isolated patches of detrital iron ore bodies. The approximate dimensions of individual detrital iron ore bodies recorded are (i) Chamakpur- 200 m x 100 m (ii) Mirgisingra-450 m x 250 m (iii) Kendra - 625 m x 125 m (iv) Basudebpur -375 m x 75 m (v) Damupur - 300 m x 125 m. The pitting work carried out indicates possibility of development of thicker detrital iron ore bodies on granitic bodies.

In Rajasthan, reconnaissance stage investigation (G-4) for ferrous and associated metallic minerals was carried out in 2010-12 in Aravalli Fold Belt and adjoining BGC to evaluate and delineate the iron ore occurrences in parts of south Rajasthan. Reconnoitry mapping in Kanpura-Bhuwer area, west of Ghatol, Banswara district showed surface indications of mineralisation in the form of old workings. The aeromagnetic signatures with values ranging from 3000- 3200 were recorded. The lithounits exposed in the area include migmatite, silicate iron formation, dolomitic marble, quartzite, amphibolite and acid intrusives, which belong to Bamanpara-Kundli Formation of the Pre-Aravalli age. Quartz-grunerite-magnetite schist represents the Silicified Iron Formation (SIF) units. These are lensoidal in shape and occur as discontinuous bands along NW-SE direction with steep dips towards west. SIF units occur along the foliation within sheared granites of BGC. Two moderately dipping BIF bands trending NE-SW have been delineated within Banded Gneissic complex (BGC).

### State Directorates

During 2011-12, Directorate of Geology and Mining, Chhattisgarh carried out exploration for iron ore in Pavaras-Kachora area, Kondagaon district by 574 sq km mapping on 1:50,000 scale, 2.05 sq km mapping on 1:4,000 scale and 238 nos of sample collection. During the year, 5.109 million tonnes of iron ore with 35-45% Fe was inferred in the area.

In 2011-12, Directorate of Geology, Odisha carried out exploration for iron ore around Karhakala and Surhang areas, Keonjhar district by mapping on 1: 25,000 scale in 65 sq km area, and collected 07 rock and 10 iron ore samples. No iron ore occurrence is reported.

DMG, Rajasthan in 2011-12 conducted mapping 1: 50,000 -150 sq km, 1:10,000-16.50 sq km and 1:4,000-01 sq km with collection 32 spot samples around Sior, Nayagaon, Tonda, etc., Jhunjhunu district. Two iron ore bands were located around Tonda village having LXW-20-100 m & 3-30 m.

### NMDC

During 2011-12, NMDC carried out exploration in Bailadila iron ore Deposit nos 14 and 11C in Dantewada district, Chhattisgarh by undertaking 5,360 m core drilling in 42 boreholes. As on 1.4.2012, the total resources of iron ore in Deposit Nos. 14 and 11C are estimated at 125.70 million tonnes and 75.60 million tonnes, respectively. Similarly, in Deposit No. 11A total 186 m drilling was carried out in 03 boreholes with collection of 192 samples. In Donimalai Iron Ore Mine, Bellary district, Karnataka, 369.50 m drilling in 03 boreholes and collection of 73 samples were done in 2011-12.

### CMDC

In Sahaspur-Lohara Forest Range, Kabirdham district, exploration for iron ore is being carried out by GSI in accordance with the UNFC format as per MoU signed between GSI and CMDC. The work includes large scale mapping, detailed mapping, drilling, core logging, core sampling and ore petrography.

### MANGANESE ORE

#### GSI

In Madhya Pradesh, reconnaissance stage investigation (G-4) was taken up during 2010-12 in Aravalli belt in parts of Meghnagar tehsil in Jhabua district to delineate the manganese ore bearing quartzite-phyllite sequence. This area represents the southern and southeastern extension of Aravalli fold belt in Jhabua district of Madhya Pradesh. The major litho-units are phyllite, quartzite and dolomite of Lunawada Group of Aravalli Supergroup, which are unconformably overlying the granite gneiss, granite, and amphibolite litho-units of Archaean basement. Mn bands were identified in Naganwat, Phuleri, Guvali -Patra and Doter areas. Five Mn bands were traced during the large-scale mapping. The longest manganese band in Mandali area is almost 700 m in length with average width of 5 m. Manganese ore bands in Rampura and Doter area



have a length of around 30 m and width of around 4 m. Out of five manganese ore bands, three are located in Mandali-Tuniya block and one each in Rampura (Anas river block) and Doter villages. A total of three test boreholes were drilled (2 boreholes in Mandali-Tuniya block and 1 borehole in Anas river block). Analytical results of 18 samples of borehole SBH-1 indicated Mn value of 0.5% to 23.3% with an average grade of 7.5%. Analytical results of samples of second borehole SBH-2, reveals Mn 0.49% to 25.82% with an average grade of 5.06%. In the third borehole SBH-3, the value of Mn is 0.33% to 7.16% with an average grade of 1.69%. The average value of Mn in 45 surface samples is 14%.

In Maharashtra, prospecting stage investigation (G-3) initiated during 2009-10 was continued during 2010-12 in Sausar fold belt in Parseoni extension area of Nagpur district in collaboration with DGM, Maharashtra to establish manganese ore horizons west of Parseoni mines. The area is occupied by Precambrian metasediments of Sausar Group comprising calc gneiss (Lohangi Formation) and garnetiferous muscovite-quartz-biotite schist (Mansar Formation) with manganese ore horizons. Out of 62 surface bed rock samples analysed for manganese, Mn values range between 9.88 to 43.05% in nineteen (19) samples and remaining samples show <5.40% Mn. Out of 38 pits/trenches samples range of 2 samples is between 10.50 to 41.67% Mn and remaining samples show <5.35% Mn. The gravity and magnetic survey had been conducted in both Savali and Mohagaon blocks and significant gravity and magnetic anomalies have brought out. Some of these anomalies have been recommended for testing manganese mineralisation by shallow drilling. DGM, Maharashtra, initiated drilling under collaborative work and completed two boreholes in Savali and Mohagaon blocks. However, the drilling has not intersected any encouraging zone of mineralisation. Surface work has also been carried out in Chargaon block.

In Odisha, prospecting stage (G-3) investigation for manganese initiated in 2009-10 was continued during 2010-12 in the identified Damurda South Block (DSB) and Bolani South Block, Bonai-Kendujhar belt, Kendujhar district. The DSB is occupied mainly by litho-units of Koira Group belonging to Iron Ore Supergroup. Manganese ore in the area occurs in three distinct

litho associations - (a) with duricrusted laterite near to the surface (b) with brecciated chert and (c) with the ferruginous shale, saprolitic clay and wady shale. The nature of the ore is lumpy, friable and powdery. Polished section studies reveal that most of the lumpy ore is pyrolusite while powdery ore is psilomelane. Collophane banding is recorded in psilomelane. Subsurface exploration so far carried out in DSB has helped in identifying mineralised zone over a strike length of 300 m and width over 300 m across the strike. The thickness of individual ore bands varies from 0.20 m to nearly 11.50 m and number of ore zones varies from 1 to 6. A total inferred manganese resource of 1.15 million tonnes (UNFC 333) has been estimated at 20% cut - off and an additional 0.608 million tonnes of marginal grade (10-20% Mn) resource also has been estimated. In addition to manganese, amorphous variety of graphite associated with dolomite has been intersected in four boreholes in the DSB. The total carbon content of graphite bearing samples varies from 19.24% to 24.33%. Reconnaissance stage investigation (G-4) initiated in 2009-10 was continued during 2010-12 for manganese in Balagorha - Champuasahi area, Bonai-Kendujhar belt, Kendujhar district. The area is occupied mainly by ferruginous, manganiferous and aluminous laterites with lenses and small bands of massive and brecciated chert. From the surface indications and pits excavated over laterite, it is found that manganese mineralisation occurs as pockets and irregular patches within the hard duricrust over a zone of 300 m x 30 m as manganiferous laterite. Based on chemical results received so far and on visual estimate for the rest of the samples manganese mineralisation in the area is evaluated to be of low potentiality.

### State Directorate

During 2011-12, DGM, Chhattisgarh conducted exploration by manganese minerals in parts of Chhura-Pursuli areas, Gariaband district by mapping on 1:50,000 and 1:4,000 scales in 151 sq km and 0.56 sq km, respectively, and collection of 28 nos of samples. The deposit is residual and uneconomic.

### GMDC

During 2011-12, GMDC carried out mapping in 900 ha area on 1:15,000 scale for manganese ore in Shivrajpur and Bhabar-Zari area in Panchmahals and Vadodara districts and 4 million tonnes of resources of manganese ore were estimated.

Mapping also carried out for manganese ore in Salapada area.

## **MOIL**

During 2011-12, MOIL carried out 7,999 m exploratory drilling involving 35 boreholes in two mines Tirodi and Bharweli situated in Balaghat district, Madhya Pradesh; four mines Dongri Buzurg & Chikla in Bhandara district and Gumgaon & Kandri in Nagpur district, all in Maharashtra. The reported resources of manganese ore as on 1.4.2012 were in Bharweli (24.28 million tonnes), Tirodi (1.40 million tonnes), Gumgaon (4.11 million tonnes), Sitapatore/Sukli (0.40 million tonnes), Kandri (5.53 million tonnes), Mansar (4.64 million tonnes), Chikla (5.10 million tonnes), Dongri Buzurg (11.90 million tonnes) and Ukwa (8.70 million tonnes).

## **STRATEGIC METALS**

### **MOLYBDENUM**

#### **GSI**

In Tamil Nadu, prospecting stage (G-3) investigation was taken up during 2010-12 for molybdenum in Harar-Uttangarai molybdenum belt in Vellakkal Central Block of Dharmapuri district. The area falls within Alkaline-Carbonatite Province (ACP). Epidote-hornblende gneiss and quartzo-felspathic gneiss are the major rock types exposed in the ACP. Molybdenum mineralisation confined to a regional shallow to moderate easterly dipping shear zone trending NNE-SSW, extending from Velampatti in the south to Nochchipatti in the north in Dharmapuri and Krishnagiri districts. The results of drilling along the shear zone in Vellakkal Central Block, has brought to light the fact that the zones of quartz veins occur one below the other in a ladder type fashion as sub-horizontal to gentle easterly dipping lensoidal and sigmoidal bodies within the shear zone. The boreholes drilled in the central part of the Vellakkal Central Block indicated Mo mineralisation ranging from 105 ppm to 307 ppm. The lead (Pb) values ranges from 1% to 2.5%.

