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(Part- I : GENERAL REVIEWS)

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EXPLORATION & DEVELOPMENT

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GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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GOVERNMENT'S POLICY

The National Mineral Policy, 2008 for non-fueland 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, a 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. The MMDR Bill, 2011 was introduced in Lok Sabha on 12.12.2011, which was referred to Standing Committee on Coal & Steel. The Committee submitted its 36th Report on the MMDR Bill on 07.05.2013.

Subsequently, the Mines and Minerals (Development and Regulation) Amendment Act, 2015 has been notified on 27th March, 2015 to amend the MMDR Act, 1957. The Amendment removes descretion in the grant of mineral concessions. Henceforth, all mineral concessions will be granted by the respective State Governments only through auctions, which will bring greater transparency and remove discretion in allocation of mineral resources. There would be no renewal of any mineral concession. The tenure of mineral concessions has been increased to 50 years compared to earlier provisions of 30 years. Thereafter, all mining lease would be put up for auction. Establishment of District Mineral Foundation in any district affected by mining related operations and National Mineral Exploration Trust for the purpose of regional and detailed exploration has also been incorporated in the Act.

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 2013-14.

In oil sector, ONGC, OIL and a few joint venture and private companies were engaged in exploration of onshore and offshore 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 2013-14, work related to updation of 100 multi-mineral leasehold maps with forest overlays on1:50,000 scale in respect of Andhra Pradesh and Bihar states were taken up. So far, scanning and georeferencing of 714 key plans and 108 toposheets have been completed. Forest overlays are prepared in collaboration with Forest Survey of India.

During 2013-14, IBM conducted 55 ore dressing investigations, chemical analysis in respect of 41,483 radicals, and 2,356 mineralogical studies and nine 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 and 1.4.2010 were updated. Updation of the NMI of mineral resources in respect of 25 selected minerals based on 1.4.2013 has been taken up.

GSI

GSI pursued its systematic geological mapping in 2013-14 and had completed 5,264 sq km large-scale mapping, 62.525 sq km detailed mapping and 68,037 m drilling as against preceding year's achievement of 4,917 sq km large-scale mapping, 45.43 sq km detailed mapping and 70,007 m drilling. Out of the total mappable areas of 3.14580 million sq km of the country, 3.09875 million sq km has been covered so far by systematic mapping bringing the total coverage to 98.50%.

Reserves Established

Reserves/resources established in the course of mineral exploration during 2013-14 are furnished below:

i) About 1,828 million tonnes resources of coal in various coalfields of Assam, Chhattisgarh, Madhya Pradesh, Odisha and West Bengal were estimated.

ii) Tentative reserves of 7.99 lakh tonnes of wollastonite were estimated in Ghoda-Bhameriya area, Banaskantha district, Gujarat.

iii) In Salaidih-Harwariya area, Sonbhadra district, Uttar Pradesh the possible tentative reserves of andalusite were estimated at 26.06 million tonnes.

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. Survey in the near-shore zones (0 m - 10 m isobaths) were carried out using hired small mechanical boats.

During 2013-14, a total of nineteen cruises were undertaken using four vessels.

The following marine geoscientific surveys were carried out during 2013-14 Field Season:

1. Six cruises aboard R.V. Ratnakar and R.V. Samudra Manthan within EEZ conducted the following:

R.V. Samudra Ratnakar

SR-001A(SR): Integrated Survey for High Resolution Seabed mapping in the Continental Shelf area off Netravathi River Mouth, Mangalore, Karnataka.

SR-002 (ER): Multichannel bathymetric mapping of part of Central Andaman Trough and study of

evolutionary history and possible locales of submarine hydrothermal mineralisation in the basin and surrounding areas.

SR-003 (ER): Multibeam bathymetric survey on the eastern extension of Sewell Rise and southern extension of West Andaman Fault.

RV Samudra Manthan

SM-230 (SR): Study of the physiography of the middle to lower part of Bengal fan belonging to the continental rise and abyssal plain region off Pudimadaka to Godavari, Andhra Pradesh coast using Multibeam bathymetric survey.

SM-231(ER): Multibeam bathymetric survey and magnetic profiling of sea bed in the Narcondam-Barren Basin, North Andaman sea.

SM-232 (SR): Magnetic survey within EEZ off Puri-Balasore, Odisha Coast.

2. Eight cruises aboard R.V.Samudra Kaustubh within the Territorial Waters (TW)EEZ off the East coast conducted:

ST-229 (SR): Study of the geophysical parameters (Seismic and Magnetic) of the seabed within territorial waters off Kakinada Coast, Andhra Pradesh.

ST-230 (SR): Placer mineral resource evaluation in the territorial waters off north of Bhimunipatnam, Andhra Pradesh.

ST-231 (ER): Placer mineral resource evaluation in the territorial waters off Palur-Malud, Odisha.

ST-232(ER): Seabed survey of continental region off West Bengal with an emphasis on sub seabed and faunal study to distinguish the sea level fluctuation.

ST-233(ER): Geotechnical appraisal off Satpara, Odisha.

ST-234 (ER): Parametric surveys off Rushikulya River Mouth, Odisha.

ST-235 (SR): Mapping of seabed in the TW and EEZ Southeast off Gopalapatnam, Tamil Nadu coast, Bay of Bengal.

ST-236 (SR): Mapping of seabed in the TW and EEZ north off Rameshwaram, Tamil Nadu coast.

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

SD-248 (SR): Study of the geophysical parameters (Seismic and Magnetic) of the seabed within territorial waters off Honavar, Karnataka.

SD-253 (SR): Preliminary evaluation of heavy mineral occurrence off Trivandrum-Attipara area, Kerala.

SD-254 (SR): Preliminary evaluation of sand resources off Cochin, Kerala.

SD-252 (SR): Geotechnical appraisal off Manjeshwaram, Kasargod, Kerala for the development of a harbour/minor port.

SD-251 (SR): Preliminary evaluation of Construction grade sand and associated placer minerals, if any, off Paravur, Kollam district, Kerala.

Airborne Survey

GSI pursued airborne geophysical survey for generating database by employing magnetic and gamma ray spectrometric techniques. The survey was followed by data processing, preparation of aerogeophysical maps and interpretations that help in ground evaluation and add information to geological maps and 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.

During 2013-14, aerogeophysical survey by the Twin Otter Aircraft (VT-ELX) was carried out in Venguria-Jamnagar area along the western offshore and also in Chandrapur-Brahmapuri area of Maharashtra. Multisensor aerogeophysical data have been acquired along total flights line of 38,308 line km in Vengurla-Jamnagar area and 14,072 line km in parts of Chandrapur-Brahmapuri area.

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 survey 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 and Karnataka), Hungund-Mudhol (Karnataka), Lalitpur (Uttar Pradesh), Mahoba-Panna (Uttar Pradesh and Madhya Pradesh), Nalgonda-Mahbubnagar (Andhra Pradesh), Bangalore-Penukonda (Karnataka and Andhra Pradesh), Mulbagal-Tambalpalle (Karnataka and Andhra Pradesh), Nagpur-Wardha valley area (Maharashtra), Baihar-Katru area (Madhya Pradesh and Chhattisgarh), Kanker area (Chhattisgarh), Mauranipur-Sarila area (Madhya Pradesh and Uttar Pradesh), Hosadurg-Vengurla area over Western offshore 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 2013-14 are given below:

i) The company has registered 346,553 m of drilling for various minerals, out of which 322,111 m was through departmental resources.

ii) A total of 165,998 m of geophysical logging was carried out.

iii) A total of 99 sq km of geological mapping was done for different minerals in various parts of the country.

iv) Inlaboratories, a total of 36,438 samples were analysed and 93,122 radicals were determined along with petrological and ore microscopic studies of 440 samples.

v) A total of 26 detailed geological reports for mineral exploration, geophysical survey, environmental & remote sensing studies were submitted.

vi) A total of 1,143 million tonnes of reserves were added to NMI. Mineral-wise details of reserves established by MECL during 2013-14 are:

• Coal - A total of 936 million tonnes of non-coking coal and coking coal in Mand-Raigarh Coalfield, Chhattisgarh; Jharia & South Karanpura Coalfields, Jharkhand; Godavari Valley Coalfield, Andhra Pradesh and Singrauli Coalfield, Madhya Pradesh were established.

• Lignite - 31 million tonnes of lignite reserves were established in Rajasthan.

• Limestone - 172 million tonnes of limestone reserves were established in Gulbarga, Karnataka.

• Copper - 4 million tonnes of copper ore reserves were established in Banera and Muradpur Central blocks, Rajasthan.

MINERAL-WISE EXPLORATION ACTIVITIES
PETROLEUM AND NATURAL GAS

The Government of India has formulated a New Exploration Licencing Policy (NELP) to accelerate and expand exploration of oil and gas in the country. A total of 254 blocks have been awarded so far in IX rounds of NELP. Exploration under NELP has shown positive results, in both inland and offshore areas. An Uniform Licencing Policy (ULP) subsuming NELP and CPM policy is proposed to enable E & P operators to explore and extract all hydrocarbon resources and 52 oil & gas exploration blocks to be offered under ULP in the Xth round of NELP.

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 onshore and offshore 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 offshore areas.

During 2013-14, ONGC acquired a total of 475 LK of 2D seismic data from inland. During the same period, 8,371 SK of 3D seismic data was also acquired which included 1,174 sq km inland and 7,197 sq km off-shore areas. ONGC's 106 exploratory wells comprised 68 wells to a total depth of 185.109 km in inland areas and 38 wells to a total depth of 135.656 km in offshore areas.

During 2013-14, ONGC reported 14 new hydrocarbons discoveries, namely, Seripalem-1, Geddanapalli-3 and Mandapeta South-1 in KG Onland; Gandhar-686, SB-300, and Nandasan-III in Western Onshore basin; Khubal-7 in AAFB Tripura basin; KGOSNO41NANL-2, KGOSN-041NANL-1 and KGD982 NA-M-3 KG Offshore basin and GK-289, GK-42-3, MBSO51NAA-1 and B-173A-8 in Western Offshore basin. As a result of these exploratory efforts, ONGC accreted 84.99 million tonnes reserves during 2013-14, leading to 2,849.04 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, Tecnho-Economic Evaluation etc.

During 2013-14, OIL carried out 105,111 m drilling in 34 wells in onshore areas of Assam.

Significant discoveries of oil/gas struck by OIL in Assam in India and Overseas during 2013-14 are as below:

i) The Well Sologuri 1 (Loc. DIBC) located in West Sologuri structure (Onshore) within Dibrugarh PEL in the Dibrugarh district, Assam was drilled down to a depth of 3,962 m within basement to probe the hydrocarbon prospects within Paleocene-Eocene formations. The well has encountered a few prospective sand ranges within Lakadong+Therria formation and is currently producing oil from one of the tested sands. The discovery of oil in this well has opened up new avenues for exploration and exploitation of hydrocarbon in Paleocene-Eocene formations in Sologuri area.

ii) The Well South Kathaloni 3 (Loc.HVX) located in South Kathaloni structure (Onshore) within Hugrijan ML in the Dibrugarh district, Assam was drilled down to 3,710 m within basement to probe the hydrocarbon prospects within Paleocene-Eocene formations. The well has encountered a few prospective sand ranges within Lakadong+Therria formation and is currently producing oil from one of the tested sands. The discovery of oil in this well has opened up new avenues for exploration and exploitation of hydrocarbon in Paleocene-Eocene formations in South Kathaloni area.

iii) The Well, Baruanagar 3 (Loc.BE) located in Baruanagar structure (Onshore) within Borhat PEL (now converted to Borhat ML) in the Dibrugarh district, Assam was drilled down to 4,375 m to probe the hydrocarbon prospects within Lakodong+Therria formation. The well has encountered a few prospective sand ranges within Lakadong+Therria formation. The discovery of oil in this well has opened up a new area for exploration and exploitation of oil in Baruanagar area.

(iv) The Well Naharkatiya 610 (Loc.HVJ) located in East Deohal structure (Onshore) within Hugrijan ML in the Tinsukia district, Assam was drilled down to 2,984 m to probe the hydrocarbon prospects within Barail Formation. The well has encountered prospective sand range within Barail Formation and is currently producing gas from the tested sands. The discovery of gas in this well has opened up new areas for exploration and exploitation of hydrocarbon in Barail Formation in East Deohal structure.

(v) The Well Naharkatiya 614 (Loc. NLE) located in the central part of Jaipur Structure (Onshore) within Naharkatiya Extension ML in Dibrugarh district, Assam was drilled down to a depth of 3,233 m to probe the hydrocarbon prospects within Barail and Tipam formations. The well has encountered a few prospective sand ranges within Tipam Formation and is currently producing oil from one of the tested sands. The discovery of oil in the Middle Tipam Formation has opened up a new reservoir for exploration and exploitation of oil in Jaipur area.

(vi) The Well Naharkatiya 405 (Loc. HDL-II) lies in the South Nagajan area of Greater Jorajan oil-field (Onshore) within Hugrijan ML in the Tinsukia district, Assam and has discovered gas on testing the new/unappraised Upper Tipam Sand during workover operations. The discovery of gas in this well has opened up a new reservoir for exploration and exploitation of gas in South Nagajan area.

(vii) The Well Lassa 1 (Loc. SC) located in Lassa structure of Shakthi Block, Gabon, South Africa was drilled to a depth of 2,141 m within basement to probe the hydrocarbon prospects within N'Dombo Formation. The well has encountered two hydrocarbon prospective sand ranges within the targeted formation and on testing produced oil along with some amount of gas. The oil discovery in the Shakthi Block, Gabon, within the N'Dombo Formation in well Lassa 1 marks Oil India Limited 's maiden success in overseas exploration venture as operator and open up areas for future exploration and exploitation within the block.

The physical achievements of exploration activities pursued for petroleum and natural gas during 2013-14 are given in Table - 1.

Table – 1 : Exploration for Petroleum & Natural Gas by ONGC and OIL, 2013-14

Agency/location/State	Seismic Survey		Drilling			
			Exploratory		Development	
	2D(GLKM)	3D(SQKM)	Wells (No)	Meterage (km)	Wells (No)	Meterage (km)
ONGC: Total	**475**	**8371**	**106**	**320.765**	**283**	**596.794**
Inland: Total	**475**	**1174**	**68**	**185.109**	**216**	**432.363**
Andhra Pradesh	–	53	7	22.232	12	35.982
Assam	77	7	7	41.556	24	89.292
Bihar	–	_	1	2.894	–	–
Gujarat	268	404	30	60.431	165	273.721
Madhya Pradesh	_	267	3	3.888	_	_
Mizoram	9	_	_	–	_	_
Rajasthan	–	95	–	–	_	_
Tamil Nadu	–	170	11	36.955	10	21.26
Tripura	65	38	7	12.684	5	12.108
Uttar Pradesh	_	–	1	1.955	–	–
West Bengal	55	141	1	2.514	_	_
Offshore: Total	–	**7197**	**38**	**135.656**	**67**	**164.431**
East Coast Offshore	–	2692	17	71.163	–	–
West Coast Offshore	_	4505	21	64.493	67	164.431
OIL : Total*	**499**	**928**	–	–	–	–
Inland: Total	**499**	**745**	–	_	–	_
Andhra Pradesh	266	131	_	–	_	–
Assam & Arunachal Pradesh	233	190	–	–	–	–
Mizoram	–	316	–	–	–	–
Rajasthan	–	108	–	–	–	–
Offshore: Total	–	**183**	–	–	–	–
Maharashtra	–	183	–	–	–	–

Figures rounded off.

** During 2013-14 , OIL carried out 1,05,111 m drilling in 34 wells in onshore areas of Assam.*

Reliance Industries Ltd (RIL)

RIL along with JV partners made two significant hydrocarbon discoveries in 2013-14, i.e. Discovery (D-55) in well MJ1 drilled in the block KG-D6 situated in the Krishna-Godavari basin and Discovery (D-56) in exploration block CY-D5 situated in the Cauvery basin.

DISCOVERY D-55 - Discovery in Development area of block KG-D6 (D1-D3 field): The KG-D6-MJ1 well was drilled in a water depth of 1,024 m, and to a total depth of 4,509 m, to explore the prospects of a Mesozoic Synrift Clastic reservoir, lying over 2,000 m below the already producing reservoirs in the D1-D3 gas fields. Formation evaluation indicates a gross gas and condensate column in the well of about 155 m in the Mesozoic reservoirs. In drill stem testing, the well flowed at 30.6 million standard cubic feet per day (MMSCFD) and 2,121 barrels of oil per Day (BOPD). The discovery, named 'D-55', has been notified to the Government of India.

DISCOVERY D-56- Discovery in block DY-D5: As part of the minimum work programme in this block, exploratory well CYIII-D5-S1 which was drilled in a water depth of 1,743 m, to a total depth of 5,731 m, with the primary objective of exploring Mesozoic-aged reservoirs has resulted in gas condensate discovery. The formation evaluation indicated a gross gas and condensate column in the well of about 143 m in the Mesozoic-aged reservoirs. In drill stem testing, the well flowed at 35.2 MMSCFD and 413 BOPD. The discovery, named 'D-56', has been notified to the Government of India. This is the second discovery in the block which will enable scope for integration of all discoveries for early monetisation.

COAL

The agencies engaged in exploration for coal during 2013-14 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, Bihar, Chhattisgarh, Madhya Pradesh, Maharashtra Odisha and West Bengal. An additional resources of 1,827.90 million tonnes of coal have been assessed from the data generated from regional exploration during 2013-14.

In Andhra Pradesh Regional exploration under G-2 stage continued at Bugga-Khammamtogu sector, Khammam district. The objectives were to explore and evaluate coal resource potentiality of Barakar coal seams already established in the Manuguru mining block. A total of 1,076.55 m was drilled in boreholes GBK- 4 to 6 of which 847 m were geophysically logged. An area of 0.75 sq km of the block was mapped on a scale of 1:10,000. Seven to nine Barakar coal /carbonaceous shale bands varying in thickness from 0.50 m to 4.80 m were intersected between 37.10 m and 516.35 m depths. Regional exploration under G-2 stage was continued at Pagaderu (west) sector, Khammam district in the dip side of Manuguru mining block and northeast of Bugga-Khammamtogu sector to establish the dip continuity of the Barakar and Lower Kamthi seams. A total of 1,230.30 m was drilled in four boreholes GPDW- 3 to 6 of which 654m was geophysically logged. 3.00 sq km area was mapped on 1:10,000 scale. Twenty seven Lower Kamthi coal /carbonaceous shale bands varying in thickness from 0.50 m to 3.70 m and eight Barakar coal / carbonaceous shale bands varying in thickness from 0.55 m to 1.70 m were intersected between 11.75 m and 447.28 m depths. Regional exploration under G-2 stage was initiated at Pagaderu (east) sector, Khammam district in the northern side of Manuguru mining block and adjacent to Pagaderu (west) sector to establish the dip continuity of the Barakar and Lower Kamthi seams. A total of 294.50 m has been drilled in borehole GPDE-1. Thin coal seams ranging in thickness from 0.50 m to 1.20 m were intersected from a depth of 14.45 m to 285.20 m. 100 sq km area has been mapped on a scale of 1:12,500 in Khairi Sector, northwestern part of Dorli-Bellampalli coal belt in the northwestern margin of Main basin of Godavari valley Coalfield, Adilabad district to examine the coal for delineating its extension below Deccan Trap cover and identifying Barakar coal seams in the northwestern side of Dorli mining block.

In Assam, Regional exploration under G-3 stage was taken up adjacent to Sukchar-Singrimari area of Dhubri district at the border of Assam and Meghalaya to explore the behaviour and the extension of Gondwana coal and their resource potentiality. A total of 346.45 m was drilled in two boreholes SK- 1 and 2. Exploration revealed 0.90 m thick coal seam occurring at a

depth of 109 m. Area map of the coalfield was also updated on a scale of 1:10,000 covering 3 sq km. The new project of Shalibhuin-Nakaigiri-Ujanggiri area, under the Dhubri district of Assam and West Garo Hills of Meghalaya is under abeyance due to adverse ground conditions. Area map of the coalfield was also updated on a scale of 1:10,000 covering 1.40 sq km.

In Bihar, taking up the exploration for coal for the first time in the reconstituted state under G-2 stage in Mirjagaon area, Bhagalpur district, to the north of already explored Hura North Extension shows encouraging results. A total of 798.25 m was drilled in two boreholes RBMG-1 and RBMG-2 during 2013-14. Eighteen Barakar coal seams varying in thickness from 0.40 m to 7.65 m were intersected between 109.75 m and 443.40 m depths in borehole RBMG-1 whereas eight Barakar coal seams varying in thickness from 0.90 m to 10.40 m (Seam No. XIV) were intersected between 172.10 m and 321.80 m depths in borehole RBMG-2. Strike continuity of the seams for about 2 km towards further north of Hura North Extension block and down-dip continuity of the seams for about 3 km in the south-eastern part of the block has been established.

In Chhattisgarh, Regional exploration under G-2 stage continued at Samarsingha block, Raigarh district. The objectives were to establish the development pattern and continuity of Barakar coal seams, already recorded in the Nawagaon block to the north, and Sithra-Kurekela area in the west, to assess the coal resource potentiality of the area and to generate baseline data for CBM exploration. A total of 2,768.20 m was drilled in seven boreholes MRSS-7 to 13 and 1,068.20 m was geophysically logged. An area of 6.00 sq km was mapped on a scale of 1:10,000. Twelve regional Barakar coal seams (I to X, XII & XIII in ascending order) and few local seams have been intersected between depths of 16.85 m and 624.77 m. Thickness of individual coal section varies from 0.59 m to 10.75 m. Seam IV is the thickest seam with cumulative thickness ranging from 5.50 to l0.75 m. The continuity of the coal seams have been established along dip direction towards south-west for about 5 km. Additional data was generated for the CBM exploration. Regional exploration under G-2 stage continued at Amlidhonda block, Raigarh district. The objectives were to establish the development pattern and continuity of Barakar coal seams, already recorded in the Gare block to the north, and Kesarchuan-Lamdand block in the east, to assess the coal resource potentiality of the area and to generate baseline data for CBM exploration. A total of 4,610.70 m was drilled in twelve boreholes, MRA- 5 to 16 and 1,786.08 m was geophysically logged during the field season 2013-14. Six regional Barakar coal seams (Seam III, IV, VI, VII, IX and X) varying in thickness from 1.30 m to 11.13 m and few local coal seams were intersected between 101.23 m and 425.04 m depths. Coal seams IX (2.85 m to 5.96 m) and combined coal seams VI+VII (4.91 m to 10.52 m) are important for their thickness and regional persistency. Continuity of the coal seams have been established for nearly 4 km along strike and 4 km in dip direction within the block. An area of 8.00 sq km was mapped on 1:10,000 scale. Additional data was generated for the CBM exploration. Promotional exploration under G-2 stage was continued at Vijaynagar-Giddhi block, Surguja district. The objectives were to establish the stratigraphy and structural disposition of Lower Gondwana sequences, continuity of Barakar Coal seams, coal resource potentiality of the area and to generate baseline data for CBM exploration. A total of 1,262.45 m was drilled in four boreholes TRVG- 9 to 12 and 1.00 sq km area was mapped on 1:10,000 scale. Ten regional Barakar coal seams (Seam II to VIII, XI to XIII) varying in cumulative thickness from 0.71 m to 17.00 m and few local coal seams were intersected between 18.00 m and 521,90 m depths. Seam No.III (cumulative thickness from 9.89 m to 17.00 m) and IV (10.79 m) are important for their thickness and regional persistency. Continuity of the coal seams has been established over 6.5 km along strike and l km in dip direction. Promotional exploration under G-2 stage has been initiated at Pipraul block, Surguja district. The objectives were to establish the stratigraphy and structural disposition of Lower Gondwana sequences, continuity of Barakar Coal seams, coal resource potentiality of the area and to generate baseline data for CBM exploration. A total of 1,565.20 m drilling was achieved in 4 boreholes; TRP-1 to 4, and 596.43 m was geophysically logged. An area of 2 sq km was mapped on 1:10,000 scale. Regional Barakar coal seams III Top (cumulative thickness

11.46 m), III Bottom (5.94 m), II (1.13 m), I (1.25 m) and two local coal seams with 1.65 m and 1,49 m thickness were intersected between 383.43 m and 548.54 m depths in borehole TRP-2.