#### **TIN**

### **State Directorate**

During 2011-12, DMG, Rajasthan carried out exploration for tin, tungsten, gold and other economic minerals around Hemardai, Karnos Odas villages, Ajmer district by mapping - 1:50,000-100 sq km, 1:10,000-10 sq km and 1:2,000- 01 sq km. About 3 km NW of Hemardai

village, within calc-silicate, ferruginous quartzite body having dimension about 50 x 3-5 m was mapped. It is magnetic in nature and gives black streak.

## **WOLFRAMITE**

### **State Directorate**

During 2011-12, DMG, Rajasthan conducted exploration for wolframite in 15 km radius around Sirohi by mapping - 1:50,000-100 sq km, 1:10,000-10 sq km with collection of 17 samples. In the north of Balda village the occurrences of wolframite in the form of disseminated grains and fine stringers in quartz veins were seen. Twelve samples were analysed.

## **RARE METALS & RARE EARTHS**

### **GSI**

In Jharkhand, reconnaissance stage (G-4) investigation for rare metals in Chhotanagpur Geneissic Complex around Kotam-Kutru area, Ranchi district, was undertaken during 2010-12. The present Kotam-Kutru block forms a part of North Purulia Shear Zone. The block exposes thin pegmatite, aplite, quartz veins, quartzite, granite gneiss and metabasic rocks. The pegmatite bodies of varying dimensions and character have occupied the contact zone of gneisses and metasedimentaries. Generally, pegmatite bodies are medium to coarse grained, weathered and consisting of quartz, feldspar, biotite, garnet and mica. Aplite veins are composed of quartz, feldspar, muscovite, pale green mica and tiny crystals of beryl. Pegmatites, having coarse laths of feldspars in fine-grained groundmass, have been found to be important for rare metal. Results of geochemical analysis show presence of REE in ppm level in pegmatite exposed in (a) south of Kotam (b) southeast of Kotam (c) east of Bisariya (d) southeast of Bisariya and (e) east of Kutru. Petrographic studies revealed presence of mineral phases like allanite, apatite, beryl, columbite, epidote, fluorite, garnet, ilmenite and tourmaline.

In Meghalaya, reconnaissance stage investigation (G-4) was carried out during 2010-12 in the peripheral part of Sung ultramafic-alkaline-carbonatite complex of East Khasi Hills district to evaluate REE potential. The Sung Valley intrusive is an oval-shaped body covering about 30 sq km area within Precambrian Shillong Group. The body is strongly discordant to the envelope rocks and its walls appear to dip steeply inwards.

The major rock types comprising the Sung ultramafic complex are serpentinite, pyroxenite, uncomphahrite, ijolite, syenite, and carbonatite and apatite-magnetite rock. Two shear zones have been identified in South-West periphery of Sung valley and bed rock samples are collected for REE and other minerals.

In Rajasthan, reconnaissance stage investigation (G-4) was taken up during 2010-12 in Trans-Aravalli area in Pali district to assess the polymetallic mineral potential of the Dhani Granite. The investigation was taken up on the basis of the encouraging results obtained during specialised thematic mapping in Dhani area of Pali District during 2009-10, in which more than 2% of total REE was analysed in bedrock samples of granite. The granitic rocks in Dhani south block is highly jointed and fractured with pods of iron carbonate veins/ pseudotachylite veins are mainly mafic poor granite with moderate to high REE contents with the range of 78 ppm-5945 ppm. EPMA study shows promising indication of REE mineralisation in both Dhani granite and protolith of Dhani granite within iron carbonate veins/ pseudotachylite. REE bearing phase's monazite, allanite, REE bearing fluoro-carbonate and xenotime have been probed. Scout drilling is carried out to trace the subsurface continuity of REE mineralisation. Analysis results of core samples of borehole DGBH-I up to 128.73 m have been received, in which the total REE ranges from 193.03 ppm to 489.31 ppm. Results of geophysical logging indicate high radioactive signatures in mafic poor granite. Chondrite normalised REE pattern characteristically shows an enriched LREE and prominent negative Europium anomaly, indicating the significant role of plagioclase fractionation from the parent magma.

## BEACH SAND MINERALS

### GSI

(i) Reconnaissance survey for glass sand in coastal area between Yermal in the north and Mukka in the south, Dakshina Kannada district, Karnataka was carried out during 2010-12. Sampling carried out along the beach as well as from berm/dune indicated that the sand is fine to medium sized. Thin layers of heavy minerals are also noted.

(ii) Placer mineral resource evaluation in the Territorial Waters off North of Bhimunipatnam,

Andhra Pradesh was carried out by vibro core sediment sampling. Heavy mineral (HM) analyses of the seabed sediment samples, in general, indicate that the weight percentage of total heavy minerals varies from 1.4021 to 8.7745 wt% with an average of 3.4745 wt%. The approximate total heavy mineral resources estimated is 1.69 million tonnes (weighed average grade of HM is 3.68%) of the total sand in 47.23 million tonnes at surface level; 1.42 million tonnes of HM (average grade 3.2854%) in the total sand of 37.42 million tonnes at 0.50-1.00 m level; 0.72 million tonnes of HM (average grade 2.9583%) in total sand of 20.25 million tonnes at 1.00 -1.50 m level. Minerals present in the sediments are ilmenite, sillimanite, garnet, monazite, zircon, rutile and others (pyroxemes/ epidote, etc.).

### AMD

During 2011-12, AMD carried out reconnaissance survey (200 sq km) and detailed survey (12.20 sq km) in coastal tracts and inland areas, in parts of West Bengal, Odisha, Andhra Pradesh, and Karnataka for delineating the potential heavy mineral (HM) concentrations.

(i) The coastal tract between Gundlakamma and Musi rivers, Prakasam district, Andhra Pradesh records 5-8% THM in the surficial layers.

(ii) The coastal tract between Rayadoruvu and Swarnamukhi river-mouth, Nellore district, Andhra Pradesh, indicates-HM concentration of 5-15% along the berm zone.

(iii) NW extension area of Brahmagiri mineral sand deposit, Puri district, Odisha records THM concentration of 8-10 per cent.

(iv) Inland paleo placers of Depal-Kanthi tract, Midnapore district, West Bengal records THM concentration of 4 per cent.

(v) The coastal sector between Manamelkundi and Thondi, Puddikkottai and Ramanathapuram districts, Tamil Nadu records-HM concentration of 1-8 per cent.

(vi) Beach placers of Kaup-Udupi-Koni-Kundapura, Udupi district, Karnataka records-HM concentration from 3 to 8 per cent.

In addition to reconnaissance surveys, detailed survey was carried out in Malikipuram deposit, East Godavari district, Andhra Pradesh

to upgrade the resources from inferred to indicated category.

### State Directorate

During 2011-12, Directorate of Geology, Odisha carried out investigation for heavy minerals (ilmenite, rutile, garnet, zircon, sillimanite, monazite, etc.) in beach sand Balarampur area, Puri district. It comprised 0.92 sq km mapping on 1:2,000 scale and 2,280 m auger drilling in 321 boreholes with collection of 2,000 samples. Four potential heavy minerals bearing areas around Gelinasi, Hunda-Samantaraipur, Mulpari and Mundabar areas have been identified. Out of which Hunda-Samantaraipur and Mulpari areas appear to be proving with THM concentration from 3 to 17.09%.

### PLATINUM GROUP OF METALS GSI

In Andhra Pradesh reconnaissance stage (G-4) investigation for PGE mineralisation has been carried out in Ramagiri Schist Belt during 2010-12. The western block of the Ramagiri Schist Belt comprises of meta-sedimentary as well as meta-volcanic rocks in association with granitoids and meta ultramafic rocks. Effects of shearing are evident in schist as well as in granite. About 14 km long, NNW-SSE trending narrow linear ultramafic bodies are traced. The bands are not continuous; they are showing pinching and swelling nature. Litho variants of ultramafic rocks are: i) serpentinite dunite; ii) Talc – tremolite schist and iii) Talc-chlorite schist. EPMA study of ultramafic rock shows that the core of the magnesite grains is rich in Mg and the rim is rich in Fe. The opaque are magnetite and chrom-spinel (core rich in Cr, rim rich in Fe). XRF study shows that the Ni value in the ultramafic rocks ranges from 443 ppm to 3001 ppm and the Cr value ranges from 458 ppm to 6973 ppm. The PGE values ranges from < 5 ppb to 55 ppb in case of platinum and that of palladium ranges from 10 ppb to 80 ppb.

In Karnataka, a reconnaissance (G-4) stage investigation for PGE in mafic-ultramafic rocks of Nuggihalli Schist Belt has been taken up during 2010-12. The area comprises granitic gneiss, amphibolite and meta ultramafites – mafites. Major ultramafics observed are serpentinite, meta pyroxenite, meta gabbro, anorthositic gabbro, gabbroic anorthosite and meta anorthosite. The serpentinites might be the altered product of

dunite and peridotites. In the mine pits for chromite the igneous layerings are well manifested at various places like Tagadur, Ranganatha Betta and Bakhtarahalli. Chromites are seen in various forms like veins, lenses, pods, laminated and also as disseminated ores. Chromitite layers are recorded within massive serpentinite in Tagadur mines. The massive chromitites are under intense mining by Mysore Minerals Limited of Karnataka. Titaniferous-vanadiferous magnetite (TVM) bands are noticed within the mafic portions of the layerings and are abundantly seen near Tagadur and Ranganatha Gudda. Sulphide mineralisation is observed only on the titanomagnetite bands and amphibolites. In the TVM bands sulphide is seen in the form of bluish, brownish, greenish and yellowish stains. In amphibolites fine disseminations of pyrite is seen rarely. Stringers of chalcopyrite are also seen near Ranganatha Gudda.

In Kerala, reconnaissance (G-4) stage investigation for PGE mineralisation in the Attapadi valley of Palakkad district has been initiated during 2010-12. The Attapadi valley is bounded by the granulites of the Nilgiri in the north and the granitic rocks of the Vellingiri in the south. The area hosts numerous mafic and ultramafic litho-units equivalent to the Archaean Sathyamangalam Group of Tamil Nadu. These are closely associated with the felsic volcanics, banded iron formation and metasedimentaries and occur as bands and enclaves within the Peninsular Gneissic Complex. Talc-tremolite schist, metapyroxenite and altered peridotite constitute the ultramafites, while the mafic unit is represented by amphibolite and metagabbro. Chromitite bearing ultramafics have been identified in Kalkandi and Narasimukku areas. An ultramafic rock with an average width of 20 m was traced continuously from North of Kavundikal to the NW of Gulikadavu for 1.25 km and intermittently up to 2.2 km. This rock is composed of coarse-grained greenish metapyroxenite which at places grades into talc-tremolite rock. This rock contains disseminated sulphides at places. The work brought to light:

- Sulphide-bearing BIF reported for the first time from this area extends intermittently over a cumulative strike length of 8 km in a zone between Anaikatti in the east and Sholayur in the west. The width of sulphide rich zone in BIF and associated rocks is about 1 km.