In Madhya Pradesh, Regional exploration under G-3 stage continued at Sarai (west) sector, Singrauli district. The objectives were to establish the development pattern and resource potentiality of coal horizons in Raniganj and Barakar formations as intersected in adjacent Hatta-Dudhmaniya and Sarai (east) area, stratigraphy and structural framework of the area and to generate baseline data for CBM exploration. Total drilling in the area for 2013-14 is 2,539.65 m in six boreholes, SSW-4 to 9. Large-Scale Mapping on a scale of 1:10,000 was completed for 5 sq km area and 1,131 m was geophysically logged. Three regional Raniganj coal seams / zones R-I to R-III (in ascending order) have been intersected in the depth range from 33.85 m to 229.80 m. The individual thickness of Raniganj coal seam varies from 0.50 m to 1.96 m. Seven regional Barakar coal seams / zones I to VII (in ascending order) have been intersected in the depth range from 263 to 585.81m. The thickness of individual coal seams vary from 0.50 m to 3.50 m. Seam No. IV (cumulative thickness 3.41 m) and III (3.50 m) are important for their thickness and regional persistency. Promotional exploration under G-2 stage continued at Malka block, Shahdol district. The objectives were to establish the development pattern and resource potentiality of coal horizons in Raniganj and Barakar formations as intersected in adjacent Chainpa, Maiki and Maiki (North) blocks and structural set up of the area. A total of 1,800.50 m was drilled in four boreholes namely, SMLK-1 to 4 and 630 m was geophysical logged. An area of 5 sq km area was mapped on 1:10.000 scale. Coal seams of both Raniganj and Barakar formations were intersected at Malka block. Five regional Barakar coal seams namely, I, II, III, IV and V (in ascending order), have been intersected within a depth range from 380.95 m to 558.50 m with cumulative coal thickness of individual seam ranging from 0.60 m to 5.67 m. Seam III is the thickest seam. Raniganj coal seams, ranging in thickness from 0.55 m to 4.70 m, are interbanded in nature and were intersected between the depth range of 12.95 m and 223.05 m. Continuity of the coal seam has been established along dip and strike directions for about 3 km and 7.5 km, respectively. Promotional exploration under G-2 stage continued at Bihar block, Shahdol district. The objectives were to establish the development pattern of superior grade Barakar coal seams at shallow depth as intersected in adjacent Devanitola and Pachri blocks, structural set up of the area and evaluate the coal resources. A total of 3,042.25 m was drilled in ten boreholes SBR- 1 to 10 and 2,169.65 m was geophysically logged. An area of 6 sq km area was also mapped on 1:10,000 scale. Four regional Barakar coal seams (Seam No. I to IV in ascending order) varying in cumulative thickness from 0.50 m to 9.20 m and few local coal seams were intersected between 109.40 m and 338.65 m depths. Seam No III with cumulative thickness from 8.06 m to 9.20 m, is important for thickness and regional persistency. Continuity of the coal seam has been established for over 6 km in strike and over 2 km in dip direction within the block. Regional exploration under G-3 stage was continued at trap covered area of Bhurkumdhana sector in Chhindwara district. The objectives were to establish the dip continuity of Barakar coal seams, already recorded in the Payalidhana sector to the south, under favourable structural set up and to assess the coal resource potentiality of the area. A total of 1315.30 m drilling in four boreholes PBK- 1 and 3 to 5 was achieved during the 2013-14 excluding the redrilling in one borehole. An area of 3.00 sq km area was mapped on a scale of 1:12,500. Four regional Barakar coal seams (I to IV in ascending order) have been intersected in PBK-3 within the depth range from 379.85 m to 418.70 m. The cumulative thickness of coal is 13.50 m. Regional exploration under G-3 stage was proposed at trap-covered area of Dhorakuhi sector in Chhindwara district as a successor item of Bhurkumdhana sector. The objectives were to establish the dip continuity of Barakar coal seams, already recorded in the Payalidhana sector to the southwest, under favourable structural set up and to assess the coal resource potentiality of the area. However, due to slow drilling progress in Bhurkumdhana sector, drilling could not be initiated during the 2013-14. An area of 6.00 sq km has been mapped on a scale of 1:12,500.

In Maharashtra, exploration under G-4 stage continued at the Trap-covered area of Jhamkola, southwest of Parsoda-Ghonsa coal belt in Yavatmal district. However, drilling was proposed to be outsourced during 2013-14. The objectives were to establish the occurrence of Barakar coal seams and to assess the coal resource potentiality of the area. During the period 154.80 m was drilled in one borehole WJ-3 in Jhamkola with in-house drill machine and the borehole was abandoned within Motur Formation. The borehole WJ-4 outsourced to M/s. APC Drilling & Construction Company, Namakkal, commenced on 22.03.2013 and progressed up to 66.00 m in Deccan Trap. Large-Scale Mapping covering an area of 5 sq km was carried out on 1:12,500 scale. Regional exploration under G-3 stage was proposed at the Trap-covered area of Dabhadi sector, northwest of Khadakdoh-Chichghat coal belt in Yavatmal district as a successor item of Jhamkola with outsourced drilling. The objectives were to establish the occurrence of Barakar coal seams and to assess the coal resource potentiality of the area. However, no drilling has been done during the field season. An area of 16.00 sq km of the coalfield was also updated on a scale of 1:12,500.

In Odisha, promotional exploration under G-4 stage in Chadchadi block, Sambalpur and Deogarh districts continued to explore continuity of the regional coal seams of Barakar and Karharbari formations already intersected in the Nuagaon North area towards north, and to appraise the coal resource potentiality of the area. A total of 330.80 m was drilled and 656 m of geophysical logging has been done in borehole TCD-1 during the field season. One coal seam of 4.17 m thickness was intersected between 577.17 m and 581.34 m depth. A total of 1.50 sq km area was mapped on a scale of 1:10,000. However, the item was abandoned prematurely due to overlapping with CBM leasehold area and exploration activity was shifted to Kantaikoliya block. Promotional exploration under G-3 stage was initiated at Kantaikoliya block, Angul district on 13.11.2013 to explore the strike continuity of the regional coal seam zones of Barakar and Karharbari formations, already established in the central part of Talcher Coalfield, identification of suitable blocks for regional exploration and to appraise the coal resource potentiality of the area. A total of 682.20 m of drilling has been completed so far in two boreholes TKK-1 and TKK-2. The thickest seam recorded from the Kantaikoliya block is of 5.23 m at a depth of 146.24 m and thinner seams are confined to depths between 61.35 m and 254.61 m. Preliminary exploration for coal by scout drilling under G-4 stage was proposed in north-eastern extension of Nuagaon North block, Angul district to explore continuity of the regional coal seam zones of Barakar Formation already explored in Nuagaon North area and Sarapal-Nuapara block and to appraise the coal resource potentiality of the area. A total of 2 sq km area has been mapped on a scale of 1: 10,000. However, the item was abandoned due to overlapping with CBM leasehold area. Promotional exploration under G-2 stage continued at Grindola block, Jharsuguda district with the objectives to establish the continuity of Raniganj and Barakar coal seams of Kuraloi (A) North block, stratigraphy and structural set up of the area and resource potentiality. A total of 2,203.30 m drilling was done in five boreholes, IBGD- 3 to 7 during the period. Four regional Raniganj coal seam zones, R-I to R-IV, varying in cumulative thickness from 1,22 m to 22.05 m were intersected within a depth range of 36.33 m to 204.80 m. Four regional Barakar seam zones Rampur, Lajkura,Parkhani and Belpahar in ascending order were intersected between 231.00 m and 794.14 m depths. Thickness of Barakar seam zones vary from 12.52 m to 62.89 m, thickest being Lajkura in borehole IBGD-5. Promotional exploration under G-2 stage in Bandbahal block in Jharsuguda district was continued during 2013-14, with the objectives to establish the continuity of regional Barakar and Raniganj seams along with establishing the structural set-up of the area. A total of 2,260.20 m was drilled in five boreholes IBBA- 1 to 4 and 1,603 m was geophysically logged. An area 4.00 sq km has been mapped on a scale of 1:10,000. Four regional Raniganj coal seam zones, R-I to R-IV, varying in cumulative thickness from 1.57 m to 19.01 m were intersected within a depth range of 82.59 m to 242.95 m. Four regional Barakar seam zones Rampur, Lajkura, Parkhani and Belpahar in ascending order were intersected between 243.89 m and 797.61 m depths. Thickness of Barakar seam zones vary from 3.79 m to 67.69 m, thickest being Lajkura in borehole IBBA-1. A reduction in thickness of Rampur seam zone in this part of the coalfield is conspicuous. Promotional

exploration under G-2 stage in Bartap block in Jharsuguda district was taken up as a successor item of Grindola block during the 2013-14, with the objectives to establish the continuity of regional Barakar and Raniganj seams along with establishing the structural set-up of the area. An area of 2 sq km has been mapped on a scale of 1:10,000. However, due to extension of time frame of Grindola block, drilling in Bartap block could not be initiated during the field season. Bioturbation within Raniganj Formation has been noted in Ib River coalfield.

In West Bengal, promotional exploration under G-2 stage was initiated at Kamalpur block, Barddhaman district with the objectives to establish the development pattern and structural disposition of Raniganj seams under Panchet cover, strike continuity of coal horizons intersected in adjacent Bishtupur-Dandeshwar block, resource potentiality and preliminary assessment of CBM potentiality of the area. A total of 1,303.35 m was drilled in two boreholes RKP-1 and RKP-2 and 1,303.00 m was geophysically logged. 4.00 sq km area was mapped on a scale of 1:10,000. Thin coal seams of Raniganj Formation varying in thickness from 1.00 m to 1.70 m were intersected between 458.00 m to 646.40 m depth. The item was abandoned prematurely on 11.01.2014 due to overlapping with CBM leasehold area. Gaurangapur-Bankati block has been taken up as an alternative item. Promotional exploration under G-4 stage was initiated at Gaurangapur-Bankati block, Barddhaman district on 17.01.2014 with the objectives to establish eastward continuity of the regional coal seams of Raniganj Formation, already established in the Bishtupur-Dandeswar Sector and to demarcate suitable blocks for follow up regional exploration for coal under G2 Stage in the eastern part of Raniganj Coalfield. A total of 833.10 m was drilled in two boreholes RGB-1 and RGB-2. Seven thin coal seams/bands with thickness varying from 0.50 m to 1.78 m were intersected between 275.35 m and 316.00 m depths in borehole RGB-1 whereas nine thin coal seams/ bands with thickness varying from 0.40 m to 1.80 m were intersected between 249.05 m and 417.17 m depth in borehole RGB-2. Needle Shale of Talcher Formation, Ajoy River section, Raniganj Coalfield has been noted.Regional exploration under G-2 stage continued at Gazipur West block, Birbhum district to examine the extent of coal-bearing Barakar and other Gondwana formations below the Tertiary and Rajmahal Trap cover and to appraise the coal and lignite seam development, if any. A total of 1,325.30 m drilling was done in three boreholes BGZW- 2 to 4 and 556.60 m geophysical logging. Six sq km area was mapped on a scale of 1:10,000. Three regional coal seams, zones IV, III and II of Barakar Formation with cumulative thickness 4.82 m, 13.12 m and 1.91 m, respectively were intersected in between 599.43 m and 720.57 m depth. Tests for baseline data generation for CBM were conducted. Regional exploration under G-3 stage continued in Heruka sector in Birbhum district, south of already explored Dhobbanpur sector, to establish the continuity and development pattern of coal-bearing Barakar Formation below the Tertiary rocks. A total of 2,142.10 m drilling was done in five boreholes BHK-4 to 8 and 1,481m geophysically logged. An area of 6.00 sq km was mapped on a scale of 1:10,000. Thin seams/bands in-between the depths of 392.06 m and 471.94 m with a maximum thickness of 0.97 m was intersected in one borehole. Tests for baseline data generation for CBM were conducted. Regional exploration under G-4 stage has been initiated on 12.03.2014 in Djhara sector in Birbhum district, south of Gazipur (west) block and east of Heruka Sector, to establish continuity of coal-bearing Barakar Formation below the cover of Tertiary sedimentaries, to examine the development pattern of coal and lignite seams and generation of baseline data related to CBM. About 336.10 m has been drilled in this sector in borehole BDJ-1. Columnar joints within Rajmahal Trap is one of the notable features in Birbhum coalfield.

Additional resources estimated by GSI in various coalfields during 2013-14 are furnished in Table-2.

Table – 2 : Additional Resources Estimated by GSI in Various Coalfields, 2013-14

(In million tonnes)

State/Coalfield/Block	Additional resources
Assam	
(A) Singrimari Coalfield	
(i) Sukchar - Singrimari area	1.34
Chhattisgarh	
(A) Mand-Raigarh Coalfield	
(i) Teram Block	265.87
Madhya Pradesh	
(A) Sohagpur Coalfield	
(i) Pachri Block	163.56
Odisha	
(A) Talcher Coalfield	
(i) Nuagaon North Area	919.91
(B) Ib River Coalfied	
(i) Khariaparha Block	442.70
West Bengal	
(A) Raniganj Coalfield	
(i) South of Hingla River	34.52
Total	**1827.90**

CMPDI

CMPDI continued its coal exploration activities in 2013-14, 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 120 to 140 drills were deployed in 2013-14, out of which 57 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, eight other contractual agencies have also deployed resources for detailed drilling/exploration in CIL/Non-CIL blocks.

In 2013-14, CMPDI and its contractual agencies took up exploratory drilling in 100 blocks/mines spread over 22 coalfields in six states. These coalfields with no. of blocks/mines are: Raniganj (6), Bajora (1), Brahmani (1), Rajmahal (3), Jharia (3), West Bokaro (2), Ramgarh (2), South Karanpura (5), North Karanpura (7), Kamptee (8), Nand-Bander (2), Wardha Valley (5), Singrauli (4), Sohagpur (11), Mand Raigarh (11), Tatapani-Ramkola (4), Korba (6), Bisrampur (2), Talcher (10), Ib Valley (6) and Sonhat (1). Out of 100 blocks/mines, 26 were Non-CIL/Captive blocks and 74 CIL blocks/mines. Departmental drills of CMPDI took up exploratory drilling in 53 blocks/mines, whereas contractual agencies drilled in 47 blocks/mines.

A total of 6.97 lakh m of exploratory drilling was carried out by CMPDI in 2013-14 through departmental resources (3.25 lakh m) and outsourcing (3.71 lakh m) to State Governments/ MECL/Tendering (CIL/Non-CIL blocks). Details of exploratory drilling carried out by CMPDI in 2013-14 are given in Table - 3.

Table - 3 : Exploratory Drilling by CMPDI (Departmental and Outsourcing) in 2013-14

Sl. No.	Agency	Target (m)	Exploratory drilling achieved (m)	Achieved (%)
1.	Departmental	285,000	325,362	114
2.	Outsourcing			
	i) State Govts.	9,000	5,942	66
	ii) MECL (MoU)	185,000	1,71,006	92
	iii) Tendering (CIL Blocks)	242,000	156,359	65
	iv) Tendering (Non-CIL Blocks)	179,000	38,171	21
	Total	**9,00000**	**696,840**	**77%**

Singareni Collieries Company Ltd (SCCL)

During 2013-14, the total production of coal from SCCL mines was at 50.47 million tonnes. The total proved geological reserves of coal in Godavari Valley Coalfield are placed at 10,073.54 million tonnes as on 1.4.2014.

State Directorates

The details of exploration for coal carried out by the State Directorates of Geology & Mining during 2013-14 are given in Table-4.

LIGNITE

GSI, MECL,State Directorates of Gujarat & Rajasthan, GMDC and NLC conducted investigation for lignite during 2013-14.

GSI

GSI continued exploration for lignite in the East Coast lignite fields of Tamil Nadu, at the Tertiary sequence in Palana and Nagaur basins, Rajasthan and also within Tertiary sediments in Birbhum & Bardhaman districts, West Bengal 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, promotional exploration under G-3 stage continued at Uttarkosamangai sector, Ramnad sub-basin, Ramanathapuram district to delineate lignite-bearing areas and to assess the resource potentiality. A total of 3,817.55 m was drilled in twelve boreholes RUL- 13 to 24. Geophysical logging of 3,240 m was conducted to demarcate the lignite zones. Three lignite seams varying in cumulative thickness from 5.00 m to 24.30 m were intersected between 175 m to 405 m depths within Neyveli Formation. The strike continuity of about 7 km and dip continuity of about 6.5 km has so far been established.

In Rajasthan, promotional exploration under G-4 stage continued at Kharicharan area, Palana basin, Jaisalmer and Bikaner districts to locate lignite-bearing blocks, stratigraphic set-up of the area and preliminary assessment of resource. A total of 653.50 m drilling has been done in seven boreholes RPKS-10 to 16 without intersecting any lignite seam. Promotional exploration under G-4 stage was also initiated at Panna sector, Palana basin, Jaisalmer and Bikaner districts to locate lignite-bearing blocks, stratigraphic set-up of the area and preliminary assessment of resource. A total of 2,124.50 m was drilled in ten boreholes RPP- 1 to 10 and 1,256.80 m was geophysically logged to ascertain the presence of lignite zones. The maximum thickness of lignite seam intersected is of 1m at 83 m depth along with thinner bands of about 0.10 m to 0.80 m thickness within a depth of 83 m to 118.35 m.

In West Bengal, preliminary exploration under G-4 stage by scout drilling was initiated at Krishnanagar area, Birbhum district for assessing the resource potentiality of lignite within Tertiary sediments and to delineate stratigraphy and structural framework of the area. Exploration in Krishnanagar area does not yield any lignite seam although very thin coal bands of a maximum thickness 0.45 m were intersected in between the depths of 14.90 m and 26.90 m with a total drilling of 179.80 m in four boreholes RKN 1 to 4. An area of 40 sq km was mapped on a scale of 1:25,000. Promotional exploration under G-4 stage continued at Adharsuli sector, Bardhaman district to search for the development of lignite within Tertiary sediments and to establish resource potentiality. Adharshuli Block was taken up based on sporadic intersection of lignite in earlier explored blocks in the surrounding area. During 2013-14 a total of 740.90 m has been drilled in four boreholes RAS 6 to 9. However, no lignite seam has been intersected.

STATE DIRECTORATES/GMDC/NLC

Particulars of exploration for lignite as carried out by these agencies are given in Table-5.

NON-FERROUS METALS

BASE METALS

GSI and HZL conducted investigations for copper, lead and zinc ores in different parts of the country during 2013-14.

GSI

The details of exploration activities carried out by GSI during 2013-14 are given in Table-6.

HZL

During the year, greenfield exploration was carried out over 392 sq km in a Reconnaissance Permit (RP) in Rajasthan and based on the review of geological data and project generation studies, 3 new RPs (6,291sq km) and one Prospecting Licence (PL) (25 sq km) were applied in Karnataka, Madhya Pradesh and Rajasthan. A total of 125,643 m core drilling was completed at various exploration sites throughout the mines and tenements. A borehole of 1,774 m was drilled at Rajpura-Dariba, which is the deepest ever at any base metal exploration site in India. The total reserves and resources at 31st March 2014 were 365.1 million tonnes containing 35.2 million tonnes of zinc-lead metal and 926 million ounces of silver.

Table – 4 : Exploration for Coal by State Directorates of Geology & Mining, 2013-14

State/ District	Location	Geological mapping		Drilling		Remarks
		Area (sq km)	Scale	Boreholes	Meterage	
Assam						
Karbi Anglong	Sapra Teron Gaon, Laldera Nepali Basti	2.6	1:25,000	04	168	One coal seam is encountered in an average depth of 13.5 m to 15 m with a thickness varying from 1.5 m to 4.5 m. Total 0.33 million tonnes of coal resources were estimated.
Chhattisgarh						
Surguja	Saidu area	160 2.24	1:50,000 1;4,000	01	872.05	Total 65.57 m coal core and 35 rock sampling were carried out. Coal resources were estimated at 105.20 lakh tonnes under 332 category.
-do-	Ghutaro-Birjupali area	125 0.50	1:50,000 1;4,000	- -	- -	Only survey work has been carried out alongwith 28 nos. of sampling. Resources were not estimated.
Jammu & Kashmir						
Rajouri	Mahogla	0.1	1:1,000	-	16	Total fifty nos. pitting/trenching have been carried out.
Maharashtra						
Chandrapur	Nandori area	-	-	-	3,577.44	Middle workable composite coal seam ranges in thickness from 10 m to 18.60 m upto a depth of 378.15 m. So far 194.83 million tonnes coal estimated.
-do-	Wilson Block	-	-	-	1,480.50	Workable composite coal seam ranges in thickness from 11 m to 18 m within depth ranges from 174 m to 342 m. So far 59.99 million tonnes coal were estimated.
-do-	Chalbardi area	-	-	-	1,553	So far 4.17 million tonnes coal reserves proved from the area.
Nagpur	Dawa Phukeshwa	-	-	-	1,849	Exploration work indicates five seams ranging in thickness from 1.30 m to 3.65 m at 30.420 m depth. So far 10.531 million tonnes coal were estimated.
-do-	Nand-Panjrepar area	-	-	-	7,042	Six coal seams ranging from 0.30 m to 5.82 m thickness were established. The depth range is from 50.25 m to 435.60 m. So far 31.97 million tonnes coal were estimated.
Yavatmal	Adkoli Khadakdoh area	-	-	-	1,894	One coal seam ranging in thickness from 4.81 m to 9.65 m within depth range of 143 m to 250 m was established. So far 5.49 million tonnes coal was established.
-do-	Ashtona Kothurna area	-	-	-	1,282.75	Total two workable coal seams with thickness of 1.84 - 4.25 m and 0.4-7.75 m were intersected within a depth range of 139.69m to 237 m. So far 1.87 million tonnes coal were estimated.

Table–5: Exploration for Lignite by DGMs & Central/State Undertakings, 2013-14

Agency/State/ District/Location	Mapping		Drilling		Sampling (No.)	Result
	Area (sq km)	Scale	No. of boreholes	Meterage		
DGM, Gujarat						
Bharuch						
Tq. Valiya	-	-	16	5,768.5	-	Lignite is found to occur in lower Eocene age and area under study is 164 sq km.
DMG, Rajasthan						
Bikaner						
N/v Kenya-ki-Basti and Diyatra	-	-	25	4,314.5	194	Geological reserves of 15.40 million tonnes of lignite have been computed.
N/v Ambasar, Barsinghsar and Hadla	-	-	02	349	-	Lignite is not encountered in two drilled boreholes.
GMDC, Gujarat						
Kachchh						
N/v Panandhro	-	-	-	-	-	Balance reserves of lignite at the end of March 2014 was 4.18 million tonnes.
NLC						
Tamil Nadu						
Thanjavur & Nagapattinam Kallalangudi block	-	-	42	13,600	179	It is inferred that this block has got substantial lignite resources.
Cuddalore East of Sethiathope block	-	-	35	14,569	169	It is inferred that the block has got substantial lignite resources.
Vayalamur block	-	-	04	1,862	09	Lignite has been encountered in two boreholes.
Rajasthan						
Barmer						
Baytu block	-	-	18	7,214.70	14	Work was in progress.
Bhurtiya block	-	-	45	15,014.90	221	
Matasar Tala block	-	-	05	2,902	12	
Nagaur						
Phalodi, Gangardi & Ucharda blocks	-	-	23	5,008.90	94	Work was in progress.
Deswal block	-	-	04	866.30	01	
Jaisalmer						
Aslai-Soda	-	-	04	356	-	Work was completed.