- EPMA and SEM studies led to the identification of PGE in significant proportions in the form of Copper- Osmium alloy within the sulphide-bearing Banded Iron Formation (BIF ) exposed around Nallasinge as well as in the meta-pyroxenites found near Narasimukku and Kalkandi.

- EPMA studies done on the chromitite rock at Kalkandi revealed that the chromite-like mineral was in fact, chrome-spinel. A single grain of Cu-Os alloy was found during SEM studies.

In Maharashtra, Kankvali-Janoli area, Sindhudurg district, reconnaissance stage investigation (G-4) was taken up to delineate zones of PGE, Ni and Cr mineralisation within the mafic-ultramafics sequence of Sindhudurg belt. The area comprises gneiss-migmatite rocks containing the dismembered lenticular bodies of Banded Iron Formation (BIF) and maficultramafic suite of rocks of Precambrian age. At places basalts of Deccan Volcanic Province cap the entire Precambrian rock assemblage. The mafic-ultramafic suite is characterised by compositional variations within itself and the ternary plots designate them as stratiform complexes and layered intrusions. The chromite deposits Kankvali, Janoli and Vagde, occurs within mafic-ultramafic suites in the area, and these were not tested for noble and precious metal association in the past. During the present work, groove samples were collected across all the ultramafic bodies of Vagde as well as Janoli area. The sample of ultramafic schist (talc-tremolite schist) collected from an abandoned chromite mine gives high PGE concentration (650 ppb). Chromitite analysed higher concentration (805 ppb) and remaining talc-tremolite schist, and serpentinite schist shows PGE concentrations in decreasing order. Nickel values ranging from 0.12 to 0.30 % (n=5) was recorded mainly in chromiferous serpentinite. The chromiferous tremolite schist samples, traced to the north of Vagde gives 2.9% Cr; 791 ppm Ni and 243 ppb PGE. Microprobe studies revealed the presence of Ni-Fe-S, Fe & Cu-Fe-S metallic phase. A sample from talc-tremolite schist has yielded 251 ppb PGE (Pt as major PGE), Cr-535 ppm, Ni-573 ppm. Prospecting stage (G3) investigation was taken up during the 2010-12 in western Bastar craton in the mafic ultramafics of Heti area in Chandrapur district, Maharashtra. SEM-EDX studies of drill core samples from this area identified Moncheite (PtPdTe) and gold grains in association with pyrrhotite-pentalindite-

chalcopyrite-millerite-siejenite-galenasphalerite-casiterite-barite, which were later confirmed by EPMA studies. Profuse sphalerite – barite minerals of 2-3 micron size grains are associated with Nickel and PGE mineralisation in drill core samples. So far analytical results of PGE received from different laboratories are not encouraging. But four samples of one m width show value of Ni as 335, 414, 428 and 571 ppm in Borehole: MHCH-3.

In Manipur reconnaissance stage investigation (G-4) was carried out in Ukhrul-Gamnom-Chingal-Chingsao-Hangkau areas of Ukhrul district during 2010-12 for Platinum Group of elements in ophiolite belt to assess the potential of PGE mineralisation in the favourable host rocks in ultramafic suite comprising chromiferous dunite, peridotite and pyroxenite. The serpentinised peridotite is the dominate rock type in the study area and probable host rocks with 30 m to 40 m width are recorded as out crops. The chromitite layers flenses were identified measuring 3 m X 1 m at three places within the ultramafics. The chromite grains are fine to coarse, sub-hedral to euhedral, dark grey in colour with metallic lustre. The petrographic studies indicate that the ultramafics are composed of olivine, estatite, bronzite, diopside with magnetite and chromite. Predominantly the rock is classified as Lherzolite and Harzburgite. In polished section, euhedral grains of bright white in colour, high reflectance and isotropic in character suspected to be of PGE has been observed. SEM-EDX studies have indicated the presence of laurite that occurs as discrete phase within the chromite grains.

In Odisha, a general exploration stage (G-2) investigation was initiated in March 2010 as a sponsored item of Orissa Mining Corporation Ltd (OMC Ltd) in the lease hold areas of OMC Limited in Bangur and Banaipank areas of Kendujhar district to delineate PGE bearing horizons in the Bangur chromite mining areas and to search for possible extension of potential ultramafics units in the Baniapank area under lease of OMC Ltd. The study indicates that the Bangur area is represented by a litho-melange consisting of assorted megacrysts of dunite, chromiferous dunite, chromitite, peridotite and other mafic-ultramafic litho associations, which is intruded by Bangur gabbro. A prominent NW-SE trending breccia zone in the footwall side of the OMC quarry acts as the host for PGE mineralisation.

The petromineralogical and SEM-EDX study of the breccia zone indicated the presence of PGE minerals. The EPMA studies confirmed the presence of PG minerals as isoferroplatinum, hollingworthite, spenylite, geversite and others. The mineralised breccia zone extends for about 550 m with intermittent ore bodies at varying depth totaling 8-14 m in thickness up to a depth of around 100 m below ground level. In Baniapank OMC leasehold area, 2500 nos of pedogeochemical samples were collected in grid pattern. Several anomalous zones of high Cr, Ni ranging values up to 77300 ppm and 1815 ppm, respectively, has been recorded.

In Tamil Nadu, a reconnaissance (G-4) stage investigation for Platinum Group of Elements initiated during 2009-10 in Solavanur and Karapadi blocks and in Mallanayakanpalaiyam block, Mettupalaiyam Mafic-Ultramafic Complex is being continued during 2010-12. Ten scout boreholes have been drilled for this field season in these blocks. One borehole (SBH-4) has been drilled in F-segment of Solavanur block up to a depth of 87.95 m. Three meta-pyroxenite bands have been delineated along the borehole with a cumulative thickness of 36.25 m. Two boreholes have been drilled in Karappadi block. In the first borehole three meta-pyroxenite bands have been delineated along the borehole with a cumulative thickness of 10.55 m, 42 samples have been processed and sent for PGE analysis. Partial results have been received for this borehole with Pt value ranging from 5 ppb to 255 ppb and Pd value ranging from 10 ppb to 730 ppb. The other borehole KBH-5 has been drilled along KPT-3D trench profile up to a depth of 75.10 m. Seven meta-pyroxenite bands with a cumulative thickness of 18.5 m have been delineated. Seven boreholes (MBH-1 to 7) have been drilled in Mallanayakanpalaiyam block to intersect the metapyroxenite ± chromitite band. Several metapyroxenite bands have been intersected; the samples collected along the metapyroxenite bands are being processed and sent for PGE and trace analyses. EPMA and ore petrographic studies have been carried out on selected section, which has given moderate to high PGE values, high temperature sulphides have been identified along with few suspected PGE grains. A reconnaissance (G-4) stage investigation for PGE in Mettupalaiyam Ultramafic Belt (MUB) has been initiated during 2010-12 to map all the ultramafic bodies in Attikadavu, Velliyankadu, Tolampalaiyam. Melbavi, Karamadai, Mettup-

alaiyam, Pugalur, Vadavalli area, Coimbatore district, within MUB and to carry out comprehensive preliminary study of the ultramafic (UM) bodies to assess its PGE potentials. The major litho-units are hornblende-biotite gneiss, charnockite, meta-gabbro. Metapyroxenite, amphibolite, ferruginous quartzite, magnetite quartzite, K-feldspar rich pegmatoidal granite, and dolerite dyke and quartz veins. The contact between hornblende biotite gneiss and pegmatoidal granite is sheared which is very well exposed south of Togarnalai hill. The shear zones are ductile to semi brittle-ductile in nature and predominantly showing dextral shear sense. A total of ten meta pyroxenite bands/bodies are demarcated. The first body is exposed from Devangapuram to north of Vadavalli and extending over a strike length of 2 km. The second metapyroxenite band exposed at Melbavi village having almost NE-SW strike direction with 1 km. Strike length is located for the first time. Reconnaissance stage (G-4) investigation for Platinum Group of Element (PGE) initiated during 2009-10 by scout drilling is being continued in 2010-12 in Tasampalaiyam Block of Sittampundi layered mafic- ultramafic complex. The Sittampundi Layered Complex exposes hornblende anorthosite gneiss with bands and lenses of meta-pyroxenite/ chromiferous meta-pyroxenite, chromitite and garnetpyroxene granulite within the tonalite-granodiorite gneisses. The Sittampundi Complex is divided into three main blocks, viz, Karungalpatti, Chettiyampalaiyam and Tasampalaiyam (from east to west) for the purpose of exploration. During 2010-12, scout drilling was carried out in T3 (eight scout boreholes) and T4 sectors (five boreholes) of Tasampalaiyam block as well as Karungalpatti block and closed spaced trenching in T4 sector of Tasampalaiyam block to intersect the PGE mineralised bands at 30 m vertical depth and also to delineate the strike continuity of the P013 mineralised zone. Analytical results of boreholes TBH-1, TBH-3, TBH/4, TBH/6 and TBH/7 drilled in T1 and T2 sectors of Tasampalaiyam block show high values of PGE in core samples. Based on the analytical results the following significant zones were delineated:  
 BH TBH – 1: 4.5 ppm PGE over 1.63 m width;  
 BH TBH – 3: 3.10 ppm PGE over 1.90 m and 0.80 ppm over 1.50 m width;  
 BH TBH – 4: 4.93 ppm PGE over 1.45 m and 6.35 ppm over 1.25 m width;  
 BH TBH – 6: 2.30 ppm PGE over 1.20 m width.

BH TBH – 7: 1.10 ppm PGE over 3.88 m and 2.10 ppm PGE over 3.10 m width.

The analytical results of boreholes drilled in T3 and T4 sectors were awaited. A new prospecting stage investigation item has been taken up in the eastern part of Tasampalaiyam block (T1 and T2) sector to prove the depth persistence of PGE mineralisation in 2012-13.

### State Directorate

During 2011-12, DGM, Uttar Pradesh carried out exploration for platinum near village Ikauna, Lalitpur district by mapping on 1:10,000 scale in 0.41 sq km area, trenching-02 nos 100 cu m and 233.72 m drilling in two boreholes.

### DIAMOND

GSI, Directorate of Geology, Odisha and DGM, Uttar Pradesh continued with their engagement in exploration for diamond in 2011-12.

### GSI

In Andhra Pradesh, reconnaissance stage investigation (G-4) was taken up during 2010-12 in Granite-Greenstone terrain in Amangal and Bhimanapali block in parts of Mahabubnagar, Nalgonda and Rangareddy districts to search for kimberlite rock, the host rock for diamond. The study area is a part of the Eastern Dharwar Craton known for emplacements of several kimberlite pipes and forms the catchment for the ancient alluvial diamond workings of the river Krishna and therefore, is a suitable target area for indicator mineral surveys. The Eastern Dharwar Craton and the Bhimanapalli block exposes rocks of the Peninsular Gneissic Complex comprising of granodiorite-granite suite which includes remnants of supracrustals belonging to Dharwar Supergroup which are later intruded by pegmatite, quartz veins and basic dykes of dolerite, gabbro and pyroxenite composition. The drainage pattern in area is dendritic. Regional as well as detailed stream sediment sampling was carried out for targeting diamond source rocks/kimberlite/lamproites. Major heavy minerals identified include crustal garnets (almandine), ilmenite, zircon, spinels and magnetite. Search for kimberlites/lamproite in Paluvayi block in Nalgonda districts, (G-4) has been undertaken with an objective to locate kimberlite/lamproite. The Paluvayi block exposes rocks of the Peninsular

Gneissic Complex which comprises granodiorite and granite. This granodiorite-granite suite includes remnants of supracrustals belonging to Dharwar Super group. The gneiss and granites are later intruded by pegmatite, quartz veins and basic dykes of dolerite, gabbro and pyroxenite composition. The area is basically drained by Halia river, a tributary of Krishna river. Systematic stream sediment sampling was carried out and the heavy mineral concentrates are being examined for kimberlite indicator minerals.

In Chhattisgarh, reconnaissance stage investigation (G-4) was taken up during 2010-12 in Raigarh- Bilaspur Belt in Lormi, Khairadongri Kosabari Sardha. Ghorbandha, Jhajhpuri Kalan areas and in the areas of Achhanakmar, Pali, Nawagaon, Tingipur naka, Kori in Bilaspur districts to locate kimberlite clan rocks in the granitic basement along the high permeable zone characterised by mafic dykes. The areas studied are mainly of Palaeoproterozoic granites, phyllite, mica schist, mafic dyke, metabasics of Bilaspur-Raigarh-Surguja belt, limestone, purple shale and sandstone of Chhattisgarh Supergroup and Talchir Formation of Gondwana Supergroup. Ground follow up of interpreted PGRS map was carried out in the area. Heavy minerals studies indicated the presence of garnet, ilmenite, spinel, zircon and other opaques in the stream sediment samples. Four grains of garnets analysed under SEM-EDX were identified as almandine garnets with FeO up to 36.31% and MgO up to 2.78% with inclusion of quartz, zircon and apatite. Regional ground evaluation of aero-geophysical anomalies (G-4) in parts of Chhattisgarh initiated during 2009-10 were continued during 2010-12 to delineate KCR bodies and other types of mineralisation. The area is occupied by Kansapathar sandstone of Chhattisgarh Supergroup followed by Barren Measure, Barakar Formation and Kamthi Formation of Gondwana group of rocks. Checking of deep seated interpreted faults and formational contacts against magnetic breaks and different litho-units from airborne spectrometric data, the suitable trap sites of nalas/streams, flowing along the fault zone/cutting across the contact of the basement and Gondwana / Chhattisgarh Supergroup of rocks by bed rock/stream sediment sampling were carried out. Chemical analysis of total 20 bed rock samples, 20 soil samples and 4 calcrete samples do not show any encouraging result. The

soil sample shows Cu - 40 ppm, Co-115 ppm, Cr - 175 ppm and Au < 100 ppb. Bedrock sample collected from Lamikhair shows as 10 ppm. Twenty KCR indicator mineral grains (garnet and ilmenite) by SEM-EDX exhibits garnets 4.31% to 7.61% MgO, which indicates possible occurrence of KCR bodies in the upstream side of sampling area.

In Karnataka, reconnaissance stage investigation (G-4) was taken up during 2010-12 in Dharwar craton in parts of Raichur district to locate kimberlites in the area based on the previous finds of kimberlites (Raichur Kimberlite Field). The area is a part of the Archean granite-greenstone terrain of the Eastern Dharwar Craton (EDC) exposing the metavolcanic and associated metasedimentary rocks of the Eastern Greenstone belts (Kushtagi, Hutti and Deodurg-Raichur schist belts), Migmatitic gneisses of Peninsular Gneiss-II, syenite, pink/grey granite and porphyritic and homophanous granite and granodiorite. All these rock types have been traversed by quartz veins, gabbro and dolerite dykes. This Archean terrain is covered in the northern part by flood basalts of Deccan Trap. Geochemical anomaly brought out by NGCM 2004-06 near Paidoddi is due to the presence of meta-ultramafic enclave in the area. Calcrete development was observed at 1 km west of Govindoddi in the vicinity of a very small exposure of ultramafic body. Dolerite and gabbro dykes have been traced intersection points of certain lineaments in parts of toposheet no. 56H/4 have been investigated. Suspected Cr- Diopside grains collected from stream sediment samples are submitted for EPMA analysis. Reconnaissance stage (G-4) investigation for search for kimberlites in parts of Raichur and Gulbarga districts has been taken up as an additional item with an objective to search for kimberlites through indicator mineral survey and close spaced geological traverses. Heavy mineral study for identification of kimberlite indicator minerals were in progress.

In Madhya Pradesh, regional ground evaluation of aerogeophysical anomalies (G-4) in parts of Chhattarpur, Sagar, Tikamgarh and Lalitpur (Uttar Pradesh) initiated during 2008-09 was continued during 2010-12 to delineate priority block to locate possible KCR bodies and other type of mineralisation. The study area is mostly covered by the sandstones of

Kaimur Formation of Vindhyan Supergroup. At places Deccan Traps and Lametas are observed. Study of heavy concentrates of stream sediments from the area indicated three (3) grains as chrome bearing diopside ( $\text{Cr}_2\text{O}_3$ -0.96% to 1.15%). The samples have been studied in detail with SEM-EDX. The elemental concentration obtained by EDX study reveals the presence of chrome bearing diopside. This finding confirms the possible presence of source rock in an area of about 1.50 sq km. Further, work did not reveal presence of any KCR body.

### State Directorates

In 2011-12, Directorate of Geology, Odisha conducted exploration for diamond around Durrimunda area, Nuapada district by mapping on 1:2,000 scale in 0.5 sq km area, 14 nos trenching (2 to 5 m x 1 m x 2 m) operations and sampling. Two lamproite bodies of 400 m strike length with width varying from 0.3 to 3 m have been delineated. Scanning of bulk samples of Supuli valley and Durrimunda area was in progress to ascertain the diamond incidence.

In 2011-12, DGM, Uttar Pradesh carried out exploration for diamond near Bant village, Lalitpur district by mapping on 1:10,000 scale in 02 sq km area, trenching 01 no -100 cum, 17 line geophysical mapping and chemical analysis of 80 samples.

### GOLD

The GSI, HGML and DGM, Uttar Pradesh were engaged in the exploration for gold during 2011-12. An account of exploration work done by GSI is given in Table-7. The details of exploration carried out by HGML and DGM, Uttar Pradesh are given in Table- 8.

### INDUSTRIAL MINERALS

The details of exploration work carried out for industrial minerals by GSI, State Governments and Central/State Undertakings during 2011-12 are given in Table - 9.

### DECORATIVE DIMENSION STONES State Directorates

The details of exploration work carried out for granite, sandstone and decorative dimension stones by State DGMs during 2011-12 are furnished in Table - 10.



## EXPLORATION &amp; DEVELOPMENT

**Table - 7: Exploration for Gold by GSI, 2011-12**

State/District	Location	Details of work done	Results obtained/Remarks
<b>Andhra Pradesh</b>			
Cuddapah	Tellakonda block	Drilling and geochemical analysis	Prospecting stage investigation (G-3) was carried out during 2010-12 in Tellakonda block of Veligallu Greenstone belt, for gold on the basis of encouraging results of earlier geochemical studies. The litho-units exposed in the area comprise of granite gneiss, quartz-muscovite-sericite schist, metabasalt, amphibolite, quartz reef and gabbro dykes. The quartz reef is sheared and brecciated and contains sulphide mineralisation. Exploration by drilling was carried out with an objective to test the subsurface behaviour of the mineralised zone of 550 m strike length at 60 m vertical depth. The four boreholes (AKT-1 to AKT - 4) have intersected feeble to moderate mineralised zones in the form sheared quartz veins within the amphibolite and granite. The analytical results of drill core samples have indicated feeble to moderate gold values with the weighted average ranging from 0.11 g/t. to 1.05 g/t. The highest gold value of 1.05 g/t has been noted in sulphide bearing quartz vein over a true width of 0.48 cm, intersected in borehole AKT-1 from 86.45 m to 86.95 m depth.
Mahaboobnagar and Kurnool	West of Remeta	Sampling and geochemical analysis	Reconnaissance stage investigation (G-4) was carried out during 2010-12 in western arm of the Gadwal Schist Belt for gold and other associated elements in the area west of Remeta, Mahaboobnagar and Kurnool districts. The Gadwal Schist Belt is one of the potential belts in the eastern part of Dharwar Craton and it is a hook shaped belt with two arms, the eastern arm considered as the main Gadwal Schist Belt and the western arm joins the Raichur Schist Belt in Karnataka. In the western arm, the schist belt consists of meta acid and intermediate volcanics and granites & granodiorites further intruded by dolerite dykes, pegmatite and quartz veins. Near Nagaladinne, mylonite is observed. A total of 164 samples were analysed for gold content, out of which only one stream sediment sample analysed gold content of 150 ppb. No significant gold mineralised zone could be delineated.

(Contd.)