Table - 6 : Exploration for Base Metals by GSI, 2013-14

State/District	Name of block	Details of exploration	Results
Haryana			
COPPER			
Mahendragarh	Jagreet-ki-Dhani	Mapping, pitting, sampling, drilling and analysis	Reconnaissance stage investigation (G-4) was carried out to assess the potentiality of copper mineralisation in depth as well as strike extension in alluvial-covered area. Detailed Mapping (DM) of 1.50 sq km area has been carried out on 1:2,000 scale. Total eighty SS and 50 PTS were collected. A total of 422.75 m drilling has been carried out in three boreholes JDBH-1 to JDBH-3. Sulphide mineralisation in the form of pyrite, pyrrhotite, chalcopyrite and bornite is observed along fracture/ foliation planes in caclareous quartz-biotite schist from 41 m to 55 m in JDBH-1, 62 m to 88.70 m in JDBH-2 and 27 m to 51.20 m in JDBH-3. Analytical results of 50 soil samples indicate Cu values from 15 ppm to 41 ppm, Pb 12 ppm to 27 ppm and Zn 20 ppm to 98 ppm. 14 pit samples indicate range of values for Cu 12 ppm to 35 ppm, Pb 15ppm to 42 ppm and Zn ppm 31 to 145 ppm. Total REE values ranging from 57.6 ppm to 262.2 ppm has been recorded from soil and pit samples.
Maharashtra			
BASE METAL			
Chandrapur	Bamni area	Mapping, geophysical survey and sampling	Reconnaissance stage investigation (G-4) for basemetal was carried out for establishing basemetal and associated gold mineralisation. The work carried out includes 50 sq km of Large Scale Mapping (LSM) on 1:12,500 scale, ground geophysical survey (magnetic, SP & IP) and sampling. LSM reveals that the major part of the investigation area is covered by quartzo-feldspathic biotite gneiss, known as Amgaon Gneiss, where the rocks of Sukma Group (quartzite and BMQ) occur as older supracrustals within the basement gneiss. NW-SE-trending quartz reefs developed along the shear zone within the basement gneisses are hosting the basemetal mineralisation. A quartz reef trending NW-SE is exposed in the Denwari area for about 1.5 km strike length and the width varies from 5 m to 25 m. Another quartz reef located near Minjhari area is continuously exposed for about 2 km with width ranging from 5 m to 20 m and trending along N-S to NW-SE. Major ore minerals noticed in the quartz reef are pyrite, galena, sphalerite and chalcopyrite occurring in the form of veinlets, specks and fine dissemination. Partially received analytical results of samples (BRS+PTS+SS) collected from quartz reefs of Minjhari area show Cu value ranging from 30 ppm to 2,000 ppm; Pb varies from 10 ppm to 750 ppm; Zn varies from 15 ppm to 750 ppm and Au varies from 50 ppb to 150 ppb. Based on the analytical results (BRS, PTS and soil samples) two potential zones of copper mineralisation were identified in the Minjhari area.

(Contd.)

Table - 6 (Contd.)

State/District/	Name of block	Details of exploration	Results
Rajasthan			
BASE METAL			
Ajmer	Chandlyawas	Mapping, sampling and analysis	Reconnaissance stage investigation (G-4) for identification of target areas for basemetal exploration was carried out to trace the north-eastern extension of Kayad basemetal deposit. LSM (1: 10,000) of 47.5 sq km area along with collection of 187 BRS/SSS has been accomplished. The area exposes rocks belonging to the Delhi Supergroup comprising quartz-mica schist, calc-silicate rock, quartzite, amphibolite and very thin lenticular bodies of carbonaceous schist. Quartz-mica schist is the host rock for sulphide mineralisation. Surface indications of mineralisation include malachite staining and fresh sulphides in dug well samples. Analytical results of 21 BRS show 10 ppm to 0.62% Zn, 10 ppm to 110 ppm Cu and < 25 to 180 ppm Pb.
COPPER			
Alwar	Khera block, Mundiyawas-Khera area	Drilling	Prospecting stage investigation (G-3) was carried out to evaluate the depth potential of copper and precious metal mineralisation. During 2012-13, six boreholes had been drilled and all the boreholes intersected sulphide mineralisation in the form of disseminations, streaks, stringers, veinlets and fracture fillings of chalcopyrite, pyrrhotite, pyrite and rare specks of bornite and covellite within quartz and carbonate veins. During 2013-14, a total of 308.55 m drilling was carried out in three boreholes KBH-11 to KBH-13. The borehole KBH-11 intersected sulphide mineralisation from 44.55 m to 78.65 m depth. The sulphide mineralisation is present in the form of foliation-parallel fine disseminations of arsenopyrite and fracture and vein-filled coarse-grained chalcopyrite with minor pyrrhotite. The borehole KBH-12 intersected sulphide mineralisation in the form of occasional specks, stringers and fracture-filled pyrrhotite, chalcopyrite and arsenopyrite from 6 m to 100 m depth. The borehole KBH-13 intersected sulphide mineralisation in the form of specks, fracture and vein-filled pyrrhotite with minor chalcopyrite and arsenopyrite from 6 m depth onwards.

(Contd.)

Table - 6 (Contd.)

State/District/	Name of block	Details of exploration	Results
COPPER			
Alwar	Khera SE block, Mundiyawas-Khera area	Drilling	Reconnaissance stage investigation (G-4) was carried out for copper and associated precious metals to evaluate the subsurface potential of Cu and precious metal mineralisation. The rock types exposed in the Khera SE block are interbanded sequence of felsic volcanic rocks (lithic tuff), meta-greywacke, quartzite, phyllite, carbon phyllite and tremolite-bearing dolomitic marble of the Thanagazi Formation of the Ajabgarh Group of the Delhi Supergroup. A total of 392.20 m drilling has been carried out in three boreholes KEBH-1 to KEBH-3. The borehole KEBH-1 has intersected sulphides in the form of chalcopyrite, arsenopyrite and pyrrhotite, besides native copper, bornite and covellite from 67.20 m to 87.85 m depth within dolomitic marble. The borehole KEBH-2 has intersected phyllite and dolomitic marble with specks of pyrrhotite and chalcopyrite between 61 m and 65 m, 92.70 m and 95.80 m, 114 m and 117 m and 122 m to 127 m depths. The borehole KEBH-3 has intersected occasional specks; occasional disseminations, stringers, vein-filled and fracture-filled chalcopyrite, pyrrhotite and arsenopyrite from 70 m to 106.65 m depth in dolomitic marble intercalated with thin quartzite bands.
-do-	Mundiyawas block, Mundiyawas-Khera area	Aerial reconnaissance/ PGRS/mapping and sampling	Reconnaissance stage investigation (G-4) for basemetal was carried out for copper and associated precious metals to evaluate the potentiality of Cu and precious metal mineralisation. Aerial reconnaissance and PGRS (1: 25/50,000) of 50 sq km and DM (1: 2,000) of 1.8 sq km area along with collection of 135 BRS/PTS/SS and 10 channel samples have been accomplished. The study area exposes the rocks of Thanagazi Formation of Ajabgarh Group of Delhi Supergroup. The main rock types observed are mica schist, quartzite, carbon phyllite, felsic volcanics, dolomite and amphibole-bearing dolomite with some intrusive quartz and calcite veins. Mineralisation is manifested by malachite stains and presence of rare specks and disseminations of chalcopyrite and arsenopyrite within dolomite observed on the western side of Bal-ki-Dhani, north of Mundiyawas-ki-Dhani. Profuse malachite staining is observed in tremolite-bearing dolomite on north-west of Mundiyawas-ki-Dhani. Investigation has been completed.

(Contd.)

Table - 6 (Contd.)

State/District/	Name of block	Details of exploration	Results
BASE METAL			
Bhilwara	Kundiyan-Parmeshwarpura and Dhamna-Devariya block	Mapping and sampling	Reconnaissance stage investigation (G-4) for basemetal was carried out to assess the basemetal potentiality for future probing. LSM on 1: 12,500 scale over an area of 40 sq km along with collection of 30 BRS/PTS/SS has been accomplished. The different lithologies observed in the area are amphibolites, schist, calc-silicate, quartzite and metabasic rocks of Potla Formation of Mangalwar Complex of Bhilwara Supergroup, calc-silicate, metabasic and metapelitic rocks of Rewara Formation of Pur-Banera Group. Surface indications of sulphide mineralisation are found in well dumps in the NW of Bamaniya area in the form of profuse malachite stains, veinlets, stringers & disseminations of chalcopyrite, pyrite and pyrrhotite in metabasic rock and in isolated outcrops in NW of Dhamana, SE of Kundiyan, Parmeshwarpura and Somarwaro-ka-Khera areas in the form of malachite stains, veinlets, stringers and disseminations of bornite, covellite, chalcopyrite and pyrite in calc-silicate rock.
COPPER			
Bhilwara	Kamalpura	Drilling and block analysis	Reconnaissance stage investigation (G-4) was carried out for copper and tungsten to test the surface copper anomalies at depth by drilling and prospecting of tungsten. The copper mineralisation in the Kamalpura Block is confined to garnetiferous amphibole-mica schist and calc-silicate rock. The sulphide mineralisation occurs as fine disseminations of chalcopyrite and pyrrhotite and occasional bornite. A total of 200.50 m has been drilled out in three boreholes KMB-1 to KMB-3. The borehole KMB-1 has intersected two mineralised zones of 4.75 m and 6.30 m width with 0.34 % and 0.65 % Cu, respectively. The third borehole KMB-3 intersected three mineralised zones of 18 m, 10 m and 7 m width with 0.30, 0.40 and 0.40 % Cu (VE), respectively.
BASE METAL			
Jhunjhunu	Bokri and Malwali prospect	Aerial reconnaissance/ PGRS/ mapping and sampling	Reconnaissance stage investigation (G-4) was carried out for copper and associated minerals in the gap area situated between already explored Bokri and Malwali prospects of the Eastern Khetri Metallotect, Jhunjhunu district to assess the basemetal potentiality in the gap area. Aerial reconnaissance & PGRS (1: 25/50,000) of 100 sq km, LSM (1; 10,000) of 50 sq km and DM (1: 2,000) of 0.2 sq km area have been carried out. Twenty three PTS were collected. The rocks exposed in the area form part of the Proterozoic Delhi Supergroup. The litho-units exposed in the area include quartz-mica schist, micaceous quartzite, calc-silicate rock, dolomite, chlorite-magnetite-garnet schist, carbonaceous phyllite, iron ore represented by magnetite and hematite, alkali aplite, amphibolite and dolerite dykes, pegmatite, quartz-porphyry and quartz veins. Old workings along the fault zone and also in carbonate rocks were recorded.

(Contd.)

Table - 6 (Contd.)

State/District	Name of block	Details of exploration	Results
BASE METAL			
Sikar	Nanagwas area	Drilling	Prospecting stage investigation (G-3) was carried out to test subsurface continuity of basemetal mineralisation and associated precious metals. A total of 920.65 m has been drilled in six boreholes WNBH-5 to KEBH-10. Details of sulphide mineralisation zones intersected in boreholes are furnished below: Borehole number — Depth of intersection of mineralised zones WNBH-5 — 30.10 m to 41.65 m & 56.45 m to 79.00 m WNBH-6 — 37.00 m to 40.80 m & 51.50 m to 58.40 m WNBH-7 — 84.30 m to 90.50 m WNBH-8 — 65.05 m to 74.35 m WNBH-9 — 57.90 m to 68.85 m & 73.75 m to 98.75 m WNBH-10 — 44.90 m to 48.65 m, 57.20 m to 63.40 m & 78.90m to 94.35 m The boreholes intersected sulphide mineralisation in the form of specks, disseminations, fracture filling and veinlets of chalcopyrite, bornite, covellite and pyrite.
-do-	Dariba North block	Drilling and analysis	Prospecting stage investigation (G-3) was carried out to assess zones of basemetal mineralisation and associated precious metals through subsurface probing and to trace the northern continuity of subsurface sulphide mineralisation, which has already been established by drilling in the southern continuation of Dariba North Block. During 2013-14, a total of 595.90 m has been drilled in four boreholes DNBH-6 to DNBH-9. The sulphide mineralisation intersected in vavious boreholes between 28.5 m to 104.5 m, width from 1 m to 6.4 m and Cu from 0.11% to 42%. The mineralisation mostly occurs in the form of fine, dusty foliation-parallel disseminations, streaks, stringers, veins and specks of bornite, covellite, chalcopyrite and pyrrhotite.

(Contd.)

Table - 6 (Contd.)

State/District	Name of block	Details of exploration	Results
BASE METAL			
Sikar	Palaswala-ki-Dhani block	Drilling and analysis	Reconnaissance stage investigation (G-4) for basemetal was carried out to test the subsurface continuity of the basemetal mineralisation and associated precious metals delineated on surface in Palaswala-ki-Dhani block. During 2013-14, a total of 298.70 m has been drilled in two boreholes PDBH-1 to PDBH-2. The borehole PDBH-1 has intersected a mineralised zone of 12.80 m with 0.32% Cu at cut off 0.2%, within this 8.45 m with 0.41% Cu at cut off 0.4% between 73.80 m and 100.80 m depth. The mineralisation is present in the form of fine dissemination of pyrite, chalcopyrite, bornite and chalcocite mainly restricted to quartz and calcite veins and occasional grains of specularite. The borehole PDBH-2 has intersected a mineralised zone of 6.20 m with 0.21% Cu between 92.85 m and 109.40 m depth.
-do-	Teliwala-Ramliyas block	Mapping and sampling	Reconnaissance stage investigation (G-4) for basemetal was carried out in Teliwala-Ramliyas Block, Sikar district to delineate the zones of basemetal mineralisation and associated precious metals. DM (1: 2,000) of 1.3 sq km area along with collection of 144 BRS/SSS/GCS and 140 channel samples has been accomplished. The area exposes rocks belonging to the Kushalgarh Formation of Ajabgarh Group of Delhi Supergroup. The litho-units exposed in the block are amphibole-bearing marble, dolomitic marble and scapolite-bearing banded calc-silicates with quartz and calcite veins. Sulphide mineralisation is manifested in the form of malachite stains, chalcopyrite and bornite. At places, pyrites have been recorded in veins cutting across the main foliation. The average width of exposed mineralised zones varies from 20 m to 30 m, with 1 km strike length.
Sirohi	Bhimana and Kivarli blocks	Mapping and sampling	Reconnaissance stage investigation (G-4) was carried out to delineate target areas for identification of basemetal mineralised zones for future follow up investigation. DM (1: 2,000) of 0.88 sq km area has been carried out. Total 240 BRS/SS and 23 PTS were collected. The rock types exposed in the area include quartz-plagioclase-chlorite (Hb) rock, chlorite schist, metabasic and quartz veins. A small patch of oxidation zone with muscovite development is recorded in the northeastern part of the Bhimana Block, which coincides with an IP anomaly that extends for about 250 m.

(Contd.)

Table - 6 (Concld.)

State/District	Name of block	Details of exploration	Results
COPPER			
Udaipur	Chari NW block	Mapping and sampling	Reconnaissance stage investigation (G-4) was carried out to evaluate the northwestern extension of Chari copper deposit and to identify target areas for sulphide mineralisation. DM (1: 2,000) of 0.80 sq km area has been carried out. Total 38 channel samples, 379 BRS/SS and 6 PTS were collected. The rock types exposed in the area belong to the Debari Group of the Proterozoic Aravalli Supergroup. The important litho-units exposed are chlorite schist, basic metavolcanics, amphibolite, gabbro, quartzite, phyllite and quartz and carbonate veins. Metavolcanics is the host rock for basemetal mineralisation. Surface indications of mineralisation include malachite staining and fresh sulphides in old working rubbles.
Sikkim			
BASEMETAL			
East District	Dickchu prospect	Mapping & sampling	Reconnaissance stage investigation (G-4) was carried out in extension areas of Dikchu basemetal prospect, East district to assess the basemetal and gold potentiality. An area of 35.5 sq km was mapped on 1: 12,500 scale. Total 30 BRS, 7 SSS and 12 PTS were collected. The rocks exposed in the area belong to Central Crystalline Gneissic Complex (CCGC), Daling Group, Lingtse Granite Gneiss and basic intrusive. The litho-units present are phyllite with interbands of fine-grained quartzite, Lingtse streaky granite gneiss, mylonite, chlorite schist/phyllite, quartz-biotite schist, garnetiferous quartz-biotite schist and banded gneiss. Sulphide mineralisation in the form of dissemination is observed within the garnetiferous mica schist and arenaceous phyllite of Gorubathan Formation, banded gneiss of CCGC and in amphibolite bands that intrude both the garnetiferous mica schist and banded gneiss.

Bauxite

State Directorates

During 2013-14, 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 64 sq km and 2.04 sq km areas, respectively; 112.8 cu m pitting; 1,146.9 m drilling in 94 boreholes; 895 sample collections and estimation of about 4.43 lakh tonnes of bauxite); in Kindha area, Raigarh district (Mapping on 1:50,000 and 1:4,000 scales in 120 sq km and 2.2 sq km areas, respectively and 49 nos. of sampling) and in Dandkeshra block Mainpat plateau, Surguja district (Mapping on 1:50,000 and 1:4,000 scales in 140 and 1.36 sq km areas, respectively; 102 cu m pitting; 1,089 m drilling in 96 boreholes; 1,055 nos. of sample collection and estimation of about 4 lakh tonnes of metal grade bauxite).

During 2013-14, Directorate of Mining & Geology, Kerala carried out exploration for bauxite/aluminous laterite along with china clay in Ulloor, Vaipiriyam, Korom and Eramom areas in Kannur district. Sixteen boreholes were drilled in Ulloor area with a cumulative thickness of 376 m and average thickness of lateritic/bauxitic overburden is 4.5 m. In Vaipiriyam area- 45 m drilling in two boreholes; in Korom area- 167 m drilling in 5 boreholes and in Eramom area- 223.5 m drilling in 11 boreholes have been carried out. The average thickness of aluminous laterite/laterite in Eramom area is about 7 m.

During 2013-14, Directorate of Geology and Mining, Maharashtra carried out 40 sq km mapping and surface sampling for bauxite in Guhaghar area, Ratnagiri district. The area shows existence of low grade bauxite and laterite.

GMDC

M/s GMDC Ltd carried out exploration of bauxite for the year 2014 in its various leases/mines (Asambiya Nana Mota, Ramaniya, Pundi-Tumbdi-Faradi, Wandh-Bhadai - Dhokla, Wandh-2 Mine, Sherdi - Bhadai - Hamala, Kotdi - Mahaderpuri - Boha, Miyani - Khirsara - Nudhtad, Mota Nandra Naredi, Wamoti Moti, Wamoti Nani Moti, Womoti Moti-Daban, Mothala - Moti Balachod and Kandhay by 20,027 m drilling in 1,953 boreholes with 2,093 nos. sampling.

FERROUS MINERALS

CHROMITE

GSI

In Andhra Pradesh, reconnaissance stage (G-4) investigation was carried out in the Chimalpahad Ultramafic Complex, Khammam district to delineate mineralised zones of chromite and PGE and associated minerals. Aerial reconnaissance and PGRS (1: 50,000) of 300 sq km and LSM (1: 2,000) of 80 sq km area have been carried out. One hundred twenty two BRS, 35 PTS and 40 SSS were collected. The area exposes litho-units of the Chimalpahad Ultramafic Complex represented by anorthosite, leucogabbro, gabbro and pyroxenite which are intruded within amphibolites of Khammam Schist Belt. The chromite occurs as podiform lenses within the ultramafic units viz. dunite, pyroxenite, websterite and talc-tremolite schist. The zones rich in mafic and felsic layering in the periphery of the Chimalpahad Ultramafic Complex near Burdharaghavpuram, Chimalpad, Rangapuram, Ramanapalem areas are favourable locations to access PGE, yet to be confirmed by analytical data. A zone of Ti-V magnetite has been traced near Rampuram Tanda, Vinobanagar, Rangapuram, Bajumallayagudem and Burdharaghavpuram villages which may be favourable locales for PGE mineralisation. These bodies are associated with pyroxenite and leucogabbro of Chimalpahad Ultramafic Complex, having extension over a strike length of approx 200 m -300 m. V-Ti magnetite is confirmed by laboratory data which reveal Fe_2O_3 upto 69.33%, TiO_2 up to 24.41%, Cr_2O_3 up to 0.26% and vanadium up to 1,470 ppm.

In Manipur, reconnaissance stage (G-4) investigation was carried out in Mantum Clung Block, Kudengthabi area, Chandel district to delineate chromite bodies within meta ultramafics emplaced in the Tertiary sedimentary sequence. An area of 4.89 sq km has been covered by Magnetic (TF) Survey. The study area is occupied by Tertiary sedimentary sequence (Disang Formation and Oceanic Pelagic sediments) comprising shale, slate, quartzite, phyllitic shale, bedded chert, limestone, pyroclastics interbedded with chert and intraformational conglomerate. The igneous members of ophiolite suite of rocks intruded into the Tertiary sedimentary sequence, comprised of basalts, granites, gabbros, serpentinite and ultramafics. The ultramafics are peridotite, dunite, harzburgite, pyroxenite, etc. Chromites are

observed within ultramafics. Few sharp magnetic anomalies more than 2,000 nT were observed at places within ultramafics may correspond to chromite mineralisation. These anomalies are of three types i.e. distinct low, sharp high and bipolar anomalies. These sharp magnetic anomalies are of isolated nature with limited areal extension. The magnetic contour map brings out distinctly the magnetic variations over ultramafic bodies and ultramafics having chromite mineralisation.

In Odisha, reconnaissance stage (G-4) investigation was carried out around Tulasipasi, Mahupal and Bhuasuni Parbat, Dhenkanal district for search of chromite bodies in the transition zone of Eastern Ghat Mobile Belt (EGMB) and Singhbhum Craton (SC) south of Sukinda ultramafic complex. DM (1: 2,000) of 1.14 sq km area has been carried out. Total 76 PTS, 23 BRS and 23 SS were collected. The area mapped is occupied by rock types belonging to the transition zone lying between the Singbhum Craton and EGMB containing rocks of both cratonic and mobile belt affinity. The rock types exposed include mainly granite gneiss ± garnet, quartzite ± sillimanite and laterite with minor bands/lenses of charnockite, quartz-sericite schist, metabasalt, amphibolite, chlorite schist and phyllite with small lensoidal bodies of mafic-ultramafic rocks. Gabbro/dolerite dykes with NW-SE and NE-SW trends have intruded into all the rock types. The chromite mineralisation is orthomagmatic confined to the chromiferous dunite, chromitite and occasionally in gabbros. Maximum mineralisation has been seen within the chromiferous laterite with minimum Cr_2O_3 of 20-25% (V.E.).

IRON ORE

GSI

In Chhattisgarh, prospecting stage (G-3) investigation was carried out for assessment of iron ore within Chilpi Group in Bhalapuri, Eklama-Chelikama block, Kabirdham (Kawardha) district. This was a sponsored project with M/s Chhattisgarh Mineral Development Corporation for two-year duration initiated in 2012-13. The work carried out includes 3.2 sq km of DM (1: 2,000) coupled with 678.60 m of drilling. The iron ore occurs at the contact of BHJQ and massive quartzite as NE-SW- and NNE-SSW-trending discontinuous band. Iron ore is massive, steel grey, mostly hematite along with goethite, specularite and rarely magnetite. Ore band is discontinuously exposed for a strike length of 9 km with average 8 m -11 m width. A total of 678.6 m drilling has been carried out in 13 boreholes. Drilling has proved occurrence of iron ore band up to 60 m vertical depth in Kesda and Bhalapuri blocks. Analytical results of surface (grab, channel) samples of iron ore show Fe content ranging from 58.98%-67.89% with an average of 64.94%, while analyses of core samples yield Fe content up to 68.24% potentiality in the rocks of Iron ore and Kolhan Group.

In Jharkhand, reconnaissance stage (G-4) investigation was carried out in parts of Bambasai-Dumurjowa-Mongra block, West Singhbhum district for assessment of low-grade iron ore, managanese ore and limestone potentiality in rocks of iron ore and Kolhan Group. Large Scale Mapping (1:12,500) of 79 sq km area has been carried out. Fifty two GCS and 15 PTS were collected. The mapped area is characterised by the presence of OMG/IOG rocks, Singhbhum granite & granodiorite, amygdular basalt (Jagannathpur lava), Kolhan Group of rocks, dolerite dykes, quartz veins and laterites. In the mapped area two dolomitic limestone bodies have been identified: 1). The Kochhra limestone has the strike extension of two kms and width of 50-70 m. 2). The Karamburu limestone extends up to a km with the average width of 20 m. Analytical result of limestone samples yielded CaO 48.19% and $SiO_2$10 percent.

In Meghalaya, reconnaissance stage investigation (G-4) was carried out around Rambrai in West Khasi Hill district to delineate the vanadiferous-titaniferous magnetite bodies within Precambrian Gneissic Complex. LSM (1: 25,000) of 20 sq km DM (1: 5,000) of 1.4 sq km and geophysical survey (Magnetic) of 3.2 L km area have been carried out. Forty five BRS have been collected. The litho-units exposed in the area are

granite gneiss, banded gneiss, granite, charnockite and metanorite. Lateritised metanorite body with bands of titaniferous-vanadiferous magnetite having a strike length of 1,800 m and width of 300 m was delineated NW of Moulih village. The analytical results of 26 samples show Fe_2O_3 between 6.82% and 30.96%, TiO_2 between 1.86% and 4.3%, vanadium up to 1,398 ppm, Cu up to 556 ppm and zirconium up to 1,802 ppm. The other two metanorite bodies were also identified and delineated in the northern part of the mapped area. These bodies are 200 m & 600 m in width and 1,500 m & 900 m in length and are associated with magnetite band (2 mm to 4 mm). Samples have been collected from these bodies. EPMA study indicated presence of ampbibole, pyroxene, plagioclase, titaniferous-vanadiferous magnetite, ilmenite, pyrite, pentlandite and chalcopyrite within these metanorite bodies.