EXPLORATION & DEVELOPMENT

Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
<b>Bihar</b>			
Gaya and Nalanda	Bathani area	Mapping and geo-chemical analysis	Reconnaissance stage investigation (G-4) was carried out during 2010-12 in Bathani area, in Gaya and Nalanda districts to assess gold mineralisation associated with Bathani volcano-sedimentary sequence and Munger-Rajgir metasediments as a follow up of earlier work in Rajabigha East Block (Bathani area) where anomalous concentration of gold in the range of 40 ppb to 504 ppb in tuff, BIF intercalated tuff and BIF samples and other surface indications for old mining activities were recorded. Large scale mapping in Bathani-Majhauri- Saren exposes plutonic rocks at southwest of Bathani village, whereas the area between Majhauri-Saren-Sitarampur establishes the southwestern continuation of volcano-sedimentary sequence in juxtaposition with Rajgir meta-sedimentary sequence. Detailed mapping around Shankarpur and Rajabigha villages indicated that the area is covered by tuff and phyllitic tuff. The tuff unit was intruded by number of quartz veins (Q2) and shows alteration. Arsenopyrite tines were suspected in alteration zone. Available analytical results near Majhauri, shows anomalous gold concentration ranging from 120 ppb to 2.25 ppm. Quartz vein associated with tuff at Saren village yielded 1.11 ppm gold concentration. 20 samples from Shankarpur and Rajabigha villages yielded 65 ppb to 250 ppb Au concentration. Taking all these together, a prospective block of 210 m strike length with 80 m width could be established.
Jamui	Gosari-Ghutwe block,Sono area	Drilling and geochemical analysis	Reconnaissance stage investigation (G-4) was carried out during 2010-12 in Gosari-Ghutwe of Sono area, as per the recommendation of SGPB, Bihar with an objective to assess the gold potentiality as well as petrographic characterisation of the host rock vis-a-vis mineralised body in the block. So far, available results of bedrock samples from east of Gosari area reveal that in schistose amphibolite Au concentration ranges from 60 ppb to 185 ppb (av. 117 ppb) whereas in quartzite - ferruginous quartzite -BMQ Au concentration ranges from 60 ppb to 125 ppb (avg. 90 ppb). In addition to these, quartz vein and granite gneiss also yielded 60 ppb Au concentration. All these imply that schistose amphibolite is the most favourable host rock for Au concentration. Four of the seven scout boreholes drilled for which analytical results are available mineralised zones could be identified only in 2 boreholes.
<b>Chhattisgarh</b>			
Raipur	Sonakhan belt, Palasapali area West of Bhanwarpur	Delineation of gold mineralisation	Reconnaissance stage investigation (G-4) was taken up during 2010-12 in Sonakhan belt in Palasapali area, west of Bhanwarpur, to delineate new prospect block for gold mineralisation. The area exposes amphibolite, metabasalt, tremolite/ actinolite schists of Baghmara Formation of Sonakhan Group. They have been

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Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
			intruded by thick gabbro and quartz vein. The primary sulphides, pyrite and pyrrhotite have been recorded in the amphibolite and quartz veins. In the quartz veins the sulphides are oxidized to brown black, lemon yellow. The gold mineralisation in the Bhanwarpur area is associated with silicification of the contact zone of granite with basic volcanics.
<b>Jharkhand</b> East & West Singhbhum	Tilaitanr-Sobhapur area	Sampling and geochemical analysis	Prospecting stage investigation (G-3) for gold, Ni and Cr initiated during 2009-10 was continued during 2010-12 in Tilaitanr - Sobhapur area, East and West Singhbhum. The area forms a part of Gorumahisani Badampahar Kunderkocha — Jaikan Archaean Greenstone belt and exposes phyllite, tuffaceous phyllite, slaty phyllite, intraformational conglomerate, BIF, cherry quartzite, chlorite schist, ultramafics (talc-tremolite schist, actinolite-tremolite schist), dolerite and granite. Gold is suspected to be associated with sulphide mineralisation, which is noticed in the form of pyrite, chalcopyrite grains hosted in quartz veins and veinlets emplaced in phyllitic rocks. Some sulphide mineralisation is also seen in mafic and ultramafic rocks. Bedrock samples have been collected from all these rock types including quartz veins. Out of 95 bedrock samples for which analytical results are available 7 samples have shown gold values between 100 ppb to 4.45 ppm and yielded Cr values between 500 ppm and 1600 ppm. Out of 65 trench samples, 12 samples have analysed between 100 ppb and more than 1 ppm gold. Only, one trench sample has yielded more than 500 ppm Cr.
Ranchi	Sindauri- Ghanshyampur block	Geochemical analysis	Prospecting stage investigation (G-3) was carried out for gold in Sindauri-Ghanshyampur Block, during 2010-12 to test the eastward continuation of already explored Sindauri East Block. Ore microscopic studies indicated the presence of gold with arsenopyrite. Analysis of core samples of BH SEB-7 confirms presence of seven gold mineralisation zones associated with sulphide mineralisation between the depths of 40.45 m and 166.00 m. The cumulative width and average grade of these zones are 11.0 m and 1.87 g/tonne, respectively. The part analytical results of the core samples of BH SEB-8 indicate extension of gold mineralisation further eastward.

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Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
West Singhbhum	Rudiya-Largadih-Balidih block	Drilling and geo-chemical analysis	Prospecting stage investigation (G-3) was carried out for gold in Rudiya-Largadih-Balidih block, to assess the gold potentiality of the block. Rudiya-Largadih-Balidih block comprises part of Dalma volcanics and metasedimentaries of Singhbhum Group. The rock types are mainly carbonaceous phyllite, siliceous tuff, mafic/ultramafic volcanic rocks, subordinate chert band/acid volcanics and brecciated quartzite. Investigation carried out during 1994-98 in this area established the occurrence of primary gold mineralisation hosted in sheared quartz reefs, which is characterised by profuse silicification, ferruginisation and carbonatisation. It extends for about 2 km in this block. Despite having good mineralised zones, due to poor core recovery in most of the boreholes the project was closed. In course of the present investigation very encouraging gold value (more than 1 ppm) has been recorded over trenches and channels put across the brecciated quartzite rock. Gold is associated with sulphide mineralisation represented by pyrite, chalcopyrite and arsenopyrite. Owing to sheared and brecciated nature of the rocks, only two boreholes could be completed (NRB-1, NRB-3) and one abandoned (NRB-2). Chemical analysis of the core samples of BH NRB-1 and parts of BH NRB-2 and NRB-3 so far available establishes a 4 m thick mineralised zone in brecciated quartzite unit between depths 78 m and 82 m. It contains gold value ranging from 50 ppb to more than 1 ppm.
<b>Karnataka</b> Chitradurga and Tumkur	Adivala-Obalapura and Mavinamadu area	Delineation of mineralised zone	Reconnaissance stage investigation (G-4) was taken up during 2010-12 in Chitradurga Schist Belt between Adivala-Obalapura and Mavinamadu in Chitradurga and Tumkur districts to assess the auriferous nature and to locate possible gold mineralisation in the eastern shear of the Chitradurga Schist Belt. The Adivala, Obalapura, and Mavinamadu block is situated 500 m, one km south east of Hiriya to south of Mavinamadu, comprising the Hiriya Formation belonging to Chitradurga Group of Dharwar Supergroup. The present area of investigation is a part of the Ajjanahalli folded BIF band sequence and falls within the minor shear very close to the eastern shear in the eastern margin of the central part of the Chitradurga Schist Belt. The main rock types are massive, schistose, pyroclastic vesicular and carbonate metabasalt BIF (5-7 BIF bands) and metagreywacke, argillite, with younger basic and acid intrusive. Based on the chemical analytical results of bedrock and trench samples and surface indications delineation of mineralised zones in the area was in progress.

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Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Shimoga Schist Belt	Bhairapura and Hosahalli areas	Large scale mapping	Reconnaissance stage investigation (G-4) for gold mineralisation in southern part of Shimoga Schist Belt in Bhairapura and Hosahalli has been carried out during 2010-12. The Shimoga Schist Belt is one of the important schist belts in Western Dharwar Craton where earlier investigation in southern part of the Shimoga Schist Belt led to identification of prospects in Jalagaragundi, Siddarahalli, Honnahatti and Singanamane areas. The major rock types noticed during the LSM mapping are PGC, metabasalt, fuchsite quartzite, quartz-chlorite schist, talc-chlorite schist, quartzite, polymictic conglomerate and basic dykes. Evidences of mineralisation are in the form of silicification, sulphide leaching and dissemination of sulphides within quartz-chlorite schist and talc-chlorite schist in the form of pyrite, pyrrhotite and arsenopyrite. The shear zone in south west of Bhairapura was traced further north.
Tumkur	Ajjanahalli block - D and block- E	Drilling	Prospecting stage investigation (G-3) for gold in Ajjanahalli Block-D and reconnaissance (G-4) stage investigation in Block-E in Sira Taluk, was taken up in the Ajjanahalli sector of Chitradurga schist, where earlier investigation identified mineralisation in BIF and adjacent country rocks. The boreholes were drilled in Ajjanahalli Block - D to intersect the mineralised BIF bands to study the subsurface nature, behaviour, depth persistence and gold content of the auriferous Banded Iron Formation. The borehole ADG-20 intersected mineralised zone VII and VIII in BIF which is highly sheared, with quartz-carbonate veins/veinlets, having plenty of sulphides such as pyrite, pyrrhotite and arsenopyrite and minor chalcopyrite. Boreholes ADG-21, 22 & 23 intersected mineralised Zones III and IV in BIF. The BIF is highly sheared, with quartz-carbonate veins/veinlets, having sulphides such as pyrite, pyrrhotite and arsenopyrite. Correlation of mineralised zones intersected in different boreholes was in progress. Reconnaissance stage investigation in Ajjanahalli Block-E helped in delineating a mineralised zone for a strike length of 900 m within BIF band. The main litho-units in Block-E are metabasalt, argillite, BIF and various generations of quartz vein and two later basic intrusives. A major old working is noticed at the western limb of the band. The old working is confined to the BIF band extending for a length of 25 m along the strike direction with a width of 4 m. The BIF band is sheared, brecciated and limonitised. The wall rock alteration of metabasalt is observed at the contact of BIF. The BIF is sheared, highly limonitised with quartz veins/veinlets. Several quartz veins are noticed in metabasalt.

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State/District	Location	Details of work done	Results obtained/Remarks
Tumkur	Ajjanahalli Block G	Mapping	Reconnaissance stage (G-4) investigation was carried out during 2010-12 in Ajjanahalli Block-G, for assessment of gold mineralisation. The major litho-units noticed in the area are meta-basalt, BIF and argillite. Various generations of quartz vein are cross cutting the BIF as well as meta-basalt. Thin, impersistent ferro-dolomite bands (~50 cm) are mapped at the contact of meta-basalt and BIF band at places. An old working is noticed at one of the BIF band. The wall rock alteration is observed at the contact of BIF with both litho-units. The BIF is sheared, highly limonitised with quartz veins/veinlets. Three new BIF bands were established named as band VIII, IX and X in the western part of the area.
<b>Rajasthan</b> Banswara	Jagpura block, Bhukia gold belt	Delineation and geochemical analysis	Reconnaissance stage investigation (G-4) was carried out during 2010-12 in Jagpura block of Bhukia gold belt to delineate the potential zones for gold and associated basemetal mineralisation in the northern continuity of mineralisation of Bhukia gold prospect. The rock types exposed in Jagpura Block form a part of Jagpura Formation of Debari Group of Aravalli Supergroup, which include phyllite, quartz-muscovite schist, impure dolomite marble, calc-silicate, quartzite and banded plagioclase-tourmaline-quartz rock. Staurolite schist and andalusite schist exposed in the eastern side form the basement for these rocks and belong to Mangalwar Complex of Bhilwara Supergroup. Pegmatite and grey and white quartz veins traverse basement and overlying cover sediments. Surface manifestations of mineralisation are in form of old workings, gossans and alteration zones. Mineralisation is accompanied by extensive alteration in the form of tourmalinisation, kaolinisation, sericitisation, chloritisation and silicification. Prismatic arsenopyrite up to one cm in length has been observed in fresh rock along with minor pyrite, pyrrhotite and chalcopyrite in plagioclase-tourmaline quartz rock. Native gold is not visible to the naked eye but can be seen in polished sections under microscope as minute discrete grains within arsenopyrite. Based on bedrock/channel samples analytical results and surface indications, N-S trending surface mineralisation zone of 400 m strike length averaging a width of 50 m has been delineated. The mean gold grade for all samples is 1.18 g/t while median is 0.8 g/t. Basemetal values are not encouraging. Lead is below 25 ppm. Zinc ranges from 6 to 45 ppm, nickel is between 15-261 ppm, cobalt ranges from 15 to 198 ppm and silver is below 5 ppm.

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State/District	Location	Details of work done	Results obtained/Remarks
Banswara	Gundelapara block,	Drilling and geo-chemical analysis	Prospecting stage Investigation (G-3) was carried out during 2010-12 for gold and copper in Gundelapara NW Block based on favourable geological setup, structure, surface manifestations and encouraging analytical results of earlier works. The rock types exposed in Gundelapara NW Block are a part of Jagpura Formation of Debari Group of Aravalli Supergroup, which include amphibolite, impure marble, pyritiferous keratophyre /keratophyre (quartz-albite rock) and calc-silicate. Vein quartz and pegmatite occur as concordant as well as discordant intrusive in all the rock types. Surface evidences of mineralisation are in the form of small old workings, gossans, malachite stains, pyrite mineralisation, silicification, carbonatisation, epidotisation, presence of ore grinding implements and slag heap in and nearby the area. Subsurface mineralisation was confirmed by drilling and all the six boreholes intersected significant mineralisation. The cumulative thickness of gold mineralised zones (2 to 7 zones) intersected in each borehole range from 2.90 m to 31.45 m and average grade from 1.05 g/t to 2.13 g/t. The main sulphide minerals are pyrrhotite, chalcopyrite, arsenopyrite and pyrite in decreasing order. The host rock is impure marble intercalated with calc silicate intercalations. The lateral correlations of these intersected mineralised zones was in progress.
<b>Uttarakhand</b> Rudraprayag	Lameri Ratura area	Delineation and geochemical analysis	Reconnaissance stage investigation (G-4) was taken up during 2010-12 in Garhwal Group based on the encouraging results of earlier work and on the proposal from Directorate of Geology and Mining, Uttarakhand in Lameri-Ratura area to delineate and assess the auriferous mineralised zones in the area. In Lameri-Ratura area, 16 nos of old workings have been recorded in dolomite with quartz vein in Lameri (=Pithoragarh) Formation. In Lameri-Tilni area cluster of five old workings was observed. Old workings are in the form of shallow pockets (0.5-1 m x 1-2 m size) and one incline (1.2 m x 1.8 m x 5 m) having malachite stained quartz vein. Brownish grey slag was observed as dump near the old working site and one retort piece has also been recorded from the site. The sulphide-mineralised lens having old workings and sulphide disseminations is 200 m x 50 m. In Tilni-Koteshwar area, cluster of five old workings were identified in dolomite with malachite stained

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State/District	Location	Details of work done	Results obtained/Remarks
			<p>quartz veins having disseminated pyrite and chalcopyrite specks and fracture filling of galena. The mineralised zone has average width of 5 m and extends up to 120 m, discontinuously and gold flake was identified earlier in quartz vein within dolomite under SEM studies. The sulphide mineralised lens extends up to 500 m discontinuously over an average width of 8 m. In Kimotha area a cluster of four old workings were identified at the contact of quartzite and dolomite. In this area mineralisation was observed in quartz vein within dolomite of Lameri Formation and mineralisation is manifested as malachite stain with few pyrites, chalcopyrite disseminations. In Dharkot area two old workings were identified at the faulted contact of quartzite and dolomite. The discontinuous extension of the mineralised zone was observed in Ratura area. The control of mineralisation is structural; mineralisation is generally confined to the quartz veins in fractures trending from 320° to 340°. In Lameri- Koteshwar area, fault breccia has been identified at places, in the sympathetic zones. During stream sediment sampling, visible gold grains were recorded from stream sediment in Alaknanda river and its tributary on right bank (Sari area) and from the banks of Mandakini river in Jugtoli-Tarwari area. On the basis of the available chemical results, in Lameri area, two mineralised zones of Zone I: Cu 0.51% x 6 m and Au 0.09 ppm in 6 m over a strike of 20 m and Zone II: Cu 0.25% x 6 m and Au &lt;50 ppm over a strike of 10 m have been delineated. The Cu mineralised zone in Koteshwar-Machendranath area is 0.19% x 7.5 m over a strike length of 15 m in the sulphide mineralised lens which extends up to 500 m discontinuously over an average width of 8 inches, having some significant spot values of 0.39% Cu &amp; 1.64% Cu. In Tilni area, Au and Cu are not encouraging but the mineralised zone of Zn 363 ppm x 7 m over a strike of 25 m in carbonaceous slate has been delineated. Here the value of Zn goes up to 988 ppm. The Au values in chlorite schist and metagabbro are 124 ppb and 75 ppb, respectively, from Jugtoli area. The overall spot values of Au in bed rock samples from the area are low and maximum is up to 475 ppb. The stream sediment samples collected from Ratura, Sumerpur area yielded Au 200-300 ppb and one sample has 1.42 ppm Au (Ratura-Dharkot area). Heavy panned residues of samples from the same areas have shown 5 ppm-80 ppm Au.</p>

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Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
<b>Uttar Pradesh</b>			
Sonbhadra	Chakoriya-Charka area	Delineation of mineralised zones	<p>Reconnaissance stage investigation (G-4 stage) was taken up during 2010-12 in Mahakoshal Group for search of gold and associated mineralisation in Chakoriya-Charka area. During large scale mapping east of Chakoriya village, 17 nos old working over a strike length of 700 m have been located. The old workings are elliptical to rounded 3 m to 70 m long, 2 m to 3 m wide and 3 m deep. The samples from Chakoriya-Charka and Machohi area have yielded Au values from &lt;20 ppb to &lt;50 ppb and trench samples have yielded &lt;20 ppb to 90 ppb. A discontinuous auriferous mineralised zone has been located in Parsoi area. The surface manifestations of mineralisation are marked by scorodite, (FeAsO<sub>4</sub>.2H<sub>2</sub>O) which is formed after alteration of arsenopyrite. The mineralised zone extends up to a strike length of about 800 m, intermittently, and width varies from 1.5 to 4 m. 19 grab spot samples, so far, have given more than 1 ppm Au value. The maximum Au value is 16.8 ppm from the scorodite lump in quartz vein from Parsoi mineralised zone. From the available analyses the average grades of the gold mineralised zone (over cut off of 65 ppb) in three trenches are 0.278 ppm X 1.5 m, 0.357 ppm X 1.5 m and 1.017 ppm X 2 m. Two more sulphide mineralised zones have been located in Phaphrakund and Arangi area, running parallel to each other. There is a parting of phyllite of 3.00 m thickness in between these zones. The strike length of the zone is about 500 m. The grab samples have yielded &lt;50 ppb to 14.8 g/t Au, with 09 samples having more than 1 ppm Au.</p>

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**Table – 8 : Exploration for Gold by HGML and State Directorates, 2011-12**

State/District	Location	Agency	Details of work done	Results obtained
<b>Karnataka</b>				
Raichur	Hutti	HGML	Underground mapping-2,831 m on 1:400 scale, surface drilling-4,179 m, underground drilling-3,270 m and collection of 9,883 samples.	A total of 9.25 million tonnes of reserves of gold ore with 5.53 g/t Au were estimated.
- do -	Hira-Buddini	HGML	Exploratory mining - 143.9 m and samples analysed - 1,038	About 0.78 million tonnes reserves of gold ore with 3.99 g/t Au were computed.
- do -	Uti	HGML	Exploratory mining -136.45 m and samples analysed - 1,004	Total mineable reserves are estimated at 2.18 million tonnes ore with 2.50 g/t to 2.91 g/t Au.
<b>Uttar Pradesh</b>				
Lalitpur	Girar	DGM	Mapping 1:1,000-0.5 sq km, trenching 4 nos. - 125 cu m, chemical analysis -1200 nos. and 163 m drilling in 01 borehole.	Reserve estimation is under process.
-do-	Berwar	DGM	Mapping 1:5,000-0.5 sq km, trenching 2 nos. - 111 cu m and chemical analysis -314	Reserve estimation is under process.
Sonbhadra	Hardi-Bagisoti	DGM	Drilling- 161.25 m in four borehole and chemical analysis -184	Reserve estimation is under process.
-do-	Deva Injani	DGM	Mapping 1:10,000 - 4.1 sq km, trenching 4 nos. - 151 cu m and chemical analysis -353	Reserve estimation is under process.