In Odisha, prospecting stage (G-3) investigation was carried out in Kalamang West Block, Bonai Kendujhar belt of Sundergarh district for assessment of iron ore potential in the eastern continuity of the area between Ghoraburhani and Sagasai East Block for augmentation of resources. The work carried out includes pitting & trenching coupled with 1,060.55 m of drilling. The area is mostly covered by ferruginous laterite with minor iron ore. Drilling in 14 boreholes (SKB-1 to SKB-14) carried out during 2012-13 established that the thickness of ore zone varies from 1m to 73.95 m. Twelve boreholes viz. SKB-15 to SKB-26 have been completed during 2013-14. Out of twelve, eight boreholes have intersected mineralised zones, the details of intersections in the boreholes are as follows:

Borehole No.	Depth of intersection
SKB-15	0.0-9 m, 44-47 m, 77-79 m & 85m-98m
SKB-16	8-11 m, 16.10-32.40 m & 37.30- 83.55 m
SKB-18	0.0-4.10 m, 55.60-65.60 m
SKB-19	0.0-54 m
SKB-20	5-62 m
SKB-23	14.90 m -18.85 m & 44.10-51.50 m
SKB-24	0.0-77.60 m
SKB-25	0.0-49 m

The analytical results received for 285 core samples show encouraging results with Fe content varying from 45.79% to 65.8%, SiO_2 from 0.94% to 13.32% and AI_2O_3 from 0.5% to 12.14%. Out of 285 samples, 241 samples have shown Fe content > 45%. Prospecting stage (G-3) investigation was carried out in Mendhamaruni block Sundergarh district for assessment of iron ore potentiality for augmentation of resources. An area of 0.35 sq km has been covered by Detailed Mapping on a scale of 1:2,000 and the litho-units exposed in the area are mainly shale (Fe-shale/variegated shale) and Fe-laterite. A total of 496.55 m drilling has been completed in four boreholes viz. SMB-1 to SKB-4. Out of four, three boreholes have intersected mineralised zones, the details of intersections in the boreholes are as follows:

Borehole No.	Depth of intersection
SMB-1	0.0-85.4 m
SMB-2	6.8 m - 95.80 m
SMB-3	60.55 m -137.70 m

The mineralised zones intersected comprise Hard Laminated Ore, Soft Laminated Ore Powdery Ore and Blue Dust. The analytical data of 239 core samples show the average Fe content of BH: SMB-1, SMB-2 & SMB-3 are 62.46%, 58.38% and 64.89%, respectively.

In Rajasthan, reconnaissance stage (G-4) investigation was carried out in Karauli-Bundi area in parts of Karauli, Sawai Madhopur, Tonk, Bundi and Bhilwara districts to delineate iron ore bodies in the rocks of Hindoli Group for future probing. LSM (1: 25,000) of 130 sq km area has been carried out. Forty-five BRS have been collected. The main litho-units exposed in the area are chert breccia, ferruginous chert breccia and quartzite with small patches of shale/porcelanite and dolomite at places. Ferruginous body has been mapped on 1: 25,000 scale of about 25 sq km in Korma area, Bundi district. The main litho-units exposed in this area are ferruginous breccia, phyllite and dolomite with quartz veins. A number of old workings of variable dimensions have been observed near Khiniya and Korma areas in Bundi district. The ore bodies mainly consist of hematite. XRF analysis of 15 grab samples of iron ore body reveals Fe_2O_3 content of 34% (nearly 20 % Fe).

In Uttarakhand, reconnaissance stage (G-4) investigation was carried out in undifferentiated Ramgarh Group in parts of Nainital district to delineate iron and sulphide mineral occurrences and assessment of economic potentiality of the area. LSM (1: 25,000) of 85 sq km area has been carried out. One hundred twenty eight BRS/SS/SSS and 30 PTS were collected. The area comprises undifferentiated rocks of Proterozoic Ramgarh Group and Neoproterozoic Betalghat Formation and Nagthat Formation (Jaunsar Group). In the mapped area, the Ramgarh Group consists of granite gneisses and a sequence of quartzite with few thin bands of phyllite and mafic sills. The rocks of Nagthat Formation (Jaunsar Group) include quartzite. In the area, iron ore is manifested as patches of limonite lenses, specks of magnetite in the calcareous phyllite and as ferruginisation of the quartzite band. The results of 41 analyses of bedrock samples/stream sediment samples for Fe and Cu, Pb, Zn, etc. yielded very low values.

State Directorates

During 2013-14, Directorate of Geology and Mining, Uttar Pradesh carried out exploration for iron ore in Baragaon area, Jhansi district by 02 sq km mapping on a scale of 1:25,000; 4 nos. trenching with 231.65 cu m excavation and 20 nos. sampling. The value of iron is 32-52 percent.

NMDC

During 2013-14, NMDC carried out exploration for iron ore in Bailadila Iron ore Deposit, South Bastar, Dantewada district, Chhattisgarh by mapping, pitting, drilling, sampling, chemical analysis etc. Deposit nos. 14 & 11 C: mapping on 1:2,000 scale; pitting 364 nos. and 2,798 m drilling in 33 boreholes; Deposit no. 05: - 1,754 m drilling in 14 boreholes and chemical analysis of 1,754 nos. samples and Deposits no. 10/11 A: 987 m drilling in 12 boreholes. Similarly, in Donimalai Iron Ore Mines, Bellary district, Karnataka 2,060.2 m drilling in 22 boreholes and collection of 846 samples have been carried out.

MANGANESE ORE

In Karnataka, reconnaissance stage investigation (G-4) was carried out in Ramanguli area, Uttad Kannad district for the assessment of manganese potentiality. LSM (1: 12,500) of 75 sq km and PT of 30 cu m area have been carried out. Seventy-five BRS, 44 PTS and 15 PCS were collected. In the studied area manganese mineralisation has been observed in phyllite, lateritic BMQ and quartzite. Pyrolusite, psilomelane and suspected needle-shaped cryptomelane, jacobsite were observed in the west in Ramanguli area. Manganese mineralisation has been traced north of Kodlagadde, for a strike length of 600 m having width of 20 m and depth of 15 m within phyllite. The analytical results of 12 bedrock samples were received so far, in which 3 samples show Mn content 13.9%, 21.77% and 7.94%, respectively. Analytical results of 3 PCS samples yielded Mn content 29.28%, 21.03% and 43.6%. Gold mineralisation has been observed in BIF west of Sunjog and along the contact between quartz-chlorite schist and argillite in *nala* section/ Gangavalli river section in Idgundi block. Occurrences of approximate 12 m wide clay horizon having a strike length of about >0.8 km has also been recorded.

In Maharashtra, reconnaissance stage investigation (G-4) for manganese was carried out in Chorbahuli extension area, Nagpur district for assessment of manganese potentiality. The work carried out includes 150 sq km of LSM (1:12,500), Ground Geophysical Survey (Gravity and Magnetic) and sampling. The area exposes biotite gneiss of Tirodi Biotite Gneiss, calcareous marble with or without manganese ore and calc-silicate of Lohangi Formation, quartz-mica schist and mica schist of Mansar Formation, quartzite and dolomitic marble of Bichua Formation, foliated granite and pegmatite bodies. Two to five m wide manganese-bearing horizon is recorded within the marble band of Lohangi Formation for a strike length of 4.5 km. But the Mn mineralisation is not continuously present throughout the marble band. Analytical results of BRS collected from Mn-bearing horizon show Mn value ranging from 1.75 to 21.62 %.

In Odisha, reconnaissance stage (G-4) investigation was carried out in Dengula-Bandhal area, Bonai-Kendujhar Belt, Sundergarh district to identify potential areas of manganese mineralisation for future exploration. LSM (1: 10,000) of 40 sq km and DM (1: 2,000) of

0.40 sq km area has been carried out. Forty-five BRS, 16 PTS and 45 PCS were collected. The litho assemblages noticed in the mapped area are shale and laterite. Manganese mineralisation in the mapped area is mostly confined to the variegated shale and in laterite capping . Chemical analysis of eleven bedrock samples collected from LSM area show manganese percentage varied from 0.92 to 41.28.

MOIL

During 2013-14, MOIL carried out 13,463 m exploratory drilling involving 58 boreholes in seven mines: two mines Tirodi & Bharweli situated in Balaghat district, Madhya Pradesh; and five mines Dongri Buzurg & Chikla in Bhandara district and Gumgaon, Kandri & Mansar in Nagpur district, all in Maharashtra. The reported resources of manganese ore were Bharweli (23.69 million tonnes), Tirodi (1.16 million tonnes), Gumgaon (4.20 million tonnes), Sitapatore/Sukli (0.40 million tonnes), Kandri (5.53 million tonnes), Mansar (4.60 million tonnes), Chikla (4.98 million tonnes), Dongri-Buzurg (11.79 million tonnes), Ukwa (8.57 million tonnes) and Beldongri (0.32 million tonnes).

STRATEGIC METALS

TUNGSTEN

GSI

In Maharashtra, reconnaissance stage investigation (G-4) was carried out in and around Inzewara, Bhandara district to identify target zones of tungsten and associated mineralisation. The work carried out includes 200 sq km aerial reconnaissance, 100 sq km LSM on a scale of 1: 12,500, 100 soil sampling on 50 m x 200 m grid, pitting & trenching of 102 cu m and collection of 51 BRS. The area exposes rocks of basement Amgaon Gneissic Complex and Sakoli Group. Tungsten mineralisation is confined mainly to the quartz veins and the tourmaline greisens within the mica schist. In Salheli area, one grab sample of quartz vein boulders containing scheelite recorded 0.62% of W. BRS samples of 5 quartz-tourmaline veins and greisens from SW of Inzewara gave values ranging from 70 ppm. to 175 ppm. Pitting and trenching in Salheti area established 10 m strike length of scheelite-bearing quartz vein having a thickness of 0.5 m. Sixteen pit samples from the Salheti area show W values ranging from 200 ppm to 0.15% and three pit samples recorded Au values of 148 ppb, 164 ppb and 208 ppb. Out of 19 soil samples from Salheti one soil sample has given Au value of 547 ppb. The SEM-EDX studies of both the quartz vein and the quartz-chlorite schist of Salheti area confirmed the presence of scheelite. A single platinum grain and REEs like xenotime and monazite were also observed in the quartz-chlorite schist near to the scheelite-bearing quartz vein. Gold grain of 2 ì m size was observed in SEM studies from smoky quartz vein located west of Chandrapur village.

RARE METALS & RARE EARTHS (RM/REE) ELEMENTS

GSI

In Andhra Pradesh, reconnaissance stage investigation (G-4) was carried out in the area between Vutukuru and Kalichedu in Nellore district to delineate potential areas for REE and other strategic minerals. LSM (1: 12,500) of 155 sq km area has been carried out. One hundred twenty nine BRS, 99 SSS, 48 PTS and 42 nos. of PCS were collected. Thirty one pegmatite bodies within migmatitised pelitic schist, quartzite, quartz-mica schist having variable strike length extending from 1 m to 120 m with a width ranging from 1 m to 50 m and 26 aplite bodies within amphibolite and quartzite having variable length ranges from 1 m to 60 m with a width ranging from 1 mm to 30 m have been delineated. EPMA study reveals presence of columbite-tantalite mineral within the pegmatite. Analytical results of 116 geochemical samples (77 BRS & 39 SSS) show total REE, LREE & HREE values ranging from 2 ppm to 572 ppm, 1 ppm to 500 ppm and 0.32 ppm to 250 ppm, respectively.

In Assam, reconnaissance stage investigation (G-4) was carried out in southern part of Agia around Sujukona Hill and Tukureswari Hill in parts of Goalpara district to evaluate potentiality of REE within Precambrian Gneissic Complex. LSM (1: 12,500) of 69 sq km area has been carried out. Total 93 BRS, 70 SSS and 24 PCS were collected. The studied area exposes banded gneiss,

migmatitic granite gneiss, basic granulite, quartz-biotite gneiss ± sillimanite, metadolerite with thin and occasional quartz and pegmatite veins. Shear zones of very restricted extent are observed south of Phuphunga Hill with a cumulative thickness of about 30 m, around Bormohora with a thickness of approximately 7 m along Dwipkai nala. A small pyrite-rich shear zone within mylonitised biotite gneiss is exposed in the western flank of Sijukona Hill. Sulphide mineralisation in the form of pyrite and pyrrhotite has been noticed south of Phuphunga. Samples collected across the shear zones and sulphide zones were submitted for chemical analysis.

In Jharkhand, reconnaissance stage investigation (G-4) was carried out in Dublaberatoli-Sundil area Ranchi district in potential pegmatites hosted within the Chhotanagpur Gneissie Complex to assess RM and REE potentiality. The study area is a part of Chottanagpur Gneissic Complex and forms the western extension of North Purulia Shear Zone. Detailed mapping over 0.30 sq km was carried out on a scale of 1:500 to delineate the individual pegmatite bodies. Pegmatite body of length of 2 km and width of 50 m to 70 m was demarcated. The identified mineral phases in the pegmatite body are columbite, cebaite, barite, rutile, anatase, lepidolite, fluocerite, becquerelite, beddeleyite, thorianite, pollucite, feniclinoho mquisite, zinnwaldite, apatite, kainosite, allanite and spodumene. Concentration of total REE up to 600 ppm is reported in the pegmatite body. In a few samples concentration of Ce, La and Nd is remarkably high, as high as Ce-242.69 ppm, La-121.14 ppm and Nd-111.63 ppm. Concentration of rare metals like Li (10 ppm - 117 ppm), Cs (<10 ppm - 52 ppm) and Rb (175 ppm - 580 ppm) has been recorded from the pegmatite. A reconnaissance stage investigation (G-4) was carried out to assess the potentiality of RM & REE in Chhotanagpur Gneissic Complex in and around Kasidih area Ranchi district. Detailed Mapping on a scale of 1: 500 over an area of 0.4 sq km along with pitting and trenching of 30 cu m was accomplished. The litho-units present in the area are granite gneiss, calc-silicate and pegmatite. The WNW-ESE-trending pegmatite bodies having a dimension of approx. 100 m - 2,000 m length and 40 m -200 m (approx.) width were demarcated. The result of EPMA analysis shows the occurrences of xenotime, monazite, zircon, uraninite, sphene, apatite, epidote, rutile and garnet in some samples of pegmatite. XRD study of pegmatite indicates presence of columbite, leucosphenite, zorite, pollucite and amblygonite. Total REE concentration in pegmatite samples shows values from 150 ppm to 400 ppm. A reconnaissance stage investigation (G-4) was carried out to assess titanium and vanadium potentiality in bauxite of Serangdag Plateau in Garna Hanrup-Kaprapat-Risapattoli-Kurbetola area of Gumla district. This was taken up on request from DMG, Jharkhand as a two-year programme initiated in 2013-14. Reconnaissance mapping of 19 sq km area has been carried out. A total of 220.50 m drilling in five boreholes has been completed. Bauxitic zones with cumulative thickness varying from 25 m to 39 m have been intersected in five boreholes between 0.30 m and 39 m depth.

In Karnataka, reconnaissance stage investigation (G-4) was carried out around Mincheri, Inchanal and Hireupperi areas, Raichur district to explore the potentiality of REE mineralisation. LSM (1: 12,500) of 60 sq km area has been carried out. Total 110 BRS, 43 PTS and 14 PCS were collected. The litho-units comprising of amphibolite, banded magnetite quartzite, talc-tremolite schist belonging to Older Metamorphic Group of the Gurgunta Schist Belt occur as enclaves within the Peninsular Gneiss. Other exposed rocks are diorites. quartz diorites, monzonites, pink granite, pink porphyritic granite, grey biotite granite and alkaline, carbonate-bearing syenite plugs. Near Kesaratti aegirine syenite plug of 100 sq km dimension has been demarcated. Analytical results of 11 samples collected from the plug have yielded La (23.71 ppm -53.52 ppm); Ce (51ppm - 99.16 ppm); Pr (5.7 ppm -11.7 ppm); Nd (20.83 ppm - 42.62 ppm); Eu (1.16 ppm - 2.24 ppm) and Sm (3.8 ppm - 7.35 ppm). A 1.9-km-long and 50 m - wide N-S-trending mylonitised quartz reef exposed near Mincheri has been mapped and sampled systematically. Out of the 15 samples collected from the reef, 4 samples have given values of La (39 ppm - 107 ppm); Ce (68ppm -167 ppm); Pr (7.2 ppm -19.1

ppm); Nd (26.53 ppm - 63.45 ppm). Another 1.2 km long smoky to white quartz vein varying in width from 1 m to 8 m parallel to the NS trending mylonitised Mincheri quartz reef has been mapped. The quartz veins to the West of Mincheri reef have yielded 500 ppm to 1,000 ppm of La, 100 ppm Nb, 10 ppm Y and 200 ppm Zr.

In Madhya Pradesh, reconnaissance stage investigation (G-4) was carried out in Sarkana-Malguwan-Gairwar area in Chhatarpur district to evaluate the potentiality of REE mineralisation of the carbonatite-syenite-lamprophyre and felsic intrusives within Banded Gneissic Complex. Large Scale Mapping of 141 sq km on a scale of 1: 12,500 was carried out. Seventy of stream sediment samples, 200 bed rock samples and 35 nos. of petrochemical samples have been collected for assessment of REE potentiality. Besides, 50 rock chips for petrographic studies, 20 samples each for ore microscopic studies, SEM-EDX studies, EPMA studies, and XRD studies were also collected. Satellite imageries study covering an area of 800 sq km was carried out. The mapped area exposes rocks of Bundelkhand Granitoid Complex with supracrustal enclaves. Numerous prominent pegmatites, quartz veins and quartz reefs intruded into the Bundelkhand Granitoid Complex. The stream sediment and bed rock samples collected from the pegmatite, syenite, carbonatite and basic rocks do not give encouraging values of REE minerals.

In Maharashtra, reconnaissance stage investigation (G-4) for REE/RM mineralisation was carried out in Sausar Mobile Belt and Tirodi Biotite Gneiss in Nagpur district to delineate pegmatite bodies, characterise the petro-mineralogy and to evaluate the potentiality of REE/RM in pegmatite. Large Scale Mapping on a scale of 1: 10,000 was carried out covering an area of 150 sq km which was followed by detailed mapping on 1:1,000 in an area of 0.32 sq km. The rocks exposed in the area belong to Basement Complex comprise Tirodi Biotite Gneiss (TBG), augen gneiss, amphibolites and granite gneiss and rocks of Sausar Group which include pink marble and calc-sillicates of Lohangi Formation, marble and quartz-mica schist of Mansar Formation and interbanded quartzite-quartz-mica schist of Chorbaoli Formation. These rocks are intruded by granite, pegmatite and number of quartz veins. Length of pegmatite ranges between 5 m and 550 m and width between 0.5 m and 30 m. Talus sample collected near weathered pegmatite shows the highest total REE value of 6,300 ppm. Two stream sediment samples collected from first order stream near this pegmatite also give the concentration of total REE up to 3,970 ppm. Analytical results of beryl samples reveal higher concentration of Be (3.58%), Li (405 ppm) and W(945 ppm). The highest concentration of Cesium (2,295 ppm) is noted in pegmatite located NNE of Ramzam village. The concentration of Ta, Rb and W in the same sample is 628 ppm, 2,500 ppm and 210 ppm, respectively. SEM data for ten pegmatites indicated the presence of monazite, zircon and xenotime and Nb-Ta-bearing phases.

In Meghalaya, reconnaissance stage investigation (G-4) was carried out in parts of Nongpoh Pluton, Ri-Bhoi district to evaluate potentiality of REE in Nongpoh granite and to locate mafic / lamprophyre / lamproite rock around lineament intersections and mineralised zones along the contact of granite and Precambrian gneiss. LSM (1: 12,500) of 55 sq km area has been carried out. Total 46 BRS, 43 SSS, 13 SS and 22 PCS were collected. Litho-units observed in the area include sillimanite-biotite gneiss, granite gneiss, diorite gneiss of Precambrian Gneissic Complex, mafic rock/ lamprophyre, diorite-granodiorite, porphyritic granite and non-porphyritic granite of Nongpoh pluton. Disseminated grains of pyrite and chalcopyrite are observed in gneisses, diorite/ granodiorite, mafic intrusive rock, porphyritic granite, quartz and pegmatite veins. Scheelite grains have been identified by EPMA study in garnet-epidote rock. Analytical results of 8 SSS show REE value ranging between 226 ppm and 2,984 ppm, 9 samples of porphyritic granite show value between 562 ppm and 980 ppm and 6 samples of non-porphyritic granite show value between 578 ppm and 2,148 ppm. Two granite samples yield REE value between 1,803 ppm and 2,148 ppm have visible spindle-shaped sphene (titanite) and allanite in hand specimen.

In Rajasthan, reconnaissance stage investigation (G-4) was carried out in the Dhani granite in Pali district to assess the potentiality of REE mineralisation. DM (1: 2,000) of 0.70 km^2 area has been carried out. Total 150 channel samples and six PCS were collected. In addition, a quantum of 188 m of drilling has been accomplished. The area is represented by Dhani granite, Erinpura granite and Sirohi Group of metasediments comprising alternate sequence of biotite schist, quartzite and impure carbonate rocks. Nine scout boreholes were drilled in Dhani area during 2010-12, 2012-13 and 2013-14. The boreholes DGBH-1 and DGBH-2 were drilled in 2010-12. No significant REE mineralisation has been intersected in these boreholes. Six boreholes DGBH-3 to DGBH-8 were drilled in 2012-13, out of which 5 boreholes, viz. DGBH-3, DGBH-4, DGBH-5, DGBH-6 and DGBH-7 encountered 13 REE-rich zones at cut off grade 0.1% total REE and width lm. The borehole DGBH-9 drilled during 2013-14 encountered one REE rich zone of 0.54 m at cut off grade 0.1% total REE and width l m. EPMA study indicated the presence of synchysite (Ce) and monazite in altered Dhani granite intersected in borehole DGBH-3 during 2012-13. Two bed rock samples from highly kaolinised rocks show REE of 0.206% and 0.545%, respectively. A reconnaissance stage investigation (G-4) was carried out in Gothara granite of Khetri Fold Belt, Jhunjhunu district to assess the potentiality of REE mineralisation. LSM (1: 12,500) of 19 sq km and DM (1:2,000) of 0.49 sq km area have been carried out. Total 224 BRS/PT/SS have been collected. Within the mapped area, the rocks exposed are metasedimentaries of NDFB, post-tectonic intrusive granites (Gothara granite), basic dykes and later quartz veins. The metasediments comprise amphibole quartzite, magnetite-bearing quartzite, garnetiferous mica schist, staurolite schist and calc-silicates. A cluster of old workings were found east of Rajota located 50 m south of the granite contact within the metasedimentary country. Sulphide mineralisation in the form of malachite staining and specks of chalcopyrite, pyrite, covellite and bornite has been observed within the dump material. Out of 90 bed rock samples collected from the LSM area, 31 yielded REE > 500 ppm and 10 samples yielded REE ranging from 0.1% ppm to 1% ppm. Out of 134 grid bed rock samples collected from the DM (1: 2,000) area, the result of 21 samples has been received so far. Out of these 21 samples, 7 samples yielded a REE > 500 ppm and 2 samples yielded a REE > 1000 ppm.

In Tamilnadu, reconnaissance stage investigation (G-4) was carried out in parts of Paramathi-Sarkar Valavandi-Kavundanur areas of Namakkal and Trichy districts to locate potential zones of REE and associated minerals within pink granite/gneiss and pegmatite. LSM (1: 12,500) of 78 sq km area has been carried out. Total 50 BRS and 30 PS were collected. The study area exposes calc-granulite, BMQ, pyroxene granulite, pink migmatitic gneiss, biotite gneiss, granite, granite gneiss, charnockite, hornblende-biotite gneiss, pyroxene gneiss, metapyroxenite, metagabbro and pegmatite and quartz veins. Analytical results of 20 BRS received so far out of which three nos. of samples collected from pink granite and pink migmatite yielded 914.89 ppm of REE (La to Lu), 1359.59 ppm of LREE (La to Sm) and 114.41 ppm of HREE (Tb to Lu). The samples collected from pegmatite bodies are not showing any encouraging values of REEs. XRD study reveals presence of almandine, apatite, allanite, ilmenite and epidote within granite and pegmatite.

State Directorate

During 2013-14, Directorate of Geology & Mining, Uttar Pradesh carried out exploration for REE near Khajraha Buzurg village, Jhansi district by mapping on a scale of 1: 2,000 scale in 0.5 sq km area and 10 nos. of sampling. The encouraging value of average grade 560 g/t is assessed.