**Table – 9: Exploration for Industrial Minerals by GSI, DGMS and Central/State Undertakings, 2011-12**

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>Geological Survey of India</b>							
<b>APATITE AND ASSOCIATED MINERALS</b>							
<b>West Bengal</b>							
Purulia	Panrkidih	-	-	07	-	-	Seven boreholes were drilled to test the depth persistence of apatite-magnetite veins up to 30 m vertical depth. It revealed that apatite-magnetite veins, about 150 m strike length and average 1 m width on the surface, do not persist up to that depth. Analytical results of bedrock samples and channel samples show average 24% P <sub>2</sub> O <sub>5</sub> , and 23% P <sub>2</sub> O <sub>5</sub> , respectively. However, gamma ray

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
							logging carried out by AMD indicates presence of radioactive zone (>0.03% e U <sub>3</sub> O <sub>8</sub> ) between 48 m and 49.50 m depth in BH: PBH-5 & (0.01-0.015% e U <sub>3</sub> O <sub>8</sub> ) between 46.90 m and 47.60 m depths in BH:PBH-6.
<b>FULLERENE</b> <b>Andhra Pradesh</b> Cuddapah	Mangampet	-	-	-	-	-	The carbon spherules and tubules within the dolomite and stromatolitic dolomite was observed for the first time during reconnoitre survey. Pseudotachylites are observed within dolomites in the Mangampet barytes mines in the vicinity of the breccia zone. The pseudotachylites are characterised by glassy black colour, aphanitic nature and a few mm thickness. The glassy carbon mineralisation observed within the dolomites is occurring as spherules and tubules showing conchoidal fracture, black streak, low specific gravity and not soiling finger. It shows resemblance to the shungites of proterozoic rocks of Karelian Province, Russia, where natural fullerenes were reported by Dr. Peter R Buseck in its physical properties and XRD peaks. Analytical results so far received of samples have not indicated any significant values for fullerene.
<b>GLASS SAND</b> <b>Himachal Pradesh</b> Shimla & Kullu	Rampur group of rocks	-	-	-	-	-	Sunda quartzite is occurring as discontinuous quartzite body within Banjar volcanic and near Sunda village has a strike length of 1 km with a maximum true thickness of 120 m. The quartzite is pure white in colour,

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
							<p>fine grained, hard compact and forming the steep cliffs. At places fuchisite is present in minor amount. Silica in bed rock samples varies from 85.31% to 97.95% <math>Al_2O_3</math> from 0.96% to 5.69% and <math>Fe_2O_3</math> from 0.12% to 1.79%.</p> <p>Quartzite near Darshai village is white in colour, fine, grained having a dimension of 400 m strike length and maximum true thickness of 60 m.</p>
<p><b>GYPSUM</b> <b>Haryana</b> Hissar and Bhiwani</p>	N/v Saharwa, Daryapur, Garanpura, etc.	-	-	05	-	-	<p>The area mapped shows the presence of both longitudinal and transverse dimes. Gypsum occurs in the area as pan and pocket type deposits. Gypsum values range from 67-85% in eight samples, 41-58% in five samples and 25-34% in four samples out of 20 bedrock samples were analysed. Analyses of 15 nos of pit samples indicate percentage of gypsum ranges from 0.09 to 82.20%. Five shallow boreholes (up to 30 m) have been drilled near Saharwa, Daryapur, Garanpura, east of Garanpura and west of Saharwa villages. All the boreholes intersected poor to moderate grade gypsum, bands/laminae. Chemical analysis of 15 nos of pit samples and 13 nos of core samples of SBH-1 indicates percentage of gypsum ranges from 0.09 to 82.20% and 14.08 to 80.84%, respectively.</p>
<p><b>LIMESTONE</b> <b>Andhra Pradesh</b> Kurnool</p>	West of Nandikotkur	-	-	-	-	-	<p>Analysis of different coloured limestone samples collected from the area indicate; (i) light pinkish colour limestone exposed in a small stream south of Alluru is high grade with</p>

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>Karnataka</b> Bagalkot	Jalikati, Lokapur and adjoining areas (DMG blocks: A&B)	-	-	-	-	-	CaO 51.10% and silica 3.04%, (ii) dark grey massive Narji limestone exposed in HNSS canal between Voddamanu and Bollavaram and between Alluru and Bollavaram are of good cement grade limestone with 40-46% CaO, 10-18% SiO <sub>2</sub> and 0.5% MgO. (iii) dark brownish limestone exposed in the HNSS canal between Brahmanakotkur and Gargeyapuram near K.G. Road bridge crossing is of poor cement grade limestone with 35.7% CaO and 30.68% SiO <sub>2</sub> and (iv) light greenish massive limestone between Gargeyapuram and Diguwapadu with 44.80-45.57% CaO and 13.69-15.08% SiO <sub>2</sub> is a good cement grade.
<b>Meghalaya</b> Jaintia Hills	Umphyruluh block	-	-	-	-	-	Preliminary assessment indicates that the dark grey limestone belonging to Yendigere Formation tentatively confirms to the specifications of flux and SMS grade limestone. It is fine grained, a massive unit of considerable width and chemical analysis has been obtained for confirmation. The lower part of the two limestone units (Yendigere and Muddapur) are variegated and may not be suitable as flux and SMS grade. It has high SiO <sub>2</sub> and grades to shaly limestone. The work was under progress to categorise the limestone based on chemical analysis results.
							The area comprises limestone of Shella Formation belonging to Jaintia Group (Eocene). The limestone is grey to dark grey in colour, medium grained and highly fossiliferous.

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>Rajasthan</b> Jaisalmer	Jiraj-ka-Toba, Asu-Tar area	-	-	12	-	-	The main objective was to search and locate SMS grade (LD grade) at shallow depth of 50 m by augur coring drilling. A total 12 numbers of borehole (JRA-1 to JRA-8, JRA-10 & JRA-11 and JRA-14 & JRA-15) from south western part to northern part of the area on grid pattern (500 m x 500 m) covering an area of 4 sq km were drilled. All the boreholes intersected SMS grade and cement grade limestone popularly known as Khuiala limestone varying in thickness from 1 m to 15 m from ground level to 50 m depth. A total of 437 nos of core samples for chemical analysis and 12 nos of samples for decrepitating test have been analysed and have yielded encouraging results and also analytical result of core samples so far received are also encouraging. It matches the specifications of SMS and cement grade limestone.
<b>PHOSPHORITE</b> <b>Madhya Pradesh</b> Chhatarpur & Sagar	Lukri-Akrotha- Raipura- Surajpura areas	-	-	-	-	-	Phosphorite is associated with ferruginous shale as irregular bands and lenses varying in thickness from 3 m to 20 m. The phosphorite ore bodies (ferruginous phosphatic sandstone and ferruginous phosphatic chert breccia) are confirmed to Hirapur Formation of Bijawar Group of rocks. Chemical analysis of bed rock and trench samples indicate P <sub>2</sub> O <sub>5</sub> percentage values ranging from 10.15 to 35.51% in Surajpura block, 19.32 to 30.50% in Raipura-Akrotha block and 20.75% in Lukri block. Twelve detached lensoidal bodies of massive, laminated, reworked and brecciated phosphorite were located around Surajpura. The dimension of the ore bodies and results are very much encouraging.

(Contd.)

EXPLORATION & DEVELOPMENT

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Jhabua	Piploda and Dhanpura-Khatamba blocks	-	-	-	-	-	The stromatolytic dolomitic limestone, cherty dolomite and brecciated chert of Kelkua Formation are the host rocks for phosphorite in this area and the bands are with NNE-SSW trend and steep dip on either side. Based on the surface geochemical sampling a zone of 340 m strike length in Piploda block and a zone of 130 m strike length in Khatamba block for phosphorite have been delineated. Subsurface data of drilling indicates presence of several bands of phosphorite parallel to the main band. A tentative resource of 279,625 tonnes of phosphorite with average 16.44% P <sub>2</sub> O <sub>5</sub> (cut off 5% P <sub>2</sub> O <sub>5</sub> ) has been estimated in Piploda block.
<b>Rajasthan</b> Banswara	Kalinjara, East of Sallupet	-	-	-	-	176	Total 176 nos of bedrock samples were collected to see the presence of phosphate in various rock types and 30 cu m of pitting/trenching was carried out in Rupgarh and Shivpura areas to expose the phosphatic dolomite band and collect samples. To the north of Rupgarh, dolomite bands is exposed and within this band stringers, patches and lamellar of brecciated stromatolyte and lenses of chert were observed. Pitting/trenching has been carried out in this area and samples collected have indicated presence of phosphate. Phosphatic dolomite bands are also delineated in Shivpura, Raipura, Rola and Ramka-Munna areas. In Sallupet area the phosphorite bodies occur as discontinues lenses within the dolomite and cherty dolomite units. The phosphatic dolomite was seen in the form of stromatolytic, brecciated banded and massive units. The true thickness of phophorite out crop varies from 50 cm to 1.2 m. (Contd.)

EXPLORATION & DEVELOPMENT

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>TALC-STEATITE</b>							
<b>West Bengal</b>							
Darjeeling	Lepcha Basti and Singla area	-	-	-	-	-	Three trenches have been dug to trace the strike of the extension of the talc lense. Trench- 1 exposed 3.2 m wide, both lumpy and platy talc. Trench-2 exposed 2.5 m wide talc of above types with impurities like Fe, mud and clay. The continuity of the talc lense has been traced down slope over a distance of about 120 m towards SE of Trench-1, where 1.5 m of talc body of both platy and lumpy types has been exposed. The analyses of 19 nos bed rock samples of pure/ impure talc bodies show 18.91-34.94% MgO with average of 31.63% MgO.
<b>State Directorates of Geology &amp; Mining</b>							
<b>CHINA CLAY</b>							
<b>Kerala</b>							
Kannur	Aravanchal area, N/v Alapadambu	-	-	05	142.5	73	Average thickness of clay is 13 m.
-do-	Perinthatta area	-	-	04	82	-	Average thickness of clay is 6 m.
Kollam	Pattamukku area	-	-	06	167.5	-	Average thickness of clay is 6 m and that of overburden is 6 m.
-do-	Kakkolil area, Kundara	-	-	02	83	-	Average thickness of clay is 20 m.

(Contd.)