BEACH SAND/PLACER MINERALS GSI

(i) To evaluate placer mineral resource, an area of 50 sq km within the territorial waters off north of Bhimunipatnam, Andhra Pradesh was covered. Total 66 vibrocore seabed sediment samples, varying in length from 0.46 m to 3.78 m with an average core length of 2.10 m were collected on a grid pattern of 1 km x 1 km within the water depths of 22.56 m to 39.47 m. Besides, current observations and water samples at surface and sub-surface levels from three stations each were collected and 55 LKM of bathymetric survey along 11 coast-perpendicular transects of 5 km each was carried out. The bathymetry reveals that the contours are parallel to the coast configuration of NE-SW and the area is with a gentle gradient of 1:295. The geomorphologic feature observed in the area of study is a terrace with a relief of 2 m to 3 m at a water depth of around 32 m. The onboard observation of seabed samples reveals that the predominant sediment type is grey medium to fine sand at surface and grey fine sand admixture with green compact clay at sub-surface level. The vibrocore sediments were sub-sampled at half a metre interval for evaluation of heavy mineral resources. Preliminary studies indicate low concentration of heavy minerals in the area. Heavy mineral analysis indicate the weight percentage variation of 0.49 to 8.54 % with an average of 2.69 % in general. The down core variation of weight percentage of total heavy minerals is 0.82 to 6.75 wt% with an average of 3.36 wt% at surface level, 0.70 to 5.50 wt% (average 3.13 wt%) at 0.50 -1.00 m level, 0.82 to 8.54 wt% (av. 2.96 wt%) at 1.00 - 1.50 m level, 0.66 to 5.82 wt% (av. 2.45 wt%) at 1.50 - 2.00 m level, 0.49 to 3.49 wt% (av. 1.71 wt%) at 2.00 - 2.50 m level and 0.50 to 3.23 wt% (av. 1.52 wt%) at 2.50 - 3 .00 m level. The studies indicate decline in the average weight percentage of heavy minerals towards sub-surface. Heavy minerals in the area constitute, in general, ilmenite, sillimanite, garnet, zircon, monazite, rutile and others. However, further studies are in progress. The ocean water current direction is SW, which is near normal condition in the north-east monsoon period, during which time the present work was carried out. The current speed decreases towards sub-surface level.

(ii)For preliminary evaluation of sand resources off Kochi, Kerala,an area of 280 sq km was covered for sampling and 73 vibrocores were collected. The water depth varies from 26.4 m to 43.8 m. The length of the cores vary for 19 cm to 4.76 m. The top sediments of the cores are analysed onboard and properties like sediment type, colour, pH and temperature are determined.The study area is about 20 km due west off Kochi. The area is a rectangle with a length of 40 km and width of 6 km and trend is NW-SE. Sampling in additional area of 40 sq km is carried out on eastern side of the area. The study indicated a channel along central part from north to south and two ridges on either side. The topography is rugged with ridges & depressions and the water depth varies from 26.4 m to 43.8 m. The bathymetry survey was carried out using the instrument Ratheon 1,500 Echo Sounder. The vibro core samples were collected in a 2 km x 2 km grid pattern starting from NW part of the area and gradually proceeding towards southern part. In total 73 samples were collected. Longest core recovered was 4.76 m and shortest one is 19 cm. Based on visual estimation of surface sediments of vibrocore samples, a Sediment Distribution Map (SDM) was prepared. From the SDM, it is evident that sand is mainly occurring on the northern and southern part and as pockets in clay at the central part and sand occupies 50% of total surface area. The different types of sand occurring in the area are coarse sand, medium sand, fine sand & clayey sand and types of clay are silty clay, sandy clay & pure clay. Sand is the predominant unit followed by clay, sandy clay & silty clay. Central part of the area is mainly occupied by clay, silty clay & sandy clay. The vibrocores were cut & logged in GS1 laboratory, Mangalore. Out of 73 cores, 39 cores contain only sand with thickness varying from 19 cm to 3.14 m. Eighteen cores contain only clay and 16 cores contains both sand & clay. In two cores, laterites are found at both top & bottom part as boulders. Oxidised clay, wood etc. is found in few cores. The size of wood ranges from 1 cm size to 5 cm size. The occurrence of laterites, wood pieces and oxidised clay in the area indicates a paleo-strandline formed by sub-aerial exposure during the Pleistocene time. The seabed during that time was 150 m below the present-day sea level. Some

representative samples from clay, sand, sandy clay, silty clay, etc. are given for chemical analysis for detecting major oxides, trace elements and chloride content. The chloride content is important because if it is <0.01% the sand can be used for construction purpose as it contains salt within the prescribed limit. The reserve estimation of sand in the area can be done only after getting the percentage of sand in each core by grain size analysis. Some samples contain heavy minerals like ilmenite, monazite, sillimanite, zircon, etc. Two beach samples were collected from Kochi & Cherayi areas to study the difference between present-day beach sand and paleo sand. Field work around Perumbavoor area is conducted to study the geology of the area and the relation between the occurrence of sand off Kochi and the hinterland rocks. Three quarries were visited and the rock samples were collected for further study.

(iii) The high demand for construction-grade sand, particularly in the State of Kerala, coupled with the government's ban on mining the onland resources instigated Marine and Coastal Survey Division of GSI to explore for marine sand resources as a productive alternative. Marine and Coastal Survey Division of GSI commenced exploration for this resource way back in the 1990s. Survey of the marine sand resources off Paravur, Quilon district, Kerala, was taken up by GSI as a continuation of the sand investigation programmes carried out for the last 10 years. This offshore sand is also known for the occurrence of heavy placer minerals. As part of the study an area of 48 sq km was surveyed by bathymetric surveys along 38 LKM and vibrocoring operations recovered 24 vibrocore samples. An aggregate of 15.32 m of core was recovered. The bathymetric survey of 38 lkm shows a gentle increase in the slope towards west with the depths ranging from 48 m to 61 m. The area is a part of 'the continental shelf and has an overall gradient of 1 in 1,575. The sediment distribution map of the area is prepared based on the visual estimation of the sediments at the top of the cores during the core logging. Medium sand occurs as the dominant surface sediment in the area followed mainly by sand further down. Towards the northern part of the area, a fining of the sand is seen to increase. The coarser fractions are found at the central part of the area. Total 24 core samples were collected from the study area. Greater water depths and presence of a shell horizon resulted in poor core recovery at many stations. The maximum core length was obtained for VC - 24 which yielded 1.49 m. Most of the cores have a medium to coarse sand horizon with shell fragments at the top followed by a shell-rich zone composed mainly of shells of lamellibranchia and gastropods. Minor amounts of heavy minerals are observed at places within the core. In VC - 24, the 02-30 cm level is occupied by medium to coarse sand with shells of lamellibranchia and beyond this up to the 54 cm depth level it is mainly a fine to medium sand. Further down core up to 130 cm it is seen to be a clayey sand with gastropod shells followed by sand-silt-clay up to the core bottom. Within the clayey sand unit, pockets of clay are found at the 71-74 cm and 78-80 cm depths.

(iv) An area of 78 sq km (30 sq km onshore & 48 sq km offshore) was covered in the Ajanur-Nileshwaram sector of Kasaragod district, Kerala as part of implementation of the second phase of FS Item No. 070. Keeping in view of the main objectives of the project aimed at: a) mapping the 0 to 10 m isobath zone, b) understanding the geomorphologic features of the nearshore zone, c) assessment of heavy minerals in the beach and offshore sector and d) demarcation of zone of active erosion, beach profiling during different seasons along with bathymetric and grab sampling in the offshore regions and sampling in 1 km x 1 km grid were carried out. In order to demarcate the zone of active erosion, shoreline changes during a span of 100 years were computed using multi-temporal satellite images and toposheets with the help of Digital Shoreline Analysis System (DSAS), an extension of Arc-GIS. Beach profile measurements were carried out along five transects spaced at 4-5 km interval during four seasons of the year before and after SW and NE monsoons. Total 40 samples on 1 km x 1 km grid were collected from the offshore region using a mechanised boat and 20 samples on similar grid were collected from the beach zone. A total of 83 beach samples were collected from the profile transects during four seasons to understand the seasonal variations in granulometric parameters

and sediment trend analysis. For computation of decadal changes in shoreline configuration, SOI Toposheets of 1913, 1969 and satellite images of 2000 and 2013 have been used. The results of beach profiling showed accretion as the dominant process in an annual cycle in the area. The results of the study of seasonal change from beach profile measurements corroborate with the decadal change computed using satellite images and toposheets which showed the present study area as a zone of accretion. The results are in contrast to the annual changes noticed in the northern part of the area (Chandragiri-Chittari sector) during the last field season. The millennial-scale shoreline change record preserved in the form of geomorphology of the area also shows characteristic features of an emerging coast which indicates that the area is under accretion phase on a millennial, annual and seasonal scale. In order to understand the causative factor for such changes, structural features of the area were studied that clearly showed sets of coast-parallel and coast-perpendicular faults intersecting in the northern boundary of the area. The free air gravity anomaly showed that the area forms a structural basement high in comparison to the northern sector. The heavy mineral (HM) analysis showed some promising zones of HM accumulation in the beach and sand dunes of the area with concentration ranging from 1 to 45%. Ilmenite, sillimanite and pyroboles (pyroxenes and amphiboles) form the major HM constituents of the area with considerable amounts of kyanite, garnet, monazite, rutile and zircon. The present study area has charnockitic terrain in the hinterland region, whereas the northern sector study during the previous field season has gneissic terrain in the hinterland region. The effect of the hinterland geology in the HM concentration will be brought out after completion of laboratory studies.

(v) To assess the heavy mineral potential in nearshore area off Attipara near Thiruvananthapuram, Kerala, sea bed surveys were carried out using a mechanised boat. Bathymetry surveys and sample collections were taken up in the nearshore areas, where mapping could not be done by earlier R.V. Samudra Shaudhikama cruises. An area of 20 sq km in the nearshore (from shoreline to about 20 m water depth) was covered during the survey. Objectives of the survey included mapping of the gap areas in the near shore sector (between 0 and 20 m) to prepare bathymetry and surface sediment distribution map and to assess the heavy mineral concentrations in the surface samples in the near shore sector off Attipara, Thiruvananthapuram, Kerala. During the boat work, 90 LKM bathymetry data and grab samples from 60 locations were collected. Accurate location along 15 km of the shoreline was also recorded at about 200 m interval to get the exact present-day shoreline. Bathymetry survey was carried out for 90 LKM along 53 transects of 08" (240 m) interval and M1.9 to 1.2 km length in the near shore areas up to water depths of around 20 m using a portable single beam echo sounder and portable GPS. Even though it was recorded continuously, data at one-minute time interval (150 m) were used to prepare bathymetry map. Measured water depth varies from 2.2 m to 22.81 m. Bathymetry contours are almost parallel to the shore line. Slope of sea floor is steeper up to the 10 m water depths (about 1 in 25 to 1 in 30). Beyond that, it is gentle. General slope of the sea floor in the northern part is about 1 in 70 and in southern sector about 1 in 50. In other words, the 20 m isobath can be marked at about 1.4 km away from the shore in the northern part of the area, and just at about one km in the southern part.In the inner shelf off the northern part of Quilon, the general slope of the area is gentler than 1 in 600 and the 20 m water depth is beyond 12 km. But, as seen in the surveyed area, inner shelf off Arabian Sea is very steep towards south of Quilon. A total of 59 grab samples of bottom sediments were collected from the sea and 14 samples from the shoreline. All the 73 samples are sandy in nature containing more than 95 % sand fraction. Coarse to medium sand is the major sediment type in the northern part of the area in the nearshore areas up to 9 m isobaths and in the deeper part beyond 13 m water depths. Detached patches of silty sand or fine sand blankets cover the sea floor between 9 m and 13 m water depth. Fine sand is major sediment in the southern part of the area. Heavy mineral content in the sediments varies from 0.3% to 9% with an average of 3%. Maximum concentration of 9% could be seen in a sample from the southern part at water depths of about 17 m.

Concentration of heavies in the near shore sediments at around 12 m water depth in the southern part is appreciable and varies from 4.5 to 6%. There is no marked pattern of heavy mineral concentration in the sediments. Even then, it can be generalised that heavy mineral concentration is more in the middle part of the area at around 12 m water depth. Preliminary studies show that ilmenite is the major heavy mineral occurring in the sediments. Other minerals include sillimanite, garnet, zircon, monazite and amphiboles.

(vi) For identification of heavy mineral occurrences, coastal survey has been carried out between Apsarakonda and Swarnagadde near Honavar, Uttar Kannada district, Karnataka and an area of 32 sq km was covered. The bathymetric survey of 0-10 m was carried out along 24 lkm. Total 40 samples were collected from the study area comprising 24 grab samples and 16 beach samples. The bathymetry contours are steeper up to 5 m and are almost parallel to the coast line. The bathymetry contours protrude towards the open sea in the northern part of the study area is due to the sediment input from the Sharavati River. Field observation on the berms and beach deposits shows high concentration of heavy mineral (black sands) and the enrichment may go up to 20% at places. The size and heavy mineral studies were in progress to ascertain the exact heavy mineral content in the offshore as well as on the onshore deposits.

(vii) Placer mineral resource evaluation in the Territorial Waters off Palur-Malud, Odisha was taken up to assess the Heavy mineral concentration and to fill up the gap area in closed-grid vibrocoring for evaluating placer mineral resources. An area of 48 sq km between the Chilka Lake (southern extension) in the north-east and Rushikulya River confluence in the south-west has been covered. Bathymetric survey was carried out at 9 shore-perpendicular lines with one km spacing along with two cross lines sub-parallel to shore. The plot of bathymetric data reveals a particular alignment of contours parallel to the coast line. The seafloor is smooth and gently sloping. The contour spacing varies at regular intervals, giving an impression of terracing. Study of seabed morphology map reveals presence of two submerged ridges (paleo-strand lines), one between 21 m - 23m water depth and the other beyond 30 m water depth (picked up from an area to the south-western part of the survey area). The top sediment in the near shore zone is dominantly very fine sand up to 12 m water depths. The 12 m - 19m zone is characterised by fine sand while the sediments from the deeper part (> 19 m) are mainly medium to coarse sand and consist of lots of shells and shell fragments. The bottom sediments reflect all types of sand depending upon the recovery below sea floor. The 26 m bathymetry contour is marked by the presence of variegated compact sticky silty sand/sandy silt at more than 50 cm below sea floor. The surface sediment collected from deepest part of the survey area ~ 29 m or more water depth is dominated by fine sand or its admixtures. The nature and character of the sediments observed in the core sediment samples more than 26 m depth indicates substantial oxidation of the sediment, which is possibly due to sub-aerial exposure during the changes in the sea level. However, further studies are required to reveal more details about the shoreline. The water sample is collected at 3 stations from water depths of 17.10 m, 22 m and 25 m. The values of different parameters of water analysis, the percentage of heavy mineral content in 45 sub-samples so far analysed ranges from 1.51wt% to 9.04 wt% with average being 4.69 wt%. Sand samples show dominance of economic heavy minerals like ilmenite, sillimanite, garnet, monazite, zircon and rutile in order of abundance. Presence of rounded pebbles of basic rocks within the core sediment samples indicate fluvial source/ buried channel in the area.

AMD

During 2013-14, AMD carried out reconnaissance survey (302.62 sq km) and detailed survey (14.45 sq km) in coastal tracts and inland area, in parts of Andhra Pradesh, Kerala, Odisha and Tamil Nadu for delineating the potential heavy mineral (HM) concentrations:

(i) Bajarkot-Brahamapur tract, Ganjam district, Odisha records THM ranging from 0.67 % to 56.27 percent.

(ii) The four inland red sediment occurrences exposed between Patsonapuram-Agastinuagan, Ganjam district, Odisha records THM ranging from 2.01% to 57.31 percent.

(iii) Swarnamukhi River Confluence-Kothapatnam tract, SPSR Nellore district, Andhra Pradesh records THM up to 1.55 percent.

(iv) Vaipar-Vembar-Naripaiyur tract, Tuticorin and Ramanathapuram districts, Tamil Nadu records THM% of 5-15 percent.

In addition to reconnaissance surveys, a detailed survey was carried out in (a) Malikipuram, East Godavari district, Andhra Pradesh and (b) Chavara, Kerala.

PLATINUM GROUP OF METALS

GSI

In Andhra Pradesh, reconnaissance stage investigation (G-4) was carried out in Chimakurthi Igneous Complex in Prakasam district to delineate the PGE potential zones. The quantum of exploration work accomplished includes Large-Scale Mapping (1: 12,500 scale) of 85 sq km area, pitting and trenching of 80 cu m and collection of 80 pitting and trenching, 120 bed rock samples, 20 petrological samples, 20 petrochemical samples, 15 SEM samples, 15 EPMA samples and 19 ore microscopy samples. Litho packages observed are Khondalite Group consisting of quartzite and garnet-sillimanite-cordierite-K-feldspar-quartz gneiss, granulite and meta-pelite. Chimakurthi Igneous Complex consisting of pyroxenite, leucogabbro/ norite, gabbro/norite, nepheline synenite and quartz monzonite and Peninsular Gneissic Complex comprising of hybrid granite gneiss/grey migmatite. EPMA study of sulphide minerals of Chimakurthi Igneous Complex indicates presence of pyrite, pentlandite and chalcopyrite. Chrome spinels are also present in stream sediments. Out of 50 stream sediment samples collected during 2012-13, two samples gave anomalous values of REE 753.77 ppm & 1,866.71 ppm.

In Arunachal Pradesh, reconnaissance stage investigation (G-4) was carried out to search for PGE and gold mineralisation in mafic-ultramafic suites of Anjaw, Lohit and Lower Dibang valley districts. An area of 42 sq km was covered by Large Scale Mapping (1: 12,500) along with collection of 31 BRS. In the study area, rocks of Tidding and Yang Sang Chu formations of Dibang Group are exposed. The Yang Sang Chu Formation consists of garnetiferous graphitic phyllite, schist and schistose amphibolite. The Tidding Formation, a low-grade volcano-sedimentary sequence conformably overlies the Yang Sang Chu Formation and comprises chlorite schist, crystalline limestone and serpentinites. Close to the contact with the limestone, small parallel-oriented shear zones have developed in the serpentinite body, which may be the possible sites for PGE mineralisation. Analytical results of 10 samples for PGE (less than 5 ppb to 15 ppb) and 6 samples for gold (less than 50 ppb) show low value and are not encouraging. Analytical results of the serpentinite indicate that the Tidding serpentinite can be used as flux material in iron and steel industry. Chemical analysis of 50 BRS show value of SiO_2 ranging from 37.73 to 42.5%, MgO from 39.34 to 44.77%, $A1_2O_3$ from 0.17 to 1.06%, CaO from 0.04 to 1.49%, Total FeO from 4.05 to 7.82%, TiO_2 from 0.04 to 1.25%, Na_2O from 0.02 to 5.82%, K_2O from 0.07 to 3.48%, P_2O_5 from 0.05 to 0.54%, MnO from 0.01 to 0.18%.

In Gujarat, reconnaissance stage investigation (G-4) was carried out in ultramafic and felsic rocks near Kanpura and Kengora, Banaskantha district to delineate the possible zones of PGE and REE mineralisation in ultramafic and felsic rocks, respectively. Large-scale mapping (1: 10,000) of 65 sq km area has been carried out. Total 90 GCS, 35 channel /grab sample and 15 PTS were collected. The study area is represented by metasediments of Delhi Supergroup intruded by basic-ultrabasic and granitic rocks. These metasediments comprise calc-silicate, migmatitic paragneiss and quartzite. The basic suite of rocks comprise epidiorite, hornblende schist and intrusive pyroxenite, anorthosite and gabbro. The gabbroic suite of rocks is found associated with the anorthosite, norite and pyroxenite and occurs extensively in the area between Dhanpura and Kengora. Subsequently, the Delhi Supergroup of rocks is intruded by granite of different phases like Sendra-Ambaji, Erinpura granite and still younger dykes belonging to Malani suite. The mineralisation is observed in the layered gabbro as disseminated sulphides and cubes of cupriferous pyrite at various locations around Kanpura and Pindoli. These could be the hosts for PGE. The investigation was closed due to non-availability of forest clearance. Reconnaissance stage investigation *(G-4)* was carried out in and around Ajapur-Vanka-Surela-Rabaran area Banaskantha district to delineate the possible zone of PGE, REE and Cu mineralisation in ultramafic rocks related to Phulad Ophiolite and felsic rocks. Large Scale Mapping (1: 10,000) of 74 sq km area has been carried out. Total 104 BRS+SS, 70 channel /grab samples and 41 PTS were collected. The rocks exposed in the area are hornblende schist/ amphibolites, epidiorite,

pyroxenite and layered gabbro-anorthosite. Sulphide mineralisation has been recorded in pegmatite and metabasic veins intruded within gabbro and in granite mylonite/felsic tuff. The suspected sulphide minerals are chalcopyrite and galena.

In Karnataka, reconnaissance stage investigation (G-4) was carried out for PGE minerals in the mafic-ultramafic rocks of Nuggihalli Schist Belt, Hassan district to delineate the strike continuity of PGE mineralised zone and search for PGE mineralisation in the adjoining area. The quantum of exploration work accomplished includes Detailed Mapping (1: 2,000 scale) of 0.75 sq km area, pitting and trenching of 220 cu m and collection of 220 trench sample, 42 petrological samples, 25 petrochemical samples, 18 SEM samples, 20 EPMA samples and 23 ore microscopy samples. Nuggihalli Schist Belt is an important Archaean greenstone belt (3.3 - 3.1 Ga) comprising dominantly of ultramafic-mafic and subordinate metasedimentary rocks engulfed by Peninsular Gneissic Complex (PGC). The various lithologies are classified as talc-serpentine-chlorite schist (TSC), serpentinite (SERP), talc-tremolite schist (TTS), tremolite-chlorite schist (TCS), gabbroic anorthosite (GA) -anorthosite gabbro (AG) and TVM possibly emplaced into the amphibolite country rock. Base metal mineralisation in the gabbro, TVM and serpentinite occur in the form of disseminations and patches of malachite. Two TVM bands are recorded within the differentiated metagabbro-anorthosite and the contact zone is identified as the target area for PGE mineralisation. At places, metapyroxenite, serpentinite and metagabbro show evidences of shearing and contain sulphide mineralisation in a 3 m wide zone in the form of malachite and azurite in pyroxenite. A total of 15 samples (467 points) were analysed by SEM-EDX. A total of 5 grains of Au-Pt ± Cu (1-3 (ì m) and single relict grain of Pt-Rh (3ì m) have been identified. Few REE phases rich in La, Nd, Ce, Yb and Bi were also identified. Reconnaissance stage investigation (G-4) was carried out in the ultramafic-mafic rocks around Bettadasenahalli, Tirumalapura, Yedegondanahalli areas, Holenarsipura Schist Belt, Hassan district to assess the PGE and Ni-Cr potentiality of the area. The quantum of exploration work accomplished includes Large Scale Mapping (1: 12,500 scale) of 59 sq km area, pitting and trenching of 70 cu m and collection of 45 trench samples, 34 petrological samples, 17 petrochemistry samples and five ore microscopy samples. The Holenarasipur belt comprises meta-ultramafites, metamafites and metasediments of the Sargur Complex and basic metavolcanics with interstratified sediments succeeded by polymictic conglomerate-metapelites and banded magnetite of the Bababudan Group of the Dharwar Supergroup. The Peninsular Gneissic Complex is intrusive into the Sargurs and serves as basement for the Bababudan sequence. Metaultramafites comprise serpentinite, talc-tremolite-chlorite schist, metamafites are amphibolites, anorthosite gabbro, metapelites comprising kyanite-staurolite-garnet-mica-schist, quartzite, autoclastic conglomerate and iron stone. In the studied area, sulphide mineralisation is observed in amphibolites along the fracture planes in the form of chalcopyrite, pyrite, pyrrhotite, pentlandite and malachite, whereas serpentinite shows sulphide in the form of pyrite. Thin chromite band has been observed within talc-tremolite-chlorite schist.

In Maharashtra, reconnaissance stage investigation (G-4) was carried out in north Shiroda in Precambrian terrain of Sindhudurg district to target causative bodies of Ni, Cr, Co anomalies reflected by stream sediment values of NGCM. Large Scale Mapping (1: 10,000) of 102 sq km area has been carried out. Total 96 BRS and eight PCS were collected. Aerial photo interpretation (aerial reconnaisance) of 150 sq km has been carried out. The main rock type exposed in the area is laterite due to the extensive weathering of Dharwarian rocks. The Dharwarian rocks comprise a suite of tonalite-trondjhemite-granodiorite (TTG) gneisses-granitoids-migmatites carrying enclaves of BIF, amphibolites and ultramafites. This forms the basement for a suite of supracrustals (meta-volcanosedimentary package with quartzite and amphibole schists/ metabasalt as an important lithotype/ rocks). Area covered by primary & secondary laterites has been identified. Classification of laterites in relation to its source rock has been made based on physicochemical parameters. The relationship between ultramafic rock (serpentinite) and laterite has been identified. Systematic sampling of the laterites has been carried out. Analytical results of samples (n=96) show that Ni ranges from 10 ppm to 2,480 ppm and Cr ranges from 33 ppm to 5,833 ppm. Reconnaissance stage investigation (G-4) was

carried out in Akeri and Khardewadi areas in Sindhudurg district for preliminary assessment of PGE, Ni and chromium with the objective to delineate the zones of PGE, Ni and Cr and to evaluate its potentiality in the mafic-ultramafic rocks of the Sindhudurg belt. Large Scale Mapping (1:10,000) of 24 sq km area has been carried out. Total 82 BRS and 11 PCS were collected. The gneiss-migmatite rocks containing the dismembered lenticular bodies of mafic-ultramafic suite of rocks of Precambrian age represent the investigation area. About five to six small isolated serpentinite bodies were recorded mainly in the lower slope areas of isolated lateritic plateau. Composite bed rock sample collected from central portion of the main serpentinite body has yielded 1,930 ppm of Ni and 2,336 ppm of Cr. Stream sediment samples of the study area, mainly draining from laterite and some from known ultramafic bodies and laterite gave elevated concentration of Ni (min.-278 ppm/ common-700-900 ppm/ max. 1215 ppm; n=21) and Cr (min.l,500ppm/ common-2,000-6,000 ppm/ max. 1.72%; n=21) suggested that the upper catchment area of Khardewadi-Sadekarwadi lateritic plateau belongs to ultramafic suite of rock. Akeri ultramafic body showed the presence of multiple sulphide phases viz. pyrrhotite-millerite-pentlandite-chalcopyrite. Microprobing confirmed the presence of few PGM (Ir-Os alloy) grains of size 3 to 5 micron in the Akeri ultramafic body. Pentlandite -nicolite-chalcopyrite phase is commonly noted in the serpentinite belong to the Akeri block. Analytical results of three groove samples of laterite developed over ultramafic body (Khardewadi) gave an increasing order of nickel concentration (i.e. 920 ppm -1,915 ppm - 2,095 ppm) and decreasing chrome concentration (i.e. 8,150 ppm - 4,050 ppm - 2,320 ppm) vertically downward with every 1 m sample interval. A silicified mylonitic zone bordering the main Khardewadi ultramafic body revealed the significant nickel values of 466 ppm -1,545 ppm and Cr values of 1,208 ppm - 2,170 ppm. Reconnaissance stage investigation (G-4) was carried out in Deccan basalt in Nandurbar and Dhule districts to locate and assess PGE and gold mineralisation and its potentiality of dykes from Deccan trap terrain. Large Scale Mapping (1: 12,500) of 79 sq km area has been carried out. Total 163 BRS and 9 PCS were collected. Lithologically, the entire area is occupied by the Deccan basaltic flows. A total of 31 dykes were mapped and a total dyke length of over 77 km has been studied from the five blocks. Based on the findings of 2012-13, dykes promising for mineralisation have been identified and systematic sampling has been carried out. Available trace elemental analyses of the samples collected from different blocks in toposheet nos.46 K/1,2,3 & 4 reveal that the dykes (n=113) of the study area have concentration of Co (10-80 ppm), Cu (57-562 ppm), Cr (10-112 ppm) and Ni (11-70 ppm) and Au (<25-78 ppb). Available PGE results of 6 dyke samples collected from topoheet no. 46K/3 reveal PGE value ranges from 7.5 ppb to 40 ppb, with majority having values around 30-40 ppb. SEM-EDX and EPMA studies of selected dyke rock samples of Field Season 2012-13 revealed occurrence of PGE mineral (sudburite-hosted niccolite) in dyke of Vadbare and a gold speck in dyke of Shanimandal.

In Nagaland, reconnaissance stage investigation (G-4) was taken up in Ophiolite belt of Nagaland to search for PGE mineralisation through traverse mapping and detailed sampling. An area of 129 sq km was covered by geological traverses. Total 25 PCS and 21 samples for PGE analysis were collected. The rocks observed are serpentinised peridotite, chromitite, dunite, gabbro and volcanics as part of Ophiolite suites and associated ocean pelagic sediment (OPS) in the form of chert and deep-ocean green and brown clays with balls of greywackes. These tectonite units are surrounded by shale and slaty phyllite of the Disang Formation. Peridotite and dunite are highly serpentinised and specks of chromite are seen in both the varieties. Pods of chromite have been observed at SW of Chokla, NNE of Chipur and Pang village. Malachite stains have been recorded NNE of Wui village in quartz veins within ultramafics and specks of pyrite and chalcopyrite were observed in basalts and ultramafics. The available PGE analytical data of peridotite (3 samples) show total PGE value of 47.5 ppb. Analytical data recorded from peridotite show Cr value ranging from 598 ppm to 3,939 ppm and Ni value from 669 ppm to 2,645 ppm. In basalt Cr value ranges from 48 ppm to 1,033 ppm and Ni value from 39 ppm to 638 ppm. In gabbro Ni value is up to 3,092 ppm.

In Tamil Nadu, a prospecting stage (G-3) investigation for Platinum Group of Elements was carried out in T_1 and T_2 sectors of Tasampalaiyam Block in Sitampundi Complex in Namakkal district. The item was oriented to prove the depth persistence of the PGE mineralisation in the eastern part of Tasampalaiyam Block (T_1 and T_2 sectors) and to evaluate the resource potential of this block. The Sitampundi Anorthosite Complex (SAC) exposes hornblende anorthosite gneiss with bands and lenses of chromitite / chromiferrous meta-pyroxenite, pyroxene granite and amphibolites

within the Bhavani Gneissic Complex. Preliminary investigation (2009-10) for PGE in Tasampalaiyam block led to the delineation of a prominent zone of chromitite and chromiferous metapyroxenite bands for a cumulative strike length of about 2.5 km in T_1 and T_2 sectors of the block. PGE mineralisation is mostly confined to the chromitite and chromiferous metapyroxenite bands/ layers within the meta-anorthosite. A total of 28 boreholes (TH-1 to Th-19, TPH-1 to TPH-9) were drilled in T_1 & T_2 Sector involving 2,916 m of drilling (FS 2012-13 & 2013-14). A total of 12 first level boreholes (TH-1 to TH-12) and six second level boreholes (TPH-1 to TPH-6) were drilled in T_1 sector and these boreholes have intersected bands/layers of chromitite/chromiferous meta-pyroxenite and sulphide-rich zones in anorthosite. A total of 82 core samples collected from six boreholes (TH-7 to TH-12) were analysed and the following PGE mineralised zones were delineated. A total of seven first level boreholes (TH-13 to TH-19) and three second level boreholes (TPH-7 to TPH-9) were drilled in T_2 sector. A total of 81 core samples collected from BH: TH-13,17,18 &19 were analysed and PGE mineralised zones were delineated in boreholes indicate TH-13 & 17 mineralised zones as delineated, indicate Pt + Pd from 0.28 ppm to 2.2 ppm in various boreholes. Ore microscopic studies indicate presence of four major sulphide phases namely, pyrite (FeS_2), chalcopyrite ($CuFeS_2$), pentlandite (NiS) and millerite (NiFeS). The SEM-EDX studies indicate the presence of native platinum, Pt telluride, Pd telluride, Pt+Pd telluride, Pd+Ni telluride, Pt+Pd+Ni telluride, Pd+Au+Ag telluride, Pd sulphide, Ru sulphide, Pt+Rh sulphide, Pt+Rh sulphide, Ru+Os sulphide, Ru+lr sulphide, Ru+Ir+Os sulphide, Ru+Pt+Pd telluride and Pd+Au telluride. A prospecting stage (G-3) investigation for PGE was carried out in Solavanur Block in Mettuppalaiyam mafic-ultramafic complex in Erode district to systematically prove the persistence of the PGE-mineralised zone and to evaluate the PGE resource potential of this block. The Mettuppalaiyam Ultramafic Complex (MUC) is characterised by a group of mafic ultramafic rocks ranging in composition from dunite through peridotite, meta pyroxenite, amphibolite, garnetiferous gabbro, gabbroic anorthosite to anorthosite with or without chromite layers occurring as large enclaves within the Bhavani Gneissic Complex. During Field Season 2012-13, First ten level (30 m vertical depth) boreholes (SL-1 to SL-10) were completed with a cumulative drilling meterage of 929.25 m. Analytical results of 240 core samples (pertaining to borehole SL-1, 2, 3, 6, 7 & 8) yielded Pt value ranging from < 5 ppb to 227 ppb and Pd < 5 ppb to 740 ppb. In field season 2013-14, a total of 1015.1 m drilling has been carried out in seven second level (60 m vertical depth) boreholes (SL-11 to SL-17). All the boreholes intersected meta-pyroxenite and chromiferous meta-pyroxenite. EPMA study reveals the presence of primary as well as secondary PGM's mainly associated with disseminated sulphides (bornite, pentlandite, chalcopyrite). The Primary PGM's are Ru-Os-Ir-Pd-Rh-Fe-S, Cu-Fe-Ni-Ag-Pd-S & Ni-Fe-Pd-Cu-S with Pd value ranging from 3.41 % to 17.24 %. The secondary PGMs were observed near grain boundaries of sulphides and are alloyed with bismuth tellurides as Pd-Bi-Te-Cu-Fe- S, Pd-Bi-Te, Ni-Fe-Cu-S-Pd-Bi-Te, Cu-Fe-Ni-S-Pd-Bi, Ag-Au-Pd-Pt-Cu-Fe-Bi-Te & Cu-Fe-Ni-S-Pd-Bi-Te. Total 11 PGM alloy grains have been identified with grain size varying from 0.5 micrometres to 10 micrometres. Reconnaissance stage (G-4) investigation for Platinum Group of Elements (PGE) was carried out in Solavanur Extension block, Mettuppalaiyam Mafic-Ultramafic Complex in Erode district to prove the persistence of the PGE-mineralised zone in Solavanur Block and to trace PGE-mineralised meta pyroxenite bands in Solavanur Extension Block. The various litho-units exposed are gabbro and its variants, metapyroxenite with/without garnets belonging to the mafic-ultramafic differentiated sequence. The other litho-units found in the area are hornblende-biotite gneiss, dunite, younger pegmatites and quartz veins. Shearing of different intensities is observed in all the rock types. Total 22 discontinuous outcrops of metapyroxenite in the form of patches/ lenses/ thin linear bodies exposed at different levels have been delineated with width varying from 10 cm to a max width of 4 m. Analytical results of 2 petrochemistry samples from metapyroxenite show 3,231 ppm and 2,253 ppm of Cr and 918.9 ppm and 797.9 ppm of Ni. Reconnaissance stage (G-4) investigation for Platinum Group of Element (PGE) was carried out in Karattadipalaiyam-Gopichettpalaiyam-Dasampalaiyam sector Mettupalaiyam Ultramafic Belt (MUB), Erode district with the objective to map all the ultramafics bodies within MUB and to assess the PGE potentiality. During 2013-14, an area of 120 sq km area was mapped on a scale of 1:12,500 along with collection of 200 bed rock samples, 155 PTS from the ultramafics and 32 petrological samples from various litho-units. The litho-units exposed in the area are banded gneiss, biotite gneiss, hornblende-

biotite gneiss (HBG), dunite, peridotite, pyroxenite, gabbro, tremolite-actinolite schist, charnockite, quartzite, amphibolites, K-feldspar rich pegmatoids, granite and quartz veins. A total of nine lenses of ultramafic body have been delineated with size ranging from 60 m to 950 m length and 10 m to 90 m width. Out of these nine bodies, four major ultramafic bodies range in length from 150 m to 550 m and width 30 m to 97 m and five minor ultramafic bodies are less than 150m length and 25 m width. Apart from these nine ultramafic bodies mapped, three ultramafic bodies viz. Sanarpalaiyam - Odathurai eri, Odathurai sluice and Perundalaiyur having 40 m to 400 m length and 2 m to 4.50m width were delineated by trenching. In addition, 24 minor mafic lenses/ bands of gabbroic composition ± garnet are also delineated.

In West Bengal, reconnaissance stage investigation (G-4) was carried out in parts of Bagalia- Sonaijuri -Kashipur-Gopalpur sector Purulia district to search for Ni, Cr & PGE group of elements in mafic-ultramafic rocks and to understand its relation with surrounding CGC rocks. This was taken up as a new item (NGCM spin off) of two-year duration initiated during 2013-14. The work components include 100 sq km of Large Scale Mapping (1: 12,500) supplemented by a quantum of 5 cu m of PT and collection of 50 BRS, 25 PCS and 2 PTS. The area exposes rocks of Chhotanagpur Gneissic Complex (CGC) and is characterised by migmatites, streaky biotite granite gneiss, porphyroclastic granite gneiss, biotite-quartz diorite with enclaves of unclassified metamorphites. The unclassified metamorphites comprise of amphibolite, pyroxene granulite and calc-silicate rocks. Analytical results of eight bed rock samples of mafic/ ultramaftc rocks show Ni value ranging from 51ppm to 632 ppm & Cr value from 110 ppm to1,821 ppm and 05 petrochemical samples show Ni value from 455 ppm to1,033 ppm & Cr value from 1,208 ppm to 2,009 ppm. One BRS from Karunmandi reported Pd value of 320 ppb and Pt value of 75 ppb. Other samples recorded Pd values in the range of < 5 ppb to 20 ppb while Pt values are in the range of < 10 ppb to 68 ppb. Ore microscopic studies indicate presence of nickel sulphide phase (pentlandite as confirmed also by EPMA/Raman Spectroscopy studies) chalcopyrite, pyrrhotite and magnetite in the mafic/ultramafic rocks of Asanbani area. Few scattered grains of silver were also observed.

State Directorate

During 2013-14, DGM, Uttar Pradesh carried out exploration for platinum group of elements near village Dangli-Ikauna, Lalitpur district by mapping on a scale of 1:1,000 in 0.41 sq km area, trenching - 02 nos. - 120 cu m, drilling - 317.8 m in two boreholes and 212 core samples were analysed. Tentative reserves of about 0.01 million tonnes with average grade 0.5 g/t is estimated.

DIAMOND

GSI, continued with its engagement in exploration for diamond during 2013-14.

GSI

In Andhra Pradesh reconnaissance stage (G-4) investigation was carried out for search of kimberlite/lamproite in Koilkonda-Devarakadra Block in Mahabubnagar and Rangareddy districts to locate kimberlite/ lamproite. During 2012-13 & 2013-14, a total of 1,440 sq km area falling in TS 56 H/13 & 14 was covered by reconnaissance survey on a scale of 1: 50,000. An integrated structural lineament map was prepared with the aid of satellite imagery, aerial photographs, toposheet and geological map. A total of 310 stream sediment samples from appropriate trap sites from 2^{nd}, 3^{rd}, 4^{th} and 5^{th} order streams were collected. The heavy mineral study indicated assemblages of magnetite, spinel, epidote, garnet, zircon, amphibole, ilmenite, goethite and hematite which are typical of granitoids and gneiss-migmatite provenance. Total 57 suspected kimberlite indicator minerals (KIM's) have been submitted for EPMA. Among the 34 grains studied under EPMA, ilmenites, one diopside, one spinel, one garnet grain show kimberlite affinity. EPMA data confirmed 16 grains (garnet, diopside, spinel and ilmenite) as KIM's. Garnet is pyrope in composition which have high Mg and falling in the field of G9 garnet field on binary plot of conventional Cr_2O_3 v/s CaO diagram. G9 garnet is lherzolitic origin. Ilmenites have high Mg and are falling in the field of kimberlitic-ilmenite field on binary plot of MgO v/s TiO_2 for kimberlite & non-kimberlitic ilmenite. Diopside is falling on the Cr diopside field for kimberlite xenoliths and xenocrysts on binary plot of Ca/(Ca+Mg) v/s Na_2O. The spinel grains are rich in chromium indicating mantle origin. Reconnaissance stage (G-4) investigation was carried out in Jadcherla-Yeljal Block in Mahabubnagar,

Rangareddy and Hyderabad districts to locate kimberlite/lamproite bodies. An area of 720 sq km by aerial reconnaissance and PGRS (1:50,000) studies and 680 sq km area by REC Survey (1: 50,000) have been covered. Total 148 SSS are collected. The investigation area forms intervening block between Narayanpet Kimberlite Field to the west and Ramadugu and Krishna Lamproite Fields to the east. The area exposes the rocks of Dharwar Supergroup of Archean age and Peninsular Gneissic Complex (PGC)-II of Archean to Paleoproterozoic age. Both acid and basic igneous rocks intrude the above pile of rocks. A lamprophyre dyke having dimension of 50 m x 30 m, located 1.5 km north of Raghavapuram, trending N-S has been recorded. Three kilometres SE of Bodijanampeta, another lamprophyre body of dimension 150 m x 80 m was noticed.

In Chhattisgarh, reconnaissance stage investigation (G-4) was carried out in Raipur Kimberlite Field to search for kimberlite clan rocks in Dhamtari, Kanker and Durg districts to locate kimberlite clan rocks in the granitic basement along the high permeable zones characterised by mafic dykes. Reconnaissance survey of 700 sq km was carried out in parts of Dhamtari, Kanker and Durg districts. A total of 150 stream sediment samples, 20 petrological samples, 20 PCS samples were collected for further studies. Regional reconnaissance was conducted in the priority zone within the mafic dyke swarms. The study area is predominantly covered with granitoids of Paleoproterozoic age. NW-SE to NE - SW- trending basic / mafic / ultramafic dykes were seen within the granitoids. The stream sediment samples were processed through HMS and binocular studies and the heavy minerals were separated. Heavy mineral separation of 40 samples was done. Heavy mineral study reveals presence of indicator minerals such as garnet, spinel and ilemenite. There are nearly 145 mafic dykes present in the study area. The mafic dykes were sampled for petrographic and petrochemical characterisation. The PCS samples were submitted for chemical analysis and further characterisation. Reconnaissance stage investigation (G-4) was carried out in Raipur Kimberlite Field to search for kimberlite clan rocks in Dhamtari and Kanker districts in the granitic basement along the high-permeable zones characterised by mafic dykes. Reconnaissance survey of 700 sq km was carried out in parts of in Dhamtari and Kanker districts. A total of 158 stream sediment samples, 29 petrological samples, 23 PCS samples were collected for further studies. PGRS studies of IRS LISS III data for 700 sq km were carried out. The area is predominantly covered by granite with scattered basic dykes and pink and grey aplitic vein and pegmatite vein. The stream sediment samples were processed through HMS and binocular studies and the heavy minerals were separated. Binocular study reveals presence of indicator minerals such as garnet and spinel. Reconnaissance stage investigation (G-4) was carried out in Mainpur Kimberlite Field to search for kimberlite clan rocks Gariaband district in the granitic basement along the high-permeable zones characterized by mafic dykes. Reconnaissance survey of 700 sq km was carried out in parts of in Gariaband district. A total of 151 stream sediment samples, 21 petrological samples, 21 PCS samples were collected for further studies. Binocular observation indicated the presence of garnet, ilmenite, spinel, zircon and other opaques in the stream sediment samples. PGRS studies of IRS LISS III data for 700 sq km were carried out. The aeromagnetic map pertaining to the area has been received from AMSE wing, GSI. The high magnetic anomalous zones in Chhura-Fingeshwar area have been selected for ground checks. The area is traversed by NW-SE, NE-SW and E-W-trending lineaments with zones of intersecting lineaments. The area is predominantly covered by granite gneisses, amphibolites, sandstone, laterite, mafic dykes and quartz veins.

In Karnataka, reconnaissance stage (G-4) investigation was carried out in Maski Block, Raichur, Koppal and Bellary districts to locate Kimberlite bodies. An area of 750 sq km by Aerial Reconnaissance and PGRS (1:50,000) studies and 754 sq km area by REC Survey (1: 50,000) have been covered. Total 160 SSS were collected. The area under investigation exposes predominantly metavolcanic-rich schistose rocks of Hungund-Kustagi Schist Belts and Kalmagi Layered Ultramafic complex of Dharwar Supergroup of Archean age, Peninsular Gneiss and granites of Neo-archean age traversed by younger gabbro and dolerite dykes. The litho-units of Hungund-Kushtagi Schist belt are represented by amphibolite, metabasalt, pillowed metabasalt, acid metavolcanics, quartz-chlorite-sericite schist and BIF. The litho-units of Kalmagi Ultramafic complex are represented by pyroxenite and anorthositic gabbro. The Peninsular gneiss in this area is represented by hornblende-biotite-granite gneiss. Granitoids are represented in the area by the grey and pink granites equivalent to Closepet granite. Lineaments inferred from remote sensing study trend NW - SE, NNW- SSE and NE - SW. Intersection of lineaments is inferred around

Kalmagi. The study of stream sediment samples revealed that the present area contains heavy minerals such as amphiboles, epidote, garnet, ilmenite, magnetite, pyroxenes, zircon, tourmaline, spinel and sphene. Based on morphological characters some grains were submitted for EPMA analysis. The EPMA results indicated that the grains are of crustal origin. Reconnaissance stage (G-4) investigation in Tawergeri Block in parts of Koppal and Bellary districts was carried out with an objective to search for kimberlites through indicator mineral survey and geological traverses. An area of 720 sq km was surveyed by aerial reconnaissance and PGRS (1:50,000) studies and 720 sq km area by REC Survey (1: 50,000) has been covered. Total 150 SSS and 4 PCS were collected. The studied area exposes rocks belonging to Dharwar Supergroup, Peninsular Gneissic Complex and granites equivalents of Closepet Granite. Basic dykes have intruded these rock types. The unclassified units of Dharwar Supergroup consist of fuchsite quartzite, amphibolite and meta ultramafites. Regional as well as detailed stream sediment sampling was done from available trap sites. Samples were processed for heavy minerals and examined under binocular microscope for kimberlite indicator minerals. The stream sediment samples yielded heavy minerals such as spinel, epidote, garnet, ilmenite, magnetite, zircon, biotite, tourmaline and sphene. A total of 34 grains of suspected kimberlitic affinity such as garnets, spinel and ilmenite were submitted for EPMA. The major oxide composition of these heavy minerals indicated that they are of crustal origin. Reconnaissance stage (G-4) investigation in Nadigaddamalkapur and Turkandoni, Raichur district was carried out with an objective to delineate surface configuration and understand subsurface nature of the recently discovered Nadigaddamalkapur (MNK-2) and Turkandoni (TK-1& TK-2) kimberlite pipes. The Nadigaddamalkapur (MNK-2) Kimberlite is highly weathered, fragile in nature and green in colour. Textural characteristics indicate that it represents diatxeme facies kimberlite. Pitting of 130 cu m and detailed mapping of 0.2 sq km area have been covered over the MNK-2 pipe. Kimberlite indicator minerals like chrome-diopside, garnet, ilmenite and spinel was recovered from the samples. A total of 284 grains collected from Nadigaddamalkapur (MNK-2) pipe were sent for EPMA study. Geophysical survey carried out over the Nadigaddamalkapur (MNK-2) Kimberlite demarcated inferred dimension of 300 m x 200 m with 30 m thick weathered kimberlite. Pitting work demarcated inferred dimension of 140 m x 140 m with 0.5 to 1 m thick black cotton soil. The two Kimberlite bodies (TK-1&2) reported near Turkandoni too are highly weathered giving rise to a greenish clayey material. Pipe TK-1&2 appears like circular body having radius of about 150 m. Pitting work carried out over the TK-1 pipe demarcated inferred dimension of 80 m x 40 m. Kimberlite indicator minerals like chrome-diopside, garnet, ilmenite and spinel were recovered from the samples and submitted for EPMA study.

NMDC

During 2013-14, NMDC conducted exploration for diamond under PL in Rampur-Moutwa area, (9.02 sq km), Panna and Satna districts, Madhya Pradesh by Ground Magnetic Survey, generation and interpretation of magnetic anomaly map, stream sediments sampling from second order stream and grid loam sampling, Gravity Survey and detail studies/refining of geophysical data. First PL renewal application has been submitted on 03.10.2014.