EXPLORATION & DEVELOPMENT

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>CLAY</b>							
<b>Rajasthan</b>							
Bikaner	N/v Kenya- ki- Basti	1:50,000	200	02	210	50	New occurrences of grey black clay were observed n/v Lohiya, Mokha and Khetolai.
<b>CLAY &amp; BAJRI</b>							
<b>Rajasthan</b>							
Bikaner	N/v Kodamdesar, Chandi, etc.	1:50,000	200	-	-	04	Clay was noted in same old pits after 8 to 10 m overburden of bajri and kankar.
<b>CLAY &amp; COLLOIDAL SILICA SAND</b>							
<b>Rajasthan</b>							
Karauli	N/v Jhakhoka, Lawanch, etc.	1:50,000 1:10,000 1:2,000	50 10 01	-	-	04	Inferred resources of colloidal silica sand were estimated at 0.09 million tonnes in the area.
<b>GYPSUM</b>							
<b>Rajasthan</b>							
Bikaner	Areas in Khajwala & Pugal Tehsil	1:50,000 1:10,000 1:2,000	200 30 10	-	-	27	New gypsum occurrences were located in about 10 sq km area and about 15 million tonnes of reserves were proved.
Jaisalmer	N/v Tadana	1:50,000 1:10,000 1:2,000	150 15 01	-	-	15	Potential horizons of gypsum are exposed 4.5 km north of Tadana village covering an area of about 0.50 sq km.
<b>LIMESTONE</b>							
<b>Chhattisgarh</b>							
Bastar	Bastar area	1:50,000 1:4,000	300 1.16	-	-	115	Deposits of high grade limestone demarcated around villages Chitapur and Devrapal. Ten lakh tonnes cement grade limestone were estimated.
Raipur	Deogaon- Kurra area	1:50,000 1:4,000	157 1.73	-	728.10	732	Total 17.98 million tonnes of cement blendable/beneficial grade limestone has been proved and about 68 million tonnes of cement grade limestone has been indicated in the area.
-do-	Kesla area	1:50,000 1:4,000	55 0.56	09	284.00	268	Total 17 million tonnes of limestone has been inferred.

(Contd.)

EXPLORATION & DEVELOPMENT

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>Karnataka</b> Gulbarga	Jewargi area	-	-	03	372	-	Three boreholes were drilled with 1:2,500 m grid.
<b>Rajasthan</b> Jaipur	N/v Meena- Ki-Dhani	1:4,000	10	-	-	82	Limestone hillock having LxW of 1100 m x 300-500 m is observed.
Jaipur and Alwar	N/v Karoi and Khation-Ki- Dhani	1:10,000 1:4,000	15 04	-	-	08	Limestone was reported from the tube well from 35 m to 55 m depth near N/v Karoi and Simatwata-Ki-Dhani spread over 500 x 200 m.
Jaisalmer	N/v Sam	1:50,000 1:10,000 1:2,000	100 15 04	-	-	15	Mapped areas shows occurrences of SMS & cement grade limestone.
Jhalawar	N/v Malanwasa, Chitwa, etc.	1:50,000 1:10,000 1:2,000	100 10 02	-	-	16	About 1.638 million tonnes limestone were estimated.
Jhunjhunu	N/v Modi, Mina-Ki-Dhani	1:50,000 1:10,000 1:4,000	150 16.50 01	-	-	32	Calc-silicate/limestone rocks were observed.
Jodhpur & Pali	N/v Murkasni- Jhak	1:5,000	11.61	42	1803.50	1160	A total of 76.8 million tonnes of geological resources of limestone were assessed.
Kota	N/v Lalahera, Mandap, Majra, etc.	1:50,000 1:10,000 1:2,000	150 10 01	-	-	21	About 3.43 million tonnes of resources of low grade to marginal cement grade limestone were inferred in the area.
Nagaur	N/v Harima	1:2,000	02	15	408	197	A total of about 48 million tonnes resources of cement grade limestone were assessed.
-do-	N/v Berathal	1:10,000 1:2,000	10 02	06	150	118	Tentative geological resources are placed at 10 million tonnes of chemical grade limestone.
Pali	N/v Kalab Kalan & Balupura	1:50,000 1:10,000	150	-	-	40	Limestone bands with 25 m width were observed from S-E of Kalab Kalan to Balupura in N-E in 7.50 km strike continuity.

(Contd.)

EXPLORATION & DEVELOPMENT

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>LIMESTONE &amp; DOLOMITE</b>							
<b>Karnataka</b>							
Tumkur	N/v Mellanhally	-	-	01	65.50	-	One borehole was drilled with 50 m grid and chemical analysis of 50 samples was under progress.
<b>Odisha</b>							
Sundergarh	N/v Badulpani, Karamtoli, etc.	1:25,000	105	-	-	-	Geological mapping could not reveal occurrence of limestone/dolomite.
-do-	N/v Lephripara and Surgura	1:25,000	150	-	-	33	Two dolomite occurrences located north of Lephripara and Surgura villages.
<b>MAGNESITE, SOAPSTONE, QUARTZ &amp; MASONRY STONE</b>							
<b>Rajasthan</b>							
Udaipur	N/v Prasad, Kharbar, etc.	1:50,000 1:10,000 1:4,000	200 20 01	-	-	10	Magnesite occurrence was reported N/v Prasad in form of thin veins.
<b>OCHRE</b>							
<b>Odisha</b>							
Koraput	N/v Maligan	-	-	-	-	-	One red ochre occurrence has been located near Maligan village having dimension of 30 m x 10 m.
<b>PYROPHYLLITE &amp; MASONRY STONE</b>							
<b>Rajasthan</b>							
Udaipur	N/v Gurli, Chandesara, etc.	1:50,000 1:10,000 1:4,000	200 20 01	-	-	-	Minor occurrences of pyrophyllite were observed. Masonry stone band was also mapped.
<b>QUARTZ &amp; FELSPAR</b>							
<b>Rajasthan</b>							
Pali	N/v Dholi, Dungari, Khenwal Kala	1:50,000 1:10,000 1:2,000	150 10 02	-	-	40	Quartz veins are mapped and they are found as intrusive in Kot, etc. felspathic schist.
Sirohi	Part of Sheoganj Tehsil	1:10,000 1:2,000	10 01	-	-	13	Pegmatites exposed near Chotila-Ki-Bagali comprise quartz, felspar with minor amount of tourmaline and other mafic minerals.

(Contd.)

EXPLORATION & DEVELOPMENT

Table - 9 (Concl.d.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>QUARTZITE</b>							
<b>Rajasthan</b> Jaipur	N/v Kharab	1:4,000	10	-	-	82	Massive quartzite, sericitic quartzite and brecciated ferruginous quartzite were observed.
<b>SILICA SAND, RED OCHRE, BARYTES &amp; SOAPSTONE</b>							
<b>Rajasthan</b> Dausa	N/v Girota, Sandhera, Ghumna, etc.	1:50,000 1:10,000	100 10	-	-	20	Silica sand and red ochre marked in the area and 35,250 tonnes of resources were estimated.
<b>SILICEOUS EARTH</b>							
<b>Rajasthan</b> Jaisalmer	N/v Kapuriya, Devra and Sajit	1:50,000 1:10,000 1:2,000	150 15 01	-	-	10	About 0.50 sq km area seems to be comprises of siliceous earth with thickness varies from 1.5 m to 3.0 m overlain by sand and bentonitic clay.
<b>Mineral Exploration Corporation Ltd</b>							
<b>PHOSPHORITE</b>							
<b>Rajasthan</b> Udaipur	Dhol-ki-Pati	-	-	-	-	-	Total 1501 nos of primary, check, trench/pit samples were analysed. In addition, 17 nos. of spectroscopic studies, 20 nos. of petrological studies, 18 nos. of mineralogical studies and 38 nos. specific gravity determination were carried out. Total 1.264 million tonnes of phosphorite resources with average grade of 8.76% P <sub>2</sub> O <sub>5</sub> was estimated under UNFC-332.
<b>Gujarat Mineral Development Corporation Ltd</b>							
<b>BALL CLAY &amp; SILICA SAND</b>							
<b>Gujarat</b> Bharuch	N/v Amod, Maljipura and Bhuri	-	-	-	-	-	Mapping, plans and location of boreholes.
<b>LIMESTONE</b>							
<b>Rajasthan State Mines &amp; Minerals Ltd</b> <b>ROCK PHOSPHATE</b>							
<b>Rajasthan</b> Udaipur	Jhamarkotra	-	-	-	-	-	Exploratory mining is being carried out in A-Extn and G-Block. Total 1.12 million tonnes of geological resources of rock phosphate were estimated under proved category.

## EXPLORATION &amp; DEVELOPMENT

**Table - 10 : Exploration for Granite and Other Dimension Stones  
by State Directorates in 2011-12**

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
<b>GRANITE</b>							
<b>Chhattisgarh</b>							
Bastar/Kanker	Charama, Kanker and Keshkal areas	1:50,000	965	-	-	68	Total 28 lakh cu m black granite has been estimated.
<b>Odisha</b>							
Sundergarh	N/v Tangargaon, Karamtoli and Deobahal	1:25,000	105	-	-	-	Granite occurrences suitable for decorative stone have been located.
<b>Rajasthan</b>							
Jalore	Areas in Bhinmal and Raniwara Teh.	1:10,000 1:2,000	10 03	-	-	68	Granite has been delineated for leasing and block mining.
<b>GRANITE GNEISS &amp; AMPHIBOLITE</b>							
<b>Rajasthan</b>							
Jaipur	Buchara block	1:4,000	10	-	-	82	Rocks are forming elevated land or mounds and are intruded by pegmatites.
<b>MARBLE</b>							
<b>Rajasthan</b>							
Jhunjhunu	N/v Sior & Nayagaon	1:50,000 1:10,000 1:4,000	150 16.50 01	-	-	32	Marble/calc-silicate were observed in 220 x 40-80 m and 420 x 20-80 m areas.
<b>MASONRY, GRAVEL &amp; BAJRI</b>							
<b>Rajasthan</b>							
Sirohi	Parts of Sheoganj Tehsil	1:10,000 1:2,000	10 01	-	-	13	Granite suitable for masonry stone, gravel and bajri suitable for construction were observed.
<b>ORNAMENTAL STONE</b>							
<b>Karnataka</b>							
Chikkaballapura	Bagepally	1:50,000	225	-	-	-	Exploration to be continued.
<b>SAND STONE</b>							
<b>Rajasthan</b>							
Dhaulpur	Titaua & Chilachond	1:50,000 1:10,000 1:3,600	105 15 01	-	-	19	Buff red, spotted red, light pink and off white coloured sandstone was marked at various places and 5.33 million tonnes resources were estimated.
Nagaur	N/v Nimbi Jodha	1:50,000 1:10,000	150 10	-	-	19	Massive and splittable sand stone deposits were observed in the area.