GOLD

The GSI, HGML and DGM, Uttar Pradesh were engaged in the exploration for gold during 2013-14. 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 2013-14 are given in Table - 9.

DECORATIVE DIMENSION STONES

The details of exploration work carried out for granite, sandstone and decorative dimension stones by GSI and State DGMs during 2013-14 are furnished in Table - 10.

Table - 7: Exploration for Gold by GSI, 2013-14

State/District	Location	Details of work done	Results obtained/Remarks
Andhra Pradesh			
Anantapur	Area between Tanakallu & Kandukuru	Mapping, sampling and chemical analysis	Reconnaissance stage (G-4) investigation for gold and associated minerals was carried out to identify auriferous zones in the area. The Kadiri schist belt consists of metamorphosed acid to basic volcanic rocks which are intruded by younger granites, quartz veins/reefs, pegmatite and basic dykes. During 2013-14, Detailed Mapping (1:1,000) of an area of 0.9 sq km has been carried out in the Kottapalle and Kandukuru blocks. A total of 251 bedrock/soil samples, 30 stream sediment sample and 71 PTS were collected along with 75 cu m of trenching and sampling. The Kottapalle block comprises meta-andesite, meta-rhyodacite and hornblende schist intruded by granite & gabbroic/ dolerite dykes whereas Kandukuru block exposes older schistose rocks (metabasic/ amphibolites). The sulphide mineralisation mainly pyrite, chalcopyrite and sphalerite manifested in the form of fine disseminations and veins is noticed in all the rocks of schist belt. The chemical analyses of the samples received so far have yielded >25 ppb to 65 ppb of Au (65 ppb in one sample of quartz feldspar porphyry, south of Kamatainpalle). In the Kottapalle block, the meta-andesite and hornblende schist contact is sheared and sporadic sulphide mineralisation noticed, manifested mostly in the form of pyrite specks. In Kandukuru block, no sulphide mineralisation or wall rock alterations has been noticed. Analytical results of 22 samples for bed rock are received and all the samples have analysed Au<25 ppb. The analytical results pertaining to Kottapalle and Kandukuru blocks are not encouraging.
Bihar			
Gaya	Majhauli-Ajaynagar Ghansura area	Mapping, pitting, and sampling	Reconnaissance stage investigation (G—4) was carried out in volcano-sediments, volcanics and associated plutonic rocks around Majhauli-Ajaynagar-Ghansura area for identification of auriferous zones for follow up probing. The investigation involved Detailed Mapping (1: 1,000) coupled with drilling of 750 m and sampling. The area exposes rocks belonging to Chhotanagpur Gneissic Complex and Rajgir metasediments. Total five boreholes NB-01 to NB-05 have been completed. All the boreholes intersected sulphide mineralisation of variable thickness. The sulphide minerals found include pyrite, arsenopyrite, covelite, pyrrhotite and chalcopyrite.

(Contd.)

Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Jamui	Jhajha-Jamui Shear zone, NE of Sono area	Mapping, pitting and sampling	Reconnaissance stage investigation (G-4) was carried out along and adjoining Jhajha-Jamui Shear Zone at northeast of Sono area to assess the potentiality of gold and associated basemetal mineralisation. The work carried out includes Large Scale Mapping (1: 12,500) of 100 sq km followed by PT and sampling. The area exposes rocks belonging to Munger Group and Bihar Mica Belt/ Chhottanagpur Gneissic Complex. Large-scale mapping has established the manifestation of mineralisation in the form of disseminated sulphides, ferruginous encrustations, limonitisation within grunerite quartzite and amphibole-bearing ferruginous quartzite. The sulphides include specks and grains of pyrite and arsenopyrite. Analytical results of 22 BRS samples have yielded anomalous gold values up to 112 ppb.
Jharkhand			
East Singhbhum	Bhitar Dari-Hakegora area	Mapping pitting and drilling	Reconnaissance stage investigation (G-4) was carried out to assess their gold potentiality. The investigation involved Detailed Mapping (1: 1,000), geophysical survey (SP & IP), PT and sampling. Detailed Mapping covering an area of 0.4 sq km has been carried out. A total of 160 geochemical samples, 60 P&T samples were collected. The area exposes rocks of Iron Ore Group (IOG) which occur as a thick volcano-sedimentary pile with a number of others igneous intrusives and extrusives. Disseminated sulphide mineralisation in the form of pyrite & chalcopyrite grains and malachite stains with suspected gold mineralisation is noted within the quartz veins and veinlets traversing the phyllite/ tuffaceous phyllite unit.
Ranchi	Sindauri-Ghanshyampur area	Drilling, pitting and sampling	Prospecting stage investigation (G-3) was carried out to assess their gold potentiality. The investigation involved Detailed Mapping (1:1,000) coupled with drilling along with PT and sampling. The area exposes metasediments of Singhbhum Group, rocks of Chhotanagpur Gneissic Complex and volcanic rocks of Dalma Group. A total of 839.55 m of drilling has been accomplished in four boreholes. Total 47 mineralised zones were intersected with a total cumulative width of 270.35 m. The sulphide mineralised zones intersected in boreholes comprise stringers of arsenopyrite, pyrrhotite, pyrite, chalcopyrite along with suspected gold grains.

(Contd.)

Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Sareikela-Kharsawan	Largadih-Balidih block	Drilling, Pitting and sampling	Prospecting stage investigation (G-3) was carried out for gold to assess the gold potentiality. This was a new item initiated during 2012-13 as a follow up of request received from DMG, Jharkhand and continued in 2013-14. The investigation involved drilling along with PT and sampling. The area exposes Dalma volcanics and metasedimentaries of Singhbhum Group. A total of 40 geochemical samples, 40 P&T samples were collected. A total of 723.05 m of drilling has been accomplished in four boreholes. The mineralised zone intersected between 21.35 m to 170 m in various boreholes. The sulphide mineralised zones intersected in boreholes comprise dissemination and stringers of pyrite, arsenopyrite, chalcopyrite and sphalerite.
Karnataka			
Chitradurga	Dindavara-Lakkavan-ahalli-Malagondan-ahalli block	Mapping, trenching, sampling and chemical analysis	Reconnaissance stage (G-4) investigation was carried out to assess the gold potentiality of the earlier demarcated mineralised zones in the area. During 2013-14, a total area of 0.20 sq km was covered by Detailed Mapping on 1: 1,000 scale and 49 cu m of trenching has been done. Total forty-nine trench samples, six bedrock samples and two PS samples were collected. The main lithounits in the area comprise the BIF/BMC, argillite-greywacke suite of rocks. Gold mineralisation in the block is confined to sheared BIF with quartz-carbonate veins/veinlets having sulphides like pyrite, pyrrhotite and arsenopyrite with minor chalcopyrite. Analytical results of 30 trench samples from Dindavara block show <25 ppb to 53 ppb Au value, at the contact of BIF and argillite. In Malagondanahalli block four BIF bands have been traced for **a** strike length between 25 m and 50 m. So far received analytical results are not showing encouraging gold values.
-do-	Paramanahalli-Hiriyur area	Mapping, trenching, sampling and chemical analysis	Reconnaissance stage (G-4) investigation was carried out to locate possible zones of gold mineralisation in the eastern part of Chitradurga Schist Belt (CSB) and to assess the auriferous potentiality in the area. A total area of 116 sq km was covered by Large Scale Mapping on 1: 12,500 scale and 236 cu m of trenching has been done. Total 202 trench samples, 140 bedrock samples, 16 SSS, 16 PS samples and 15 PCS samples were collected. The area exposes meta-argillite suite of rocks with BIF bands and younger dykes. The meta-argillites consist of meta-greywackes, chlorite phyllites and metamorphosed marly sediments. In the course of mapping two BIF bands west of Tavandi were identified, in addition to the bands in 1:50,000 maps. Localised shears are identified along the quartz veins. The sheared contact of argillite and BIF band show intense carbonitisation and silicification. Presence of discontinuous alteration zones and sulphide-rich zones indicate localised mineralisation.

(Contd.)

Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Tumkur	Ajjanahalli Blocks-E & C	Drilling and geochemical analysis	Prospecting stage investigation (G-3) was carried out for assessment of gold mineralisation. In Block- E, a total of 804.30 m drilling has been carried out in seven boreholes (ADEG-14 to ADEG-20). The borehole ADEG-14 has intersected gold mineralised zone of 2 m with an average value of 0.41 g/t (max value 0.70 g/t/ 0.5m) whereas in borehole ADEG-17 the same mineralised zone continues with a width of 4.5 m showing an average gold value of 1.12 g/t (max value 2.10 g/t/0.5m). In borehole ADEG-15 and 16, few encouraging gold assay values indicated a mineralised zone of 1.5 m with an average of 0.24 g/t and 2.5 m with an average of 0.12g/t, respectively. In Block-C, total 747.50 m drilling has been carried out in three boreholes (ACG-11, 12 & 13) and two boreholes ACG 14 and 15 are in progress. Gold mineralisation is confined to sheared BIF with quartz-carbonate veins/veinlets having sulphides like pyrite, pyrrhotite, and arsenopyrite with minor chalcopyrite.
-do-	Gungrupenta South Block	Mapping, trenching and sampling	Reconnaissance stage (G-4) investigation was • carried out for assessment of gold mineralisation. The main litho-units in the area are BIF/BMC, metabasalt and argillite-greywacke of Hiriyur Formation of Chitradurga Group within the Dharwar Supergroup. In this block (G-4) exploration is being carried out by detailed mapping (1: 1,000 scale), trenching and bedrock sampling. Total six parallel to sub-parallel BIF bands having a strike length of 6,800 m and average band width of 2 m to 15 m have been established by Detailed Mapping and trenching. Gold mineralisation in the block is confined to sheared BIF with quartz-carbonate veins/ veinlets having sulphides like pyrite, pyrrhotite, and arsenopyrite with minor chalcopyrite. The analytical results for 200 samples yielded gold value up to 0.3 g/t/lm in trench samples and 0.6 g/t/lm in BRS.
-do-	Dodbanakunte-Ramanahalli area	Mapping, trenching and analysis	Reconnaissance stage (G-4) investigation was carried out for assessment of gold mineralisation. A total area of 65 sq km was covered by Large Scale Mapping on a scale of 1: 12,500 and 105 cu m of trenching has been done. Total 88 trench samples, 100 bedrock samples, 13 PS samples and 10 PCS samples were collected. The area exposes rocks of Peninsular Gneiss, Vanivilas Formation and Hiriyur Formation of Chitradurga Group of Dharwar Supergroup. The litho-units comprise Fe-Mn chert/phyllite, banded ferruginous chert (BFC), dolomitic limestone of Vanivilas Formation, metavolcanics (metabasalt) and volcano-sedimentary rocks (BIF band and phyllite) of Hiriyur Formation. The BIF is represented mainly by banded hematite quartzite (BHQ) and banded hematite chert (BHC). A total of 12 BHQ bands were delineated in the area. Out of 12 bands, five bands are important, as they are sulphidic/carbonate facies with quartz veins and having a total of 25 LKM strike length. Sulphide phases are pyrite, pyrrhotite and arsenopyrite. Partially received analytical results for the trench/ bedrock samples have indicated Au values ranging from 115 ppb to 135 ppb.

(Contd.)

Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Kerala			
Thrissur	Anappara area	Mapping and sampling	Reconnaissance stage (G-4) investigation was carried out around Anappara area to delineate mineralised zones for gold and copper. A total area of 42 sq km was covered by Large Scale Mapping on a scale of 1: 12,500. The mapped area is predominantly covered by charnockites with elongate bodies of alkali granites and associated pegmatites, diorite and lamprophyre dykes. Quartz-anhydrite-magnetite-sulphide veins and quartz-carbonate-sulphide veins associated with the alkali granites are present at several places. A total of 85 bedrock samples have been collected mainly from the anhydrite-sulphide-bearing zones and quartz-carbonate-sulphide zones. Soil sampling on 250 m x 50 m grid is being carried out over Muttikkal and Anappara areas to cover the sulphide-bearing veins. A total of 45 stream sediment samples have been collected for major, trace and REE geochemistry of the associated rocks.
Madhya Pradesh			
Betul	Amla, Bel Nadi, Jambara, Sonatalai etc.	Mapping, sampling and analysis	Reconnaissance stage investigation (G-4) was carried out for delineation of auriferous zones for follow up probing. The work carried out includes Large Scale Mapping (1: 12,500) of 100 sq km followed by 400 bed rock and 175 stream sediment sampling. The area exposes rocks belonging to Proterozoic Betul belt with outliers of Deccan basalt. Large Scale Mapping has established incidence of disseminated sulphide mineralisation in foliated rhyolite, metabasics (amphibolites) and quartz veins. The sulphides include specks of sphalerite, chalcopyrite, pyrite, bornite, covellite and malachite. The part analysis of 97 BRS and 44 SSS received so far doesn't show significant Au mineralisation. The gold values of two BRS from Parsori-Toranwara quartz vein and Ratera Kalan pyroxenite have indicated 70 ppb and 60 ppb Au, respectively.
Katni	Nanhwara-Vilayat Kalan area	Mapping, pitting, trenching, sampling and analysis	Reconnaissance stage investigation (G-4) was carried out for delineation of auriferous zones for follow up probing. Large Scale Mapping on a scale of 1: 12,500 of 100 sq km area and pitting & trenching of 100 cubic metre along with collection of 100 bed rock samples, 15 stream sediments samples and 100 pitting and trenching samples were carried out in Nanhwara-Vilayat Kalan area. The area exposes rocks belonging to Mahakoshal Group comprises of phyllite, quartzite, dolomite, banded/brecciated quartzite, metavolcanics (Agori Formation) and sheared polymictic conglomerate (Parsoi Formation) which are at places intruded by younger quartz veins. The analytical results of 225 samples (including BRS, SSS and PTS samples) collected during 2012-13 indicate gold content of 805 ppb for 1 PTS, 13 samples show Au values ranging from 100 ppb to 180 ppb and rest of the Au values are below 100 ppb. Analytical results of the 43 samples (including 34 BRS, 2 SSS and 7 PTS) collected during 2013-14 have shown Au values below 50 ppb.

(Contd.)

Table - 7 (Contd.)

State/District	Location	Details of work done	Results obtained/Remarks
Odisha			
Mayurbhanj	Barkeram-Chalkadisahi and Champani-Hatia blocks	Mapping and pitting	Reconnaissance stage investigation (G-4) was carried out in Badampahar-Gorumahisani belt to search for potential blocks for gold mineralisation. Detailled Mapping was carried out on a scale of 1: 1,000 over an area of 0.70 sq km to the west of Tilaijhari village. A total of 140 BRS/SS and 40 PTS were collected. The area is occupied mainly by schistose to massive metabasalts, amygdular metabasalt, amphibolite, chlorite-actinolite-hornblende schist, talc-tremolite-serpentine schist with pockets of metagabbro and metapyroxenite. Sulphide mineralisation was noticed in the sheared contact of metabasalt and granodiorite. Besides, the acid volcanics and black chert contain disseminations of sulphides. The sulphides include pyrite, chalcopyrite and occasionally arsenopyrite.
Rajasthan			
Banswara	Jagpura area	Drilling and geo-chemical analysis	Prospecting stage investigation (G-3) was carried out to assess the potentiality of gold-copper mineralisation.Three mineralised zones of 400 m strike length and each with the exposed width from 5 m to 30 m having average gold content of 1.18 ppm were delineated. The drilling in each zone intersected the surface mineralised zones besides some additional zones. The cumulative thickness of sulphide zones intersected in 8 boreholes ranges from 60 m to 114.15 m with total sulphides ranging from 0.5% to 2 %. The sulphide minerals include pyrrhotite, pyrite chalcopyrite and arsenopyrite.
-do-	Gundelapara South Block	Mapping, Sampling and analysis	Reconnaissance stage investigation (G-4) was carried out to delineate potential zones for gold and associated base metal mineralisation for future exploration. Detailled Mapping (1: 2,000) of 0.73 sq km area has been carried out. Total 235 channel samples have been collected. The area exposes rocks belonging to Jagpura Formation of Debari Group of the Paleoproterozoic Aravalli Supergroup comprising impure marble, albite-rich rock, calc-silicate, amphibolite, pegmatite and. quartz vein. Four mineralised zones were identified at the eastern contact of impure marble and albite-rich rock and in the calc-silicate rock on the basis of surface features such as ferruginisation and malachite staining. About 7-10 metre thick two ferruginised impure marble bands are present in the western part of area. The northern band is about 50 m long. Analytical results of channel samples collected from northern impure marble band indicate presence of 7 m thick zone having 0.16 ppm average gold with 0.14% copper. The second band is nearly 550 m long. Analytical results of channel samples collected from the second band indicate presence of 3-m-thick zone with 0.14% average copper at 0.1% cut off. Three patches of ferruginised albite-rich rock having cumulative strike length of about 100 m with 5 m to 20 m width have been observed in the mapped area. Old workings are recorded in the eastern part of the area within impure marble as well as in calc-silicate and also at the contact of these units.

(Contd.)

Table - 7 (Concld.)

State/District	Location	Details of work done	Results obtained/Remarks
Rajasthan			
Banswara, Udaipur and Dungarpur	Areas between Khamera and Devla Pal	Mapping and and sampling	Reconnaissance stage investigation (G-4) was carried out to assess the potentiality of gold-copper mineralisation. Large Scale Mapping (1: 10,000) of 66 sq km area has been carried out. Total 80 BRS, 98 channel samples and 3 PTS were collected. The area exposes rocks of Debari Group of Aravalli Supergroup comprising magnetite-bearing schist, staurolite-bearing schist, quartzite, dolomitic marble and amphibolite with quartz, carbonate and pegmatite veins. Some old workings in association with malachite staining and ferruginisation are recorded from the calc-silicate and carbonate bands present within magnetite-bearing schist. Seven ferruginised/ gossanised zones were recorded.
Uttar Pradesh			
Sonbhadra	Parsoi area	Mapping, sampling, drilling and analysis	Prospecting stage investigation (G-3) was carried out to assess the auriferous mineralised zones belonging to Mahakoshal Group. Large Scale Mapping (1: 12,500) of 36 sq km and Detailed Mapping (1: 2,000) of 0.34 sq km area have been carried out. Total 350 BRS/SS/ channel samples and 23 PTS were collected. A total of 724.95 m drilling has been carried out in six boreholes (PRS-7, PRS-8 & PHA-1 to PHA-4) . Analytical results of core samples of BH-PRS-1 (FS 2012-13) have yielded Au value up to 1.77 ppm. One gold-bearing zone of 1.05g/t x 1.96 m occurring between 147 and 149 m depth has been established in BH-PRS-1. Two samples from BH-PRS-5 have given Au values of 0.170 ppm and 0.15 ppm. Similarly two core samples of PRS-6 have yielded Au values of 0.81 ppm and 0.09 ppm. The analytical results of trench samples in Phaphrakund-Arangi area have given high values of Au like 1 ppm, 1.3 ppm, 1.6 ppm in T-13, 3.2 ppm in T-l l, 2.75 ppm in T-4 and 0.45 ppm in T-8.

Table – 8: Exploration for Gold by HGML and State Directorates, 2013-14

State / District	Location	Agency	Details of work done	Results obtained
Karnataka				
Raichur	Hutti	HGML	Underground mapping -1,892 m on 1:400 scale; trenching - 6 nos - 177.75 cu m; surface drilling - 2,821.8 m (13 boreholes); underground drilling - 919.70 m (18 boreholes); collection of samples 11,787 nos; and exploratory mining - 2,109.05m.	As on 31-03-2014, reserves of gold ore were estimated at 9.21 million tonnes with 5.28 g/t Au under proved and 7.23 million tonnes with 4.83 g/t Au under probable category.
-do-	Hira-Buddini	HGML	Exploratory mining - 290.5 m and samples analysed - 1,484	About 0.541 million tonnes of proved reserves of gold ore with 4.31 g/t Au were computed.
-do-	Uti	HGML	Exploratory mining - 507.10 m and samples analysed - 1,885	Total mineable reserves were estimated at 2.18 million tonnes ore with 2.59 g/t Au.
Uttar Pradesh				
Lalitpur	Girar-Tori-Khutgaon area	DGM	-	In BHQ of Girar block, the probable reserves of 1,687 kg of average grade 0.35 g/t were assessed.
-do	Berwar	DGM	Mapping 1:1,000 - 0.5 sq km; trenching 02 nos. - 132 cu m and chemical analysis - 90	Tentative reserves of gold was assessed at 87.5 kg with an average value of 0.2 g/t
Sonbhadra	Hardi	DGM	Mapping - 1:5,000 -1 sq km; trenching -02 nos. - 120 cum; drilling - 198 m in four boreholes and chemical analysis of 120 samples	-

Table - 9: Exploration for Industrial Minerals by GSI, DGMs and Central/State Undertakings, 2013-14

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Geological Survey of India							
ANDALUSITE							
Uttar Pradesh							
Sonbhadra	Salaidih-Harwariya area	1:25,000 1:12,500	200 91	-	-	309	Reconnaissance stage (G-4) investigation was carried out for andalusite to delineate and assess the andalusite-bearing zones. LSM had delineated 65.14 sq km area of andalusite-bearing phyllite/schist out of total 91 sq km area mapped. These andalusite-bearing phyllite and schist of Parsoi formation of Mahakoshal Group, form a linear ridge in ENE-WSW direction. The andalusite content in phyllite/schist, in general, varies from 15% to 20 % by weight. The chemical analysis of samples viz. residual andalusite crystals collected from surface and streams give average AI_2O_3 content 42%, while the andalusite crystals separated from bedrock by crushing and sieving yielded average 30% AI_2O_3. Scheelite ($CaWO_4$) mineralisation was noted under UV lamp survey in hormfels. Sulphide disseminations (pyrite +few arsenopyrite) are noted in brecciated rock in Ghiwihi area. Different andalusite-bearing bands were demarcated on map based on andalusite content The possible tentative reserve of andalusite is 25.90 MT approx. per 1 m depth for an area of 67.99 sq km The possible andalusite placer reserve calculated is 0.16 million tonnes approx. for average gravel bed thickness of 1.75 m and area covered by residual/ float deposit is 0.34 sq km.

(Contd.)

Table - 9(Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
APATITE							
West Bengal							
Purulia	Lanka-Parbahal area	-	-	08	384.15		Prospecting stage investigation (G-3) for apatite and associated minerals in the apatite-magnetite rocks was carried out to assess the resources of apatite and associated REE-RM. The investigation was carried out involving drilling, PT and sampling. The study area exposes rocks of Chhotanagpur Gneissic Complex. Out of eight boreholes, only one borehole intersected 1 m thick mineralised zone between 12 and 13 m depth.
GRAPHITE							
Madhya Pradesh							
Betul	Tikri, Gauthana and Chiklar areas	1:2,000	-	04	464.40	-	Prospecting stage investigation (G-3) was carried out to evaluate the extent and potential of graphite mineralisation. The investigation was carried out involving Detailled Mapping on 1: 2,000 scale coupled with drilling. The various litho associations of the area include Archean-Proterozoic gneisses, polydeformed supracrustals and a variety of minor intrusives. The graphite-bearing zones were hosted in quartz mica schist, which forms a part of the supracrustals and occurs as enclaves within the Betul gneisses. The southern band which has proved graphite mineralisation for a strike length of 700 m. Thickness of the mineralised zones varies from 6.85 m to 29.69 m, continuing up to 45 m vertical depth and fixed carbon content varies from 3.30 % to 15.71 %.

(Contd.)

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
LIMESTONE							
Andhra Pradesh							
Cuddapah & Kurnool	Area between Kolimigundla and Jamalamadugu	1:12,500	91	-	-	202	Reconnaissance stage investigation (G-4) was carried out to delineate the cement-grade limestone. The Narji Limestone Formation of Kurnool Group is the dominant lithology observed in the area disconformably underlained by Gandikota Quartzite of Cuddapah Supergroup and conformably overlain by Owk Shale which is in turn overlain by plateau quartzite of Paniam Formation. In the studied area limestone is exposed along 18 km long and 60m wide canal with vertical thickness of 12-15 m with approximate 2-6 m overburden. Analytical results of 92 BRS of bedded massive limestone show high CaO% (average 44.18%) and corresponding low SiO_2% (16.16%). The massive limestone is cement grade in nature.
Guntur	Areas between Mittagudipadu-Goli and Jettipalem	1:5,000	09	33	1650	87	Prospecting stage investigation (G-3) was carried out to assess the potentiality of limestone. Litho-units belonging to Narji Formation of Kurnool Group viz. 1) Lower purple limestone, 2) Middle massive limestone and 3) Upper flaggy limestone are exposed in the area. Core and DTH drilling revealed that the thickness of massive and variegated limestone units which progressively increases from west to east and north-eastern part of the area is about 18 to 25 m. The analytical results in respect of massive/ variegated limestone are encouraging and the deposit may be proved useful for the development of cement industry in the area.

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Nalgonda & Guntur	Western part of districts	1:12,500	98	-	-	201	Reconnaissance stage investigation (G-4) was carried out to delineate the cement grade limestone in the area. In the studied area the Narji Limestone is lying over the Banganapalli Quartzite and shale. Thickness of the bedded limestone is < lm to ~1.5 m near the contact with shale and the thickness increases towards south. Thickness of the massive limestone is generally 1 to 5 m near Mudimanikyam and it ranges more than 5 m at places. The analytical results of 62 BRS, 8 PCS and 2 PTS show high CaO% (42% to 49.18%) and these are of cement grade to marginally cement grade in nature due to variation of other oxides.
Arunachal Pradesh							
East Siang	-	1:12,500	73	-	-	82	Reconnaissance stage investigation (G-4) was carried out in to delineate the economic potentiality of limestone/ dolomitic limestone along the eastern continuity of western limb of Siang antiform. The rocks in the study area comprise purple/grey quartzites of the Miri Formation and limestone bands with intercalation of purple/ pink shales/grey shales of Dalbuing Formation. Minor bands of limestone were observed within the quartzites of Miri Formation. The entire litho package of Dalbuing Formation has been divided into four types on the basis of lithological and associated characters.

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
West Siang	Daba Gamlin area	1:12,500	45	-	-	104	Prospecting stage investigation (G-3) was carried out to assess the potentiality of limestone. The area exposes quartzite, phyllite, carbonaceous phyllite, with patches of garnetiferous mica schist, graphite schist and carbonate bands of Khetabari Formation of Bomdila Group. Five discontinuous dolomitic limestone bands having a general strike of NE-SW with moderate-steep northwesterly dip, occur within carbonaceous phyllite. The outcrop width varies from 8 m - 50 m over variable strike length of 50-300 m. Three carbonate caves SW of Daba Gamlin were observed. The openings vary from 4-6 m and cave is branched inside. The walls as well as floor bear dark grey fine grained dolomitic limestone. Developments of numerous stalactites and stalagmites have been observed within the cave.
Himachal Pradesh							
Shimla & Mandi	-	1:50,000	300	-	-	100	Reconnaissance stage investigation (G-4) to delineate and assess the quality of limestone/ dolomite bands in different members of Shali Group for use in cement, fertilizer, poultry grit and glass industries. PGRS studies and LSM have been carried out. In the studied area rocks of Shali Group are exposed. Shali Group is predominantly comprises carbonate rocks with subordinate purple, olive green, grey phyllitized shale partings and white and pink/ purple quartz arenite.
		1:12,500	110	-	-	-	

(Contd.)

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Meghalaya							
East Khasi Hills	Mawlong-Ishamati block	1:5,000	1.20	02	65.40	17	Prospecting stage investigation (G-3) was to assess the potentiality of limestone along the western continuity. The main litho-units observed in the area are Upper Sylhet limestone of Sheila Formation and splintery shale of Kopli Formation. All the boreholes intersected boulders of limestone.
Jaintia Hills	Larket block, Litang valley	1:5,000	1.40	02	140.60	19	Prospecting stage investigation (G-3) was carried out to explore limestone resources in the peripheral area of the Litang valley limestone deposit. Geologically the area exposes the middle Tertiary sedimentary sequence comprising Kopili and Sheila formations of Middle to Upper Eocene age and recent to sub recent alluvium. The Sheila Formation is represented by nummulitic limestone and the Kopili Formation by shale and ferruginous nummulitic argillaceous limestone/marl. The borehole JNLK-1 intersected 79.08 m thick limestone between 6.84m to 85.92 m depth. Analytical results of 7 grab samples collected from the limestone ridge show an average CaO 50.75%, Fe_2O_3 0.21%, MgO 0.81% and SiO_2 3.51%. The analytical data indicate chemical grade limestone.

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Rajasthan							
Jaisalmer	Minyun-ki-Dhani, East Block -A	1:5,000	2.50	09	443	-	Prospecting stage investigation (G-3) was carried out for low-silica SMS-grade & LD-grade limestone. The area exposes scattered outcrops of calcrete, ferricrete, gritty ferruginous sandstone, gritty weathered sandstone and foraminiferal limestone. Drilling has been established for 25 m to 30 m thickness of limestone with CaO ranging from 48% to 54%, which qualifies for cement grade, the SMS grade has to be ascertained after the decrepitating test is performed.
-do-	Sabbu-ka-Toba Block-A	1:5,000	2.80	10	452	-	Prospecting stage investigation (G-3) was carried out for low-silica SMS and LD-grade limestone. The area exposes scattered outcrops of hard, nodular impure limestone & gritty ferruginous sandstone/nodular ironstone. The lithology intersected in the boreholes is few metres of loose sand followed by a thick limestone horizon made up of hard, impure chalky limestone, few thin bands of hard & compact limestone & clayey limestone up to a depth of about 30 m, followed by clays up to 50 m. A total 252 core samples from seven boreholes have been submitted for chemical analysis.

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
MAGNESITE							
Gujarat							
Panchmahal	Near Chalvad-Gandhra -Ranjitpura and Wadli areas	1:5,000	3.40	-	-	133	Reconnaissance stage investigation (G-4) was carried out for demarcation of dolomitic limestone band with a focus on investigation for magnesite, near Chalvad-Gandhra-Ranjitpura and Wadli areas to locate magnesite bands within dolomitic limestone. Three variants of dolomite are exposed in the mapped area viz. siliceous dolomite, brownish grey dolomite and tremolite-bearing dolomite. Crystals of magnesite occur as patches in association with talc within brownish grey dolomite. Near Ranjitpura village, 10 m long and 2 m wide alternate bands of rhodonite and magnesite are observed in association with chert vein within this dolomite. The investigation has been closed due to non-availability of forest clearance.
PHOSPHORITE							
Andhra Pradesh							
Kurnool & Anantapur	Area between Ankireddipalle and Owk	1:25,000	122	-	-	324	Reconnaissance stage (G-4) investigation was carried out in the area between Ankireddipalle and Owk for delineating the potential zones of phosphorite. The Owk shales host the phosphatic bands. The phosphatic bands are mainly associated with the khaki-green shale at the interface of khaki-green and variegated shale. Two types of phosphatic bands have been delineated viz. 1. The interbanded phosphatic band occurring between the khaki-green shale and upper variegated shale and 2. Phosphatic bands occurring within khaki-green shale, which are discontinuous and lensoidal in nature. Analytical results of 118 BRS and 18 PTS collected during 2012-13 & 2013-14 show 5.01- 19.08% and 5.6 to 15.1% of P_2O_5, respectively.

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Rajasthan							
Rajsamand	Lal-Madri and Karoli-ki-Dhani areas	1:25/50,000	70	-	-	130	Reconnaissance stage investigation (G-4) was carried out for low-grade phosphorite. Ferruginous chert unit occurring in the form of discontinuous massive parallel bands and as lenses within the dolomitic marble is hosting the phosphorite mineralisation. The general thickness of these bands varies between 5 m and 25 m, whereas the strike length varies between 50 m and 500 m. Based on the Shapiro's kit analysis a zone of 50 m x 5 m with 10 to 12% P_2O_5 has been demarcated.
		1:25,000	100	-	-	-	
		1:5,000	1.5	-	-	-	
-							
POTASH							
Uttar Pradesh							
Sonbhadra	Newari-Barwadih area	1:25,000	90	-	-	343	Reconnaissance stage investigation (G-4) was carried out for potash. The main source of potash is observed in two forms, viz. in bedded form and pelletal form in sandstone of Basuhari Formation. In Semiyan area, potash-bearing glauconite layer with a strike length of 300 m with an average width of 15-20 m was delineated on the surface. Samples from Trench (Tr-1) indicate wt. avg. of K_2O = 4.305% x 10 m. Spot samples analysed for potash from the area range from 4.63% to 6.22%. In Semiyan-Chitikpurwa area, potash-bearing glauconite layer of 40 m strike length with average thickness of 10 m has been delineated. The spot samples indicate K_2O maximum up to 7.02% in transitional facies glauconitic sandstone. I Spot samples from Kurcha area show K_2O value ranging from 5.23% to 6.51%. In the south of Manib-ki-Pahari area, one sample from glauconitic sandstone yielded 6.04% K_2O and seven samples yielded 4.52%, 4.34%, 4.11%, 4.34% 4.52%, 4.36% and 4.11% K_2O. Chemical results of 78 spot samples from glauconitic sandstone indicate K_2O ranging from 0.26% to 6.92%.
		1:1,000	0.42	-	-	-	

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
PYROPHYLLITE							
Uttar Pradesh							
Lalitpur	Karitoran-Tikra area	1:25,000 1:12,500 1:2,000	200 85 0.50	- - -	- - -	226 - -	Reconnaissance stage (G-4) investigation was carried out to delineate and assess the pyrophyllite-diaspore mineralisation. Analytical results of ten samples of quartz-sericite-pyrophyllite schist yielded Al_2O_3 ranging from 20% to 22.36% and 51 samples yielded <20%Al_2O_3.
-							
WOLLASTONITE							
Gujarat							
Banaskantha	Dhanpura-Ghoda area	1:10,000	50	-	-	82	Reconnaissance stage (G-4) investigation was carried out to assess the potentiality of wollastonite and search for other strategic minerals. The study was mainly confined to the contact zone of extensive calc- silicate/gneissic terrain with intrusive granite. During 2012-13, a number of skarn zones have been recorded near the contact of calc-silicate/gneiss rocks and intrusive granites. These skarns are characterised by the presence of wollastonite ($CaSiO_3$), scheelite, powellite, garnet, tourmaline, vesuvianite, calcite, hornblende, felspar, apatite, epidote, quartz, pyrite/chalcopyrite and iron oxides. Two new wollastonite occurrences are identified in Ghoda-Bhameriya area in addition to already assessed deposits in Ghoda-Dhanpura area by earlier workers. During 2013-14, skarn zones have been recorded 1 km SSE & N of Siyawa village. These skarns are characterised by the presence of wollastonite ($CaSiO_3$), calcite, felspar, diopside, tourmaline, amphibole and quartz.The tentative cumulative reserves calculated at 7,98,896 tonnes for the different occurrences of wollastonite.

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Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Gujarat Mineral Development Corporation Ltd							
BALL CLAY & SILICA SAND							
Gujarat							
Bharuch	N/v Amod, Maljipura and Bhuri	-	-	-	-	-	Production of ball clay and silica sand was at 1.27 and 0.76 lakh tonnes, respectively.
Rajasthan State Mines & Minerals Ltd							
ROCK PHOSPHATE							
Rajasthan							
Udaipur	Jhamarkotra Mines	-	-	02	149.5	-	As on 1.4.2014, the balance resources and reserves are placed at 49.39 and 28.754 million tonnes, respectively.
State Directorates of Geology and Mining							
BENTONITE							
Rajasthan							
Barmer	N/v Devka,	1 cm = 500 m	100	-	-	-	Three plots of bentonite each of 2 hect were delineated N/v Devka.
	Pusad and	1 cm = 100 m	05	-	-	-	
	Rajral	1 cm = 20 m	03	-	-	-	
CHINA CLAY							
Kerala							
Kollam	Kanjiracode area	-	-	09	421	-	A tentative resource of 0.73 million tonnes of dull white to slightly greyish sandy clay is estimated over an area of 1.5077 hectares.
CHINA CLAY AND ALUMINOUS LATERITE							
Kannur	Ulloor	-	-	16	376	-	A tentative resource of variegated clay estimated about 13 million tonnes and that of laterite/ aluminous laterite is 7.2 million tonnes.
-do-	Koram	-	-	05	167.5	-	Resources will be computed after completion of the investigation.
-do-	Eramom	-	-	11	223.5	-	Average thickness of clay is about 7 m. Resources will be computed after topographic survey and chemical analysis.
CHINA CLAY/BAUXITE							
Kannur	Vaipiriyam	-	-	02	45	-	The average thickness of clay is about 12 m. Resources will be computed after completion of investigation.

(Contd.)

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
CHINA CLAY/SILICA SAND							
Gujarat							
Kachchh	Tq. Rapar	-	-	198	9,898	-	Resources yet to be assesed.
DOLOMITE							
Chhattisgarh							
Janjgir-Champa	Pachri-Bhalwahi area	1:50,000 1:4,000	120 2.10	- -	1236.65 -	905 -	Total 300 lakh tonnes of dolomite resource estimated (332).
Rajasthan							
Udaipur	N/v Selu, Bansaliya, Sangat and Kaloda	1:10,000 1:4,000	10 01	- -	- -	- -	-
GLUCONITE (POTASH) BEARING SHALE & SAND STONE							
Rajasthan							
Chittorgarh	N/v Abapur, Bhimpuriya and Achalpura	- - -	150 10 01	- - -	- - -	15 - -	The glauconitic shale has low potash value (K_2O-2.13% to 2.49% and Na_2O-0.91% to 2.79%) and have a strike length of about 4,250 m.
GYPSUM							
Jammu & Kashmir							
Ramban	Sildhar area	1:1,000	0.1	-	-	25	Total 25 cu m pitting/ trenching has been done.
Rajasthan							
Hanumangarh	N/v Baramsar, Ramka	1 cm = 100 m 1 cm = 20 m	06 04	- -	- -	12 -	-
LIMESTONE							
Chhattisgarh							
Raipur	Kesla area	1:50,000 1:4,000	76 1.682	33 -	1065.40 -	836 -	Total 586.84 lakh tonnes of limestone has been estimated out of which 562.58 lakh tonnes (333) and 24.26 lakh tonnes (332).
-do-	Tekapar-Kalkasa area	1:50,000 1:4,000	93 1.45	- -	816.50 -	659 -	Total 122 and 46.40 lakh tonnes of limestone resources has been inferred under 333 and 332 categories, respectively.
Sukma	Birsatpal	1:50,000	40	-	-	03	Resources were not estimated
Gujarat							
Junagadh	Tq Una	1:8,000	568	86	2,576	600	Resources were not estimated.
Himachal Pradesh							
Shimla	Ogli area	-	-	-	-	78	Detailed geological mapping is proposed for 2014-15.

(Contd.)

Table - 9 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Jammu & Kashmir							
Rajouri	Kabian area	1:1,000	0.1	-	-	25	Total 25 cu m pitting/ trenching has been done.
Kargil	Matayan Drass	1:1,000	0.1	-	-	75	Total 20 cu m pitting/ trenching has been carried out.
Rajasthan							
Chittorgarh	N/v Anjankhera-Nilod	1 :4,000	04	08	435	141	Reserves will be computed after receiving of analysis results of core samples.
Churu	N/v Asrasar, Telap and Mundra	1 cm = 500 m 1 cm = 100 cm 1 cm = 20 cm	300 10 03	- - -	- - -	12 - -	-
Jaipur & Alwar	N/v Bithloda, Mandha, Bhankri Karoi etc.	-	-	04	404.50	140	Limestone/impure limestone was encountered at various depths.
Jaisalmer	N/v Sam (Rahu-ki-Par)	1:50,000 1:10,000 1:2,000	100 15 05	28 - -	1299 - -	715 - -	Resources of cement grade limestone were estimated at 204 million tonnes.
Nagaur	N/v Harima and Khetolav	1 cm = 20 m	2.25	25	1000	508	Geological reserves of 64.93 million tonnes of cement grade limestone were inferred.
-do-	Block-I-N/v Bhed-Ghodhan Block - II N/v Taras-Charda	1 cm = 100 m 1 cm = 20 m	15 02	21 -	734.50 -	225 -	Geological reserves of 36.67 million tonnes in Block-I and 36.28 million tonnes in Block-II were estimated.
Sirohi	Parts of Tehsil Pindwara	1:10,000 1:4,000	05 02	- -	- -	20 -	About 16 million tonnes reserves of limestone were expected from the area.
Udaipur	N/v Ghasa Palana, Thamla etc.	1:50,000 1:10,000 1:4,000	200 15 1.5	- - -	- - -	45 - -	-
POTASH							
Gujarat							
Kachchh	Tq. Khavda	-	-	-	-	392	Total 392 pits were made for potash exploration.

(Contd.)

Table - 9 (Concld.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
PYROPHYLLITE/SILLIMANITE							
Maharashtra							
Chandrapur	Walni-Khatgaon area	-	-	-	1,039.50	-	So far 3.82 million tonnes of reserves were proved.
QUARTZ, ORTHOQUARTZITE, LIMESTONE, SILICASAND, SOAPSTONE, OCHRE ETC.							
Rajasthan							
Jaipur	Various villages of Jamwa, Ramgarh and Bassi Tehsils	1:50,000	202	-	-	16	Impure limestone/ dolomitic limestone was observed in pits N/v Raori and Chainpura.
		1:10,000	16	-	-	-	
QUARTZITE							
Jammu & Kashmir							
Udhampur	Sudh-Mahadev area	1:1,000	0.1	-	-	25	Total 25 cu m pitting/ trenching has been done.
RED OCHRE, YELLOW OCHRE, QUARTZ & MASONRY STONE							
Rajasthan							
Alwar	Tintpur	1:10,000	10	-	-	12	Quartz veins with cumulative thickness of 10 m and hard & compact quartzite were observed.
		1:4,000	01	-	-	-	
ROCK PHOSPHATE							
Rajasthan							
Udaipur	N/v Bagurwa, Adwas, Ajabara etc.	1:50,000	160	-	-	51	No rock phosphate deposit was located.
		1:10,000	10	-	-	-	
		1:4,000	01	-	-	-	
SOAPSTONE, MAGNESITE, KYANITE ETC.							
Rajasthan	N/v Arjunpura	1:50,000	160	-	-	40	Dolomitic limestone was located at various localities
Ajmer	Kothaj, Makreda etc.	1:10,000	10	-	-	-	
		1:2,000	01	-	-	-	

Table - 10 : Exploration for Granite and Other Dimension Stones by GSI and State Directorates in 2013-14

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Geological Survey of India							
GRANITE							
Jammu & Kashmir	Ladakh Granitoid Complex	PGRS 1:12,500	300 50	300 -	- -	155 -	Three different types of granitic phases have been observed. Fifty four slab samples for geotechnical studies, 26 samples for polishing character, 21 samples for thin section studies and 26 each for REE and whole rock analysis were collected.
LIMESTONE							
Jammu & Kashmir							
Ladakh Region	Zanskar basin	PGRS 1:12,500	300 50	- -	- -	171 -	Samples collected include for polishing character (16), geochemical (106), geotechnical (22) whole rock analysis (25) and paleontological studies (2).
DIRECTORATES OF GEOLOGY & MINING							
CONSTRUCTION MINERALS							
Maharashtra							
Nasik	Around Yeola	-	110	-	-	-	The suitable areas for excavating construction minerals are located around the villages Badapur, Sateli, etc.
DECORATIVE STONE/MASONRY STONE							
Rajasthan							
Jaipur,Sikar and Jhunjhunu	- -	1:10,000 1:4,000	11 5.27	- -	- -	- -	Investigation is aimed to assess marketable and blockable granite/marble areas and to ascertain its suitability as decorative stone/masonry stone.
GRANITE							
Chhattisgarh							
Dantewara	Chingavaram Bhusaras area	1:50,000	25	-	-	02	-
Kanker	Mudpar-Bundeli, Bhanbhera area	1:50,000 1:4,000	270 180	-	-	32	Resources estimated at 8,000 cu m in Mudpar-Bundeli area and 85.5 cu m (334) in Bhanbhera area.
Jammu & Kashmir							
Leh	Khaltsi	1:1,000	0.1	-	-	20	Twenty nos. pitting/ trenching have been carried out.
-do-	Hemishukpachan	1:12,500	20	-	-	10	-
Rajasthan							
Bhilwara	N/v Nareli, Duwala etc.	- - -	110 10 05	- - -	- - -	- - -	Resources were not estimated.

(Contd.)

Table - 10 (Contd.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
Rajasthan							
Jalore	N/v Dhawala	1:4,000	02	-	-	-	Preliminary survey has been carried out to locate the blockable granite.
MASONRY STONE							
Bhilwara and	N/v Khamore	1:10,000	20	-	-	-	Calc-silicate and
Rajsamand	Saroth	1:4,000	4.00 -	-	-	-	amphibolite rocks are
	and Amner						located in the area.
MASONRY STONE, GRANITE, MARBLE,PHYLLITE, SCHIST							
Ajmer and	-	1:50,000	100	-	-	-	Total 55 plots were
Tonk	-	1:10,000	11	-	-	-	delineated of size one hect
		1:2,,000	4.50	-	-	-	each for masonry stone.
MASONRY STONE/PHYLLITE & BASALT							
Jalore	Raniwara	1:10,000	05	-	-	07	Areas suitable for the
	Tehsil	1:4,000	01	-	-	-	masonry stone were mapped N/v Tavidar, Tavidar choraha and Padavi and plots were also delineated.
MASONRY STONE & SAND STONE							
Alwar, Bharatpur and Dhaulpur	-	-	6.75	-	-	08	Total 67 plots of 1-4 hect size were delineated for masonry stone and sand stone.
RHYOLITE							
Barmer	N/v Asada,	1 cm = 500 m	200	-	-	20	Total 35 plots of one hect each were delineated.
	Jasol and	1 cm = 100 m	05	-	-	-	
	Variya	1 cm = 20 m	02	-	-	-	
-do-	N/v Luma,						
	Bisala,	1 cm = 500 m	150	-	-	22	A total of 40 plots were
	Somaniyou-ki	1 cm = 100 m	05	-	-	-	delineated for masonry
	Dhani	1 cm = 20 m	1.50	-	-	-	stone of one hect each.
-do-	N/v Kuship, Hinglaj mata,						
	Kerli pahari,	1 cm = 500 m	250	-	-	36	N/v Thapan total 86 plots
	Indrana,	1 cm = 100 m	05	-	-	-	for masonry stone have
	Thapan etc.	1 cm = 20 m	02	-	-	-	been proposed of one hect each.
RHYOLITE (MASONRY STONE)							
Jaisalmer	N/v Pokaran	1:50,000	150	-	-	12	About 0.25 sq km potential
	Barli etc.	1:1,000	10	-	-	-	area of rhyolite N/v Bukna
		1:2,000	01	-	-	-	and south of Pokaran tehsil were observed.

(Contd)

Table - 10 (Concld.)

Agency/ Mineral/ State/District	Location	Geological mapping		Drilling		Sampling	Remarks
		Scale	Area (sq km)	Boreholes	Meterage		
SANDSTONE (DIMENSIONAL STONE)							
Nagaur	N/v Khari,						
	Goga Nada	1:10,000	25	-	-	08	Preliminary survey shows alternate beds of shale and sandstone SSW of Khari village and sandstone near Goga Nada and Thalunja villages.
	and Thalunja	1:2,000	03	-	-	-	
SANDSTONE, MASONRY STONE & LIMESTONE							
Bundi	N/v Chatarganj,	1:50,000	155	-	-	12	Reserves of masonry stone and limestone are estimated at 80 million tonnes and 0.726 million tonnes, respectively.
	Gordhanpura,	1:10,000	10	-	-	-	
	Chauhada etc.	1:2,000	1.75	-	-	-	
SANDSTONE & RIVER SAND							
Mizoram	Toposheet 84 A/15 NE & NW	1:25,000	180	-	-	-	-
SILICEOUS YELLOWISH LIMESTONE (MASONRY STONE)							
Jaisalmer	N/v Polji-ki	1:50,000	50	-	-	05	Occurrences of yellowish brownish coloured limestone was observed in about 0.50 sq km area and 20 plots N/v Bhinya for masonry stone were delineated.
	Dehri, Bhinya	1:10,000	10	-	-	-	
	Jaga etc.	1:2,000	02	-	-	-	
SPLITTABLE SANDSTONE AND MASONRY STONE							
Jhalawar &	N/v Kham Khera,	1:50,000	150	-	-	-	A total reserves of sandstone in nonforest areas are estimated about 13.725 million tonnes.
Baran	Nanera, Mawasa,	1:10,000	11	-	-	-	
	Pathariya	1:2,000	1.50	-	-	-	
	Lambawar etc.						
SPLITTABLE SCHIST/PHYLLITE							
Dungarpur	N/v Balwara,	1:50,000	50	-	-	13	-
	Mara, Ghata	1:10,000	05	-	-	-	
	etc.	1:2,000	03	-	-	-	